SUPPLEMENT I

INDIAN POINT UNITS 2 AND 3
RISTROPH SCREEN RETURN SYSTEM
PROTOTYPE EVALUATION AND SITING STUDY

Prepared by

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and

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EXECUTIVE SUMMARY

Background

In December 1988, agreement was reached among Hudson River Settlement Agreement parties on the installation of Ristroph screens at Indian Point Units 2 and 3. The Agreement provided for consultation and mutual concurrence among interested parties on the design of the fish and debris return systems for these projects. On March 15, 1989, study plans for the development of the return systems were reviewed with the parties, and in the summer, agreed-upon dye recirculation and conduit design studies were initiated.

Dye studies were conducted at selected sites offshore of Units 2 and 3. Recirculation from sites north of the Unit 2 intake was higher than expected during both full and reduced cooling water flow pumping conditions, and caused uncertainty as to the most appropriate location for the discharge. Additional studies using live fish to determine whether their rate of recirculation would differ from that of the dye were recommended. During winter-time reduced flow pumping, dye recirculation from sites west of the discharge canal at Unit 3 was lowest from a shoreline location. Although recirculation from this site was higher during full-flow conditions, it was selected as the location for the Unit 3 return system discharge because of its lower recirculation during the winter when white perch are abundant and more susceptible to passive transport by water currents.

Conduit design studies were conducted in the clear water of the Verplanck quarry, which allowed direct observation of fish behavior and condition following discharge into collection nets. Results demonstrated that various design elements, including pipe diameters of 6 and 10 inches, lengths from 40 to 250 feet, and operating water volumes from 245 to 1000 gpm, as well as debris in the return flow, did not cause damage to fish. Testing also demonstrated that, with the possible exception of white perch in the winter, a minus 35 foot discharge depth was not detrimental to fish. With respect to white perch, underwater videos documented their attempts to escape the collection net and swim upward following discharge when the water was about 2°C. During warmer conditions (8°C) they swam quietly upon discharge at this depth. The increased mortality of white perch in the cold water appeared to be due to confinement by the nets, and not the return system.

Results of the dye recirculation and conduit design tests were provided to the parties by letter dated July 23, 1990. Comments from the New York Department of Environmental Conservation (DEC) and the environmental groups' consultant, Dr. Ian Fletcher, prompted live-fish recirculation studies and additional return system design evaluations.

In September and October 1990, live fish were released at several locations from which dye had been released north of the Unit 2 intake. Recirculation under full circulating water flow was 36.5% and 14.0%, from 110 feet and 210 feet offshore, respectively. These rates were substantially lower than those for dye (Table i), and declined more sharply with increasing distance offshore than did dye: At 110 feet offshore, fish re-impingement was 41% of dye recirculation under full flow conditions (36.5% versus 89%), while at 210 feet offshore, it was only 26% of that for dye (14% versus 54%). These results suggested that fish recirculation might be, at least in part, a behavioral response, and not simply a passive transport phenomenon.

Table i. 1990 Live Fish and Dye Recirculation Rates (%) from Sites North of the Indian Point Unit 2 Intake during Full and Reduced Flow Pumping Conditions.

Distance OffShore (Ft)	Live Fish	Dye	
	Full Flow	Full Flow	Reduced Flow
110	36.5	89	55
210	14.0	54	32

Results were provided to the DEC and Dr. Fletcher in December 1990. Dr. Fletcher suggested in a January 1991 review that recirculation from the Unit 2 return system might be reduced by about 50% if the discharge was located south of the Unit 2 intake rather than north of it. By letter dated May 10, 1991, the DEC requested further studies to evaluate recirculation from the offshore site north of the Unit 2 intake, the site suggested by Dr. Fletcher, and two sites at Unit 3. Results of these recirculation and return system design evaluations are summarized below.

Part I. Unit 2 Return Line Siting Studies

The potential discharge sites evaluated in accordance with the DEC's May 10, 1991 letter were: 1) the originally proposed site, 2-A, located 210 feet offshore and 145 feet north of the Unit 2 intake, 2) site F-A located 210 feet offshore and 175 feet south of the intake, 55 feet further south than a site suggested by Dr. Fletcher, 3) site 3-B, the Unit 3 return system shoreline discharge site located 275 feet south of its intake, and 4) site 3-A located 60 feet offshore of site 3-B. Two additional sites were also evaluated. One site, 2-B, located 60 feet offshore and 145 feet north of the Unit 2 intake, was considered to be a control site from which recirculation might be high. The other site, F-B, located 60 feet offshore and 175 feet south of the unit 2 intake, was a location to which a return system could be installed relatively quickly, if recirculation from it was acceptably low. Recirculation from the six sites was evaluated during the fall 1991 when the seasonally low river flows and full flow circulating water pumping rates were expected to maximize the potential for "re-impingement". Live hatchery-reared striped bass were used as test fish.

Tidal stage-averaged live-fish recirculation from offshore sites 2-A and F-A near Unit 2 was 3.7%, and 3.0%, respectively, while that from near-shore sites 2-B and F-B was 29.2%, and 14.6%, respectively (Figure i). Contingency

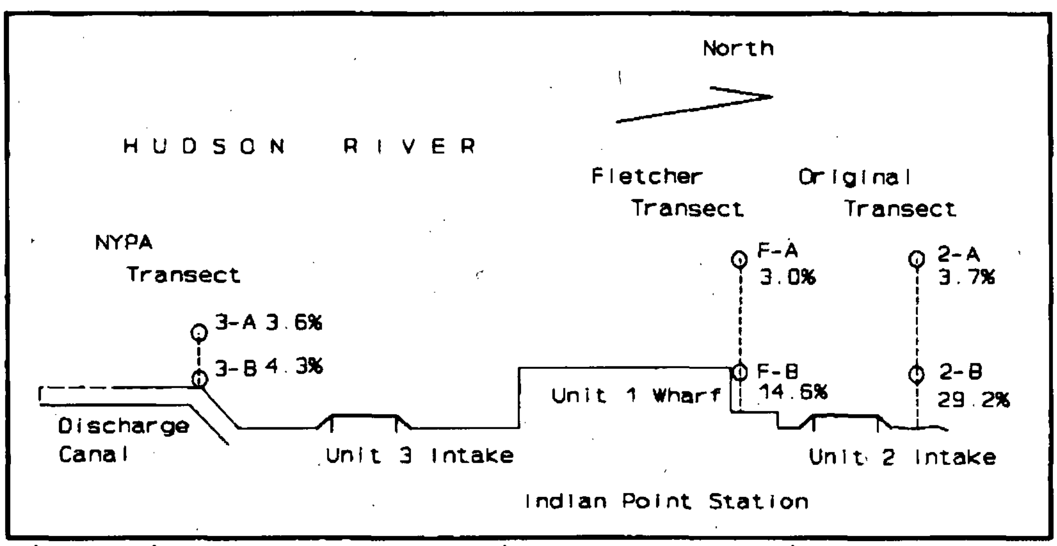

Figure i. Percent Recoveries of Marked Live Hatchery Striped Bass Released at Six Locations at Indian Point Station, Fall 1991.

analyses indicated the presence of location effects in comparisons of recirculation from sites F-A and 2-A, and from F-A and 3-B. However, the range of differences in rates within each of these pairs (0.7 and 1.3 percentage points, respectively) appeared to be so small as to be negligible.

Study results also demonstrated a diminishing difference in recirculation between north-of-intake and south-of-intake locations at the offshore sites at Unit 2 compared to their onshore components. Tide-specific fish recirculation rates from the nearshore sites at Unit 2 supported Dr. Fletcher's projection of an approximately 50% reduction in recirculation from a site south of the intake relative to that from a comparably located site north of it (see Appendix D). However, tide-specific fish recirculation rates from the off-shore sites did not. Recirculation from 2-B was 100% higher that from F-B, while that from 2-A was only 23% higher than from F-A. This and the fact that fish recirculation was substantially lower than that of dye from Site 2-A (see Table i dye; recirculation from site F-A was not evaluated), suggested that both offshore sites may be so close to the margin of the withdrawal zone that the movements of fish released at those points quickly removed them from the influence of passive transport processes. The recirculation of a few fish to the intakes might have been due more their random movements than to transport by water. The same may have been true at the Unit 3 sites. Recirculation from sites 3-A (3.6%) and 3-B (4.3%) near Unit 3 was essentially the same as that from the off-shore sites at Unit 2 (Figure i).

Based on the live fish observations, any one of the offshore sites at Unit 2 or the sites at Unit 3 would be suitable for a return system discharge. However, a 1985 winter-time hydroacoustic survey offshore of Indian Point detected fish movements which followed the direction and rate of tidal flows, indicating that at least some fish were being passively transported. Impingement collections suggested that the fish observed were white perch. If white perch or other species are transported passively by water currents in cold water, the fall 1991 live-fish recirculation rates might not be an accurate indicator of overall annual recirculation potential. Rather, live-fish rates may apply to warmer seasons, while dye recirculation rates might more realistically reflect recirculation in the winter, particularly for white perch.

In order to evaluate the potential influence of passive fish recirculation among the sites, in the absence of winter-time live fish recirculation data, live fish and dye recirculation rates were used along with average monthly impingement rates (1975 - 1990) at Indian Point Unit 2 (Appendix G) to project potential levels of annual recirculation. Hydraulic model data suggested that dye recirculation from F-A would not be higher than from 2-A (which was determined to be 32% at winter flows), and Dr. Fletcher estimated that it might be on the order of 50% of the 2-A rate. However, because it is unlikely that any indigenous Hudson River species of fish is entirely "passive" in cold water, application of dye rates to all species would almost certainly overestimate total recirculation. Accordingly, various assumptions about "winter" recirculation were made as follows:

- Essentially passive fish recirculation is most likely to occur when water temperatures are low. Two "cold water" periods of assumed "passivity" were selected to reflect a range of potential conditions:

  - December - March (projected maximum duration; long-term monthly average water temperature at or below 40° F)

  - January - February (most likely interval; water temperature at or below 36° F)

- White perch recirculation rates from sites 3-A, 3-B and 2-A, for which dye recirculation data are available, were assumed to be reflected by the dye rates during the passive recirculation period. Recirculation rates of other species (e.g. Atlantic tomcod) were assumed to be reflected by live-fish rates during the passive recirculation window.

- Passive white perch recirculation from site F-A, for which dye recirculation rates are not available, may be reflected by the rate projected by Dr. Fletcher, but could actually be lower or higher. Accordingly, a range of recirculation rates, including 25%, 50%, and 100% of the dye recirculation rate for site 2-A, were applied. Recirculation rates of other species (e.g. Atlantic tomcod) were assumed to be reflected by live-fish rates during the passive recirculation window.

Since differences in recirculation rates among sites are important only to the extent that they affect the numbers of fish saved by the Ristroph screen system, adjustments were made to reflect that some of the fish collected by the screens are not returned to the water alive, and that recirculation and re-impingement on the screens, while probably stressful, does not necessarily result in morbidity. In order to evaluate differences in the numbers of fish mortalities due to differences in recirculation among return sites, Dr. Fletcher's mortality/morbidity data (Fletcher 1990) were applied in two steps, as follows:

1). The numbers of fish that might be returned alive to each site after their initial encounter with the screens were calculated. Species-specific survival rates were used when available; for other species, best estimates were derived from the studies. For example, alewife rates determined by Dr. Fletcher were applied to other herrings plus anchovies because these species have relatively similar sensitivities to handling.

2). Since an individual fish can, in theory, be recirculated several times and no re-impingement survival data are available, calculations were made on the assumption that survival during the first recirculation episode was 50% of the survival during the initial impingement, 25% on the second recirculation episode, and 0% on the third iteration.

Table ii presents estimated numbers of all fish combined that may be lost as a result of recirculation from each release site under various assumed conditions. As discussed above, a range of passive recirculation rate values is applied in order to project possible lower and upper bounds for recirculation from site F-A. In addition, data for two possible passive recirculation windows (December through March; January through February) are presented.

Annual percent losses due to recirculation from each site can be calculated as the number of fish lost due to recirculation (re-impingement) divided by the number of impinged fish initially returned alive to the river (Table iii).

Based upon the information available, and the various assumptions made regarding recirculation, it appears that any of the Unit 2 offshore sites or the Unit 3 sites would be suitable return system discharge sites.

Table ii. Estimated Annual Fish Mortalities Due to Recirculation from Four Potential Discharge Sites for the Indian Point Unit 2 Return System.				
Site	Recirculation Rate (%)*		Estimated Numbers (1000) Annual Fish Mortalities	
	Active Fish	Passive Fish (Estimated)	Passive Recirculation Window	
			Dec - Mar	Jan - Feb
3-A	3.6	18	85	62
3-B	4.3	12	65	52
2-A	3.7	32	148	98
F-A(.25)	3.0	8	43	35
F-A(.50)	3.0	16	74	53
F-A(1.0)	3.0	32	145	94

* Estimated recirculation rates for sites 3-A, 3-B, and 2-A are based on winter-time dye recirculation rates; estimated recirculation rates for site F-A are based on 25%, 50%, and 100% of the site 2-A winter-time dye recirculation rate.

Table iii. Estimated Annual Mortality (Percent)* of Fish from Four Potential Return Locations for the Indian Point Unit 2 Ristroph Screen System.				
Site	Recirculation Rate (%)		Estimated Percent Annual Fish Mortalities	
	Active Fish	Passive Fish (Estimated)**	Passive Recirculation Window	
			Dec - Mar	Jan - Feb
3-A	3.6	18	6.4	4.6
3-B	4.3	12	4.8	3.9
2-A	3.7	32	11.1	7.4
F-A(.25)	3.0	8	3.2	2.6
F-A(.50)	3.0	16	5.5	4.0
F-A(1.0)	3.0	32	10.8	7.0

* Percent (%) of impinged fish initially returned alive at Indian Point Unit 2 as a result of recirculation and re-impingement.

** Estimated recirculation rates for sites 3-A, 3-B, and 2-A are based on winter-time dye recirculation rates; estimated recirculation rates for site F-A are based on 25%, 50% and 100% of the site 2-A winter-time dye recirculation rate.

Part II. Unit 2 Return System Design Studies

Following flume and return pipe evaluations (Con Edison and NYPA 1990), the test program was expanded to include fish collection sluices (Figure ii). During the summer 1990, a preliminary design for the complete Unit 2 return

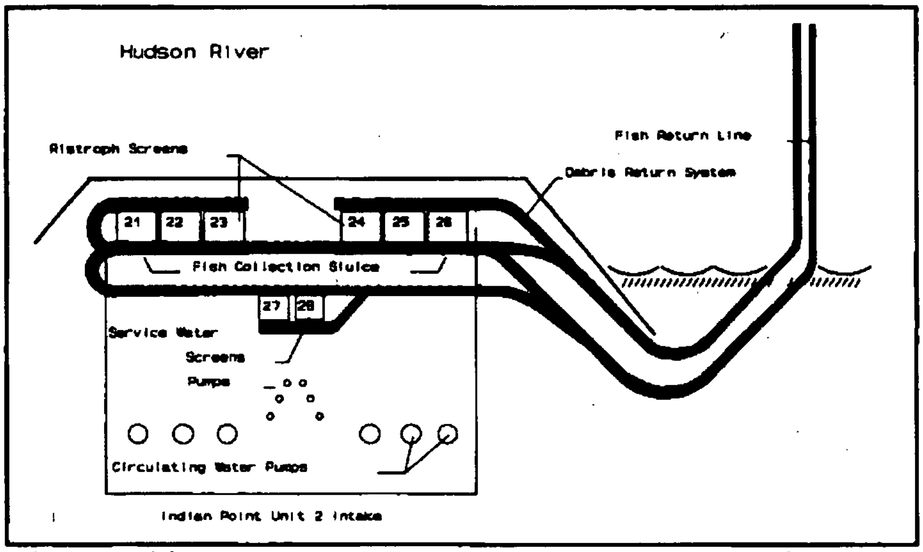

Figure ii. Layout for the Fish and Debris Return Systems for the Indian Point Unit 2 Ristroph Screens. (Extension of return line into the Hudson River is shown for illustrative purposes only.)

system, which included collection sluices, channel bends, elevation changes, the confluence of flows from two channels, and a chamber to vent entrained air from the return flow, was installed at the quarry and tested. Results indicated that the full system did not impose injuries to fish. Survival of golden shiners was 100% except during exposure to a 15°C temperature differential between the surface and the discharge depth when it averaged about 92.5%. Alewife survival was also lower than that observed in earlier tests, a result attributed to cold shock. White perch and striped bass survival rates averaged nearly 95% and 90%, respectively, although these results may be affected by high control fish mortality. Based on the facts that few fish showed signs of damage during these tests, test species experienced high survival rates in earlier studies, and temperature differentials during testing were extreme, it appeared unlikely that the return system was the cause of observed mortalities.

In spring 1991, following receipt of comments from the DEC and Dr. Fletcher, the prototype system was modified for further testing. The return pipe diameter was increased from 10 inches to 12 inches to reduce the potential for blockage by debris, channel bends were smoothed to reduce turbulence, and the return pipe was outfitted with a 30° upward bend at its discharge to simulate the design expected to be installed in the river. In addition, the return pipe discharge was positioned at minus 60 feet, the approximate depth for a discharge if a system were extended about 250 feet offshore of the Unit 2 intake to further reduce potential recirculation.

Fish collection nets for these tests were 60 foot tall cylinders of mesh that extended from the return pipe to the surface to eliminate confinement of fish at the depth of the discharge, a suspected contributor to the mortality incurred by white perch during the 1990 winter testing.

Tests demonstrated that the refined system did not induce damage to white perch, golden shiners, or striped bass, although evaluations with the latter species were limited. Survival among golden shiners was 100%. Survival among both test and control white perch was low, but essentially the same in most tests, suggesting that the return system was not the cause of the mortality observed. Stresses associated with collection (trawling) and handling appeared to be the primary causes of mortality among the species tested.

During testing, surface-acclimated fish, including control fish, made a concerted effort to swim upward when discharged at minus 60 feet. Fish that reached an apparent equilibrium depth swam quietly thereafter. Those that did not tended to settle in the water. This response was in contrast to the relative ease of depth maintenance of most fish discharged at about 35 feet.

In summary, results indicate that the effects on fish of the return system design planned for Unit 2 will be slight, and that effectiveness may be enhanced by placing the discharge at a depth of approximately 40 feet rather than at greater depths.

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INTRODUCTION

In December 1988, agreement was reached among the signatories to the December 19, 1980 Hudson River Settlement Agreement to proceed with the installation of Ristroph screens at Indian Point Units 2 and 3. The Agreement contemplated consultation and mutual concurrence among interested parties on the design of the fish and debris return systems for these projects. On March 15, 1989, an overall plan for the development of the return systems was reviewed with the parties. The plan included two major activities: 1) selection of return system discharge locations from which recirculation to the intakes would be acceptably low, and 2) design of conduits to convey fish to those locations safely. Potential discharge locations were to be selected from existing hydraulic model assessments of tidal and plant cooling water circulation, and then evaluated through dye or marker release/recirculation studies. Designs for two of the three principal components of the return systems were to be evaluated with prototype systems at the Verplanck quarry. These two components were the flume, which would convey fish from the intake deck (elevation 15 feet) to the river (elevation zero feet), and the return pipe, which would convey fish from the flume to the discharge location. The third component, the fish collection sluice, would be tested at Indian Point after the screens were installed.

In 1989, potential return system discharge locations were selected along westerly oriented lines 145 feet north of the Unit 2 intake and 275 feet south of the Unit 3 intake from analyses of cooling water zones of withdrawal (Parkinson and Goulet 1976; Neale 1973). These locations were evaluated by dye release/recirculation studies (Aquatec 1990).

At Unit 2, dye recovery from sites 110 feet and 210 feet offshore were higher than expected under both full and reduced flow circulating water pumping rates (Table 1)

Table 1. 1990 Dye Recirculation Rates (%) from Sites North of the Indian Point Unit 2 Intake during Full and Reduced Flow Pumping Conditions.

Distance OffShore (Ft)	Dye Recirculation Rate (%)	
	Full Flow	Reduced Flow
110	89	55
210	54	32

and caused uncertainty as to the appropriate location for its return system discharge. The following recommendations were offered (Con Edison and NYPA 1990):

"Complete engineering specifications and solicit proposals for construction of a fish and debris return line to discharge at a point approximately 225 feet from the shoreline along a westerly-oriented line 145 feet north of the intake centerline.

Consider tagging studies to determine whether live fish released at various locations along the westerly-oriented line would return to the intakes at rates different from those for dye particles."

In the fall, 1990, live fish release/recovery studies were conducted to address the uncertainty regarding the site for the Unit 2 return line discharge.

At Unit 3, five sites were evaluated along a line extending off-shore of the circulating water discharge canal. Under reduced flow circulating water pumping conditions, dye recovery was lowest (12%) from a shoreline site (Aquatec 1990). The next lowest recovery (18%) was from a site 60 feet offshore. Under full flow pumping conditions, dye recovery from the shoreline site was 24%. However, since the reduced flow pumping conditions were expected to be in effect in the winter when white perch are abundant at the intakes (EA 1989) and when they seem to be passively transported by the water currents (Biosonics 1987), the shoreline site was considered the most appropriate site for the Unit 3 return line discharge. Although dye recovery from an alternate site located south of the discharge canal was 3% (Aquatec 1990) under the reduced flow pumping rate, this site was considered undesirable because it would require an approximately 900 foot return line that would be difficult to install.

Also in 1989, flume and return pipe tests were initiated at the Verplanck quarry. Damage and mortality among white perch, striped bass, golden shiner and alewife were assessed following exposure to a variety of component design and operating considerations including return pipe diameter, length, discharge depth, flow volume, and the presence of debris. Representatives of the environmental parties oversaw the performance of the tests. Conclusions from the studies (Con Edison and NYPA 1990) were as follows:

Fish survival did not appear to be influenced by the diameter of the return system conduit over the range of the conditions (6 inch and 10 inch) tested.

Fish survival did not appear to be influenced by return pipe length up to 250 feet.

Fish survival did not appear to be influenced by water flow volumes, which ranged from 245 gpm to 1,000 gpm, nor to discharge velocities, which ranged from 2 to 5 fps.

Fish survival did not appear to be compromised by the presence of debris in the return system.

With the exception of white perch at winter-time low water temperatures, fish survival did not appear to be influenced by the depth at which they were discharged up to minus 35 feet. During January 1990, observations of white perch discharged at minus 35 feet suggested that, after having been acclimated to shallow water, prolonged entrapment within the collection nets at that depth was detrimental. The behavior of surface-acclimated white perch discharged at minus 35 feet and raised immediately to the surface was comparable to that of control fish held at the surface, and surface-acclimated control fish lowered to minus 35 feet displayed behavior comparable to that of test fish discharged and held at that depth.

The designs for the fish sluice transitions, the flume, and the return pipe, including placement of the discharge at minus 35 feet, appear suitable for application in return systems at Indian Points Units 2 and 3.

Results of the quarry site tests were applied in developing engineering designs for the Units 2 and 3 fish and debris return systems. Unit 3 return system construction plans and a notice of intent to fabricate and install the systems to discharge at the shoreline site were transmitted to the parties by letter dated June 4, 1990. The Unit 3 installation was completed during the fall 1990 refueling outage, and became operational when the unit returned to service in December 1990.

During the development of engineering plans for the Unit 2 return system, spatial constraints dictated the need for a fish collection sluice layout that was different from what had originally been contemplated. Since the Ristroph screens were to be moved to a forward location in the intake bays, a conventional layout for the sluice would block access to the front of the deck. In such a layout the fish sluice would extend as a straight channel from screen 21 through screen 26 at about 4 feet above deck level, and would span the approximately 30 foot access way to the front of the intake between screens 23 and 24. Further, access to the front of the intake would not be possible from either the south end because of the location of wash water and electrical supply systems for the Ristroph Screens, or from the north end because of the location of the fish and debris sluices. In the favored alternate layout (Figure 1), the fish and debris collection sluices for screens 21 through 23 would drain to the south, make 180° turns, and then discharge into existing sluices below deck level that drain

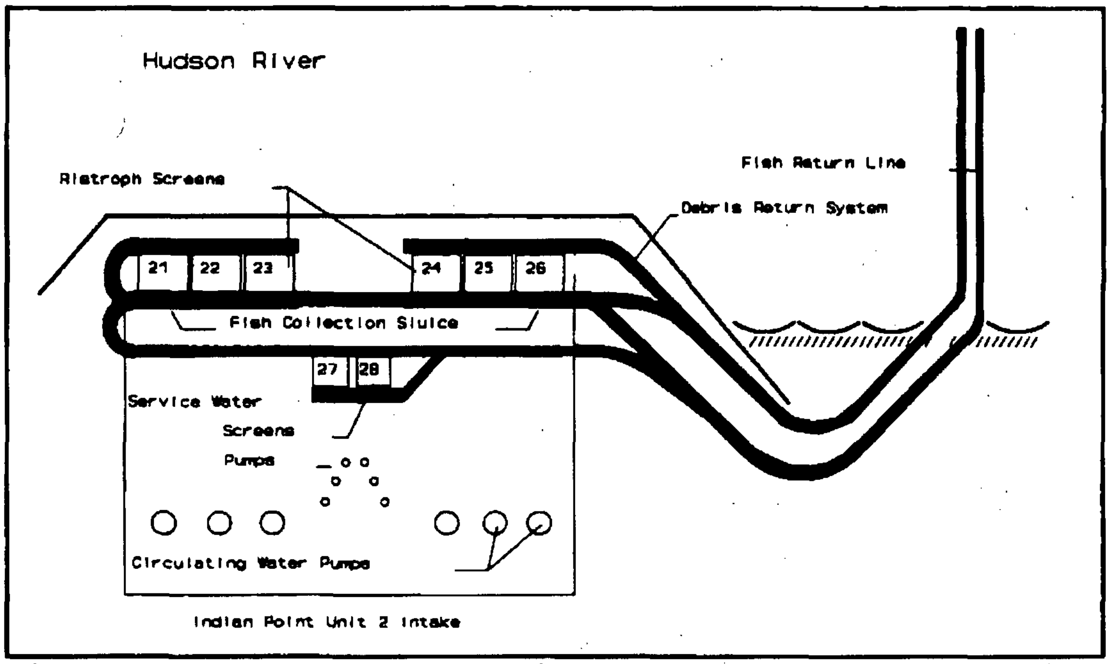

Figure 1. Layout for the Fish and Debris Return Systems for the Indian Point Unit 2 Ristroph Screens. (Extension of return line into the Hudson River is shown for illustrative purposes only.)

to the north end of intake. The sluices for screens 24 to 26 would drain to the north and discharge into the sluices conveying fish and debris from screens 21 to 23. The combined fish sluices and debris sluices would then funnel into their respective return pipes to the river. This arrangement provided the necessary access to the front of the intake structure. However, because of the additional turns required by this design, it was believed prudent to evaluate fish and debris transport through a prototype at the Verplanck quarry. Testing with the prototype began in the summer 1990.

This report presents the results and conclusions drawn from the additional live fish release/recovery studies and the fish collection sluice/return system tests. Part I contains the results of the marked live fish release and recovery studies performed in the fall 1990, and additional tests performed in the fall 1991 at the recommendation of the NYSDEC. Part II contains the results of the sluice tests performed in the summer 1990, and the spring 1991.

PART I. UNIT 2 RISTROPH SCREEN RETURN LINE SITING STUDIES

Section A - 1990 Live Fish Recirculation Studies

Following discussions with the environmental groups' consultant, Dr. Ian Fletcher, and the New York State Department of Environmental Conservation (DEC), tests were conducted to determine whether live fish recirculation would differ from that of dye from locations offshore of Unit 2 (Aquatec 1990). In September 1990, marked live hatchery striped bass were released at sites 110 feet and 210 feet offshore at points from which dye had been released (Figure 2). Releases were made on each of four tidal

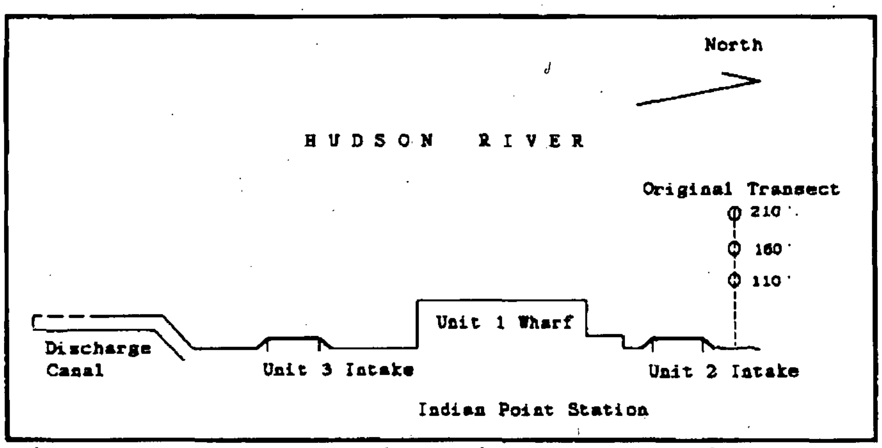

Figure 2. Alternative Fish Return Line Discharge Sites Evaluated by Release of Live Marked Fish in 1990.

currents: low slack, maximum flood, high slack, and maximum ebb. Circulating water pumps at Units 2 and 3 were operating at full flow (summer rates). Live fish releases were not made at the Unit 3 return system discharge location because recirculation potential was considered resolved by the dye studies. Intake screen washings at both units were monitored for 96 hours for the recovery of the test fish. In addition, the efficiency at which these fish could be expected to be collected from the intakes, if recirculation occurred, was assessed by determining recovery rates for marked dead fish (golden shiners) released in front of the Units 2 and 3 intakes.

Marked fish recirculation, adjusted for impingement collection efficiency, was 13.4% and 5.9% from the 110 foot and 210 foot locations, respectively. However, since collection efficiency (6.7%) was much lower than expected, and heavy debris loadings required unscheduled screen washings as well as interruption of Unit 2 circulating water pump operation, uncertainty existed as to the reliability of the results. A decision was made to repeat the test.

During October, live fish were released at a site 160 feet offshore (Figure 2), in addition to the sites at 110 and 210 feet offshore. The Unit 2 circulating water pumps were operating at the full flow rate. However, the Unit 3 circulators were off, since the unit was out of service for refueling. Intake screen washings at Unit 2 were monitored for 96 hours.

The October test was completed as scheduled, although some difficulties were again encountered in assessing collection efficiency. Recirculation, adjusted for the 19.8% collection efficiency, was 35.3%, 15.1%, and 11.1%, from the sites 110 feet, 160 feet and 210 feet offshore, respectively. Since this test was performed while Unit 3 was out of service, an adjustment was made to reflect recirculation as if both units were in operation. This adjustment was made on the basis of the relative distribution of fish collected at the two Units during the September test (see Appendix A). The adjusted percent recirculation from the three release locations was 36.5%, 15.9% and 14.0%, respectively. Though sensitive to the collection efficiency factor, these recirculation values were, nevertheless, substantially lower than those for dye (Table 1). Results (Appendix A) were transmitted to the environmental groups' consultant and to the DEC by letter dated December 5, 1990.

Dr. Fletcher indicated in a review of the live fish recirculation studies (Fletcher 1991), that, although recirculation from 160 feet offshore might not be significantly different from that from 210 feet, the latter appeared to be the best choice of the three sites tested. He concluded that substantial uncertainty still remained as to the most appropriate location for the return lines, and suggested that, based on volumetric flux alone, recirculation from a site 210 feet offshore and about 120 feet south of the Unit 2 intake might be about 50% of that from the originally proposed location 210 feet offshore and 145 feet north of the intake.

In a May 10, 1991 letter, the DEC requested that additional live fish release studies be conducted to evaluate recirculation from four sites: 1) the original proposed site, 2) the site suggested by Dr. Fletcher, 3) the Unit 3 shoreline discharge site, and 4) an alternate to the shoreline site located 60 feet offshore. DEC also requested that engineering and cost assessments be made for installing return lines to these sites. Arrangements were made to conduct the additional live fish recirculation studies, and to prepare the engineering and cost assessments for installing fish return lines to the various areas specified by the DEC. By letter dated August 6, 1991, a proposed scope of work for the live fish recirculation tests was transmitted to the DEC and to Dr. Fletcher. The work scope specified the study design and the locations along each of three transects at which marked live hatchery-reared striped bass would be released. A revised work scope, reflecting comments received from the DEC and Dr. Fletcher by letters dated August 9, 1991 and August 16, 1991, respectively, was transmitted to them by letter dated September 20, 1991. Results of these studies, as well as those of full scale return system tests, are presented here. Engineering and cost assessments are presented under separate cover (see UE&C 1992).

Section B - 1991 Live Fish Recirculation Studies

1. Experimental Design for 1991 Recirculation Tests

Factors considered in the design of the recirculation study included: a) release locations; b) water circulation patterns; c) precision of results, and d) duration of monitoring period.

a. Release Locations

Six release locations were proposed for examination (Figure 3): Four sites, designated as 3-A, 3-B, F-A, and 2-A, had been identified by the DEC; a fifth (2-B) was selected as a "control" from which recirculation was expected to be relatively high; and a sixth site, F-B, represented a location to which a return system might be relatively quickly installed, if recirculation from it proved to be acceptably low. Two of the sites, 2-B and F-B, each at 60 feet offshore, appeared to be well within the river zone supplying water to Units 2 and 3 (Figure 4). Two other sites, 2-A and F-A, each at 210 feet offshore (185 feet west of the face of the intake) appeared to be near the outer margin of this zone. The remaining two sites, 3-A and 3-B, at 60 feet and 0 feet offshore, respectively, appeared to be outside of it.

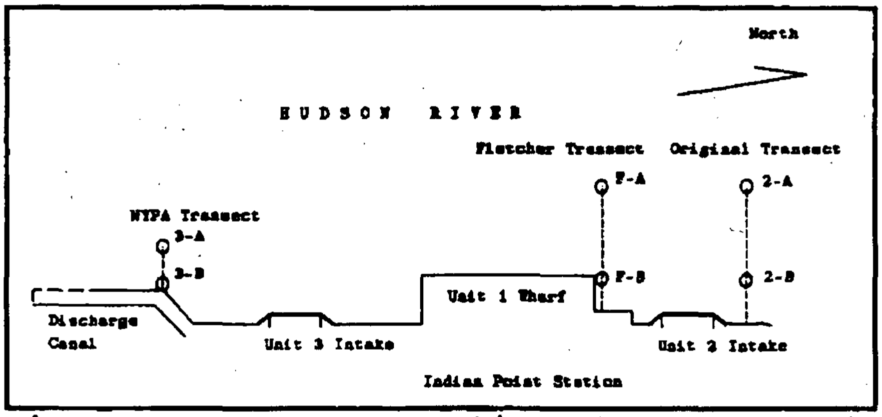

Figure 3. Proposed Locations for Release of Marked Live Striped Bass for Recirculation Assessments at Indian Point Station During the Fall 1991.

b. <u>Water Circulation Patterns</u>

In order to assess tidal effects on fish recirculation, four tidal current stages (low slack, maximum flood, high slack, and maximum ebb) were selected as release times. These stages represented the range of tidal conditions that, presumably, would have the greatest influence on recirculation of live fish. Also, in order to assess the maximum influence of cooling water withdrawal on fish recirculation, the tests were conducted when river flows were near annual lows and when both Units 2 and 3 were operating at full circulating water pumping rates. Dye studies (Aquatec 1990) showed that the highest rates of recirculation occurred when circulating water pumps were operated at full capacity (Table 1).

c. <u>Precision of Results</u>

The precision of the results was expected to be primarily a function of the number of fish available for recovery from each location. In defining an acceptable level of precision, the most relevant reference appeared to be that of Robson and Regier (1964). They proposed as a standard for "research" studies that the 95% confidence limits of a parameter estimate be no wider than +/-10% of

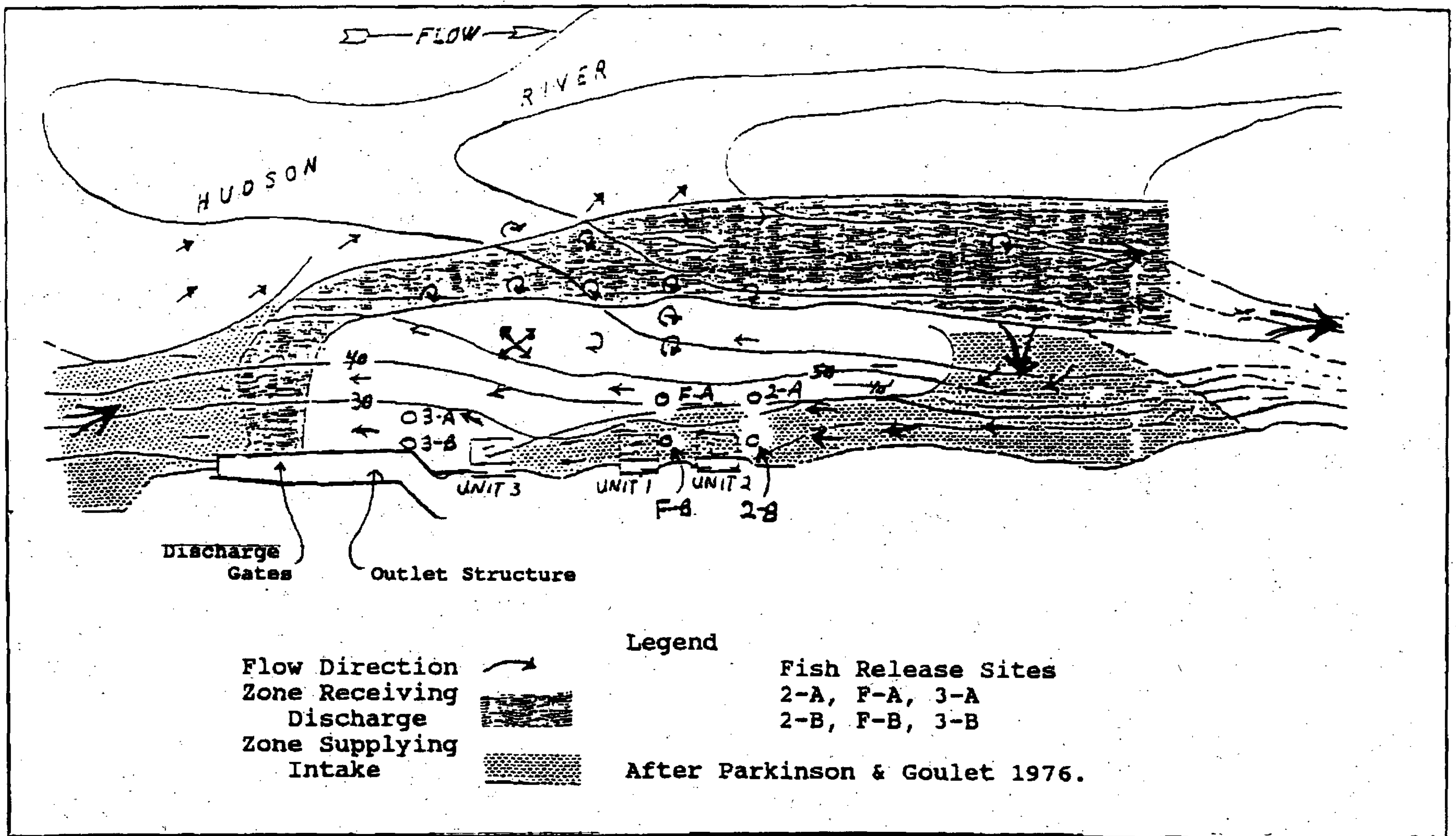

Figure 4. Location of Six Release Locations for Live Fish Relative to Hudson River Zone Supplying Cooling Water and Receiving Cooling Water at the Indian Point Station During an Average Flood Tide.

its true value. Based on Robson and Regier, a 4,000 fish sample would be sufficient to achieve a +/-10% confidence limit at the 95% level of confidence, if the true recirculation rate was 0.08 or greater. For this recirculation study, the major interest was in the number of fish recirculated over a complete tidal cycle. Accordingly, by releasing 1,000 fish per tide stage, the sample size would be 4,000 fish per location.

d. Duration of Monitoring Period

The duration of the monitoring period for recovery of the marked fish was calculated to be approximately 170 hours. This interval reflected the approximate time required for a parcel of water, beginning on a flood tide to be eventually moved downstream by the lowest monthly average freshwater inflow to a point from which it would not return to the intakes on some later flood tide. Conceptually, the interval reflected the approximate time required for fish, moving passively with tidal currents, to be removed from the zone within which exposure to recirculation might be greater than that for the population of fish in the river as a whole. The computations for determination of the duration for the monitoring period followed those outlined by Fletcher (1991), and included the cross-sectional area of the river at Indian Point (16,182 m^2), the long-term lowest average monthly (August) fresh water inflow at Green Island (159 m^3/s; EA 1991), and an adjustment factor of 1.2 to reflect downstream input (LMS 1975). Higher flows during other months of the year would be expected to substantially reduce the duration of tidally-induced exposure to the water intakes at Indian Point (Figure 5).

2. Materials and Methods for 1991 Recirculation Tests

a. Marked Live Fish

Hatchery reared striped bass were selected as the test fish for the recirculation study because of their availability in adequate quantities of a size typical of fish impinged (3 to 4 inches, total length). During the week of September 9, 1991, 24 lots of 1,100 fish each were marked by clipping one or more fins for identification of the six locations and four tidal current stages (Appendix B) at which they would be released. (Although the number scheduled to be released per location per tide stage was 1,000 fish, an extra 100 fish were marked to provide allowances for handling and marking mortality.) Fish were anesthetized with quinaldine to facilitate handling.

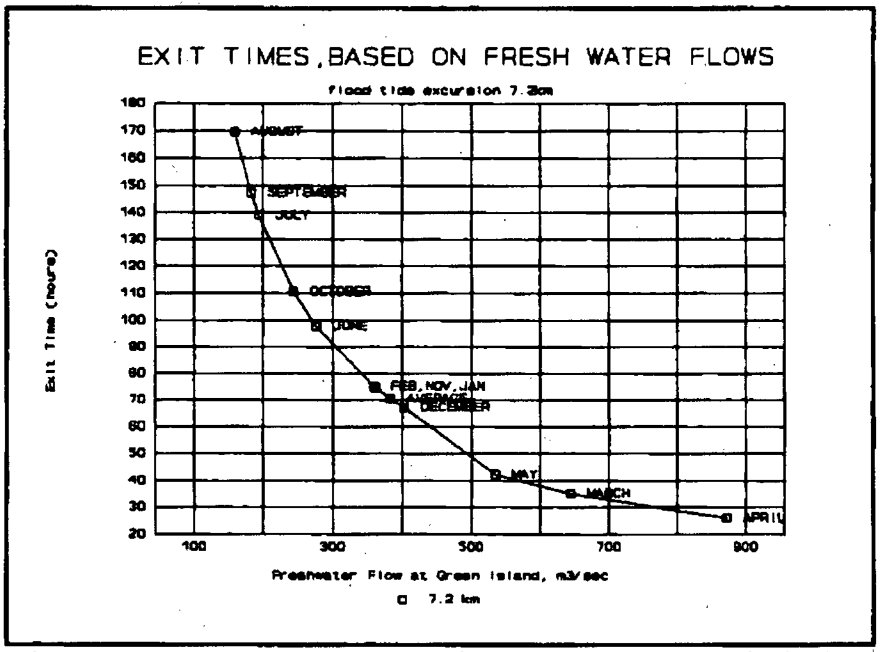

Figure 5. Water Exit Times from the Vicinity of Indian Point Station Based on Discharges at the Green Island Dam, Adjusted for Downstream Inflow.

Following clipping, each lot was placed in a 6 foot diameter by 2.5 foot deep river water-filled holding tank and given a 15 0/00 salt bath for one hour to stimulate mucus production and to prevent infections. Mortality within each lot was assessed 24 hours after tagging. In addition, handling and marking mortality was also assessed after 17 to 21 days (depending on the lot) because the start date for the tests was delayed. Four lots of fish were supplemented with additional fish to offset higher than expected mortalities prior to the release.

b. Collection Efficiency

The efficiency at which released fish might be recovered by the Ristroph screens at Units 2 and 3, if recirculation occurred, was determined in two steps. First, the efficiencies at which live and dead fish would be transferred from the Ristroph screen baskets to the collection sluices were determined. Marked live and dead hatchery-reared striped bass were introduced through a 4 inch diameter by 8 foot long PVC pipe into the screen basket fish rails before their rotation through the high pressure spray wash on the front (river-side) of the screens. Approximately 10 to 15 fish were added per rail; a total of 150 fish were used in each test. Although observations were made to determine if fish missed or observations were made to determine if fish missed or escaped the rail during introduction, the auxiliary mesh on the leading edge of the rails appeared to effectively prevent such losses. None were observed to be lost nor were any collected from the front debris sluices during these tests. Test fish were recovered by screening the collection sluice water flow and by inspection of the sluices at the end of each test.

The second step of the collection efficiency testing included the determination of the rate at which dead hatchery-reared striped bass would be collected from the intake water. These tests were conducted prior to and during the recirculation study. Marked dead striped bass were released at two locations: 1) at the face of the bar screens at the entrance to the intakes; and 2) seven feet inside the intake forebay, approximately five feet in front of the Ristroph screens. Similar tests were not performed at Unit 3 because the common plenum formed by the bar screens at the entrance to the intakes precluded access to individual intake bays. Also, these tests were not performed with live fish at either unit because it was considered likely that some of the fish would escape to the river, making the interpretation of numbers recovered relative to numbers released of uncertain meaning.

Marked dead fish released in front of the bar screens were lowered to the desired depth in a ten gallon container outfitted with a remotely removable cover. Fish released into the forebay were flushed through a 1.5 inch diameter PVC pipe inserted through the bar screen. Although the calculated time for recovery of the fish for releases at both the bar screen location as well as inside the intake bay was approximately 18 minutes for a screen rotation speed of 2.5 feet per minute, the sluices were monitored for one hour. A total of 150 fish were released on each of the tests.

Following initial tests of recovery from in front of the bar screens, approximately neutrally buoyant objects (water-filled ping-pong balls) were released to determine whether the observed losses of fish was due to predation. In one test, 21 balls were released with 150 dead striped bass at a depth of 17 feet at the face of a bar screen. In the second test, 18 balls were released with 150 fish at a depth of 21 feet also at the face of a bar screen. Recoveries were made in the same manner as for the dead fish.

c. Plant Operations

All circulators were to be operated continuously at 140,000 gpm/pump (full flow rate) at both Units 2 and 3 during the test interval. In addition, all Ristroph screens were to be rotated continuously at 2.5 feet/minute at both units during the test interval.

d. Live Fish Release

The release of marked striped bass commenced at the time of the low slack tidal current (Noon) on September 30, 1991. Fish were transported by boat from the Verplanck hatchery approximately one mile to the release locations at the Indian Point Station in ten gallon screen-sided containers within an oxygenated water bath. The fish were released five feet above the river bottom, the approximate depth at which the return line discharge would be placed. Offshore sites were marked with buoys to facilitate their repeated location for releases. The specific mark (fin-clip) for the tide stage and the location of release was recorded and verified by removal and preservation of one fish from each lot released. The quantities of fish released by tag code were determined by subtracting from the numbers marked, the cumulative mortalities plus the single fish removed for tag verification.

e. Recirculated Fish Recovery

Recirculated fish were recovered with nets and screens installed in the sluices during the monitoring period, which was continuous from 12:00 hours on September 30, 1991 through 12:00 hours on October 7, 1991 (168 hours). At Unit 2, the front debris sluice for screens 24 to 26 was monitored separately, while that for screens 21 to 23 was monitored in conjunction with the rear debris sluice into which it discharged. At Unit 3, the front debris sluice was not monitored since collection efficiency results showed only negligible potential for fish to be washed out of the basket rail by the front high pressure wash. Nets and screens were examined hourly, or at more frequent intervals, as necessary. The times and dates of collection of marked hatchery and wild striped bass were recorded. Also, the quantity of blue crabs collected in the screen washings was recorded for assessment of potential predation losses. Screen operation status and water quality parameters were monitored at approximately 12 hours intervals (Appendix C).

f. Data Analyses

The numbers of recaptured hatchery striped bass were compiled, evaluated for potential biases, and then subjected to contingency analyses (Sokal and Rohlf 1969) to determine whether their recirculation was related to the release location and tidal current. An error rate of $\alpha = 0.05$ was used in these analyses. In addition, planned comparisons were made among the release locations 2-A and F-A, 3-A and 3-B, 2-A and 3-B, and F-A and 3-B in response to the May 10, 1991 DEC request. Although these comparisons involved repeated tests with the same data, and accordingly, justified a more restrictive error rate, $\alpha = 0.0125$ (0.05/4; 4 = the number of tests performed), the experiment-wise rate of $\alpha = 0.05$ was used to avoid failure to detect differences that would be significant at the more conventional error rate.

3. <u>Results of 1991 Recirculation Tests</u>

A total of 2,497 (9.8%) of the 25,374 marked hatchery striped bass released were recovered: 1,810 were recovered at Unit 2; 687 at Unit 3 (Table 2; Appendix D). The tidal-

Table 2. Total Numbers of Marked Hatchery Striped Bass Released at Six Locations and Recovered at Indian Point Units 2 and 3 September 30 to October 7, 1991.

		Number Recovered					
		Unit 2		Unit 3		Total	
Release Location	Number Released	No.	%	No.	%	No.	%
Original Transect							
2-A (210 ft site)	4,297	107	2.49	54	1.26	161	3.75
2-B (60 ft site)	4,307	1,210	28.09	49	1.14	1,259	29.23
Fletcher Transect							
F-A (210 ft site)	4,250	77	1.81	49	1.15	126	2.96
F-B (60 ft site)	4,279	363	8.48	262	6.12	625	14.60
NYPA Transect							
3-A (60 ft site)	3,980	33	0.83	110	2.76	143	3.59
3-B (0 ft site)	4,261	20	0.47	163	3.83	183	4.30
Total	25,374	1,810	7.13	687	2.71	2,497	9.86

averaged recirculation from four locations (3-A, 3-B, F-A and 2-A) was uniformly low (range 3.0 to 4.3%), suggesting that these potential return sites were near the outer limits of the model-projected zone of intake water withdrawal (Figure 6).

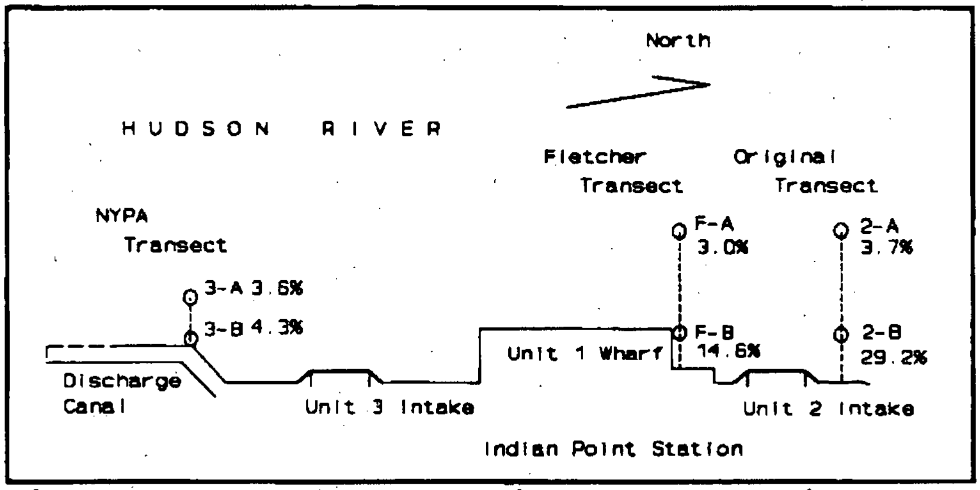

Figure 6. Percent Recoveries of Marked Live Hatchery Striped Bass Released at Six Locations at Indian Point Station, Fall 1991.

Percent recirculation of fish from the two near-shore sites at Unit 2 (2-B 29.2%, and F-B 14.6%), which appeared to be within the intake water zone of withdrawal, supported Dr. Fletcher's projection that recirculation would be approximately 50% lower from a discharge site south of the intake relative to that from one located north of it.

Prior to analysis, the data were examined to determine whether adjustments for potential biases were necessary. Factors considered included:

a. <u>Adequacy of Sampling Interval</u>

A plot of the cumulative percent recovery of fish recirculated (Figure 7) showed that most recirculation occurred within three days (approximately six tidal cycles) following release, with the exception that on the 7th day the numbers collected from two locations were slightly higher than on the immediately preceding day. These increases were probably due to the recovery of fish that had been collected from the intake by the screens but had remained in the sluices longer than most and were recovered only when the sluices were thoroughly cleaned at the end of the test. The overall results suggested that the monitoring period was adequate in duration.

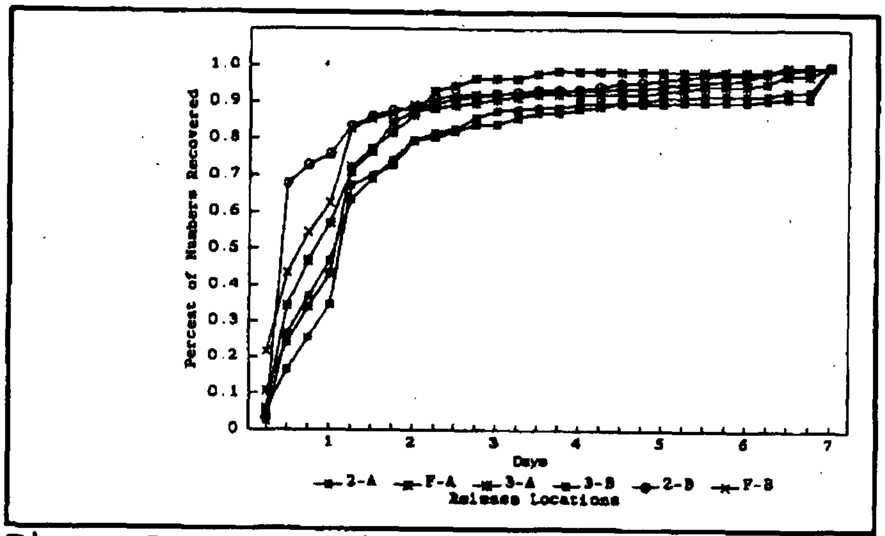

Figure 7. Cumulative Percent Recovery of Marked Striped Bass Released at Six Locations at Indian Point Station, Fall 1991.

b. <u>Handling and Tagging Mortality</u>

Mortality among the hatchery striped bass from handling and fin-clipping averaged 3.1% over the first 24 hours (Table 3). Since the start of the recirculation test was delayed from September 13 until September 30, 1991 due to intake bar screen fouling with widgeon grass (*Vallisneria sp.*), handling and tagging latent effects were monitored until testing began. The additional mortality over the two and one-half week delay averaged approximately 1%, for a total of about 4.1% (Table 3).

The numbers of fish in four tanks in which the mortalities were elevated were supplemented by marking additional fish. Since the overall mortality of marked fish was low, particularly during the two week plus delay in the start of testing, adjustment of the numbers released to reflect marking and handling mortality was considered unnecessary.

c. <u>Collection Efficiency</u>

At Unit 2, the efficiency of transfer of live and dead hatchery striped bass from the Ristroph screen baskets to the collection sluices averaged 97.5% and 97.3%, respectively (Table 4). At Unit 3, live and dead fish transfer efficiencies averaged 87.8% and 100%, respectively. Results

Table 3. Handling and Tagging Mortality of Hatchery Striped Bass Marked by Fin Excision for Assessment of Live Fish Recirculation Rates From Proposed Ristroph Screen Return System Discharge Locations During the Fall 1991.

Clip Code	Number Clipped	24 Hour Mortality Number	Percent	21 Day Mortality Number	Percent
1	1100	26	2.4	31	2.8
2	1100	4	0.4	6	0.5
7	1100	0	0.0	11	0.1
4	1100	0	0.0	4	0.4
3	1100	0	0.0	4	0.4
6	1100	29	2.6	35	3.2
5	1100	13	1.2	18	1.6
12	1100	6	0.5	24	2.2
17	1100	0	0.0	14	1.3
16	1100	1	0.1	30	2.7
15	1100	129 a	11.7	145	13.2
26	1100	70 b	6.4	81	7.4
25	1100	34	3.1	36	3.3
76	1100	38	3.4	84	7.6
75	1100	38	3.4	45	4.1
14	1100	45	4.1	48	4.4
13	1100	57	5.2	61	5.5
24	1100	36	3.3	40	3.6
23	1100	1	0.1	26	2.4
74	1100	1	0.1	5	0.4
73	1100	2	0.2	7	0.6
127	1100	192 c	17.4	195	17.7
27	1100	96 d	8.7	104	9.4
45	1100	12	1.1	13	1.2
Totals	26400	830	3.14	1079	4.09

Supplements: a - 100; b - 25; c - 150; d - 50 fish.

of the initial Unit 3 live fish transfer efficiency were determined to be biased low when hatchery fish were observed in the collection sluice but could not be recovered with the equipment available at the end of the test.

Table 4. Efficiency of Transfer of Live and Dead Hatchery Striped Bass from Ristroph Screen Baskets to Collection Sluices at Indian Point Units 2 and 3.						
Date	Unit	Screen	Fish Condition	Number Released	Number Recovered	Percent Recovered
9/6	2	24	alive	150	144	96.0
9/6	2	23	alive	150	146*	97.3
9/6	2	23	alive	150	149	99.3
Unit 2 Live Fish Average = 97.5						
9/13	2	23	dead	150	145	96.7
9/13	2	24	dead	150	144	96.0
9/13	2	23	dead	150	149	99.3
Unit 2 Dead Fish Average = 97.3						
9/16	3	31	alive	150	135**	90.0
9/16	3	36	alive	150	120**	80.0
9/16	3	36	alive	150	140**	93.3
Unit 3 Live Fish Average = 87.8						
9/13	3	31	dead	150	150	100.0
9/13	3	31	dead	150	150	100.0
Unit 3 Dead Fish Average = 100.0						

* One fish was recovered from the rear debris sluice.

** Recovery was hampered by residency in the sluice. Actual transfer efficiency is believed to be comparable to that observed for live fish tested at Unit 2.

At Unit 2, the recovery of dead striped bass released in front of the bar screens averaged 76.7% (Table 5). An assessment of whether predators might be reducing these recoveries was made by determining the percent recovery of "neutrally buoyant" objects. The average of two tests was 79.5 % (range = 71.4 to 88.9%), which was similar to the 76.7% recovery for dead fish (Table 5). Since it was

Table 5. Efficiency of Collection of Dead Striped Bass from the Indian Point Unit 2 Intake Water.						
Date	Screen	Release Location	Depth (Feet)	Number Released	Number Recovered	Percent Recovery
9/13	25	River*	14	150	109	72.7
9/13	25	River	7	150	99	66.0
9/16	22	River	17	150	104	69.3
9/16	22	River	21	150	148	98.7
River Front Recovery of Dead Fish Average = 76.7						
9/17	25	Forebay	7	150	144	96.0
10/3	25	Forebay	7	150	148	98.7
10/3	22	Forebay	7	150	147	98.0
Forebay Recovery of Dead Fish Average = 97.5						
9/16	22	River**	17	21	15	71.4
9/16	22	River**	21	18	16	88.9
River Front Recovery of Neutrally Buoyant Objects Avg = 79.5						

* Fish were released at the face of the bar screen.
** Tests were performed with water-filled ping pong balls.

doubtful that the "neutrally buoyant" objects were preyed upon by fish or blue crabs, the results suggested that other factors were influencing recoveries from this area. Localized eddies may have swept the dead fish away from the intakes or entrapped them in areas out of the inflow currents.

The recovery of dead striped bass released inside the intake bay averaged 97.5%, and was essentially the same as efficiency of transfer of fish from the screen baskets to the collection sluice. Based on these results, it was expected that nearly 100% of the fish that actually encountered the Ristroph screens would be recovered. Accordingly, it was considered unnecessary to adjust numbers of fish recirculated for collection efficiencies.

d. Plant Operations

Two mechanical problems occurred that had the potential to influence fish recovery rates. One occurred at Unit 3 shortly after the start of testing. The sampling screen for the front debris sluice became clogged with debris and caused the sluice to overflow. This flooding interrupted other work, and, when it became evident that small amounts of debris could cause recurrences, management requested that the screen be removed. Although monitoring of this sluice was terminated early, this circumstance was considered to be inconsequential because the transfer of live and dead fish from screen baskets to the fish collection sluices at both Units 2 and 3 averaged over 98% and suggested that few, if any, fish would be discharged to the front debris sluice.

The second mechanical problem occurred at Unit 2 when screen 21 was shut down for a six-hour period. This incident was believed to have not influenced fish recovery rates because the associated circulating water pump continued to operate. With the continued intake flow, it was considered unlikely that fish impinged on the screen mesh, or residing in the fish rails would have escaped. The only apparent potentially adverse condition associated with this incident was that recirculated fish might be recovered damaged or dead due to the extended impingement interval.

e. Predation

Recirculated hatchery fish were examined for evidence of damage due to predation. A total of 2,300 (92.1%) were collected alive and undamaged; 163 (6.5%) were injured, and 34 (1.4%) were dead. Injuries ranged from slight bruises to hemorrhages. Of the 34 hatchery striped bass collected dead, all were missing relatively cleanly excised body parts, suggestive of bites by other fish. The predators observed in the collections included blue crabs and bluefish. Although a total of 476 juvenile and adult blue crabs were collected (Table 6), it appeared unlikely that they caused the mortalities. During monitoring, crabs appeared to actively avoid live fish in the sluices. Also, during collection efficiency tests, none of the blue crabs in the recovery samples were observed to prey on the test fish. Approximately 35 bluefish, (8-10 inches in length), were collected from the sluices during the testing, and were suspected to be the species most likely to have preyed on the hatchery striped bass. However, no adjustment for potential losses were made since information on the quantity of bluefish in the area or their feeding habit was not available.

Table 6. Occurrence and Distribution of Blue Crabs During the September 30 - October 7, 1991 Live Hatchery Striped Bass Release and Recovery Study at Indian Point Units 2 and 3.			
Date	Unit 2	Unit 3	Total
September 30	11	10	21
October 1	37	22	59
October 2	38	9	47
October 3	50	16	66
October 4	40	22	62
October 5	26	56	82
October 6	24	52	76
October 7	14	49	63
Totals	240	236	476

f. <u>Miscounts</u>

Although collection efficiency tests showed that the potential for miscounts of marked fish was low, a potential bias existed with respect to the 34 fish that had experienced predation damage. Fin loss occurred on all of these fish, precluding determination of their release locations. The primary concern about these fish was that they represented recoveries, which if classifiable to a specific release location, could result in a different interpretation of recovery rates from among the six locations. Under a worst case scenario, all 34 fish could have come from a single release location. However, it was thought that a more likely scenario would be that they were recirculated from several release sites. Since 30 of these fish were recovered at Unit 3, their origin was assumed to be most realistically represented by the proportional distribution among release sites of the recaptures at that Unit (Table 7). Based on this distribution, site F-B would have contributed 11 of the 30 fish (0.38 X 30 = 11), site 3-B would have contributed 7, and Site 3-A - 5. The other three locations would have contributed about 2 fish each. Since the overall recirculation rate for fish released at F-B was relatively high (14.6%) compared to recoveries from the other four locations [excluding site 2-B, since few fish (49 out of 4,307; 1.1%) released at that site were collected

Table 7. Source Distribution for Hatchery Striped Bass Recovered at Indian Point Unit 3, Fall 1991.		
Release Location	Number Recovered	Percent Contribution
2-A	54	7.86
2-B	49	7.13
F-A	49	7.13
F-B	262	38.14
3-A	110	16.01
3-B	163	23.73
Total	687	100.00

at Unit 3}, the allocation of 11 more fish to the number collected from it would be of little consequence in the selection of the Unit 2 return line discharge site. As for the other sites, based on the distribution of the unclassified fish among them, the incremental increase in recirculation from each was negligible. For example the addition of seven fish to the recoveries from site 3-B increased the return rate by less than 0.2 percentage points (From Appendix Table D-7: {183 + 7}/{4261} X 100 = 4.46% versus 4.29%). Accordingly, the source of the 34 fish was considered immaterial in the analyses of recovery rates, and they were excluded.

Other potential contributions to miscounts, such as entanglement in debris, or technician errors, were believed to have been minor and random, if they occurred at all. Debris loads were relatively light during the test interval, making collections of hatchery fish easy, and pooling the numbers recirculated across tides reduced the influence that miscounts could have on small sample sizes.

4. <u>Analyses and Discussion of Recovery Rates</u>

The live fish recovery data were subjected to a three-way contingency analysis to determine whether the numbers recirculated were independent of location and tidal current at the time of release. The analysis demonstrated that significant interaction ($G = 1075.2$, $d.f = 15$, $\alpha = 0.05$; Critical $G = 25.0$; Appendix Table E-1) existed among the three variables, indicating that recirculation was a function of release location and tide stage. Upon inspection of the data (Figure 8), it became obvious that

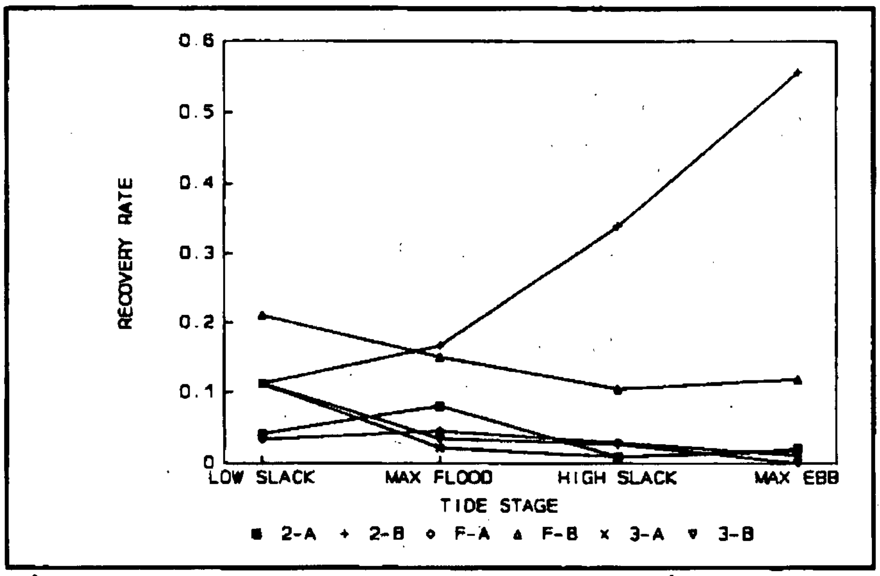

Figure 8. Percent of Hatchery Striped Bass Recovered at Indian Point Station Relative to Release Location and Tide Stage at Six Sites, Fall 1991.

the relatively high recirculation from locations 2-B and F-B were major contributors to the lack of independence. Total numbers recovered by tide stage at these two locations were usually substantially higher than those from the other four locations, indicating that these sites were probably unsuitable as permanent return line discharge sites. Accordingly, they were not considered in further analyses.

Recirculation from the four remaining locations (2-A, F-A, 3-A, and 3-B) were also subjected to a three-way contingency analysis, which disclosed that significant interaction still existed ($G = 176.5$, d.f. $= 9$, $\alpha = 0.05$; Critical $G = 16.9$; Appendix Table E-2). However, since the magnitude of the recirculation rate differences across tide stages at each of these locations was small, generally less than 10% (Figure 8), and our primary interest was in the differences in overall recirculation from the various locations, data were pooled across tide stages for the analyses suggested by the DEC. Four location-specific contingency analyses were performed: 1) Fletcher location versus the original proposed site (F-A versus 2-A); 2) NYPA shoreline discharge location versus the 60 foot offshore release site (3-B versus 3-A); 3) original proposed site versus the NYPA shoreline discharge (2-A versus 3-B); and 4) the Fletcher site versus the NYPA shoreline discharge site (F-A versus 3-B). For these comparisons, the experiment-wise error rate of $\alpha = 0.05$, instead of the allowable $\alpha = 0.0125$, was used.

a. Fletcher Site Versus Original Proposed Site

The 2 x 2 contingency analysis disclosed significant site effects in the recirculation from F-A and 2-A ($G = 4.04$, d.f. = 1, $\alpha = 0.05$; Critical $G = 3.84$; Appendix Table E-3). Since the actual difference was only 0.7 percentage points (3.0% and 3.7%, respectively), it was concluded that there was no practical difference in recirculation from these the two locations.

b. NYPA Shoreline Discharge Versus Offshore Site

Recirculation from locations 3-A and 3-B (3.6% and 4.3%, respectively), were found to be independent of release location ($G = 2.68$, d.f. = 1, $\alpha = 0.05$, Appendix Table E-3), indicating that there was no difference in recirculation from these two sites.

c. Original Proposed Site Versus NYPA Shoreline Discharge

Recirculation from the Unit 3 discharge site (3-B) relative to the recirculation from the originally proposed site (2-A) was also found to be independent of release location ($G = 1.67$, d.f. = 1, $\alpha = 0.05$; Appendix Table E-3).

d. Fletcher Site Versus NYPA Shoreline Discharge

The 2 x 2 contingency analysis disclosed significant site effects in recirculation from F-A and 3-B (3.0% and 4.3%) ($G = 10.82$, d.f. = 1, $\alpha = 0.05$; Critical $G = 3.84$; Appendix Table E-3). Since the actual difference in recirculation rates between 3-B and F-B was 1.3 percentage points, it was concluded that there was no practical difference in recirculation between these two sites.

Overall, recirculation of fish from the originally proposed site and the two Unit 3 sites was substantially lower than that noted for both dye and live fish during the 1990 studies. The results demonstrated a diminishing difference in recirculation between north-of-intake and south-of-intake locations at the offshore sites compared to their onshore components. Recirculation at 2-B was 100% higher that at F-B, while recirculation at 2-A was only 23% higher than at F-A. Although tide-specific fish recirculation rates from the nearshore sites at Unit 2 supported Dr. Fletcher's projection of an approximately 50% reduction in recirculation from an on-shore site south of the intake relative to that from a comparably located site north of it (see Appendix D), tide-specific fish recirculation rates from the off-shore sites did not. This and the fact that fish recirculation was substantially lower than that of dye from Site 2-A (see Table 1; dye recirculation from site F-A was not evaluated), suggested that both sites may be so close to the margin of the withdrawal zone that the movements (directed or random) of fish released at those points quickly removed them from the influence of passive transport processes. The return of a few fish to the intakes might have been due more to random movement than to transport by water. The same may have been true at the Unit 3 sites. Recirculation from sites 3-A (3.6%) and 3-B (4.3%) near Unit 3 was essentially the same as that from the off-shore sites at Unit 2 (Figure 6). Based on the relatively low recirculation rates from these four sites (range = 3.0 to 4.3%), it would appear that any one would be suitable as a fish return line discharge site for the operating conditions tested. Further, with increased fresh water discharges during other seasons, the duration of exposure to recirculation would be shorter, which might reduce recirculation below the levels recorded.

However, a 1985 winter-time hydroacoustic survey offshore of Indian Point detected fish movements which followed the direction and rate of tidal flows, indicating that at least some fish were being passively transported. Impingement collections suggested that the fish observed were white perch. If white perch or other species are transported passively by water currents in cold water, the fall 1991 live-fish recirculation rates might not be an accurate indicator of overall annual recirculation potential. Rather, live-fish rates may apply to warmer seasons, while dye recirculation rates might more realistically reflect recirculation in the winter, particularly for white perch. Accordingly, under the winter-time reduced flow pumping conditions, if recirculation of white perch from site 2-A located north of the intake was entirely passive and, as a result, the same as that for dye (32%), then by application of Dr. Fletcher's projection, recirculation from Site F-A, located downstream of the intake, might only approach 16%. At Unit 3, where the test discharge sites are south of the intake, white perch recirculation might approach 12% from the shoreline site (3-B) and 18% from the offshore site (3-A), the respective dye recirculation rates from these sites under reduced flow pumping conditions.

In order to evaluate the potential influence of passive fish recirculation among the sites in the absence of winter-time live fish recirculation data, live fish and dye recirculation rates were used along with average monthly impingement rates (1975 - 1990) at Indian Point Unit 2 (Appendix G) to project potential levels of annual recirculation. Hydraulic model data suggested that dye recirculation from F-A would not be higher than from 2-A (which was determined to be 32% at winter flows), and Dr. Fletcher estimated that it might be on the order of 50% of the 2-A rate. However, because it is unlikely that any indigenous Hudson River species of fish is entirely "passive" in cold water, application of dye rates to all species would almost certainly overestimate total recirculation. Accordingly, various assumptions about "winter" recirculation were made as follows:

- Essentially passive fish recirculation is most likely to occur when water temperatures are low. Two "cold water" periods of assumed "passivity" were selected to reflect a range of potential conditions:

  - December - March (projected maximum duration; long-term monthly average water temperature at or below 40° F)

  - January - February (most likely interval; water temperature at or below 36° F)

- White perch recirculation rates from sites 3-A, 3-B and 2-A, for which dye recirculation data are available, were assumed to be reflected by the dye rates during the passive recirculation period. Recirculation rates of other species (e.g. Atlantic tomcod) were assumed to be reflected by live-fish rates during the passive recirculation window.

- Passive white perch recirculation from site F-A, for which dye recirculation rates are not available, may be reflected by the rate projected by Dr. Fletcher, but could actually be lower or higher. Accordingly, a range of recirculation rates, including 25%, 50%, and 100% of the dye recirculation rate for site 2-A, were applied. Recirculation rates of other species (e.g. Atlantic tomcod) were assumed to be reflected by live-fish rates during the passive recirculation window.

Since differences in recirculation rates among sites are important only to the extent that they affect the numbers of fish saved by the Ristroph screen system, adjustments were made to reflect that some of the fish collected by the screens are not returned to the water alive, and that recirculation and re-impingement on the screens, while probably stressful, does not necessarily result in morbidity.

In order to evaluate differences in the numbers of fish mortalities due to differences in recirculation among return sites, Dr. Fletcher's mortality/morbidity data (Fletcher 1990) were applied to long term average impingement levels at Unit 2 (Appendix G) in two steps, as follows:

1). The number of fish that might be returned alive to each site after their initial encounter with the screens was calculated. Species-specific survival rates were used when available; for other species, best estimates were derived from the studies. For example, alewife rates determined by Dr. Fletcher were applied to other herrings plus anchovies because these species have relatively similar sensitivities to handling.

2). Since an individual fish can, in theory, be recirculated several times and no re-impingement survival data are available, calculations were made on the assumption that survival during the first recirculation episode was 50% of the survival during the initial impingement, 25% on the second recirculation episode, and 0% on the third iteration.

Table 8 presents estimated numbers of all fish combined that may be lost as a result of recirculation from the release sites under various assumed conditions. As discussed above, a range of passive recirculation rates was applied in order to project possible lower and upper bounds for recirculation from site F-A. In addition, estimates were made for two possible passive recirculation windows (December through March; January through February).

Annual percent losses due to recirculation from each site can be calculated as the number of fish lost due to recirculation (re-impingement) divided by the number of impinged fish initially returned alive to the river (x 100; Table 9). Based upon the information available, and the various assumptions made regarding recirculation, it appears that any of the Unit 2 offshore sites or the Unit 3 sites would be suitable return system discharge sites.

Table 8. Estimated Annual Fish Mortalities Due to Recirculation from Four Potential Discharge Sites for the Indian Point Unit 2 Return System.

Site	Recirculation Rate (%)*		Estimated Numbers (1000) Annual Fish Mortalities	
	Active Fish	Passive Fish (Estimated)	Passive Recirculation Window	
			Dec - Mar	Jan - Feb
3-A	3.6	18	85	62
3-B	4.3	12	65	52
2-A	3.7	32	148	98
F-A(.25)	3.0	8	43	35
F-A(.50)	3.0	16	74	53
F-A(1.0)	3.0	32	145	94

* Estimated recirculation rates for sites 3-A, 3-B, and 2-A are based on winter-time dye recirculation rates; estimated recirculation rates for site F-A are based on 25%, 50%, and 100% of the site 2-A winter-time dye recirculation rate.

Table 9. Estimated Annual Mortality (Percent)* of Fish from Four Potential Return Locations for the Indian Point Unit 2 Ristroph Screen System.

Site	Recirculation Rate (%)		Estimated Percent Annual Fish Mortalities	
	Active Fish	Passive Fish (Estimated)**	Passive Recirculation Window	
			Dec - Mar	Jan - Feb
3-A	3.6	18	6.4	4.6
3-B	4.3	12	4.8	3.9
2-A	3.7	32	11.1	7.4
F-A(.25)	3.0	8	3.2	2.6
F-A(.50)	3.0	16	5.5	4.0
F-A(1.0)	3.0	32	10.8	7.0

* Percent (%) of impinged fish initially returned alive at Indian Point Unit 2 as a result of recirculation and re-impingement, based upon the two step analysis described above.

** Estimated recirculation rates for sites 3-A, 3-B, and 2-A are based on winter-time dye recirculation rates; estimated recirculation rates for site F-A are based on 25%, 50% and 100% of the site 2-A winter-time dye recirculation rate.

PART II. UNIT 2 RETURN SYSTEM DESIGN STUDIES

Section A - 1990 Fish Sluice Design Studies

Following evaluations of the flume and return pipe components (Con Edison and NYPA 1990), the return system design testing was expanded to include the third component, the fish collection sluice. Although the original plan was to evaluate these sluices following installation of the Ristroph screens at Indian Point, the convenience of testing at the quarry site provided the basis to perform this work there as well.

1. Prototype Fish Collection Sluice and Return System

During the summer 1990, a preliminary design for a complete Unit 2 return system, which included collection sluices, channel bends, elevation changes, and the confluence of flows from two channels, was installed at the quarry and tested. Conceptual engineering designs for the favored alternative layout were used to fabricate the prototype (Figure 9). The width of the fish collection sluices was 3 feet, the same as that evaluated on the Unit 2 Ristroph test screen (Fletcher, personal communication 1985). The sluice side wall to bottom union was formed on a 3-inch radius of curvature to minimize the area of flow stagnation in corners (Sellin 1970) and to enhance fish transport. The 36 foot long sluice for screens 21 to 23 was set at a slope of approximately 0.125 inches per foot. It discharged through an 18 inch long tapered channel into a 12 inch diameter pipe, which made a lateral 180° bend (C-bend) on a 3 foot radius, and then angled downward at a 45° (vertical offset section) for approximately 8 feet to the simulated "in-deck" sluice (sluice located below the level of the intake deck surface). The in-deck sluice, which at its head end, was positioned five feet lower in elevation than the fish sluice for screen 21, was simulated with a series of pipes and channels set at a slope of 0.1 inch per foot. The in-deck sluice terminated at the end of a 45° lateral bend (four foot radius of curvature) at the entrance to the 3 foot wide confluence channel. The fish sluice for screens 24 to 26 was identical to that for screens 21 to 23. It discharged through a 10 foot long tapered channel into a 10 inch diameter pipe, which made a lateral 45° bend and then sloped downward on a 45° angle for about 12 feet to the confluence channel. Downstream of the 12 foot long confluence channel, the flow passed through a 12 foot long tapered channel and a 10 inch wide by 4 foot long covered "funnel", which were set at a pitch of about 0.8 inches per foot. These sections created the transition from the open channel of the in-deck sluice to the closed conduit of the flume. The increased pitch caused the flow to accelerate,

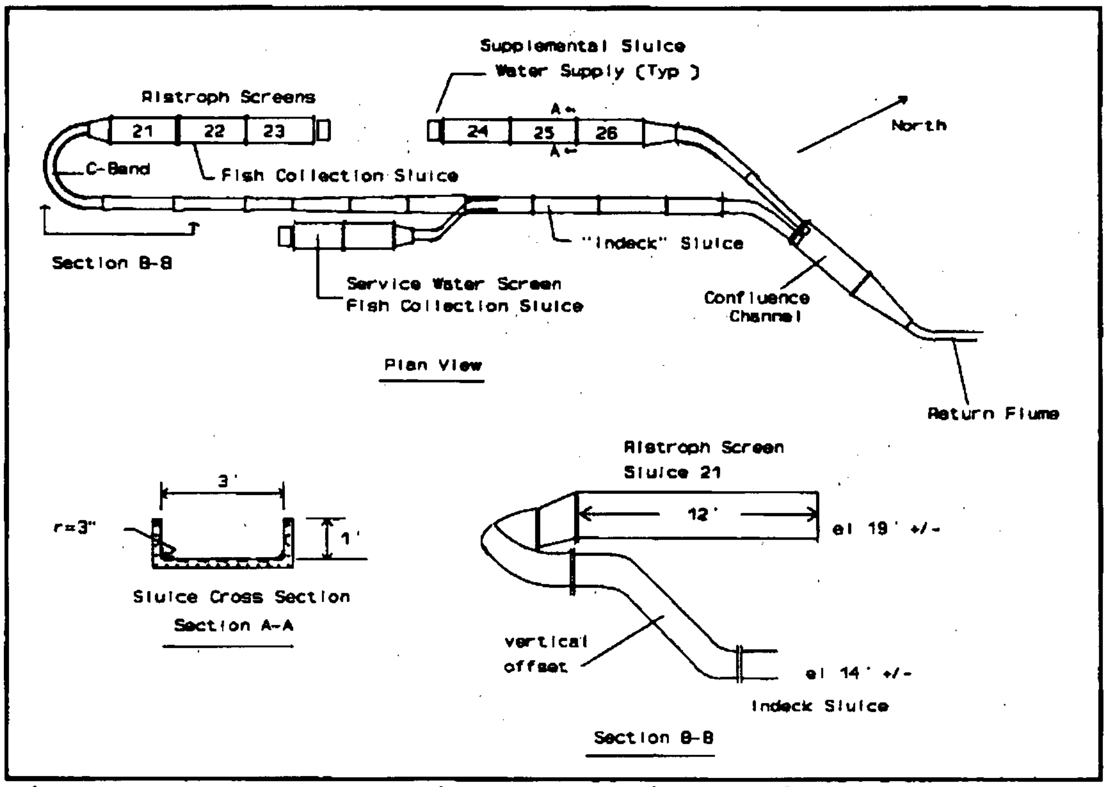

Figure 9. Prototype Fish Collection Sluice Layout for Indian Point Unit 2.

which reduced the potential for a hydraulic jump at the entrance to the flume. The approximately 90 foot long flume discharged at quarry level into the 10 inch diameter 150 foot long return pipe.

The return pipe was set to discharge in a horizontal direction at a depth of 40 feet, which would be the approximate depth of the discharge for a return line extending about 200 feet offshore at Unit 2.

In addition to the prototype collection sluices for the circulating water Ristroph screens, a similar sluice system was constructed to model those for Ristroph screens to be installed in the service water bays (Figure 9). These sluices were installed to discharge into the in-deck sluice conveying fish from screens 21 to 23.

Water for operation of the return system was by supplied by gasoline-powered pumps of 300 to 500 gpm capacity. Water was added by 1) a manifold system that simulated the entrance of spray wash water from each screen, and 2) a supplemental supply at the upstream end to gently flush fish out of the sluices.

2. Test Procedures for the Collection Sluice and Return System

Test procedures followed those outlined in the July 1990 report, and consisted of installing a fish collection cage at the return pipe discharge, adjusting the sluice flow to the desired volume, and then releasing the test fish, generally in quantities of 50 fish per species per test, into the upstream end of a sluice. Control fish were released into a separate cage, which was either held in surface water, or lowered to the 40 foot depth at which test fish would be collected. Test and control fish were then either held in surface water, or at minus 40 feet for assessment of latent effects. At the end of the latent effects assessment period, fish were removed from the cages and classified as alive, damaged but alive, dead, or missing. Tests were performed with alewife, white perch, striped bass and golden shiner.

3. Test Results

a. July 18, 1990 Tests

The initial tests to evaluate the effects on fish of transport through the full scale return system were performed with alewives and golden shiners on July 18, 1990. Test fish were obtained from a local live bait dealer. In the first test, fish were released into the screen 21-23 portion of the sluice system (See Table 8 for test conditions). During transit through the system five alewife and 2 golden shiners were discharged through a portal in the flume located approximately 4 feet above the quarry when escaping air disrupted flow. These fish were not included in the assessments of survival. (Fish that were missing from the collection nets were also not included in the assessment of survival, since their condition could not be determined.)

Divers reported that following discharge from the return pipe most of the alewives appeared to be in excellent condition and stayed near the top of the net; two were apparently injured and were laying on the bottom. However, golden shiners were agitated and within seconds all appeared lifeless at the bottom of the net. In a second test, which was performed in the screen 24-26 portion of the system, divers observed the alewives again to be discharged without apparent damage, while the golden shiners became agitated and then went into a state of lifelessness. The response of the golden shiners was in marked contrast to their relatively calm behavior and nearly 100% survival following passage through a flume and return pipe arrangement set to discharge at minus 35 feet (Con Edison and NYPA 1990). The exposure to the 10.1°C temperature at minus 40 feet relative to the 24.8°C surface water temperature to which they had been acclimated was the suspected cause of the response rather that the design of the fish collection sluice system. To confirm this, 20 golden shiners were placed in a five gallon screen-covered pail and taken to minus 40 feet by divers. These fish became agitated during the descent and within two minutes, all were motionless on the bottom of the pail. After 20 minutes, the pail was returned to the surface, and within minutes all of the shiners resumed active swimming.

Latent effects assessment after a 24 hour hold period at minus 40 feet disclosed that 19 of the 45 alewives discharged into the collection net in the first test were alive, 5 were dead and 21 were missing (Table 10). A total of 10 golden shiners were alive, one was dead, and 37 were missing. Upon examination, a hole was found in the collection net, the apparent avenue of escape for the missing fish. Results of the second test included 16 alewives alive, 23 dead and 11 missing; a total of 47 golden shiners were alive, while 3 were dead.

Although these initial tests were performed without control fish for assessment of handling effects, the levels of survival among alewives in the two tests (19 of 24, 79.2%; and 16 of 39, 41.0%) was lower than the nearly 86% survival (unadjusted for control fish survival) recorded during earlier tests (Con Edison and NYPA 1990). Temperature shock was a suspected contributor to the mortality. Interestingly, most of the golden shiners that displayed adverse reaction to the cold water eventually recovered. Survival rates for golden shiners were 90.9% and 94.0% in the two tests. Although test fish were examined for signs of damage, only minor scale loss was observed on a few fish.

The loss of fish through the portal in the flume and the inability to discharge quantities of water greater than about 1,000 gpm during these tests was caused by intermittent blockage of flow by accumulations of air in the pipe at the quarry surface. As a means to vent the entrained air, a 10 inch wide by 12 foot long "chimney" was added to the upper half of the return pipe at the quarry water interface (Figure 10). This chamber provided about 10 square feet of area directly above the return pipe and across which air bubbles could rise while allowing the flow to enter the return pipe.

Table 10. July 18, 1990 Evaluation of Model of Indian Point Unit 2 Fish Collection Sluice and Return System.

Test Conditions	
Sluice 21 to 23	Sluice 24 to 26
Return Pipe Length: 150′	Return Pipe Length: 150′
Discharge Depth: 40′	Discharge Depth: 40′
System Water Flow: 950 gpm	System Water Flow: 950 gpm
Debris: 2 gals leaves	Debris: 2 gals leaves
Transit Time: 92 Sec	Transit Time: 81-168 sec
Temp (°C): Surface 24.8, -40 Feet 10.1	Temp (°C): Surface 24.8, -40 Feet 10.1

Sluice 21 to 23

Alewife N = 50, C = 0

Time	A	D	I	M
15 min	43	0	2	5
24 hr	19	5	0	21

Survival* (19/24)x100 = 79.2%

Golden Shiner N = 50, C = 0

Time	A	D	I	M
15 min	0	0	46	2
24 hr	10	1	0	37

Survival (10/11)x100 = 90.9%

Sluice 24 to 26

Alewife N = 50

Time	A	D	I	M
15 min	50	0	0	0
24 hr	16	23	0	11

Survival (16/39)x100 = 41.0%

Golden Shiner N = 50

Time	A	D	I	M
15 min	0	0	50	0
24 hr	47	3	0	0

Survival (47/50)x100 = 94.0%

A = Alive; D = Dead; I = Damaged but alive; M = Missing

* Since the status of missing fish could not be determined, these fish were discounted as numbers available for computation of survival rates.

Other observations of the return system disclosed that the confluence of flows from the two sluices caused an undesirable hydraulic jump. The in-deck sluice flow was approximately three times the volume but substantially slower in velocity as that discharged from sluice 24 to 26. In order to reduce the hydraulic jump, the confluence channel was modified so that the flow from the screens 24 to 26 sluice discharged tangentially onto the surface of the flow entering from the in-deck sluice.

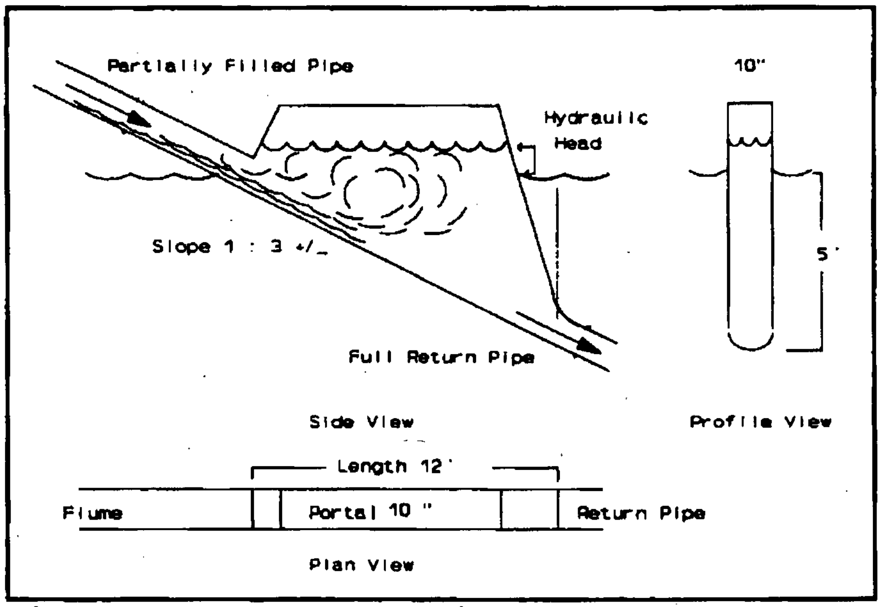

Figure 10. Concept Design for Chamber for Removal of Entrained Air from the Fish Return Pipe at the Indian Point Unit 2 Ristroph Screen System.

b. <u>July 24, 1990 Tests</u>

Tests to evaluate the effects on fish of the air relief chamber and the redesigned confluence section were performed with alewives and golden shiners on July 24, 1990. Procedures were the same as before, with the exception that leaf debris was mixed with the test fish before release into the sluices. Control fish were added to the cages at the surface, which were then lowered to minus 40 feet during the period that test fish were discharged into the collection net. Holding procedures in this test differed from those on July 18 in that the test and control fish nets were lifted to the surface and held for the 24 hour latent effects assessment. Alewife and golden shiner survival, adjusted for control fish mortality, was 100% (Table 11). There was no observable damage to the test fish. These results indicated that passage through the sluice systems for both screens 21 to 23 and 24 to 26, as well as the modified confluence sluice, the air relief chamber, and the 150 foot long return pipe that discharged at minus 40 feet did not induce mortality among the fish. The 100% survival of both test species strengthened the belief that the stresses

Table 11. July 24, 1990 Evaluation of Model of Indian Point Unit 2 Fish Collection Sluice and Return System, Including the Air Relief Chamber.

Test Conditions

Sluice 21 to 23

Return Pipe Length:	150′
Discharge Depth:	40′
System Water Flow:	1350 gpm
Debris:	2 gals leaves
Temp. (°C):	Surface 25.0
	-40 Feet 10.8
Transit Time:	183 sec

Alewife N = 49
C = 50

Time	A	D	I	M
24 hr				
N	48	0	0	1
C	45	0	0	5

Adjusted Survival = 100%

Golden Shiner N = 50
C = 50

Time	A	D	I	M
24 hr				
N	45	4	0	1
C	42	7	0	1

Adjusted Survival = 100%

Sluice 24 to 26

Return Pipe Length:	150′
Discharge Depth:	40′
System Water Flow:	950 gpm
Debris:	2 gals leaves
Temp. (°C):	Surface 25.0
	-40 Feet 10.8
Transit Time:	83 sec.

Alewife N = 50

Time	A	D	I	M
24 hr				
N	48	0	0	2

Adjusted Survival = 100%

Golden Shiner N = 50

Time	A	D	I	M
24 hr				
N	44	4	0	2

Adjusted Survival = 100%

N = Number of fish tested C = Number of control fish

Adj. Surv. = [1-{(P - C)/(1-C)}] x 100 where P = Proportion of test fish dead or injured, C = proportion of control fish dead or injured; (Finney 1964); for P =,> C < 1; Note: Missing fish were subtracted from the test number (N) since their condition could not be determined.

observed during the July 18 tests were due to exposure to the nearly 15°C lower temperature, rather than transport through the return system. During these tests, observations disclosed that the chamber designed to vent air was effective in preventing flow blockages in the return pipe, and was not detrimental to fish. Also, the modifications made to the confluence sluice were effective in reducing the undesirable jump observed in the previous design tested.

On July 24, assessments of damage to fish passage through the service water screen collection sluice were made. Alewives and golden shiners were released at the sluice for screen 27 and then collected from the return pipe at the 40 foot depth. The collection net was raised to the surface for latent effects assessment. After 24 hours, 47 of the alewives were alive, none were dead, and three were missing; 45 golden shiners were alive, one was dead and four were missing. None of the fish showed substantive signs of damage. The adjusted survival rates for both alewives and golden shiners were 100%.

c. <u>August 1, 1990 Tests</u>

An Alternative design for the entrained air vent system was evaluated during tests on August 1, 1990. The alternative design consisted of an enlarged diameter flume at the air-water interface. A 14 inch diameter PVC pipe was positioned to receive the flow from the 10 inch diameter flume at a point about four feet above the quarry surface. The entrance to the 14 inch pipe was open, which, excluding the cross-sectional area of the 10 inch diameter flume, provided an approximately 75 inch^2 vent for entrained air. In addition, the 14 inch diameter pipe was set on about a 30°angle, which provided about a 2 square ft surface area inside the pipe across which entrained air could escape from the flow. The 14 inch diameter flume discharged underwater into a 12 inch diameter by 20 foot long pipe that in turn discharged into the 10 inch diameter return pipe.

Evaluations of this system were performed with white perch and hatchery-reared striped bass. Fish were discharged at minus 40 feet and then brought to the surface for the 24 hour latent effects assessment. White perch survival, corrected for control mortality, was 89.2% in one test and 100% in the other (Table 12).

Table 12. August 1, 1990 Evaluation of Model of Indian Point Unit 2 Fish Collection Sluice and Return System, Including Air Relief Chamber.

Test Conditions	
Sluice 21 to 23	Sluice 24 to 26
Return Pipe Length: 150'	Return Pipe Length: 150'
Discharge Depth: 40'	Discharge Depth: 40'
System Water Flow: 1050 gpm	System Water Flow: 950 gpm
Debris:	Debris:
Temp. (°C): Surface 27.5	Temp. (°C): Surface 27.5
-40 Feet 10.5	-40 Feet 10.5
Transit Time:	Transit Time: sec.

White Perch N = 50 C = 50					White Perch N = 50				
Time	A	D	I	M	Time	A	D	I	M
24 hrs					24 Hrs				
N	33	17	0	0	N	37	13	0	0
C	37	13	0	0					
Adjusted Survival = 89.2%					Adjusted Survival = 100%				
Striped Bass N = 50 C= 49					Striped Bass N = 50				
24 hrs					24 hrs				
N	30	17	0	3	N	25	25	0	0
C	31	18	0	0					
Adjusted Survival = 100%					Adjusted Survival = 79.0%				

Striped bass survival, adjusted for control mortality, was 100% in one test and 79.9% in a second test (Table 12). These results are somewhat tenuous, however, since control fish mortalities were high. Test fish displayed few signs of damage such as abrasion or scale loss as a result of passage through the system.

The "enlarged diameter flume" air relief chamber was determined to be ineffective when accumulations of air caused intermittent discharges of flow at its entrance.

4. Discussion of Results of 1990 Summer Tests

Results indicated that the full system did not impose injuries to fish. Test fish were passed through the collection sluices and traversed areas of turbulence including the sharply tapered discharge from sluice 21, the vertical offsets, the confluence channel, and the air relief chamber, without incurring cuts, bruises or scale loss. Survival rates of test fish (Table 13) were generally high, and similar to rates reported earlier (Con Edison and NYPA, 1990). Survival of golden shiners was 100% except during exposure to the approximately 15°C temperature differential between the surface water and the discharge depth when it was about 92.5%. Alewife survival was also lower than observed in earlier tests, a result attributed to cold shock. However, similar cold shock conditions are not expected to occur in the Hudson River where vertical temperature differentials are generally small (LMS 1975). White perch and striped bass survival rates averaged nearly 95% and 90%, respectively, although these results may be affected by high control fish mortality. Based on the facts that few fish showed signs of damage during these tests, test species experienced high survival rates in earlier studies, and temperature differentials during testing were extreme, it appeared unlikely that the return system was the cause of observed mortalities.

Table 13. Summary of Adjusted Percent Survival of Four Species of Fish Transported Through the Prototype Unit 2 Return System Summer 1990.

	Species			
Date	Alewife	Golden Shiner	White Perch	Striped Bass
July 18*	88.9 54.0	97.9 94.0	- -	- -
July 24	100 100	100 100	- -	- -
August 1	- -	- -	89.2 100	100 79.0

* Control fish survival rates were not determined during this test.

Difficulties in obtaining and holding white perch, as well as the substantial temperature differential between surface water and that at minus 40 feet, an unrealistic condition relative to that typical in the Hudson River, made further testing at this time of dubious value.

In a September 27, 1990 letter, Dr. Fletcher identified concerns about the Unit 2 prototype tested in July and August, as well as component designs tested earlier (Con Edison and NYPA 1990). He noted that the return pipe did not have a 30° upward bend at its terminus as indicated on engineering drawings (the upturn would extend the buried pipe above the river bed for discharge), and indicated that he could not speculate as to how its presence might influence fish. He also expressed concern about the air relief chamber. In a November 20, 1990 letter, the DEC provided comments on both the July 1990 report and the mid-summer 1990 testing. They noted that additional studies should include testing of organisms at the maximum expected depth for the return pipe, including some margin of safety, and offered suggestions for testing white perch, for which control fish survival had been poor. They emphasized that white perch survival at minus 35 feet during the winter needed additional study. In a January 1991 report (Fletcher 1991) Dr. Fletcher noted that extension of a return line 210 feet offshore could involve installation to depths of about 50 feet, although the actual discharge would be at about 45 feet. He added that a system constructed as such would expose fish to an additional 0.6 atmospheres of pressure relative to that at 35 feet, and that pressure effects, especially in the winter, should be further examined.

The comments of Dr. Fletcher and the DEC provided the basis for refinement of the return system components and the performance of additional testing in 1991.

Section B - 1991 Refined Return System Evaluation

1. Design of the Unit 2 Fish Return System

In response to the concerns expressed by the DEC and Dr. Fletcher, improvements were made in the design of the return system. Although the refined prototype return system consisted of the same basic layout as that tested in 1990, the 180° bend (C-bend) at the south end of the system was redesigned as a uniform transition from the 36 inch wide fish collection sluice to the 20 inch wide in-deck sluice (compare designs illustrated in Figure 9 with those in Figure 11). The vertical offset channel, which conveyed flow from the C-bend to the indeck sluice, was constructed with large radius curves to reduce hydraulic jumps and turbulence (Figure 11). A similar transition was provided for the flow from the screen 24 to 26 sluice to its confluence channel. The confluence channel was redesigned to enhance the union of the dissimilar volumes and velocities from the two sluice systems (Figure 11). At the entrance to the quarry, the return pipe was outfitted with a chamber of the design found to alleviate flow blockages by entrained air. The diameter of the return pipe was increased from 10 inches to 12 inches to reduce the potential for blockage by debris, and the terminus was

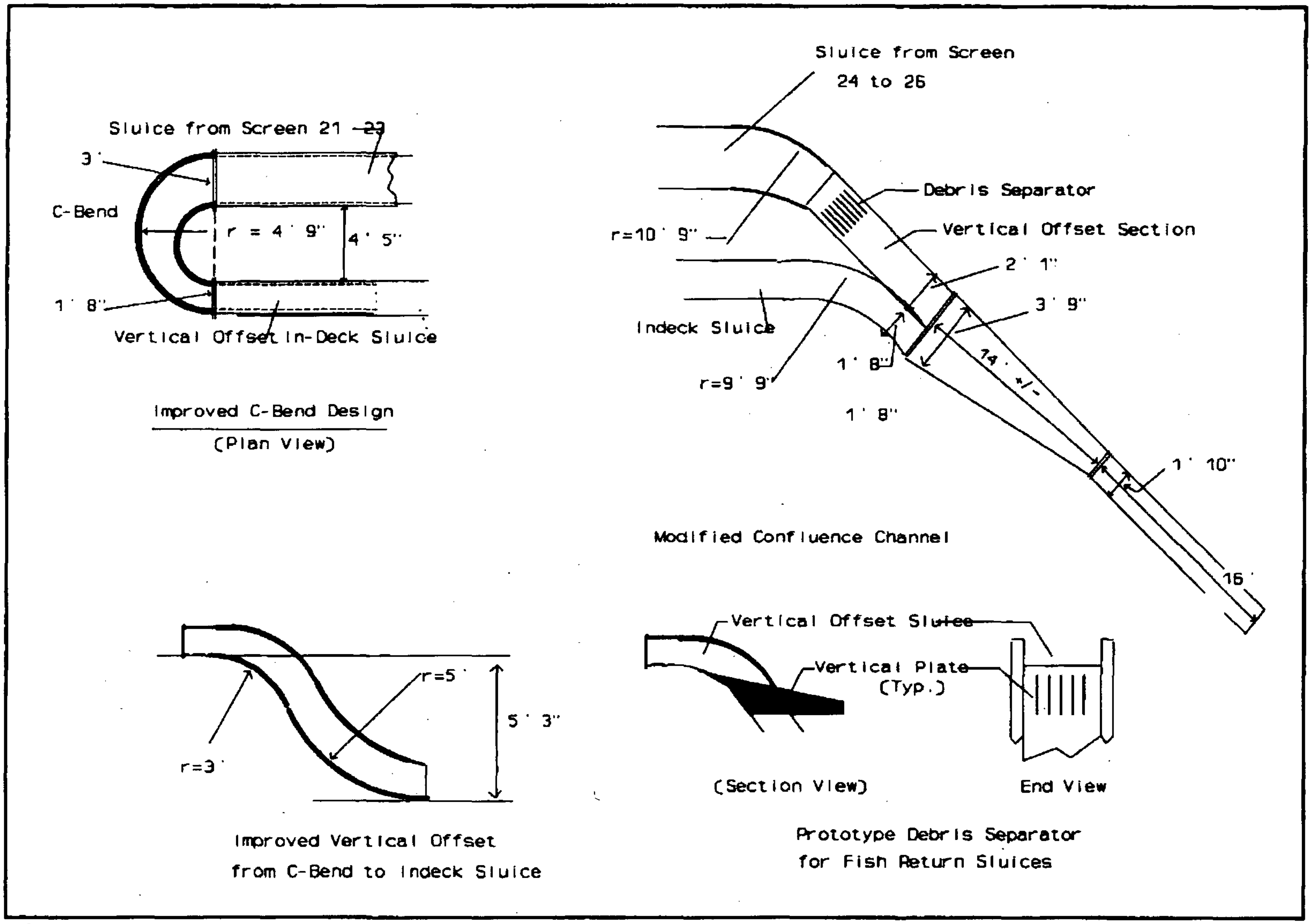

Figure 11. Improved Design Layout for Components of the Unit 2 Ristroph Screen Fish Collection and Return Sluice System.

outfitted with a large radius (r = approx 10 ft) 30° upward bend to simulate the expected design eventually to be installed in the river. In addition, the return pipe was positioned to discharge at minus 60 feet, the approximate maximum discharge depth for a return system extending about 250 feet offshore of the Unit 2 intake. The lowest part of the return pipe was at approximately 64 feet as a result of the upsweep created by the 30° bend.

As a means to alleviate potential entrapment of test fish at a depth to which they were not acclimated, a suspected contributor to the mortality incurred by white perch during the 1990 winter testing (Con Edison and NYPA, 1990), collection nets were redesigned as 5 foot diameter 60 foot tall mesh cylinders. When installed on the end of the return pipe, the net extended to the quarry surface. Upon discharge into the nets, fish would be free to swim upward to any favored depth. The bottoms of the nets were outfitted with pails to facilitate recovery of fish in water as the nets were retrieved from the quarry. Water for operating the system was supplied with gasoline powered pumps of 300 to 500 gpm rated capacity. Test procedures were similar to those followed during the summer 1990.

A scope of work outlining additional studies was sent to the DEC and Dr. Fletcher by letters dated March 14 and March 15, 1991, respectively. In a March 26, 1991 letter, Dr. Fletcher provided general comments, including a note that evaluation of return pipes longer than 180 feet was of less concern than the depth to which the fish would be exposed. He noted that a shorter pipe would provide a more severe test in that the rate of pressure change would be greater than in a longer pipe passing to the same depth.

2. Test Results

a. Air Relief Chamber

During installation of the full-scale model, tests were performed to evaluate the effectiveness of the air relief chamber to prevent the accumulation of air at the entrance to the return pipe. For this test, the chamber was outfitted with a temporary 50 foot discharge pipe that extended downward at an approximately 30° angle to a depth of 12 feet and then horizontally for 30 feet. At a flow rate of approximately 1,800 gpm, the level of the water in the chamber rose approximately 1.5 feet above the quarry surface and appeared to be full of air bubbles. Since water did not overflow the chamber nor was it discharged from the flume portal located about 4 feet above the quarry surface, as had occurred earlier, it appeared that air did not accumulate and block the flow entering the pipe. In addition, divers observed that only a very fine stream of bubbles was carried out the end of the pipe by the flow. It was concluded from these observations that the chamber was highly effective in venting entrained air from the return flow.

b. March 29, 1991 Tests

Initial tests with the improved fish collection sluice and return system were performed with white perch on March 29, 1991. Test fish were trawled from the Hudson River the morning of the test day, and were only briefly held in quarry water before testing. Other procedures were similar to those applied during the summer 1990 tests. Following discharge into the collection nets, divers noted that most fish swam upward. However, 15 minutes after the start of one test, 7 fish were on the bottom of the net, and 45 minutes after the start of another test, 16 white perch were on the bottom. Control fish, which had been released at the surface, stayed within the top 10 feet of the water column. At the end of a 96 hour latent affects assessment period, mortalities among test and control fish were found to be high (Table 14). The adjusted survival rate was 43.7% in each of the two tests performed. Fish were examined for signs of damage attributable to transport through the sluice systems. However, all appeared to be in good condition; signs of hemorrhaging or other forms of damage were not observed.

Table 14. March 29, 1991 Evaluation of Full-Scale Prototype of Indian Point Unit 2 Fish Collection Sluice and Return System, Including Air Relief Chamber.

Test Conditions

Sluice 21 to 23		Sluice 24 to 26	
Return Pipe Length:	250'	Return Pipe Length:	250'
Discharge Depth:	60'	Discharge Depth:	60'
System Water Flow:	2300 gpm	System Water Flow:	2300 gpm
Debris:	None	Debris:	None
Temp. (°C): Surface	5.5	Temp. (°C): Surface	5.5
-60 Feet	5.0	-60 Feet	5.0

White Perch N = 49, C = 50					White Perch N = 50				
Time	A	D	I	M	Time	A	D	I	M
96 hrs					96 hrs				
N	4	43	0	2	N	4	42	1	2
C	14	36	0	0					
Adjusted Survival = 43.7%					Adjusted Survival = 43.7%				

N = Number of fish tested C = Number of control fish
A = Alive D = Dead S = Damaged M = Missing

Adj. Surv. = [1-{(P - C)/(1 - C)} X 100]; for P =,> C < 1; P = proportion dead or injured; C = Proportion of control fish dead or injured. (Finney 1964). Note: Since the status of missing fish could not be determined, these fish have been excluded from the computations of adjusted survival rates.

c. April 2, 1991 Tests

The next series of tests were performed with golden shiners because of the inability to obtain white perch. Test fish were obtained from a local live bait dealer. During these tests, the vertical offset channel for the screens 24 to 26 fish sluice was outfitted with a prototype debris separator, which consisted of a series of 1/4 inch wide vertical plates spaced two inches on center (Figure 11). These plates, which extended outward from the downward-angled bottom of the sluice, were designed to remove large debris, such as sticks that are occasionally deposited in the fish sluice by the Ristroph screens, and which could block the entrance to the flume. Tests were performed to evaluate its effectiveness in removing debris as well as to allow the passage of fish without imparting damage to them.

During testing with the debris separator, some fish were observed to be carried by the flow onto the rounded ends of the vertical plates, but none showed signs of injury at the conclusion of the test. The vertical plates appeared to be effective in separating large sticks and mats of debris from the water. (Although large debris was occasionally observed in the collection sluice for the test Ristroph screen, similar conditions have not been observed since the new Ristroph screens became operational in July 1991. New bar screens, installed along with the Ristroph screens, were outfitted with ice barriers that extend 3 feet below mean low water. These barriers appear to be effective in preventing floating debris from entering the intakes. Accordingly, it is doubtful that a debris separator will be necessary.)

Control fish for these tests were placed in a screen-covered pail and lowered to minus 60 feet for release into the net to duplicate depth effects. Although agitated by the descent, the golden shiners did not display shock syndromes as they did during summer 1990 tests at depths of 40 feet. The temperature differential between surface water and that at minus 60 feet during the April 1991 tests was approximately 0.5°C in contrast to the nearly 15°C differential during the July 1990 tests. Upon release into the net, the control fish swam upward. After a 16 hour period, test and control fish were removed from the nets and examined for latent effects. Aside from 5 fish that were observed to be caught in a construction seam in the air relief chamber, survival among test fish was 100% (Table 15). One control fish died during the interval. None of the test fish showed signs of damage.

d. <u>April 3, 1991 Test</u>

On April 3, 1991, tests were performed with white perch and golden shiners. The white perch were trawled from the Hudson River during the morning of April 3. They were brought to the quarry and placed in a 4 x 4 x 6 net at minus 26 feet, the approximate depth at which they had been collected. Testing commenced approximately two hours later. Only fish that appeared to be in good condition were used for the tests.

Table 15. April 2, 1991 Evaluation of Full-Scale Prototype of Indian Point Unit 2 Fish Collection Sluice and Return System, Including Air Relief Chamber.

Test Conditions									
Sluice 21 to 23 Return Pipe Length: 250' Discharge Depth: 60' System Water Flow: 2600 gpm Debris:N None Temp. (°C): Surface 5.5 -60 Feet 5.0					Sluice 24 to 26 (With Debris Separator) Return Pipe Length: 250' Discharge Depth: 60' System Water Flow: 2600 gpm Debris: 1 gal leaves/sticks Temp. (°C): Surface 5.5 -60 Feet 5.0				
Golden Shiner N = 50 C = 50					Golden Shiner N = 50				
Time	A	D	I	M	Time	A	D	I	M
16 hrs					16 Hrs				
N	50	0	0	0	N	45	0	0	5
C	49	0	1	0					
Adjusted Survival = 100%					Adjusted Survival = 100%				

Test white perch were released into the return system within approximately 20 minutes after retrieval from the holding net. Control white perch and golden shiners were placed in a screen-covered pail and taken to the 60 foot depth for release into the holding net. Again, mortality among control white perch was high (Table 16), making adjusted survival rates dubious. All but one of the test white perch were free of signs of damage. The damaged fish had a torn opercle, the cause of which was not determined. Golden shiner survival was high, and none displayed signs of damage.

Table 16. April 3, 1991 Evaluation of Full-Scale Prototype of Indian Point Unit 2 Fish Collection Sluice and Return System, Including Air Relief Chamber.

Test Conditions									
Sluice 21 to 23 Return Pipe Length: 250' Discharge Depth: 60' System Water Flow: 2600 gpm Debris: None Temp. (°C): Surface 5.5 -60 Feet 5.0					Sluice 24 to 26 (With Debris Separator) Return Pipe Length: 250' Discharge Depth: 60' System Water Flow: 2600 gpm Debris: None Temp. (°C): Surface 5.5 -60 Feet 5.0.				
White Perch N = 50 C = 50					White Perch N = 50 C = 50				
Time	A	D	I	M	Time	A	D	I	M
23 hrs					23 Hrs				
N	7	35	0	8	N	8	36	0	6
C	4	46	0	0					
Adjusted Survival = 100%					Adjusted Survival = 100%				
Golden Shiner N = 50 C = 50					Golden Shiner N = 50				
23 hrs					23 hrs				
N	48	0	0	2	N	41	0	0	9
C	49	0	1	0					
Adjusted Survival = 100%					Adjusted Survival = 100%				

e. <u>April 9, 1991 Test</u>

There was concern that the tests performed on March 29 and April 3, 1991 might have been biased because the white perch may not have been fully acclimated to the quarry. Since several hundred white perch were still available in the 4 x 4 x 6 holding cage, which had been returned to the 26 foot depth, further testing was planned. In an effort to gradually acclimate the fish to shallow water from which they would be removed for the tests, the holding cage was raised from the 26 foot depth to 16 feet on April 5; two days later it was raised another 10 feet, and on the following day it was brought to the surface in preparation for testing on April 9.

On April 9, fish in good condition were selected for testing. Golden shiners, that had been obtained from a local bait dealer, were also used as test fish. Both species were mixed with approximately one gallon of debris (leaves) and then released into sluices 21 to 23 and 24 to

26. Control fish were placed in a screen-covered pail and released at the 60 foot depth. Divers observed both test fish and control fish to swim upward upon entrance to the nets. Several white perch swam to a depth of about six feet and appeared to be neutrally buoyant. Others that did not reach an apparent equilibrium depth settled toward the bottom. At four hours after the start of the test, divers observed 15 to 20 of both species swimming near the bottom of each of the nets. Other fish were swimming near the surface.

After a 21 hour holding period, the fish were examined for latent effects. Control white perch experienced a higher mortality rate than did test fish; 17 of the 30 control fish were dead (Table 17). Of the white perch released into sluice 21 to 23, 24 were alive, 9 were dead and 7 were moribund (showed no physical injuries, but were in poor condition). A total of 31 of the 40 white perch released into sluice 24 to 26 were alive, six were dead and three were moribund. Again, interpretation of an adjusted survival rate for white perch, although calculated, is tenuous, given the high mortality among control fish. Golden shiner adjusted survival was 100% for the two tests; only one test fish died, while 2 of the controls died. Although one of the golden shiners was injured during transit through the 24 to 26 sluice, the nature of the injury was not recorded.

f. <u>April 10, 1991 Test</u>

On April 9, trawling crews collected additional white perch as well as striped bass from the Hudson River. These fish were placed into a 12 foot diameter by 2 foot deep tank filled with approximately 1,500 gallons of river water. Quarry water was pumped into the tank at a rate of 4 gallons per minute to gradually acclimate the fish for testing. However, during the 24 hour acclimation period, most of the fish died. Although the quantities remaining were small, the white perch and striped bass were separated into 3

Table 17. April 9, 1991 Evaluation of Full-Scale Prototype of Indian Point Unit 2 Fish Collection Sluice and Return System, Including Air Relief Chamber.									
Test Conditions									
Sluice 21 to 23 Return Pipe Length: 250' Discharge Depth: 60' System Water Flow: 1800 gpm Debris: None Temp. (°C): Surface -7.5 -60 Feet -5.2					Sluice 24 to 26 (With Debris Separator) Return Pipe Length: 250' Discharge Depth: 60' Water Flow: 2300 gpm Debris: 1 gal leaves Temp. (°C): Surface -7.5 -60 Feet -5.2				
White Perch N = 40 C = 30					White Perch N = 40				
Time	A	D	I	M	Time	A	D	I	M
21 hr N C	 31 13	 6 17	 3 0	 0 0	21 Hrs N	 24	 9	 7	 0
Adjusted Survival = 100%					Adjusted Survival = 100%				
Golden Shiner N = 50 C = 50					Golden Shiner N = 50				
21 hr N C	 48 48	 1 2	 1	 0	21 hrs N	 50	 0	 0	 0
Adjusted Survival = 100%					Adjusted Survival = 100%				

approximately equal groups: one for release through sluice 24 to 26; a second to serve as a control, and the third to remain in the holding tank. Control fish were released into the net at the surface of the quarry. After 23 hours, the fish were recovered for examination of latent effects (Table 18). A total of 12 of the 16 test white perch were alive, 3 were dead and 1 was moribund. A total of 13 of the 18 control white perch were alive, 4 were dead and 1 was moribund. The adjusted white perch survival rate for this test was 100%. A total of 12 of the 17 white perch left in the holding tank were alive, 3 were dead and 2 were moribund. The overall percent survival rates among these three groups of white perch (test fish, 75%; control fish, 73%; and holding tank fish, 70%) suggested the observed

Table 18. April 10, 1991 Evaluation of Full-Scale Prototype of Indian Point Unit 2 Fish Collection Sluice and Return System, Including Air Relief Chamber.

Test Conditions									
Sluice 21 to 23 Return Pipe Length: 250' Discharge Depth: 60' System Water Flow: 1750 gpm Debris: Temp. (°C): Surface 7.7 -60 Feet 5.2					Sluice 21 to 23 Return Pipe Length: 250' Discharge Depth: 60' System Water Flow: gpm Debris: Temp. (°C): Surface 7.7 -60 Feet 5.2				
White Perch N = 16 C = 18 T = 17					Golden Shiner N = 49 C = 0				
Time	A	D	I	M	Time	A	D	I	M
23 hrs					23 Hrs				
N	12	3	1	0	N	49	0	0	0
C	13	4	1	0					
T	12	3	2	0					
Adjusted Survival = 100%					Survival = 100%				
Striped Bass N = 8 C = 8 T = 9									
23 hrs									
N	4	3	1	0					
C	4	3	1	0					
T	3	6	0	0					
Adjusted Survival = 100%									

mortality among test fish passed was due to factors other than passage through the return system. A total of 4 of the 8 striped bass tested April 10 were alive, 3 were dead and 1 was moribund. Control striped bass incurred the same level of mortality. Out of the 9 striped bass left in the holding tank only 3 were alive at the conclusion of the test. A total of 49 of the 50 golden shiners were alive at the end of the 23 hour period; one was missing.

Because of the difficulty in obtaining and holding test fish, particularly white perch, no further evaluations of the effects of the return system on fish were performed.

3. Hydraulic Conditions

During fish testing, a diagonal hydraulic jump (wave) in the confluence channel created by the union of the two dissimilar sluice flows, caused fish to be carried toward one wall of the channel. The jump, as well as the transport of fish toward the side of the channel, was greatly reduced by elimination of angular joints and increasing the radius of curvature on one wall of the confluence channel.

Transport velocities (Appendix H) through various components of the system were measured: fish collection sluices = 2.5 to 3.4 fps; in-deck sluice = 6.4 fps; combined channel section = 7.2 fps; and the flume = 7.2 fps. Velocity through the return pipe was calculated to be approximately = 7.1 fps for a flow of 2,300 gpm. Transit time over the maximum length of the system (the entrance to screen 23 sluice and the discharge point of the return pipe), a distance of approximately 540 feet, was estimated to be about two minutes, based on diver observations of fish passage through the system. Water depths in the fish collection sluices and throughout the other components of the sluice system were relatively uniform across the width of the sluices, and generally averaged approximately 1.5 to 2.0 inches.

During testing, fish were relatively efficiently transported through the system. Residency occurred only within the fish collection sluices where the transport velocity was the lowest and was generally brief in duration.

4. Discussion of Results of the 1991 Spring Tests

Tests performed during the spring 1991 suggested that the refinements to the alternative layout for Unit 2 fish collection sluice and return pipe system were not detrimental to white perch, golden shiners, or striped bass, although testing with the latter species was limited (Table 19). Survival among golden shiners was 100%. Survival among both test and control white perch was low, but essentially the same in most tests, suggesting that the return system was not the cause of the mortality observed. Although control fish mortalities were often high, survival rates of test and control fish in most tests were about the same, which suggested that the return system was not the cause of the mortality observed. Further, test fish incurred little or no damage such as bruises, loss of scales, or hemorrhages as a result of passage through the system, including a chamber designed to allow entrained air to escape from the return pipe flow. Stresses associated with collection (trawling) and handling appeared to be the primary causes of mortality among the species tested.

Table 19. Summary of Adjusted Percent Survival of Four Species of Fish Transported through the Unit 2 Return System, Spring 1991.

	Species		
Date	Golden Shiner	White Perch	Striped Bass
March 29	- -	43.7 43.7	- -
April 2	100 100	- -	- -
April 3	100 100	100 100	- -
April 9	100 100	100 100	- -
April 10	100	100	100

Observations disclosed that upon discharge at minus 60 feet, surface-acclimated fish made a concerted effort to swim upward, even when water temperature differentials between the surface and the discharge depth were small (0.5°C). Those that did not reach an apparent pressure equilibrium depth tended to settle in the water column. Except for white perch in the winter, which were trapped by the nets at the discharge depth, similar responses were not observed among test fish when the discharge was at about 35 to 40 feet. Based on these responses, a return pipe that discharges at a shallower depth would appear to be beneficial, although many of the species of fish commonly observed in impingement samples at Indian Point are collected in trawls at or below the 60 foot depth (Table 20).

The prototype of the return system tested in 1991 appeared to successfully correct the concerns raised by Dr. Fletcher and NYSDEC. The 30° upturn at the discharge of the return pipe neither interfered with fish or debris transport nor entrapped air.

In summary the results of the component design tests indicate that the effects on fish of a return system consisting of these design elements will be minimal, and that effectiveness at Indian Point Unit 2 may be enhanced by placing the discharge at a depth of approximately 40 feet rather than at greater depths further offshore.

Table 20. Depth Distribution of Fish Species Collected in River Surveys in the Indian Point Region of the Hudson River, 1986-1990.

Species:		Alewife	Bay Anchovy	Bluefish	Hogchoker	Blueback Herring	Striped Bass	Atlantic Tomcod	White Perch	Weakfish
Numbers of fish collected:		114	9,395	29	46,657	1,862	3,074	3,835	5,513	1,173
Depth (Ft)	Number of Tows	Percentage of Total Observed								
10	11	0	5.6	0	0	0	20.1	0	0	11.1
20	24	0	16.7	11.4	9	1.3	8.5	1	0	2
30	37	4.7	13	31.9	20	15.8	13.8	1.1	11.6	6.1
40	16	7.3	27.2	0	36.5	17.8	16.8	1.2	12.5	4.6
50	20	14.7	19.5	56.8	12.8	8.1	40.9	2.4	10.4	23.3
60	4	12.9	1.7	0	0	6.6	0	24.6	27.2	0
70	6	11.7	14	0	8.6	11.1	0	3.2	38.2	52.9
80	3	48.6	2.4	0	13.1	39.3	0	66.5	0	0
Total	121	100	100	100	100	100	100	100	100	100

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APPENDIX A

Con Edison
Consolidated Edison Company of New York, Inc.
4 Irving Place, New York, N.Y. 10003

December 5, 1990

Dr. R. Ian Fletcher
Great Salt Bay Experiment Station
P.O. Box 1056
Damariscotta, Maine 04543

Dear Ian:

Enclosed is a draft report on the results of the live marked fish release/ recirculation tests that we conducted at Indian Point during September and October.

I will be calling you in a few days to discuss the interpretation of the results we obtained. If you have any questions or need additional information, please call Ken Marcellus or John Young.

Sincerely,

Bill

William L. Kirk, Ph.D.
Director
Biological Studies and Evaluation

KLM/bjd
enclosure
cc: K. L. Marcellus
J. R. Young

RISTROPH SCREEN RETURN LINE LOCATION STUDIES
RECIRCULATION OF LIVE MARKED STRIPED BASS

INTRODUCTION

In the July 1990 report *"Indian Point Units 2 and 3 Ristroph Screen Fish Return System Prototype Evaluation and Siting Study"*, several studies of the zones of cooling water withdrawal at the Indian Point Generating Station, including a recently completed dye recirculation study, were summarized and the results used to select a location for the fish return system discharge. The conclusion drawn from these studies was that some uncertainty remained as to the most desirable terminus for the Unit 2 fish return pipe. The gross recirculation rate for dye released near the river bed 210' offshore of the Unit 2 intake was 54% (43% to Unit 2, 11% to Unit 3) during full circulating water flow. Although the dye recirculation rate was unadjusted for eddy current diffusion, which may have biased upward the total quantity recorded in the intakes relative to that representing the parcel of water marked by the dye, a recirculation rate on the order of 54% would clearly be higher than desirable for released fish.

The July report also noted that test fish, including striped bass, alewife, golden shiner, and white perch, almost always swam actively downward to the bottom of the enclosure positioned at the 40 foot water depth upon discharge from a full-scale prototype return pipe at the Verplanck quarry. This behavior suggested that they would be unlikely to be passively transported by water currents, like molecules of dye, following release into the river. Recirculation to the intakes would be, at least in part, a behavioral response of the fish, and not simply a passive transport phenomenon. If the quarry tests accurately reflect fish behavior after discharge from the return system, then the dye studies at Indian Point may not reliably predict the probable rates of fish recirculation to the intakes. In light of these considerations, the following recommendations were included in the July 1990 report:

- Complete engineering specifications and solicit proposals for construction of a fish and debris return line to discharge at a point approximately 225' from the shoreline along a westerly oriented line 145' north of the intake centerline.
- Consider tagging studies to determine whether live fish released at various locations along the westerly oriented line would return to the intakes at rates different from those for dye particles.

This strategy would allow engineering design work for the return line to move forward so that construction could be completed in the spring of 1991 when the screens are scheduled to begin operating. If any additional information on rates of live fish return to the intakes became available, the final length of pipe might be reduced.

In early September, a study plan for evaluating the recirculation of live, marked striped bass released at potential return pipe discharge locations was developed in consultation with Dr. Ian Fletcher and then implemented at the Indian Point station.

STUDY PLAN

Model Of The Reimpingement Process

When a fish is released into the Hudson River from the outlet of the fish return system, it can be considered to be located within a particular small "parcel" of water. The tidal current of the river will move this parcel either upstream or downstream, depending on the tidal conditions at the time of release. Eventually, the tide will reverse directions and the parcel of water will move past the plant intakes and be vulnerable to being drawn into the cooling system. The fish, if still within the parcel, will then be vulnerable to reimpingement with each reversal of tidal direction until net downstream movement removes the parcel entirely from the withdrawal zone; therefore, reimpingement vulnerability can be considered as a series of episodes that occur as the parcel moves past the intakes twice in each tidal cycle.

As time passes, fish will not remain in the original parcel of water, but instead will disperse out of the parcel to other locations. Thus their actual vulnerability to reimpingement will be different than it would be if they remained within the parcel. The probability of reimpingement of these dispersing fish could increase or decrease with time, depending upon the direction and speed of movement of the fish rather than of the water:

$$P(R|N)_t = P(R)_0 \, \phi(t) \qquad \textbf{Equation 1}$$

where $P(R\|N)_t$	=	probability of being reimpinged (R) in time interval t given that the fish is not reimpinged (N) prior to t
$P(R)_0$	=	initial probability of reimpingement at the time of release
$\Phi(t)$	=	function describing relative change in probability of reimpingement through time
t	=	time intervals since release

If movement out of the original parcel were strictly a diffusion process, then $\Phi(t)$ might be reasonably approximated by an exponential function. However, since the process actually involves not only eddy diffusion of the parcel, but also active movement of the fish, the form of $\Phi(t)$ cannot be determined *a priori*.

The marginal probability of reimpingement in each period is:

$$P(R)_t = P(R|N)_t \, [1-\sum_{i=0}^{t-1} P(R)_i] \qquad \textbf{Equation 2}$$

where $P(R)_t$	=	probability of being reimpinged in interval t
$[1-\Sigma P(R)_i]$	=	probability of not being reimpinged prior to t

The total probability of reimpingement is the sum of the marginal probabilities of reimpingement for each sampling interval after release:

$$P(R) = \sum_{t=0}^{\infty} P(R)_t \qquad \textbf{Equation 3}$$

Values of the conditional probability of reimpingement during each interval, $P(R|N)_t$, can be estimated directly by conducting a mark-recapture study in which marked fish are released at the potential discharge locations, then recaptured on the intake screens over several subsequent tidal cycles. The estimate of $P(R|N)_t$ is the number of marked fish impinged in the interval divided by the number of marked fish remaining in the river at the beginning of the sampling interval. If the conditional probabilities do not decline to zero over the course of the sampling, then statistical analysis can be used to estimate the form and parameter values for $\Phi(t)$ and $P(R)_0$.

Once the $P(R|N)_t$ are estimated for each release location, either directly or through use of $P(R)_0$, $\Phi(t)$ and Equation 1, the marginal probability of reimpingement, $P(R)_t$ can be estimated from Equation 2. The total probability of reimpingement for each release location can be determined from Equation 3.

Utilizing the model as a planned base for analyses, the following generalized study design elements were formulated to provide the best opportunity for obtaining the requisite input data:

1) Release fin clipped striped bass near the bottom at the specified locations on the low slack tide, maximum flood, high slack, and maximum ebb tidal currents. Fish will be distinctly marked by group-specific fin clips for identification of the location and tide stage of release.

2) Monitor impingement collections for marked and unmarked striped bass for several days.

3) Conduct experiments to estimate the efficiency at which impinged fish are collected from the intake screens.

An important consideration in this study is the need to discriminate impingement that results from fish being at particular locations relatively near the intakes, i.e., potential end points of the fish return pipe, from impingement that results from fish being in the general vicinity of the Indian Point Generating Station. Since the actual behavioral/environmental factors which result in fish becoming impinged are unknown, the study design could not positively account for these two different contributors to impingement; however, the conceptual model of the reimpingement process may allow us to attempt this discrimination. The focus of data analyses is to identify, by release location, the probability that fish will return to the intake due to their presence at the discharge point. If possible the probability of impingement due to their presence in the plant vicinity will be factored out of the total impingement probability. Fish impingement probabilities will be compared with discharge location specific recirculation rates for dye-marked water.

RISTROPH SCREEN RETURN LINE LOCATION STUDIES
RECIRCULATION OF LIVE MARKED STRIPED BASS

MATERIALS AND METHODS

TRIAL 1: September 11 to 14, 1990

The first marked fish release was performed September 11-14, 1990. Hatchery-reared striped bass were used as test fish. The plan called for the release of 4,000 fish at each of two proposed return line discharge locations, one at 110' offshore and other at 210' offshore. Each point was located along an imaginary westerly oriented line situated 145' north of the centerline of the Indian Point Unit 2 intake, and was marked with a buoy. In order to evaluate the influence of the tidal currents at each location, approximately 1,000 test fish were released on each of four tidal current stages: flood tide; high slack; ebb tide; and low slack. Striped bass were marked by clipping fins to signify the location and stage of tide for release. The fish were released within five feet of the bottom in lots of approximately 200 fish at half hour intervals starting one hour before and ending one hour after the nominal tidal condition.

The six circulating water pumps at each Indian Point unit were scheduled to be operated at 100% flow (140,00 gpm/pump). However, a leak occurred in a steam condenser at Unit 2 and, as a consequence, pump 26 was shut down for most of the test.

As a measure of the efficiency at which impinged fish were recovered from the Unit 2 intake screens, marked dead golden shiners were periodically released at about mid-depth (-15') within a few inches of the fixed fine mesh intake screen at bay 22 and about 12' in front of the Ristroph screen at bay 26. When the circulating water pump at bay 26 was shut down, fish scheduled to be released at bay 26 were released into bay 25 at which the fixed screen had been pinned up. Approximately 50 striped bass that had died prior to release were remarked and also released at bay 22 to evaluate impingement collection efficiency. Collection efficiency fish were also released at Unit 3 (at screen 35).

The six traveling screens at Unit 3 were washed, two at a time, for 30 minutes every 1-1/2 hours throughout the test period. At Unit 2, the fixed fine-mesh screens at the entrance to four intakes were to be raised and washed every 12 hours. Their associated traveling screens were to be washed for 20 minutes each at these locations. The remaining two screens, screens 25 and 26, were to be operated continuously. The fine-mesh screen at intake 25 was blocked in the up position for the duration of the test, a condition that was expected to facilitate the collection of fish on the traveling screen. The coarse mesh screen at the entrance to bay 26 was left down since it did not prevent movement of fish into the intake. Debris and associated impinged fish washed from the screens were to be retained in the debris collection basin for recovery by the impingement monitoring personnel.

Prior to the start of the tests, pump 26 was shut down because of condenser tube leaks, effectively eliminating active impingement on the test Ristroph screen. At approximately 21 hours into the test, the fixed screen at bay 24 was pinned up and its associated traveling screen was switched to continuous wash for two hours because of heavy debris loading; the remaining three traveling screens were switched to continuous wash, even though their associated fixed screens were left down. This unscheduled screen washing procedure resulted in excessive accumulations of debris and the consequent overflow of the collection pit. As a result, possible losses of recirculated striped bass as well as impingement collection efficiency test fish may have occurred. After this incident on September 12, screens were washed every four to six hours throughout the duration of the test.

TRIAL 2: October 17 to 22, 1990

The procedures followed during the October fish recirculation tests were similar to those used during the first test, with the following exceptions:

1) 5,300 hatchery-reared striped bass were planned to be released at each of three locations: 110 feet, 160 feet, and 210 feet offshore.
2) Collection efficiency fish (dead dyed and finclipped centrarchids) were to be released approximately 11 hours and one hour before routine intake screen washing at Unit 2. (This double release was to evaluate predation rates of blue crabs on impinged fish over the 12 hour interval between screen washings.)
3) The circulating water pumps at Unit 2 were to be operated at the 100% flow rate; those at Unit 3 would not be operated since a refueling outage was in progress.

4) The fixed screens at intakes 22 and 24 were to be blocked up and their associated traveling screens operated continuously to facilitate the collection of impinged fish.

5) The fixed screens at intakes 21, 23, and 25 were to be raised for washing every 12 hours during the test.

Impinged fish were to be collected during every fixed screen washing, and at more frequent intervals for those screens at which the fixed screens were blocked up and the associated traveling screens run continuously.

RESULTS

TRIAL 1: (September Test)

1) Intake Water Flows

Only five of the six circulating water pumps were operated at Unit 2 during the first 59 hours of the test. Pump 26 was out of service because of a leak in a condenser tube. The resultant flow was 700,000 gpm. Upon completion of repairs, the flow was increased to 840,000 gpm. Four and a half hours later the flow was reduced to 700,000 gpm again due to the reoccurrence of the tube leak. Sixteen hours later the flow was increased to 840,000 gpm for a four hour period, but then reduced to 700,000 gpm for the remaining 10 hours of the test interval. (Although pump 26 ran intermittently, screen 26 was operated continuously throughout the test.)

The circulating water flow rate at Unit 3 was 840,000 gpm for the duration of the test. Service water flow rates at the station averaged 47,000 gpm throughout the test period. The combined total intake water flow rate for the test period was approximately 1,585,000 gpm.

2) Test Fish Recoveries

A total of 37 of 3,958 fish released at the 110' location were recovered from the intake screens, while only 17 of 4015 fish released at the 210' location were recovered (Table 1). All but one of the recovered fish came from Unit 2. The one recovered at Unit 3 had been released at the 210' location. The overall gross recovery rates, unadjusted for impingement collection efficiency, were 0.009 and 0.004 for the 110' and 210' release locations, respectively. The recovery rate for 210' was 44% of the rate for 110'.

RISTROPH SCREEN RETURN LINE LOCATION STUDIES
RECIRCULATION OF LIVE MARKED STRIPED BASS

Table 1

Release and Recapture of Marked Striped Bass During the First Experimental Period, September 11-15, 1990

Release Time	Tide	Location	Number Released	Number Recaptured	Recapture Rate
1328- 1400	Low Slack	110' 210'	983 1010	10 3	0.010 0.003
1502-1700	Flood	110' 210'	1000 1015	5 9	0.005 0.009
1839-2020	High Slack	110' 210'	991 995	9 1	0.019 0.001
2224-2400	Ebb	110' 210'	984 995	13 4	0.013 0.004
--	Combined	110' 210'	3958 4015	37 17	0.009 0.004

During this test period, the gross recovery rate was higher from the 110' release location than from the 210' location on three of the four tidal stages; the recovery rate for fish released on the flood tide was higher for the 210' location (Figure 1).

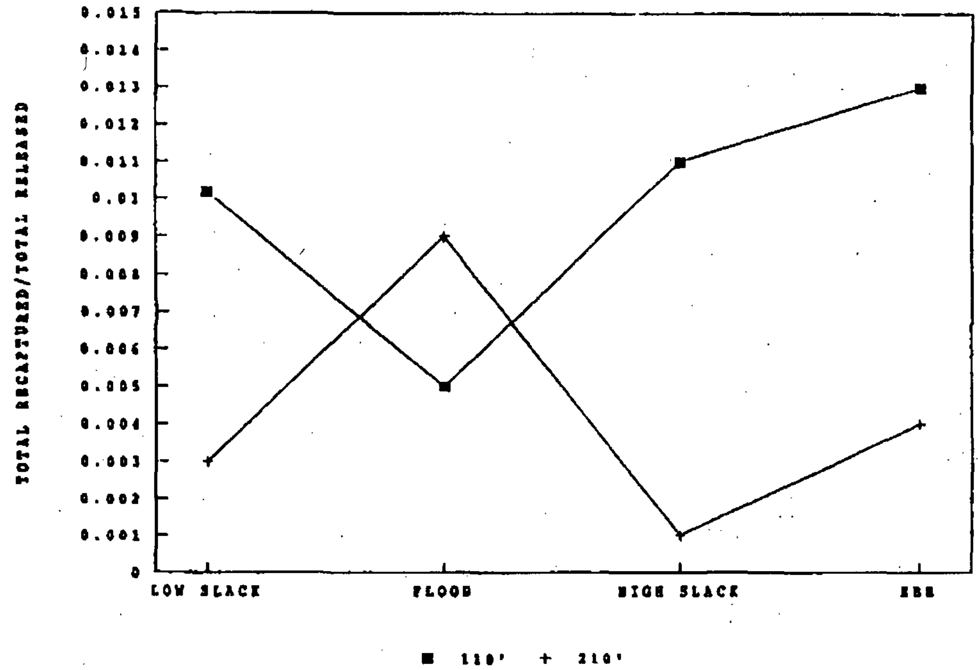

Figure 1 Unadjusted Recapture Rates of Striped Bass Released During the First Experimental Period, September 11-15, 1990

3) Collection Efficiency Fish Recoveries

Recoveries of impingement collection efficiency test fish were extremely variable (Table 2). Out of 750 fish released at both units combined, only 50 were recovered (gross recapture rate = 0.067). At Unit 2, a total of 27 out of 100 released at intake 26 were recovered even though the circulating water pump was operated only briefly during the test period. Five fish were recovered out of 100 released at intake 25, while none of the 350 released on the fixed screen at bay 22 were recovered following any of the 13 screen washings during the test interval. At Unit 3, a total of 18 of the 200 fish released were recovered.

Table 2

Release and Recapture of Collection Efficiency Test Fish (Golden Shiner, Striped Bass) During the First Experimental Period, September 11-15, 1990

Date	Time	Location	Number Released	Number Recovered	Rate
9/11/90	1317	26	100	27	0.27
	2325	25	100	5	0.05
	1311	35	100	13	0.13
	2339	35	100	5	0.05
9/12/90	0700	22	50	0	0.00
	1900	22	50	0	0.00
9/13/90	0100	22	50	0	0.00
	0730	22	50	0	0.00
	1800	22	50	0	0.00
9/14/90	0200	22	50	0	0.00
	0200	22	50	0	0.00
Totals			750	50	0.067

4) Application of Reimpingement Model (September Test Results)

Due to the small number of recaptured fish, the data were not suitable for application of the model described earlier. Probabilities of reimpingement are therefore estimated from the gross recapture rates.

If it is assumed that the collection efficiency rates are a true measure of recovery rates of test fish released at the alternative discharge locations, the adjusted fish recirculation rates for the 110' release point might be 0.134 (0.009 + 0.067), and for the 210' release point 0.059 (0.004 + 0.067). These rates are substantially lower than the gross recirculation rates to Units 2 and 3 combined for dye released at 110' (0.89) and 210' (0.54).

TRIAL 2: (October Test)

1) Intake Water Flows

During the first 22 hours of the planned 96 hour test period, the Unit 2 circulating water flow rate was 840,000 gpm. It was briefly (40 minutes) reduced to 700,000 gpm when the traveling water screen at bay 26 failed and was shut down at about 22 hours into the test. The circulating water flow rate averaged 822,000 gpm over the duration of the test.

The Unit 3 circulating water pumps were not operated during the test interval. The average service water flow for the test period was 25,800 gpm. The total intake water flow rate for the test period was approximately 847,000 gpm.

2) Test Fish Recoveries

During the second release experiment, total recaptures were 375 out of 5,371 fish released at the 110' location, 138 out of 4,586 fish released at the 160' location, and 98 out of 4,426 fish released at the 210' location (Table 3). Overall gross recapture rates (number recaptured/number released) were 0.070, 0.030, and 0.022 for the three locations. The overall ratio of recoveries from the 210' release location relative to the 110' location was 32%, and that for the 160' location relative to the 110' location was 43%. The ratio of the 210' location relative to the 160' location was 73%.

During this test, gross recapture rates for fish released at the 110' location were consistently higher than were the recovery rates for the 160' and the 210' release locations regardless of the tide stage. Recovery rates from the 210' release location were also generally comparable to or less than the recovery rates from the 160' release location (Table 3; Figure 2).

Table 3

Release and Recapture of Marked Striped Bass
During the Second Experimental Period, October 17-22, 1990

Release Time	Tide	Location	Number Released	Number Recaptured	Recapture Rate
0911-1111	Flood	110	1299	120	0.092
		160	962	40	0.041
		210	1311	53	0.040
1206-1406	High Slack	110	1368	59	0.043
		160	1128	49	0.043
		210	420	14	0.033
1530-1730	Maximum Ebb	110	1378	50	0.036
		160	1142	3	0.002
		210	1334	9	0.006
1836-2036	Low Slack	110	1326	146	0.110
		160	1354	46	0.033
		210	1361	22	0.016
	Combined	110	5371	375	0.069
		160	4586	138	0.030
		210	4426	98	0.022

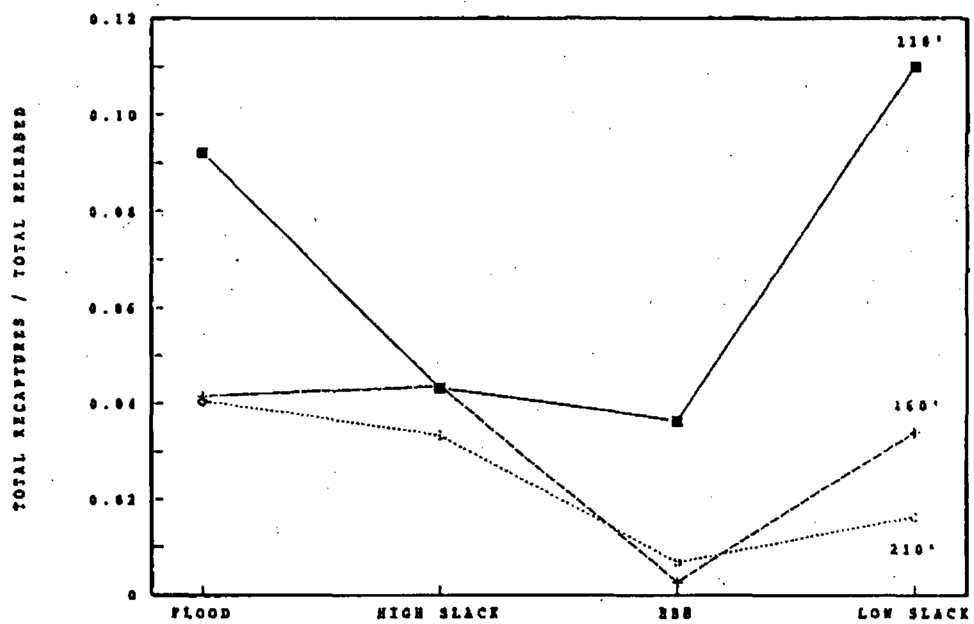

Figure 2 Unadjusted Gross Recapture Rates of Striped Bass Released During the Second Experimental Period, October 17-22, 1990

3) Collection Efficiency Fish Recoveries

Recoveries of impingement collection efficiency test fish were also highly variable during the October test (Table 4). Collection efficiency from intakes at which fixed screens were down (21, 23, and 25) averaged 0.272, while the efficiency at intakes with fixed screens blocked partially up was 0.086, the opposite relationship to the intake screen position effect expected. The lower recovery of fish at intakes with fixed screens blocked up is difficult to explain, especially since an effort was made to release fish directly into the intake bay. The overall average collection efficiency rate for all screen positions combined was 0.198. Assuming these are accurate reflections of recovery rates of test fish released at the alternative discharge locations, the adjusted recirculation rate for the 110' release point might be 0.353 (0.070 + 0.198); for the 160' release point, 0.151 (0.030 + 0.198); and for the 210' release location, 0.111 (0.022 + 0.198).

Collection efficiency recoveries were examined for potential losses due to predation by blue crabs. Seventeen percent of the collection efficiency fish released more than nine hours before the screen wash were recovered, while 22% of those released less than three hours before the wash were recovered (Table 4). Although the relative abundance of blue crabs at the intake screens during the test period was considered low, the results do suggest that recovery rates decline with increased duration of impingement on non-moving screens.

Table 4

Release and Recapture of Collection Efficiency Test Fish (Bluegills) During the Second Experimental Period, October 17-22, 1990

Date	Release Time Before Screen Wash	Fixed Screens Down			Fixed Screens Up			Total		
		Rel	Rec	Rate	Rel	Rec	Rate	Rel	Rec	Rate
Oct. 17	>9 hours	150	37	0.25	100	10	0.10	250	47	0.19
	<3 hours	150	25	0.17	100	11	0.11	250	36	0.14
Oct. 18	>9 hours	300	63	0.21	200	14	0.07	500	77	0.15
	<3 hours	300	117	0.39	200	21	0.10	500	138	0.28
Oct. 19	>9 hours	150	37	0.25	100	10	0.10	250	47	0.19
	<3 hours	150	48	0.32	100	3	0.03	250	51	0.20
Totals	>9 hours	600	137	0.23	400	34	0.08	1000	171	0.17
	<3 hours	600	190	0.32	400	35	0.09	1000	225	0.22
		1200	327	0.27	800	69	0.09	2000	396	0.20

5) Application of Reimpingement Model (October Test Results)

To facilitate data analyses, a standardized reimpingement rate was calculated for each screen wash interval to adjust for irregular durations between screen washes and the declining number of fish available for recapture using the following equation:

$$P_i = \frac{1000\ R_i}{[M - \sum_{i=1}^{i-1} R_i] D_i}$$

where

P_i = *standardized rate of reimpingement* = *(number per 1000 fish per hour)* Equation 4

M = *number of marked fish released*

$\sum_{i=1}^{i-1} R_i$ = *number previously recaptured*

D_i = *hours since last collection*

R_i = *number recaptured in interval i*

The standardized impingement rate data are presented in Appendic C. Even with the higher number and longer period of occurrence of recaptured fish in the second experiment, the data were still not well-suited to formal parameter estimation for the *a priori* theoretical model of the reimpingement process described in the introduction. The high variability of the standardized rates (Figures 3, 4, and 5), which are estimates of $P(R|N)_0$ with many values near zero and a few relatively high values, precluded estimation of $P(R)_0$ and $\Phi(t)$. However, the decline in occurrence of recaptures of marked fish at all three locations to near zero levels within the period of the experiment makes the estimation of $P(R)_0$ and $\Phi(t)$ unnecessary.

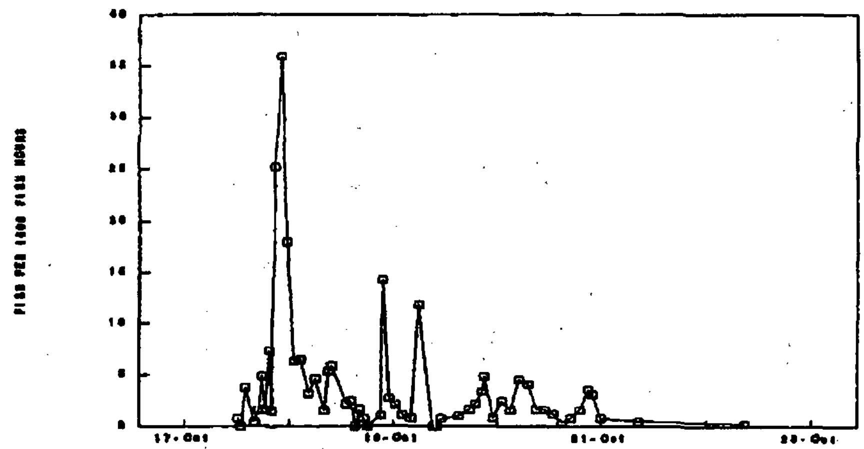

Figure 3 Standardized Reimpingement Rates for Striped Bass Released At 110' During the Second Release Experiment, October 17-22, 1990

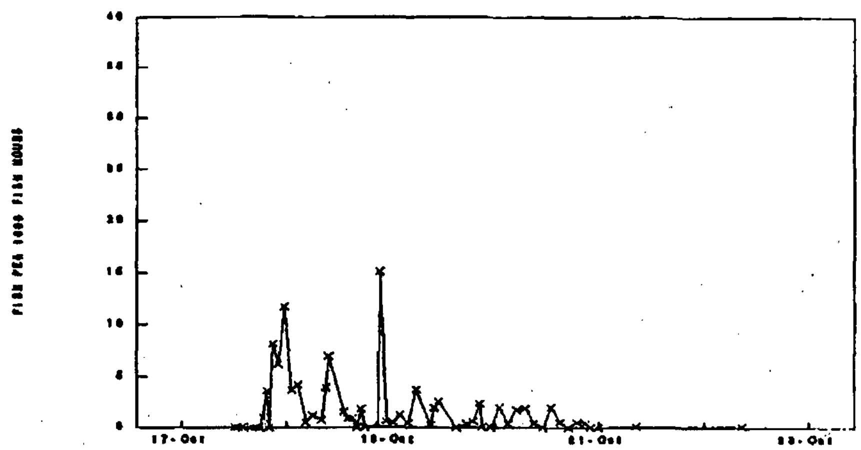

Figure 4 Standardized Reimpingement Rates for Striped Bass Released At 160' During the Second Release Experiment, October 17-22, 1990

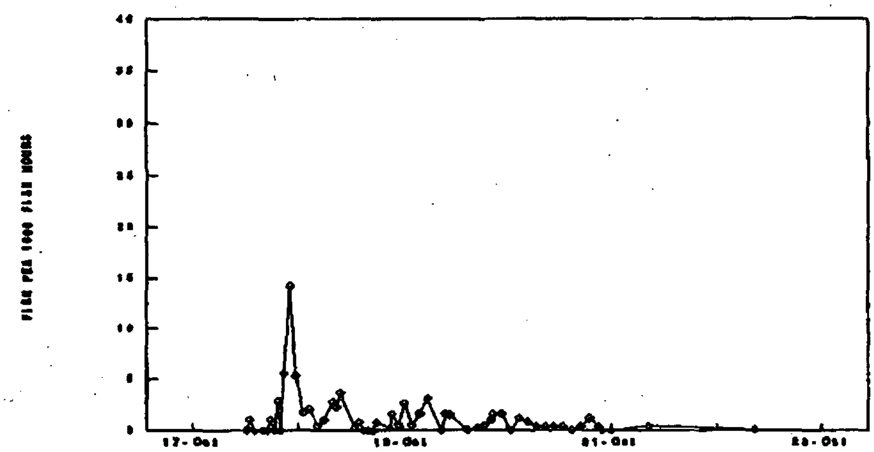

Figure 5 Standardized Reimpingement Rates for Striped Bass Released At 210' During the Second Release Experiment, October 17-22, 1990

The high standardized impingement rates seemed to occur primarily at night (before 6 AM or after 6 PM) and on a flooding tide (Figures 6, 7, and 8). The correspondence with nighttime periods was strongest for fish released at 110' (Figure 6), and was less obvious for 160' and 210' release groups (Figures 7 and 8). The correspondence with tides is not especially distinct; however, the tide values represent the predicted tidal current (m/sec) at the midpoint of the collection interval. Thus, when intervals are more than a few hours long, actual tidal current can range from one extreme to the other during the interval.

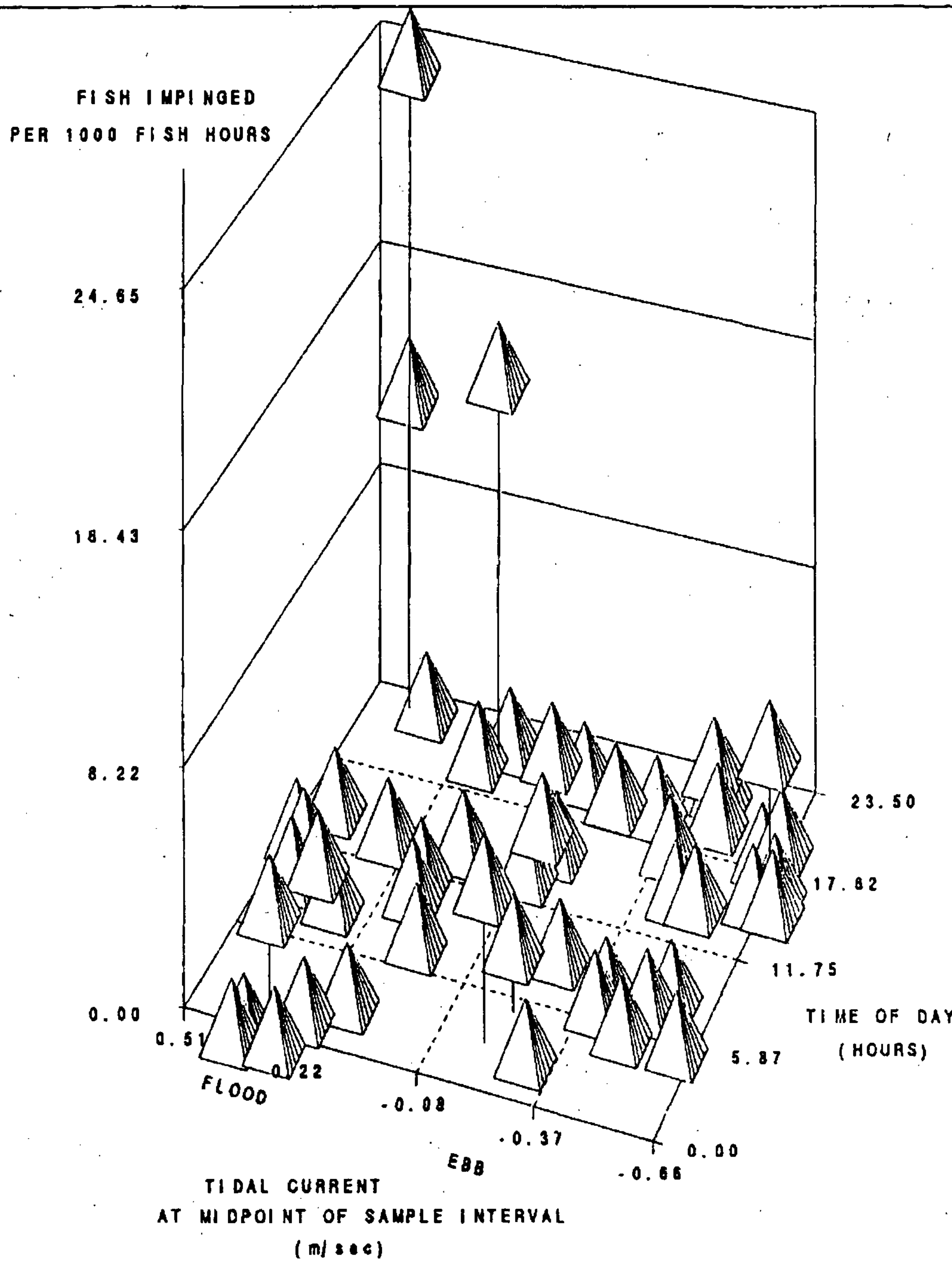

Figure 6 Standardized Reimpingement Rates for Striped Bass Released At 110' as a Function of Time of Day and Tidal Current

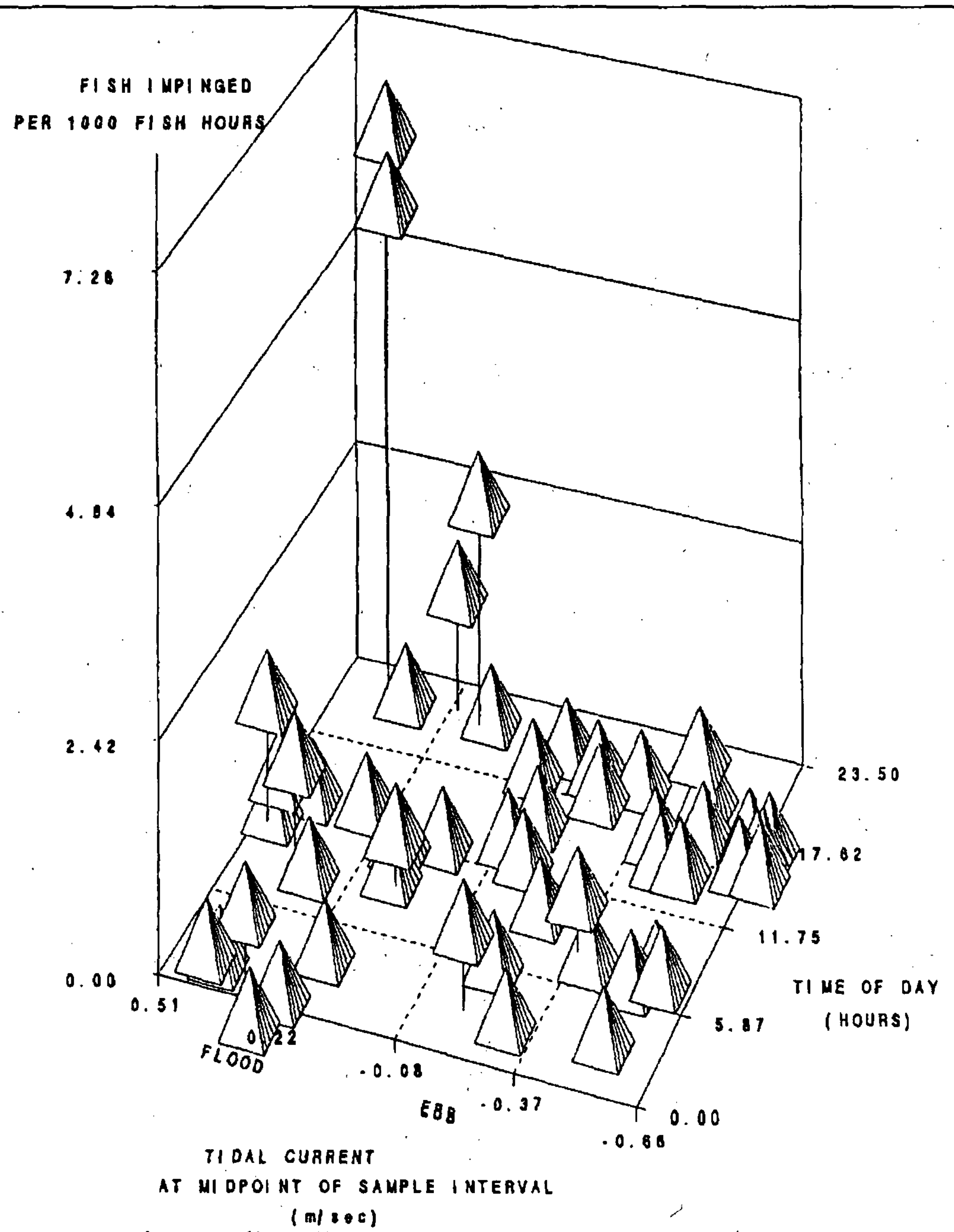

Figure 7 Standardized Reimpingement Rates for Striped Bass Released At 160' as a Function of Time of Day and Tidal Current

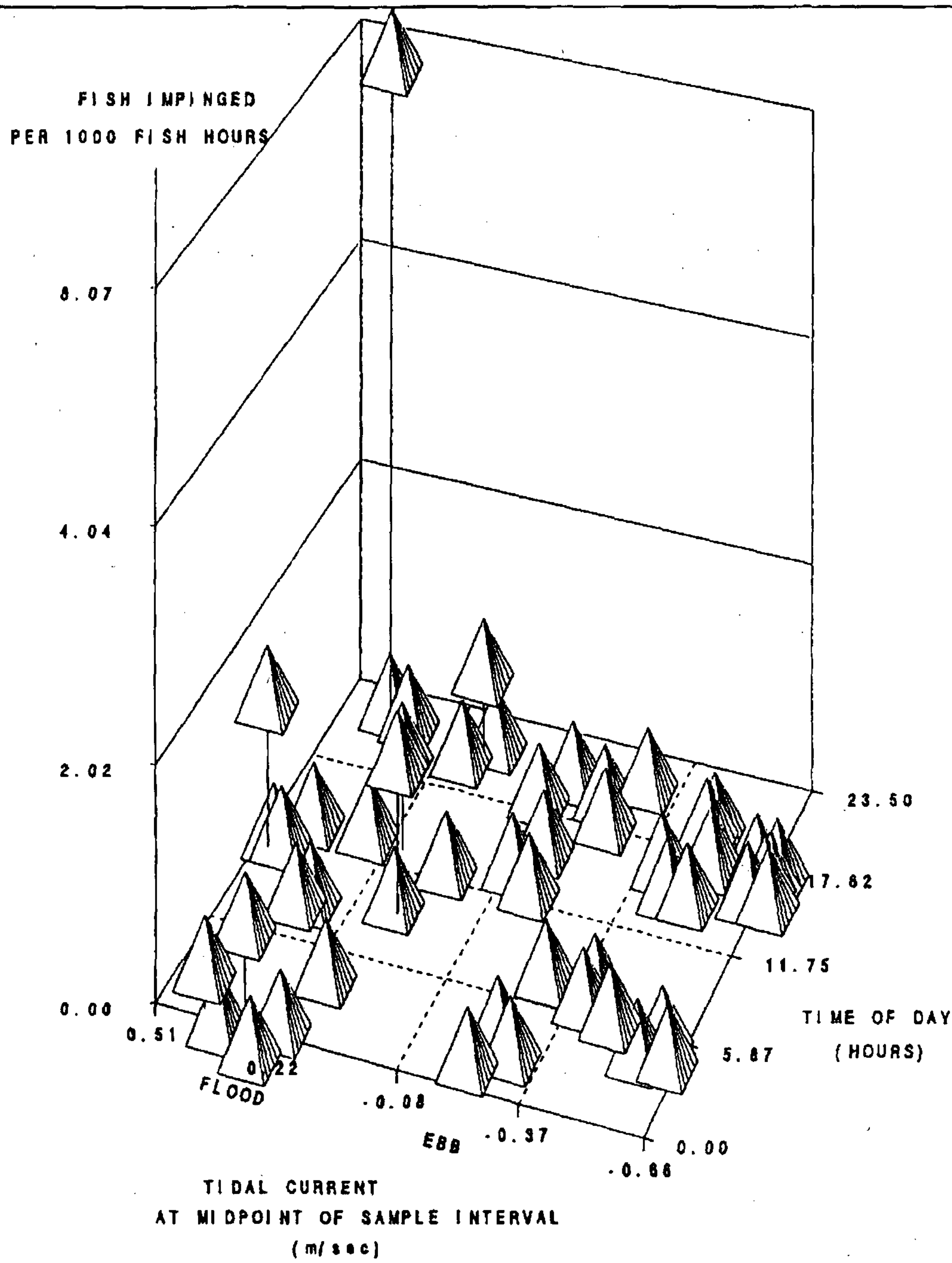

Figure 8 Standardized Reimpingement Rates for Striped Bass Release At 210' as a Function of Time of Day and Tidal Current

The standardized reimpingement rates exhibited distinct spikes for all three release locations, but the spikes were much higher for the 110' location (Figure 3) than for the 160' (Figure 4) and 210' locations (Figure 5). The maximum observed rate was 37 fish per 1,000 fish per hour (37 fish impinged in an hour for each 1,000 fish in the river). This rate occurred when fish released during low slack tide at 110' were impinged within hours of the time they were released (Figure 3). Although the 160' and 210' releases also exhibited spikes, maximum observed rates were 17 and 15 fish per 1,000 fish per hour respectively (Figures 4 and 5). These maxima were also composed primarily of fish released at low slack tide. During most collection intervals impingement rates were less than 3 fish per 1,000 fish per hour for releases at all three locations, which may represent the maximum base probability of impingement for fish in the vicinity of the intake structures.

6) Natural Impingement

During the interval October 17 to October 22, when impingement collections were monitored for marked striped bass, a total of 538 wild striped bass were collected. The fraction of the total striped bass impingement that was comprised of wild fish ranged from 0.12 on October 17 to 0.86 on October 22 (Table 5).

Table 5

Number of Hatchery and Wild Striped Bass in Impingement Collections During the Second Experimental Period, October 17-22, 1990

Date	Total Number Impinged	Recaptured	Wild	Proportion Wild
October 17	275	242	33	0.12
October 18	218	145	73	0.33
October 19	244	105	139	0.57
October 20	298	97	201	0.67
October 21	15	8	7	0.47
October 22	99	14	85	0.86
Totals	1,149	611	538	-

The decline in the proportion of the striped bass impingement composed of marked fish could have two causes. First, the marked fish could be dispersing from the plant vicinity so that the fraction of the near-field population composed of marked fish continually declines. A second possible reason for the decline in proportion of marked fish is an influx of wild striped bass. During the fall, many juvenile striped bass move down river to the lower estuary and spend the winter near the mouth of the Hudson River. An influx of unmarked wild striped bass into the area would therefore be expected at this time. Actually, both activities were probably occurring to some extent. The data in Table 5 suggest that an influx of wild striped bass occurred during the interval October 17 to October 20, based on the increase in numbers collected each succeeding day. The data in Table 6 suggests that substantial dispersal from the 110' release location occurred between October 17 and October 18. The expected number of recaptures from the 110' release location on October 18, based on the recovery rate on October 17, might have been 162 fish {(5371-167) x (167/5371) = 162} if dispersal was not occurring. However, less than half that number (72) were recovered. Overall, the data suggest that after about four days, most of the released fish were no longer available for recirculation.

Table 6

Marked Fish Recoveries by Release Location and Date

	110'	Proportion	160'	Proportion	210'	Proportion	Total
Date	5,371 Released		4,586 Released		4,426 Released		14,383
Oct. 17	167	0.031	42	0.009	33	0.007	242
Oct. 18	72	0.013	47	0.010	26	0.006	145
Oct. 19	62	0.011	23	0.005	20	0.004	105
Oct. 20	62	0.011	21	0.004	14	0.003	97
Oct. 21	5	0.001	1	0.000	2	0.000	8
Oct. 22	7	0.001	4	0.001	3	0.001	14

DISCUSSION

During September, 1989, dye release studies were performed to determine the potential for fish to be recirculated to the Indian Point Units 2 and 3 intakes from alternative return line discharge points. Results suggested that recirculation to the Unit 2 intake from a point 110' offshore might be 86%, while that from 160' might be 61%, and from 210', 43%. Return rates to the Unit 3 intake were 3%, 3%, and 11%, respectively for these three release locations offshore of Unit 2. These results reflected totally passive transport, including diffusion, from the alternative locations.

During September and October, 1990, live marked fish were released at the same discharge points to evaluate recirculation rates for non-passive organisms. During the first test, when both Units 2 and 3 were operating at nearly full flow capacity, recirculation rates for fish, adjusted for impingement collection efficiency, were 0.134 from the 110' location and 0.059 from the 210' location. However, these results were suspect since uncertainty existed about whether recirculated fish, collection efficiency fish, or both, were lost when the collection basin overflowed due to excessive debris accumulations during the test interval.

The test was re-performed in October and recirculation rates for fish, adjusted for collection efficiency, were 0.348 from 110', 0.151 from 160', and 0.111 from 210'. During this test, circulating water flow rates were approximately one-half of those during the September test because Unit 3 was shut down for refueling. Although results of the

September 1989 dye recirculation and the September 1990 fish-release studies suggested that the contribution of Unit 3 to reimpingement of fish released at various potential Unit 2 return sites was small, the Unit 2 fish recirculation data were adjusted to reflect possible recirculation rates had Unit 3 been operating. The projected recirculation rate, adjusted for Unit 2 collection efficiency, to both Units 2 and 3 from the 110' release location was calculated to be 0.365:

$$[(375 \div 0.198) \times ((86\% + 3\%) \div 86\%)] \div 5371$$

The projected recirculation rate for the 160' release location was 0.159:

$$[(138 \div 0.198) \times ((61\% + 3\%) \div 61\%)] \div 4586$$

and that for the 210' release location was 0.140:

$$[(98 \div 0.198) \times ((43\% + 11\%) \div 43\%)] \div 4426.$$

The similarity of the latter two projected recirculation rates, 0.140 from 210' and 0.159 from 160', suggests there may be little difference in potential recirculation between the 160' and the 210' release points, particularly when the projected influence of Unit 3 is considered.

Results of impingement collection efficiency tests were low during both the September and the October recirculation rate studies. However, these results do not necessarily constrain their use for projecting potential recirculation rates, provided that impingement collection loss rates for collection efficiency fish do not differ from loss rates for marked fish that become impinged.

EXPERIMENT 1: RELEASE AND RECAPTURE DATA

APPENDIX A

Location		110'						210'					
Release Time		1506-1700	1843-2030	2224-2355	1328-1358			1502-1656	1839-2026	2230-2400	1338-1400		
Tide		MAX FLOOD	HIGH SLACK	MAX EBB	LOW SLACK			MAX FLOOD	HIGH SLACK	MAX EBB	LOW SLACK		
Clip		LPel	Anal	RPec	2Dor	TOTALS		LPec	1D-RPec	RPel	1Dor	TOTALS	
Number Released		1000	991	984	983	3958		1016	995	995	1010	****	
Recapture													
Date	Time												
11-Sep	13:30									1		1	1
12-Sep	00:00	3	4	1	5	13		5			2	7	
12-Sep	04:00		1	6	2	9		1				1	
12-Sep	10:00		3	1		4				1		1	
12-Sep	12:30			1		1		2				2	
12-Sep	18:00	1		2		3	30						11
13-Sep	04:30							1				1	
13-Sep	09:00				1	1							
13-Sep	13:00	1		1		2			1	1		2	
13-Sep	16:00									1	1	2	
13-Sep	22:00						3						5
14-Sep	04:20			1		1							
14-Sep	09:30		1		2	3	4						
TOTALS		5	9	13	10	37	37	9	1	4	3	17	17

EXPERIMENT 2: RELEASE AND RECAPTURE DATA

Location		110°						160°						210°					
Release Time		0911–1111	1206–1406	1530–1730	1836–3026			0911–1111	1206–1406	1530–1730	1836–3026			0911–1111	1206–1406	1530–1730	1836–3026		
Tide		MAX FLOOD	HIGH SLACK	MAX EBB	LOW SLACK			MAX FLOOD	HIGH SLACK	MAX EBB	LOW SLACK			MAX FLOOD	HIGH SLACK	MAX EBB	LOW SLACK		
Clip		2D	LPec	RPel	2D-RP	TOTALS		1D	A	2D-RP	2D-LP	TOTALS		LPel	RPec	2D-LPec	2D-LP	TOTAL	
Number Released		1299	1368	1378	1326	5371		962	1128	1142	1354	4586		1311	420	1334	1361	4426	
Recapture																			
Date	Time																		
17-Oct	12:15	1				1													
17-Oct	13:00													1				1	
17-Oct	14:00	2	3			5													
17-Oct	16:00	1				1													
17-Oct	17:00	2				2													
17-Oct	17:45			5	1	6								1				1	
17-Oct	18:40			2	1	3			1			1							
17-Oct	19:30	5	1	1	16	23		2	1			3			1			1	
17-Oct	20:00				43	43													
17-Oct	20:50	4	3	5	20	32		1	4		3	8		2	1		1	4	
17-Oct	22:10	8	6	6	9	29				1	10	11		4	2	4	11	21	
17-Oct	23:30	3	4	4	11	22	167	2	6		11	19	42	3	2			5	3
18-Oct	01:15	2	2	1	3	8		3	2		2	7		2			2	4	
18-Oct	0:245	1			1	2		2	3		2	7		4				4	
18-Oct	04:30	3		1		4			1			1					1	1	
18-Oct	06:00	3	4	1		8		1			1	2		2				2	
18-Oct	08:00	2	2		1	5					2	2		4	1			5	
18-Oct	09:00	3	3	1	1	8		3			1	4				1	2	3	
18-Oct	09:40	2	1	1	1	5		2	1	1	1	5			1			1	
18-Oct	13:00	7		1		8		3	2			5		1				1	
18-Oct	14:00	2				2			1			1		1				1	
18-Oct	15:00								1			1							
18-Oct	16:00	2				2													
18-Oct	17:00			1		1			2			2							
18-Oct	18:00													1				1	
18-Oct	21:00	3	1		1	5			1			1					1	1	
18-Oct	21:30	7	1	1		9		3	4		1	8		1				1	
18-Oct	23:00	4			1	5	72		1			1	47	1				1	2
19-Oct	00:30	2	2			4					1	1		1	1		1	3	
19-Oct	02:00	1			4	5			2			2		1				1	
19-Oct	04:00	2				2			1			1		1	1			2	
19-Oct	05:50	18	4	1		23		4	2		1	7		1	2			3	
19-Oct	08:00								1			1							
19-Oct	10:00				3	3		1		1		2		2				2	
19-Oct	11:00			1	2	3		1			2	3					2	2	
19-Oct	15:00	1	1		2	4													
19-Oct	17:30	2		1	4	7			1			1		1				1	
19-Oct	18:00	1		1		2			1			1		1				1	
19-Oct	20:30	2				2			3		1	4		2				2	
19-Oct	21:00	2	1			3								1				1	
19-Oct	23:00	2			2	4	62						23	1	1			2	2
20-Oct	01:00	4	2		7	13		3			1	4							
20-Oct	03:00		1	1	4	6					1	1		1		1	1	3	
20-Oct	05:00	2	1	1	2	6			3		1	4		2				2	
20-Oct	07:00	3	2	1	1	7		2	1		1	4		1				1	
20-Oct	09:00	1	1			2					1	1				1		1	
20-Oct	11:00	1	1	1		3								1				1	
20-Oct	13:00	2		1		3		3			1	4				1		1	
20-Oct	15:00	1			1	2		1				1							
20-Oct	17:00	1		1	3	5										1		1	
20-Oct	19:00	1	1	1		3		1				1		3				3	
20-Oct	21:00	1	2	3	1	7			1			1		1				1	
20-Oct	22:00	1	2	1		4													
20-Oct	24:00		1			1	62						21						14
21-Oct	08:30	2		3		5	5	1				1	1	1	1			2	2
22-Oct	08:40		6	1		7	7	1	2		1	4	4	3				3	3
TOTALS		120	59	50	146	375	375	40	49	3	46	138	138	53	14	9	22	98	9

FISH IMPINGED PER 1,000 FISH-HOURS

Location		110'				160'				210'			
Tide		MAX FLOOD	HIGH SLACK	MAX EBB	LOW SLACK	MAX FLOOD	HIGH SLACK	MAX EBB	LOW SLACK	MAX FLOOD	HIGH SLACK	MAX EBB	LOW SLACK
Date	Time												
17-Oct	12:15	0.77	.	.	.		.	.	.		.	.	
17-Oct	13:00		.	.	.		.	.	.	1.02	.	.	
17-Oct	14:00	1.54	2.19	.	.			.	.			.	
17-Oct	16:00	0.39		.	.			.	.			.	
17-Oct	17:00	1.54		.	.			.	.			.	
17-Oct	17:45			4.64	.				.	1.02			
17-Oct	18:40			1.59	.		0.97		.				
17-Oct	19:30	4.64	0.85	0.88	0.90	2.49	1.06				2.86		
17-Oct	20:00				1.81								
17-Oct	20:50	3.73	2.64	4.36	14.50	1.25	4.28		2.88	1.83	2.88		0.8
17-Oct	22:10	4.67	3.31	3.30	24.86			0.68	5.56	2.30	3.59	2.25	6.0
17-Oct	23:30	1.76	2.21	2.21	11.86	1.56	4.01		6.16	1.73	3.61		
18-Oct	01:15	0.90	0.85	0.42	4.13	1.79	1.02		0.86	0.88			0.8
18-Oct	02:45	0.52			5.93	1.40	1.80		1.00	2.05			
18-Oct	04:30	1.35		0.42	1.40		0.51						0.4
18-Oct	06:00	1.58	1.98	0.49	0.55	0.70			0.50	1.03			
18-Oct	08:00	0.79	0.74						0.75	1.55	1.21		
18-Oct	09:00	2.38	2.23	0.74		3.15			0.76			0.75	1.4
18-Oct	09:40	2.38	1.12	1.11	1.23	3.16	1.35	1.31	1.13		3.63		
18-Oct	13:00	1.67		0.22	0.25	0.95	0.54			0.23			
18-Oct	14:00	1.60			0.82		0.90			0.78			
18-Oct	15:00						0.90						
18-Oct	16:00	1.60											
18-Oct	17:00			0.74			1.81						
18-Oct	18:00									0.78			
18-Oct	21:00	0.80	0.25				0.30						0.2
18-Oct	21:30	11.28	1.49	1.48		6.38	7.26		1.51	1.56			
18-Oct	23:00	2.16			0.55		0.61			0.52			
19-Oct	00:30	1.08	1.00						0.51	0.52	1.62		0.5
19-Oct	02:00	0.64			0.55		1.22			0.52			
19-Oct	04:00	0.61					0.46			0.39	1.22		
19-Oct	05:50	8.00	1.63	0.40	1.79	2.32	1.00		0.41	0.43	2.68		
19-Oct	09:00						0.29						
19-Oct	10:00					1.07		0.88		1.56			
19-Oct	11:00			0.74		1.07			1.62				1.4
19-Oct	15:00	0.21	0.19		0.62								
19-Oct	17:30	0.66		0.30	0.66		0.37			0.31			
19-Oct	19:00	0.55		0.50	1.10		0.61			0.52			
19-Oct	20:30	1.11			2.21		1.84		0.51	1.05			
19-Oct	21:00	3.33	1.50							1.57			
19-Oct	23:00	0.63								0.39	1.23		
20-Oct	01:00	1.67	0.75			1.61			0.38				
20-Oct	03:00		0.38	0.37	0.83				0.38	0.39		0.38	0.3
20-Oct	05:00	0.84	0.38	0.37	2.92		1.38		0.38	0.79			
20-Oct	07:00	1.26	0.75	0.37	1.68	1.07	0.46		0.38	0.39			
20-Oct	09:00	0.42	0.38		0.84				0.38			0.38	
20-Oct	11:00	0.42	0.38	0.37	0.42					0.39			
20-Oct	13:00	0.84		0.37		1.61			0.38			0.38	
20-Oct	15:00	0.42				0.54							
20-Oct	17:00	0.42		0.37								0.38	
20-Oct	19:00	0.42	0.38	0.37	0.42	0.54				1.18			
20-Oct	21:00	0.42	0.76	1.12	1.27		0.46			0.40			
20-Oct	22:00	0.85	1.52	0.75									
21-Oct	00:01		0.38		0.42								
21-Oct	08:30	0.20		0.26		0.13				0.09	0.29		
22-Oct	08:40		0.19	0.03		0.04	0.08		0.03	0.10			

APPENDIX B

Table B-1. Release Data for Fin-Clipped Hatchery Striped Bass Released at Six Locations on Four Tidal Current Stages Offshore of the Indian Point Station on September 30, 1991.

Release Station	Tide Stage	Release Time	Fin-Clip	Clip Code	Number Released
2-A	LS	1247	LP	3	1095
2-B	LS	1254	RP	4	1095
F-B	LS	1301	A	7	1088
F-A	LS	1305	2 D	2	1093
3-B	LS	1310	RPL	6	1064
3-A	LS	1315	LPL	5	833
2-A	MF	1553	1&2 D	12	1075
2-B	MF	1557	1 D,A	17	1085
F-A	MF	1604	1 D,RPL	16	1069
F-B	MF	1610	1 D,LPL	15	1054
3-A	MF	1615	1 D,LP	13	1038
3-B	MF	1621	1 D,RP	14	1051
3-B	HS	1911	A,LPL	75	1054
3-A	HS	1915	A,RPL	76	1015
F-B	HS	1920	2 D,LPL	25	1063
F-A	HS	1925	2 D,RPL	26	1043
2-B	HS	1929	2 D,RP	24	1059
2-A	HS	1934	2 D,LP	23	1073
3-A	ME	2235	A,RP	74	1094
3-B	ME	2241	A,LP	73	1092
F-A	ME	2246	2 D,A	27	1045
F-B	ME	2253	RP,LPL	45	1074
2-A	ME	2257	Q&2D,A	127	1054
2-B	ME	2301	1 D	1	1068

LS = low slack
MF = maximum flood
HS = high slack
ME = maximum ebb
1 D = first dorsal (1)
2 D = second dorsal (2)
LP = left pectoral (3)
RP = right pectoral (4)
LPL = Left pelvic (5)
RPL = right pelvic (6)
A = anal (7)

APPENDIX C

TABLE C-1 WATER QUALITY AND SCREEN PERFORMANCE DATA FOR INDIAN POINT UNIT 2 DURING SLUICE MONITORING FROM 30 SEPTEMBER THROUGH 7 OCTOBER 1991.

			INTAKE 21		INTAKE 22		INTAKE 23		INTAKE 24		INTAKE 25		INTAKE 26	
	WATER TEMPERATURE (°C)	WATER CONDUCTIVITY* (MS/cm)	FISH SLUICE PRESSURE (PSI)	DEBRIS SLUICE PRESSURE (PSI)	FISH SLUICE PRESSURE (PSI)	DEBRIS SLUICE PRESSURE (PSI)	FISH SLUICE PRESSURE (PSI)	DEBRIS SLUICE PRESSURE (PSI)	FISH SLUICE PRESSURE (PSI)	DEBRIS SLUICE PRESSURE (PSI)	FISH SLUICE PRESSURE (PSI)	DEBRIS SLUICE PRESSURE (PSI)	FISH SLUICE PRESSURE (PSI)	DEBRIS SLUICE PRESSURE (PSI)
Date: 9/30 Time. 1300	20.5	5906	10	85	18	83	--	86	12	10	11	80	12	86
Date: 9/30 Time: 2014	20.1	7941	10	86	15	85	14	85	12	83	11	83	12	86
Date: 10/1 Time: 0955	20.1	6176	--	--	15	84	14	85	12	83	11	83	12	86
Date: 10/1 Time: 2050	22.0	7313	15	88	17	88	17	88	16	84	16	82	16	88
Date: 10/2 Time: 0810	21.0	6493	15	86	16	88	16	88	16	85	16	83	16	88
Date: 10/2 Time: 2048	22.2	7388	11	77	12	86	12	86	15	82	13	70	12	83
Date: 10/3 Time: 0820	22.0	6253	11	77	12	86	12	86	15	82	13	71	12	83
Date: 10/3 Time: 2330	22.2	7282	11	85	14	95	11	90	14	85	16	70	12	83
Date: 10/4 Time: 0840	22.1	7297	10	85	14	95	11	89	14	85	16	70	12	83
Date: 10/4 Time: 2330	22.5	6398	11	80	13	95	7	90	14	90	16	80	14	88
Date: 10/5 Time: 0925	23.1	5490	12	87	14	96	12	91	13	88	13	82	14	88
Date: 10/5 Time: 2130	22.5	6188	11	80	13	95	11	90	13	90	14	80	14	88

(Continued)

TABLE E-4. (CONTINUED)

	WATER TEMPERATURE (°C)	WATER CONDUCTIVITY[a] (MS/cm)	INTAKE 21 FISH SLUICE PRESSURE (PSI)	INTAKE 21 DEBRIS SLUICE PRESSURE (PSI)	INTAKE 22 FISH SLUICE PRESSURE (PSI)	INTAKE 22 DEBRIS SLUICE PRESSURE (PSI)	INTAKE 23 FISH SLUICE PRESSURE (PSI)	INTAKE 23 DEBRIS SLUICE PRESSURE (PSI)	INTAKE 24 FISH SLUICE PRESSURE (PSI)	INTAKE 24 DEBRIS SLUICE PRESSURE (PSI)	INTAKE 25 FISH SLUICE PRESSURE (PSI)	INTAKE 25 DEBRIS SLUICE PRESSURE (PSI)	INTAKE 26 FISH SLUICE PRESSURE (PSI)	INTAKE 26 DEBRIS SLUICE PRESSURE (PSI)
Date: 10/6 Time: 1000	22.1	7297	11	82	13	95	11	90	13	80	14	80	14	87
Date: 10/7 Time: 0900	20.5	6453	15	90	13	95	14	90	14	85	14	80	14	90

[a]Conductivity adjusted to 25°C

TABLE C-2. WATER QUALITY AND SCREEN PERFORMANCE DATA FOR INDIAN POINT UNIT 3 DURING SLUICE MONITORING FROM 30 SEPTEMBER THROUGH 7 OCTOBER 1991.

			INTAKE 31		INTAKE 32		INTAKE 33		INTAKE 34		INTAKE 35		INTAKE 36	
	WATER TEMPERATURE (°C)	WATER CONDUCTIVITY* (MS/cm)	FISH SLUICE PRESSURE (PSI)	DEBRIS SLUICE PRESSURE (PSI)	FISH SLUICE PRESSURE (PSI)	DEBRIS SLUICE PRESSURE (PSI)	FISH SLUICE PRESSURE (PSI)	DEBRIS SLUICE PRESSURE (PSI)	FISH SLUICE PRESSURE (PSI)	DEBRIS SLUICE PRESSURE (PSI)	FISH SLUICE PRESSURE (PSI)	DEBRIS SLUICE PRESSURE (PSI)	FISH SLUICE PRESSURE (PSI)	DEBRIS SLUICE PRESSURE (PSI)
Date: 9/30 Time: 1300	22.0	6465	27	66	20	72	20	68	19	120	21	115	25	68
Date: 9/30 Time: 2027	21.5	8675	30	--	22	--	20	--	20	--	20	--	27	--
Date: 10/1 Time: 0745	22.0	7525	27	--	20	--	20	--	20	--	24	--	25	--
Date: 10/1 Time: 1945	24.5	7548	27	--	22	--	20	--	21	--	25	--	24	--
Date: 10/2 Time: 0730	23.0	7370	27	--	22	--	22	--	23	--	25	--	22	--
Date: 10/2 Time: 1945	23.5	7808	27	--	19	--	23	--	23	--	23	--	22	--
Date: 10/3 Time: 0715	23.9	7030	27	--	19	--	23	--	21	--	23	--	22	--
Date: 10/3 Time: 1940	24.0	7219	28	--	19	--	24	--	21	--	23	--	21	--
Date: 10/4 Time: 0745	23.1	7147	27	--	19	--	24	--	20	--	23	--	21	--
Date: 10/4 Time: 1940	23.1	7458	28	--	19	--	25	--	21	--	23	--	21	--
Date: 10/5 Time: 0740	22.9	6345	27	--	19	--	24	--	20	--	23	--	21	--
Date: 10/5 Time: 1935	23.4	6589	28	71	19	120	25	125	21	68	23	71	21	65

(Continued)

TABLE C-2 (CONTINUED)

	WATER TEMPERATURE (°C)	WATER CONDUCTIVITY* (MS/cm)	INTAKE 31 FISH SLUICE PRESSURE (PSI)	INTAKE 31 DEBRIS SLUICE PRESSURE (PSI)	INTAKE 32 FISH SLUICE PRESSURE (PSI)	INTAKE 32 DEBRIS SLUICE PRESSURE (PSI)	INTAKE 33 FISH SLUICE PRESSURE (PSI)	INTAKE 33 DEBRIS SLUICE PRESSURE (PSI)	INTAKE 34 FISH SLUICE PRESSURE (PSI)	INTAKE 34 DEBRIS SLUICE PRESSURE (PSI)	INTAKE 35 FISH SLUICE PRESSURE (PSI)	INTAKE 35 DEBRIS SLUICE PRESSURE (PSI)	INTAKE 36 FISH SLUICE PRESSURE (PSI)	INTAKE 36 DEBRIS SLUICE PRESSURE (PSI)
Date: 10/6 Time: 0740	21.9	5045	27	70	18	119	18	120	25	66	23	70	21	65
Date: 10/6 Time: 1940	21.6	4702	28	70	19	120	26	122	21	69	23	72	21	66
Date: 10/7 Time: 0740	20.2	4017	27	70	18	120	25	120	22	67	23	70	20	62

*Conductivity adjusted to 25°C

APPENDIX D

Table D-1. Distribution By Unit of Recovered Hatchery Striped Bass Following Release at Six Locations at Indian Point, Fall 1991.

Release Location	Number Released	Number Recovered	Recovery Location (Percent) Unit 2	Recovery Location (Percent) Unit 3
2-A	4,297	161	66.4	33.6
2-B	4,307	1,259	96.1	3.9
F-A	4,250	126	61.1	38.9
F-B	4,279	625	58.1	41.9
3-A	3,980	143	23.1	76.9
3-B	4,261	183	10.9	89.1

Table D-2. Recovery Distribution for Location 2-A Released Striped Bass.

Tide Stage	Number Released	Recoveries			
		Numbers			Percent
		Unit 2	Unit 3	Total	
Low Slack	1,095	29	16	45	4.11
Maximum Flood	1,075	61	25	86	7.99
High Slack	1,073	7	2	9	0.84
Maximum Ebb	1,054	10	11	21	1.99
Totals	4,297	107	54	161	3.74
Percent Distribution		66.4	33.6		

Table D-3. Recovery Distribution for Location 2-B Released Striped Bass.					
		Recoveries			
		Numbers			
Tide Stage	Number Released	Unit 2	Unit 3	Total	Percent
Low Slack	1,095	108	15	123	11.22
Maximum Flood	1,085	167	14	181	16.67
High Slack	1,059	351	9	360	33.96
Maximum Ebb	1,068	584	11	595	55.66
Totals	4,307	1210	49	1259	29.27
Percent Distribution		96.1	3.9		

Table D-4. Recovery Distribution for Location F-A Released Striped Bass.					
		Recoveries			
		Numbers			
Tide Stage	Number Released	Unit 2	Unit 3	Total	Percent
Low Slack	1,093	21	16	37	3.38
Maximum Flood	1,069	44	4	48	4.49
High Slack	1,043	5	25	30	2.87
Maximum Ebb	1,045	7	4	11	1.05
Totals	4,250	77	49	126	2.96
Percent Distribution		61.1	38.9		

Table D-5. Recovery Distribution for Location F-B Released Striped Bass.					
		Recoveries			
		Numbers			
Tide Stage	Number Released	Unit 2	Unit 3	Total	Percent
Low Slack	1,808	213	16	229	21.03
Maximum Flood	1,054	144	14	158	14.98
High Slack	1,063	4	107	111	10.43
Maximum Ebb	1,074	2	125	127	11.81
Totals	4,279	363	262	625	14.597
Percent Distribution		58.1	41.9		

Table D-6. Recovery Distribution for Location 3-A Released Striped Bass.					
		Recoveries			
		Numbers			
Tide Stage	Number Released	Unit 2	Unit 3	Total	Percent
Low Slack	833	4	89	93	11.15
Maximum Flood	1,038	16	6	22	2.12
High Slack	1,015	5	4	9	0.89
Maximum Ebb	1,094	8	11	19	1.74
Totals	3,980	33	110	143	3.59
Percent Distribution		23.1	76.9		

Table D-7. Recovery Distribution for Location 3-B Released Striped Bass.

Tide Stage	Number Released	Recoveries			
		Numbers			Percent
		Unit 2	Unit 3	Total	
Low Slack	1,064	11	108	119	11.17
Maximum Flood	1,051	3	33	36	2.42
High Slack	1,054	6	22	28	2.65
Maximum Ebb	1,092	0	0	0	0.9
Totals	4,261	20	163	183	4.29
Percent Distribution		10.9	89.1		

APPENDIX E

Table E-1. THREE-WAY CONTINGENCY ANALYSIS OF MARKED HATCHERY STRIPED BASS RECOVERIES AT INDIAN POINT UNITS 2 & 3 FOLLOWING RELEASE AT SIX LOCATIONS ON SEPTEMBER 30, 1991.

REFERENCE: SOKOL, R.R & F.J. ROHLF. 1969. BIOMETRY. W.H. FREEMAN & CO. SAN FRANSCISCO. 776pp.

LOCATION		LOW SLACK	MAX FLOOD	HIGH SLACK	MAX EBB	Total
	Recovered	45	86	9	21	161
2-A	Escaped	1050	989	1064	1033	4136
	Total	1095	1075	1073	1054	4297
	% Recovered	4.11	8.00	0.84	1.99	3.75
2-B	Recovered	123	181	360	595	1259
	Escaped	972	904	699	473	3048
	Total	1095	1085	1059	1068	4307
	% Recovered	11.23	16.68	33.99	55.71	29.23
F-A	Recovered	37	48	30	11	126
	Escaped	1056	1021	1013	1034	4124
	Total	1093	1069	1043	1045	4250
	% Recovered	3.39	4.49	2.88	1.05	2.96
F-B	Recovered	229	158	111	127	625
	Escaped	859	896	952	947	3654
	Total	1088	1054	1063	1074	4279
	% Recovered	21.05	14.99	10.44	11.82	14.61
3-A	Recovered	93	22	9	19	143
	Escaped	740	1016	1006	1075	3837
	Total	833	1038	1015	1094	3980
	% Recovered	11.16	2.12	0.89	1.74	3.59
3-B	Recovered	119	36	28	0	183
	Escaped	945	1015	1026	1092	4078
	Total	1064	1051	1054	1092	4261
	% Recovered	11.18	3.43	2.66	0.00	4.29
Total	Recovered	646	531	547	773	2497
	Escaped	5622	5841	5760	5654	22877
	Total	6268	6372	6307	6427	25374
	% Recovered	10.31	8.33	8.67	12.03	9.84

Table E-1, Continued; COMPUTATION OF N*LN(N)

		LS	MF	HS	ME	TOTAL
2-A	Recovered	171.300	383.074	19.775	63.935	818.106
	Escaped	7304.373	6820.831	7415.857	7169.250	34442.476
	Total	7663.368	7503.582	7487.623	7336.207	35947.294
2-B	Recovered	591.899	940.928	2118.997	3801.194	8986.834
	Escaped	6686.734	6153.374	4578.206	2913.252	24451.790
	Total	7663.368	7583.429	7376.020	7447.744	36040.963
F-A	Recovered	133.604	185.818	102.036	26.377	609.372
	Escaped	7352.129	7074.037	7010.640	7177.191	34330.563
	Total	7647.373	7455.718	7248.700	7264.602	35507.366
F-B	Recovered	1244.322	799.890	522.758	615.212	4023.595
	Escaped	5803.206	6090.955	6529.354	6490.074	29975.873
	Total	7607.401	7336.207	7407.888	7495.602	35778.750
3-A	Recovered	421.532	68.003	19.775	55.944	709.687
	Escaped	4888.921	7034.407	6955.220	7503.582	31664.636
	Total	5601.953	7208.963	7026.484	7655.370	32990.368
	Recovered	568.716	129.007	93.302	0.000	953.336
3-B	Escaped	6474.370	7026.484	7113.692	7639.377	33901.890
	Total	7415.857	7312.330	7336.207	7639.377	35610.281
Total	Recovered	4180.136	3331.899	3448.533	5140.666	19533.645
	Escaped	48542.837	50656.991	49874.070	48851.230	229636.748
	Total	54802.457	55816.609	55182.563	56353.627	257329.921

SUMMATION OF VALUES

a	170282.91	cells
b	204868.16	location x recovery
c	176721.37	tide X location
d	214026.36	tide X recovery
e	211875.02	loclocation
f	222155.26	tide
g	249170.39	recovery
h	257329.92	grand total

Three-way test of independence of Recovery, Location, & Tide

	d.f.	G	(COMPUTATIONS)
Location X Recovery Independence	5	2305.3 *	2*(b-e-g+h)
Tide X Recovery Independence	3	61.3 *	2*(d-f-g+h)
Location X Tide Independence	15	42.0 *	2*(c-e-f+h)
Location X Recovery X Tide Interaction	15	1075.5 *	2*(a-b-c-d+e+f+g+h)
Location X Recovery X Tide Independence	38	3484.2 *	

* Significant; X sq @ 0.05

Table E-2. THREE-WAY CONTINGENCY ANALYSIS OF MARKED HATCHERY STRIPED BASS RECOVERIES AT INDIAN POINT UNITS 2 & 3 FROM FOUR SELECTED RELEASE LOCATIONS.

REFERENCE: SOKOL, R.R & F.J. ROHLF. 1969. BIOMETRY. W.H. FREEMAN & CO. SAN FRANSCISCO. 776pp.

LOCATION		LOW SLACK	MAX FLOOD	HIGH SLACK	MAX EBB	Total
2-A	Recovered	45	86	9	21	161
	Escaped	1050	989	1064	1033	4136
	Total	1095	1075	1073	1054	4297
	% Recovered	4.11	8.00	0.84	1.99	3.75
F-A	Recovered	37	48	30	11	126
	Escaped	1056	1021	1013	1034	4124
	Total	1093	1069	1043	1045	4250
	% Recovered	3.39	4.49	2.88	1.05	2.96
3-A	Recovered	93	22	9	19	143
	Escaped	740	1016	1006	1075	3837
	Total	833	1038	1015	1094	3980
	% Recovered	11.16	2.12	0.89	1.74	3.59
3-B	Recovered	119	36	28	0	183
	Escaped	945	1015	1026	1092	4078
	Total	1064	1051	1054	1092	4261
	% Recovered	11.18	3.43	2.66	0.00	4.29
Total	Recovered	294	192	76	51	613
	Escaped	3791	4041	4109	4234	16175
	Total	4085	4233	4185	4285	16788
	% Recovered	7.20	4.54	1.82	1.19	3.65

Table E-2, Continued. COMPUTATION OF N*LN(N)

		LS	MF	HS	ME	TOTAL
2-A	Recovered	171.300	383.074	19.775	63.935	818.106
	Escaped	7304.373	6820.831	7415.857	7169.250	34442.476
	Total	7663.368	7503.582	7487.623	7336.207	35947.294
F-A	Recovered	133.604	185.818	102.036	26.377	609.372
	Escaped	7352.129	7074.037	7010.640	7177.191	34330.563
	Total	7647.373	7455.718	7248.700	7264.602	35507.366
3-A	Recovered	421.532	68.003	19.775	55.944	709.687
	Escaped	4888.921	7034.407	6955.220	7503.582	31664.636
	Total	5601.953	7208.963	7026.484	7655.370	32990.368
3-B	Recovered	568.716	129.007	93.302	0.000	953.336
	Escaped	6474.370	7026.484	7113.692	7639.377	33901.890
	Total	7415.857	7312.330	7336.207	7639.377	35610.281
Total	Recovered	1670.972	1009.439	329.136	200.523	3934.458
	Escaped	31239.300	33557.464	34190.722	35357.721	156755.518
	Total	33967.090	35348.370	34899.811	35834.923	163320.709

SUMMATION OF VALUES

a	114402.55	cells
b	137430.06	location x recovery
c	116803.71	tide X location
d	137555.28	tide X recovery
e	140055.31	loclocation
f	140050.19	tide
g	160689.98	recovery
h	163320.71	grand total

Three-way test of independence of Recovery, Location, & Tide

	d.f.	G	(COMPUTATIONS)
Location X Recovery Independence	3	10.978 *	2*(b-e-g+h)
Tide X Recovery Independence	3	271.632 *	2*(d-f-g+h)
Location X Tide Independence	9	37.836 *	2*(c-e-f+h)
Location X Recovery X Tide Interaction	9	176.541 *	2*(a-b-c-d+e+f+g+h)
Location X Recovery X Tide Independence	24	496.988 *	

* Significant; X sq @ 0.05

Table E-3. 2 X 2 CONTINGENCY ANALYSES OF RECOVERY RATES FROM FOUR SETS OF RELEASE LOCATIONS

REFERENCE: SOKOL, R.R & F.J. ROHLF. 1969. BIOMETRY W.H. FREEMAN & CO. SAN FRANCISCO. 776 PP.

LOCATION 2-A VS LOCATION F-A

	2-A	F-A	Total	Ln Values
Rec	161	126	287	1624.27
Esc	4136	4124	8260	74498.43
Total	4297	4250	8547	77378.86

Ln Values			
Rec	818.11	609.37	1624.27
Esc	34442.48	34330.56	74498.43
Total	35947.29	35507.37	77378.86

cells =	70200.5163	G =	4.04 *
locations =	71454.6598		
recoveries =	76122.6971	X2 at 0.05, 1 df	
error =	77378.8596		= 3.841

Since G is larger, conclude that
Returns are not independent of location

LOCATION 3-A VS LOCATION 3-B

	3-A	3-B	Total	Ln Values
Rec	143	183	326	1886.53
Esc	3837	4078	7915	71049.12
Total	3980	4261	8241	74308.08

Ln Values			
Rec	709.69	953.34	1886.53
Esc	31664.64	33901.89	71049.12
Total	32990.37	35610.28	74308.08

cells =	67229.5484	G =	2.68
locations =	68600.6489		
recoveries =	72935.6446	X2 at 0.05, 1 df	
error =	74308.0831		= 3.841

Since G is smaller, conclude that
Return rates are independent of location.

Table E-3. 2 X 2 CONTINGENCY ANALYSES, CONTINUED.

LOCATION 2-A VS LOCATION 3-B

	2-A	3-B	Total	Ln Values
Rec	161	183	344	2009.18
Esc	4136	4078	8214	74037.67
Total	4297	4261	8558	77489.45

Ln Values

Rec	818.11	953.34	2009.18
Esc	34442.48	33901.89	74037.67
Total	35947.29	35610.28	77489.45

cells =	70115.8077	G =	1.67
locations =	71557.5755		
recoveries =	76046.8525	X2 at 0.05, 1 df	
error =	77489.4533		= 3.841

Since G is smaller, conclude that
Return rates are independent of location.

LOCATION F-A VS LOCATION 3-B

	F-A	3-B	Total	Ln Values
Rec	126	183	309	1771.60
Esc	4124	4078	8202	73917.52
Total	4250	4261	8511	77017.02

Ln Values

Rec	609.37	953.34	1771.60
Esc	34330.56	33901.89	73917.52
Total	35507.37	35610.28	77017.02

cells =	69795.1607	G =	10.82 *
locations =	71117.6469		
recoveries =	75689.1198	X2 at 0.05, 1 df	
error =	77017.0154		= 3.841

Since G is larger, conclude that
Returns are not independent of location.

Table E-3. 2 X 2 CONTINGENCY ANALYSES, CONTINUED.

LOCATION F-A VS LOCATION 3-A

	F-A	3-A	Total	Ln Values
Rec	126	143	269	1504.98
Esc	4124	3837	7961	71508.17
Total	4250	3980	8230	74197.90

Ln Values

Rec	609.37	709.69	1504.98
Esc	34330.56	31664.64	71508.17
Total	35507.37	32990.37	74197.90

cells =	67314.2571	G =	2.56
locations =	68497.7333		
recoveries =	73013.1465	X2 at 0.05, 1 df	
error =	74197.9048		= 3.841

Since G is less, conclude that
Returns are independent of location.

LOCATION 2-A VS LOCATION 3-A

	2-A	3-A	Total	Ln Values
Rec	161	143	304	1737.98
Esc	4136	3837	7973	71627.97
Total	4297	3980	8277	74668.77

Ln Values

Rec	818.11	709.69	1737.98
Esc	34442.48	31664.64	71627.97
Total	35947.29	32990.37	74668.77

cells =	67634.9041	G =	0.14
locations =	68937.6619		
recoveries =	73365.9423	X2 at 0.05, 1 df	
error =	74668.7692		= 3.841

Since G is less, conclude that
Returns are independent of location.

APPENDIX F

Table F-1. Distribution of Wild Striped Bass Among Collections At Indian Point Units 2 and 3, September 30 - October 7, 1991

Tide Cycle	Unit 2	Unit 3	Cycle Total	Total
1 Flood	21	0	21	83
Ebb	32	30	62	
2 Flood	34	17	51	83
Ebb	10	22	32	
3 Flood	107	51	158	182
Ebb	22	2	24	
4 Flood	28	5	33	64
Ebb	24	7	31	
5 Flood	3	10	13	32
Ebb	19	0	19	
6 Flood	18	6	24	28
Ebb	3	1	4	
7 Flood	4	6	10	45
Ebb	34	1	35	
8 Flood	15	0	15	24
Ebb	9	0	9	
9 Flood	4	6	10	24
Ebb	9	5	14	
10 Flood	5	6	11	21
Ebb	10	0	10	
11 Flood	10	4	14	31
Ebb	8	9	17	
12 Flood	3	0	3	3
Ebb	0	0	0	
13 Flood	10	6	16	65
Ebb	16	33	49	
14 Flood	9	4	13	146
Ebb	0	133	133	
Totals				831
Flood	271	121	392	
Ebb	196	243	439	

APPENDIX G

Appendix G. Table 1.
Impingement Data Base: Projected Mean Monthly Impingement of Twelve Species of Fish At Indian Point Unit 2, Based on observed rates (aadjusted for collection efficiency) and average flows during 1975 – 1990.

Month	White Perch	Alewife	Blueback Herring	American Shad	Gizzard Shad	Anchovy	Bluefish	Hogchoker	Rainbow Smelt	Striped Bass	Atlantic Tomcod	Weakfish	Other Species	All Taxon
January	235,262	19	37	6	1,220	42	1	510	1,276	8,976	1,972	0	2273	251,594
February	160,611	16	17	1	115	4	0	89	743	5,521	424	0	1643	169,184
March	121,570	9	10	1	25	2	0	66	583	3,302	396	0	2207	128,171
April	70,368	6	35	0	0	0	0	1,278	994	849	178	0	1802	75,510
May	23,947	126	211	13	0	426	1	5,787	975	310	26,648	1	1061	59,506
June	8,427	274	357	336	0	3,679	1,440	1,858	908	133	81,980	1	1431	100,824
July	11,040	3,420	7,383	9,883	0	65,184	2,734	2,729	2,517	2,525	140,831	2,667	2907	253,820
August	21,071	1,675	5,056	2,311	1	48,183	296	7,136	712	2,998	43,104	8,476	1799	142,818
September	14,529	692	10,619	562	3	22,399	271	7,408	412	1,913	9,147	5,263	1765	74,983
October	32,380	1,502	136,779	1,407	59	8,953	31	5,533	1,086	2,982	1,101	1,154	7143	200,110
November	73,193	1,091	34,226	1,261	445	400	2	1,885	609	1,705	238	250	5368	120,673
December	169,939	63	1,858	50	1,161	36	1	2,178	1,348	3,877	3,254	27	4597	188,389
Total	942,337	8,893	196,588	15,831	3,029	149,308	4,777	36,457	12,163	35,091	309,273	17,839	33,996	1,765,582
Percent	53.4	0.5	11.1	0.9	0.2	8.5	0.3	2.1	0.7	2.0	17.5	1.0	1.9	100.0

Appendix G. Table 2.

Impingement Survival Rate: Based on Fletcher 1990. Flow Dynamics and Fish Recovery Experiments: Water Intake Systems. Trans. Amer. Fish. Soc. 119:393–415, 1990.

Species	Number Tested	% Dead & Injured	No. Dead & Injured	% Alive	% of Total
Alewife	71	62	44	38	2.5
Atlantic Tomcod	603	17	103	83	21.5
Pumpkinseed	210	7	15	93	7.5
Striped Bass	86	9	8	91	3.1
White Catfish	25	40	10	60	0.9
White Perch	1806	14	253	86	64.5
Total	2801		432	85	100

Projection of Impinged Fish Initial Survival Rates for Computation of Losses Due to Recirculation of Returned Fish at Indian Point Unit 2.

Species	all Taxon	White Perch	Alewife	Blueback Herring	American Shad	Gizzard Shad	Anchovy	Bluefish	Hogchoker	Rainbow Smelt	Striped Bass	Atlantic Tomcod	Weakfish	Other Taxon	All Species Except WP
No. Impinged	1,765,582	942,337	8,893	196,588	15,831	3,029	149,308	4,777	36,457	12,163	35,091	309,093	17,839	33,996	823,065
Survival (%)	76	86	38	38	38	38	38	85	100	85	91	83	85	85	64
No. Alive	1,341,842	810,410	3,379	74,703	6,016	1,151	56,737	4,060	36,457	10,339	31,933	256,547	15,163	28,897	525,382

Recirculation Survival: (Estimated)

			Rate
First =	50% of Impingement Survival Rate	=	0.5
Second =	50% of First Recirculation Survival Rate	=	0.25
Third =	0%	=	0

Recirculation Rates:

	Site			
Basis	3-A	3-B	2-A	P-A
Live Fish	3.6	4.3	3.7	3
Dye (a)	18	12	32	8
Dye (b)	18	12	32	16
Dye (c)	18	12	32	32

Appendix G. Table 3.
Computational Format for Projection of Potential Annual Losses Due Recirculation.
Example = Site 2-A; January - February Recirculation Window.

	Initial Impingement			First Recycle		Second Recycle		Third Recycle	
Month	Number Impinged (1)	No. Rtn'd Alive(2)	Recycle Rate(2)	Recycled 1st Time	No. Rtn'd Alive 1st Rcyle(2)	Recycled 2nd Time	No. Rtn'd Alive 2nd Rcyle(2)	Recycled 3rd Time	No. Rtn'd Alive 3rd Rcyle(2)
January wp	235,262	202,325	0.320	64,744	27,840	8,909	1,915	613	0
January all other	16,332	10,425	0.037	386	123	5	1	0	0
February wp	160,611	138,125	0.320	44,200	19,006	6,082	1,308	418	0
February all othe	8,573	5,472	0.037	202	65	2	0	0	0
March wp	121,570	104,550	0.037	3,868	1,663	62	13	0	0
March all others	6,601	4,214	0.037	156	50	2	0	0	0
April	70,368	60,516	0.037	2,239	963	36	8	0	0
April all others	5,142	3,282	0.037	121	39	1	0	0	0
May	23,947	20,594	0.037	762	328	12	3	0	0
May all others	35,559	22,698	0.037	840	268	10	2	0	0
June	8,427	7,247	0.037	268	115	4	1	0	0
June all others	92,397	58,979	0.037	2,182	696	26	4	0	0
July	11,040	9,494	0.037	351	151	6	1	0	0
July all others	242,780	154,972	0.037	5,734	1,830	68	11	0	0
August	21,071	18,121	0.037	670	288	11	2	0	0
August all others	121,747	77,714	0.037	2,875	918	34	5	0	0
September	14,529	12,495	0.037	462	199	7	2	0	0
Sept. All others	60,454	38,589	0.037	1,428	456	17	3	0	0
October	32,380	27,847	0.037	1,030	443	16	4	0	0
Oct. all others	167,730	107,066	0.037	3,961	1,264	47	7	0	0
November	73,193	62,946	0.037	2,329	1,001	37	8	0	0
Nov. all others	47,480	30,308	0.037	1,121	358	13	2	0	0
December	169,939	146,148	0.037	5,407	2,325	86	18	1	0
Dec. all others	18,450	11,777	0.037	436	139	5	1	0	0
Total =	1,765,582	1,335,907		145,776	60,529	15,497	3,318	1,035	0
Mortality =					85,247		12,179		1,035

Mortality Due to Recirculation = (Initial impingement survival - sum of Recirculation survival) = 98,461
Percent Mortality due to Recirculation = (Recirculation Mortality/No. Returned Alive) X 100 = 7.4

(1) See Appendix G. Table 1.
(2) See Appendix G. Table 2.

APPENDIX H

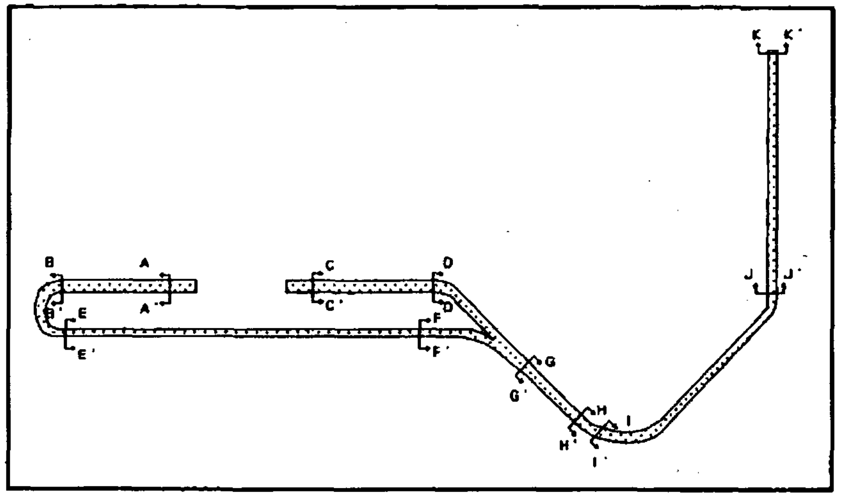

Figure H-1. Proposed Layout for Unit 2 Ristroph Screen Return System and Schematic Location of Return System Water Depth and Transit Time Measurement Points.

Table H-1. Water Depths Within Proposed Unit 2 Fish Collection Sluice System.

Section	Location	Width (inches)	Estimated Flow (GPM)	Water Depth (inches) Left*		Center		Right
A - A′	Screen 23 midpoint	36	500	1.7	1.9	1.9	1.9	2.0
B - B′	Screen 21 discharge	36	800	1.7	2.0	1.7	1.9	2.0
C - C′	Screen 24 midpoint	36	500	1.5	1.5	1.5	1.7	1.5
D - D′	Screen 26 discharge	36	800	2.5	2.2	1.7	1.5	1.2
E - E′	In-deck Entrance	20	800	1.0	1.0	1.0	1.4	1.4
F - F′	In-deck Discharge	20	800	2.0	2.0	1.7	1.7	1.7
G - G′	End of Confluence	22	800	1.0	1.2	1.0	2.0	1.5
H - H′	Entrance to taper	22	800	2.0	2.0	-	1.7	1.2

* Facing downstream

Table H-2. Transit Times Through Segments of the Proposed Unit 2 Fish Return System (Transport time for a float over a specified distance.)

Segment	Estimated Flow (GPM)	Distance (Feet)	Time (Seconds) Trials 1	2	3	4	Ave.
A - A′ to B - B′	500 + 300	30	11.5	11.8	12.2	13.1	12.1
C - C′ to D - D′	500 + 300	30	8.9	8.7	8.4	-	8.7
E - E′ to F - F′	800	96	15.6	14.8	14.4	15.2	15.0
G - G′ to H - H′	800	16.5	2.2	2.2	2.4	2.4	2.3
I - I′ to J - J′	2300	65	9.2	8.7	9.0	9.1	9.0
J - J′ to K - K′	2300	250		Calculated			35.2

Approximate Transport Velocity:

	Feet/sec
A - A′ to B - B′	2.5
C - C′ to D - D′	3.4
E - E′ to F - F′	6.4
G - G′ to H - H′	7.2
I - I′ to J - J′	7.2
J - J′ to K - K′	7.1

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FACSMILIE TRANSMISSION

TO: Paul Geoghegan
NAI

FAX: 603-472-7052

FROM: KENNETH L. MARCELLUS

TELEPHONE: 212 - 460 - 6059

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NUMBER OF PAGES INCLUDING COVER SHEET: 11

NOTES:

For your information
- changes regarding fish collection and sluice monitoring are on pages 2 and 4, respectively

Ken

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Ken

Attachment A

Winter-Time Recirculation of White Perch from Two Potential Discharge Sites for the Indian Point Unit No. 2 Fish Return System

Background

Results of a fall 1991 live fish recirculation test, which was performed at Indian Point Station pursuant to a DEC request dated May 10, 1991, were presented in the document entitled:

Summary and Discussion
Indian Point Unit No. 2 Ristroph Screen
Fish and Debris Return System,

which was provided to Settlement Party representatives by letter dated December 21, 1992. The results indicated that any one of four sites, including two sites offshore of Unit No. 2 and two sites south of Unit No. 3, would be suitable discharge locations for the Unit 2 fish return system. However, it was also noted that a winter-time hydroacoustic survey offshore of the Station disclosed the apparent passive transport of fish, which were believed to be white perch. It was concluded that if passive transport was occurring, then the results of the fall recirculation test, which was conducted in warm water, might not apply to white perch during cold water periods. Rather, dye recirculation rates, determined from an earlier study, might more accurately reflect the potential winter-time recirculation of white perch to the intakes from alternative discharge locations.

In the absence of winter-time live fish recirculation data for the sites evaluated, as well as dye recirculation rates for a site suggested by Dr. Ian Flather, several assumptions were made in order to project potential annual fish losses due to recirculation from alternative locations for the Unit 2 return system. Based on these projections, as well as engineering assessments of return line design and construction costs, two sites located south of the Unit 3 intake did not appear to be suitable for the Unit 2 return system discharge. Use of these sites would require return systems more than two times greater in length and cost two to three times more than would a system installed to the furthest site offshore of Unit 2, yet provide no apparent advantage with regard to reduction in recirculation. Also, based on the projections, there was no appreciable difference in potential losses from the two sites offshore of Unit 2. However, because of the inherent uncertainty within the projections due to the necessity of the various assumptions about recirculation, we noted in the December 21, 1992 transmittal letter our intention to conduct a winter-time marked live fish release recirculation test to obtain a factual basis to help better determine the location for the Unit 2 return system discharge. The results of that study are presented here.

<u>Study Plan</u>

The potential discharge sites evaluated during the "winter-time" live fish recirculation test included:

1) the originally proposed site, 2-A, located 210 feet offshore and 145 feet north of the Unit No. 2 intake, and

2) the site suggested by Dr. Fletcher, F-A, located 210 feet offshore and 175 feet south of the Unit No. 2 intake.

White perch were selected to be the test species because of their historical abundance in winter-time collections of impinged fish at the Indian Point Station, and the expectation that they would be susceptible to passive transport in cold water. For consistency with the fall 1991 study, it was planned that 1,000 marked white perch would be released at each of the two sites on each of four tidal current states: low slack, maximum flood, high slack, and maximum ebb.

Test fish were initially collected from the Ristroph screens at Indian Point Unit No. 2. However, due to mechanical difficulties with the temporary fish return sluice, screen operation was halted to facilitate repairs. As a result, trawling was required to collect test fish. Because of the stresses associated with trawling, only approximately 1,200 of the 8,000 fish required were available at test time. Accordingly, to develop the potentially best estimate of recirculation under the circumstances, we elected to release marked fish on the two tidal current stages that resulted in the largest quantity of returned fish during the fall 1991 tests: low slack water, and maximum flood tide (Appendix A). As a result, the quantity of white perch to be released per site per tide stage was approximately 300.

Test fish, which were held at the striped bass hatchery in six foot diameter by two foot deep tanks through which river water was pumped, were marked with a fin clip to indicate the tidal current stage and location of release. Handling and tagging mortality after approximately 24 and averaged 2.8% (Table 1).

Table 1. Handling and Tagging Mortality among White Perch Marked by Fin Excision for Recirculation Tests at Indian Point Unit 2 in January 1993.

Clip Location	Number Clipped	24 Hour Mortality Number	Percent
Left Pelvic	298	8	2.7
Right Pelvic	298	5	1.7
First Dorsal	298	15	5.0
Second Dorsal	298	5	1.7
Total	1192	33	2.8

White perch releases were made by placing the fish in a ten gallon container, and then lowering it to a depth of five feet above the river bed before activating the remotely removable cover. Test sites were marked with buoys to facilitate repeated location for each release. The first drop, which was scheduled to be made at low slack water at 1933 hours on January 22, 1993, was delayed approximately one hour due to mechanical difficulties. The release planned for the time of maximum flood current at 2230 hours occurred on schedule.

During the test period, minimum daily intake water temperatures at Indian Point ranged from 0.8 to 1.8 C°, and were similar to long-term average annual lows[1]. Circulating water pumps were operated at reduced flow at Indian Point Unit No. 3, and at full flow at Unit No. 2. Screen operation at Unit No. 3 was continuous throughout the monitoring period, but was intermittantly interrupted to accommodate maintenance during the last three days of monitoring at Unit No. 2.

[1] 1990 Year Class Report for the Hudson River Estuary Monitoring Program. January 1992. Appendix B.

since the circulating water pump operation was continuous at Unit No. 2, it was considered unlikely that any impinged fish would have been lost during the intervals the screen rotation was halted.

Ristroph screen fish sluices were monitored continuously for 118.5 hours, beginning at 2030 hours on January 22, 1993, and ending at 1900 hours on January 27, 1993. This interval exceeded by nearly two days the projected length of time required for natural down-stream transport, beginning on a flood tide, such that a returned fish could not be recirculated to the vicinity of the station on some succeeding flood tide (Figure 2). Accumulations of fish were tallied hourly.

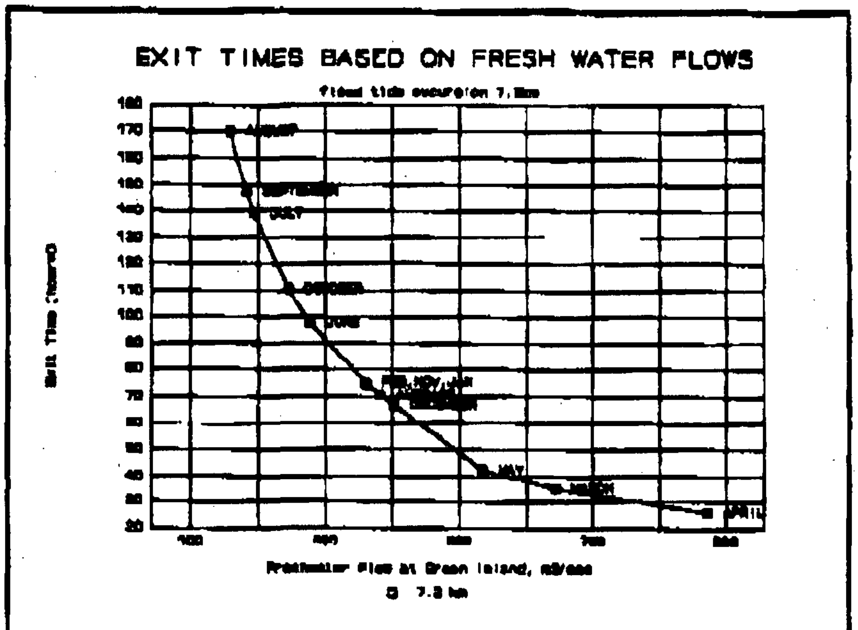

Figure 2. Water Exit Times from the Vicinity of Indian Point Station, based on Discharges at the Green Island Dam, Adjusted for Downstream Inflow.

Recirculated fish were recovered with nets and screens installed in the sluices. Accumulations were tallied hourly. Debris sluices were not monitored because few fish were recovered from these sluices during the fall 1991 test. Further, debris conditions, which could have contributed to inefficient transfers of fish to the fish sluices were non-existant during this test.

Results

A total of 103 (8.8%) of the 1,159 marked white perch released were recovered: 80 were recovered at Unit No. 2; 23 at Unit No. 3 (Table 2).

Table 2. Numbers of Marked White Perch Released at Two Locations and Recovered at Indian Point Units Nos. 2 and 3 January 22-27, 1993.

Release Location & Tide	Number Released	Number Recovered					
		Unit No. 2		Unit No. 3		Total	
		No.	%	NO.	%	No.	%
2-A Low Slack	293	7	2.4	6	2.0	13	4.4
2-A Max Flood	293	6	2.0	6	2.0	12	4.1
Total	586	13	2.2	12	2.0	25	4.3
F-A Low Slack	283	58	20.5	5	1.8	63	22.3
F-A Max Flood	290	9	3.1	6	7.1	15	5.2
Total	573	67	11.7	11	1.9	78	13.6

A plot of the cumulative percent recovery of fish (Figure 3) showed that most recirculation occurred within approximately 84 hours (approximately 6.7 tidal cycles) following release. These results suggested that the 118.5 hour long (9.5 tidal cycles) monitoring period was adequate in duration.

A collection efficiency assessment was made at Unit No. 2 by releasing marked dead white perch within each of the forebays for intake screens numbers 22 and 25. Overall recovery rates averaged 94.3% (Table 3), which was slightly lower than that for dead striped bass (97.5%) released during the fall 1991 study. However, these results suggested that a high percentage of the fish that entered the intake in a passive state could be expected to be recovered by the Ristroph screens. Accordingly, no adjustment for collection efficiency appeared necessary.

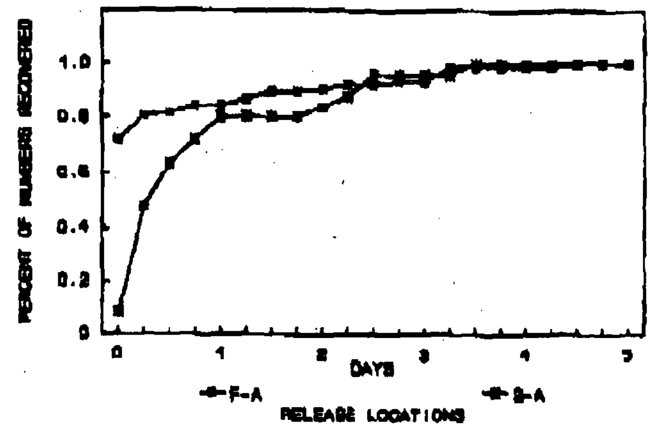

Figure 3. Cumulative Percent Recovery of Marked White Perch Released at Two Locations at Indian Point Station, January 1993.

Table 3. Efficiency of Collection of Dead White Perch from Indian Point Unit 2 Intake Forebays.

Screen	Number Released	Number Recovered	Percent Recovery
22	150	141	94.0
25	150	142	94.7
		Average =	94.3

The numbers of recaptured white perch were subjected to contingency analyses (Sokal and Rohlf 1969) to determine whether recirculation was related to the release location and tidal current stage. An error rate of $\alpha = 0.05$ was used in these analyses. When recoveries of white perch were summed across the two tide stages of release, the 2 x 2 contingency analysis disclosed significant site effects in the recirculation from F-A and 2-A (G = 32.61, d.f. = 1, $\alpha = 0.05$; Critical G = 3.84; Appendix B). The differences in recovery rates from the two sites was due to substantially more fish being recirculated to Unit 2 from the low slack tide release at site F-A relative to the number recovered from site 2-A. The numbers of fish recovered from the releases on the maximum flood tide were only slightly greater from site F-A relative to those from site 2-A.

Discussion

The overall purpose of the "winter-time" fish recirculation study was to determine whether: 1) live white perch would be transported passively by currents; 2) recirculation rates would be substantially different between the sites F-A and 2-A; and 3) whether winter-time recirculation rates would differ from those observed during the fall 1991. Results indicated that: 1) white perch were not entirely passive; 2) recirculation rates were essentially similar between the two sites, other than for the almost immediate (within approximately 2 hours of release) recovery of nearly 20% of the fish released on low slack tide at site F-A relative to less than 1% being recirculated within the same time interval (total recovery was 4.4% after 118.5 hours) from those released on the same tide at site 2-A; and 3) overall, the rates of recovery were similar to those observed during the fall 1991 (Appendix A). If white perch had been entirely passive, recovery rates should have reflected those for dye released at site 2-A, which were substantially higher after the start of the release when the ebb tide returned the dye past the intakes[2] (Appendix C). Apparently, the white perch were able to orient themselves such that they were not passively returned to the intakes, with the exception of the release at low slack tide at site F-A.

The almost immediate and relatively high level of recirculation from the low slack release at site F-A suggests that these white perch were transported toward the intake. These results differed from those for striped bass in the fall 1991 in that none of the over 1,000 marked fish released on the low slack tide at this site were recirculated to the intake within two hours. One explanation for the high recirculation during the present study may be the potential for the direction of localized currents to be highly variable

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[2] Aquatec, Inc. 1990. Hydraulic Study of the Hudson River. (See Con Ed and NYPA 1990. Indian Point Units 2 and 3 Ristroph Screen Fish Return System Prototype Evaluation and Siting Study - Appendix A-V.)

Indian Point Units 2 and 3

Ristroph Screen Fish Return System

Prototype Evaluation and Siting Study

Prepared By

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July 1990

INDIAN POINT UNITS 2 AND 3

RISTROPH SCREEN FISH RETURN SYSTEM

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8/1/90

Mark

Here is a copy of our fish return line study report. NAI's report is appended to it.

Ken

INDIAN POINT UNITS 2 AND 3

RISTROPH SCREEN FISH RETURN SYSTEM

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Indian Point Units 2 and 3
Ristroph Screen Fish Return Systems

I. INTRODUCTION

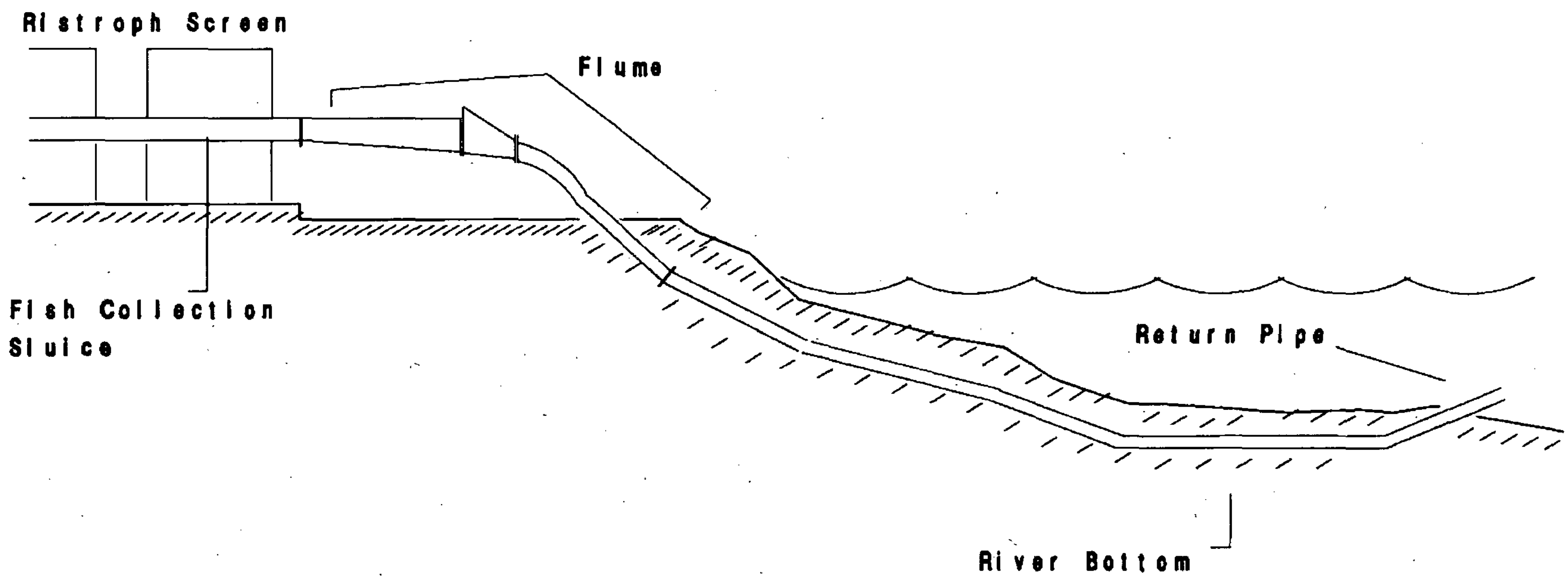
In December, 1988, agreement was reached among the Parties to proceed with the installation of Ristroph screens at all the circulating water intake bays at Indian Point Units 2 and 3. The Agreement stated, among other things, that the Indian Point Utilities were to "consult and reach mutual agreement with interested Parties on the design of fish and debris return systems for the projects ... and conduct tests that may be reasonably required to design those systems prior to installation; such tests will be carried out as mutually agreed upon by the interested parties, giving appropriate consideration to their cost and potential fish protection benefits".

On March 15, 1989, an overall plan for the development and evaluation of the Ristroph Screen Fish Recovery and Return System for Indian Point Units 2 and 3 was reviewed with the Settlement Parties. The plan included: evaluation of the conduits for conveying fish back to the river; determination of locations in the river from which recirculation to the intakes would be reasonably low and; final evaluation of the fish recovery components, including fish flaps and debris shields, on the Ristroph screens.

Conceptual designs (Figure 1) for the three major components of the conduits for the fish return systems were identified. These included: 1) the fish collection sluice which is attached

Indian Point Units 2 and 3
Ristroph Screen Fish Return Systems

Figure 1 Conceptual Layout of the Three Major Components of a Fish Return System



to the Ristroph screens; 2) the flume which conveys fish from the collection sluice through a partially filled conduit to the river level, and 3) the return pipe which connects with the flume at the river water level and conveys fish to the point of discharge away from the intakes.

A study plan for assessing the effects on fish of passage through the system was outlined. The plan called for construction of a prototype flume and return pipe system at the Verplanck Quarry where the clear water would permit underwater video observation of fish behavior and early assessment of damage and mortality upon discharge into collection nets. The fish collection sluice was to be tested at Indian Point after the screens were installed.

Suitable locations for the terminus of each of the return pipes in the river, tentatively established on the basis of previous studies, were to be further evaluated by recirculation studies using dyes or neutrally buoyant drifters to identify areas where the probability of return of fish to the intakes would be acceptably low.

Based upon the collective comments of the Parties during and subsequent to the March 15 meeting, final study plans were revised and sent to the Parties by letter dated April 14, 1989. This report summarizes results of the fish flume and return pipe tests at the Verplanck Quarry, and the information used to select suitable locations for the fish and debris return systems for the Indian Point Units 2 and 3 Ristroph screen installations.

II. FISH AND DEBRIS RETURN SYSTEMS

Fish return conduits serve to receive fish from recovery systems and convey them to locations for release. In general, Ristroph screen return systems have three major components (collection sluice, flume and return pipe) as outlined earlier, and are operated using water from the spray wash system, and, as necessary, an auxiliary supply to augment fish and debris transport. Principle design considerations for safe-guarding fish during transport to a release location include:

- Cross-sectional forms (shape and dimensions) that facilitate transport and minimize flow discontinuities that could cause damage to fish, facilitate settlement of debris or residency of fish.
- Water depth and flow velocities that minimize damage to fish and prevent debris deposition.
- Discharge locations that result in acceptably low levels of recirculation of fish and debris to intakes at reasonable costs.

These and other considerations including protection of fish from predatory birds; prevention of icing; and avoidance of abrasive-surfaced materials were applied. The flume and return pipe studies at the Verplanck Quarry evaluated the effects on fish of return system length, discharge depth, operating flow volume, and the presence of debris. Field studies at Indian Point investigated return system discharge locations and the likelihood of recirculation of fish to the intakes from alternative sites.

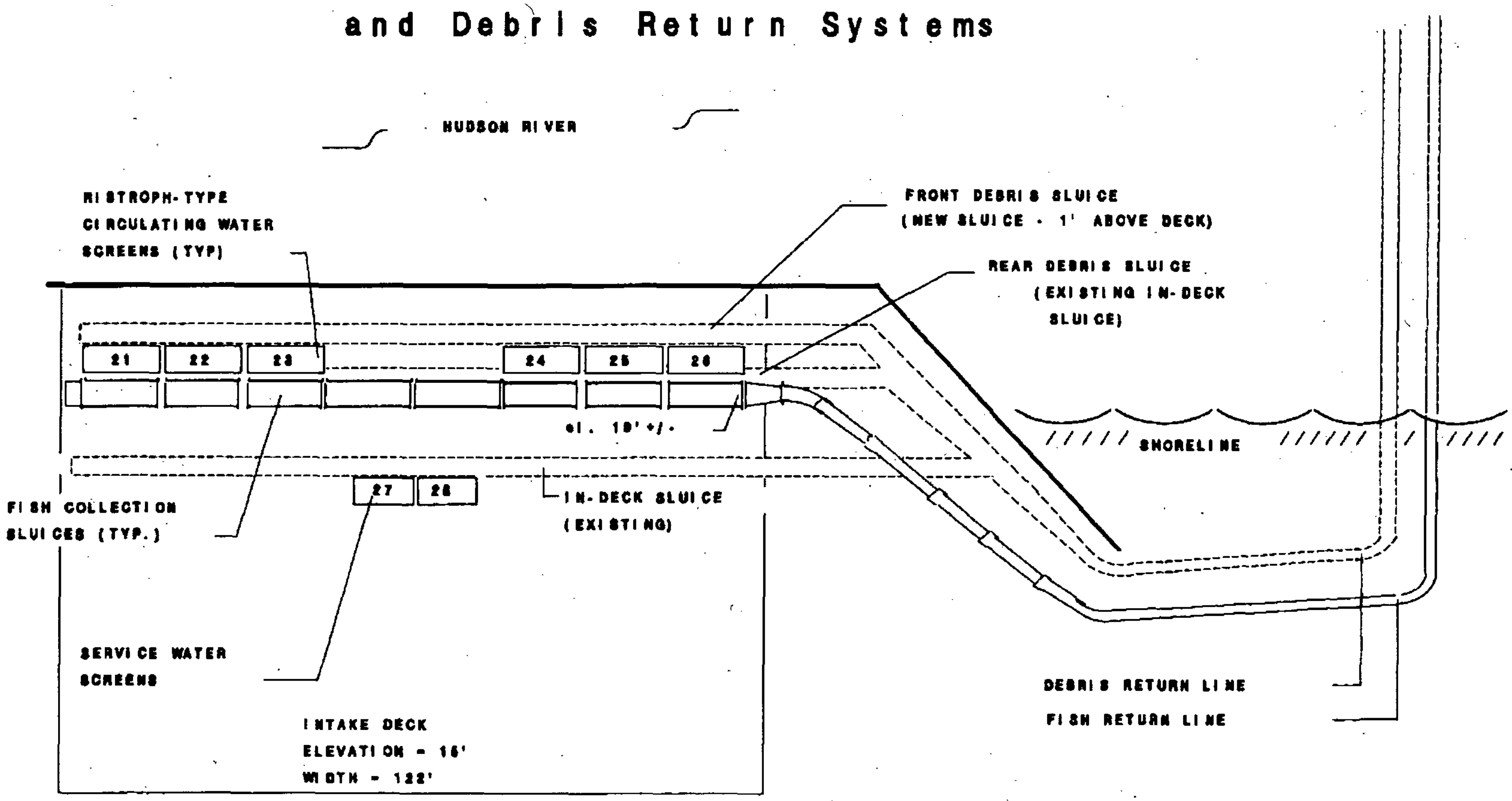
III. EVALUATION OF RETURN SYSTEM DESIGN

A. Partial-Scale System Design

Return system tests began with a partial-scale prototype reflecting the conceptual flume and return pipe design proposed for Indian Point Unit 2 (Figure 2) and encompassing the general design features planned for Unit 3 (Figure 3). The partial-scale system differed from the planned full-scale system in that the return pipe was 6" in diameter, rather than the planned 12". All other features, including conduit lengths, directional turns and elevation changes reflected the projected full-scale system design.

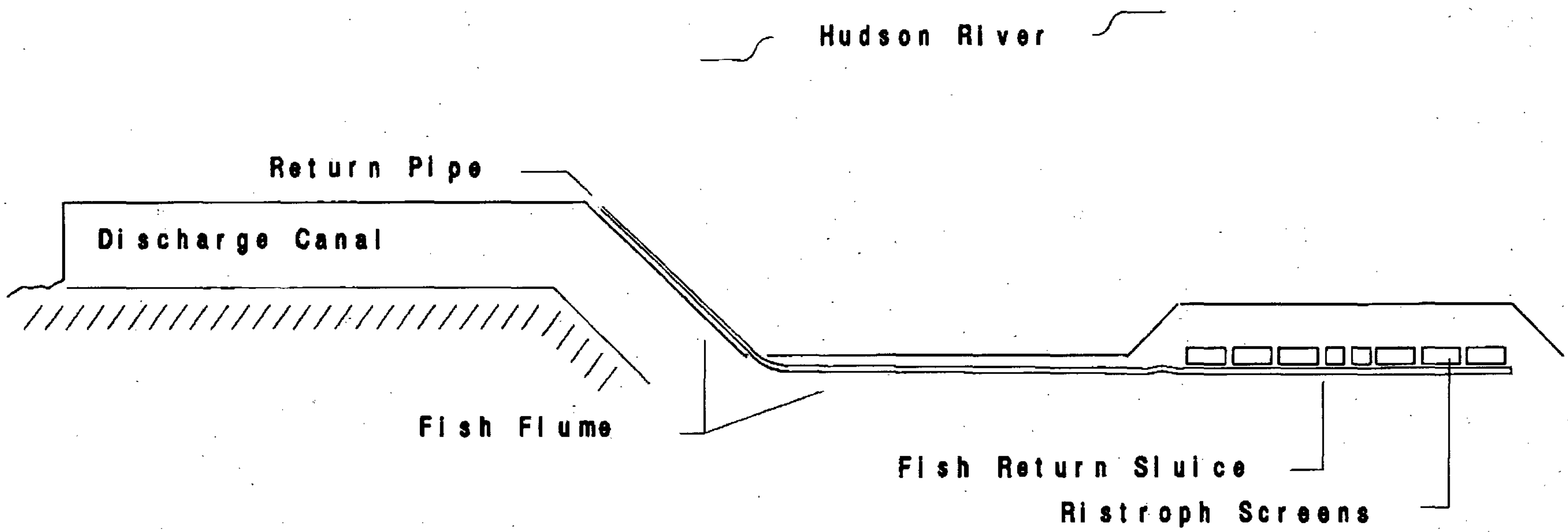
Testing with a partial-scale system was undertaken first to preliminarily assess, as economically as possible, several basic areas of uncertainty regarding the potential for damage to fish. These included the effects on fish of: 1) water velocity at the interface of the flume and the surface of the quarry, 2) pipe

Figure 2 Plan View of Indian Point Unit 2 Proposed Fish and Debris Return Systems



NOT TO SCALE

Figure 3 Proposed Ristroph Screen Fish Return System
Layout for Indian Point Unit 3

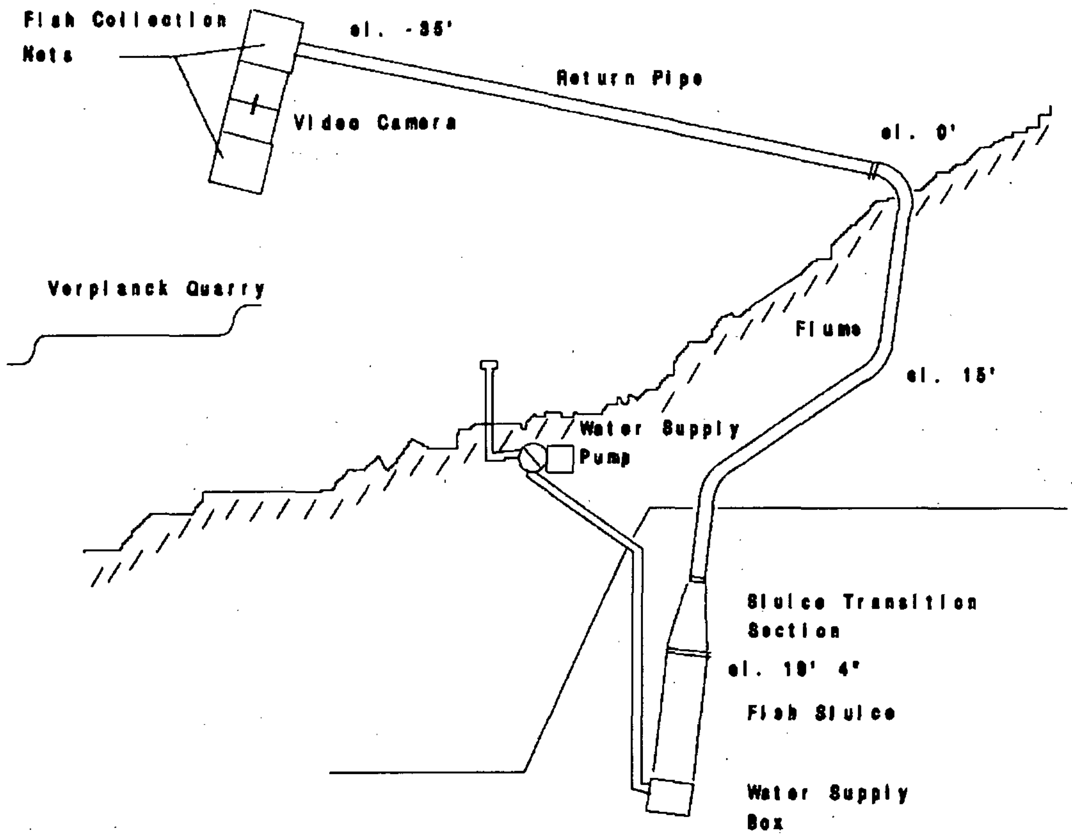


length, and 3) the effects of pipe discharge depth. If these preliminary tests indicated that the basic design was unacceptable, major changes could be made quickly and economically to establish a suitable design. Once a partial-scale system was proven to not impose significant damage, a more costly full-scale prototype would be built and tested in greater detail.

A contract for construction and evaluation of the partial and full-scale prototype fish return system components was competitively bid and awarded to Normandeau Associates, Inc., Bedford, New Hampshire, and installation of the partial-scale system began in August 1989. The system simulated the transfer of fish from a screen collection sluice into a flume which conveyed the fish to the return pipe for discharge at locations up to 150' offshore and at water depths of up to 35'. The length of the pipe reflected a preliminary estimate of the distance offshore of the face of the intake (and the associated approximate depth) to which a return line might have to extend to minimize the potential for recirculation of fish to the intakes at Indian Point.

The partial-scale test flume and return pipe system (Figure 4) included a water supply system and a 30" wide by 12' long aluminum sluice for introduction of fish. The sluice was positioned 19'4" above the quarry level, the elevation of the

Figure 4 Plan View of Ristroph Screen Test Fish Return Flume and Pipe System at the Verplanck Quarry



Ristroph screen fish collection sluices above the river at mean sea level. Quarry water was supplied to the return system through gasoline-powered 4" diameter centrifugal pumps which discharged into the bottom of the "sluice water supply box". Water upwelled within the box and overflowed into the 30" sluice. A gate system at the entrance of the sluice allowed the creation of a hydraulic head that induced a flow velocity sufficient to rapidly wash fish from the sluice into the transition section. The rectangular flat-bottomed sluice was rounded along its edges to form a 3" radius of curvature with the sidewall. This form was intended to minimize the zone of reduced flow velocity observed along the sides of the straight sidewalled fish collection sluice installed on the test Ristroph screen at Indian Point Unit 2. Low flow velocity allowed fish to resist transport and caused debris to settle out. The sluice was initially set with 0" pitch. The transition section between the sluice and the flume tapered within its 7.5' length from the cross-sectional form of the 30" wide sluice to that of the 6" diameter flume. Initially, the transition section was pitched at 0.4" per foot (3" in 7.5') to accelerate sluice flow. With this slope, a volume of 250 gpm could be accommodated at the flume entrance. Higher volumes created a head of water extending above the 6" diameter entrance to the flume. Later the pitch was increased to 0.8" per foot (6" in 7.5'), increasing system flow capacity to approximately 450 gpm.

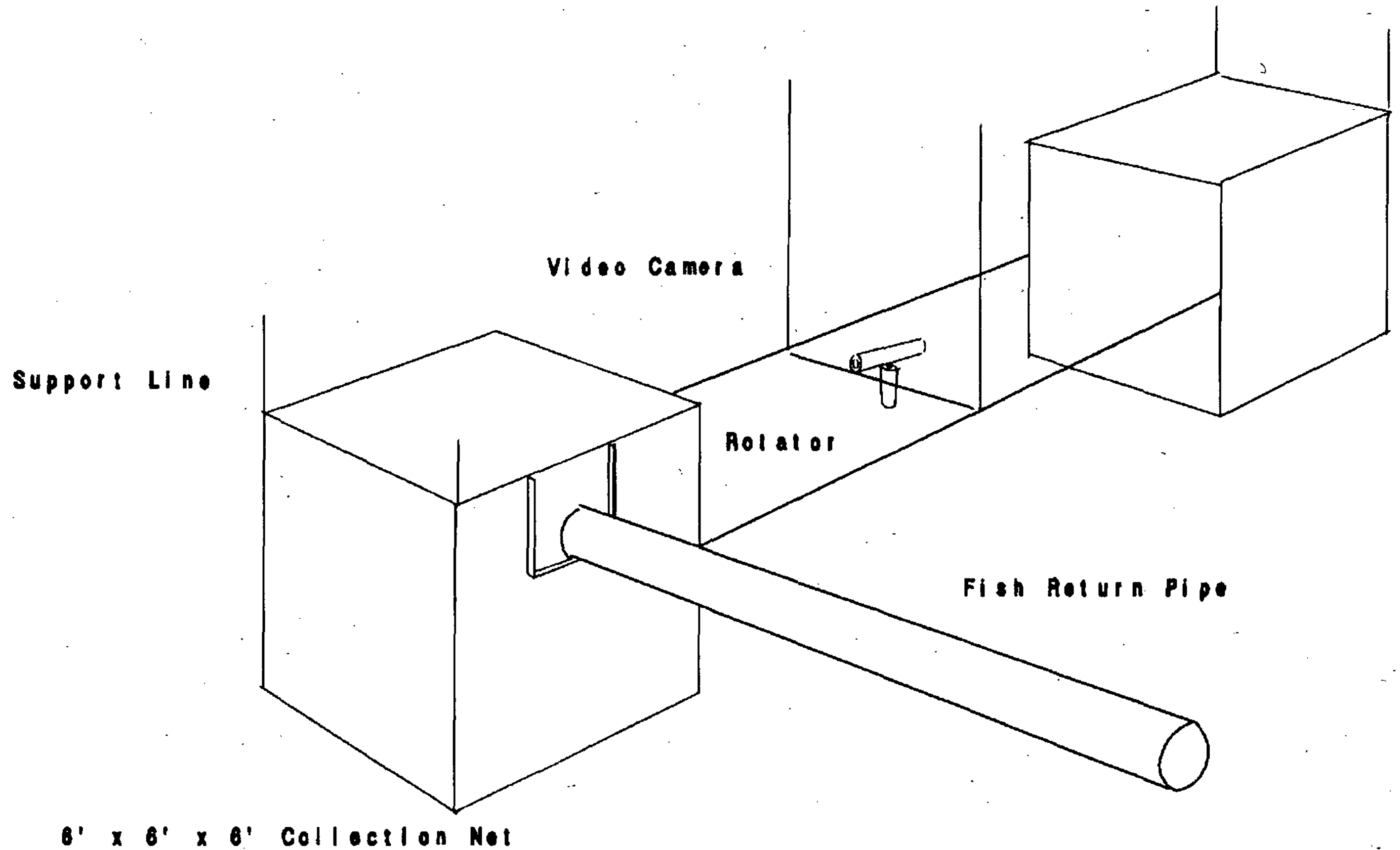
The flume and return pipe conduits were made from opaque PVC pipe. However, two 10' long sections of clear PVC were installed to observe flow conditions at specified areas, including a segment immediately above the 15' elevation and a segment immediately below the quarry level interface. Pipe connections were a mix of belled ends and couplings, which provided smooth surfaces free of protrusions that could damage fish or impede debris transport.

B. Partial-Scale System Tests

Test fish were obtained from a variety of sources, including the Indian Point Unit 2 Ristroph screen (white perch), Verplanck hatchery (striped bass), Hudson River fish survey trawling (Atlantic tomcod), and local bait stores (alewife and golden shiner). These fish were held in shallow pools into which quarry water was circulated.

Tests were initiated by first attaching a 6' x 6' x 6' net to the end of the return pipe (Figure 5) positioned to discharge at either minus 1' or minus 35', depending on test objectives, and then establishing a specified flow of water through the system. The underwater video system was set to record the discharge of fish (and debris if present) into the collection net and their subsequent behavior and condition at intervals up

Figure 5 Fish Return System Collection Net



into the holding net fish were fully oriented. Most fish "sounded" to the bottom of the net and then began to leisurely swim about, generally following the netting. None appeared to be damaged.

Table 1

Fish Survival Test Conditions and Results

Partial-Scale System - Flume Only

Conditions:

Date:	10/10/89
Flow:	245 gpm
Debris:	None
Temperature:	7.0°C

		Striped Bass TN = 50 CN = 50			Alewife TN = 50 CN = 50		
Time		A	D	S	A	D	S
Hr 8	Test Control	50 50	0 0	0 0	50 50	0 0	0 0
$M\text{-}Adj_{8\text{-}hr}$ [1]	%	0.0			0.0		

TN = Number of test fish; CN = Number of control fish
A = Number of fish alive; D = Number of fish dead
S = Number of fish stunned or injured

Based upon the absence of aberrant behavior and damage among test fish, it was decided that testing should proceed immediately to the projected worst case condition. This test was

[1] Note: Adjusted mortality (%) is calculated using Abbotts' formula: M-Adj = (P-C/1-C) x 100 where P = proportion of test fish dead or stunned, and C = proportion of control fish dead or stunned. (Finney, 1964. Statistical Method in Biological Assay. Hafner Publishing Company, New York)

to 96 hours after release. The time between release of the fish into the sluice and their discharge into the net was recorded. Shortly after the last fish entered the net, the water flow was halted, and the collection net was sealed from the return pipe to prevent the escape of fish. Control fish were placed in a net similar to the collection net suspended 1' below the quarry surface. During tests of the effects of debris on fish, control fish were not exposed to debris. Control fish were observed by video on the same schedule as the test fish.

The condition and behavior of test and control fish were observed at selected intervals (during and immediately after discharge into the net, and after 8, 24, 48, 72, and 96 hours). At the end of the retention period, all test and control fish were removed from the cages and examined for damage and mortality.

The initial tests were performed on October 10, 1989, and addressed the question regarding the influence of the air/water interface on striped bass (a relatively hardy species) and alewife (a relatively sensitive species) that were conveyed through the flume directly into the collection net; no return pipe was used. Water flow was approximately 245 gpm. Survival among test and control fish for each species after an 8-hour latent effects evaluation period was 100% (Table 1). Video observation showed that within a few seconds after discharge designed to determine whether fish could be successfully transported with debris through a) the 100' long flume, b) its air/water interface with the quarry, and c) a 150' long return pipe discharging at minus 35'. White perch (a relatively hardy species), striped bass, alewife and golden shiner (a relatively sensitive species) were tested. Several gallons of wet leaves and eelgrass, which had been collected from the Indian Point intake screens, were mixed with the fish in 10 gallons of water and then released into the test sluice. The water flow rate during this test was approximately 250 gpm, which provided a 2.8 fps discharge velocity into the collection net. Transport times in seconds for fish and debris are listed in Table 2.

Table 2

Transport Times in Seconds for Fish and Debris Through The Partial-Scale (6" Diameter) Flume and Return Pipe System

Date	Pipe Diameter	Length	Discharge Depth	Flow Rate GPM	Transport Time (Seconds) First	Last	Item
10/13/89	6"	150'	33'	250	59	80	Golden shiner
					58	103	White perch
					56	90	White perch
					53	87	Striped bass
						108	Eelgrass
						111	Styrofoam cups
10/24/89	6"	150'	1'	440	39	60	Alewife, golden shiner

During testing, water passage through the transition section was observed. The flow appeared to accelerate uniformly and converge toward the 6" diameter flume entrance without the formation of turbulent hydraulic jumps. The flow into the flume pipe was smooth and uniform. Some turbulence was noted at the union of the transition section and the flume because of the slight offset caused by the pipe flange. This condition did not appear to impede fish or debris passage. No changes, other than of pitch in the transition section, appeared to be necessary to improve operations. Water passage through the clear sections of conduit disclosed that flows near the 15' elevation were swift (calculated velocity: 8.0 fps), but relatively uniform (no splashing, sloshing from side-to-side, or hydraulic jumps). The water surface was relatively smooth and predictable in position. Centerline depth appeared to be approximately 2". At the quarry surface, flume water velocity was rapid (calculated velocity: 16.3 fps) and caused considerable entrainment of air into the return pipe as the flow plunged beneath the level of the quarry. Upward surges of water and air in the top half of the conduit above the downward flow of water in the lower half occurred periodically.

Observations of test and control fish condition at the end of 8-, 24-, 48-, 72- and 96-hour evaluation periods are listed in Table 3. Upon discharge, golden shiner and striped bass were well oriented within a few seconds and immediately swam to the bottom of the net. White perch and alewife also quickly oriented themselves and began swimming about the net without sign of stress.

Table 3

Fish Survival Test Conditions and Results

Partial-Scale System

Conditions:

Date:	10/13/89
Return Pipe Length:	150'
Return Pipe Depth:	35'
Flow:	250 gpm
Debris:	5 gallons; leaves, eelgrass
Temperature:	8.0°C

		White Perch TN = 20 CN = 20			Striped Bass TN = 49 CN = 50			Golden Shiner TN = 49 CN = 50			Alewife TN = 49 CN = 50		
Time		A	D	S	A	D	S	A	D	S	A	D	S
Hr 8	T C	19 18	1 2	0 0	49 50	0 0	0 0	49 50	0 0	0 0	46 50	1 0	2 0
Hr 24	T C	18 18	2 2	0 0	49 50	0 0	0 0	49 50	0 0	0 0	46 50	1 0	2 0
M-Adj$_{24\text{-}Hr}$	(%)	0.0			0.0			0.0			6.1		
Hr 48	T C	15 18	5 2	0 0	47 49	2 1	0 0	49 50	0 0	0 0	45 49	1 1	3 0
Hr 72	T C	15 18	5 2	0 0	47 49	2 1	0 0	49 50	0 0	0 0	45 49	3 1	1 0
Hr 96	T C	15 16	5 4	0 0	47 48	2 2	0 0	48 48	1 2	0 0	42 43	7 7	0 0
M-Adj$_{96\text{-}Hr}$	(%)	6.3			0.1			0.0			0.3		

The adjusted mortality/morbidity rates for striped bass, white perch and golden shiner were zero through 24 hours.

Alewife mortality/morbidity was 6.1% initially and through 24 hours. After 96 hours, mortality/morbidity rates for these four species ranged from 6.3% for white perch to zero for golden shiner.

Testing was next performed on October 24, 1989 at an increased flow rate, 440 gpm. This discharge volume was achieved by adjusting the pitch of the transition section from 0.4" per foot to 0.8" per foot to accelerate the flow and allow its constriction from the approximately 45" square cross-sectional area of its volume within the sluice (1-1/2" deep x 30" wide) to the 28" square (cross-sectional area of the flume pipe) without creating an entrance head depth greater than the 6" flume pipe diameter. Alewife and golden shiner were the test species. The return pipe was suspended at the minus 1' depth over its length of 150'. No debris was present.

Transport time (Table 2) for the first fish to be discharged was 39 seconds; the last fish was discharged in 60 seconds during this October 24, 1989 test. The calculated discharge velocity for the 440 gpm flow through the 6" diameter return pipe was 5.0 fps. Water flow through the clear section of flume conduit above the 15' elevation appeared to be comparable, except for a slight increase in depth to about ≈2-1/2"±, relative to conditions at the 245 gpm rate. At the quarry water interface, air entrainment appeared to be more intense at

440 gpm than at 245 gpm and extended further into the return pipe. A series of 1/2" diameter holes were drilled in the top of the return pipe to allow air to escape, which effectively reduced the tendency for the return pipe to be lifted by entrapped air. Passage of floatable debris through this zone appeared to be more rapid at the higher flow rate. Based on the lack of evidence of damage, fish were not impaired by passage through this turbulent zone.

Observations for latent effects after 8 hours and 24 hours (Table 4) showed survival among the 50 test fish of each species to be 100%. One alewife control fish appeared stunned, and one golden shiner control fish was dead at the 8 hour mark. None of the test fish showed signs of damage, including scale loss, that could be attributed to transport through the flume and return pipe system.

Table 4

Fish Survival Test Conditions and Results

Partial-Scale System

Conditions:

Date:	10/24/89
Return Pipe Length:	150'
Return Pipe Depth:	1'
Flow:	440 gpm
Debris:	None
Temperature:	8.0°C

		Alewife TN = 50 CN = 50			Golden Shiner TN = 50 CN = 50		
Time		A	D	S	A	D	S
Hr 8	T	50	0	0	50	0	0
	C	49	0	1	49	1	0
Hr 24	T	50	0	0	50	0	0
	C	49	0	1	49	1	0
$M\text{-}Adj_{24\text{-}Hr}$	(%)	0.0			0.0		

Mr. Edward Radle (NYSDEC) and Dr. Ian Fletcher (consultant to HRFA, NRDC and Scenic Hudson) observed test facilities on October 11, 1989, and on October 18 were briefed on the results of the initial tests. Based on the minimal mortality (adjusted for control fish mortality) of test fish over the range of conditions tested (flume only, 150' return pipe with near-surface discharge as well as a deep [minus 35'] discharge, alternative operating water volumes and the presence of debris), the proposed layout for the fish return system at Unit 2 appeared to be acceptable. It was concluded that further testing with the partial-scale system was not necessary and that a full-scale system should be installed.

C. Full-Scale System Design

The design for the full-scale system utilized through-pipe discharge velocity data from the 6" partial-scale system (2.8 to 5.0 fps) plus the operating volume of 1,000 gpm of water expected to be available for operation of the full-scale system at Indian Point. In order to maintain a discharge velocity in excess of 4 fps to minimize fish residency within the return pipe and to facilitate debris transport, the diameter of the prototype system was decreased from the initially estimated diameter, 12", to 10". In addition, recognizing the uncertainty about the ultimate required length of the return pipe when the system was installed at Indian Point, the effect of conduit length on fish transport was addressed by providing for tests of the full-scale system with a return pipe length of 150' and 250'. Messrs. Radle and Fletcher informally concurred with these design modifications.

The full-scale prototype return system consisted of the same layout and general design features as the partial-scale system. The flume and return pipe were fabricated from 10" diameter PVC pipe. The sluice transition section, which was made from aluminum, tapered from the 30" rectangular form of the sluice to its 5" radius (10" diameter) discharge into the flume. The transition was sloped at 0.8" per foot (6" drop) over its 7.5' length. The flume extended from elevation 19'4" a distance of 100' to the quarry level (elevation 0'). The first 65' of the flume were sloped at 0.75" per foot. The remaining 35' were sloped at 5.5" per foot to the quarry surface, reflecting the approximate projected site layout at Unit 2. The flume contained two large-radius (≥5 pipe diameters) 45° bends and one similarly large-radius 90° bend. The return pipe was initially set to be 150' in length and positioned to discharge at a depth of minus 35'. In contrast to the partial-scale system, the full-scale system did not contain segments of conduit made from clear materials.

The 10" return system was supplied water at 500 gpm or 1,000 gpm, depending on test requirements. Based on a tendency for the return pipe to lift due to air entrainment when operated at 1,000 gpm, a series of slots were cut in the return pipe below the air/water interface to allow air to escape. Observations disclosed that test fish were occasionally discharged through the slots. The slots were subsequently covered, and weights were attached to the return pipe to successfully prevent entrained air from lifting it. At the request of Dr. Fletcher, following a site visit in December, the sluice width was increased to 36" and the length to 24'. The transition section was extended 1.5' to accommodate the increase in sluice width, and a 6' long 10" diameter round-bottom channel plus a 4' long 10" wide round-bottom funnel section (Figure 6) were added to more closely reflect the expected system design.

D. Full-Scale System Tests

In early December 1989, a series of 24-hour latent effects assessments were made with the full-scale prototype system which included the 150' return pipe positioned to discharge at minus 35' below the surface. These initial full-scale system tests were designed to determine the levels of damage and mortality to fish conveyed through the return system without the added influence of debris. Results would reflect the combined effects of the transition section, the flume, the flow velocity and turbulence through the quarry water interface, the transport velocity through the return pipe and the discharge at the minus 35' depth. The effects of debris were to be evaluated later.

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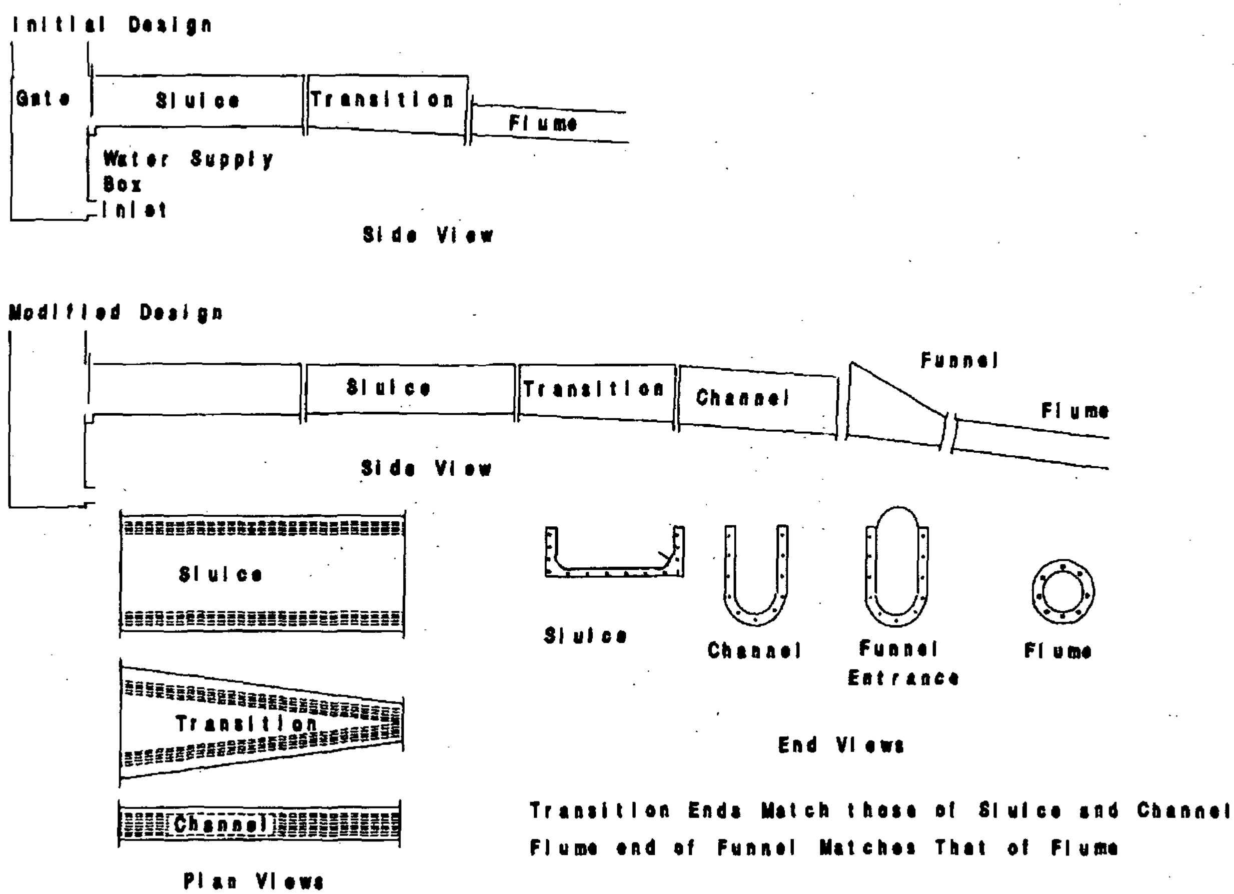
Figure 6 Fish Sluice, Transition Section, and Flume



On December 5, 1989, the initial test was performed with golden shiner and white perch at a flow rate of 500 gpm. Water flow through the transition section was uniform and without excessive hydraulic jumps or turbulence. There was little difference in conditions from those observed in the partial-scale system. No changes in the design of the transition section appeared necessary. Upon discharge into the collection net, test fish were well-oriented; most were discharged tail first, indicating they were oriented upstream within the return pipe. Survival among both test and control fish through the end of the 24-hour latent effects evaluation period was 100% (Table 5). Observations for latent effects at the 8-hour mark were not performed because of insufficient natural light for video system observation. Examination of the fish at the end of the test disclosed that none appeared to have been damaged by transport through the system. Discharge velocity was calculated to be 2.0 fps for the 500 gpm flow rate. Transit times ranged from 105 to 167 seconds (Table 6).

On December 11, 1989, golden shiner and white perch were tested in the full-scale prototype system operated at a flow rate of 1,000 gpm. Test fish were less oriented at discharge, but quickly regained orientation and generally sounded to the bottom of the net. Again, survival among test and control fish after 24 hours was 100% (Table 7). All fish were examined for signs of damage at the conclusion of each test: none appeared to have incurred any type of damage attributable to transport through the return system. Discharge velocity was calculated to be 4.1 fps. Transit times ranged from 40 to 160 seconds (Table 6). Water temperatures during the tests ranged from 7°C to 8°C.

Table 5

Fish Survival Test Conditions and Results

Partial-Scale System

Conditions:

Date:	12/05/89
Return Pipe Length:	150'
Return Pipe Depth:	35'
Debris:	None
Flow:	500 gpm
Temperature:	8.0°

		Golden Shiner TN = 50 CN = 50			White Perch TN = 50 CN = 50		
Time		A	D	S	A	D	S
Hr 8	T	-	-	-	-	-	-
	C	-	-	-	-	-	-
Hr 24	T	50	0	0	50	0	0
	C	50	0	0	50	0	0
$M\text{-}Adj_{24\text{-}Hr}$	(%)	0.0			0.0		

Table 6

Transport Times in Seconds for Fish and Debris Through The Prototype Full-Scale (10" Diameter) Flume and Return Pipe System

Date	Pipe Diameter	Length	Discharge Depth	Flow Rate GPM	Transport Time (Seconds) First	Last	Item
12/05/89	10"	150'	35'	500	105	167	Golden Shiner and White Perch
12/11/89	10"	150'	1'	1000	40 40	160 90	Golden Shiner and White Perch
12/19/89	10"	150'	1'	1000	38 36	75 80	Atl Tomcod and White Perch

Table 7

Fish Survival Test Conditions and Results

Full-Scale System

Conditions:

Date:	12/11/89
Return Pipe Length:	150'
Return Pipe Depth:	35'
Flow:	1,000 gpm
Debris:	None
Temperature:	7.0°

		Golden Shiner TN = 50 CN = 50			White Perch TN = 50 CN = 50		
Time		A	D	S	A	D	S
Hr 8	T C	- -	- -	- -	- -	- -	- -
Hr 24	T C	50 50	0 0	0 0	50 50	0 0	0 0
$M\text{-}Adj_{24\text{-}Hr}$	(%)	0.0			0.0		

On December 19, 1989, the tests were performed with Atlantic tomcod (a relatively hardy species) and white perch. The 150' return pipe was reset to discharge at a depth of minus 1'. The only flow rate tested was 1,000 gpm; no debris was added. Upon discharge into the collection net, the test fish became oriented quickly and generally sounded, but soon began to swim along the edges of the net. There were no discernible signs of damage or mortality among the test fish. At the end of the 24-hour observation period, Atlantic tomcod survival was 100%. Two of the 49 white perch test fish found in the collection net at the end of the latent effects observation period (one apparently escaped) had died, while one of the 50 control white perch had died for an adjusted mortality rate of 2.1% (Table 8). The water temperature during these tests was 4°C. Transit time through the flume and return pipe operated with a water flow of 1,000 gpm ranged from 36 to 85 seconds.

Table 8

Fish Survival Test Conditions and Results

Full-Scale System

Conditions:

Date: 12/19/89
Return Pipe Length: 150'
Return Pipe Depth: 1'
Flow: 1,000 gpm
Debris: None
Temperature: 4.0°C

		White Perch TN = 50 CN = 50			Atlantic Tomcod TN = 50 CN = 50		
Time		A	D	S	A	D	S
Hr 8	T	-	-	-	-	-	-
	C	-	-	-	-	-	-
Hr 24	T*	47	2	0	50	0	0
	C	49	1	0	50	0	0
$M\text{-}Adj_{24\text{-}Hr}$	(%)	2.1			0.0		

* One fish missing - presumed to have escaped from net.

On January 4 and 5, 1990, tests similar to those performed in December with the 150' return pipe at the minus 35' depth were performed to evaluate the effects on fish of being intermixed with several gallons of debris. Flows on January 4th were at 500 gpm while flows on January 5th were 1,000 gpm. Test fish included golden shiner and white perch. Observations disclosed that test white perch following discharge into the collection net quickly re-oriented themselves, but then swam at an approximate 45° upward-oriented angle, and gathered near the upper surface of the net. Also, they appeared to be constantly moving. Control fish, which were released into a net suspended in the minus 1' to minus 6' depth range, swam naturally or were quiescent. Golden shiners displayed no apparent stress when discharged at minus 35'. Latent mortalities at 24, 48, 72 and 96 hours are listed in Tables 9 and 10. Neither golden shiner test fish nor control fish experienced any mortality throughout the 96-hour latent effects observation periods for both flow tests. However, both white perch test and control fish experienced much higher levels of mortality than had been observed in the previous tests of a similar nature. General protocols for controlled experiments dictate that if control animals experience greater than 20% to 25% mortality, interpretation of results will be constrained, and accordingly, the test results should not be used.

Table 9

Fish Survival Test Conditions and Results

Full-Scale System

Conditions:

Date: 01/04/90
Return Pipe Length: 150'
Return Pipe Depth: 35'
Flow: 500 gpm
Debris: 3 gallons; leaves, eelgrass
Temperature: 1.0°C

		White Perch TN = 44 CN = 26			Golden Shiner TN = 23 CN = 24		
Time		A	D	S	A	D	S
Hr 8	T	-	-	-	-	-	-
	C	-	-	-	-	-	-
Hr 24	T	38	6	0	23	0	0
	C	24	2	0	24	0	0
Hr 48	T	31	13	0	23	0	0
	C	20	6	0	24	0	0
M-Adj$_{48\text{-}Hr}$	%	8.4			0.0		
Hr 72	T	24	20	0	23	0	0
	C	18	8	0	24	0	0
Hr 96	T	3	41	0	23	0	0
	C	13	13	0	24	0	0
M-Adj$_{96\text{-}Hr}$	%	86.4			0.0		

Table 10

Fish Survival Test Conditions and Results

Full-Scale System

Conditions:

Date:	01/05/90
Return Pipe Length:	150'
Return Pipe Depth:	35'
Flow:	1,000 gpm
Debris:	3 gallons; leaves, eelgrass
Temperature:	1.0°C

		White Perch TN = 50 CN = 50			Golden Shiner TN = 50 CN = 50		
Time		A	D	S	A	D	S
Hr 8	T C	- -	- -	- -	- -	- -	- -
Hr 24	T C	45 48	5 2	0 0	30 50	0 0	0 0
Hr 48	T C	38 44	12 6	0 0	30 50	0 0	0 0
M-Adj$_{48\text{-}Hr}$	%	13.6			0.0		
Hr 72	T C	31 43	19 7	0 0	30 50	0 0	0 0
Hr 96	T C	12 38	38 12	0 0	30 50	0 0	0 0
M-Adj$_{96\text{-}Hr}$	%	44.4			0.0		

The high level of mortality through 96 hours among control fish in the tests at both flow rates suggested that the mortality experienced by the test fish was not solely due to passage through the return system. At the termination of the test, fish were examined for signs of damage. Both test and control fish showed signs of hemorrhaging at the base of the fins. No other signs of trauma were evident. The only substantive difference in conditions during the January 4 and 5, 1990 tests relative to the December 5 and 11, 1989 tests were that debris was present, and the water temperature was near 1°C (≈6° to 7°C lower than during the early December tests).

On January 10, 1990, the tests were repeated with these two species at the 500 gpm and 1,000 gpm flow rates to determine if debris contributed to the white perch mortality. White perch latent mortalities adjusted for control fish mortality (Tables 11 and 12) after 48 hours, the termination point of the test, were even higher than they had been at 48 hours during the January 4 and 5 tests with debris present (Tables 9 and 10). Adjusted mortality rates without debris present were 78.5% in the 500 gpm test and 31.2% in the 1,000 gpm test; they were 8.4% and 13.6% for the 500 gpm and 1,000 gpm flows, respectively, with debris present. Test fish responded similarly upon discharge during the January 10 test as they did during the January 4 and 5 tests. Evidence of hemorrhaging was present among both white perch test and control fish. The water temperature was approximately 1.5°C. These mortality levels among white perch indicated that debris was not the primary cause of mortality in the earlier test. Also, the fact that the mortality during these mid-January tests occurred at flow rates at which high survival had been achieved in earlier tests (December 5 and 11, 1990) suggested that transport through the system was not a principle causative agent either. Golden shiner survival among test and control fish was again 100%.

Table 11

Fish Survival Test Conditions and Results

Full-Scale System

Conditions:

Date:	01/10/90
Return Pipe Length:	150'
Return Pipe Depth:	35'
Flow:	500 gpm
Debris:	None
Temperature:	1.0°C

		White Perch TN = 41 CN = 50			Golden Shiner TN = 34 CN = 50		
Time		A	D	S	A	D	S
Hr 8	T	-	-	-	-	-	-
	C	-	-	-	-	-	-
Hr 24	T	35	6	0	34	0	0
	C	49	1	0	50	0	0
Hr 48	T	8	33	0	34	0	0
	C	45	5	0	50	0	0
$M\text{-}Adj_{48\text{-}Hr}$	%	78.3			0.0		

Table 12

Fish Survival Test Conditions and Results

Full-Scale System

Conditions

Date:	01/10/90
Return Pipe Length:	150'
Return Pipe Depth:	35'
Flow:	1000 gpm
Debris:	None
Temperature:	1.0°C

		White Perch TN = 38 CN = 50			Golden Shiner TN = 26 CN = 50		
Time		A	D	S	A	D	S
Hr 8	T	-	-	-	-	-	-
	C	-	-	-	-	-	-
Hr 24	T	29	9	0	26	0	0
	C	46	4	0	50	0	0
Hr 48	T	23	15	0	25	1	0
	C	44	6	0	50	0	0
$M\text{-}Adj_{48\text{-}Hr}$	%	31.2			3.8		

The peculiar upward angle orientation of the test fish entrapped in the collection net suspended at the minus 35' depth compared to the naturally oriented control fish contained in the net suspended in surface waters, and the accumulation of the test fish at the top of the collection net while control fish in surface waters showed no such inclination, suggested that the white perch were stressed by the confinement at the 35' depth.

The fact that this behavior had not occurred during earlier tests suggested that temperature was a factor in inducing this condition. Water temperatures during these tests were near 1° to 1.5°C, while during the early December tests they were near 7° to 8°C.

On January 18, 1990, these tests were repeated again with golden shiner and white perch. However, following collection at the minus 35' depth, the net was raised to the surface strata for observation for 24 hours. Golden shiner test fish survival under the two flow conditions was 100%. Although white perch displayed the symptoms of apparent stress (e.g., upward swimming) due to the 35' depth following collection, once the net was raised to the surface, their behavior changed to that comparable to the control fish. Mortality at the end of the 24-hour latent effects assessment period, adjusted for control fish mortality, was 0% (Tables 13 and 14), in contrast to 24-hour adjusted mortality rates of 6% to 17% during the tests on January 4, 5, and 10, when the collection net was kept at minus 35', as summarized in Table 15.

Table 13

Fish Survival Test Conditions and Results

Full-Scale System

Conditions:

Date:	01/18/90
Return Pipe Length:	150'
Return Pipe Depth:	35'
Flow:	500 gpm
Debris:	None
Temperature:	1.5°C

		White Perch TN = 50 CN = 50			Golden Shiner TN = 50 CN = 50		
Time		A	D	S	A	D	S
Hr 8	T	-	-	-	-	-	-
	C	-	-	-	-	-	-
Hr 24	T	45	5	0	51	0	0
	C	44	6	0	49	1	0
M-Adj$_{24\text{-}Hr}$	(%)	0.0			0.0		

Table 14

Fish Survival Test Conditions and Results

Full-Scale System

Conditions:

Date:	01/18/90
Return Pipe Length:	150'
Return Pipe Depth:	35'
Flow:	1,000 gpm
Debris:	None
Temperature:	1.5°C

		White Perch TN = 50 CN = 50			Golden Shiner TN = 50 CN = 50		
Time		A	D	S	A	D	S
Hr 8	T	-	-	-	-	-	-
	C	-	-	-	-	-	-
Hr 24	T	46	4	0	49	0	0
	C	44	6	0	49	1	0
M-Adj$_{24\text{-}Hr}$	(%)	0.0			0.0		

Table 15

White Perch 24-Hour Latent Mortality Rates

150' Return Pipe - 35' Depth

	Duration: 24 Hours				
Test Date		N	A	D	S
01/04/90 (500 gpm)	T C	44 26	38 24	6 2	0 0
Left at 35'	M-adj$_{24\text{-Hr}}$ (%)	6.4			
01/05/90 (1,000 gpm)	T C	50 50	45 48	5 2	0 0
Left at 35'	M-adj$_{24\text{-Hr}}$ (%)	6.2			
01/10/90 (500 gpm)	T C	41 50	35 49	6 1	0 0
Left at 35'	M-adj$_{24\text{-Hr}}$ (%)	12.9			
01/10/90 (1,000 gpm)	T C	38 50	29 46	9 4	0 0
Left at 35'	M-adj$_{24\text{-Hr}}$ (%)	17.0			
01/18/90 (500 gpm)	T C	50 50	45 44	5 6	0 0
Raised to -1'	M-adj$_{24\text{-Hr}}$ (%)	0.0			
01/18/90 (1,000 gpm)	T C	50 50	46 44	4 6	0 0
Raised to -1'	M-adj$_{24\text{-Hr}}$ (%)	0.0			

On January 18, 1990, testing was also performed with the return pipe shortened to a length of 30' with the discharge positioned at a depth of 1'. This test was performed to determine whether transport through the air/quarry water interface within the flume was contributing to the mortality observed among white perch collected at the minus 35' depth. The flow rate during this test was 700 gpm; no debris was added. The flow velocity at the entrance to the quarry was calculated to be 20.0 fps, which was comparable to that for flows of 500 gpm (18.2 fps) and 1,000 gpm (22.2 fps). The water temperature was 1.5°C. At the end of the 24-hour latent effects observation period, the mortality among test fish adjusted for control fish mortality was 0% (Table 16) which suggested that the turbulence present at the flume/quarry water interface was not a causative factor in the mortality observed during the early January tests.

Table 16

Fish Survival Test Conditions and Results

Full-Scale System

Conditions:

Date:	01/18/90
Return Pipe Length:	30'
Return Pipe Depth:	1'
Flow:	700 gpm
Debris:	None
Temperature:	1.5°C

		White Perch TN = 50 CN = 50		
Time		A	D	S
Hr 8	T C	- -	- -	- -
Hr 24	T C	44 44	6 6	0 0
M-Adj$_{24\text{-}Hr}$	%	0.0		

On January 23, 1990, white perch test fish were placed directly into a collection net at the quarry surface. The net was then lowered to the minus 35' depth. The water temperature was approximately 3.0°C. Upon reaching the minus 35' depth, the test fish began swimming upward toward the top of the net, suggesting behavior comparable to that of fish discharged through the return system positioned at minus 35' when water temperatures were 1° to 1.5°C. After an 18-hour latent effects observation period, 4 of the 50 (8%) test fish had died (Table 17). Because of the scarcity of white perch, control fish, which were to be held in a net at the surface, were unavailable. As a result, attribution of these mortalities to retention at minus 35' as opposed to say, handling mortality, would be tenuous. However, the behavioral response suggests that entrapment at that depth was stressful, and that the cause of the white perch mortality during the early January tests was related to entrapment at the minus 35' depth to which they could not readily acclimate, apparently because of the cold water temperatures.

For comparative purposes, 50 previously used white perch were placed in another cage that was lowered to the minus 35' depth. An additional 22 previously used white perch were held in a net near the quarry surface as controls. Previously used fish held at minus 35' displayed behavior comparable to that of

Table 17

Control Fish Survival Test When Lowered to -35'

Conditions:

Date: 01/23/90
Debris: None
Temperature: 3.0°C

		White Perch Unused TN = 50 CN = 0			White Perch Used TN = 50 CN = 22		
Time		A	D	S	A	D	S
Hr 18	T C	46 -	4 -	- -	12 13	38 9	- -
Mortality	(%)	8.0 Unadjusted			59.4		

unused fish held at the same depth. By the end of the 18 hour latent effects observation interval, 38 of the 50 (76%) previously used fish that were held at the minus 35' depth had died, while 9 of 22 (40.9%) previously used control fish held at the surface had succumbed (Table 17; used fish adjusted mortality = 59.4%). As noted above, general protocol suggests that the results of tests in which the previously used control fish mortality is excessive (greater than 20% to 25%) should not be used in analyses. It appears worthy to note, however, that proportionally, nearly twice as many of the previously used fish held at minus 35' died as did those held near the surface.

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A series of tests were performed with a 250' return pipe positioned to discharge at minus 35' during the period January 19 to February 2, 1990. Tests were performed at 500 and 1,000 gpm both with and without debris present. After fish collections at minus 35', the test cage was raised and held at the minus 1' depth. Water temperatures ranged from 1.5°C to 4°C. Test fish included white perch, golden shiner and Atlantic tomcod. Golden shiner survival through the 96 and 120 hour latent effects observation periods was 100% (Tables 18-21). Atlantic tomcod survival after 96 hours was 100% at 500 gpm; at 1,000 gpm, mortality was 2.6% (Tables 22 and 23). White perch test, as well as control, fish mortalities were high (Tables 24-27), which suggested that the fish were stressed before testing began. Again, protocol dictates that since control fish mortality exceeded 20%, the test results should be discarded. However, it is interesting to note that mortality levels among test as well as control fish at succeeding latent effects observation periods were comparable. This suggested that the test conditions did not affect the levels of mortality observed among test fish.

Table 18

Fish Survival Test Conditions and Results

Full-Scale System

Conditions:

Date:	01/19/90
Return Pipe Length:	250'
Return Pipe Depth:	35'
Flow:	500 gpm
Debris:	None
Temperature:	1.5°C

		Golden Shiner TN = 50 CN = 50		
Time		A	D	S
Hr 8	T	-	-	-
	C	-	-	-
Hr 24	T	50	0	0
	C	50	0	0
Hr 48	T	50	0	0
	C	50	0	0
Hr 72	T	50	0	0
	C	50	0	0
Hr 96	T	50	0	0
	C	50	0	0
M-Adj$_{96\text{-}Hr}$	%	0.0		

Table 19

Fish Survival Test Conditions and Results

Full-Scale System

Conditions:

Date:	01/19/90
Return Pipe Length:	250'
Return Pipe Depth:	35'
Flow:	1,000 gpm
Debris:	None
Temperature:	1.5°C

		Golden Shiner TN = 50 CN = 50		
Time		A	D	S
Hr 8	T	-	-	-
	C	-	-	-
Hr 24	T	50	0	0
	C	50	0	0
Hr 48	T	50	0	0
	C	50	0	0
Hr 72	T	50	0	0
	C	50	0	0
Hr 96	T	50	0	0
	C	50	0	0
$M\text{-}Adj_{96\text{-}Hr}$	%	0.0		

Table 20

Fish Survival Test Conditions and Results

Full-Scale System

Conditions:

Date:	01/24/90
Return Pipe Length:	250'
Return Pipe Depth:	35'
Flow:	500 gpm
Debris:	3 gallons; leaves
Temperature:	4.0°C

		Golden Shiner TN = 48 CN = 50		
Time		A	D	S
Hr 8	T C	- -	- -	- -
Hr 24	T C	48 50	0 0	0 0
Hr 48	T C	48 50	0 0	0 0
Hr 72	T C	48 50	0 0	0 0
Hr 96	T C	48 50	0 0	0 0
Hr 120	T C	48 50	0 0	0 0
M-Adj$_{120\text{-Hr}}$	%	0.0		

Table 21

Fish Survival Test Conditions and Results

Full-Scale System

Conditions:

Date:	01/24/90
Return Pipe Length:	250'
Return Pipe Depth:	35'
Flow:	1,000 gpm
Debris:	3 gallons; leaves
Temperature:	4.0°C

		Golden Shiner TN = 50 CN = 50		
Time		A	D	S
Hr 8	T	-	-	-
	C	-	-	-
Hr 24	T	50	0	0
	C	50	0	0
Hr 48	T	50	0	0
	C	50	0	0
Hr 72	T	50	0	0
	C	50	0	0
Hr 96	T	50	0	0
	C	50	0	0
Hr 120	T	49	1	0
	C	50	0	0
M-Adj$_{120\text{-Hr}}$	%	2.0		

Table 22

Fish Survival Test Conditions and Results

Full-Scale System

Conditions:

Date: 01/29/90
Return Pipe Length: 250'
Return Pipe Depth: 35'
Flow: 500 gpm
Debris: 3 gallons; leaves
Temperature: 3.0°C

		Atlantic Tomcod TN = 40 CN = 40		
Time		A	D	S
Hr 8	T C	- -	- -	- -
Hr 24	T C	39 40	1 0	0 0
Hr 48	T C	39 40	1 0	0 0
Hr 72	T C	39 39	1 1	0 0
Hr 96	T C	39 39	1 1	0 0
M-Adj$_{96\text{-}Hr}$	%	0.0		

Table 23

Fish Survival Test Conditions and Results

Full-Scale System

Conditions:

Date:	01/29/90
Return Pipe Length:	250'
Return Pipe Depth:	35'
Flow:	1,000 gpm
Debris:	None
Temperature:	3.0°C

		Atlantic Tomcod TN = 40 CN = 40		
Time		A	D	S
Hr 8	T	-	-	-
	C	-	-	-
Hr 24	T	40	0	0
	C	40	0	0
Hr 48	T	39	1	0
	C	40	0	0
Hr 72	T	39	1	0
	C	39	1	0
Hr 96	T	38	2	0
	C	39	1	0
M-Adj$_{96\text{-}Hr}$	%	2.6		

Table 24

Fish Survival Test Conditions and Results

Full-Scale System

Conditions:

Date:	01/19/90
Return Pipe Length:	250'
Return Pipe Depth:	35'
Flow:	500 gpm
Debris:	None
Temperature:	1.5°C

		White Perch TN = 50 CN = 50		
Time		A	D	S
Hr 8	T	-	-	-
	C	-	-	-
Hr 24	T	45	5	0
	C	45	5	0
Hr 48	T	42	8	0
	C	42	8	0
Hr 72	T	36	14	0
	C	35	15	0
Hr 96	T	30	20	0
	C	26	24	0
M-Adj$_{96\text{-}Hr}$	%	0.0		

Table 25

Fish Survival Test Conditions and Results

Full-Scale System

Conditions:

Date:	01/19/90
Return Pipe Length:	250'
Return Pipe Depth:	35'
Flow:	1,000 gpm
Debris:	None
Temperature:	1.5°C

		White Perch TN = 50 CN = 50		
Time		A	D	S
Hr 8	T	-	-	-
	C	-	-	-
Hr 24	T	44	6	0
	C	45	5	0
Hr 48	T	41	9	0
	C	42	8	0
Hr 72	T	34	16	0
	C	35	15	0
Hr 96	T	26	24	0
	C	26	24	0
M-Adj$_{96\text{-}Hr}$	%	0.0		

Table 26

Fish Survival Test Conditions and Results

Full-Scale System

Conditions:

Date: 01/24/90
Return Pipe Length: 250'
Return Pipe Depth: 35'
Flow: 500 gpm
Debris: 3 gallons; leaves
Temperature: 4.0°C

		White Perch TN = 50 CN = 50		
Time		A	D	S
Hr 8	T	-	-	-
	C	-	-	-
Hr 24	T	47	3	0
	C	36	14	0
Hr 48	T	44	6	0
	C	31	18	0
Hr 72	T	41	9	0
	C	29	21	0
Hr 96	T	39	11	0
	C	26	11	0
Hr 120	T	39	11	0
	C	26	24	0
M-Adj$_{120\text{-}Hr}$	%	0.0		

Table 27

Fish Survival Test Conditions and Results

Full-Scale System

Conditions:

Date:	01/24/90
Return Pipe Length:	250'
Return Pipe Depth:	35'
Flow:	1,000 gpm
Debris:	3 gallons; leaves
Temperature:	4.0°C

		White Perch TN = 50 CN = 50		
Time		A	D	S
Hr 8	T	–	–	–
	C	–	–	–
Hr 24	T	35	15	0
	C	36	14	0
Hr 48	T	39	21	0
	C	31	19	0
Hr 72	T	31	19	0
	C	29	21	0
Hr 96	T	28	22	0
	C	26	24	0
Hr 120	T	25	25	0
	C	26	24	0
$M\text{-}Adj_{120\text{-}Hr}$	%	3.0		

E. Conclusions

Results of tests with both the partial-scale system and the full-scale system for the various combination of factors, including return pipe length, operating water flow rates, and debris, suggest the following:

1. Fish survival did not appear to be influenced by the design of the sluice to flume transition section nor to the diameter of the return system conduit.
2. Fish survival did not appear to be influenced by the return pipe length up to 250'.
3. Fish survival did not appear to be influenced by the water flow volume, which ranged from 245 gpm to 1,000 gpm, nor to flow discharge velocity, which ranged from 2 fps to 5 fps.
4. Fish survival did not appear to be compromised by the presence of debris in the return system water.
5. With the exception of white perch at winter-time low water temperatures, fish survival did not appear to be influenced by discharge depth up to minus 35'. Observations of white perch during the January 1990 tests suggested that the artificial retention of test fish within collection nets at minus 35', when they had acclimated to shallow water conditions, was detrimental. When test fish collected at the 35' depth were raised in

the collection net to the near-surface depth, their behavior changed to that comparable to both control fish and other test species discharged at that depth. Also, when control fish were lowered to a depth of minus 35', they displayed behavior comparable to that of the test fish discharged at that depth. In natural conditions, fish collected by the Ristroph screens would be held in shallow water (≈4"±) for less than about 15 minutes and thus would not be expected to become acclimated to shallow water depths nor would they be restrained to a specific depth when released at minus 35'. They would be able to select the depth of their choice. Accordingly, it is unlikely that fish returned under operating conditions would experience the levels of mortality observed during these tests.

6. The design concept for the fish sluice transition section, the flume, including installation slopes, and the return pipe, including placement of the discharge at minus 35', and operating flow rates up to 1,000 gpm that were tested at the Verplanck Quarry appear suitable for application in Ristroph screen fish return systems at Indian Point Units 2 and 3.

IV. RETURN SYSTEM SITING PROGRAM

A. Introduction

The purpose of a fish return system is to convey fish to a location within a source water from which there is little likelihood that they will reappear among the intake water screenings. Bases for the reappearance of returned fish could be either by their own behavior or by transport via intake water currents. Since understandings of behavioral bases for the appearance of fish at water intakes are vague, and, as a consequence, not exploitable for exclusion purposes, the principal basis for siting a return system discharge remains a knowledge of the extent of the volumetric zone from which water is withdrawn. However, the boundaries of withdrawal zones may vary, particularly with changes in the tide, and in volumes of water pumped, as occurs at Indian Point. Conceptually, placement of the return system discharge at the outer limit would eliminate the probability that a fish would be passively drawn back to the intakes and, assuming that no other environmental factors compromise the safe release of fish at this location, provide a balance between the fish protective benefits of the Ristroph screen system, and its costs.[2]

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[2] The Agreement for installation of Ristroph screen systems at Indian Point Units 2 and 3 requires, for cost control purposes, that, to the extent practicable, competitive bids be obtained for equipment and installation contracts and that studies to design the fish return systems consider the costs and environmental benefits to be obtained. A logical extension of these principles suggests that the fish return system should represent a balance between costs and benefits.

Placement of the return system discharge further from the intake might reduce the probability that a fish would actively swim back into the vicinity of the intakes, but at a higher cost, and conversely, a discharge closer to the intake would generally reduce its cost, but might increase the risk of return to the intakes.

However, extension of the line to the maximum extent of the withdrawal zone might be based on worst case conditions that are relatively short in duration (slack tide) or occur when relatively few fish would be susceptible to recirculation (low impingement period). For example, at Indian Point, nearly 70% of the total annual impingement occurs during the period of the year when circulating water pumping rates are at 60% (504,000 gpm) of full flow (840,000 gpm) per unit (Table 28).

Table 28

Approximated Circulating Water Flow Rates For Indian Point Units 2 And 3

Time Period	Flow Rate (GPM)	Seasonal Distribution of Impingement (%)
November 1 - December 31	504,000	20.6
January 1 - May 15	504,000	48.2
May 16 - May 22	560,000	4.0
May 23 - May 31	672,000	7.2
June 1 - June 8	731,000	0.4
June 9 - September 30	840,000	14.1
October 1 - October 31	731,000	5.5

Only 14% of the annual numbers of fish impinged are collected when the pumping rates are at the maximum (Table 28). It is at low winter temperatures when flows are minimal that passive recirculation of fish to intakes is most likely to occur. These factors should be considered in evaluating alternative locations for fish return system discharges for Indian Point Units 2 and 3.

3. Zone of Water Withdrawal at Indian Point

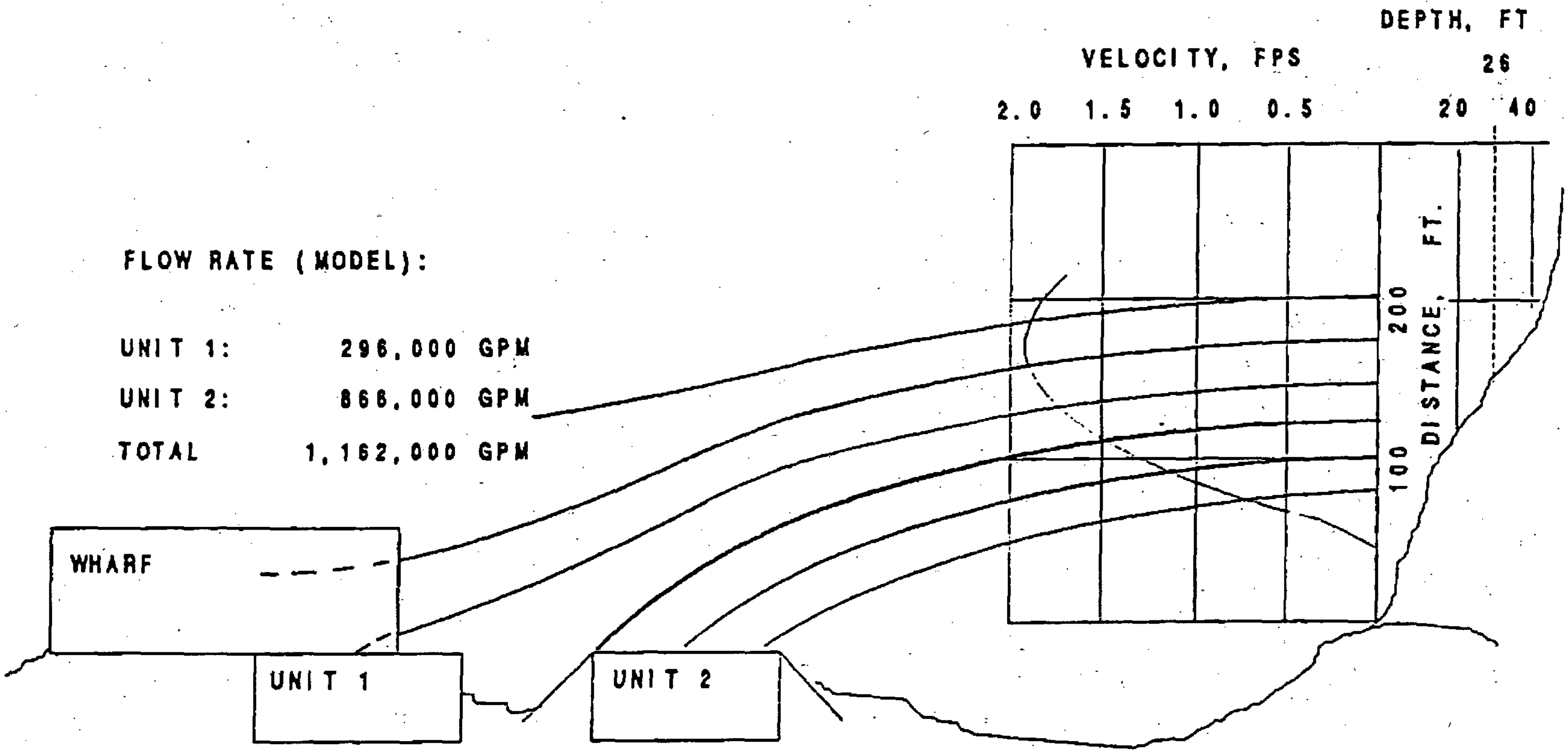
Cooling water withdrawal zones at the Indian Point Generating Station have been the subject of several studies, and much of this information is relevant to the question of where to locate the end of the fish return pipe so that fish are not passively recirculated back to the intakes.

The following studies are particularly helpful in resolving the question of where to locate the ends of the return pipes. Alden Research Laboratories, using a 1/75 scale physical hydraulic model, described ebb tide streamlines into the intakes when Units 1 and 2 were operating at full circulating water flow rates (*Neale, 1973*). LaSalle Hydraulic Laboratory, Ltd., using a 1/84 scale physical hydraulic model, described the withdrawal zone, velocity patterns and recirculation for flood, ebb and slack tide conditions when Units 1, 2, and 3 were in full circulating water flow operation at the Indian Point Generating Station (*Parkinson and Goulet, 1976*).

Neale (1973) determined that with an ebb tide current of 1.4 fps and an intake withdrawal rate of 1,162,000 gpm, (comparable to the reduced flow rate of both units combined, 1,080,000 gpm), the Unit 2 zone of withdrawal extended from the intake approximately 100' offshore at the surface to about 140' offshore near the bottom. These distances reflect the position at which flow streamlines cross the proposed return line route, which is approximately 145' upstream from the centerline of the intake (Figures 7 and 8). When the ebb current speed decreased to 0.5 fps, the withdrawal zone for Unit 2 expanded riverward of the face of the intake to about 190' at the surface and to about 165' near the bottom (Figures 9 and 10).

The LaSalle study (*Parkinson and Goulet, 1976*) described tidal effects more extensively than the Alden study. Their studies were performed for Units 1, 2 and 3 operating at a combined water intake withdrawal rate of 2,100,000 gpm, which is 25% greater than the full flow pumping rate (1,680,000 gpm) for Units 2 and 3. The withdrawal zone was found to be a band along the eastern shore that, at approximately 145' upstream of the intake centerline, extended offshore of the face of the intake from about 150' during maximum ebb tide to about 175' during average ebb tide (Figures 11 and 12).

FIGURE 7 Indian Point Units 1 and 2 Intake Water Withdrawal Zone Study
Surface Flow Net at 1.4 FPS Ebb Tide

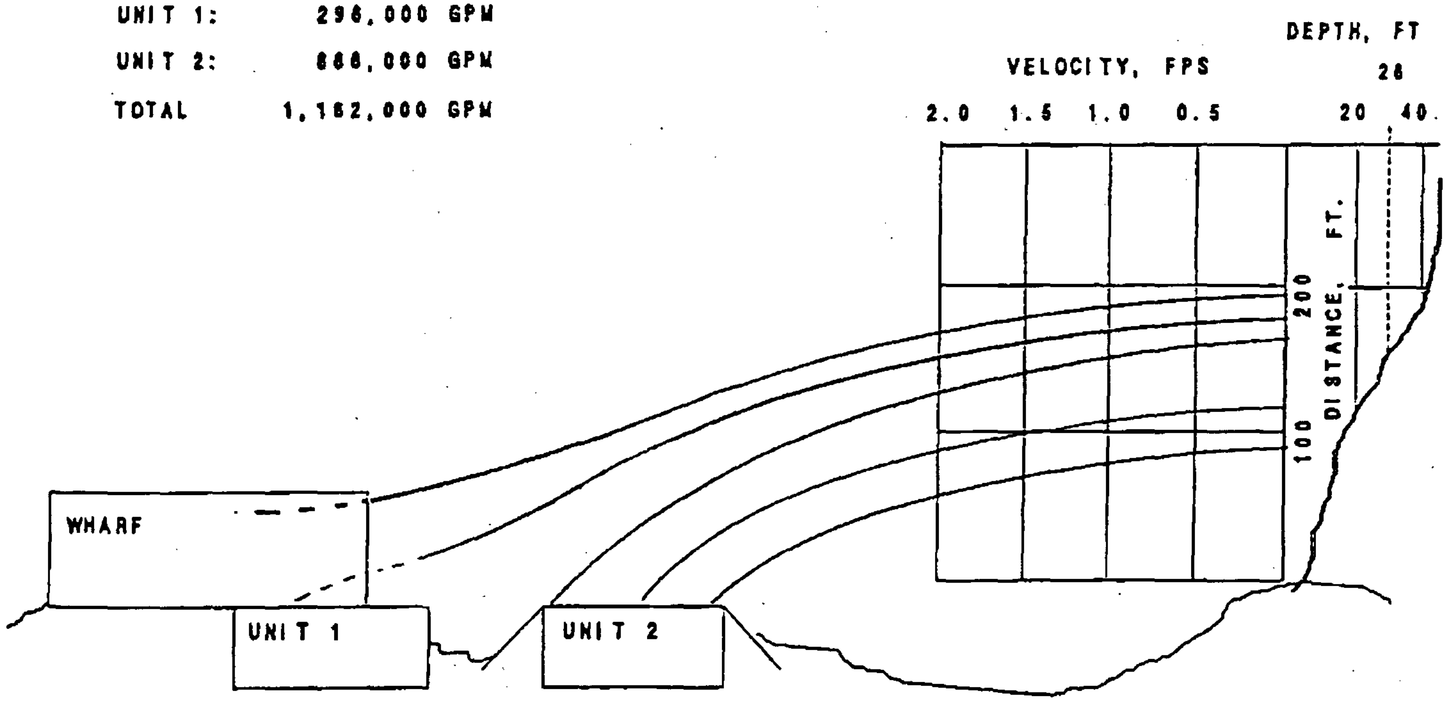


Source: Alden Research Laboratory
Neale, 1973

FIGURE 8 Indian Point Units 1 and 2 Intake Water Withdrawal Zone Study
Bottom Flow Net at 1.4 FPS Ebb Tide

FLOW RATE (MODEL):

UNIT 1:	296,000 GPM
UNIT 2:	866,000 GPM
TOTAL	1,162,000 GPM

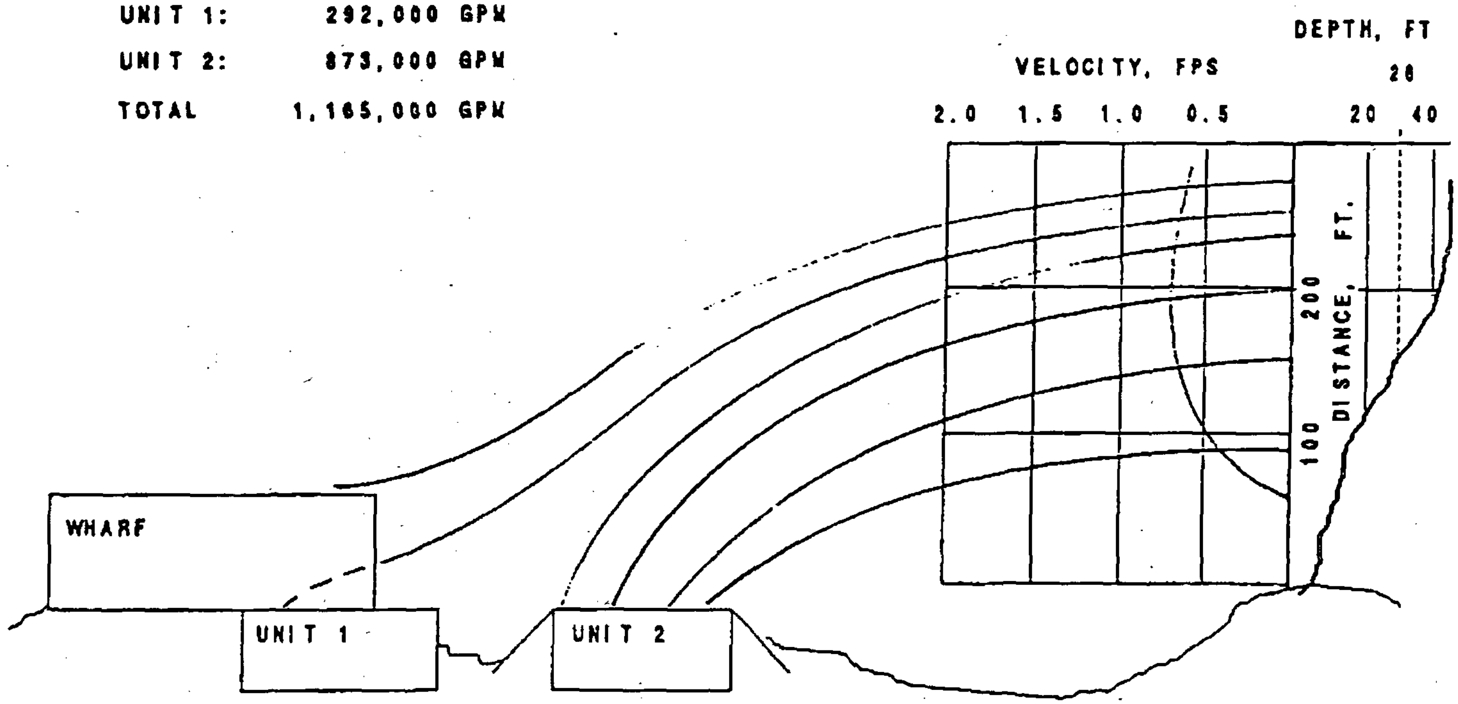


Source: Alden Research Laboratory
Neale, 1973

FIGURE 9 Indian Point Units 1 and 2 Intake Water Withdrawal Zone Study
Surface Flow Net at 0.5 FPS Ebb Tide

FLOW RATE (MODEL):

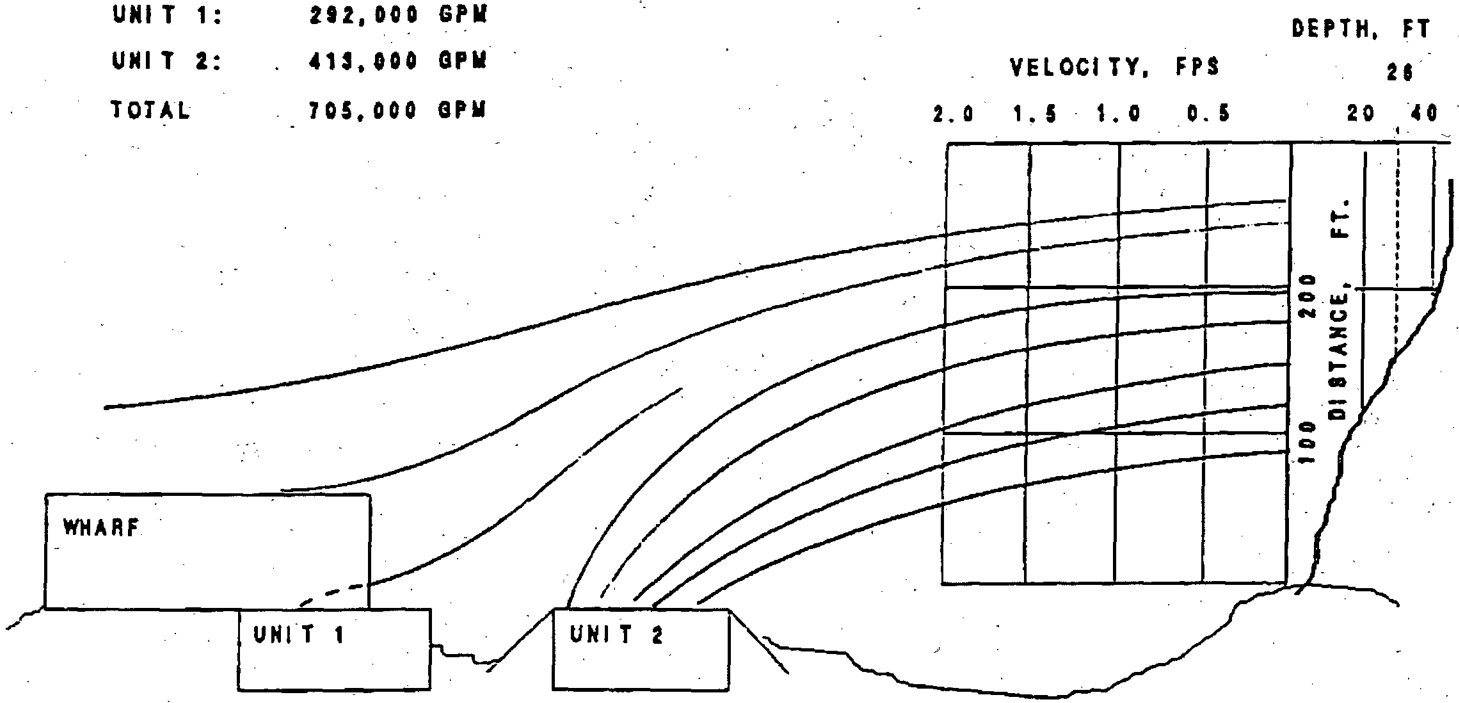
UNIT 1: 292,000 GPM
UNIT 2: 873,000 GPM
TOTAL 1,165,000 GPM



Source: Alden Research Laboratory
Neale, 1973

FIGURE 10 Indian Point Units 1 and 2 Intake Water Withdrawal Zone Study
Bottom Flow Net at 0.5 FPS Ebb Tide

UNIT 1: 292,000 GPM
UNIT 2: 413,000 GPM
TOTAL 705,000 GPM



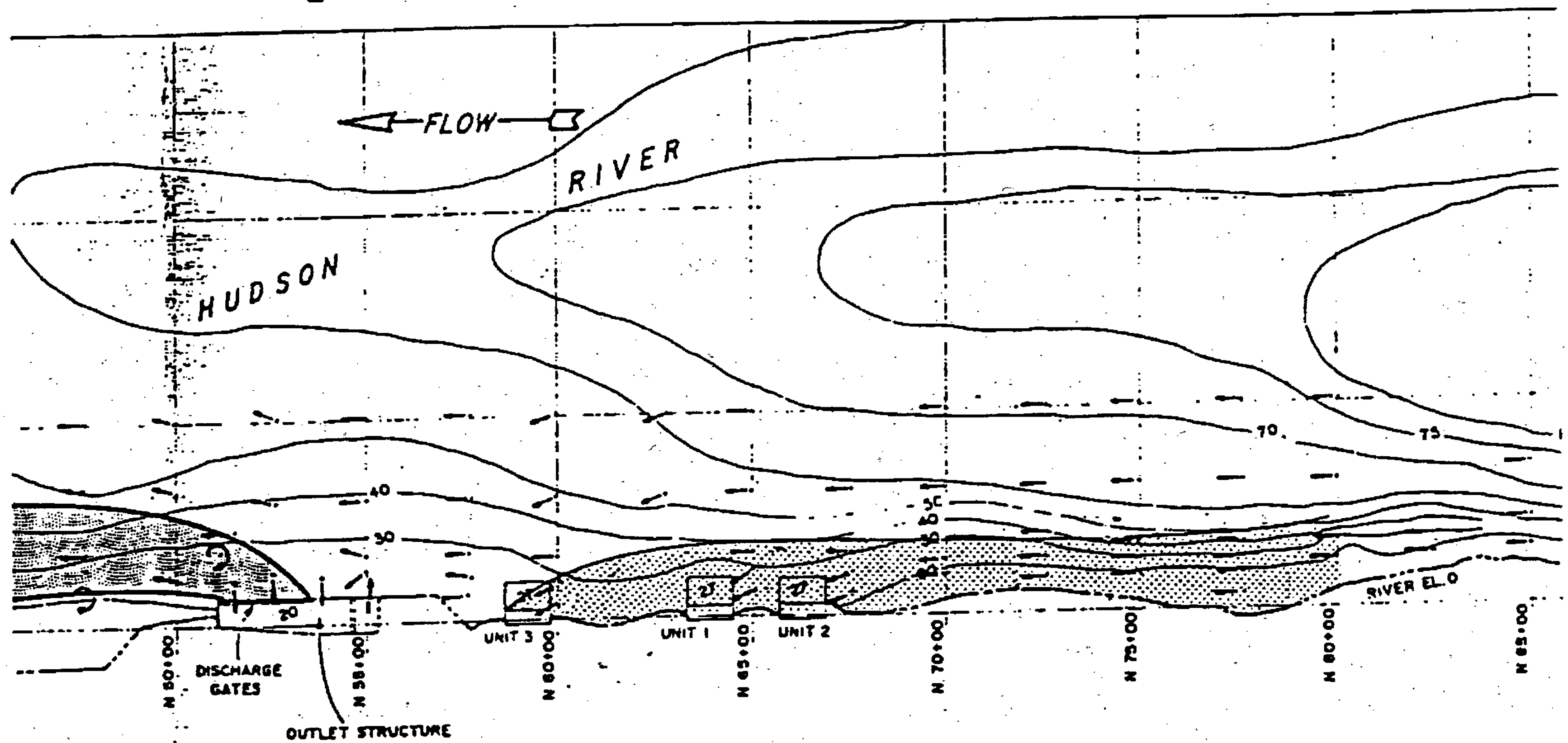
Source: Alden Research Laboratory
Neale, 1973

During the flood tide, at the same withdrawal rate, the interaction between the outward flowing cooling water effluent from the station, the upstream (northward) flowing tidal current and the inward flowing intake water created a large oval-shaped eddy in front of the station. As a result, the zone of withdrawal was actually from north of the intakes even though the source of the water was from downstream of the station. The zone of withdrawal, as measured at approximately 145' north of the station, was about 120' wide during maximum flood and about 150' wide during average flood tide (Figures 13 and 14).

During slack tide, the withdrawal zone extended nearly 200' offshore but mostly upstream from the intakes since the effluent discharge cut off the inflow of water from downstream (Figure 15).

Parkinson and Goulet's (1976) composite illustration of the distribution of cooling water supply (Figure 16) suggested the predominant flow of water to the intakes at Units 2 and 3 was from a zone extending approximately 170' offshore of the intake and near the region of the 40' depth contour as measured at about 145' north of the station (Figure 16). Based on the results from these two model studies, a fish return line located approximately 175' to 200' offshore of the Unit 2 intake would appear to provide the "balance" of minimal potential return of fish with minimal return line length (Table 29). Although the withdrawal zone at Unit 3 extends a similar distance offshore northward of the intake, southward of the intake, no withdrawal zone could be defined. At Unit 3, a return line located generally south of the intake would appear to be outside of the immediate zone of withdrawal.

Figure 11 Hudson River Zone Supplying Water and Receiving Cooling Water at the Indian Point Station During Maximum Ebb Tide (Tidal Discharge - 350,000 CFS)

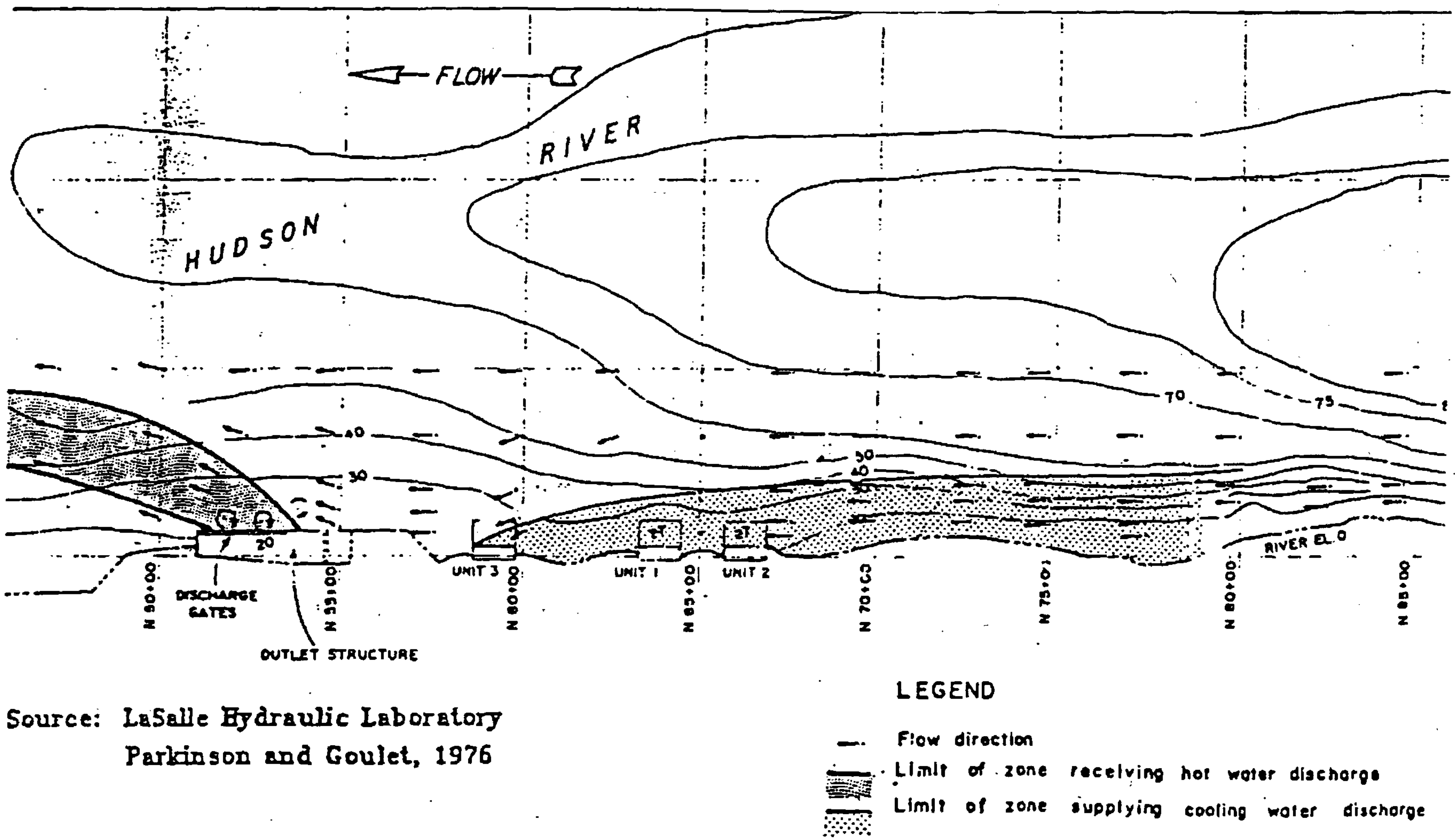


Source: LaSalle Hydraulic Laboratory
Parkinson and Goulet, 1976

LEGEND

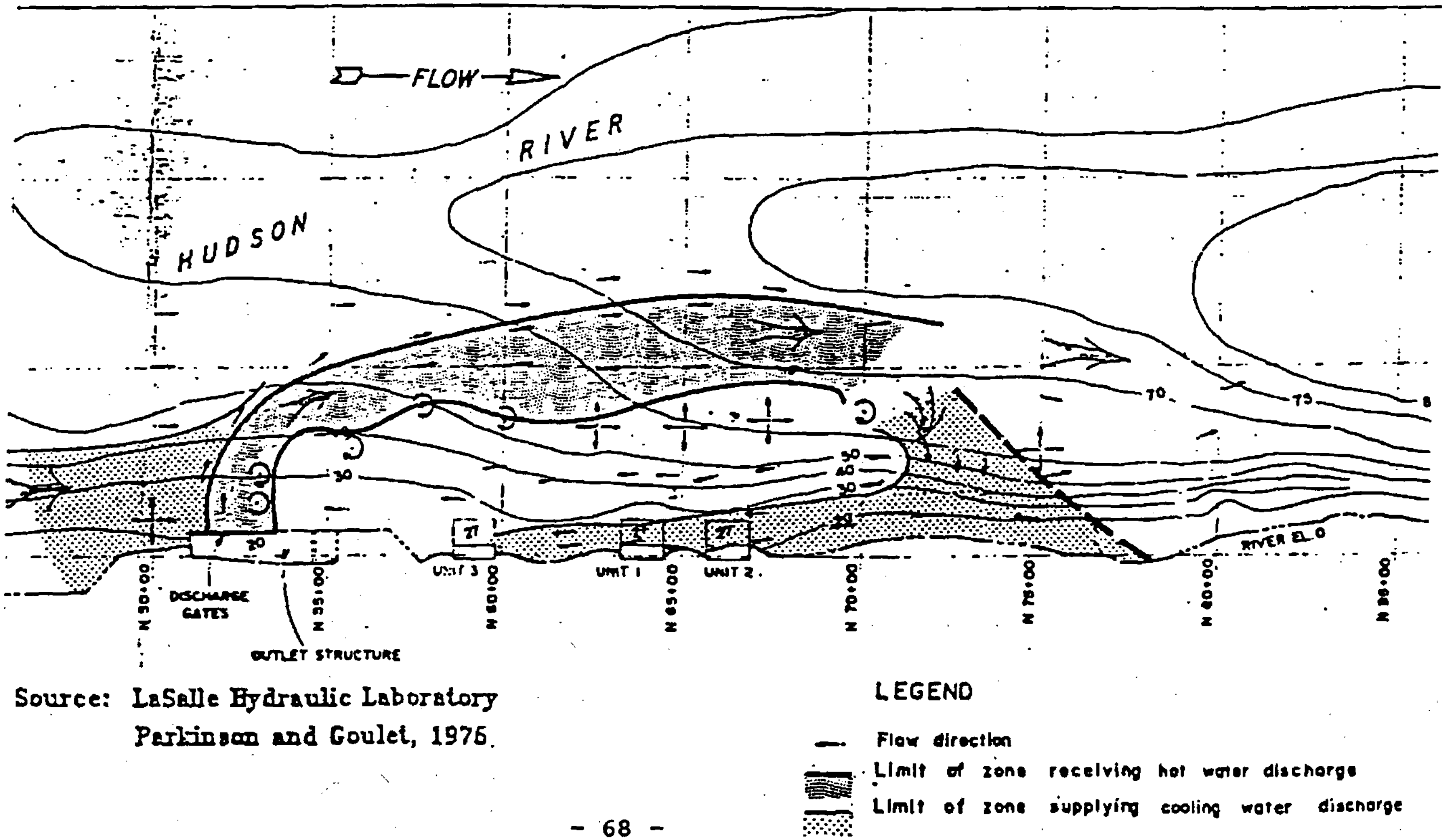
- Flow direction
- Limit of zone receiving hot water discharge
- Limit of zone supplying cooling water discharge

Figure 12 Hudson River Zone Supplying Water and Receiving Cooling Water at the Indian Point Station During Average Ebb Tide (Tidal Discharge – 210,000 CFS)



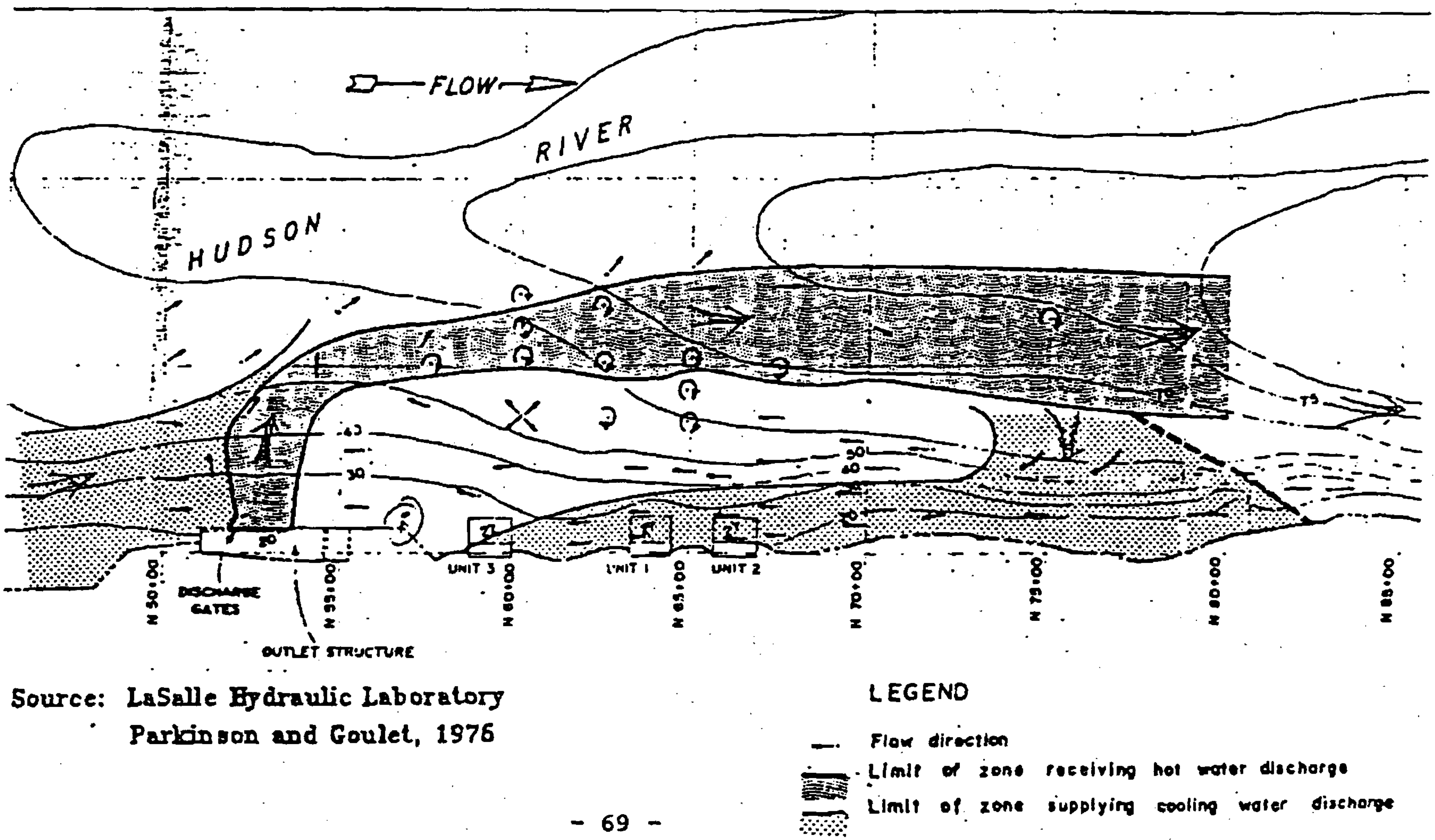
Source: LaSalle Hydraulic Laboratory
Parkinson and Goulet, 1976

Figure 13 Hudson River Zone Supplying Water and Receiving Cooling Water at the Indian Point Station During Maximum Flood Tide (Tidal Discharge - 300,000 CFS)



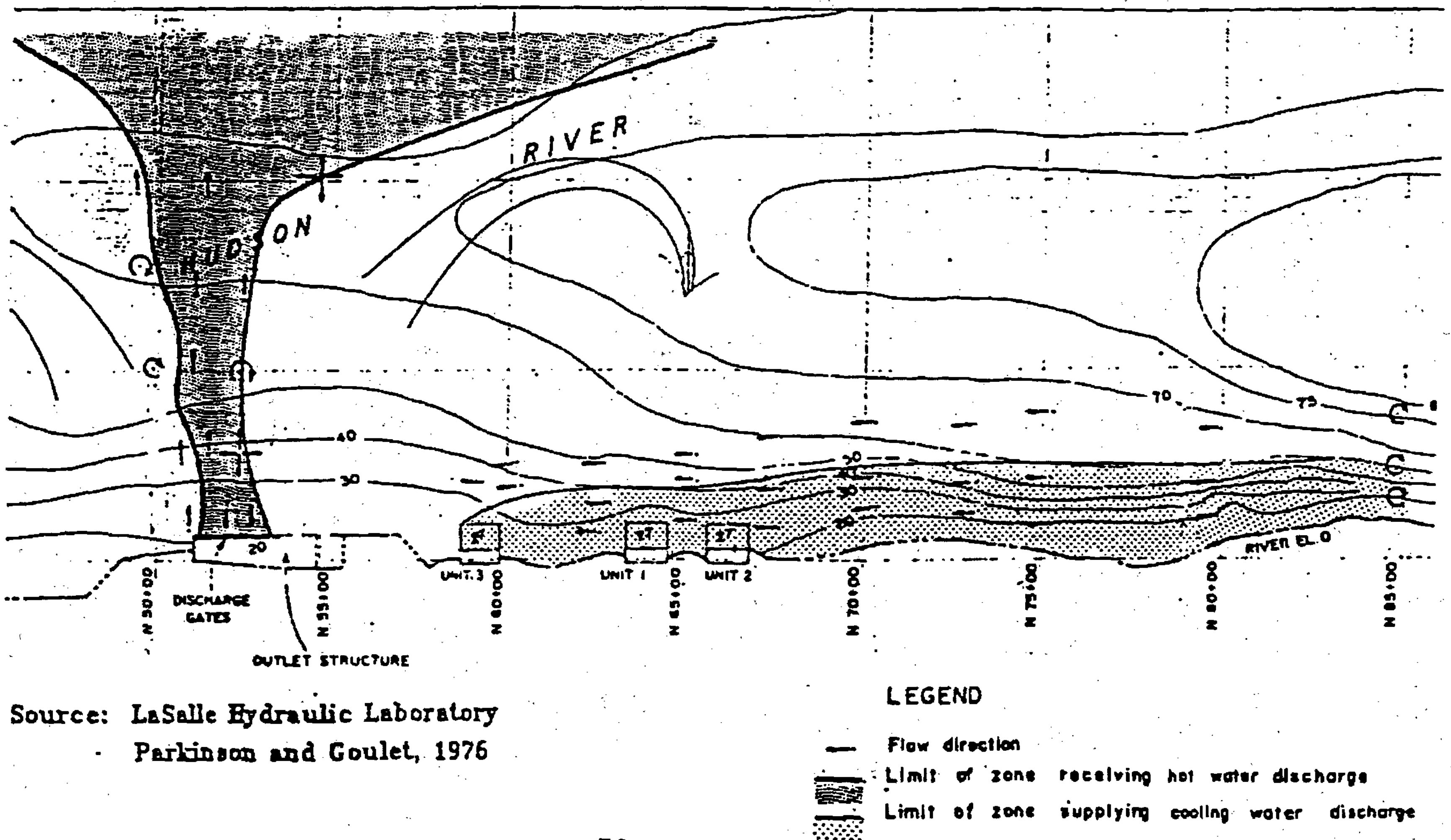
Source: LaSalle Hydraulic Laboratory
Parkinson and Goulet, 1976.

Figure 14 Hudson River Zone Supplying Water and Receiving Cooling Water at the Indian Point Station During Average Flood Tide (Tidal Discharge - 180,000 CFS)



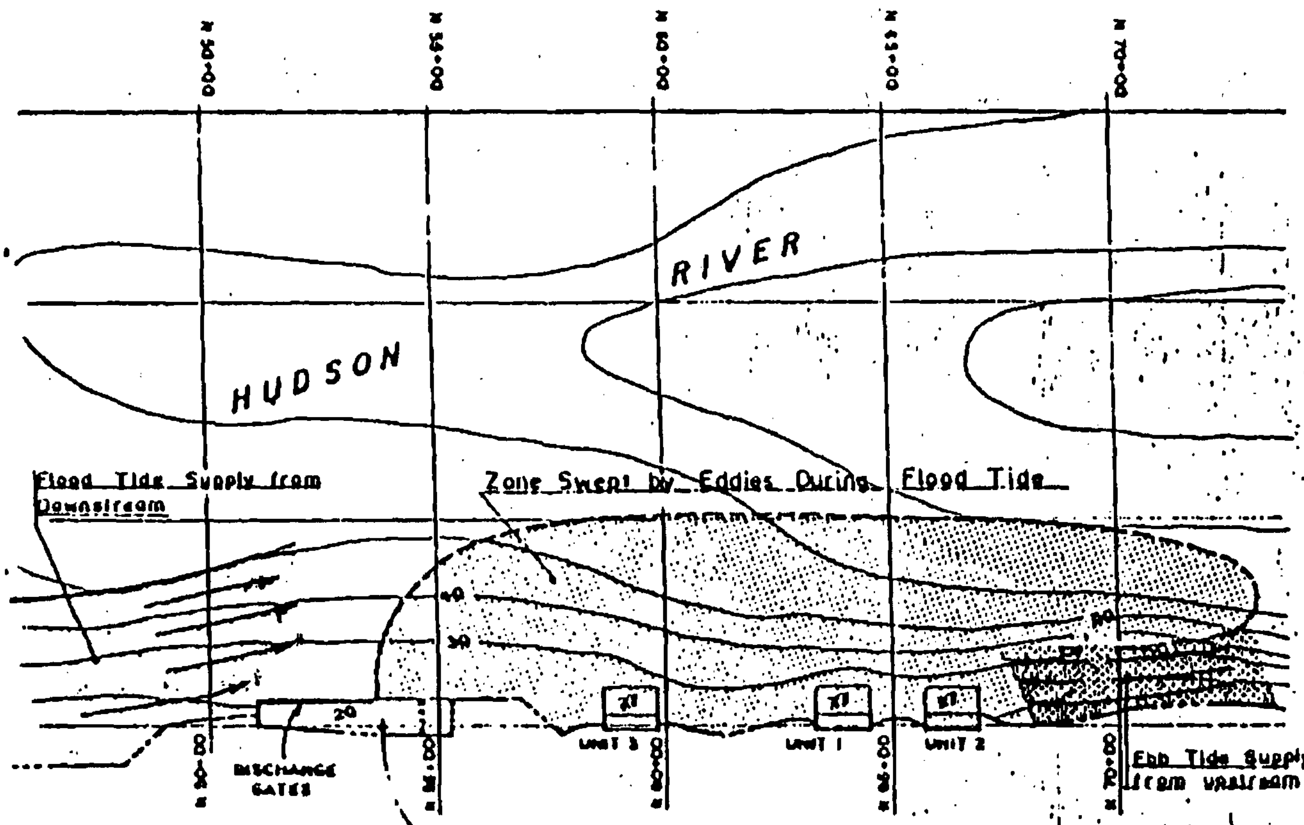
Source: LaSalle Hydraulic Laboratory
Parkinson and Goulet, 1976

Figure 15 Hudson River Zone Supplying Water and Receiving Cooling Water at the Indian Point Station During Slack Water



Source: LaSalle Hydraulic Laboratory
Parkinson and Goulet, 1976

Figure 16 Distribution of Cooling Water Supply



Flood Tide Supply from Downstream	Assumed Tides	Ebb Tide Supply from Upstream
50%	Theoretical Mean Tide (Fig.3)	50%
45%	N.O.S. Tide Tables (1976)	55%
32%	May 18, 1976, Observed (Fig 37)	68%

Source: LaSalle Hydraulic Laboratory
Parkinson and Goulet, 1976.

Table 29

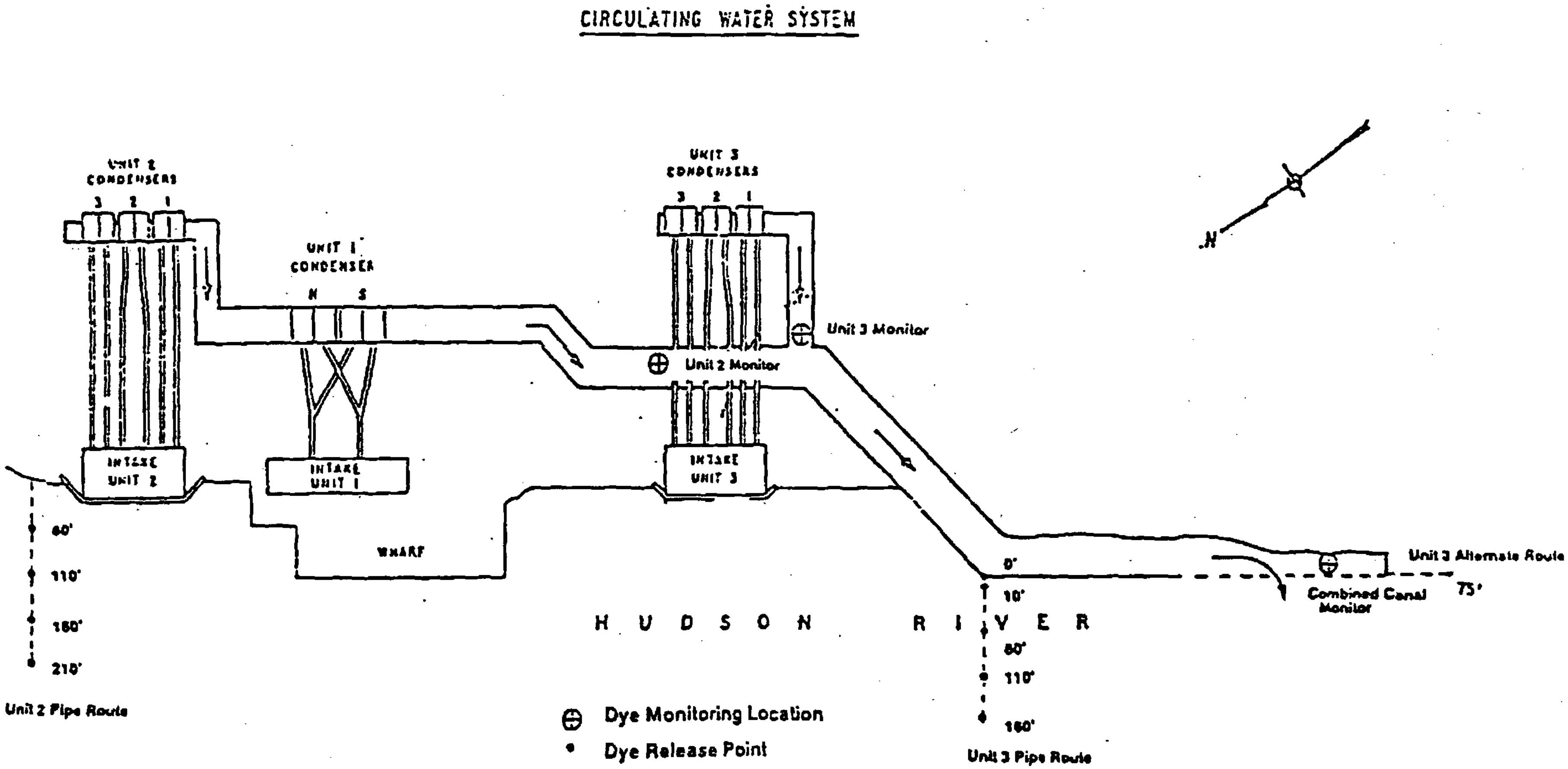
Indian Point Hydraulic Model-Projected
Water Withdrawal Streamline Limits at a
Westerly-Oriented Transect 145' North of the Unit 2 Intake

			Distance (Ft) Off The Intake		
Withdrawal Rate (GPM)	Tide Stage	Tide Velocity (FPS)	Surface	Bottom	Source
1,162,000	Ebb	0.5	190	165	Neale (1973)
	Ebb	1.4	100	140	"
2,100,000	Ebb	1.7	175	-	Parkinson and Goulet (1976)
	Ebb	2.4	150	-	"
	Flood	1.1	150	-	"
	Flood	2.0	120	-	"
	Slack	-	200	-	"
	Composite	-	170	-	"

C. Dye Release Recirculation Studies

With the concurrence of the Parties, we agreed to further evaluate the recirculation potential from return line discharges situated offshore of Units 2 and 3 using either dyes or neutral density drifters. Through competitive bidding, a contract was issued to Aquatec, Inc., to determine the potential for dye transport to the intakes from discharges along two transects. One transect was located 145' north of the center of the Unit 2 intake and extended 210' out into the river from the shoreline (185' offshore of the face of the intake). The other was

Figure 17 Indian Point Station Ristroph Screen System
Proposed Fish Return Pipe Discharge Locations
For Dye Recirculation Rate Evaluations



located south of the Unit 3 intake at the northwest corner of the common discharge canal and extended 160' out into the river, 230' offshore of the intake (Figure 17). Dye releases were made at various points along each of these two proposed routes to determine the probability that passively drifting, neutrally buoyant fish, released at the points, would be carried to the intakes by natural and induced water currents.

Four points along the Unit 2 transect and five points along the Unit 3 transect were studied. The points along the Unit 2 transect were located 60', 110', 160' and 210' from shore at low slack. The points along the Unit 3 transect were located at 0', 10', 60' 110', and 160' from the northwest corner of the discharge canal. An additional point identified as the "Alternate" point was located 75' south of the end of the discharge canal, along the line defined by the outer wall of the canal.

A solution of Rhodamine WT fluorescent dye was released from each of several points along each transect at a constant rate for a duration of one complete tidal cycle. All releases were initiated at the beginning of low slack. Each release cycle was preceded by and followed by at least one complete tidal cycle during which no dye was released. Readings of fluorescence in intake water during preceding tidal cycles provided background fluorescence levels for adjustment of levels observed during dye release tidal cycles.

All dye was released 5' above the bottom of the river, the anticipated location of return pipe discharge points relative to the river bed. Fluorescence and temperature were measured continuously at each unit's discharge and digitally recorded at a rate of once per minute.

To determine the influence of intake water pumping rates on the probability of return from each point, dye releases were performed at both summer and winter withdrawal rates. During the Phase I releases (full circulating water pumping rates), the cooling water withdrawal at each unit was 840,000 gpm. During the Phase II releases (reduced flow circulating water pumping rates), the cooling water withdrawal at Unit 3 was 504,000 gpm and that at Unit 2 varied from 336,000 to 504,000 gpm. (The overall average withdrawal rate at Unit 2 was 449,000 gpm). During Phase I, the service water flow was 30,000 gpm at each unit. During Phase II, it was 30,000 gpm at Unit 3 and 15,000 gpm at Unit 2.

The estimate of the cumulative return rate of dye to the intakes was defined as the mass of all dye returned to the intake through a time interval relative to the quantity of dye released through that time interval. Cumulative return rates were adjusted for background fluorescence.

1. Dye Releases at Unit 2

Results showed that at the full flow circulating water pumping rate (Phase I), the overall cumulative recovery rate of dye at the Unit 2 intake through one tidal cycle (13 hours) was uniformly high from the Unit 2 release points at 60' and 110' (82% and 78%, respectively) offshore, but decreased to 54% at the 160' and 31% (11 hour value) at the 210' release points (Table 30). The extended recovery rates after 26 hours, which included the tidal cycle following termination of dye release at the end of the preceding cycle during Phase I, were approximately seven to twelve percentage points higher than recovery rates through 13 hours (Table 30).

Table 30

Probability of Return to Unit 2 from Proposed Unit 2 Fish Return Line Discharge Locations

Unit 2 Release Location	Phase I Cumulative Return Rate (%) Hour of Tidal Cycle, Beginning at Low Slack Water													
	1	2	3	4	5	6	7	8	9	10	11	12	13	26
60'	80	98	98	74	59	55	66	73	77	81	84	85	82	94
110'	92	104	89	67	53	45	47	62	69	75	80	83	78	86
160'	75	86	82	62	49	41	35	36	40	46	49	54	54	61
210'	0	0	18	16	13	11	11	17	29	33	31	-	-	43

Unit 2 Release Location	Phase II Cumulative Return Rate (%) Hour of Tidal Cycle, Beginning at Low Slack Water													
	1	2	3	4	5	6	7	8	9	10	11	12	13	26
60'	23	40	45	35	29	24	21	24	39	46	50	53	53	52
110'	39	44	48	41	37	31	26	23	30	36	40	43	43	46
160'	31	39	36	31	25	21	18	25	28	35	39	43	42	44
210'	5	25	29	23	19	16	14	15	15	14	13	15	14	13

At the reduced pumping rate (Phase II), the cumulative recovery rate at Unit 2 through one tidal cycle was relatively uniform (e.g., 53%, 43%, and 42%, respectively), from the 60', 110', and 160' release points but was substantially lower, 14%, from the 210' release point (Table 30). The extended recovery through 26 hours during Phase II studies, in contrast to Phase I results, was virtually unchanged relative to cumulative levels recovered through one tidal cycle (Table 30).

The cumulative return rate data also indicated that return rates varied with tidal stage. Under full flow circulator pumping rate conditions, a greater recovery rate occurred from the 210' release location during the ebb tide than during the flood tide. From hours 1 through 6 of the tide cycle, the presumed duration of flood tide, the recovery rate ranged from zero during the first two hours to a high of 18% during the third hour. On the ebb tide, the recovery rate ranged from 11% during the seventh hour (first hour of high slack/ebb tide) to 33% during the tenth hour (fourth hour of ebb tide).

Under reduced flow circulating water pumping rates, a somewhat greater percent of dye was recovered from the 210' release point on the flood tide than on the ebb tide (Table 30), and approximately reversed the range of values observed under full flow pumping rate conditions.

The studies disclosed that dye released at Unit 2 proposed return site locations could be transported to the Unit 3 intake. However, the overall recovery of dye at the Unit 3 intake following its discharge at the Unit 2 release points was relatively low. Cumulative recovery rates over the tidal cycle during which dye was discharged was highest from the 210' release locations. Levels ranged from 7% during full flow circulating pumping rates to 20% under reduced flow pumping rates (Table 31). Extended cumulative recovery rates (26 hour) were essentially no different from 13 hour rates at either full flow or reduced flow pumping conditions (Table 31).

Table 31

Cumulative Return Rate to Unit 3 from
Proposed Unit 2 Fish Return Line Discharge Locations

Unit 2 Release Location	Phase I Cumulative Return Rate (%) Hour of Tidal Cycle, Beginning at Low Slack Water													
	1	2	3	4	5	6	7	8	9	10	11	12	13	26
60'	1	1	0	0	0	0	0	0	1	1	1	1	1	0
110'	1	1	0	0	0	0	0	1	1	2	2	2	2	3
160'	2	2	1	1	1	1	0	0	1	1	2	3	3	3
210'	10	14	15	12	9	8	7	6	7	8	8	-	-	11

Unit 2 Release Location	Phase II Cumulative Return Rate (%) Hour of Tidal Cycle, Beginning at Low Slack Water													
	1	2	3	4	5	6	7	8	9	10	11	12	13	26
60'	4	10	10	10	8	7	6	5	6	7	6	6	7	8
110'	5	10	12	10	8	7	6	5	5	8	9	10	10	9
160'	5	9	10	9	7	6	5	5	9	10	11	11	11	9
210'	15	20	17	13	10	9	7	11	16	15	14	16	17	19

Although a greater level of recovery at Unit 3 occurred from the 210' release point at Unit 2 than from the three points located nearer the shoreline, this was expected based on the earlier hydraulic model study results.

2. Dye Releases at Unit 3

Cumulative dye recovery at Unit 3 over one tidal cycle from all release locations at Unit 3 was relatively low regardless of circulating water pumping rates. Recovery rates through 13 hours ranged respectively from 8% to 14% under the full flow circulating water pumping rate, and from 10% to 16% under the reduced flow rate for release locations 0' to 160' offshore (Table 32). Extended recovery through 26 hours ranged from one to five percentage points higher than 13 hour rates during Phase I studies, and from zero to four percentage points higher during Phase II studies (Table 32).

Table 32

Cumulative Return Rate to Unit 3 from Proposed Unit 3 Fish Return Line Discharge Locations

Unit 3 Release Location	Phase I Cumulative Return Rate (%) Hour of Tidal Cycle, Beginning at Low Slack Water													
	1	2	3	4	5	6	7	8	9	10	11	12	13	26
0'	3	2	1	12	16	22	20	18	17	15	14	14	13	18
10'	1	1	3	14	12	12	12	11	10	10	9	9	8	11
60'	1	1	15	16	16	16	15	14	12	11	10	10	9	10
110'	1	1	3	23	22	21	21	20	18	16	15	14	14	14
160'	2	2	4	7	10	12	15	15	13	12	11	10	10	12
ALT.	1	1	1	1	0	0	0	0	0	1	1	1	1	1

Unit 3 Release Location	Phase II Cumulative Return Rate (%) Hour of Tidal Cycle, Beginning at Low Slack Water													
	1	2	3	4	5	6	7	8	9	10	11	12	13	26
0'	0	0	20	21	20	20	18	16	14	12	11	10	10	10
10'	0	0	0	14	14	14	17	16	14	13	12	12	12	16
60'	0	0	15	21	26	26	25	23	20	18	16	15	14	13
110'	0	0	1	16	23	29	30	27	24	21	19	18	16	16
160'	0	0	0	11	15	19	20	19	17	16	14	13	12	14
ALT.	0	0	0	1	1	1	1	1	1	1	1	1	0	2

Recovery of dye from the alternate release location located south of the discharge canal was nil under both pumping rates.

Recovery of dye at Unit 2 from release points at Unit 3 was low under both full flow and reduced flow circulating water pumping rates. Recovery rates ranged from 1% to 5% at the full flow rate to 1% to 6% at the reduced flow rate; extended recovery rates were essentially the same as 13 hour rates (Table 33).

Table 33

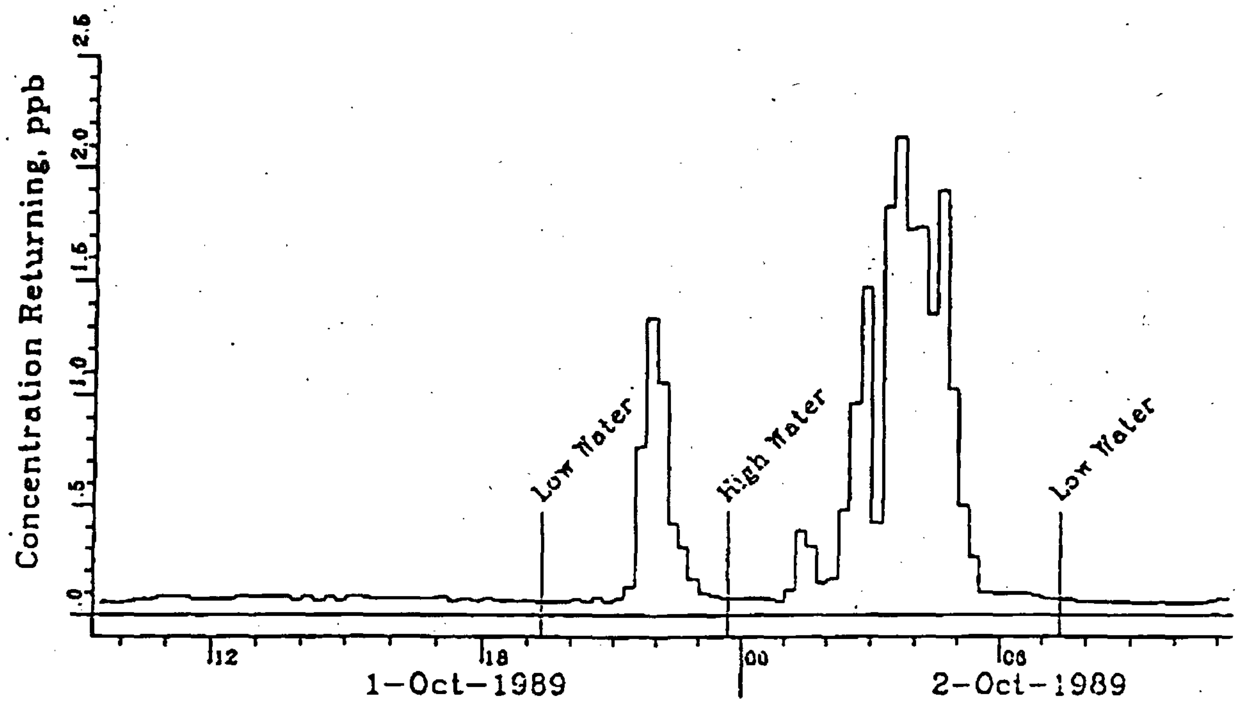
Cumulative Return Rate to Unit 2 from Proposed Unit 3 Fish Return Line Discharge Locations

Unit 3 Release Location	Phase I Cumulative Return Rate (%) Hour of Tidal Cycle, Beginning at Low Slack Water													
	1	2	3	4	5	6	7	8	9	10	11	12	13	26
0'	1	1	1	1	2	4	5	5	4	4	4	4	4	6
10'	0	0	0	1	2	4	5	6	5	5	5	4	4	4
60'	0	0	0	3	4	6	7	7	7	6	5	5	5	4
110'	0	0	0	1	3	5	6	7	7	6	6	6	5	5
160'	0	1	1	4	5	6	6	7	6	5	5	5	4	5
ALT.	0	0	0	0	0	1	1	1	1	1	1	1	1	3

Unit 3 Release Location	Phase II Cumulative Return Rate (%) Hour of Tidal Cycle, Beginning at Low Slack Water													
	1	2	3	4	5	6	7	8	9	10	11	12	13	26
0'	0	0	0	3	4	5	4	4	4	3	3	3	2	2
10'	0	0	0	0	3	4	5	5	5	4	4	4	3	3
60'	0	0	0	4	6	7	7	7	7	6	6	6	5	5
110'	0	0	0	2	7	9	9	9	8	7	7	6	6	4
160'	0	0	0	1	5	9	9	8	8	7	7	6	6	7
ALT.	0	0	0	0	1	1	1	1	1	1	1	1	1	1

The recovery rates at Unit 3 from Unit 3 release points located westward of the discharge canal showed no substantive relationship to distances offshore of the release point. These results appear to confirm the conclusions of Parkinson and Goulet (1976) that the area offshore and south of the Unit 3 intake consists of a mixture of eddies, particularly during flood tides, and does not appear to be within the principle zone of withdrawal for the unit. This condition apparently exists because of the combination of the arrangement of the station circulating water discharge facilities, which eject cooling water at 10 fps at an angle normal to the Hudson River, and the intakes, which withdraw water at approximately 0.6 fps to 1.0 fps, depending on pumping rates. The continuous high velocity discharge of cooling water appears to draw adjacent water (both north and south of the plume) offshore; this movement, coupled with the intake water withdrawal at the two units, induces a continuous southward drift in front of the station. This condition appeared to have been demonstrated by the dye release studies. Intake water fluorescence monitors were operated continuously during the flood tide following cessation of dye release as well as throughout the 13-hour tidal cycles during which dye was released. Dye recovery rates in the intakes on the succeeding flood tide essentially reflected only background levels of fluorescence (Figure 18). Flood tide water apparently did not flow back upstream along the face of the intakes. Rather, it apparently moved offshore or away from the intakes. If it had returned along the shoreline, residual levels of dye would have been present in the intake water.

Figure 18 Dye Tracer Returned to the Indian Point Unit 2 Intake Following Release at the Unit 2 Proposed Fish Return Pipe Location 210' Offshore



D. Dead Fish Recirculation Studies

In 1986, as a preliminary means to evaluate recirculation potential from release points situated along the proposed return line routes at Units 2 and 3, dead white perch were released and impingement collections were monitored to evaluate impingement rates under reduced circulating water pumping rates. White perch, approximately 3" in length, were obtained from impingement collections at Units 2 and 3, and separated into batches of 200 individuals. A total of 20 batches of 200 fish were assembled and frozen. On December 15, 1986, 1,000 fish were thawed and dyed a specific color for identification purposes and then released at each of four tide stages: maximum flood, high slack, maximum ebb, and low slack. These 4,000 dead fish were released at a point 150' offshore and approximately 100' north of the face of the Unit 2 intake, at a depth of 35'. Cooling water flows averaged 497,000 gpm at Unit 2 and 500,000 gpm at Unit 3 during the period impingement collections were monitored for return of dyed fish.

Impingement collections were monitored for the presence of released fish at Unit 2 intake bay 26 starting three hours after the initial release of fish. Monitoring continued at approximately three-hour intervals until the last sample had been in the river four tidal cycles (total time - 50 hours). Impingement collections were also monitored at Unit 2 intake bays 21 through 25, and Unit 3 intake bays 31 through 36 during routine screen washings and all intermediate non-routine screen washings for two days following the release of the fourth group of fish (approximately 51 hours).

A second series of fish releases occurred on December 18, 1986. During this series, fish were released at the initial location at Unit 2 utilized on December 15, 1986, and at a second point located 200 feet offshore from the northwest corner of the discharge canal at Unit 3. At both sites, fish were released in 35' of water. Four groups of fish, each containing 750 individuals, were released at each of the two sites during various current stages. These eight groups of 750 fish (6,000 fish total) were dyed different colors to distinguish them from each other and from the groups of fish released during the first series. Impingement collections at both units were monitored for the presence of dyed fish, according to the schedule utilized during the first fish release. The circulating water flow rate averaged 477,000 gpm at Unit 2 and 499,000 gpm at Unit 3 (combined total of 976,000 gpm) during the period that impingement collections were monitored for return of dyed fish.

Only nine fish were recovered from the 4,000 released on December 15, 1986; a return of 0.24% within 51 hours from the time of the last release. Of the 6,000 fish released on

December 18, 1986, only three were recovered within the four tidal cycles (50 hours) following the last release. A fourth fish was recovered during a scheduled screen wash approximately 63 hours after the last release. One of the four fish recovered was from the group released at the site north of Unit 2; the remaining three came from the group released south of Unit 3.

Of the 13 fish recovered, all were recovered at Unit 2. None were recovered at Unit 3. All of the fish recovered had been released at the start, during, or at the end of flood tide. None of the fish released during the maximum ebb tide were recovered.

Thawed dead fish, unlike dye particles, are not neutrally buoyant; they sink toward the bottom when released. This tendency to sink and perhaps contact the bottom may have kept them from being carried into the intakes from the Unit 2 release location, even though they were released within the withdrawal zone based on the recirculation of dye from this area. These results suggest that non-neutrally buoyant items (dead fish, debris) that may be returned will not have a high probability of reappearing on the intake screens. They also suggest that demersal fish, such as Atlantic tomcod and hogchokers, which contribute 17.8% and 3.3% respectively to the annual numbers of fish impinged (Appendix A-II) and which orient positively with the bottom, may not be as likely as pelagic species, which are not usually found in close proximity to the bottom, to be passively returned to the intakes.

E. Conclusions

1. Indian Point Unit 2

Some uncertainty remains as to the most cost effective terminus for the Unit 2 fish return pipe. Dye studies indicate that up to 54% of totally passive neutrally buoyant particles might eventually be returned to the Units 2 (43%) and 3 (11%) intakes from a release point 210' offshore of Unit 2, during the period of full cooling water flow. However, a relatively small proportion of total annual impingement (14%) occurs during this period, and the various fish species involved are unlikely to be passive at summer temperatures. Observations in the quarry show that fish begin actively swimming almost immediately after emerging from the return pipe even at low water temperatures. During the period of minimum cooling water flow in which nearly 70% of total impingement occurs, a substantially smaller proportion (24%) of neutrally buoyant, passive particles return to Units 2 (13%) and 3 (11%) from the 210' location. Moreover, fish are not totally passive as evidenced by the quarry studies and the actual rate of fish return may be less than that predicted by the dye return studies.

The simplest option to further reduce the passive return of fish to the cooling water intakes would appear to be to extend the line further offshore. Based on the substantial decline in dye return rate from 210' offshore relative to that at 160' and the conformity between dye study results and predictions based upon earlier hydraulic studies, it appears that extending the Unit 2 pipe 25' to 50' would move the discharge point outside of the withdrawal zones for both units. The river depth increases by 10' to 15' over this distance. Quarry test studies indicated that during winter tests white perch showed signs of stress that might be related to discharge depths. However, none of the other species exhibited any adverse effects and, under expected return system conditions at Indian Point Unit 2, white perch would not be confined to a specific depth. Accordingly, hydrostatic effects should not be important.

In light of the information available to date, Con Edison recommends the following course of action:

- Complete engineering specifications and solicit proposals for construction of a fish and debris return line to discharge at a point approximately 225' from the shoreline (200'± off the face of the intake), along a westerly oriented line 145' north of the intake centerline.
- Consider tagging studies to confirm that the probability of live fish returning passively to the intakes is lower than that of dye particles. (Hatchery striped bass might

be used for summertime studies and white perch collected from the Ristroph screens might be used for winter studies in 1990/91.)

Under this strategy, engineering work on a fish return line extending up to 250' into the river could move forward so that construction could be completed by the spring of 1991 when the screens are scheduled to be installed. Based on any additional information on rates of live fish return to the intakes and length-related costs of the line, the final length of the pipe might be reduced.

2. Indian Point Unit 3

Based on the hydraulic model studies by Parkinson and Goulet (1976), the proposed area for location of the fish return line at Unit 3 was outside of the defined intake water zone of withdrawal. Further, cumulative return rates for dye released at various locations along a line extending riverward from the northwest corner of the discharge canal did not exhibit any relationship with increasing distance offshore. In fact, the lowest cumulative return rate was observed at the shoreline release point under winter operating conditions. Since the majority of the fish impinged at the Indian Point Generating Station are impinged during the winter, the apparent optimum location of the Unit 3 fish return pipe would be at the shoreline (bulkhead line) at the northwest corner of the discharge canal.

V. RETURN SYSTEM DESIGN

The return system will consist of three major components: 1) the sluice to collect fish from the screens, 2) the flume to convey fish from the sluice to the river level, and 3) the return pipe to convey the fish to the point of discharge.

The proposed sluices are planned to be 36" in width by approximately 12" in depth. They will extend from screen to screen and be pitched at about 1/16" to 1/8" per foot to facilitate water flow. They will be constructed of smooth surfaced materials such as fiberglass, stainless steel or epoxy-lined channels, and be free of protrusions, sharp angles, or other conditions that may cause damage to fish or interfere with their transport. Covers will be installed on exposed sections to prevent predation on fish by birds. Operating water will be derived from two sources: 1) the low pressure spray wash system, the operation of which will require approximately 1,500 gpm, half of which may enter the sluices; and 2) a supplemental water supply system which will provide approximately 800 gpm to 1,000 gpm. The flume will consist of three components: 1) a transition section to change the cross-sectional form of the sluice to that of a round-bottomed channel/funnel of a width comparable to the diameter of the flume; 2) a channel/funnel to convey flow into the flume; and 3) the flume pipe to convey flow to the river level. The transition section is expected to be about 10' long, and pitch downward at about 1"/1'± This slope will accelerate the 3 fps± sluice flow without formation of a backflow or excessive standing wave at the entrance at the flume pipe. The flume is expected to drop from the sluice level (19'±) to deck level (15') within a distance of approximately 50', and then continue downward at a pitch of about 4"± per foot for 50'± to the water level (0') where it will connect with the 10" diameter return pipe. Space constraints may require that the elevation drop from the sluice elevation to the deck level be at a pitch comparable to that between the deck level and the river level.

A. Return Pipe at Unit 2

The Unit 2 return pipe is expected to be buried to a depth of about 3' in the river bed for a distance of approximately 225'±. It will then extend at an approximately 30° angle (radius of curvature greater than three pipe diameters) upward out of the river bed in a westerly direction for approximately 10' to an elevation of approximately 5' above the river bed (40'± below the water surface). The section of pipe extending above the river bed will be protected from water currents and submerged debris by rock rip-rap. Fish discharged at a velocity of about 5.0 fps along the upward trajectory would be reoriented in the river at a depth of approximately 35'.

B. Return Pipe at Unit 3

The Unit 3 return pipe, which will be supported from the outer edge of the circulating water discharge canal, will extend to a depth of minus 15' where it will terminate at the bulkhead line. It will be oriented horizontally in a southwesterly direction, away from the intake. Discharge velocity is expected to be approximately 15' per second, a velocity lower than that observed in the prototype flume tested in the Verplanck Quarry.

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Normandeau Associates, Inc. (NAI) 1987. Ristroph Screen Fish Return Line Recirculation Study - Recovery of Dead Fish Report to Con Edison by NAI, Bedford, New Hampshire.

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APPENDIX

BACKGROUND MATERIALS

A-I. INDIAN POINT STATION

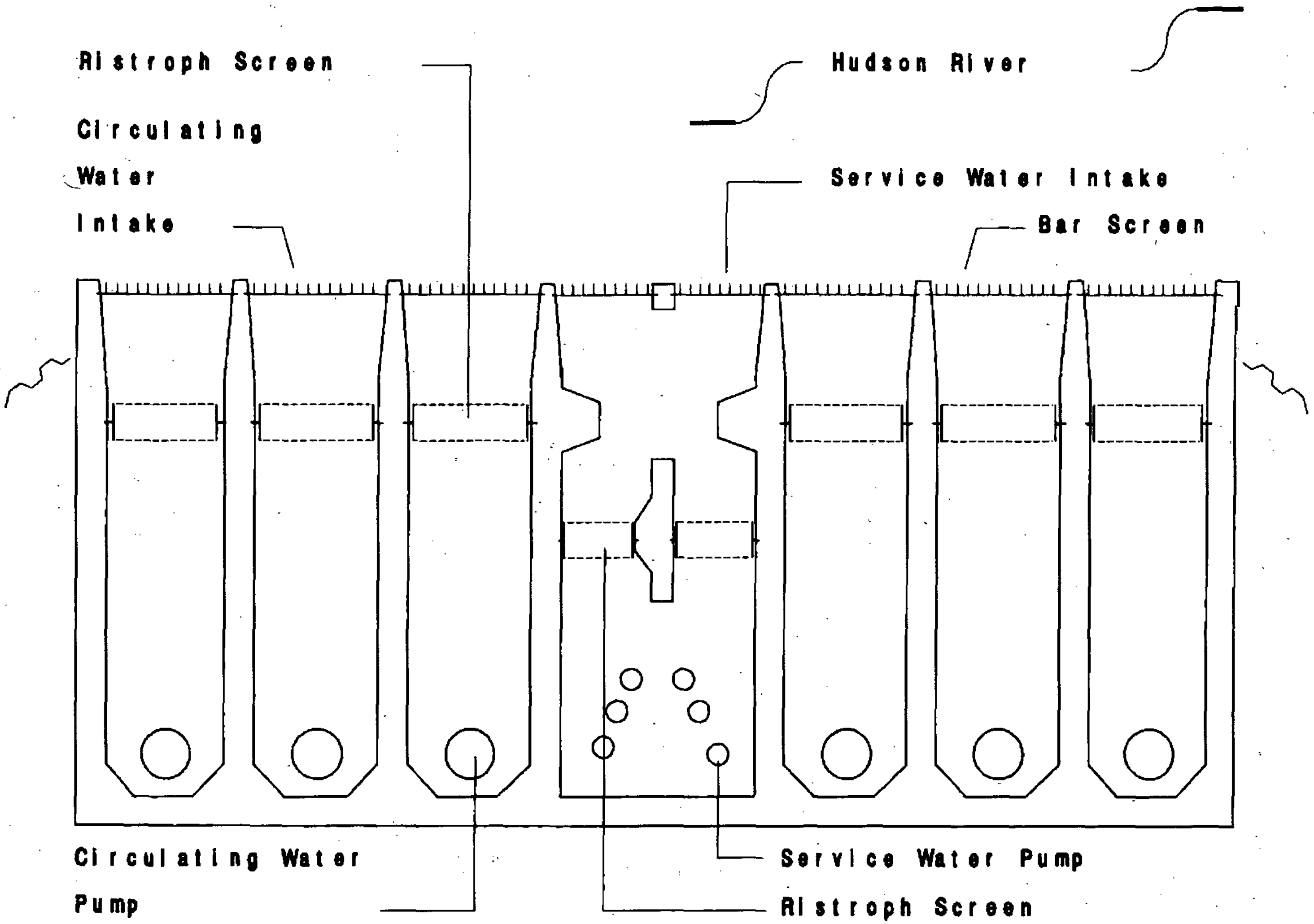
The Indian Point Station is located at milepoint 43 on the east side of the Hudson River. It consists of three nuclear generating units. Unit No. 2 is northernmost (upstream) in position at the site, followed in a southerly direction by Units Nos. 1 and 3. Unit No. 1, owned by Con Edison, has not operated since October 31, 1974. Unit No. 2 is owned and operated by Con Edison; Unit no. 3 is owned and operated by the New York Power Authority.

1. Description of Intake Structures

The intake for Unit 2 (Figure A1) consists of seven pump bays, six for circulating water pumps, and one for service water pumps. Each of the circulating water pump bays is approximately 53' long and is independent of the adjoining bays. The bays are 13'4" wide from the back wall to a point approximately 11' from the entrance from which point they taper outward to a width of 14'10" at the entrance. The bottoms of the intakes are at minus 27' MSL. The equipment decks are at elevation 15'. An ice curtain wall extends to minus 1' MSL at the entrance to each of the forebays and serves to prevent floating debris as well as

Indian Point Units 2 and 3
Ristroph Screen Fish Return Systems

Figure A1 Indian Point Unit 2 Cooling Water Intake



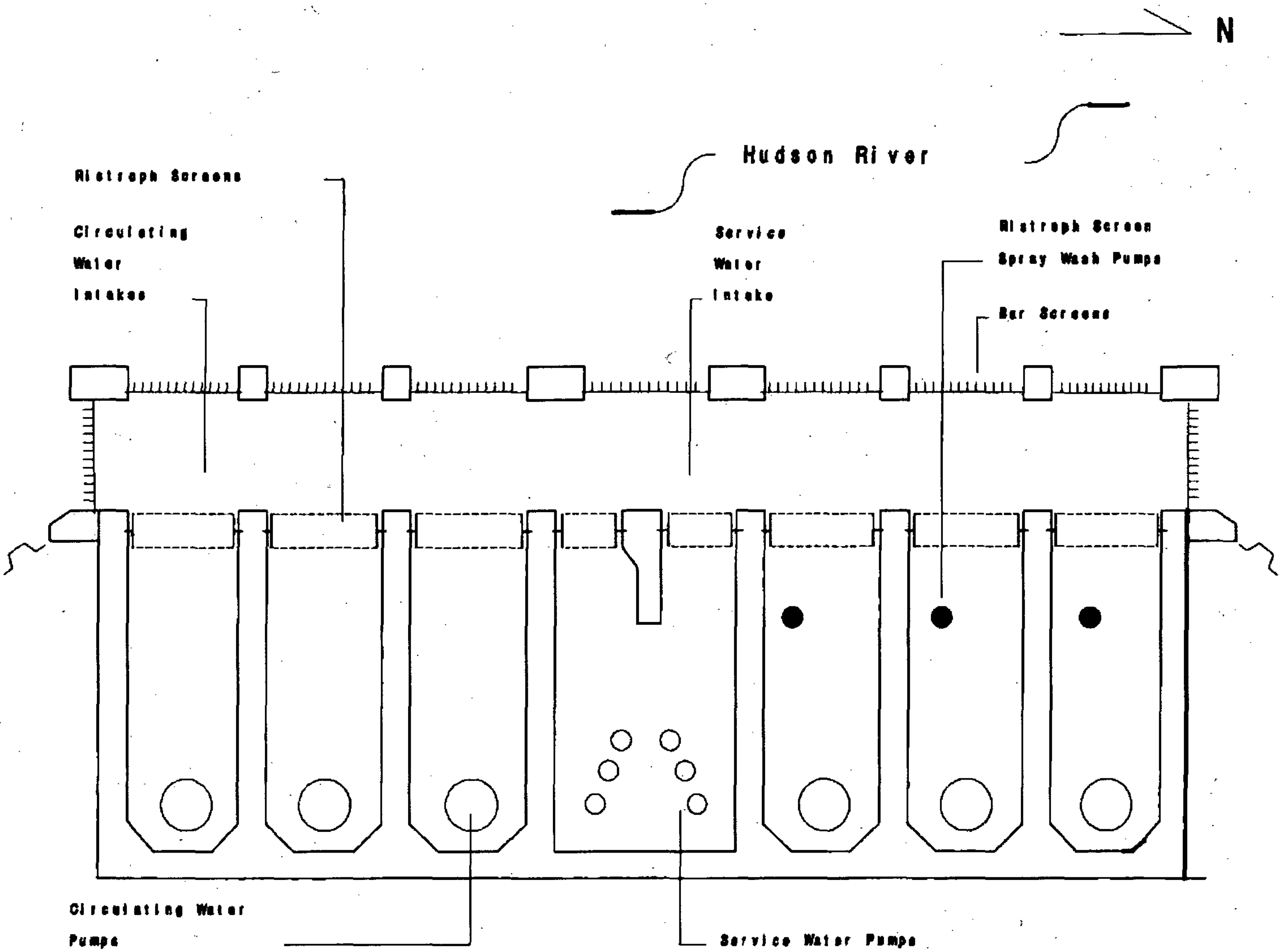
ice from entering the bays. The centerline of each circulating water pump is 47'6" from the intake entrance.

The new Ristroph screens at Unit 2 will be installed at a point about 12' behind the intake entrance. With the installation of the new screens, bar screens, comprised of 1/2" bars spaced 3" on center, will be installed at the intake entrances. The calculated average intake water approach velocity at the Unit 2 fixed screens is 0.8 fps at mean sea level during summer full flow operation and 0.5 fps during minimum winter flow operation. Intermediate flows occur during spring and fall. Velocities are dynamic, however, and changes occur with changes in tides.

The intake at Unit 3 (Figure A2) also consists of seven pump bays, six for circulating water pumps and for service water pumps. The pump bays do not extend out to the bar racks. They open into a common plenum. The plenum is 12' wide and 120'±. Nine bar racks form its walls. Seven comprise the western wall of the plenum and one each forms the north and south walls. Thus, the opening of each pump bay is located 12' behind the western bar racks. The circulating pump bays are 13'4" wide over their entire length. The bottoms of the intakes are at minus 27' MSL. The equipment deck and ice curtail wall are as described for Unit 2. At Unit 3, the new Ristroph screens will be installed at the pump bay entrances to the common plenum.

Indian Point Units 2 and 3
Ristroph Screen Fish Return Systems

Figure A2 Indian Point Unit 3 Water Intake



The calculated average approach velocity at mean sea level is 1.0 fps at full flow, and 0.6 fps at reduced flow.

The service water intake bays (Figures A1 and A2) are centrally located within each of the Units 2 and 3 intake structures. Six service water pumps (5,000 gpm/pump) draw water from each of these bays for operation of heat exchange equipment such as turbine lubricating oil coolers and systems required for the safe shutdown of each unit. Two 6' wide modified Ristroph screens will be installed within the service water bays at each unit as illustrated in Figures A1 and A2. The calculated average approach velocity at the entrance to the service water bay when all six service water pumps are operating is about 0.2 fps.

2. Circulating Water Pump Operation

Under full flow operation, which occurs from June 9 through September 30 in accordance with Settlement Agreement-established circulating water flow rates, each circulator withdraws 140,000 gpm from the river, for a unit total of 840,000 gpm and a site total of 1,680,000 gpm. At minimum flow from November 1 through May 15 each circulator withdraws 84,000 gpm for a unit total of 504,000 gpm and a site total of 1,008,000 gpm. During other periods of the year, circulating water flow rates are between the reduced and full flow rates (Table A1).

Table A1

Approximated Circulating Water Flow Rates For Indian Point Units 2 And 3

Time Period	Flow Rate (GPM)
November 1 - December 31	504,000
January 1 - May 15	504,000
May 16 - May 22	560,000
May 23 - May 31	672,000
June 1 - June 8	731,000
June 9 - September 30	840,000
October 1 - October 31	731,000

The total service water pumping capacity is 30,000 gpm at each unit and is additional to the values noted above.

3. Discharge Structures

Each of the units discharges circulating and service water to a common canal which in turn discharges through a series of 12 submerged ports into the Hudson River. The ports are centered 12' below mean low water and are 4' high by 15' wide. They are positioned 6' apart and extend for a lateral distance of 246'±. Ten of the ports are outfitted with moveable gates that are adjusted as necessary to maintain a head differential in the canal of 1.75' above the level of the river. This differential generates a mean discharge velocity of 10 fps. The centerline of the discharge ports is approximately 700' from the centerline of the Unit 3 intake structure and about 1,400' from that of the Unit 2 intake structure.

4. Hudson River in the Vicinity of the Indian Point Station

The Hudson River, in the vicinity of the Indian Point Station, is approximately 5,000 feet wide and averages about 40 feet deep. About 600 feet north of the station and 300 feet offshore, the river depth is nearly 80 feet. A half mile south (600 feet south of the discharge canal) and a comparable distance offshore, the depth is less than 50 feet.

The tide range in the vicinity of Indian Point is about 3.2' and the tidal excursion distance is approximately four miles. The salinity ranges from less than 0.1 ppt salt when fresh water flows are above 17,000 cfs to approximately 5.0 ppt when they are minimal (3,000 cfs). Temperatures range from approximately 32°F to 85°F.

River bed materials are comprised of hard silts and sand that range up to 20 feet or more in depth to bedrock. Siltation in the vicinity of the station during the period 1970 to 1982 has been minimal, but has occurred near shore (within 50'±) south of the Unit 1 wharf near the entrance to the Unit 3 intake. This condition apparently results from the stilling effect that the pilings supporting the Unit 1 wharf has on river water passing under it.

A-II. IMPINGEMENT AT INDIAN POINT STATION

Recent trends in impingement (1986 through 1989) were examined relative to the Settlement Agreement specified circulating water flow rates for the Indian Point Station. Generally, during the interval from November 1 through mid-May when pumping rates per unit are at 504,000 gpm, nearly 70% of the total annual number of fish impinged are collected (text Table 28). During the summer when the pumping rate is 840,000 gpm, only about 14% of the annual tally of fish is impinged. The remaining 16% are collected during the spring and fall when pumping rates are at intermediate levels. Table A2 presents the estimated maximum mean total number of ten species of fish that might be expected to be impinged per time interval throughout the calendar year. White perch, which are impinged predominately during December through March, are projected to contribute approximately 66% of the annual total. Atlantic tomcod, which are most abundant in the impingement collections during the spring and early summer, are projected to contribute nearly 18%. Other species, such as bay anchovy and blueback herring, which in previous years had been collected in greater proportions to the total (Table A3), are estimated based on

Indian Point Units 2 and 3
Ristroph Screen Fish Return System

Table A2. Projected Mean Monthly Impingement of Ten Species of Fish at the Indian Point Station Based on Observed Rates During 1986 Through 1989

	Alewife	Bay Anchovy	American Shad	Hogchoker	Blueback Herring	Rainbow Smelt	Striped Bass	Atlantic Tomcod	White Perch	Weakfish	All Taxon
November	57	236	234	1,077	4,559	236	2,605	128	36,800	89	51,296
December	8	7	2	3,651	31	66	1,351	823	111,957	1	122,877
January	4	89	7	1,140	49	368	8,341	685	130,840	0	151,111
February	23	3	0	156	28	515	6,231	197	117,779	0	127,673
March	53	2	1	132	6	479	2,703	123	78,954	0	84,200
April	92	2	38	3,513	246	580	228	68	23,098	0	28,856
May 1-15	108	5	33	2,961	148	256	136	70	11,659	2	16,159
May 16-22	78	39	20	3,053	118	215	137	13,156	16,523	0	33,848
May 23-31	79	157	4	951	273	239	47	50,285	8,819	0	61,081
June 1-8	15	0	3	37	45	73	31	475	2,972	0	3,683
June 9-31	69	1,300	34	598	263	346	23	30,478	1,714	0	35,863
July	72	1,086	149	955	150	248	150	52,596	1,718	164	58,107
August	123	680	164	4,135	343	42	552	658	5,114	1,375	13,600
Sept.	185	2,975	174	2,947	908	42	753	352	2,223	1,036	12,256
October	264	5,866	545	2,854	16,088	160	5,920	306	11,479	1,367	46,436
Total	1,230	12,448	1,408	28,160	23,253	3,864	29,210	150,400	561,651	4,035	847,045
All Fish	0.15%	1.47%	0.17%	3.32%	2.75%	0.46%	3.45%	17.76%	66.31% (Dec. through March = 78.26%)	0.48%	100.00%

Table A3. Projected Mean Monthly Impingement of Ten Species of Fish at the Indian Point Station Based on *Observed Rates During 1975-1989*

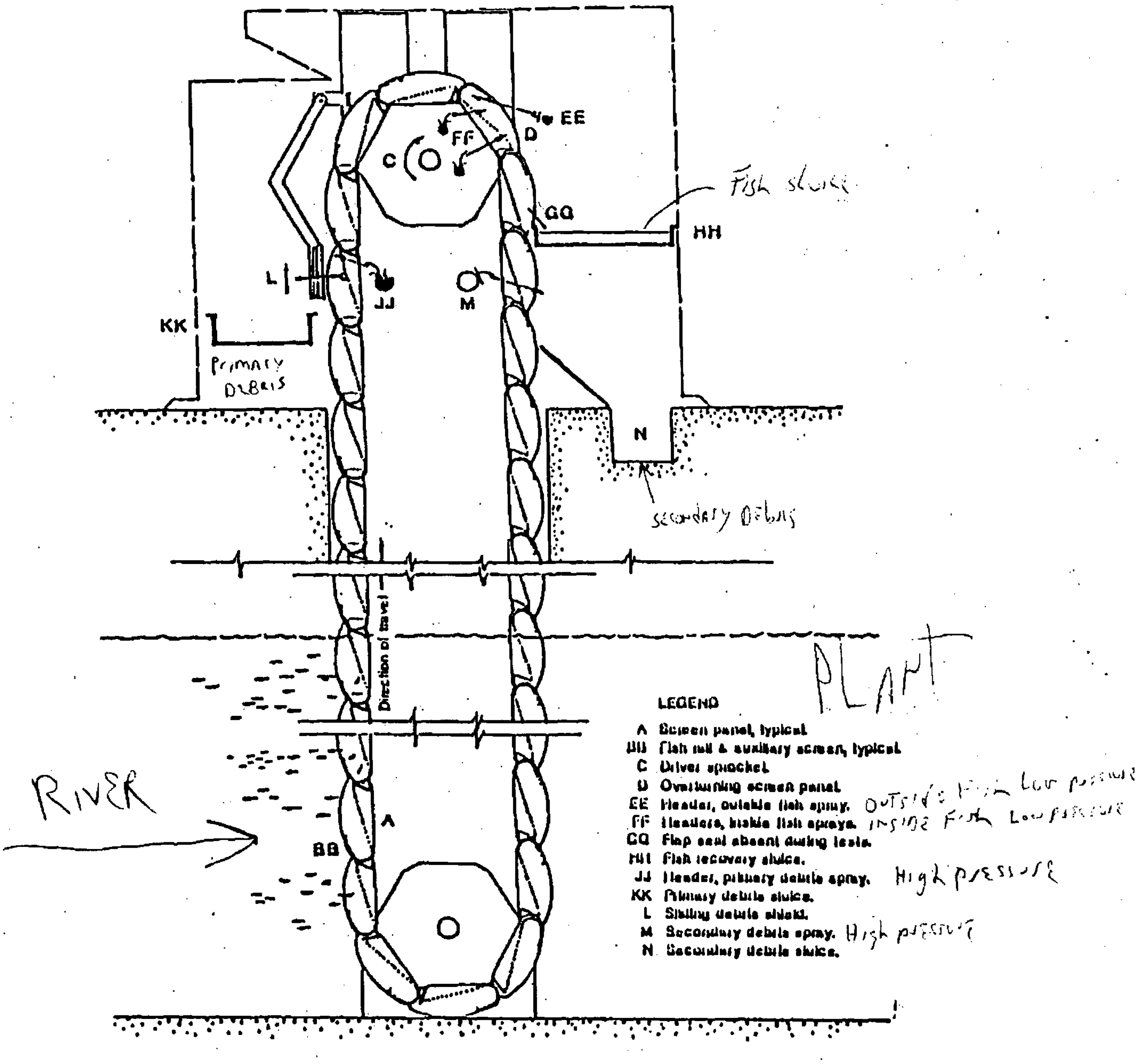
	Alewife	Bay Anchovy	American Shad	Hogchoker	Blueback Herring	Rainbow Smelt	Striped Bass	Atlantic Tomcod	White Perch	Weakfish	All Taxa
November	3,527	657	3,554	3,083	76,653	1,666	2,964	656	149,851	419	256,506
December	211	84	173	1,811	5,113	2,663	6,771	5,016	256,609	75	288,174
January	29	76	10	408	71	2,114	12,330	2,923	361,681	0	387,175
February	39	4	2	55	27	1,340	13,391	756	253,369	0	272,113
March	22	4	1	72	11	1,026	4,833	460	183,573	0	193,246
April	139	76	10	2,361	333	3,019	1,222	277	115,656	0	127,658
May 1-15	178	604	9	6,455	489	2,043	334	1,166	30,252	1	43,594
May 16-22	121	188	5	2,330	180	575	95	4,962	6,787	0	15,756
May 23-31	163	931	4	1,274	258	475	77	23,862	6,099	0	33,816
June 1-8	100	272	7	311	281	447	57	28,827	4,070	0	34,919
June 9-31	603	5,508	397	1,492	1,328	2,214	151	107,885	11,151	2	135,908
July	10,888	99,779	12,239	2,446	18,243	3,853	3,678	130,364	12,886	4,300	309,135
August	7,194	106,447	6,640	9,261	9,879	1,412	4,171	100,939	38,626	16,254	306,245
Sept.	1,982	37,256	1,512	13,158	16,287	663	2,024	22,586	25,477	6,177	130,571
October	4,675	17,816	3,843	9,532	383,955	3,137	4,572	2,327	74,201	1,390	523,399
Total	29,870	269,702	28,405	54,051	513,109	26,646	56,671	433,007	1,530,288	28,617	3,058,214
All Fish	0.98%	8.82%	0.93%	1.77%	16.78%	0.87%	1.85%	14.16%	50.04%	0.94%	100.00%

current records to contribute about 1.5% to 2.7%, respectively (Table A2). Nearly all the fish impinged are young-of-the-year or yearlings in age and range in length from about 2" to 5".

A-III. RISTROPH SCREENS

Ristroph modified travelling water screens are conventional travelling water screens outfitted with special water retaining troughs on the screen panels for the purpose of collecting fish. The machines are also designed for continuous operation in order to continuously collect and remove fish from intake water for transfer to a conduit through which they are returned alive to the source water. The design for the modified Ristroph screens to be installed at Indian Point Units 2 and 3 was developed from tests with a prototype installed at Unit 2. This machine (Figure A3) was outfitted with screen baskets that had bottom rails uniquely shaped to not only retain water but also protect fish from turbulent rolling conditions as they were collected and carried upward through the inflowing intake water. In addition, the machine was outfitted with a high pressure spray wash system to transfer debris from the screen mesh to the primary debris sluice as the baskets were raised. This operation freed the smooth-surfaced screen mesh of entangling debris and enhanced the transfer of fish to the return sluice as the baskets rotated over the headshaft and started their

Figure A3 Modified Ristroph Traveling Water Screen



VERTICAL CROSS SECTION

Source: Great Salt Bay Experiment Station
Fletcher, 1986

descent. The machine was outfitted with a low pressure spray wash system to flush the fish from the collection rail onto the mesh of the inverted basket and then into the return sluice.

A second series of high pressure water jets served to wash the mesh a second time to remove remaining debris into a secondary debris sluice passing along the rear of the screen array in the intake deck floor (Figure A3).

Special seals may be operated on the screen to facilitate fish and debris transfer to the return sluices. One seal may be positioned on the front of the machine to protect fish in the collection rail from the accumulations of seasonally prolific filamentous algae as it was washed from the ascending screen panels. The device articulates inward to cover the tray as it passed through the front mounted spray, and then moves outward to transfer debris to the sluice and reset itself for the next screen panel. On the rear side of the machine, a flexible seal may be installed on an angle at the edge of the fish sluice to facilitate the transfer of fish from the mesh into the sluice and reduce the opportunity for their passage into the rear-mounted debris sluice below.

KLM/bjd
July 19, 1990

A-IV

QUARRY SITE PROTOTYPE FISH RETURN SYSTEM

Normandeau Associates, Inc.
25 Nashua Road
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(603) 472-7052 (Fax)

NORMANDEAU ASSOCIATES

Ref. No. 10088.00

5 July 1990

Dr. Kenneth L. Marcellus
Consolidated Edison Company
of New York, Inc.
4 Irving Place - Room 306S
New York, NY 10003

Dear Ken:

This letter and the attached tables present a summary of the fish testing and survival results for the 1989 Quarry Site Evaluation of Prototype Ristroph Screen Fish Return System for Indian Point Units 2 and 3 (Con Edison Purchase Order No. 9-17264). Partial and full scale testing of aluminum and PVC pipe models of various configurations of the proposed Ristroph Screen Fish Return System for Indian Point Units 2 and 3 were conducted at the Verplanck Quarry by Normandeau Associates, Inc. (NAI) between 1 August 1989 and 29 January 1990.

OBJECTIVES

The purpose of the flume and return pipe tests was to collect data to address specific questions regarding the design and operation of the Ristroph Screen Fish Return Systems that will be installed at Indian Point Station. The specific questions addressed were:

What is the effect on fish of the transition of water flow from a wide, flat bottomed sluice to an enclosed tubular conduit (pipe) with and without debris present?

What is the effect on fish of transport through the air-water interface at the river level in a partially filled conduit with and without debris present?

What is the effect on fish of transport through return pipes of various diameters and lengths when operated at various flow rates with and without debris present?

What is the effect on fish of discharge from a return pipe at a depth of -35 feet with and without debris present?

TEST SYSTEM

The partial and full-scale systems tested reflected the layout proposed for installation at Indian Point Unit 2 and encompassed the features projected to be included at Unit 3. Test system dimensions were:

Sluice elevation: 19' 4"
Flume elevation, upper end: 18' 10"
Flume elevation, lower end: -1'
Flume length between elevations 18' 10" and 15': 65'
Flume length between elevations 15' and -1': 35'
Fish return pipe elevation, upper end: -1'
Fish return pipe elevation, lower end: -1' or 35' depending on test
Fish return pipe lengths: 30', 150', 250'

Transit times through the test systems were determined on different species of live fish and on inanimate objects of various degrees of buoyancy. These trials were performed for several different configurations of the test system, and the resulting transit times are shown in Tables 9 and 10.

TEST PROCEDURES

Fish were obtained from a variety of sources including the Indian Point Unit 2 Ristroph Screen (white perch), Verplanck Hatchery (striped bass), trawling (Atlantic tomcod), and local bait stores (alewife and golden shiner). Test and control fish were acclimated to quarry water conditions in shallow pools into which quarry water was circulated.

Test procedures were as follows: At the beginning of each test the water supply pumps were started and the flow adjusted to the desired rate. After a constant flow rate was established, test subjects (live test fish for survival studies with or without debris, or inanimate objects of various degrees of buoyancy for supplementary transit time observations) were introduced into the sluice. Fish were poured into the sluice from a height of approximately six inches above the surface of the water from buckets or fish boxes partially filled with water. Fish were introduced to the sluice in the direction of the water flow. Almost all fish were carried by the flow immediately into the flume. Debris and inanimate objects were simply placed into the sluice. Time of transit was measured from when test subjects first entered the flume until the first and last fish entered the test cage as observed on underwater video. Observed transit times are shown in Table 9. If sequential tests were to be conducted, the test cage was uncoupled from the return sluice by a diver and moved. The second test cage was then coupled to the return pipe and the above process repeated for the next test.

Control fish were introduced directly into a separate 6x6x6 ft cage <u>in situ</u> without traveling through the prototype return system. Control fish were placed in a bucket with water and brought out to the cage in a boat. The control fish were introduced to the cage by opening a closure in the top and pouring them in from a height of six inches or less.

Fish survival was determined by videotape observation of both test and control subjects at 0 hours for immediate mortality and after several intervals of holding time for latent mortality. Observations were made after 15 minutes, 1 hours, 4 hours, and 8 hours. For longer tests, one or more of the following observations were also made, depending on the length of the test: 24 hours, 48 hours, 96 hours, and (for one set of tests) 120 hours.

Results of survival tests were expressed in terms of percent mortality at the end of the holding period for each test (i.e., it includes latent mortality). The percent mortality for each test group was adjusted for any mortality occurring in the corresponding control group using Abbott's formula (Finney, 1964. Statistical methods in biological assay. Hafner Publishing Co., NY):

$$M_{adj} = (M_{test} - M_{cont})(100\%)/(1-M_{cont})$$

where: M_{adj} = adjusted percent mortality of test group,
M_{test} = proportion of test fish dead or stunned, and
M_{cont} = proportion of control fish dead or stunned.

When M_{cont} exceeded M_{test} the M_{adj} was defined as zero percent.

EXPERIMENTAL DESIGN

The original scope of work proposed a testing sequence designed to detect effects of various system components on fish survival. Factors varied in the proposed design were:

1. Flume and return pipe
   Partial scale = 6 inch diameter
   Full scale = 12 inch diameter

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2. Return pipe length
   Short = 30 ft long
   Long = 150 ft long

3. Discharge depth
   Surface = - 1 ft
   Deep = - 35 ft

4. Fish species/sensitivity
   Sensitive = Golden shiner or alewife
   Average hardiness = White perch, Striped bass or Atlantic tomcod

5. Debris present or absent

6. Water flow rate (X or 2X gpm)

The experimental design was fractionated so that all combinations of experimental factors were not tested independently. Tables 1A through 8A present the combinations of experimental factors proposed for evaluation. The proposed testing protocol required that (with replication) sensitive and hardy fish species at both water flow rates with and without debris were exposed initially to the partial-scale flume under four test system configurations (Tables 1-4, series A):

- without a return pipe at a surface discharge depth
- with a short return pipe at a surface discharge depth
- with a long return pipe at a surface discharge depth
- with a long return pipe and a deep discharge depth.

The same four combinations of factors were then proposed for testing with a full scale flume and return pipe system (Tables 5-8, Series A).

TEST RESULTS

The first series of tests (Test Numbers 1 and 5) demonstrated 100% survival at the end of an 8-hour latent effects assessment of both sensitive (alewife) and hardy (striped bass) fish (Table 1B). After these results were reviewed with Con Edison, it was decided to proceed directly to the partial scale flume and 150 ft. return pipe with a deep discharge depth (Table 4B). Both sensitive and hardy fish species exhibited relatively low latent mortality following passage through the 150-ft partial scale system with a 35-foot deep discharge, and test subject latent survival differed little from control fish latent survival (Table 4B). The partial scale system with a 150-ft return pipe was also tested with a surface discharge depth; test fish survival was 100% at the end of a 24-hour holding period (Table 3B).

The results of the partial scale tests were reviewed with Con Edison who then conferred with Messrs. Ian Fletcher and Elwan Radle. NAI was requested to proceed to full scale testing. The full scale system was fabricated as requested by Con Edison using 10-inch diameter pipe instead of 12-inch pipe. The full scale system with a 150-ft discharge pipe was first tested with a deep discharge on 5 December 1989, and both golden shiner (sensitive) and white perch (hardy) exhibited 100% survival when held for 24 hours (Table 8B). Further testing of the full scale system for the various combination of factors included a 30-ft return pipe (Table 6B), 150-ft return pipe with a surface discharge (Table 7B), and a 250-ft return pipe (Table 8C).

OBSERVATIONS ON INITIAL BEHAVIOR OF TEST FISH

In tests with the partial scale system, fish discharged at both -1 ft and -35 ft exhibited different behavior depending on the water flow rate in the return pipe. At flow rates of about 250 gpm, fish gently floated into the cage head first with the discharge water, quickly oriented themselves to the boundaries of the cage and swam to the bottom of the net. They displayed no apparent signs of stress. At flow rates of about 440 gpm, the majority of the fish entered the cage tail first, apparently swimming against the current in the return pipe.

These fish also moved quickly out of the plume of the return pipe discharge to the sides and bottom of the test cage, oriented to the boundaries of the test cage and slowly swam to the bottom of the cage. They also displayed no apparent signs of stress.

In tests with the full scale system operated at 500 to 1,000 gpm, all species of fish, except white perch when water temperatures were low, generally displayed behavior comparable to that of fish discharged from the partial scale system operated at approximately 440 gpm. White perch discharged at -35 feet when water temperatures were less than or equal to 4 C were apparently stressed as indicated by their head up orientation when swimming. In addition, white perch in this condition were clustered in the top 1/4 of the test cage. This swimming attitude and behavior was consistent with an underinflated swimbladder. When white perch in this condition were raised to the surface, they no longer exhibited the head up swimming attitude, and they occupied all parts of the test cage. When white perch were discharged at -1 foot and then lowered to -35 feet, they exhibited the same symptoms of stress shown by white perch discharged at -35 feet. These observations indicated that white perch were not able to adapt to rapid increases in water depth following acclimation to shallow depths when water temperatures were less than 4 C.

OBSERVATIONS ON LATENT BEHAVIOR OF TEST FISH

Test fish at the various latent effects time intervals exhibited the same basic behavior as control fish. Both test and control fish were usually found in the lower 1/2 of the test cage in loosely defined schools. Exceptions to this generalization were golden shiners and white perch. Both test and control golden shiners were occasionally found in the upper quadrants of the cage. With the exception of white perch discharged at -35 feet at water temperatures below 4 C, none of the fish displayed signs of damage or injury. Most species swam along the edges of the cage, suggesting they were seeking a way out.

OBSERVATIONS ON PHYSICAL DAMAGE TO TEST FISH

Almost all test fish displayed no signs of physical damage when examined at the completion of tests except for white perch when water temperatures were generally below 4 C. The damage that was observed consisted of minor abrasions and the loss of a few scales. It was not possible to determine if this damage was inflicted by the prototype return system or collection and handling procedures. White perch were collected from the Ristroph screen at intake 26 of Indian Point Unit 2. Golden shiners and alewives were obtained from a commercial bait dealer. The process of collection, handling and acclimation of test fish may have introduced more physical trauma to the fish than the transit through the prototype return system. Both test and control white perch tested at temperatures below 4 C were found to have hemorrhages at the bases of their fins.

CALCULATED WATER VELOCITIES

The calculated velocity of the water at specified locations in the test system under various test conditions is presented in Table 11. Velocity of water was calculated using the Manning equation modified for a partially filled pipe. The velocities presented are average calculated velocities. These velocities are likely to be slight overestimates because losses due to friction and turbulence are assumed to be insignificant. In addition, these calculations assume that the water was in the pipe long enough to reach steady state conditions. This last assumption may only be true for the return pipe.

DISCUSSION

The following generalizations can be made regarding the results of the survival tests:

1. Differences in fish survival between the partial and full scale system were not apparent.

2. Fish survival did not appear to be related to return pipe length or water flow rate.

3. The presence of debris in the discharge water did not appear to reduce fish survival.

4. With the exception of white perch when water temperatures were at or below 4 C, discharge depth did not appear to influence the survival of species of fish tested. The 35-ft discharge depth appeared to stress white perch held at that depth after acclimation at the surface.

Mortality of test and control white perch was high during testing conducted in January (test dates 1/4; 1/5; 1/10; 1/19; 1/24) Unadjusted mortality among control fish was as high as 50% during this period and unadjusted mortality among test fish was as high as 93%. The high mortality occurred when testing was conducted with the full scale flume, and the 150 ft or 250 ft return pipe discharging at -35 ft. As this excessive mortality did not occur with golden shiners and Atlantic tomcod tested under the same conditions, it is likely that some mechanism acting only on white perch caused this mortality. There are several possible sources of this mortality, including the prototype return system, the condition of the white perch prior to testing, and the physiology of the white perch.

Some of the mortality to white perch may be due to acclimating the fish to quarry water conditions in shallow (3 ft.) pools prior to their use as experimental subjects, and to a slow metabolism and response to pressure changes at cold temperatures. Test fish discharged through the return pipe into holding cages at a depth of -35 ft. were observed to exhibit equilibrium problems indicative of compression or underinflation of the swimbladder. These fish swam to the top of the holding cage immediately upon release at -35 ft. In natural conditions, these fish would not be acclimated to shallow depths, nor would they be entrapped at the 35-ft depth upon discharge. They could swim to a depth of neutral buoyancy. This scenario was evaluated with mixed results by lifting the holding cage to the surface within 30-60 minutes of discharge of the fish from the return pipe at -35 ft. The behavior of the white perch changed from the upward oriented swimming to that of "quiescent floating" typical of the control fish being held in surface waters. Relatively high survival of both control and test white perch was observed on 18 January 1990 (Table 8B) and relatively poor survival was observed on 19 January 1990 (Table 8C).

It did not appear that the prototype return system was the cause of the excessive mortality observed in white perch because mortality occurred in control fish that were not exposed to the return system. The condition of the fish prior to testing may have been a major contributing factor to the high mortality observed. These fish had been collected some time previously from the Ristroph screen at intake 26 of Indian Point Unit 2 and held for several days prior to testing. Both test and control fish were held for the same extended period prior to testing, but only test fish were subjected to the prototype return system. Mortality was equally high among both test and control fish and the condition of the fish prior to testing was the only common factor between test and control fish. Therefore, the condition of the fish prior to testing is the likely cause for the high mortality observed in some January tests.

Finally, the physiology of white perch may provide some insight to the mechanism of the mortality observed in the white perch held at -35 ft. It was apparent, based on observations of the swimming

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attitude of white perch discharged at -35 ft, that white perch were having considerable difficulty maintaining buoyancy due to underinflation of their swimbladders. Inflation of the swimbladder in the white perch is a physiological process dependent on the partial pressure of gases in the blood (Alexander 1974). Swimbladder inflation is driven by the circulatory system which in fish is dependent on the environmental temperature. It appeared that at temperatures below 4 C, the metabolism of the white perch was too slow to inflate the swimbladder at -35 ft. Secretion of gases into the swimbladder is a relatively slow process. Alexander (1974) estimated that it would take 4-8 hours for teleost fish without connections between the swimbladder and esophagus to inflate a fully deflated swimbladder.

Please contact me or Mr. James Reichle if you have any questions or require additional information about these tests.

Sincerely,

NORMANDEAU ASSOCIATES, INC.

Mark T. Mattson

Mark T. Mattson, Ph. D.
Assistant Vice President

Attachments: As stated

cc: Dennis Dunning

Reference

Alexander R. McN.]974 Functional design in Fishes
Hutchison Univ. Lib., London 160pp.

1989 QUARRY SITE EVALUATION OF PROTOTYPE RISTROPH RETURN SYSTEM

FOOTNOTES FOR FISH SURVIVAL TESTING CONDITIONS PRESENTED IN TABLES 1-8.

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[1]Fish survival observation intervals: immediate, 15 minutes, one hour, four hours and eight hours. Terminate test after eight hours unless noted otherwise under footnote number 7 (96 hour survival).

[2]Flow: X = actual flow rate in gpm determined experimentally
2X = two times the actual flow rate of X gpm

[3]Species: Species of fish tested. Number of different fish species to be tested is in parentheses if more than one species and test.
H = average hardiness species (white perch, striped bass or Atlantic tomcod)
S = potentially sensitive species (herrings, rainbow smelt or bay anchovy).
Object = dead, finclipped fish.

[4]Number: Number of fish in each test and control batch.
(T) = if testing is to measure transit time only.

[5]Control: Yes if a control batch of the same fish species is used
Blank if no control is used.

[6]Add debris: Yes if quantity of debris is reflective of the kind and amount expected to be collected from up to six Ristroph screens in operation (eelgrass in summer and filamentous algae in winter)
Blank if no debris.

Footnotes (cont.)

[7]96 hour survival: Yes = fish survival observation intervals for the second batch of fifty fish tested are: immediately, 15 minutes, one hour, four hours, eight hours, 24 hours, 48 hours, 72 hours and 96 hours. Terminate test after 96 hours.
Blank = 96 hour observation interval is not used.

[8]Fish species (sensitivity): alewife (sensitive)
golden shiner (sensitive)
striped bass (hardy)
Atlantic tomcod (hardy)
white perch (hardy)

[9]In tests conducted between 01/04/90 through 01/10/90, venting holes were cut into the top of the full scale return pipe to permit release of entrained air. These vent holes were observed by scuba divers to allow escapement of fish during transit through the return system. Although 50 fish were released into the return system for each test, not all of these fish arrived in the holding cage for survival. Therefore, the number of fish tested was adjusted to represent the actual number in the holding cage to the end of the holding period. (Later the holes were closed to alleviates losses future tests.)

[10]In all tests conducted on 01/18/90 and 01/19/90, the full scale return pipe discharged into a holding cage at -35 ft and then the cage was raised and fish were held at -1 ft for survival observations.

[11]Adjusted percent mortality was calculated for each test as: $M_{adj} = (M_{test} - M_{cont})(100\%)/(1 - M_{cont})$, where M_{adj} = adjusted percent mortality of test group, M_{test} = proportion of test fish dead or stunned, and M_{cont} = proportion of control fish dead or stunned. If the proportion of dead or stunned fish was greater in the control group than in the test group, the adjusted percent mortality was defined as zero percent.

TABLE 1A. PROPOSED FISH SURVIVAL[1] TESTING CONDITIONS FOR PARTIAL SCALE (6 INCH) FLUME WITH DISCHARGE AT -1 FT.

TEST NO.	DAY	PROPOSAL OBJ/TASK	FLOW[2]	SPECIES[3]	NUMBER[4]	CONTROL[5]
1	1	II/7	X	H(2)	50 each	Yes
2	1	II/7	X	H(2)	50 each	Yes
3	2	II/8	2X	H(2)	50 each	Yes
4	2	II/8	2X	H(2)	50 each	Yes
5	3	II/9	X	S(2)	50 each	Yes
6	3	II/9	X	S(2)	50 each	Yes
7	4	II/9	2X	S(2)	50 each	Yes
8	4	II/9	2X	S(2)	50 each	Yes

TABLE 1B. ACTUAL FISH SURVIVAL TESTING CONDITIONS AND RESULTS FOR PARTIAL SCALE FLUME (6 INCH) WITH DISCHARGE AT -1 FT.

	TEST CONDITIONS					FISH SURVIVAL RESULTS					
TEST DATE	TEST NO.	FISH SPECIES	WATER TEMP. (C)	FLOW RATE (gpm)	VEGETATION/ DEBRIS ADDED	NO. FISH TESTED	HOLDING PERIOD (Hours)	NO. FISH AT END OF HOLDING PERIOD ALIVE	DEAD	STUNNED	ADJUSTED(11) PERCENT MORTALITY
10/10/89	1	S. Bass	7.0	245	No	50	8	50	0	0	0
	Control	S. Bass	7.0			50	8	50	0	0	
10/10/89	5	Alewife	7.0	240	No	50	8	50	0	0	0
	Control	Alewife	7.0			50	8	50	0	0	

TABLE 2A. PROPOSED FISH SURVIVAL[1] TESTING CONDITIONS FOR PARTIAL SCALE FLUME (6 INCH) AND 20' PARTIAL SCALE RETURN PIPE WITH DISCHARGE AT -1 FT.

TEST NO.	DAY	PROPOSAL OBJ/TASK	FLOW[2]	SPECIES[3]	NUMBER[4]	CONTROL[5]
9	5	IIIA/3	X	Object	1 (T)	
10	5	III/3	X	H	3 (T)	
11	5	III/4	X	H(2)	47 each	Yes
12	5	IIIA/5	2X	Object	1 (T)	
13	5	IIIA/5	2X	H	3 (T)	
14	5	IIIA/5	2X	H(2)	47 each	Yes
16	6	IIIA/6	X	Object	1 (T)	
17	6	IIIA/6	X	S	3 (T)	
18	6	IIIA/6	X	S(2)	47 each	Yes
19	6	IIIA/6	2X	Object	1 (T)	
20	6	IIIA/6	2X	S	3 (T)	
21	6	IIIA/6	2X	S(2)	47 each	Yes

TABLE 2B. ACTUAL FISH SURVIVAL TESTING CONDITIONS AND RESULTS FOR PARTIAL SCALE FLUME (6 INCH) AND 30' PARTIAL SCALE RETURN PIPE WITH DISCHARGE AT -1 FT.

(No tests conducted)

TABLE 3A. PROPOSED FISH SURVIVAL[1] TESTING CONDITIONS FOR PARTIAL SCALE FLUME (6 INCH) AND 150' PARTIAL SCALE RETURN PIPE WITH DISCHARGE AT -1 FT.

TEST NO.	DAY	PROPOSAL OBJ/TASK	FLOW[2]	SPECIES[3]	NUMBER[4]	CONTROL[5]	ADD DEBRIS[6]	96 HOUR SURVIVAL[7]
22	7	IIIB/2	X	Object	1 (T)			
23	7	IIIB/2	X	H	3 (T)			
24	7	IIIB/2	X	H(2)	47 each	Yes		
25	7	IIIB/2	X	H(2)	50 each	Yes		Yes
26	8	IIIB/3	2X	Object	1 (T)			
27	8	IIIB/3	2X	H	3 (T)			
28	8	IIIB/3	2X	H(2)	47 each	Yes		
29	9	IIIB/3	2X	H(2)	50 each	Yes		Yes
30	10	IIIB/4	X	Object	1 (T)			
31	10	IIIB/4	X	S	3 (T)			
32	10	IIIB/4	X	S(2)	47 each	Yes		
33	10	IIIB/4	X	S(2)	50 each	Yes		Yes
34	11	IIIB/5	2X	Object	1 (T)			
35	11	IIIB/5	2X	S	3 (T)			
36	11	IIIB/5	2X	S(2)	47 each	Yes		
37	12	IIIB/5	2X	S(2)	50 each	Yes		Yes
38	13	IIIB/6	X	Object	1 (T)		Yes	
39	13	IIIB/6	X	H	3 (T)		Yes	
40	13	IIIB/6	X	H(2)	47 each	Yes	Yes	
41	13	IIIB/6	2X	Object	1 (T)		Yes	
42	13	IIIB/6	2X	H	3 (T)		Yes	
43	13	IIIB/6	2X	H(2)	47 each	Yes	Yes	
44	14	IIIB/6	X	Object	1 (T)		Yes	
45	14	IIIB/6	X	S	3 (T)		Yes	
46	14	IIIB/6	X	S(2)	47 each	Yes	Yes	
47	14	IIIB/6	2X	Object	3 (T)		Yes	
48	14	IIIB/6	2X	S	3 (T)		Yes	
49	14	IIIB/6	2X	S(2)	47 each	Yes	Yes	

TABLE 3B. ACTUAL FISH SURVIVAL TESTING CONDITIONS AND RESULTS FOR PARTIAL SCALE FLUME (6 INCH) AND 150-FT PARTIAL RETURN PIPE WITH DISCHARGE AT -1 FT.

	TEST CONDITIONS					FISH SURVIVAL RESULTS					
TEST DATE	TEST NO.	FISH SPECIES	WATER TEMP. (C)	FLOW RATE (gpm)	VEGETATION/ DEBRIS ADDED	NO. FISH TESTED	HOLDING PERIOD (Hours)	NO. FISH AT END OF HOLDINNG PERIOD ALIVE	DEAD	STUNNED	ADJUSTED(11) PERCENT MORTALITY
10/24/89	36	Alewife	8.0	440	No	50	24	50	0	0	0
	Control	Alewife	8.0			50	24	49	0	1	
10/24/89	36	G. Shiner	8.0	440	No	50	24	50	0	0	0
	Control	G. Shiner	8.0			50	24	49	1	0	

TABLE 4A. PROPOSED FISH SURVIVAL[1] TESTING CONDITIONS FOR PARTIAL SCALE FLUME (6 INCH) AND 150' PARTIAL SCALE RETURN PIPE WITH DISCHARGE AT -35 FT.

TEST NO.	DAY	PROPOSAL OBJ/TASK	FLOW[2]	SPECIES[3]	NUMBER[4]	CONTROL[5]
50	15	IIIC/2	X	Object	1 (T)	
51	15	IIIC/2	X	H	3 (T)	
52	15	IIIC/2	X	H(2)	47 each	Yes
53	15	IIIC/2	2X	Object	1 (T)	
54	15	IIIC/2	2X	H	3 (T)	
55	15	IIIC/2	2X	H(2)	47 each	Yes
56	16	IIIC/2	X	Object	1 (T)	
57	16	IIIC/2	X	S	3 (T)	
58	16	IIIC/2	X	S(2)	47 each	Yes
59	16	IIIC/2	2X	Object	1 (T)	
60	16	IIIC/2	2X	S	3 (T)	
61	16	IIIC/2	2X	S(2)	47 each	Yes

TABLE 4B. ACTUAL FISH SURVIVAL TESTING CONDITIONS AND RESULTS FOR PARTIAL SCALE FLUME (6 INCH) AND 150-FT PARTIAL RETURN PIPE WITH DISCHARGE AT -35 FT.

	TEST CONDITIONS					FISH SURVIVAL RESULTS					
TEST DATE	TEST NO.	FISH SPECIES	WATER TEMP. (C)	FLOW RATE (gpm)	VEGETATION/ DEBRIS ADDED	NO. FISH TESTED	HOLDING PERIOD (Hours)	NO. FISH AT END OF HOLDING PERIOD ALIVE	DEAD	STUNNED	ADJUSTED(11) PERCENT MORTALITY
10/13/89	52	W. Perch	8.0	250	Yes	20	96	15	5	0	6.3
	Control	W. Perch	8.0			20	96	16	4	0	
10/13/89	52	S. Bass	8.0	250	Yes	49	96	47	2	0	0.1
	Control	S. Bass	8.0			50	96	48	2	0	
10/13/89	58	G. Shiner	8.0	250	Yes	49	96	48	1	0	0
	Control	G. Shiner	8.0			50	96	48	2	0	
10/13/89	58	Alewife	8.0	250	Yes	49	96	42	7	0	0.3
	Control	Alewife	8.0			50	96	43	7	0	

TABLE 5A. PROPOSED FISH SURVIVAL[1] TESTING CONDITIONS FOR FULL SCALE FLUME (12 INCH) WITH DISCHARGE AT -1 FT.

TEST NO.	DAY	PROPOSAL OBJ/TASK	FLOW[2]	SPECIES[3]	NUMBER[4]	CONTROL[5]
62	17	IV/7	X	H(2)	50 each	Yes
63	17	IV/8	2X	H(2)	50 each	Yes
64	18	IV/9	X	S(2)	50 each	Yes
65	18	IV/9	2X	S(2)	50 each	Yes

TABLE 5B. ACTUAL FISH SURVIVAL TESTING CONDITIONS AND RESULTS FOR FULL SCALE FLUME (10 INCH) WITH DISCHARGE AT -1 FT.

(No tests conducted)

TABLE 6A. PROPOSED FISH SURVIVAL[1] TESTING CONDITIONS FOR FULL SCALE FLUME (12 INCH) AND 20 FT FULL SCALE RETURN PIPE WITH DISCHARGE AT -1 FT.

TEST NO.	DAY	PROPOSAL OBJ/TASK	FLOW[2]	SPECIES[3]	NUMBER[4]	CONTROL[5]
66	19	VA/3	X	Object	1 (T)	
67	19	VA/3	X	H	3 (T)	
68	19	VA/4	X	H(2)	47 each	Yes
69	19	VA/5	2X	Object	1 (T)	
70	19	VA/5	2X	H	3 (T)	
71	19	VA/5	2X	H(2)	47 each	Yes
72	20	VA/6	X	Object	1 (T)	
73	20	VA/6	X	S	3 (T)	
74	20	VA/6	X	S(2)	47 each	Yes
75	20	VA/6	2X	Object	1 (T)	
76	20	VA/6	2X	S	3 (T)	
77	20	VA/6	2X	S(2)	47 each	Yes

TABLE 6B. ACTUAL FISH SURVIVAL TESTING CONDITIONS AND RESULTS FOR FULL SCALE FLUME (10 INCH) AND 30-FT PARTIAL RETURN PIPE WITH DISCHARGE AT -1 FT.

	TEST CONDITIONS					FISH SURVIVAL RESULTS					
TEST DATE	TEST NO.	FISH SPECIES	WATER TEMP. (C)	FLOW RATE (gpm)	VEGETATION/ DEBRIS ADDED	NO. FISH TESTED	HOLDING PERIOD (Hours)	NO. FISH AT END OF HOLDING PERIOD ALIVE	DEAD	STUNNED	ADJUSTED PERCENT MORTALITY
01/18/90	68	W. Perch	1.5	700	No	50	24	44	6	0	0
	Control	W. Perch	1.5			50	24	44	6	0	

TABLE 7A. PROPOSED FISH SURVIVAL[1] TESTING CONDITIONS FOR FULL SCALE FLUME (12 INCH) AND FULL SCALE 150' RETURN PIPE WITH DISCHARGE AT -1 FT.

TEST NO.	DAY	PROPOSAL OBJ/TASK	FLOW[2]	SPECIES[3]	NUMBER[4]	CONTROL[5]	ADD DEBRIS[6]	96 HOUR SURVIVAL[7]
78	21	VB/2	X	Object	1 (T)			
79	21	VB/2	X	H	3 (T)			
80	21	VB/2	X	H(2)	47 each	Yes		
81	21	VB/2	X	H(2)	50 each	Yes		Yes
82	22	VB/3	2X	Object	1 (T)			
83	22	VB/3	2X	H	3 (T)			
84	22	VB/3	2X	H(2)	47 each	Yes		
85	23	VB/3	2X	H(2)	50 each	Yes		Yes
86	24	VB/4	X	Object	1 (T)			
87	24	VB/4	X	S	3 (T)			
88	24	VB/4	X	S(2)	47 each	Yes		
89	24	VB/4	X	S(2)	50 each	Yes		Yes
90	25	VB/5	2X	Object	1 (T)			
91	25	VB/5	2X	S	3 (T)			
92	25	VB/5	2X	S(2)	47 each	Yes		
93	26	VB/5	2X	S(2)	50 each	Yes		Yes
94	27	VB/6	X	Object	1 (T)		Yes	
95	27	VB/6	X	H	3 (T)		Yes	
96	27	VB/6	X	H(2)	47 each	Yes	Yes	
97	27	VB/6	2X	Object	1 (T)		Yes	
98	27	VB/6	2X	H	3 (T)		Yes	
99	27	VB/6	2X	H(2)	47 each	Yes	Yes	
100	28	VB/6	X	Object	1 (T)		Yes	
101	28	VB/6	X	H	3 (T)		Yes	
102	28	VB/6	X	H(2)	47 each	Yes	Yes	
103	28	VB/6	2X	Object	1 (T)		Yes	
104	28	VB/6	2X	H	3 (T)		Yes	
105	28	VB/6	2X	H(2)	47 each	Yes	Yes	

TABLE 7B. ACTUAL FISH SURVIVAL TESTING CONDITIONS AND RESULTS FOR FULL SCALE FLUME (10 INCH) AND 150-FT. FULL SCALE RETURN PIPE WITH DISCHARGE AT -1 FT.

	TEST CONDITIONS					FISH SURVIVAL RESULTS					
TEST DATE	TEST NO.	FISH SPECIES	WATER TEMP. (C)	FLOW RATE (gpm)	VEGETATION/ DEBRIS ADDED	NO. FISH TESTED	HOLDING PERIOD (Hours)	NO. FISH AT END OF HOLDING PERIOD ALIVE	DEAD	STUNNED	ADJUSTED(11) PERCENT MORTALITY
12/19/89	85	A. Tomcod	4.0	1000	No	50	24	50	0	0	0
	Control	A. Tomcod	4.0			50	24	50	0	0	
12/19/89	85	W. Perch	4.0	1000	No	50(a)	24	47	2	0	2.1
	Control	W. Perch	4.0			50	24	49	1	0	

(a) One fish was lost during the holding period

TABLE 8A. PROPOSED FISH SURVIVAL[1] TESTING CONDITIONS FOR FULL SCALE FLUME (12 INCH) AND 150' RETURN PIPE WITH DISCHARGE AT -35 FT.

TEST NO.	DAY	PROPOSAL OBJ/TASK	FLOW[2]	SPECIES[3]	NUMBER[4]	CONTROL[5]
106	29	VC/2	X	Object	1 (T)	
107	29	VC/2	X	H	3 (T)	
108	29	VC/2	X	H(2)	47 each	Yes
109	29	VC/2	2X	Object	1 (T)	
110	29	VC/2	2X	H	3 (T)	
111	29	VC/2	2X	H(2)	47 each	Yes
112	30	VC/2	X	Object	1 (T)	
113	30	VC/2	X	S	3 (T)	
114	30	VC/2	X	S(2)	47 each	Yes
115	30	VC/2	2X	Object	1 (T)	
116	30	VC/2	2X	S	3 (T)	
117	30	VC/2	2X	S(2)	47 each	Yes

TABLE 8B. ACTUAL FISH SURVIVAL TESTING CONDITIONS AND RESULTS FOR FULL SCALE FLUME (10 INCH) AND 150-FT FULL SCALE RETURN PIPE WITH DISCHARGE AT -35 FT.

	TEST CONDITIONS					FISH SURVIVAL RESULTS					
TEST DATE	TEST NO.	FISH SPECIES	WATER TEMP. (C)	FLOW RATE (gpm)	VEGETATION/ DEBRIS ADDED	NO. FISH TESTED	HOLDING PERIOD (Hours)	NO. FISH AT END OF HOLDING PERIOD ALIVE	DEAD	STUNNED	ADJUSTED(11) PERCENT MORTALITY
12/05/89	114	G. Shiner	8.0	500	No	50	24	50	0	0	
12/05/89	108	W. Perch	8.0	500	No	50	24	50	0	0	
12/11/89	117	G. Shiner	7.0	1000	No	50	24	50	0	0	
12/11/89	117	W. Perch	7.0	1000	No	50	24	50	0	0	
01/04/90(9)	108	W. Perch	1.0	500	Yes	44	96	3	41	0	86.4
	Control	W. Perch	1.0			26(a)	96	13	13	0	
01/04/90(9)	114	G. Shiner	1.0	500	Yes	23	96	23	0	0	0
	Control	G. Shiner	1.0			24(a)	96	24	0	0	
01/05/90(9)	111	W. Perch	1.0	1000	Yes	50	96	12	38	0	68.4
	Control	W. Perch	1.0			50	96	38	12	0	
01/05/90(9)	117	G. Shiner	1.0	1000	Yes	30	96	30	0	0	0
	Control	G. Shiner	1.0			50	96	50	0	0	
01/10/90(9)	114	G. Shiner	1.0	500	No	34	48	34	0	0	0
	Control	G. Shiner	1.0			50	48	50	0	0	
01/10/90(9)	108	W. Perch	1.0	500	No	41	48	8	33	0	78.3
	Control	W. Perch	1.0			50	48	45	5	0	

Table 8B. (Cont.)

TEST DATE	TEST NO.	FISH SPECIES	WATER TEMP. (C)	FLOW RATE (gpm)	VEGETATION/ DEBRIS ADDED	NO. FISH TESTED	HOLDING PERIOD (Hours)	NO. FISH AT END OF HOLDING PERIOD ALIVE	DEAD	STUNNED	ADJUSTED (11) PERCENT MORTALITY
	TEST CONDITIONS					FISH SURVIVAL RESULTS					
01/10/90(9)	108	W. Perch	1.0	1000	No	38	48	23	15	0	31.2
	Control	W. Perch	1.0			50	48	44	6	0	
01/10/90(9)	114	G. Shiner	1.0	1000	No	26	48	25	1	0	3.8
	Control	G. Shiner	1.0			50	48	50	0	0	-
01/18/90(10)	114	G. Shiner	1.5	500	No	51	24	51	0	0	0
	117	G. Shiner	1.5	1000	No	50(b)	24	49	0	0	0
	Control	G. Shiner	1.5			50	24	49	1	0	
01/18/90(10)	108	W. Perch	1.5	500	No	50	24	45	5	0	0
	111	W. Perch	1.5	1000	No	49	24	46	4	0	0
	Control	W. Perch	1.5			50	24	44	6	0	

(a) A hole was found in the netting of the cage for control fish from 01/04/90 which permitted escapement of control fish during the holding period. The number of fish in the control cage is adjusted downward from the 50 fish initially held to represent the total number found in the control cage at the end of the holding period.

(b) One fish was lost during the holding period.

TABLE 8C. ACTUAL FISH SURVIVAL TESTING CONDITIONS AND RESULTS FOR FULL SCALE FLUME (10 INCH) AND 250-FT FULL SCALE RETURN PIPE WITH DISCHARGE AT -35 FT.

	TEST CONDITIONS					FISH SURVIVAL RESULTS					
TEST DATE	TEST NO.	FISH SPECIES	WATER TEMP. (C)	FLOW RATE (gpm)	VEGETATION/ DEBRIS ADDED	NO. FISH TESTED	HOLDING PERIOD (Hours)	NO. FISH AT END OF HOLDING PERIOD ALIVE	DEAD	STUNNED	ADJUSTED(11) PERCENT MORTALITY
01/19/90(10)	114	G. Shiner	1.5	500	No	50	96	50	0	0	0
	117	G. Shiner	1.5	1000	No	50	96	50	0	0	0
	Control	G. Shiner	1.5			50	96	50	0	0	
01/19/90(10)	108	W. Perch	1.5	500	No	50	96	30	20	0	0
	111	W. Perch	1.5	1000	No	50	96	26	24	0	0
	Control	W. Perch	1.5			50	96	26	24	0	
01/24/90	114	G. Shiner	4.0	500	Yes	50(a)	120	48	0	0	0
	117	G. Shiner	4.0	1000	Yes	50	120	49	1	0	2.0
	Control	G. Shiner	4.0			50	120	50	0	0	
01/24/90	108	W. Perch	4.0	500	Yes	50	120	39	11	0	0
	111	W. Perch	4.0	1000	Yes	50	120	25	25	0	3.8
	Control	W. Perch	4.0			50	120	26	24	0	
01/29/90	114	G. Shiner	3.0	500	Yes	50	96	45	5	0	8.2
	117	G. Shiner	3.0	1000	Yes	50	96	47	3	0	4.1
	Control	G. Shiner	3.0			50	96	49	1	0	
01/29/90	108	A. Tomcod	3.0	500	Yes	40	96	39	1	0	0
	111	A. Tomcod	3.0	1000	Yes	40	96	38	2	0	2.6
	Control	A. Tomcod	3.0			40	96	39	1	0	

(a) Two fish were lost during the holding period.

Table 9. Transit time for fish and inanimate objects under various test conditions.

DATE MM	DATE DD	DATE YY	PIPE DIAMETER INCHES	TEST LENGTH FEET	DISCHARGE DEPTH FEET	TEST FLOW RATE GALLONS PER MINUTE	TRANSIT TIME SECONDS	TESTED ITEM
10	13	89	6	150	-33	250	59-80	Golden shiner
10	13	89	6	150	-33	250	58-103	White perch
10	13	89	6	150	-33	250	108	Eel grass
10	13	89	6	150	-33	250	56-90	White perch
10	13	89	6	150	-33	250	53-87	Striped bass
10	13	89	6	150	-33	250	111	Empty styro cup
10	13	89	6	20	-12	200	35	Empty styro cup
10	13	89	6	20	-12	250	21	Empty styro cup
10	13	89	6	20	-12	200	48	Covered empty styro cup
10	13	89	6	20	-12	250	41	Covered empty styro cup
10	13	89	6	20	-12	250	80	Covered empty styro cup
10	13	89	6	20	-12	200	180+	2 liter bottle 1/2 full
10	13	89	6	20	-12	250	45	2 liter bottle 1/2 full
10	13	89	6	20	-12	200	Floated pipe	2 liter bottle empty
10	13	89	6	20	-12	250	27	2 liter bottle empty
10	13	89	6	20	-12	200	No	Light bulb
10	13	89	6	20	-12	250	45	Light bulb
10	13	89	6	20	-12	200	No	1 liter bottle 1/2 full
10	13	89	6	20	-12	250	103	1 liter bottle 1/2 full
10	13	89	6	20	-12	200	No	1 liter bottle empty
10	13	89	6	20	-12	250	No	1 liter bottle empty
10	24	89	6	150	- 1	440	39-60	Alewife, golden shiner
12	11	89	10	150	- 1	1000	40-160	Golden shiner
12	11	89	10	150	- 1	1000	40-90	White perch
12	19	89	10	150	- 1	1000	38-85	Tomcod
12	19	89	10	150	- 1	1000	36-80	White Perch

Table 9 (cont.)

MM	DATE DD	YY	PIPE DIAMETER INCHES	TEST LENGTH FEET	DISCHARGE DEPTH FEET	TEST FLOW RATE GALLONS PER MINUTE	TRANSIT TIME SECONDS	TESTED ITEM
01	04	90	10	150	-35	500	65 minimum(a)	Golden shiner
								White perch
								Debris
01	05	90	10	150	-35	1000	65-115	Golden shiner
								White perch
								Debris
01	05	90	10	150	-35	500	105-167	Golden shiner
								White perch
01	10	90	10	150	-35	500	92	Golden shiner
01	10	90	10	150	-35	500	100	White perch
01	10	90	10	150	-35	1000	65	Golden shiner
01	10	90	10	150	-35	1000	67	White perch
01	10	90	10	150	-35	1000	139	Empty 16 oz. bottle
01	18	90	10	150	-35	500	72-180	Golden shiner
01	18	90	10	150	-35	500	72-180	White perch
01	18	90	10	150	-35	1000	48-70	Golden shiner
01	18	90	10	150	-35	1000	47-75	White perch
01	18	90	10	30	- 1	700	18-24	White perch
01	19	90	10	250	-35	500	113-305	Golden shiner
01	19	90	10	250	-35	500	132-217	White perch
01	19	90	10	250	-35	500	157	1/2 full 16 oz. bottle
01	19	90	10	250	-35	1000	78-135	Golden shiner
01	19	90	10	250	-35	1000	76-104	White perch

(a) Maximum transit time could not be determined due to low visibility.

TABLE 10. FREQUENCY OF TIME OF TRANSIT FOR GOLDEN SHINERS, WHITE PERCH AND ATLANTIC TOMCOD AT 500 AND 1,000 GPM THROUGH THE 150 AND 250 FT RETURN PIPES DISCHARGED AT -35 FT

TIME PERIOD (SECONDS)	500 GPM					1,000 GPM				
	150 FT RETURN PIPE		250 FT RETURN PIPE			150 FT RETURN PIPE		250 FT RETURN PIPE		
	GOLDEN SHINERS	WHITE PERCH	GOLDEN SHINERS	WHITE PERCH	ATLANTIC TOMCOD	GOLDEN SHINERS	WHITE PERCH	GOLDEN SHINERS	WHITE PERCH	ATLANTIC TOMCOD
0- 15										
16- 30										
31- 45										
46- 60						44	46			1
61- 75	3					6	4			3
76- 90	3	3						20	45	3
91-105	6	23						23	5	15
106-120	10	16	1		5			4		10
121-135	11	3	1	1	1			3		7
136-150	7	4	6	15	5					
151-165	7	1	5	16	3					
166-180	3		7	8	4					
181-195			3	4	1					
196-210			8	5	0					
211-225			4	1	2					
226-240			4		2					
241-255			4		0					
256-270			2		1					
271-285			2		1					
286-300			2		2					
301-315			1		2					
316-330					3					
331-345					1					
346-360					2					
361-375					1					
376-390					2					
391-405					0					
406-420					2					
n	50	50	50	50	40	50	50	50	50	40
MEAN	124.7	109.5	200.9	163.7	234.3	56.3	53.0	95.7	83.3	103.2
STANDARD ERROR	3.90	2.24	6.80	2.82	15.37	0.70	0.60	1.84	0.79	3.09

TABLE 11. CALCULATED WATER VELOCITIES IN THE PROTOTYPE RISTROPH SCREEN FISH RETURN SYSTEM

FLOW (gal/min)	PIPE DIAMETER (in)	CALCULATED DEPTH OF FLOW (in)			CALCULATED AVERAGE VELOCITY (ft/sec)			TOTAL TIME-OF TRAVEL (sec)
		SECTION 1[a]	SECTION 2[b]	SECTION 3[c]	SECTION 1	SECTION 2	SECTION 3	
250	6	2.30	1.38	6.0	8.0	16.3	2.8	64
400	6	3.00	1.74	6.0	9.0	18.6	4.5	42
500	10	2.70	1.62	10.0	9.3	18.2	2.1	84
700	10	3.28	1.98	10.0	10.3	20.0	2.9	60
1000	10	3.86	2.33	10.0	11.3	22.2	4.1	42

[a]Section 1 = Flume between elevation 18' 10" and 15'

[b]Section 2 = Flume between elevation 15' and -1

[c]Section 3 = Return pipe

A-V

INDIAN POINT FISH RETURN SITE DYE RECIRCULATION STUDY

Hydraulic Study of the Hudson River

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Abstract

Aquatec conducted a dye tracer study in two phases to determine to what extent water released from various points along two proposed fish return pipe routes at the Indian Point Nuclear generating Station would enter the Unit 2 and Unit 3 intakes. The proposed route for the Unit 3 return pipe originates at the northwest corner of the common discharge canal and lies perpendicular to the shore south of the Unit 3 intake. The Unit 2 route lies perpendicular to the shore north of Unit 2. The study was conducted for two circulating flow conditions. During Phase I, six circulating water pumps were operating at full capacity at each intake. During Phase II, six circulating pumps were operating at 60% capacity at Unit 3 and four to six pumps were at 60% capacity at Unit 2.

During each phase, a tracer solution was released at five points along the Unit 3 route, four points along the Unit 2 route, and at an additional point lying 75 feet south of the discharge canal along a line defined by the westernmost wall of the canal. Tracer concentrations were measured at the individual discharges of Units 2 and 3 and in the common discharge canal to determine the amount of tracer returned to each unit.

The data collected indicate that the highest rates of tracer return flow to each unit result from releases along their respective routes. However, releases from the Unit 2 route resulted in the highest overall rate of return to the intakes.

While the amount of tracer returned from points along the Unit 2 route showed a strong inverse relationship to distance from shore in both phases, the return rates from points along the Unit 3 route had no obvious relationship to distance from shore.

The release from the point south of the discharge canal resulted in the lowest overall return flow rate for the duration of the return periods studied during each phase.

1. Introduction

Consolidated Edison and the New York Power Authority plan to install modified Ristroph traveling screen systems at Units 2 and 3 respectively of the Indian Point Nuclear Generating Station. Each system will include pipes for returning fish and debris from the screens back to the Hudson River. Routes for the pipes have been proposed. The proposed Unit 2 route lies perpendicular to the shore at 145 feet north of the center of the Unit 2 intake structure. The proposed Unit 3 route originates at the northwest corner of the common discharge canal and lies perpendicular to the shore at 265 feet south of the Unit 3 ~~2~~ intake structure.

The purpose of the study was to determine to what extent water released from several points lying along the proposed pipe routes would enter the Unit 2 and Unit 3 intakes during each of two operational modes of the circulating water systems. A solution of Rhodamine WT fluorescent dye was released from each of the study points at a constant rate for a duration of one tidal cycle per point. All releases were initiated at the approximate occurrence of low water. Each release cycle was preceded by and followed by at least one cycle during which no dye was released. Fluorescence and temperature were measured continuously at each unit's discharge and digitally recorded at a rate of once per minute. During Phase I, each unit's circulating water system was pumping water from and returning it to the Hudson River at a nominally constant rate of 840,000 gallons per minute (gpm). During Phase II, the Unit 3 circulating water system was pumping about 504,000 gpm, and the Unit 2 circulating water system pumped from 336,000 to 504,000 gpm. Service water flow rate was 30,000 gpm for each unit during Phase I and for Unit 3 during Phase II; service water flow was 15,000 gpm for Unit 2 during Phase II.

Four points along the Unit 2 route and five points along the Unit 3 route were studied. The points along the Unit 2 route were at 60, 110, 160 and 210 feet from the shore at low water. The points along the Unit 3 route were at 0, 10, 60, 110 and 160 feet from the northwest corner of the discharge canal. An additional point referred to as the "Alternate" point lay 75 feet south of the end of the discharge canal, along the line defined by the western-most wall of the canal. All points were five feet from the bottom of the river. See Figure 1 for approximate locations of all the release points.

2. Methods

2.1 Dye Release

A twenty percent solution of Rhodamine WT fluorescent dye was pumped at a constant rate of approximately 1.44 kg/hr from a five-gallon plastic bucket using a Liquid Metronics, Inc. (LMI) fluid metering pump during Phase I, and at a rate of approximately 0.90 kg/hr during Phase II. Dye was released at a lower rate during Phase II to compensate for the reduced circulating water flow rate at that time (about sixty percent of the Phase I flow rate). The LMI pump discharged the dye solution into a three-quarter inch diameter flexible hose carrying river water from a submersible pump to the planned release point. The significant dilution of the dye solution with river water in the hose resulted in a discharge solution of density nearly equal to that of river water at the release point.

The combination of a lap-top computer and an A&D 150-kg electronic balance continuously weighed the five-gallon bucket of dye solution and recorded the mass at a rate of at least once every five minutes. The mass release rate was found to be substantially constant (<7% variation) throughout each release period.

2.2 Fluorometer Calibration

Turner Designs Model 10 fluorometers in flow-through configuration were used in the study. The fluorometers were calibrated before each phase of the study using water from the study area.

One hundred liters of water from the discharge canal was collected into a clean forty-gallon plastic container. The water was circulated through the fluorometers, each with its own temperature probe, in series. Rhodamine dye calibration solution, prepared from the same lot used in the releases, was added incrementally to the circulating water. After each addition of solution, the system was allowed to reach well-mixed conditions and the scale reading and temperature corresponding to each fluorometer was digitally recorded at a rate of once per second for about sixty seconds before the next addition or scale change. All fluorescence readings were later corrected to a reference temperature using the equation:

$$Rc = R \exp[.015(Tobs - Tr)] \quad \text{(equation 1)}$$

where;

Rc = Corrected Reading
R = Reading
Tobs = Observed Temperature
Tr = Reference Temperature

The corrected readings for each scale were then linearly regressed against their corresponding dye concentrations to determine the coefficients (A and B) of the linear equation:

$$\text{Concentration} = A(Rc) + B \quad \text{(equation 2)}$$

which was later used to reduce the fluorescence data measured by the fluorometers.

2.3 Fluorescence Measurements

Aquatec setup Turner Designs Model 10 fluorometers in flow-through mode at the discharges of each unit's circulation water system and, as a backup, at the well-mixed end of the discharge canal (see Figure 1). Discharge water was pumped through each fluorometer by individual 110 volt submersible or impeller pumps. Water exiting each fluorometer passed through a temperature cell utilizing a YSI series 700 thermister before returning to the discharge canal.

Portable IBM PC compatible computers running Aquatec custom data collection software were used to record the reading and scale of each fluorometer and the local water temperature from signal conditioning modules connected to the instruments. Data were recorded at all stations at a rate of once per minute through the entire duration of each phase of the study with no significant interruption.

The internal clocks of all computers were synchronized at the start of, and checked for clock drift at the end of, each phase of the study.

2.4 Data Processing

All fluorescence data were converted to equivalent dye concentration by correcting individual data for temperature (equation 1) and applying the calibration equation (equation 2) using the appropriate coefficients. Dye concentrations measured during the ten hour period preceding the start of each release were averaged to determine background apparent dye concentration (C_b) for the subsequent release period.

The probability of return by hour to each unit was calculated for each of thirteen successive one-hour intervals beginning at the start of each release. The probability of return associated with a given hour is defined as the mass of dye entering the unit within that hour divided by the mass of dye released to the river within the same hour. The probability of return for each one-hour interval was calculated by subtracting the background apparent dye concentration from each observed dye concentration within the one-hour interval, numerically integrating the background-corrected dye concentration over the one-hour interval, multiplying the time-integrated concentration by the volume flow rate of water through the circulating water system, and dividing by the mass of dye released to the river during the same hour. This calculation is expressed mathematically as

$$p = 100\%Q \sum_{i=1}^{n} (C_i - C_b)t_i/m \qquad \text{(equation 3)}$$

where;

p = the percent probability of return associated with a one-hour interval
n = the number of observations within the one-hour interval
i = observation number
C_i = dye concentration corresponding to observation i, mass/volume

C_b - background apparent dye concentration during 10 hour preceding release, mass/volume
t_i - length of time represented by observation i, time
Q - volume flow rate of water through circulating system, volume/time
m - mass of dye released during the one-hour interval, mass

The calculation was performed using data from each phase of the study, applying the appropriate flow rates. The one-hour intervals are defined such that the corresponding time interval among release periods represent the same portion of the tidal cycle, thus allowing direct comparison between release points on an hourly basis.

During some conditions, the calculations resulted in probabilities of return by hour which exceeded unity (>100%). This could result from the accumulation of dye upstream of an intake during flood and slack tidal periods and its subsequent return to the intake during ebb tide, thus adding to the dye which was still being released. Values greater than one could also be due to simple recirculation of water more than once through the system as dye continued to be added and the accumulated concentration measured.

An alternative parametric indication of the mass return rate to the intakes is the Gross Return Rate, which also appears in Table 1 and results from integration of the return concentration over two tidal cycles. Unlike the hourly probabilities of return, the Gross Return Rate accounts for any dye which may return during the non-release tidal cycle following the release cycle.

The same phenomena that caused some calculated probabilities of return by hour to exceed unity would have a similar effect on the calculation of Gross Return Rates, thus resulting in some Gross Return Rates which also exceed unity.

The Gross Return Rate for a release point was defined as the mass percentage of all dye released over one tidal cycle which returned to an intake during a two-cycle period comprised of the release cycle and the following non-release cycle. Gross return rates were calculated for each release point and intake unit by subtracting the background apparent dye concentration from each dye concentration observed during the two-cycle period, numerically integrating the background corrected concentration over the two cycle period, multiplying the time integrated of concentration by the volume flow rate of water through the unit, and dividing by the total mass of dye released from the point over the first cycle. The mathematical expression is similar to equation 3 with n equal to the number of observations in the two-tidal-cycle period and m equal to the total mass of dye released from the point.

3. Results

Table 1.1 and 1.2 contain Phase I release data including the start and end times of each release period, the release rate, and the percent probability of return to each unit for each of thirteen one-hour intervals beginning at the start of each release period as well as the gross return rate over 2 tidal cycles. Tables 2.1 and 2.2 contain the same information for Phase II of the study.

Figures 2 and 13 show the concentration of dye detected at Units 2 and 3 as a function of time for the duration of each study phase while Figures 3 through 12 and 14 through 23 depict 15 minute average dye concentrations at each unit during each release period and during the ten hours preceding the release (background apparent concentration). The figures are arranged in the chronological order of the releases.

Because the concentration of dye in the circulating water is a function of several dynamic variables including the circulating water flow rate, the dye release rate, and recirculation effects, direct comparison of dye concentrations between phases and even within a phase (circulating water flow rate was not constant for Phase II) will be misleading. The concentration plots are provided primarily to offer an indication of the time distribution of returning dye as affected by tidal influences.

The releases from the Unit 3 route, in general, resulted in more return flow to Unit 3 than to Unit 2. Likewise, the releases from the Unit 2 route resulted in more return to Unit 2 than to Unit 3. The amount of dye returned to the Unit 2 intake from releases along the Unit 2 route decreased as the distance of the dye release point from shore increased. No other relationships between rate of return and distance of release point from shore were strongly defined.

The plots and tables indicate that the lowest observed concentrations and probabilities of return to both units under the two flow conditions studied resulted from the releases at the Alternate Unit 3 route. It should be noted, however, that dye concentrations observed at the intakes during the tidal cycle following the release cycle were greater than those observed during the release cycle.

Figures 8 and 9 show the concentration of dye returning to the intakes continuing to rise even after the release from the alternate Unit 3 route was terminated. The late rise in return concentrations suggests that water may recirculate from the alternate point to the intakes on a larger time scale than was observable within the structure of the present study.

Overall, the highest probabilities of return were derived from observations at Unit 2 during releases along the Unit 2 route. Return rates to Unit 2 from the Unit 2 route during Phase I were an order of magnitude higher than other return rates.

During Phase II, with circulating pumps at 60% of capacity, the Gross Return Rates to Unit 2 from the Unit 2 route dropped to about one-half their Phase I values. The most dramatic reduction in Gross Return to Unit 2 was from the point 210 feet from shore along the Unit 2 route. It was also from this point that the most dramatic increase in Gross Return to Unit 3 occurred.

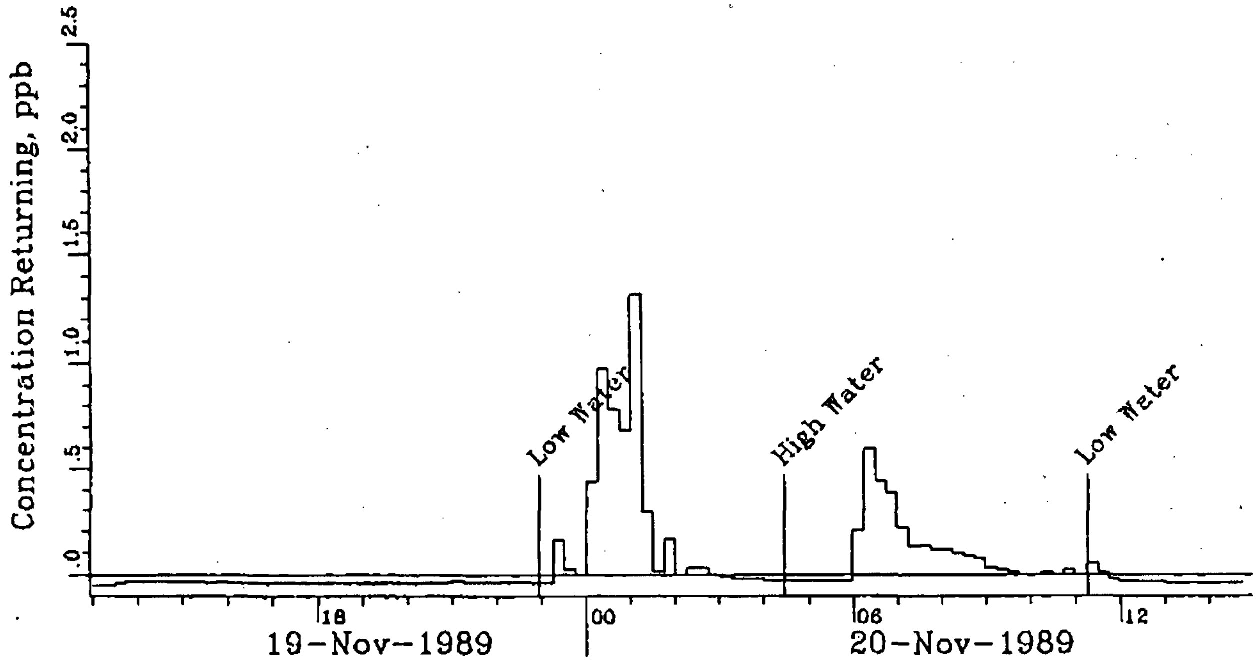
Additional tidal effects are illustrated by the plots of dye concentration at the unit 2 discharge resulting from releases along the unit 2 route. In these plots, the dye returned to the unit 2 intake is distributed bi-modally in time. The bi-modal distribution is a result of the relative strengths and directions of the naturally occurring currents and the currents induced by the circulating water pumps.

Around the time of low water and low slack, when the current induced by the circulating water pumps is large relative to the natural currents, a large portion of the dye injected along the Unit 2 route is drawn into the intakes. During flood tide, natural currents transport the dye upstream, away from the intake, causing less to be entrained by the pump-induced currents. As the flood currents lessen, a significant portion of dye is again entrained by the pump induced currents and drawn into the intake. During ebb tide, the natural currents move dye downstream, toward the intakes, thus increasing the amount of dye which is entrained and enters the intake.

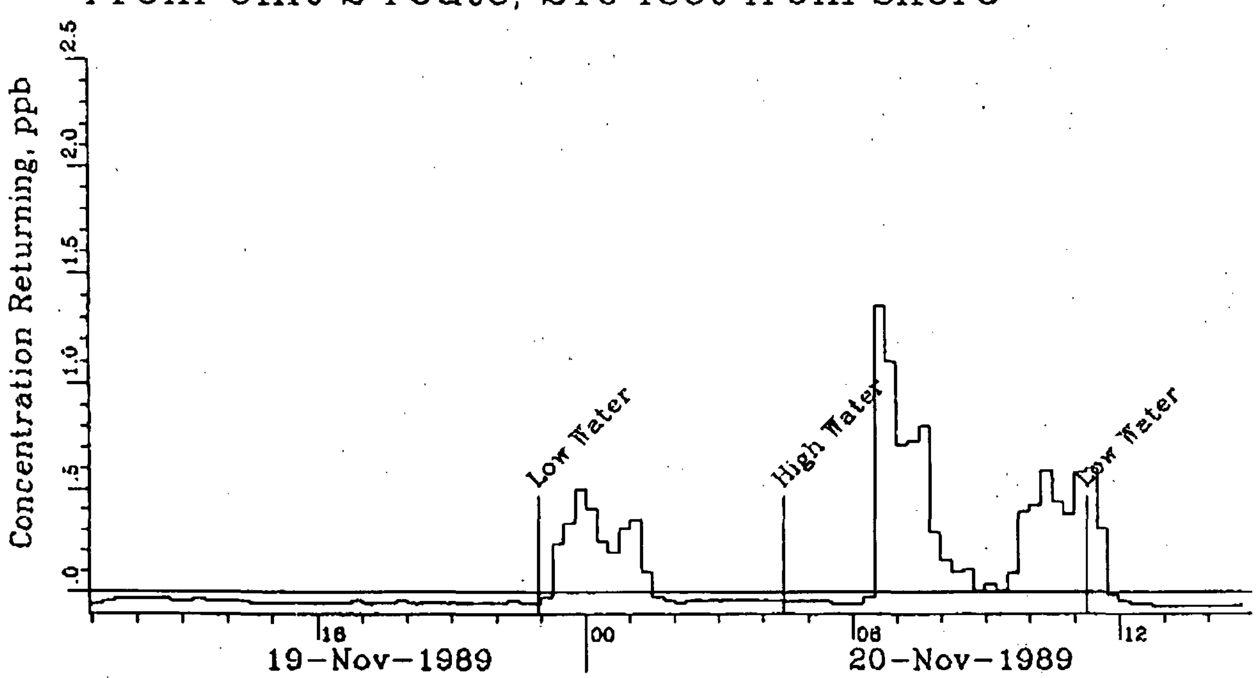
89123E21FEB90

Figure 23

Tracer Returned To Unit 2 during Phase II
From Unit 2 route, 210 feet from shore



Tracer Returned To Unit 3 during Phase II
From Unit 2 route, 210 feet from shore



Appendix A

Tables

Table 1.1: Probability of Return by Hour to Unit 2 Intake During Release -- Phase I

Location Route	Location Station	Date	Start Time hhmm	End Time hhmm	Release Rate kg/hr	Hours After Start of Release 1	2	3	4	5	6	7	8	9	10	11	12	13	Gross Return Rate
3	160	21-Sep-89	1033	2311	0.32	0%	1%	1%	12%	12%	9%	10%	7%	1%	0%	1%	1%	2%	5%
3	0	23-Sep-89	1305	0157	0.29	1%	1%	1%	1%	6%	15%	7%	4%	3%	2%	2%	2%	2%	6%
3	10	24-Sep-89	1411	0252	0.28	0%	0%	0%	4%	8%	11%	13%	11%	2%	1%	1%	1%	1%	4%
3	60	25-Sep-89	1505	0339	0.28	0%	0%	0%	11%	11%	13%	15%	8%	1%	0%	0%	0%	0%	4%
3	110	26-Sep-89	1556	0423	0.28	0%	0%	0%	4%	12%	11%	17%	13%	4%	1%	2%	3%	1%	5%
3	Alt.	27-Sep-89	1642	0504	0.28	0%	0%	0%	0%	2%	2%	1%	2%	2%	2%	1%	2%	2%	3%
2	160	28-Sep-89	1725	0545	0.29	75%	97%	73%	1%	0%	0%	1%	38%	75%	97%	86%	102%	54%	61%
2	60	29-Sep-89	1806	0620	0.29	80%	115%	98%	3%	0%	35%	132%	117%	115%	115%	110%	100%	45%	94%
2	110	30-Sep-89	1853	0655	0.27	92%	115%	59%	1%	0%	0%	63%	164%	128%	127%	126%	116%	25%	86%
2	210	01-Oct-89	1920	0634	0.27	0%	0%	55%	9%	0%	3%	12%	60%	121%	74%	3%	—	—	43%

Table 1.2: Probability of Return by Hour to Unit 3 Intake During Release -- Phase I

Location Route	Location Station	Date	Start Time hhmm	End Time hhmm	Release Rate kg/hr	Hours After Start of Release 1	2	3	4	5	6	7	8	9	10	11	12	13	Gross Return Rate
3	160	21-Sep-89	1033	2311	0.32	2%	2%	9%	14%	23%	23%	29%	14%	1%	0%	2%	3%	4%	12%
3	0	23-Sep-89	1305	0157	0.29	3%	1%	0%	45%	32%	49%	7%	4%	6%	6%	5%	5%	5%	18%
3	10	24-Sep-89	1411	0252	0.28	1%	1%	8%	44%	6%	10%	11%	6%	4%	4%	4%	4%	4%	11%
3	60	25-Sep-89	1505	0339	0.28	1%	1%	43%	18%	16%	15%	13%	2%	1%	0%	3%	3%	4%	10%
3	110	26-Sep-89	1556	0423	0.28	1%	0%	8%	84%	16%	18%	21%	10%	3%	3%	4%	4%	4%	14%
3	Alt.	27-Sep-89	1642	0504	0.28	1%	1%	0%	0%	0%	0%	0%	0%	2%	3%	3%	3%	4%	1%
2	160	28-Sep-89	1725	0545	0.29	2%	1%	0%	0%	0%	0%	0%	0%	5%	5%	12%	6%	6%	3%
2	60	29-Sep-89	1806	0620	0.29	1%	0%	0%	0%	0%	0%	0%	1%	3%	5%	3%	3%	2%	5% → 0%
2	110	30-Sep-89	1853	0655	0.27	1%	0%	0%	0%	0%	0%	0%	4%	5%	8%	6%	4%	3%	3%
2	210	01-Oct-89	1920	0634	0.27	10%	17%	19%	0%	0%	0%	0%	1%	14%	15%	14%	—	—	11%

— = Value not defined

Table 2.1: Probability of Return by Hour to Unit 2 Intake During Release -- Phase II

Location		Date	Start Time	End Time	Release Rate	Hours After Start of Release													Gross Return Rate
Route	Station		hhmm	hhmm	kg/hr	1	2	3	4	5	6	7	8	9	10	11	12	13	
3	160	10-Nov-89	1445	0259	0.17	0%	0%	0%	5%	20%	26%	11%	5%	3%	2%	1%	1%	0%	7%
3	0	11-Nov-89	1605	0346	0.18	0%	0%	1%	9%	9%	8%	4%	1%	0%	0%	0%	0%	0%	2%
3	10	12-Nov-89	1630	0436	0.18	0%	0%	0%	1%	12%	12%	10%	4%	2%	1%	0%	0%	0%	3%
3	60	13-Nov-89	1722	0524	0.17	0%	0%	0%	14%	14%	11%	13%	5%	3%	3%	2%	1%	0%	5%
3	110	14-Nov-89	1813	0614	0.18	0%	0%	0%	8%	27%	21%	8%	4%	3%	2%	1%	0%	0%	4%
3	Alt.	15-Nov-89	1903	0703	0.19	0%	0%	0%	1%	3%	2%	1%	1%	1%	0%	0%	0%	0%	1%
2	160	16-Nov-89	1956	0756	0.18	31%	46%	31%	14%	4%	2%	0%	71%	54%	93%	83%	85%	29%	44%
2	60	17-Nov-89	2048	0953	0.16	23%	56%	57%	5%	4%	0%	0%	45%	159%	114%	83%	86%	58%	52%
2	110	18-Nov-89	2147	1002	0.17	39%	49%	56%	21%	18%	2%	0%	0%	89%	86%	78%	80%	44%	46%
2	210	19-Nov-89	2252	1116	0.18	5%	45%	37%	5%	2%	1%	0%	26%	14%	9%	4%	3%	4%	13%

Table 2.2: Probability of Return by Hour to Unit 3 Intake During Release -- Phase II

Location		Date	Start Time	End Time	Release Rate	Hours After Start of Release													Gross Return Rate
Route	Station		hhmm	hhmm	kg/hr	1	2	3	4	5	6	7	8	9	10	11	12	13	
3	160	10-Nov-89	1445	0259	0.17	0%	0%	0%	42%	32%	39%	28%	11%	3%	1%	1%	1%	0%	14%
3	0	11-Nov-89	1605	0346	0.18	0%	0%	60%	23%	16%	19%	6%	1%	0%	0%	0%	0%	0%	10%
3	10	12-Nov-89	1630	0436	0.18	N/D	0%	0%	55%	15%	13%	38%	6%	2%	1%	1%	12%	9%	16%
3	60	13-Nov-89	1722	0524	0.17	0%	0%	46%	38%	44%	26%	22%	4%	0%	0%	0%	0%	0%	13%
3	110	14-Nov-89	1813	0614	0.18	0%	0%	2%	62%	51%	61%	32%	5%	1%	0%	0%	0%	0%	16%
3	Alt.	15-Nov-89	1903	0703	0.19	0%	0%	0%	4%	1%	0%	0%	0%	1%	0%	0%	0%	0%	2%
2	160	16-Nov-89	1956	0756	0.18	5%	12%	14%	4%	1%	0%	0%	0%	43%	22%	18%	13%	5%	9%
2	60	17-Nov-89	2048	0953	0.16	4%	15%	11%	11%	0%	0%	0%	0%	12%	13%	3%	6%	14%	8%
2	110	18-Nov-89	2147	1002	0.17	5%	14%	16%	4%	0%	0%	0%	0%	7%	35%	18%	18%	10%	9%
2	210	19-Nov-89	2252	1116	0.18	15%	24%	13%	0%	0%	0%	0%	36%	52%	11%	7%	36%	32%	19%

N/D = No data available

Appendix B

Figures

CIRCULATING WATER SYSTEM

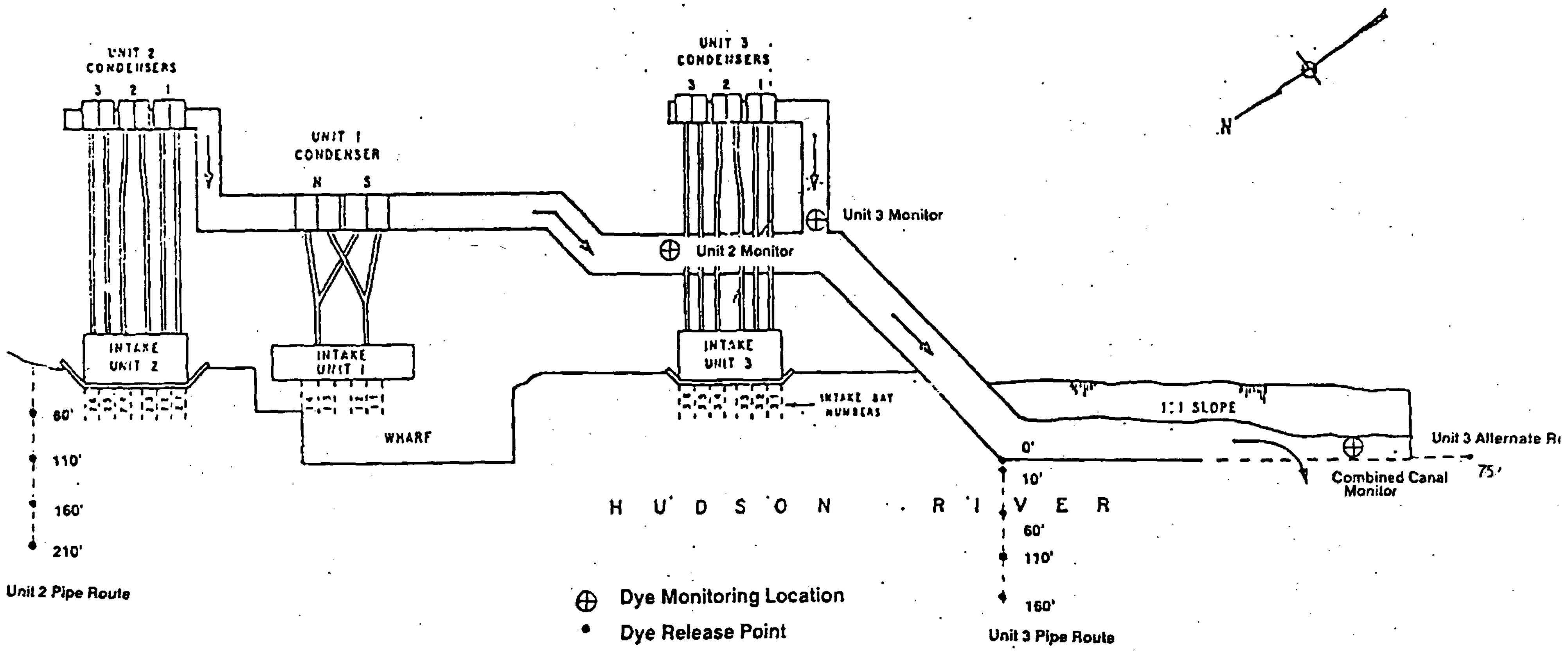


Figure 1

Scale: 1" = 180'

Tracer Dye Recirculation Results, Phase I

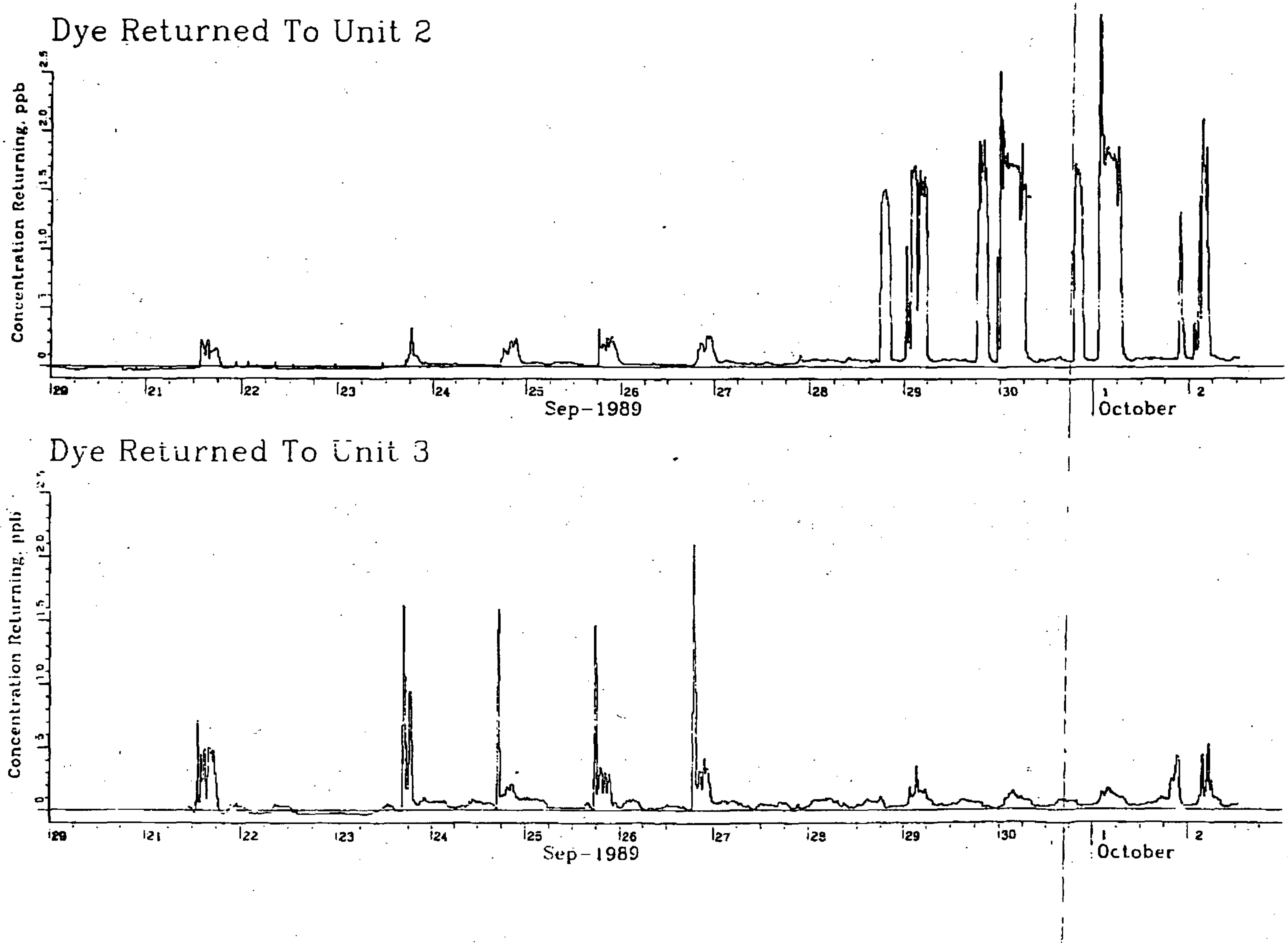
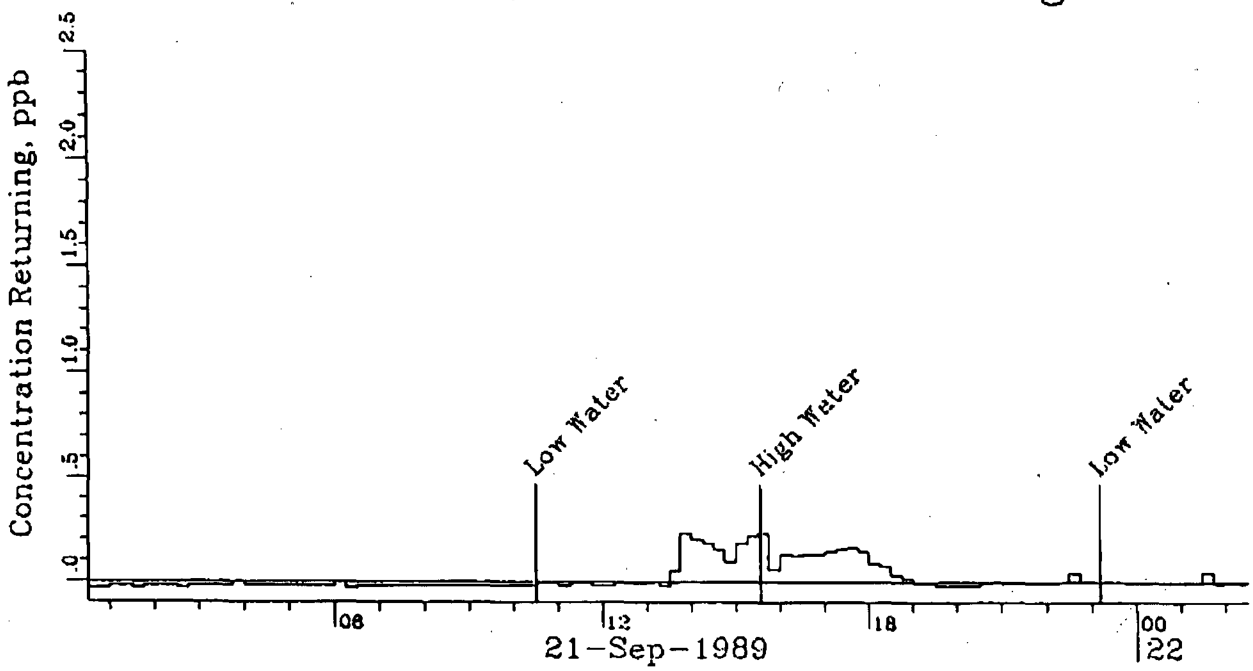


Figure 2

Figure 3

Tracer Returned To Unit 2 during Phase I
From Unit 3 route, 160 feet from discharge canal



Tracer Returned To Unit 3 during Phase I
From Unit 3 route, 160 feet from discharge canal

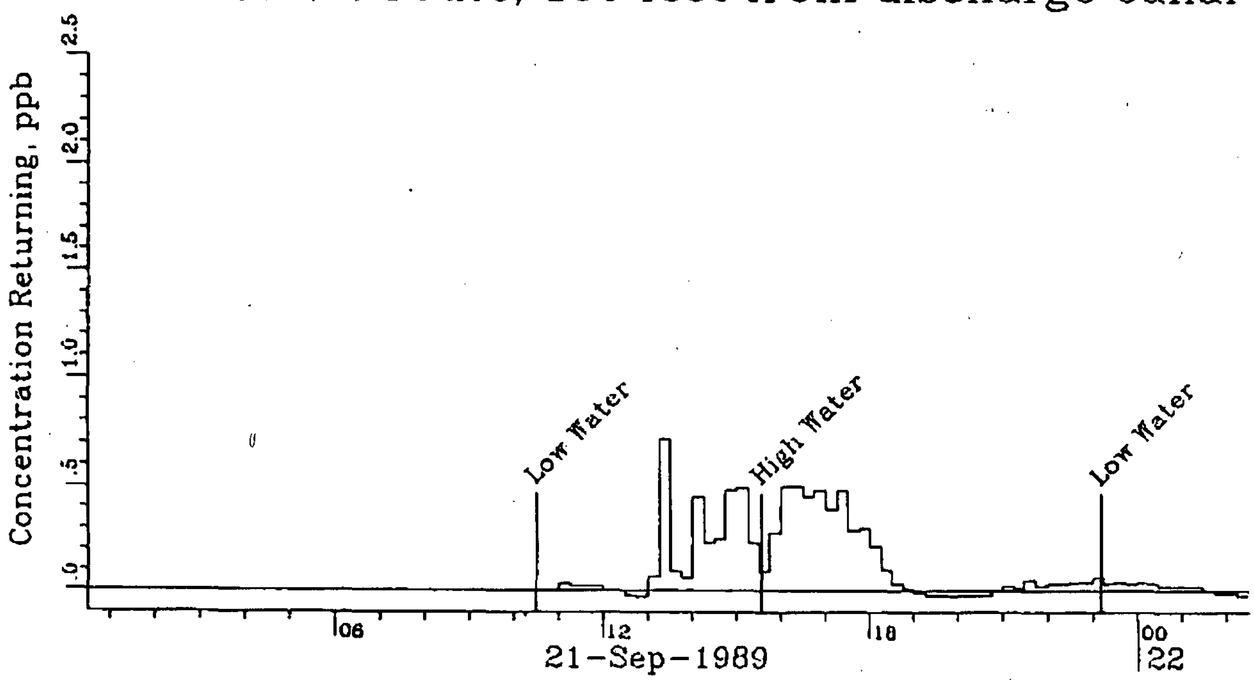
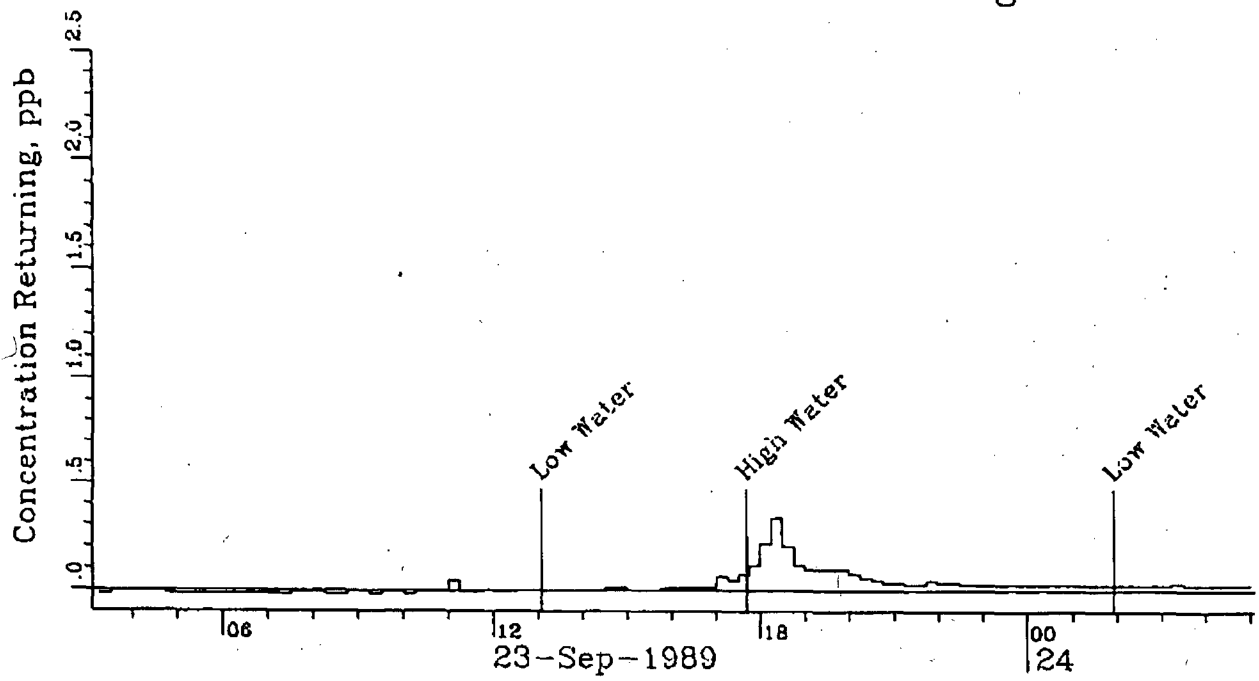


Figure 4

Tracer Returned To Unit 2 during Phase I
From Unit 3 route, 0 feet from discharge canal



Tracer Returned To Unit 3 during Phase I
From Unit 3 route, 0 feet from discharge canal

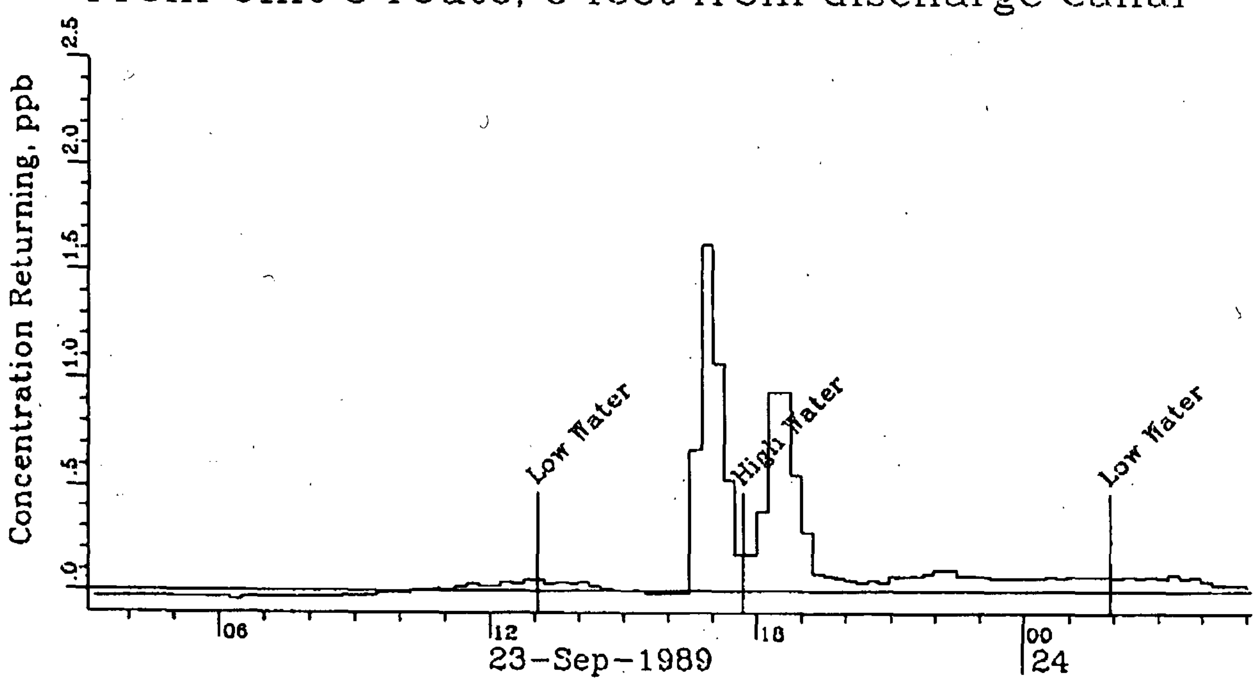
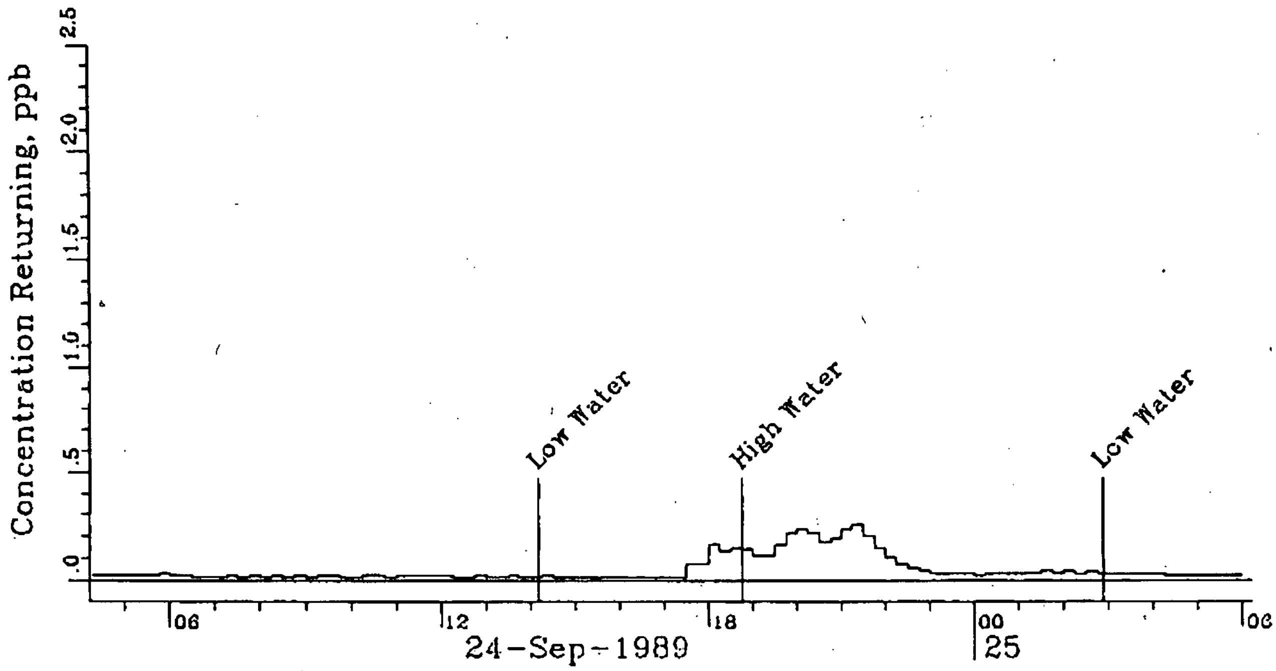


Figure 5

Tracer Returned To Unit 2 during Phase I
From Unit 3 route, 10 feet from discharge canal



Tracer Returned To Unit 3 during Phase I
From Unit 3 route, 10 feet from discharge canal

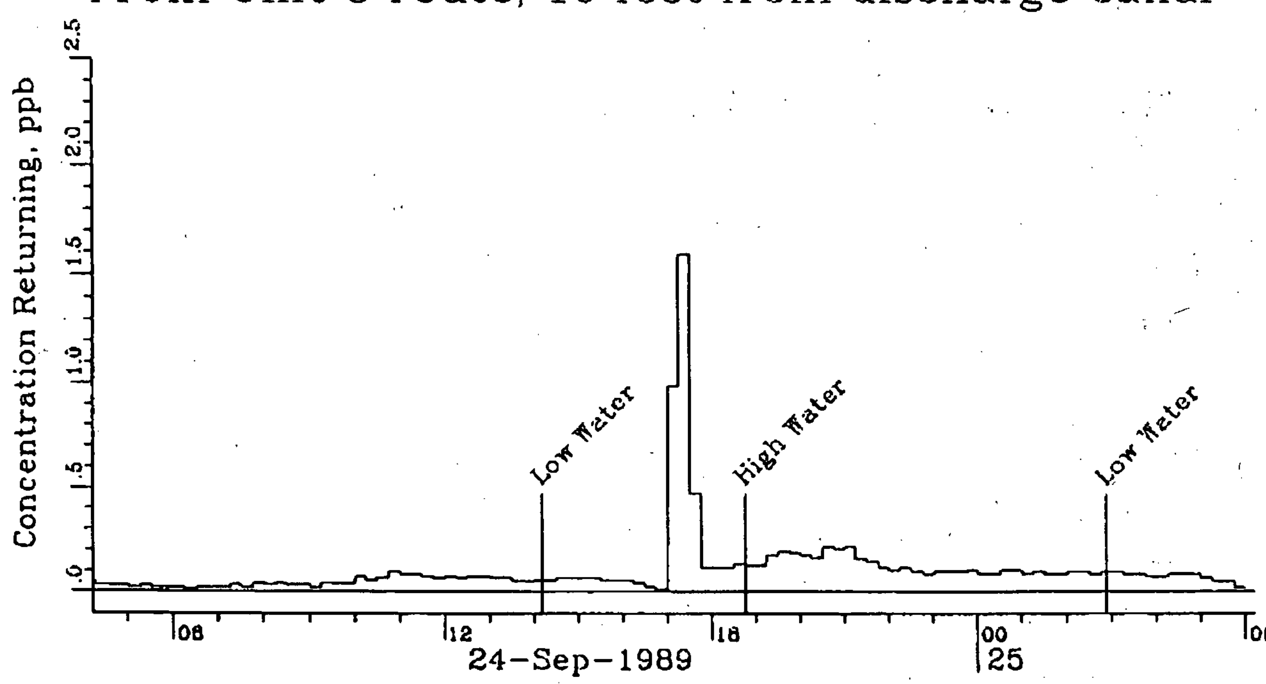
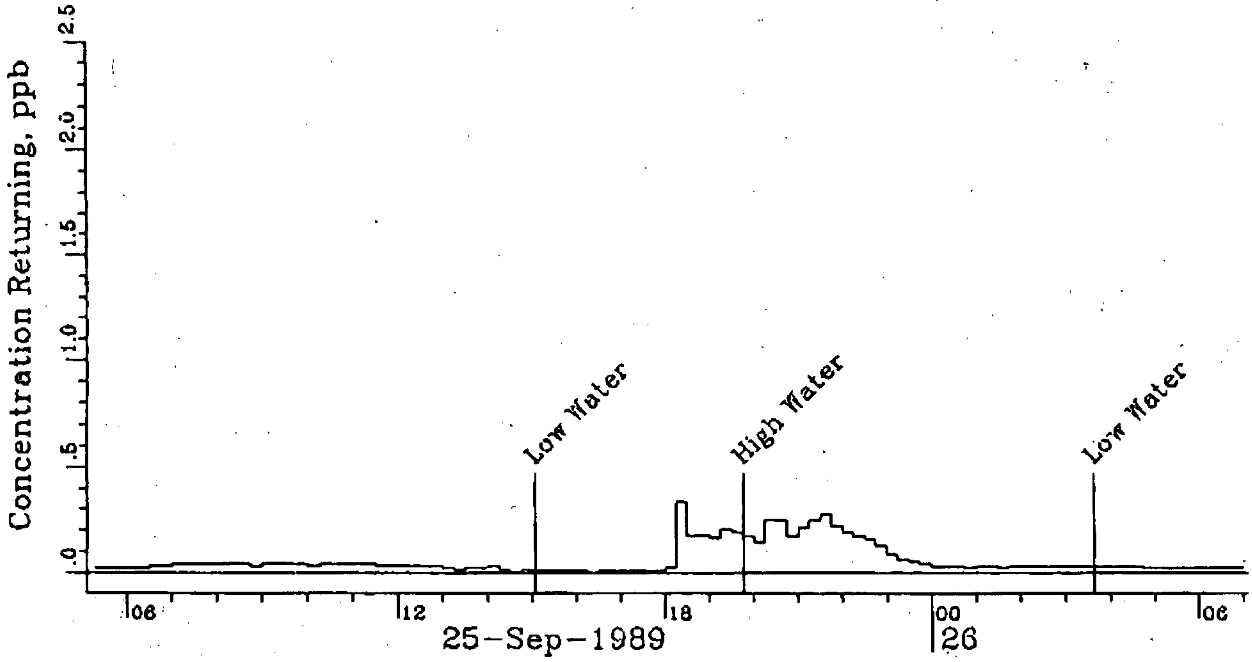


Figure 6

Tracer Returned To Unit 2 during Phase I
From Unit 3 route, 60 feet from discharge canal



Tracer Returned To Unit 3 during Phase I
From Unit 3 route, 60 feet from discharge canal

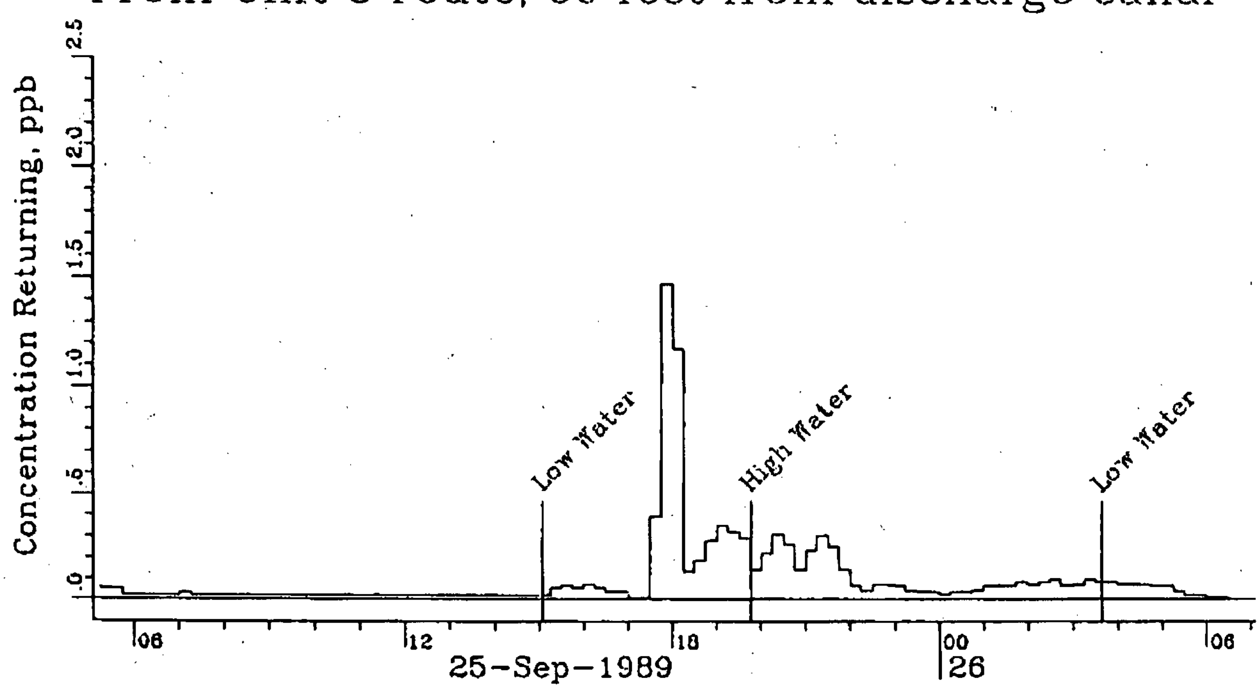
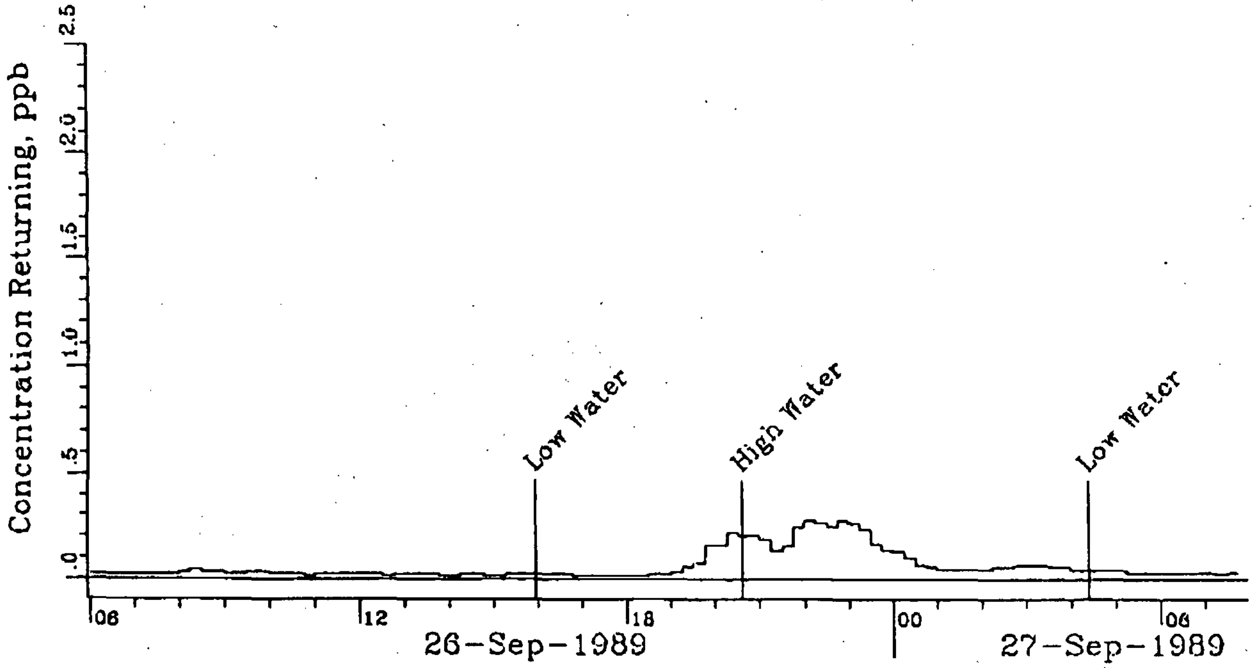


Figure 7

Tracer Returned To Unit 2 during Phase I
From Unit 3 route, 110 feet from discharge canal



Tracer Returned To Unit 3 during Phase I
From Unit 3 route, 110 feet from discharge canal

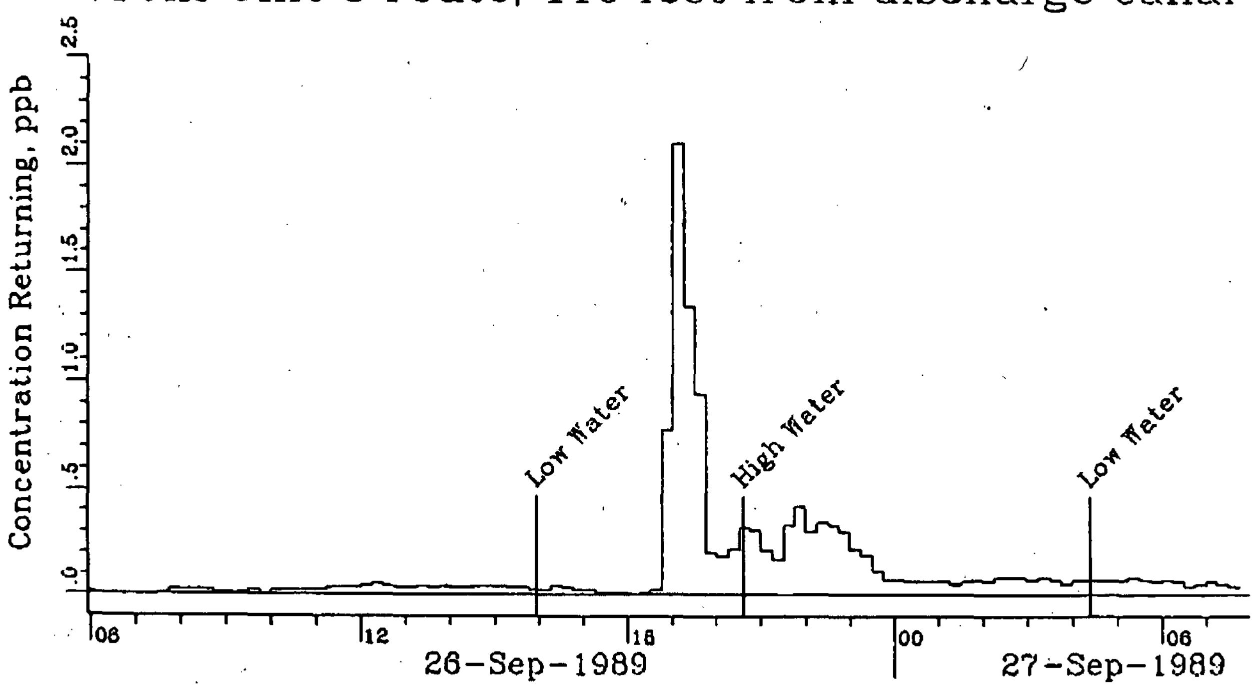
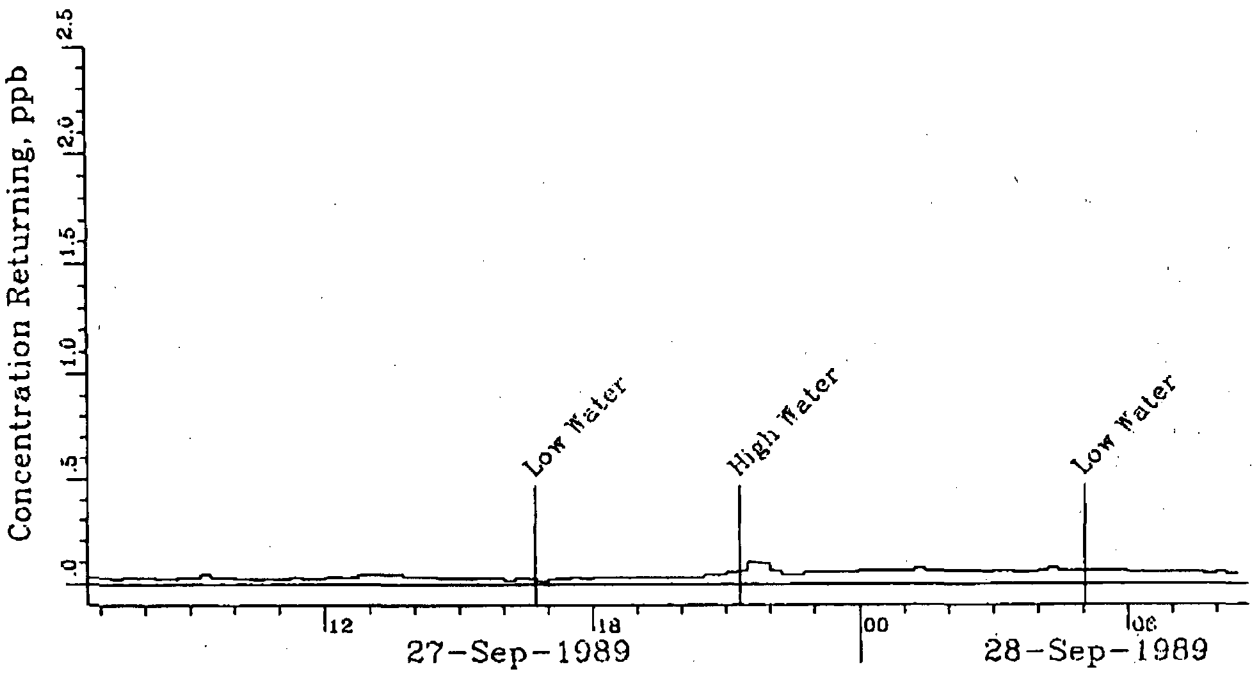


Figure 8

Tracer Returned To Unit 2 during Phase I
From Unit 3 alternate route



Tracer Returned To Unit 3 during Phase I
From Unit 3 alternate route

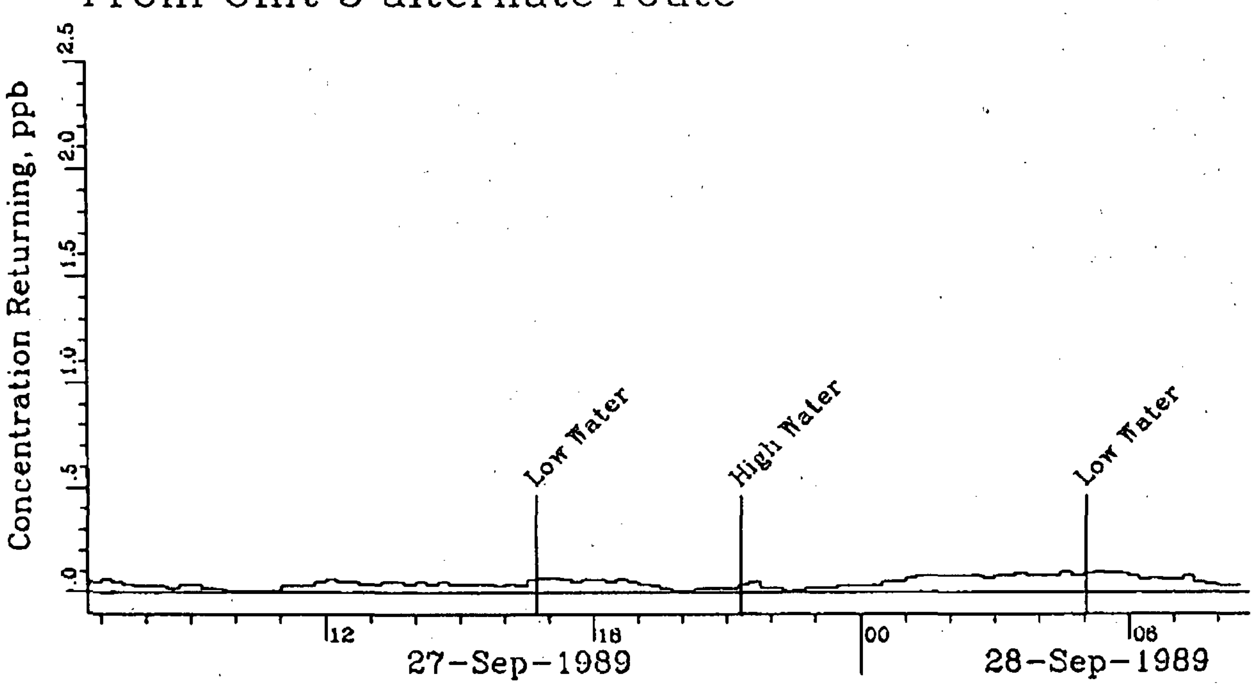
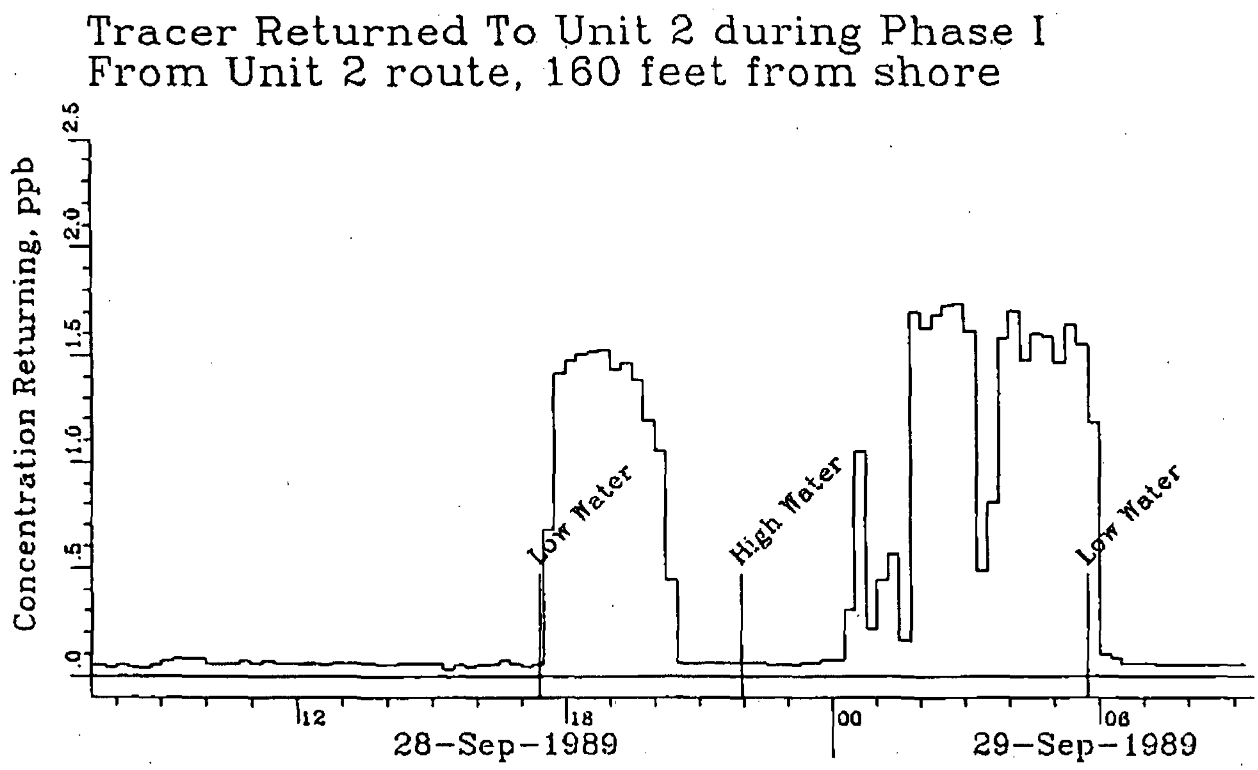
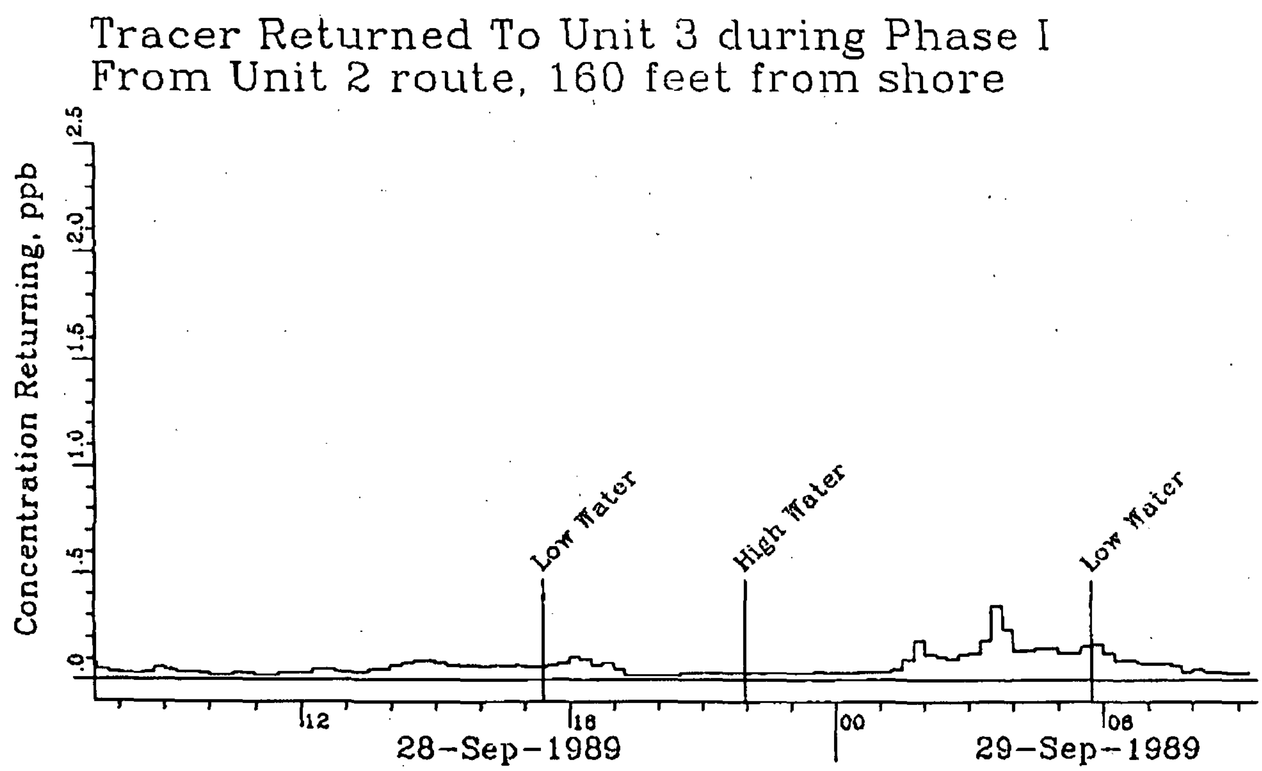


Figure 9



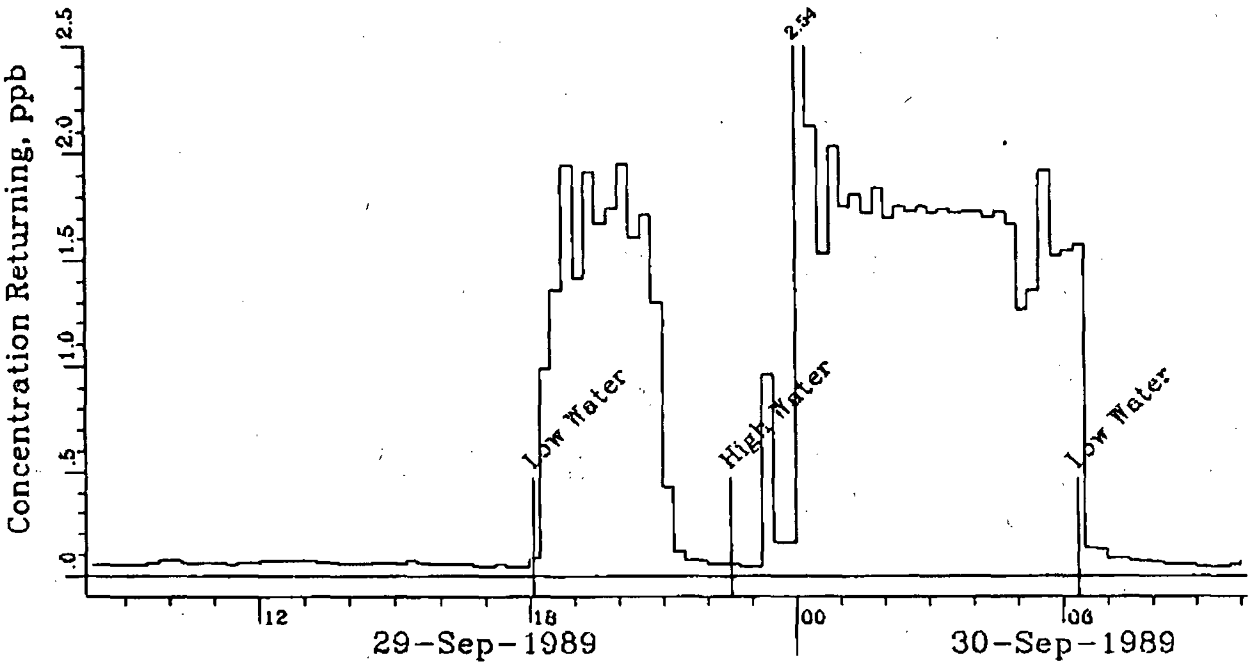
Tracer Returned To Unit 2 during Phase I
From Unit 2 route, 160 feet from shore
Concentration Returning, ppb
.0
.5
1.0
1.5
2.0
2.5
Low Water
High Water
Low Water
12
18
00
06
28-Sep-1989
29-Sep-1989



Tracer Returned To Unit 3 during Phase I
From Unit 2 route, 160 feet from shore
Concentration Returning, ppb
.0
.5
1.0
1.5
2.0
2.5
Low Water
High Water
Low Water
12
18
00
06
28-Sep-1989
29-Sep-1989

Figure 10

Tracer Returned To Unit 2 during Phase I
From Unit 2 route, 60 feet from shore



Tracer Returned To Unit 3 during Phase I
From Unit 2 route, 60 feet from shore

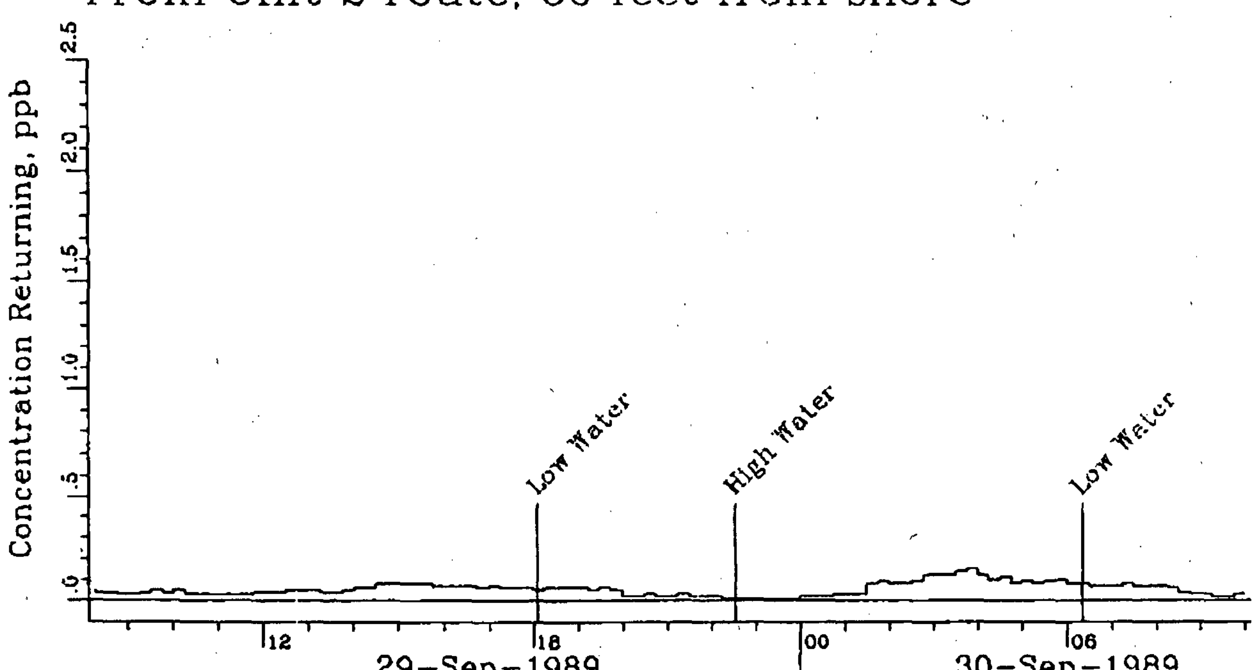
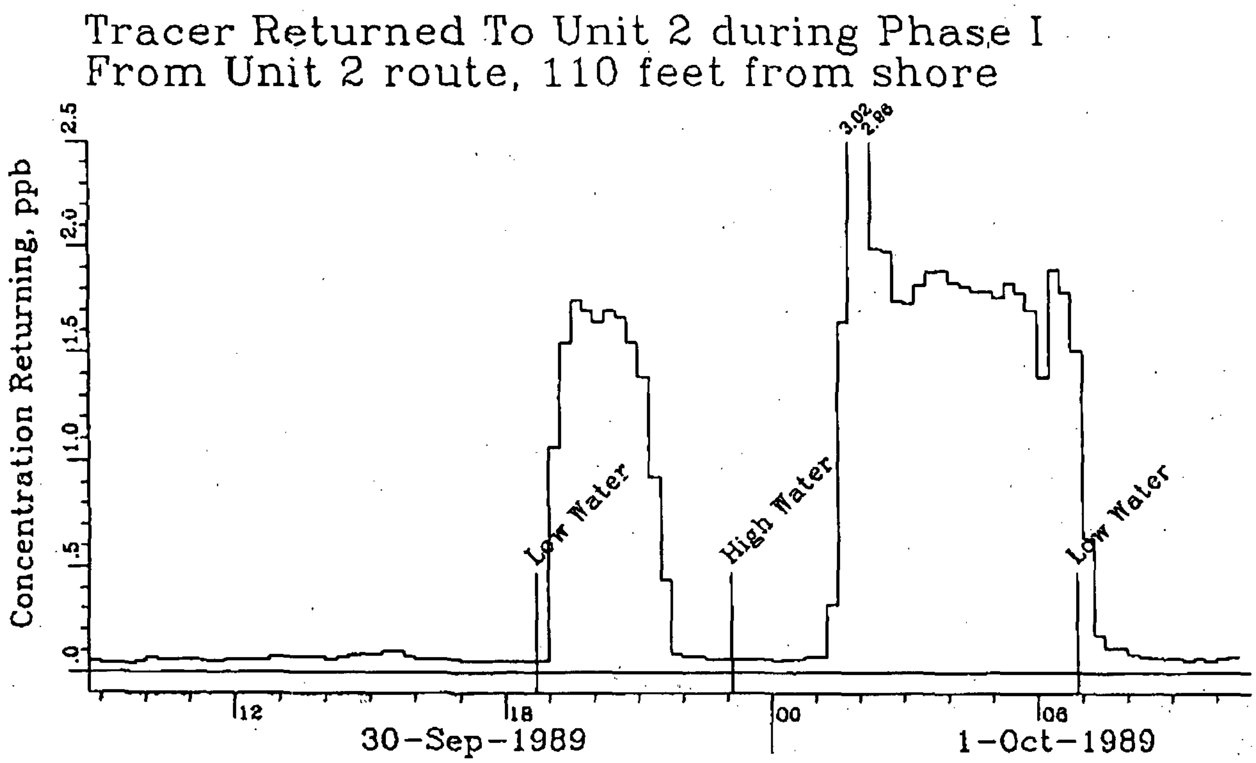
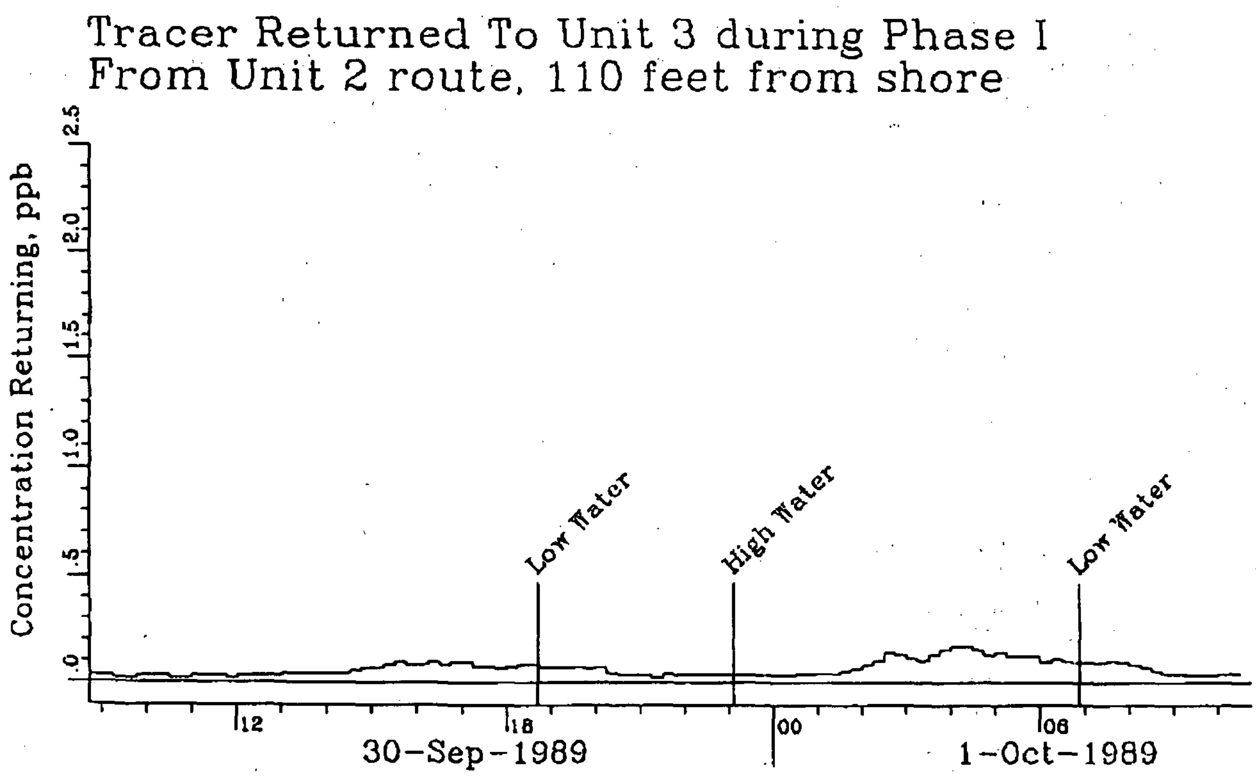


Figure 11



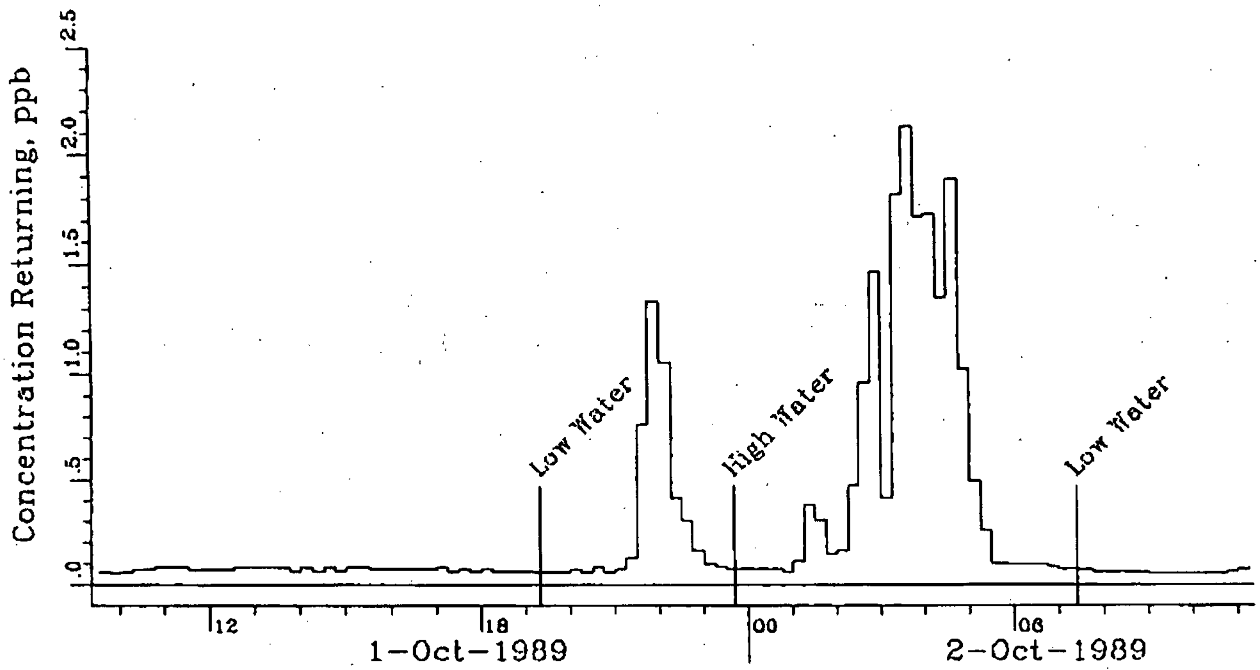
Tracer Returned To Unit 2 during Phase I
From Unit 2 route, 110 feet from shore
Concentration Returning, ppb
2.5
2.0
1.5
1.0
.5
.0
3.02
2.98
Low Water
High Water
Low Water
12
18
00
06
30-Sep-1989
1-Oct-1989



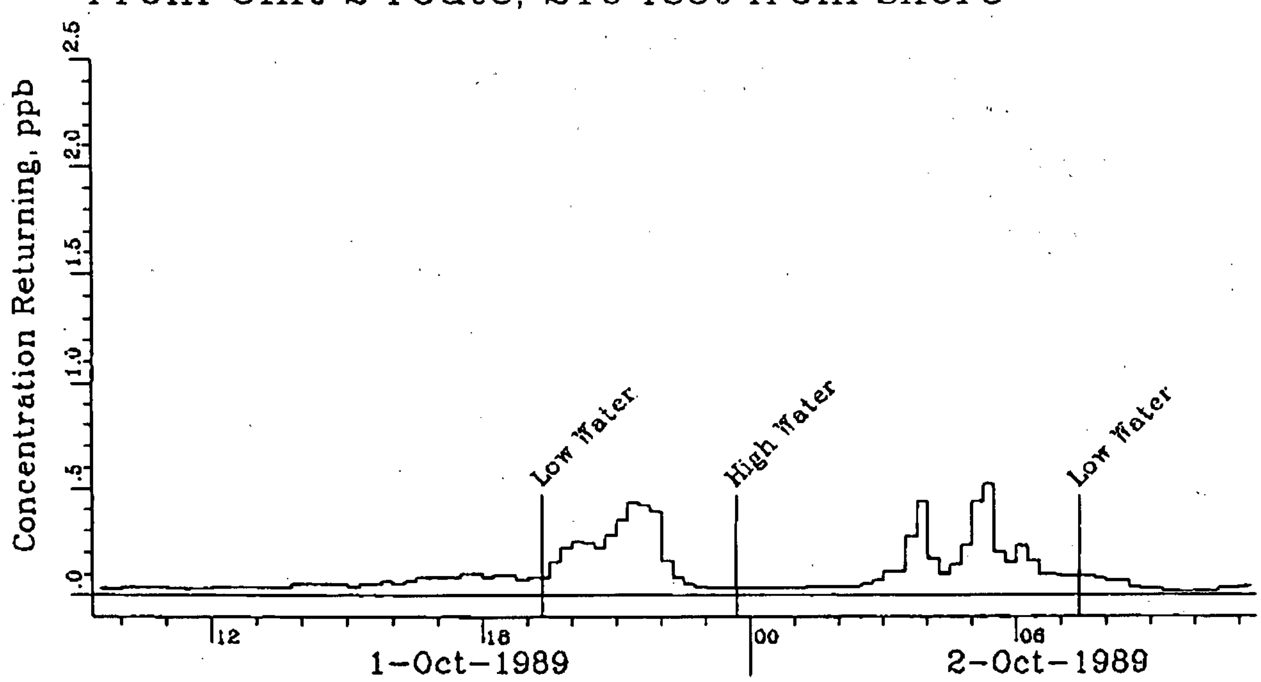
Tracer Returned To Unit 3 during Phase I
From Unit 2 route, 110 feet from shore
Concentration Returning, ppb
2.5
2.0
1.5
1.0
.5
.0
Low Water
High Water
Low Water
12
18
00
06
30-Sep-1989
1-Oct-1989

Figure 12

Tracer Returned To Unit 2 during Phase I
From Unit 2 route, 210 feet from shore

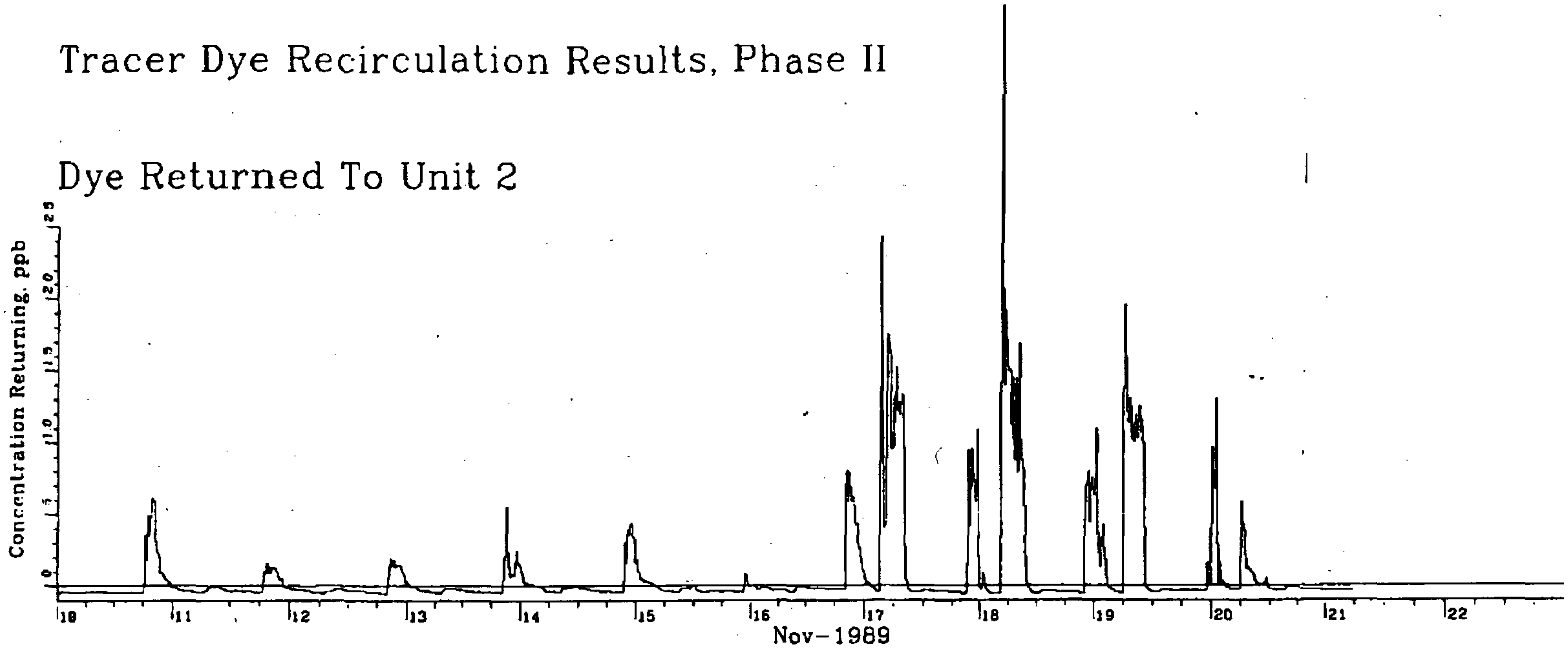


Tracer Returned To Unit 3 during Phase I
From Unit 2 route, 210 feet from shore



Tracer Dye Recirculation Results, Phase II

Dye Returned To Unit 2



Dye Returned To Unit 3

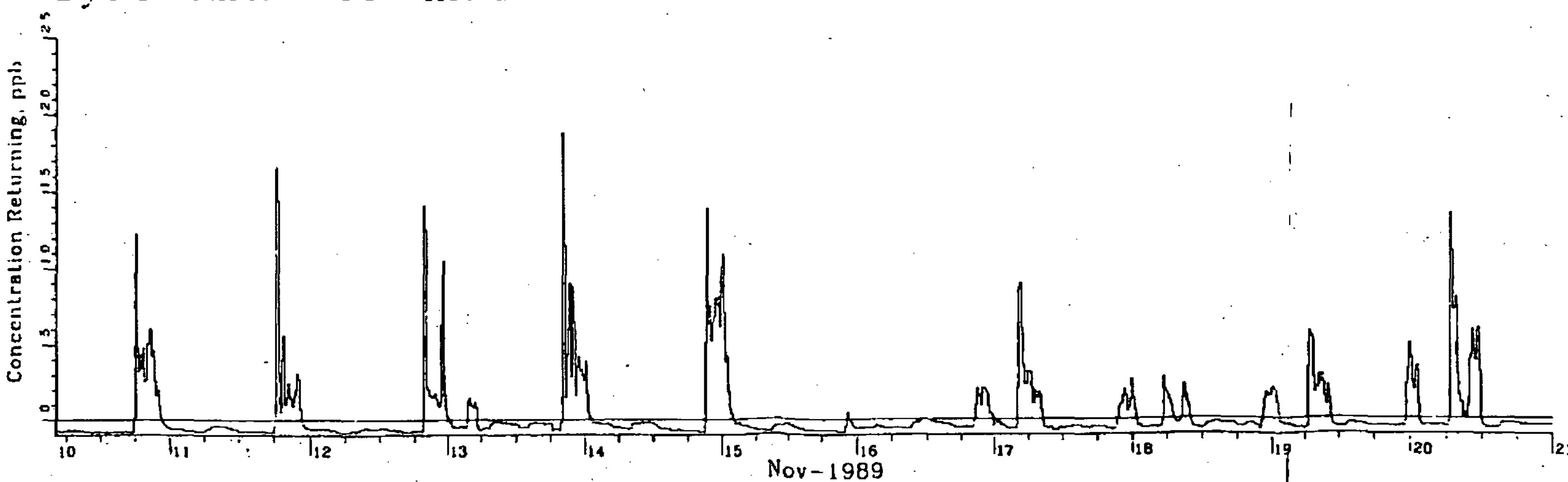
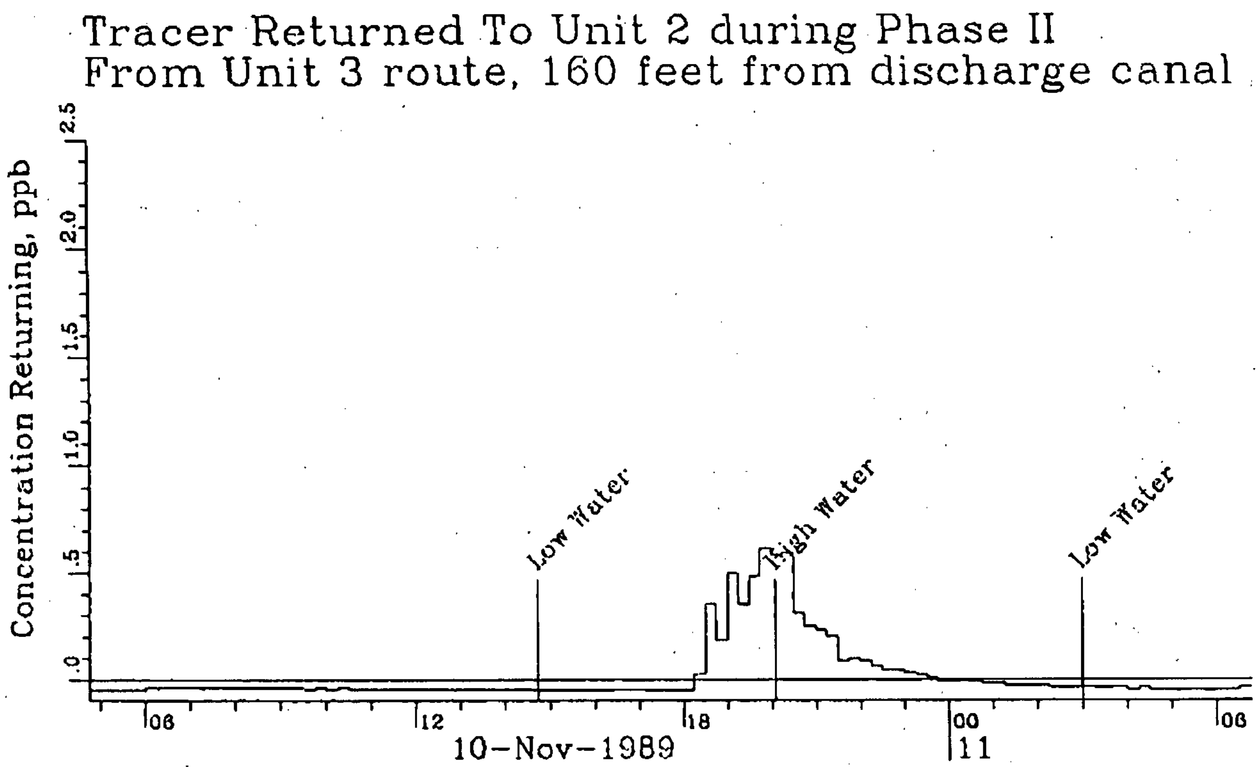
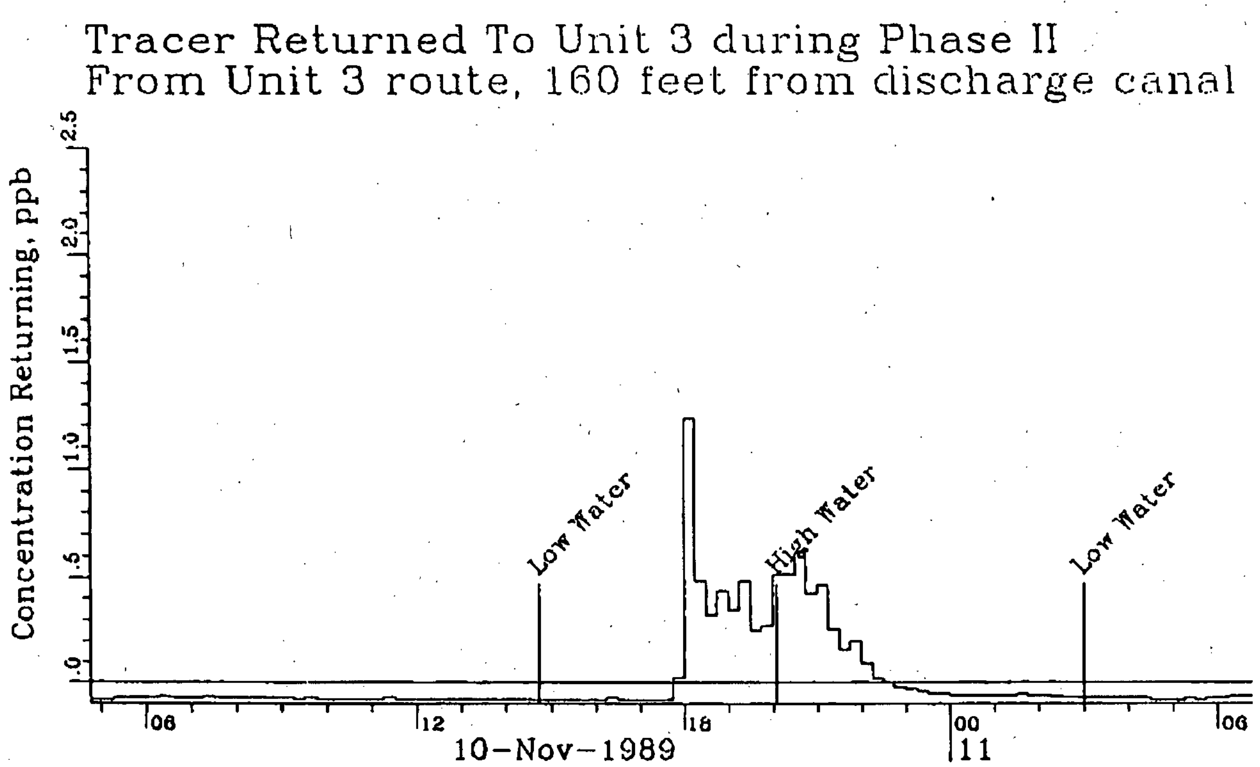


Figure 13

Figure 14

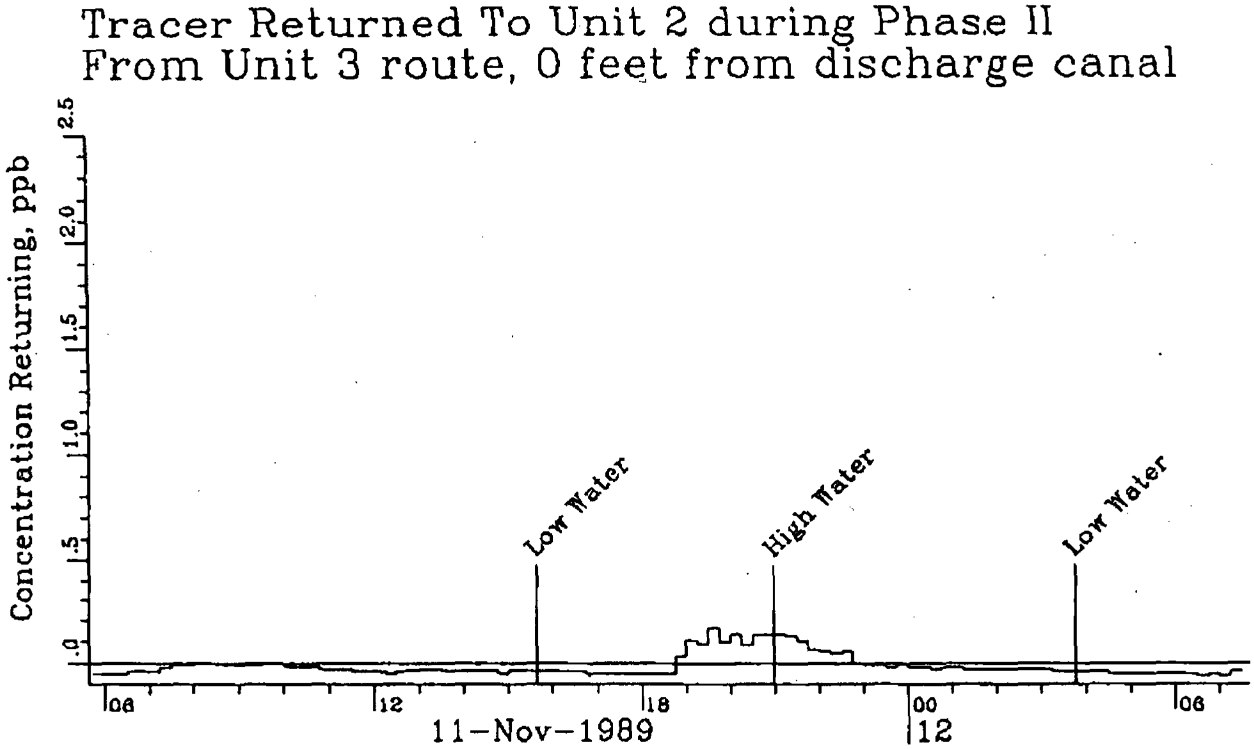


Tracer Returned To Unit 2 during Phase II
From Unit 3 route, 160 feet from discharge canal
Concentration Returning, ppb
.0
.5
1.0
1.5
2.0
2.5
Low Water
High Water
Low Water
06
12
18
00
06
10-Nov-1989
11

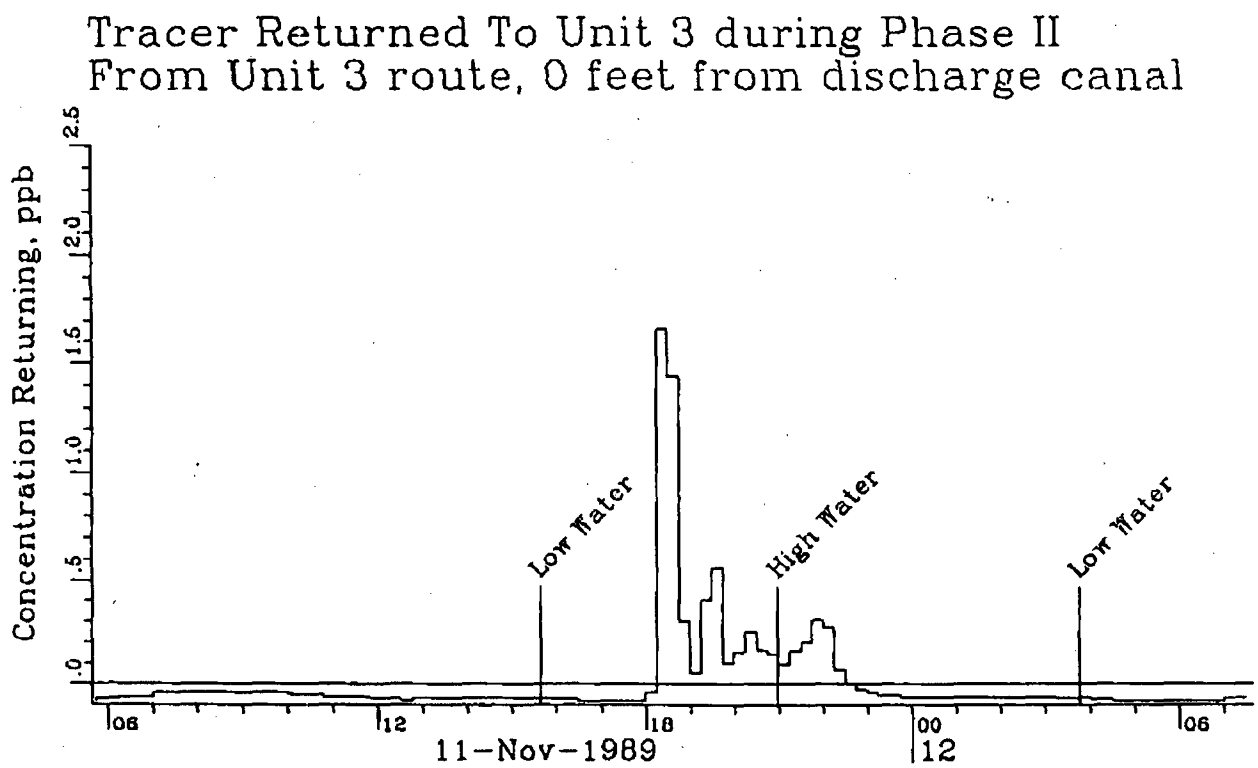


Tracer Returned To Unit 3 during Phase II
From Unit 3 route, 160 feet from discharge canal
Concentration Returning, ppb
.0
.5
1.0
1.5
2.0
2.5
Low Water
High Water
Low Water
06
12
18
00
06
10-Nov-1989
11

Figure 15



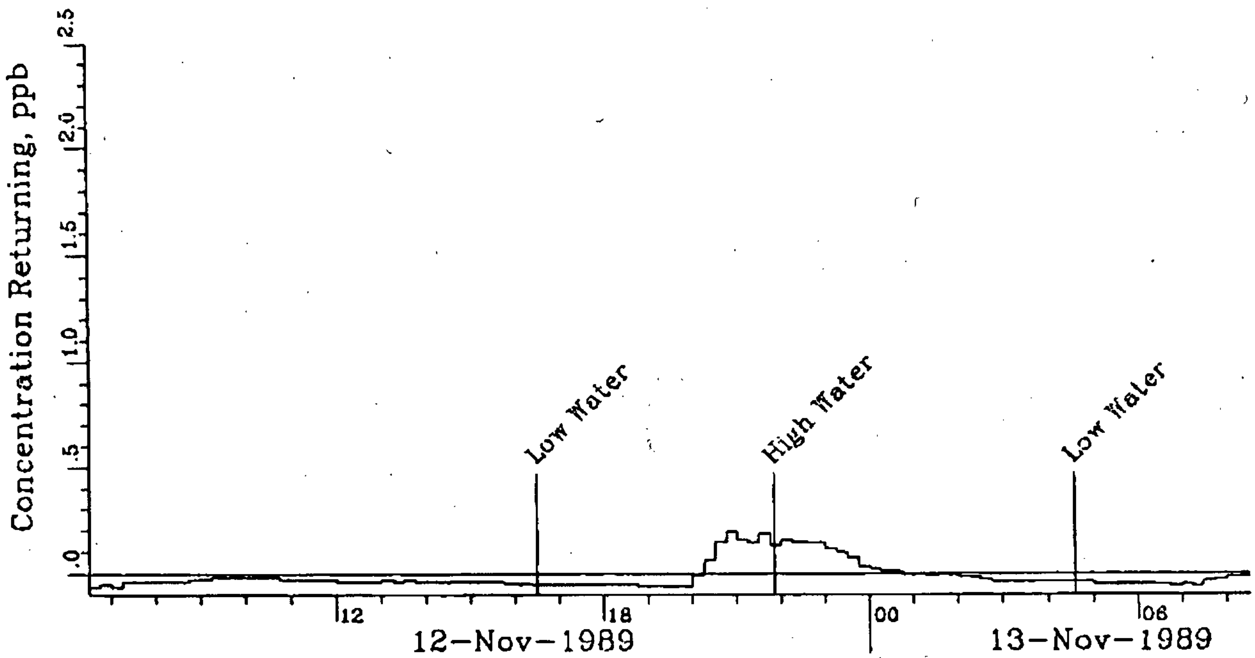
Tracer Returned To Unit 2 during Phase II
From Unit 3 route, 0 feet from discharge canal
Concentration Returning, ppb
2.5
2.0
1.5
1.0
.5
.0
Low Water
High Water
Low Water
06
12
18
00
06
11-Nov-1989
12



Tracer Returned To Unit 3 during Phase II
From Unit 3 route, 0 feet from discharge canal
Concentration Returning, ppb
2.5
2.0
1.5
1.0
.5
.0
Low Water
High Water
Low Water
06
12
18
00
06
11-Nov-1989
12

Figure 16

Tracer Returned To Unit 2 during Phase II
From Unit 3 route, 10 feet from discharge canal



Tracer Returned To Unit 3 during Phase II
From Unit 3 route, 10 feet from discharge canal

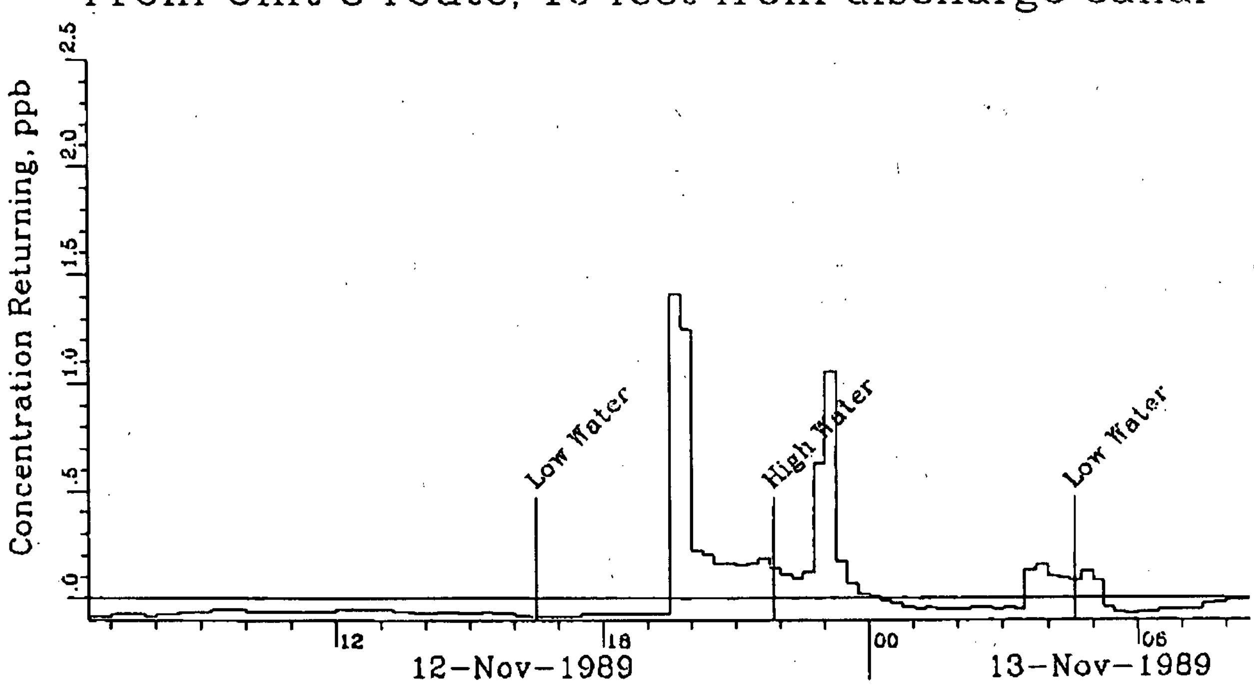
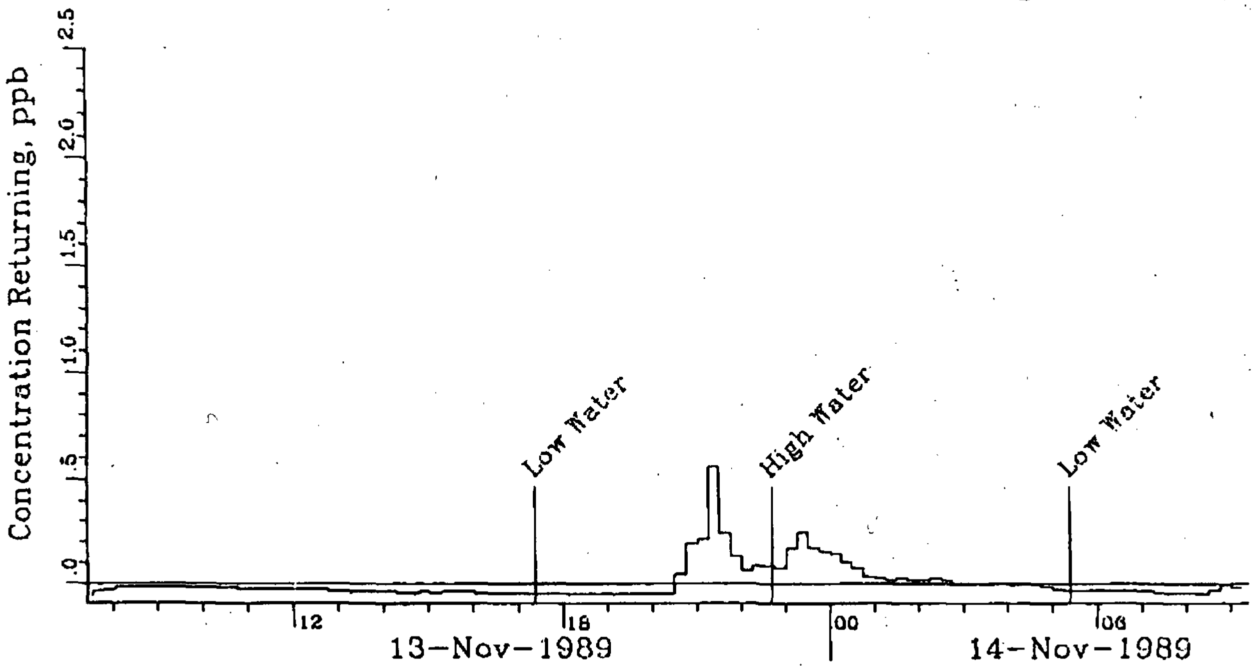


Figure 17

Tracer Returned To Unit 2 during Phase II
From Unit 3 route, 60 feet from discharge canal



Tracer Returned To Unit 3 during Phase II
From Unit 3 route, 60 feet from discharge canal

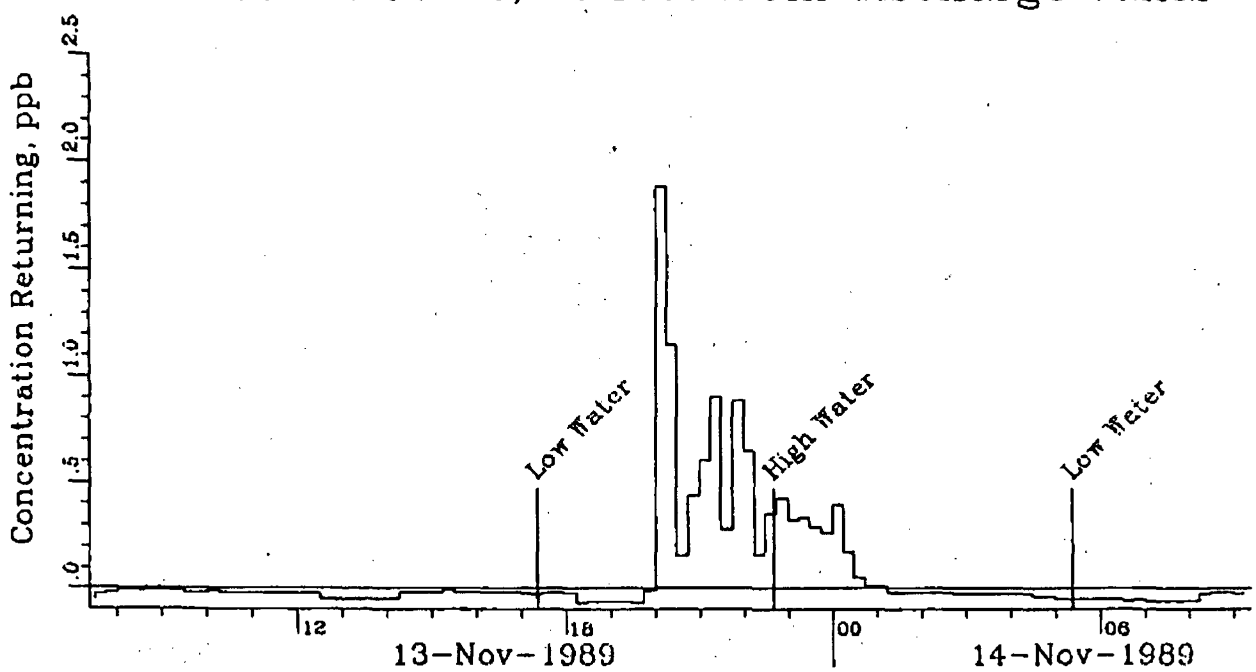
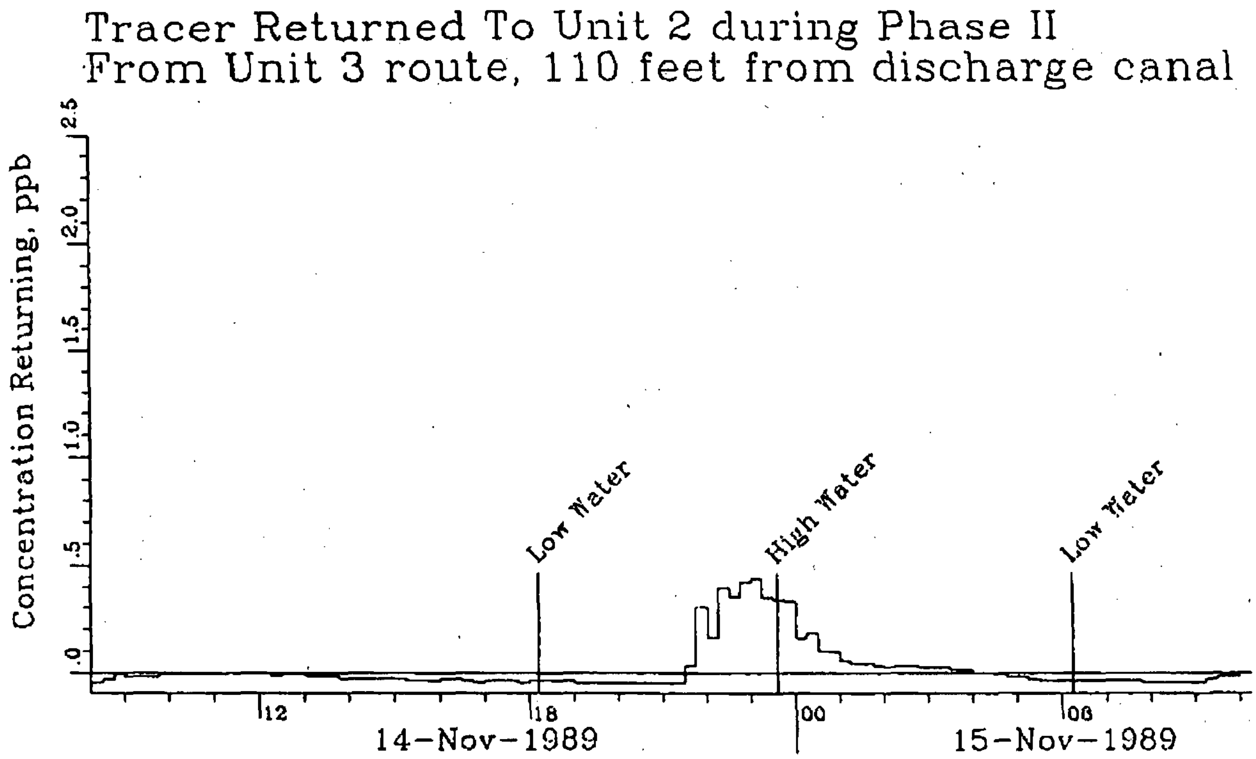


Figure 18


Tracer Returned To Unit 2 during Phase II
From Unit 3 route, 110 feet from discharge canal
Concentration Returning, ppb
.0
.5
1.0
1.5
2.0
2.5
Low Water
High Water
Low Water
12
18
00
06
14-Nov-1989
15-Nov-1989

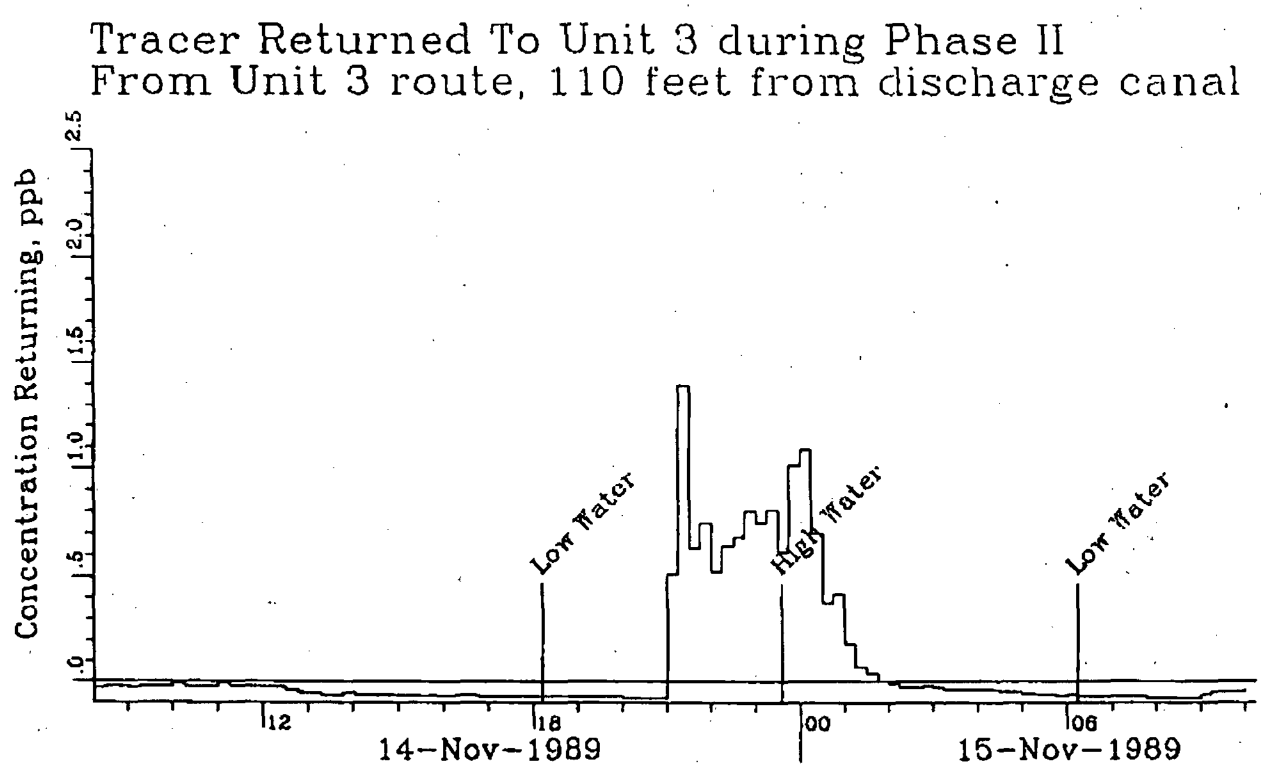
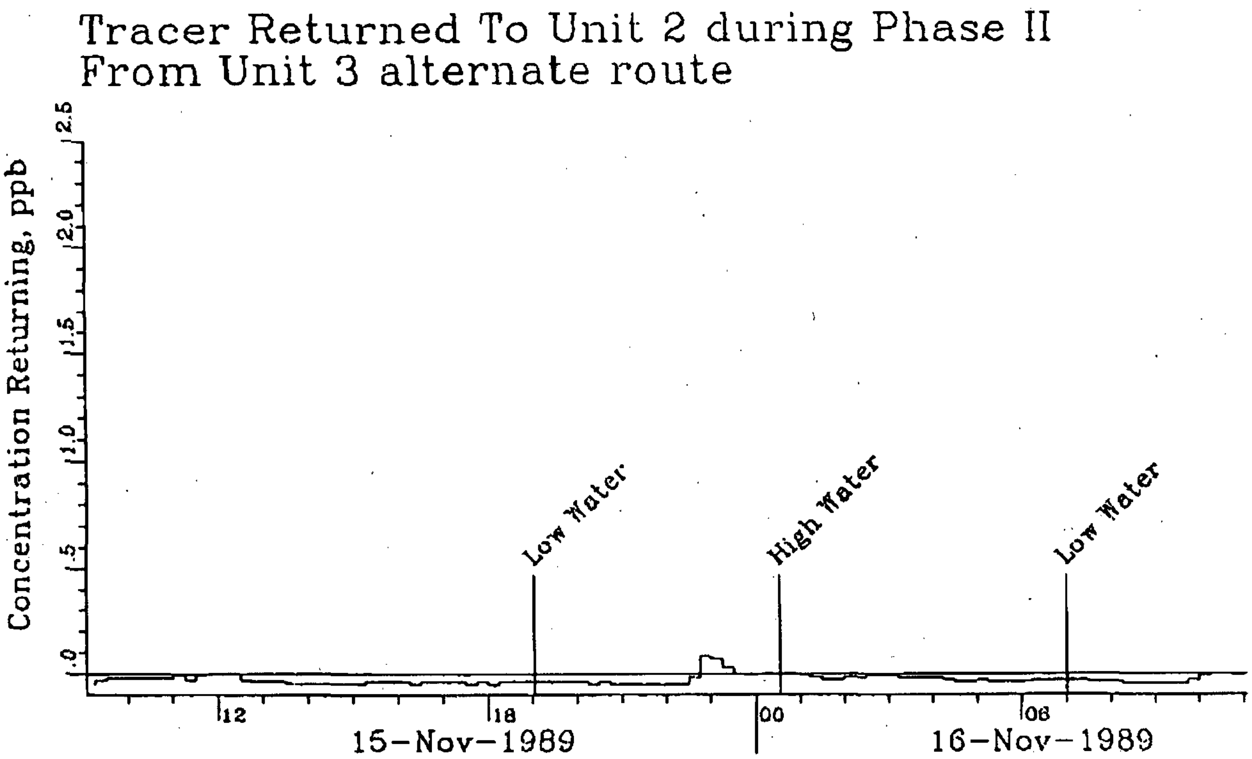
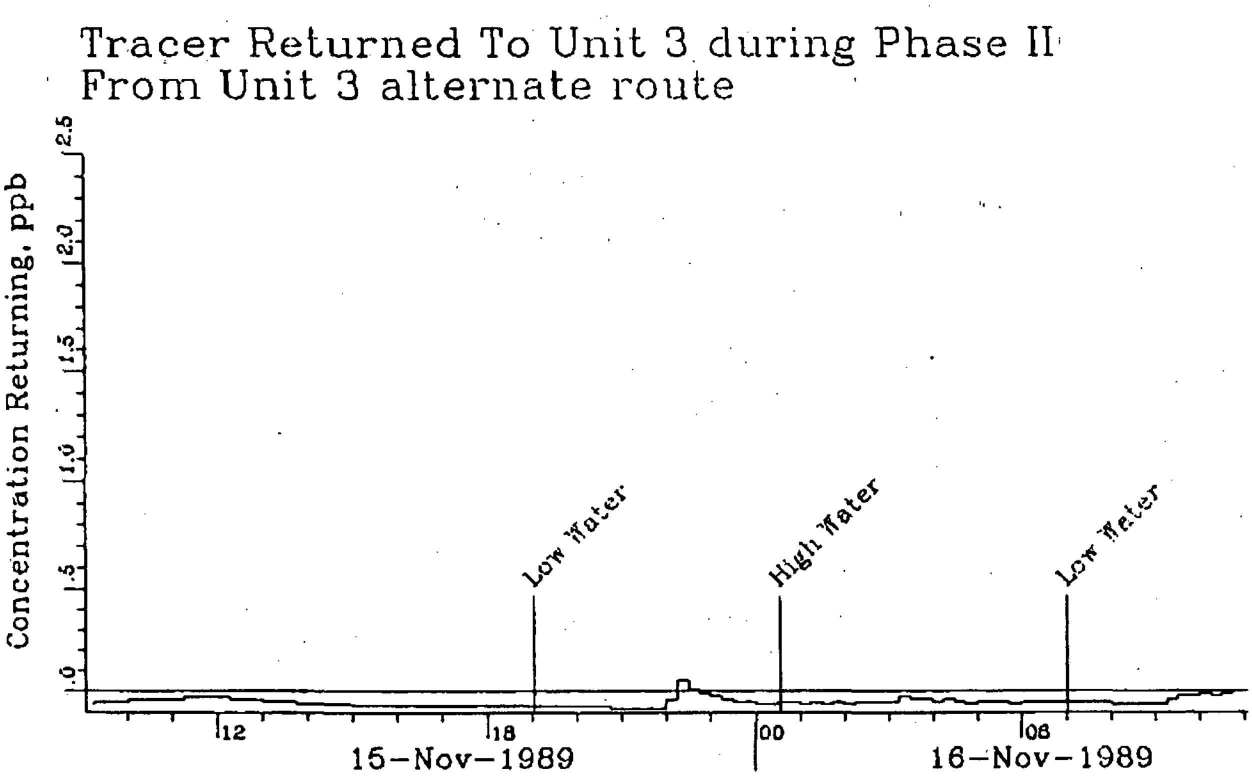

Tracer Returned To Unit 3 during Phase II
From Unit 3 route, 110 feet from discharge canal
Concentration Returning, ppb
.0
.5
1.0
1.5
2.0
2.5
Low Water
High Water
Low Water
12
18
00
06
14-Nov-1989
15-Nov-1989

Figure 19



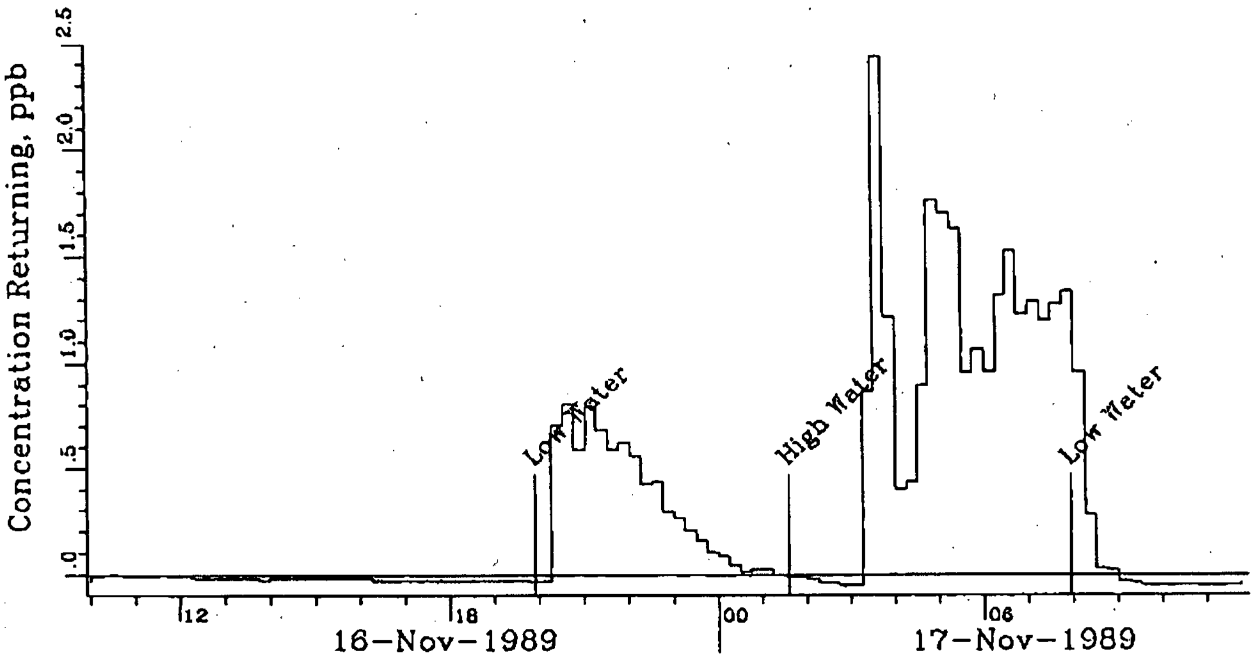
Tracer Returned To Unit 2 during Phase II
From Unit 3 alternate route
Concentration Returning, ppb
2.5
2.0
1.5
1.0
.5
.0
Low Water
High Water
Low Water
12
18
00
06
15-Nov-1989
16-Nov-1989



Tracer Returned To Unit 3 during Phase II
From Unit 3 alternate route
Concentration Returning, ppb
2.5
2.0
1.5
1.0
.5
.0
Low Water
High Water
Low Water
12
18
00
06
15-Nov-1989
16-Nov-1989

Figure 20

Tracer Returned To Unit 2 during Phase II
From Unit 2 route, 160 feet from shore



Tracer Returned To Unit 3 during Phase II
From Unit 2 route, 160 feet from shore

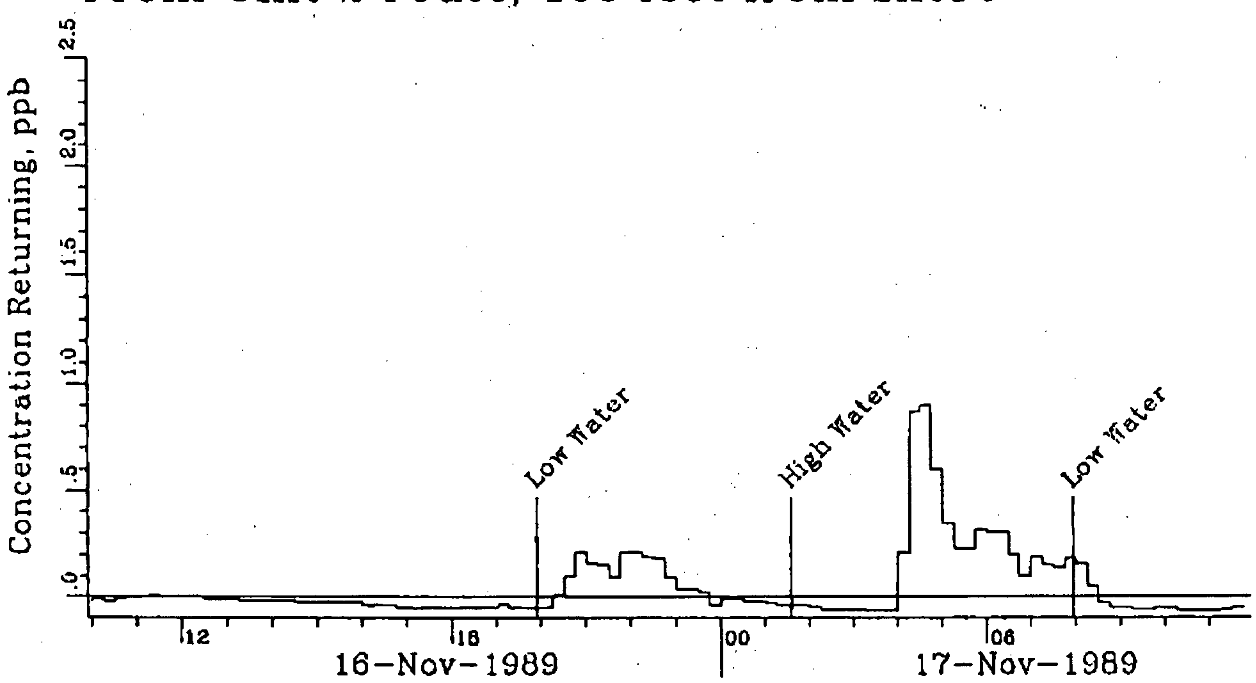
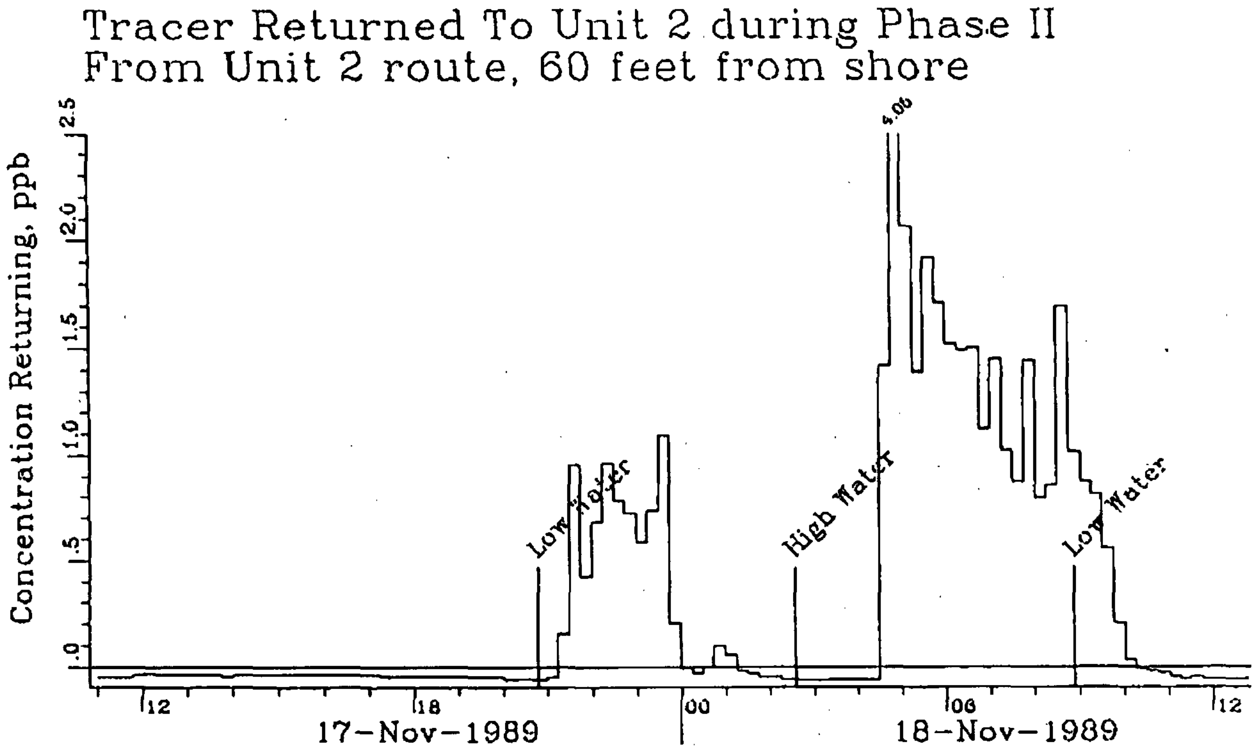
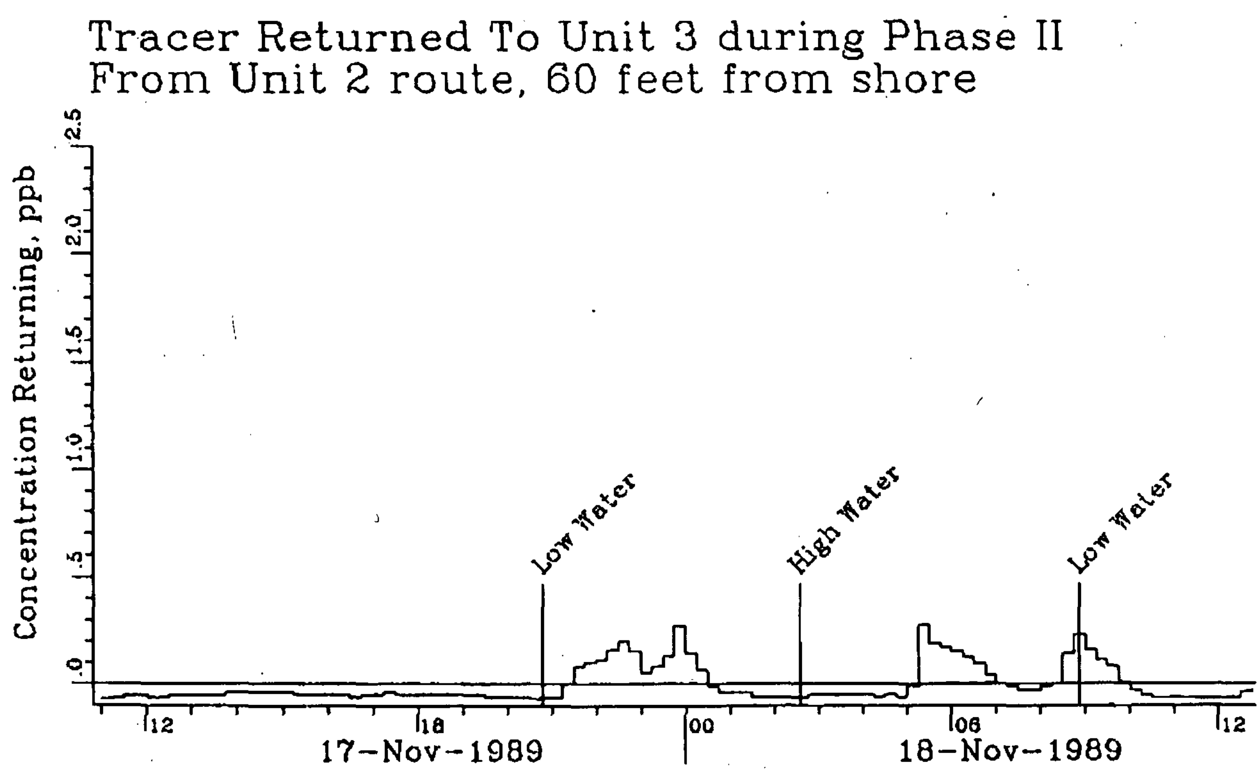


Figure 21



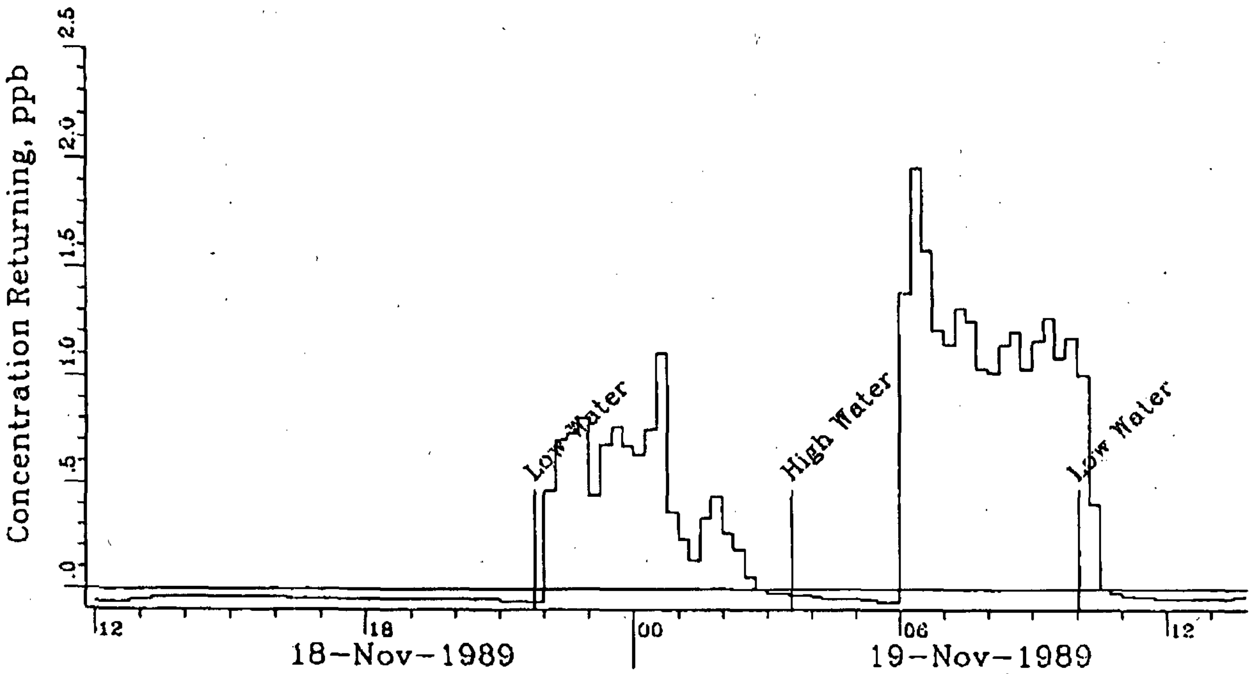
Tracer Returned To Unit 2 during Phase II
From Unit 2 route, 60 feet from shore
Concentration Returning, ppb
0.
.5
1.0
1.5
2.0
2.5
4.06
Low Water
High Water
Low Water
12
18
00
06
12
17-Nov-1989
18-Nov-1989



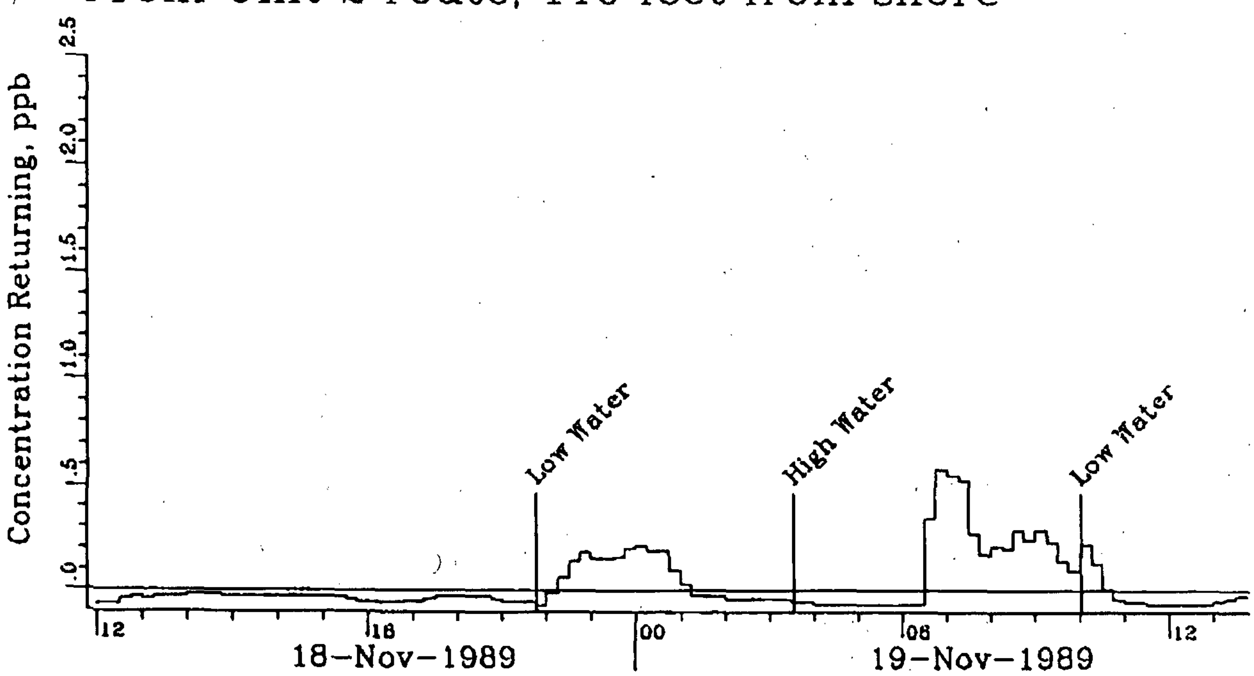
Tracer Returned To Unit 3 during Phase II
From Unit 2 route, 60 feet from shore
Concentration Returning, ppb
0.
.5
1.0
1.5
2.0
2.5
Low Water
High Water
Low Water
12
18
00
06
12
17-Nov-1989
18-Nov-1989

Figure 22

Tracer Returned To Unit 2 during Phase II
From Unit 2 route, 110 feet from shore



Tracer Returned To Unit 3 during Phase II
From Unit 2 route, 110 feet from shore



BIOLOGICAL EVALUATION OF A RISTROPH SCREEN AT INDIAN POINT UNIT 2

Prepared by:
Office of Environmental Affairs
Consolidated Edison Company of New York, Inc.

(June 1985)

EXECUTIVE SUMMARY

Con Edison commenced a study of the mechanical and biological effectiveness of a Ristroph-modified vertical travelling screen installed in one intake forebay at Indian Point Unit 2 in January 1985. This study was performed pursuant to the agreement of the parties to the Hudson River Settlement Agreement reached at a meeting held on September 12, 1984. The purpose of the study was to evaluate the efficacy of installing such screens at all intakes of the Indian Point facility in furtherance of the parties' obligations under Section 2.F.3 of the Settlement Agreement. The biological part of the study was conducted by Normandeau Associates of Bedford, New Hampshire under contract to Con Edison, using funds provided for in Section 2.F of the Agreement. Company personnel were closely involved in all phases of the study.

The specific objectives of the biological studies were to evaluate the post-impingement survival of fish, and determine whether installing the screens inside the intake forebay would increase the number of fish impinged relative to the numbers impinged on a screen installed at the intake bay entrance. Installation of the screens at the present, slightly recessed position could be accomplished much more rapidly and at lower cost than installation at the entrance to the intakes.

Studies began on January 16, 1985, the day after installation of the screen was completed (January 15, 1985). Data collection continued through April 19, 1985. The effectiveness of a Ristroph screen in reducing the numbers of fish killed by impingement was evaluated by determining the percentage of impinged fish which survived for up to 96 hours after collection from the screen. At the time of initial collection, fish were categorized as live (and undamaged), damaged (but alive) and dead. Live fish (both damaged and undamaged) were then

transferred to aquaria and observed for 96 hours after which they were again classified as alive, damaged or dead.

Survival was calculated by three different methods which differed only in whether fish in the damaged category were considered to be alive or dead. In the method ordinarily used to report results of studies such as these, fish disoriented or showing evidence of trauma are considered to be survivors if they are alive after an extended holding period. In an extremely conservative approach fish which show any evidence of damage, even brief disorientation, are considered to be dead. An intermediately conservative approach assumes that only those fish which continue to show evidence of damage after 96 hours would be likely to die. Since most fish which were damaged at the time of collection either died or were fully recovered after 96 hours, few differences exist between estimates based on the standard and the intermediately conservative approaches.

The results of the survival tests demonstrated that Ristroph-modified screens will substantially reduce the numbers of fish killed by impingement at Indian Point. Ten species of fish were collected in adequate numbers to evaluate survival. Survival ranged from approximately 11% (alewife) to 100% (tesselated darter) after 96 hours when derived by the standard method, and from 0% (red hake) to 100% (tesselated darter) when derived by the most conservative method. For seven of the ten species survival exceeded 70% when calculated by the standard method; four of ten exceeded 70% when calculated by the most conservative method.

In a report prepared by Con Edison and the Power Authority in August 1984, survival rates which could be expected if Ristroph screens were installed were projected for the 10 species impinged in greatest numbers at Indian Point. Of those, five were evaluated during these studies. The results obtained for those five species during the period January through April are consistent with achieving the levels of annual survival that were projected for them. For white perch, striped bass and rainbow smelt a substantial proportion of the total annual impingement occurs during the period January through April, and the survival rates derived from the intermediately conservative method of 66.1%, 68.6% and 85.7%, respectively, can be compared with the projected survival rates for them for this period of approximately 58%, 61% and 40%, respectively. For alewife and Atlantic tomcod, less than 1% of the total annual impingement occurs from January through April, and the survival rates attained during this period have little influence on the annual projections.

Conditions of this study precluded any attempts to optimize screen operating characteristics to maximize survival. Improvements in survival rates over those observed during this study can be achieved by modifying settings and operating conditions for the low pressure spray wash system, screen travel speeds and the fish sluice flap seal.

In order to determine whether more fish would be impinged if the Ristroph screens were installed inside the intake bays rather than across the entrance, comparisons were made between the rates of fish impingement (fish/hr) on the Ristroph screen and rates of fish impingement on a fixed (nonrotating) screen installed at the entrance to the same forebay. On alternate days the fixed screen was either lowered into position across the entrance to the bay or blocked up out of the water to allow fish to move freely into and out of the bay. On those days when the fixed screen was lowered fish were impinged on it; on days when the fixed screen was up fish were impinged on the Ristroph screen. Fish impinged on the fixed screen were generally collected twice during the 24 hour period, once at the midway point and once at the end. Fish were collected by raising the screen and washing the fish and debris off with a high pressure spray. Fish and debris which fell back into the water were carried into the forebay by the flow of waters into the intake and subsequently collected from the Ristroph screen. Fish impinged on the continuously rotating Ristroph screen were collected more frequently but on a schedule which made it possible to assign them to a 12 hour impingement period. Since not all of the fish impinged on either the fixed or Ristroph screens were successfully collected and the efficiency with which fish were collected differed between screens, marked dead fish were periodically released in front of the screens to provide a basis for adjusting the numbers of fish collected to better reflect the numbers actually impinged.

Although more fish were collected from the Ristroph screen than from the fixed screen, the difference cannot be attributed solely to the difference in their position. Biases in the sampling procedures and the probability that the efficiency with which fish were collected from the Ristroph screen was underestimated probably account for much of the difference. When adjustments were made to account for the maximum possible influence of these factors, differences become statistically insignificant. However, the validity of the assumptions upon which these adjustments were based, remains to be confirmed.

TABLE OF CONTENTS

Section 1

INTRODUCTION

In August 1984, Con Edison and NYPA issued a report entitled "Evaluation of Alternatives to Angled Screens for Mitigation of Fish Impingement at Indian Point," which was prepared at the request of the Parties to the December 1980 Hudson River Settlement Agreement. That report concluded that among the alternatives to angled screens which were considered (Ristroph screens, horizontal traveling screens, fish diversion systems, and cylindrical wedge wire screens), only Ristroph modified screens had been proven to provide effective mitigation of impingement and acceptable operating performance under environmental and operating conditions similar to those at Indian Point. The report noted that over 140 Ristroph-type screens had been installed at 30 water intake facilities, and they had been approved by U.S.E.P.A. as best available technology for fish protection at 24 of the installations.

Results of fish survival studies at five east coast generating stations at which Ristroph-modified screens were tested (Salem Nuclear Station, Danskammer Point Generating Station, Mystic Generating Station, Surry Nuclear Station and Indian Point Unit 1 Generating Station) were reviewed and utilized to project fish survival rates that might be achieved should these type of screens be installed at Indian Point (Table 1-1). The report concluded that if state-of-the-art Ristroph screens were installed at Indian Point, 50% or more of the fish impinged could be expected to be returned alive to the Hudson River.

At a September 12, 1984 meeting, the Settlement Parties agreed that Ristroph traveling screens were the most viable impingement mitigation alternative available, and approved Con

Edison's plans to install and test the mechanical reliability of one Ristroph modified traveling screen at Indian Point Unit 2 (IP 2) during the winter of 1985. The Parties requested that during the course of the mechanical evaluation, studies be conducted to confirm that survival rates for impinged fish on the order projected in the August report could be achieved and, to determine whether more fish would be impinged on Ristroph screens if they were recessed within the intake bay rather than installed at the entrance to the intake. Con Edison was asked to report on the results of the survival and screen position tests and the assessment of the screen system's mechanical acceptability by June 1985.

A study plan was prepared and reviewed with representatives of NYSDEC, U.S.E.P.A., and the Hudson River Fishermen's Association. Screen installation was completed on January 15, 1985. Studies began at IP 2 on January 16 and continued through April 19, 1985. Studies were coordinated with the routine impingement monitoring program that has been conducted at the Station since the mid-1970's. The survival of six fish species (white perch, striped bass, rainbow smelt, white catfish, spottail shiner and Atlantic tomcod) commonly found in impingement collections at Indian Point during previous winters (Normandeau Associates 1984a; Con Edison and NYPA 1983; Con Edison and PASNY 1982a, 1982b; Texas Instruments 1974, 1975, 1976, 1977, 1979, 1980a, 1980b) was to be specifically examined. The survival of any other fish collected in adequate numbers was also to be evaluated.

This report, which is divided into four sections, provides the results of these studies. Section 2 provides a description of the test facility, the sampling design, and field and laboratory procedures used; sections 3 and 4 contain the results of the survival and screen location studies, respectively.

Table 1-1. Projected Survival Rates (Extended) of Selected Fish Species Collected From Ristroph Modified Traveling Screens (Con Edison and NYPA, 1984).

Species	Projected Survival Rate (Indian Point 2)
White perch	71%
Atlantic tomcod	40%
Blueback herring	23%
Bay anchovy	10%
Striped bass	61%
American shad	25%
Hogchoker	95%
Weakfish	35%
Alewife	13%
Rainbow smelt	30%

Section 2

TEST FACILITY, SAMPLING DESIGN AND GENERAL PROCEDURES

Intake Configuration

IP 2 has six intake bays (numbered 21-26) through which river water is withdrawn for its once-through cooling system. The standard screening associated with each consists of a 3/8 inch square mesh fixed screen, flush-mounted at the entrance, a bar rack (3 inch opening) near the fixed screen, and a conventional traveling screen positioned about 25 feet inside the entrance (Figure 2-1). Under normal pumping conditions, fish and debris become impinged upon the fixed screens, which are periodically raised and cleaned with a high pressure spray wash system. When the fixed screen is raised, the wash contents are carried into the intake to the traveling screens, which subsequently convey it to a collection pit.

During the test period, the circulating water pump at intake bay 26 was generally operated at 60% of full flow or 84,000 gpm, which is the normal operating procedure for the months during which the study took place. The 60% flow rate through the intake bay created a cross-sectional approach velocity to the traveling screen of approximately 0.5 fps. At full flow, the approach velocity averages approximately 0.9 fps, based on field measurements obtained during July, 1984 (Alden Research Laboratory, 1984).

Intake 26 was modified by installing a continuously operating Ristroph-modified traveling screen in place of the conventional traveling screens which are employed at intakes 21-25. The Ristroph screen was installed at intake bay 26 because of its immediate proximity to debris collection pits and available space for placement of fish collection facilities. In addition, the end bays (21 and 26) at the intake structure historically had accounted for greater numbers of fish than had the more centrally located bays, and it was statistically desirable to base the analyses on the maximum number of fish that any one intake bay could obtain.

There were three locations considered for placement of the Ristroph screen: at the entrance to the bay, at the existing bar rack location, or at the location of the conventional traveling screen. In order to install the screen at the intake entrance, substantial structural modifications and a potentially lengthy permitting process would have been required. Installation at the position of the existing traveling screen was considered inappropriate because intake water flow patterns caused by structures associated with the new circulating water pumps created a flow of water back toward the river at the surface. It was believed that this flow, moving outward through the screen, might dislodge some fish and debris which would then not be collected and removed from the intake. Based on these considerations the existing bar rack location, at which only minor structural changes were required, was selected. Placement of the Ristroph screen at this location resulted in the screen face being located approximately 11 feet inside the intake.

In addition to the Ristroph screen, a specially designed coarse screen bar rack (½" bars spaced on 3½" centers) and a new fixed screen were installed at the entrance of intake bay 26 to accommodate the biological studies. The bar rack was approximately one foot riverward of the fixed screen and provided protection from river ice and other heavy floating debris when the fixed screen was not in place.

The new fixed screen consisted of two panels 14 feet wide and 17 feet high, unlike the single panel used at the other intakes. Two panels were used because it was not structurally feasible to block a single screen in the raised position. The two panels were raised and lowered on separate guides, approximately 6 inches apart. A rubberized flap on the bottom panel created a seal between the panels in the lowered position. The screen also was made with mesh of the same dimension as that used on the Ristroph screen (¼ x ½ inch slotted mesh) so that the vulnerability to impingement would be the same for both screens.

Ristroph Screen

The Ristroph screen is a modified vertical traveling screen consisting of a continuous belt of mesh panels (Figure 2-2). The lower rail of each panel is formed as a tray to hold water as the panel ascends. Impinged fish drop from the mesh into the tray as it leaves the water and remain there until the panel reaches the peak of its ascent. As each panel rotates across the top of the frame, fish are momentarily spilled back onto the mesh, and then rinsed by a soft spray wash system into a discharge sluice (fish sluice) containing flowing ambient water. There are two low pressure spray washes, one located inside, and the other outside and above the belt of screen baskets (Figure 2-2). Water pressure in each of these washes could be controlled. Normal operating pressures were 5-10 psi for the outside secondary wash, and 10-15 psi for the inside wash main wash. A 6 inch wide adjustable rubber flap seal was mounted on the edge of the return sluice to close the space between it and screen baskets and to facilitate the transfer of fish from the screen baskets into the return sluice.

As the panels descend further, they are subsequently exposed to a high pressure spray (95 psi) wash which removes most debris and any remaining fish into a second sluice (debris sluice) which discharges into a debris collection pit (Figure 2-3). Unlike conventional traveling screens which are usually operated intermittently (e.g. once per day or when the head loss across the screen reaches a certain level), a Ristroph screen is designed to operate continuously to return impinged fish to the source water.

The Ristroph modified traveling screen installed at IP 2 was manufactured by the Royce Equipment Company, Houston, Texas. The screen was outfitted with a ¼ x ½ inch slotted mesh screen material woven to produce a relatively smooth surface to reduce abrasion to fish during impingement and transfer to the return sluice. This machine has a variable speed drive unit to rotate the screen at up to 20 feet per minute. When rotated at that speed, a fish collected at the bottom of the screen's path reaches the intake bay's water surface in less than two minutes. Fish impinged closer to the surface are released proportionately faster.

Fish Collection System

Ancillary facilities were designed to collect all fish continuously from both the low pressure fish-sluice and the high pressure debris-sluice (Figure 2-3). Two tanks 8 feet long by 3 feet wide by 2 feet deep were installed to collect fish from the fish sluice. A rectangular shaped fiberglass trough (22 inches wide x 17 inches deep and containing one 90° turn with an approximately 18 inch radius at the trough centerline) transferred the fish from the Ristroph screen to these tanks, which were positioned approximately 19 feet from the screen. A diversion gate was used to transfer the fish to either one or both of these tanks. A second diversion gate was installed in the trough to transfer all fish sluice water (and associated fish and debris) to the main debris collection basins in the event the fish-sluice abundance collection tanks could not be used. Debris-sluice wash water was channeled to one or the other of two screened debris collection pits. These pits, below the intake deck level, were approximately 38 inches deep by 5 feet wide by 5.9 feet long.

Study Design

In order to evaluate the effect of screen position on the number of fish impinged, alternating 24 hour periods were established during which the fixed screen at intake bay 26 was either lowered to cover the entrance to the intake, or raised and blocked up out of the water. When the fixed screen was blocked up, fish could enter the bay and be impinged directly on the Ristroph screen. Collections made during, or at the end of, these intervals are referred to as Ristroph screen collections or as having been made from the "recessed" position. When the fixed screen was lowered (to again cover the intake), fish could be impinged on it. These fish were subsequently collected by raising and washing this screen so that they could drift into the intake bay and then be recovered from the Ristroph screen (generally within 5 to 10 minutes). Collections made following the washing of the fixed screen are referred to as fixed screen collections or as having been made in the "front position." For purposes of this study, it was assumed that impingement on the fixed screen at the entrance to the intake (i.e. front position collections) was representative of impingement which would have occurred if the Ristroph screen had been installed at that point.

It was necessary to establish a sampling design which alternated collections between the front and recessed locations frequently because daily impingement at Indian Point is extremely variable. The fluctuations presumably reflect changes in abundance of fish near the intakes in response to changes in environmental factors. Periods of many days of very high impingement may be followed by days or weeks of very low impingement. If the sampling design consisted of several consecutive days in each position rather than the alternating 24 hour pattern, which was used, the occurrence of impingement peaks during a single mode could bias the results. The selected design (two collections during each 24 hour period, one approximately 12 hours after the interval began and the second approximately 12 hours later at the termination of the interval) was expected to more evenly distribute the high impingement counts, as well as to provide sufficient numbers of discreet sample periods for statistical analyses.

Screen Collections

The collections at intake bay 26 consisted of four non-exclusive categories:

a. recessed position (Ristroph screen)

b. front position (fixed screen)

c. entrapment

d. survival

a. Recessed position

These samples were collected during the periods when the fixed screen was blocked in a position above the water level. The sampling period began as soon as the collection from the second of the two 12 hour fixed screen washes was completed. Fish impinged by the Ristroph screen were continuously washed off into either the fish or the debris sluice. Each sluice discharged into a separate collection chamber. Fish in each chamber were periodically removed and returned to the laboratory for identification and counting. Debris was removed for disposal in a sanitary landfill.

b. Front position

As the fixed screens were raised, they were washed using a 2 inch diameter fire hose. The top panel was raised first and the spray was directed downward so that fish and debris washed off the screen face dropped into the water in front of intake bay 26. A fixed spray system which was directed outwards (i.e., away from the intake) was also used occasionally to wash fish and debris off the panels as they were raised. After the top panel was washed and blocked up, the bottom panel was treated in a similar manner. If a second 12-hour fixed screen sampling interval was to follow, the two panels were promptly unblocked and lowered into position upon completing the wash of the bottom panel. If a 24 hour recessed sampling period followed, then both panels remained blocked up.

The fixed screen wash process took from 15 to 60 minutes depending on the amount of debris on the screen. Field personnel collecting the sample monitored the composition of the catch and terminated the sample once it was generally apparent that dead fish and debris from the fixed screen had ceased to enter the collection areas.

c. Entrapment

During the period that the fixed screen was down, fish continued to be collected from the Ristroph screen. Some of these fish were presumably trapped within the forebay at the time the fixed screen was lowered. However, some might also have entered through or around the fixed screens while those screens were in place, or entered during the time when the fixed screens were raised to be washed at the end of the first 12 hours of a front position collection.

There were two entrapment collections of approximately 12 hours each during each 24 hour fixed screen period. Entrapment collections were completed immediately before the fixed screen was raised and washed. Although these fish were collected during the front position collection intervals they were processed and recorded separately.

At the suggestion of NYSDEC, intensive examinations of fish impingement on the Ristroph screen during front position collection intervals were implemented to provide some inferential information on the numbers of fish that are likely to be resident in the forebay. It was also requested that a similarly intensive examination be conducted once the fixed screens were raised. Attempts to perform this type of sampling (intensive was defined as a collection to be made every two hours) for 48 hour periods were made on eight occasions from February 16 to April 18, generally when abundance was relatively high. However, because of the high levels of debris in the river it was seldom possible to leave the fixed screen down without washing for more than 12 hours.

d. Survival

These collections were made only when the fixed screens were blocked up and out of the water. Procedures associated with this aspect of the study are described in detail in Section 3.

Collection Efficiency

Collections from the fixed screens at Indian Point Unit 2 are known to underestimate true impingement because not all of the fish impinged are collected (Con Edison and NYPA, 1983). The sources of loss are uncertain, but most of the loss is thought to occur during the screenwash process. As the screen is raised, it is washed with a high pressure wash system and some of the fish and debris dislodged can be seen to float out into the river or onto adjacent screens. Some dislodged fish are recovered up to several days later. Other fish are lost to the collections permanently because they never reach the traveling screen, they adhere to the traveling screen (particularly in the presence of debris), or technicians fail to recover them from the debris during sample processing. Previous studies at Indian Point have provided data with which counts of collected fish could be corrected for such losses.

In this study, collection efficiency was estimated by releasing known numbers of marked fish in front of intake bay 26 and monitoring subsequent collections there for recaptures. Fish were usually released twice each day at approximately 12 hour intervals, corresponding with the beginning of each sampling interval. Most releases consisted of 100 dead fish. Most of the test fish were yearling white perch; however, on some occasions yearling striped bass were also used.

Collection efficiency fish for nearly all of the front and recessed position periods were released directly in front of the trash rack, approximately 11 feet from the Ristroph screen. The trash rack abuts the fixed screen when it (the fixed screen) is lowered into position. Releases were made at a water depth of 3m in the center of the forebay. The standard release device was a weighted 15cm diameter, 46cm long PVC cylinder, that was plugged at both ends. The test fish were placed in the cylinder; the device was lowered into position; then the plugs at the ends were pulled loose and the fish were released into the water flowing into the forebay. Recaptures were monitored for four days following a given release, after which missing individuals were considered lost or decomposed.

On one occasion, later in the study, marked fish were also released through a 3 inch diameter PVC pipe which was inserted through a floor drain in the forebay deck at a point approximately two feet in front of the Ristroph screen. Fish dropped approximately 3-5 feet before reaching the bay's water surface.

Fish used for collection efficiency testing were associated with a specific release by a combination of color marks and/or colored tags. Fish were color marked by soaking them in a dye for approximately 6-12 hours. Five different dye colors were used. Fish were also tagged with colored Dennison tags inserted into the bony structures in the head. Five different colored tags were used. The combination of five body dyes and five colored tags allowed for 25 unique pair combinations.

Some portion of the fish being collected at intake bay 26, particularly during recessed position intervals, were likely to have been previously impinged on one of the other five intake bays' screens. To assess the extent to which these fish might influence the results of survival tests at intake 26, dead fish were marked and released in front of each of the Unit 2 intakes. Approximately ten releases were made for each bay over a two week period. A release consisted of dropping one hundred fish in front of each forebay shortly after each screen wash. The wash interval was approximately 24 hours for screens 21-25 and every 12 hours for screen 26. Recaptures at each of the six intakes were recorded.

<u>Collection Procedures for Intake Bay 21-25</u>

As soon as the Ristroph screen became operational on January 16, collections of fish and debris impinged on the fixed screens at intakes 21-25 were made daily. These collections were made by operating the conventional traveling screens at intakes 21-25. From these screens, fish and debris entered into a common sluice which discharged into the intake 21-25 collection pit (Figure 2-1).

Procedures for washing the fixed screens at intakes 21-25 were similar to those for the fixed screens at intake bay 26 except that their fixed screens are not separated into two panels but are one continuous panel. The wash system used for cleaning these screens was similar to that used at intake bay 26, and involved both the use of a fire hose and a fixed spray system located approximately 6 feet above mean low water (MLW).

The traveling screens at intakes 21-25 were turned on prior to washing each fixed screen and remained on until all the fish and debris associated with that fixed screen had been collected in the collection pit. The traveling screen at that intake was then shut off and a fixed screen and traveling screen at another intake were similarly washed until all fixed screens were cleaned. This procedure produced discrete samples from each of the fixed screens at intakes 21-25. The duration of screen washes for each of intakes 21-25 depended on the amount of fish and debris on each screen, but all screen washes were completed usually between 0800 and 1200 hours.

Laboratory Procedures

All non-survival samples collected from the front or recessed position at intake 26, and intakes 21-25 were returned to the laboratory for processing. All fish were enumerated by species and sorted into various length classes, segregating them basically into yearling and older categories. A total weight for all fish in each length class was also obtained. For each of the front or recessed samples total length (mm) was recorded for up to 500 individuals in each length class for each species. Fish collected for survival studies during any recessed position collection interval were tallied at the end of the survival holding period and the numbers added to the number of non-survival study fish collected to provide a total number collected during that interval. Fish in the intake 21-25 samples were processed similarly, except that only 25 randomly selected white perch per length class within each sample were measured.

Water Quality Measurements

Temperature (nearest 0.5°C), dissolved oxygen (nearest 0.1 ppm), conductivity (nearest 10 μmhos per mm), and pH (nearest 0.1 units) were recorded at the 3m depth in intake 26 in front of the fixed screen during each 12 hour sample interval. Of these four variables, pH remained fairly constant at about 7.5-7.7, temperature increased with time, dissolved oxygen fluctuated slightly (Figures 2-4 and 2-5 respectively) and conductivity fluctuated widely (Figure 2-6).

Temperature (to nearest 0.5°C) and conductivity (to nearest 10 μmhos per mm) associated with the daily collections from intakes 21-25 were obtained from a depth of 1 meter in intake 22. These measurements were made during the flood tide which occurred closest to the early morning collection at intake screens 21-25.

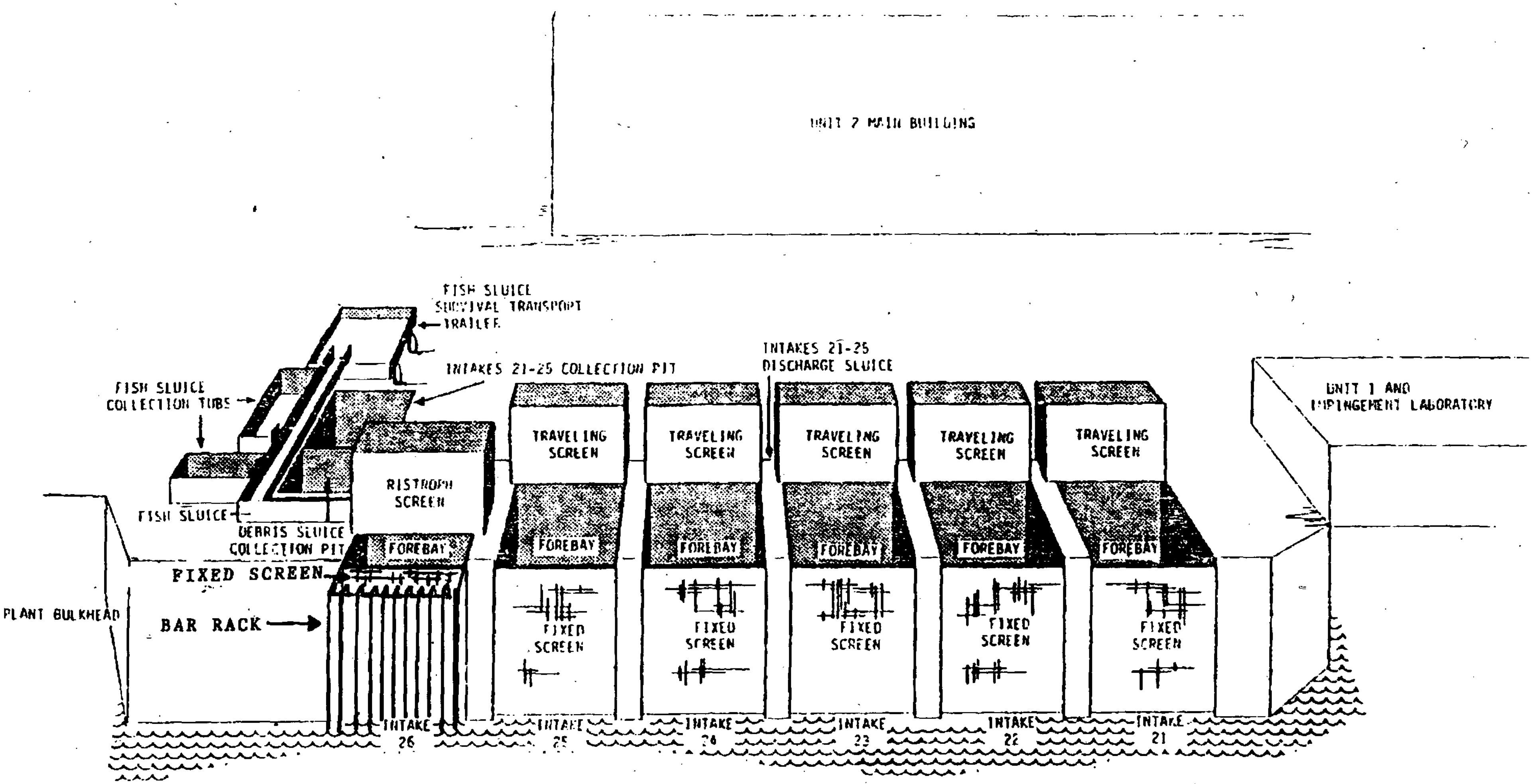


Figure 2-1. Indian Point Unit 2 cooling water intake bay configuration.

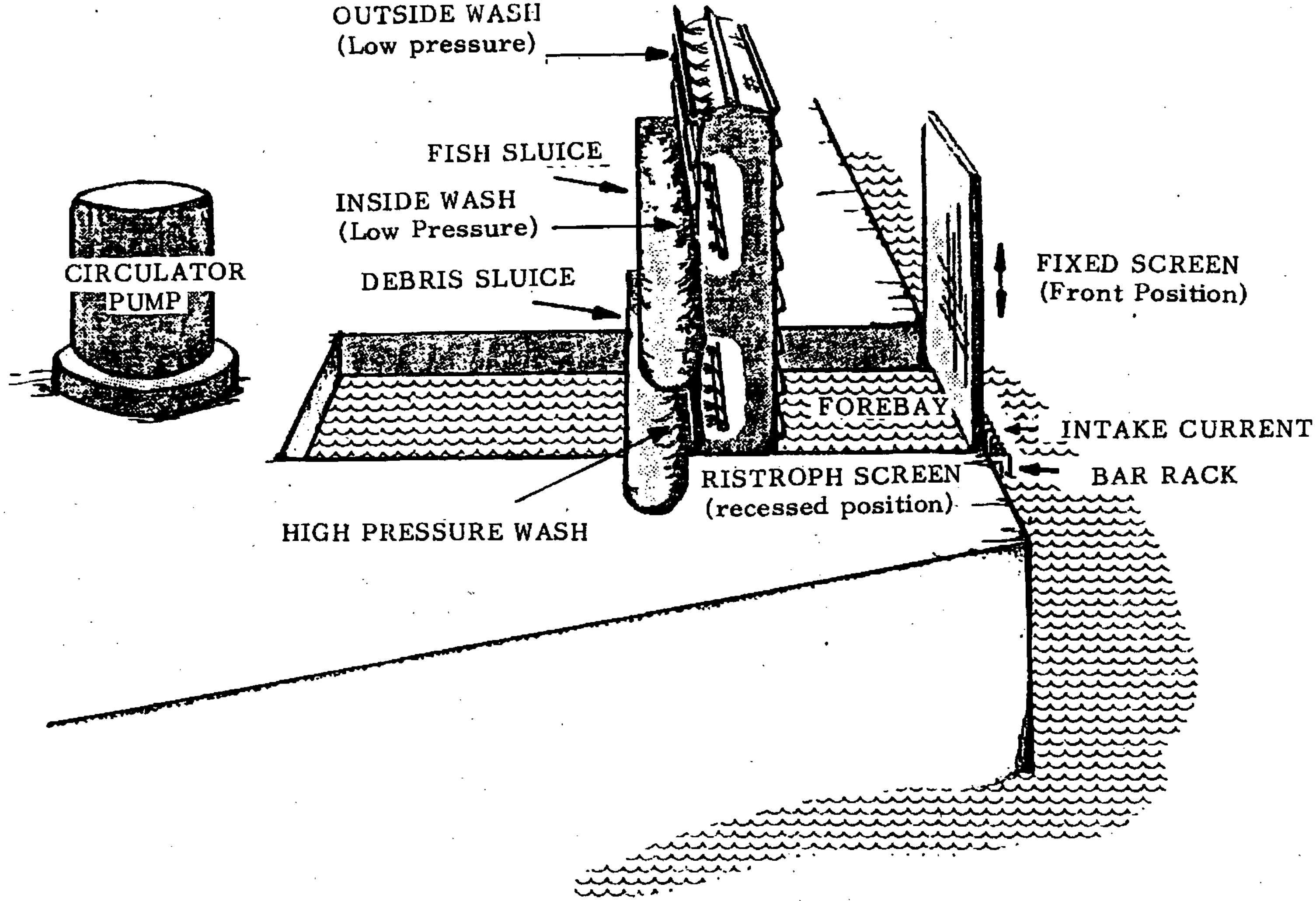


Figure 2-2. Cut-away schematic view of fish conveyance mechanisms at intake at Indian Point Intake 26.

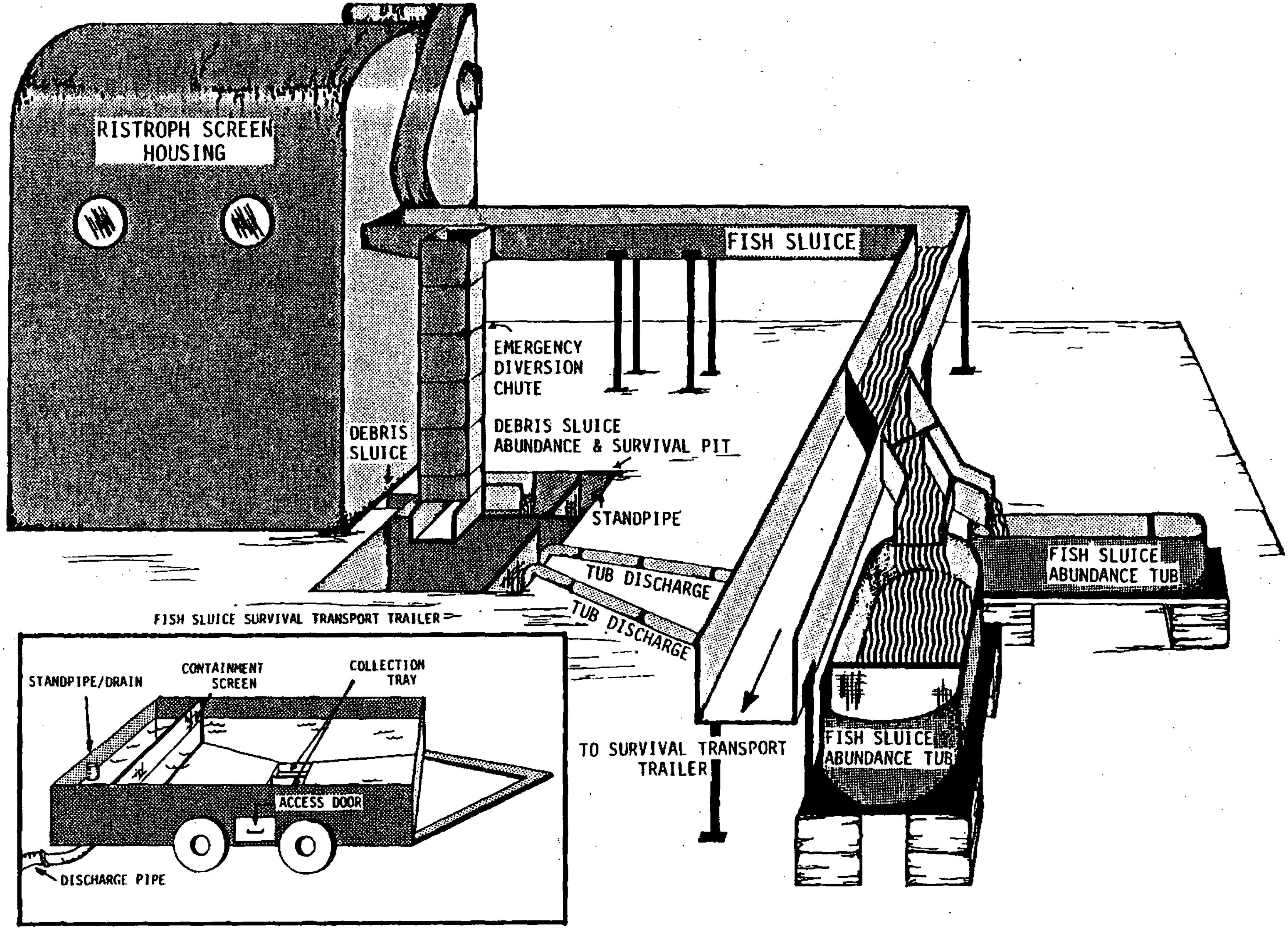


Figure 2-3. Indian Point Unit 2 Ristroph Screen fish sluice and debris sluice collection area (abundance collection configuration illustrated).

INSET: Fish Sluice survival collection trailer.

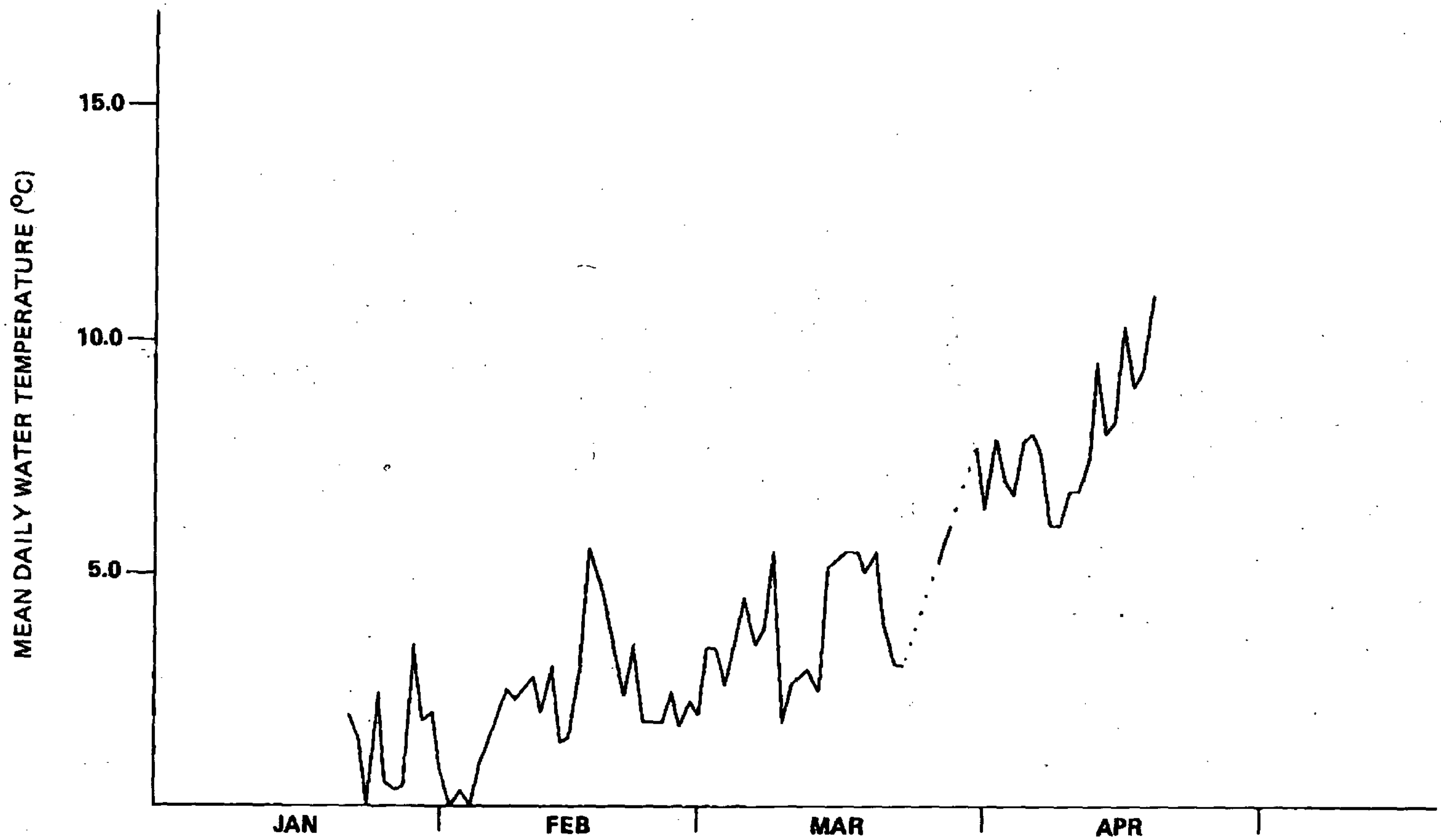


Figure 2-4. Mean daily water temperature (^{o}C) at intake forebay No. 26, Indian Point Unit 2, January - April, 1985.

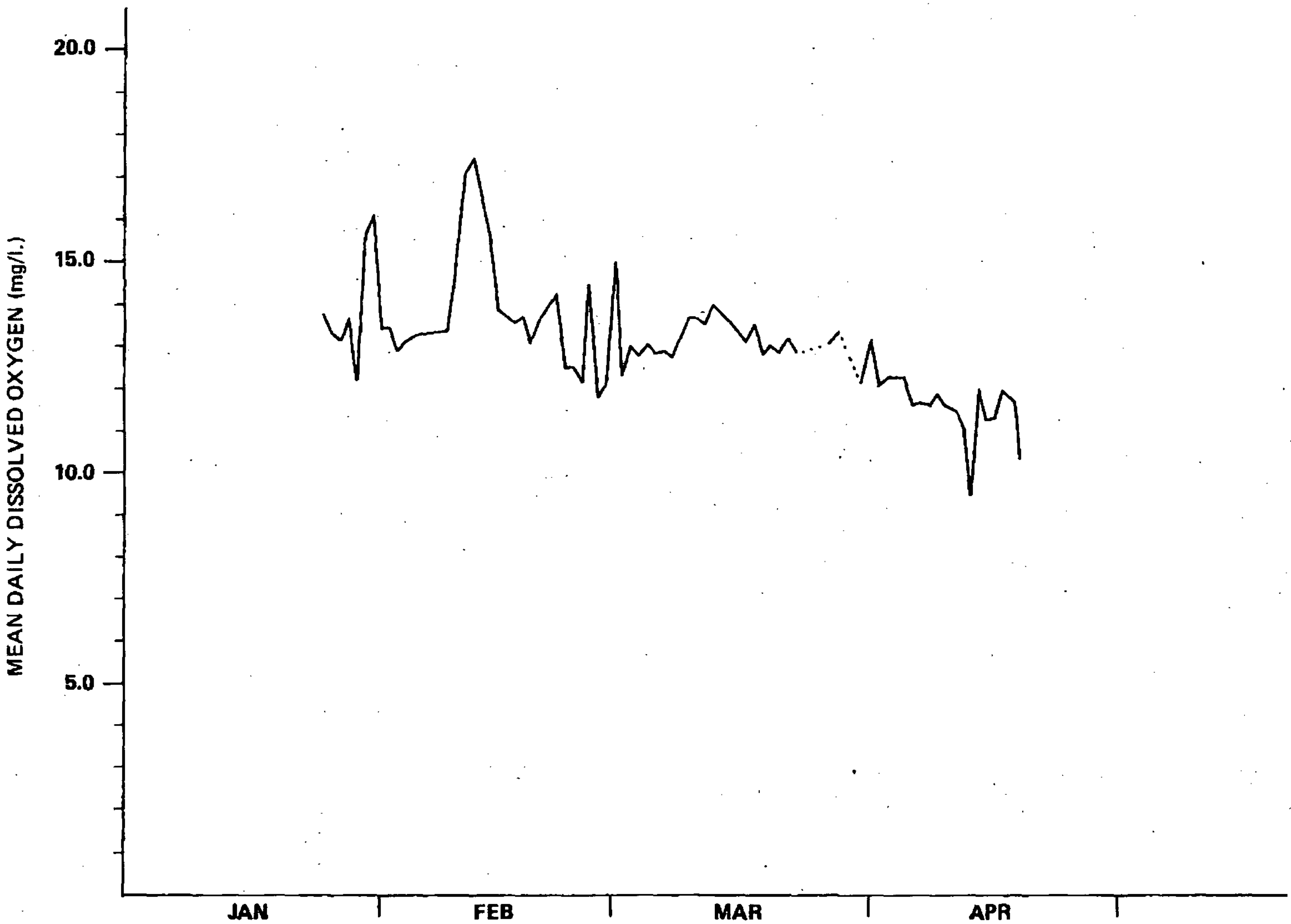


Figure 2-5. Mean daily dissolved oxygen (mg/l.) at intake forebay No. 26, Indian Point Unit 2, January - April, 1985.

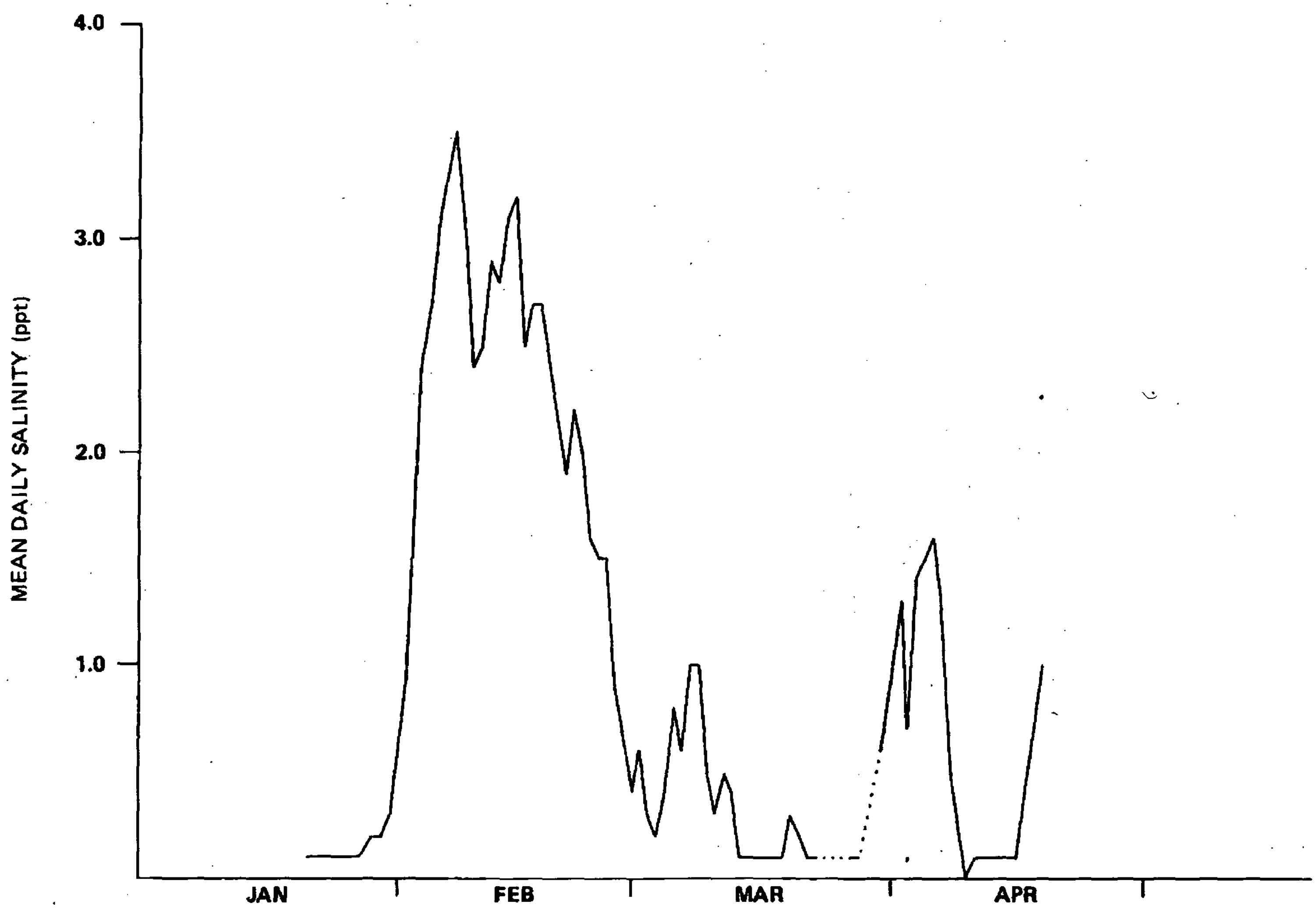


Figure 2-6. Mean daily salinity (ppt) at intake forebay No. 26, Indian Point Unit 2, January - April, 1985.

Section 3
SURVIVAL

The primary purpose of the survival studies was to confirm that the projections of survival rates for various species made in the August 1984 report (Con Edison and NYPA, 1984) could be achieved. Projections of total annual survival rates for ten species were presented in that report. In this report, survival rates for ten selected fish species, five of which were discussed in the earlier report, are provided. The other five species listed in the August 1984 report are primarily found at other times of the year, and as a result were not available for survival rate evaluation.

Field Methods

Survival collections were made only on days when the fixed screen was raised, enabling fish from the river to become directly impinged on the Ristroph screen and removed from the intake bay. Collections were not made unless the Ristroph screen was running in a normal fashion nor were collections made when screen washes at the other intake bays were occurring. The wash water used to flush the screens and the sluices was not chlorinated.

Survival samples were collected simultaneously from the fish sluice and debris sluice (Figure 2-3). Prior to a survival collection, both the fish sluice and debris sluice collecting chambers were filled with ambient water to a depth of approximately 30 cm (1 foot) to provide a layer of "cushion" water. The collection chamber for the fish sluice was a trailer designed to accumulate fish and transport the survival sample to the laboratory located approximately 150 m (500 feet) away (Figure 2-3). The collection chamber for the debris sluice was the debris collection pit with a standpipe in the drain to provide "cushion" water as described above. Samples were collected by diverting sluice water from the abundance collection tanks (Figure 2-3) to the survival collection chambers. Sample duration ranged from 0.50 to 9.0 hours, but was usually less than two hours. The shortest durations occurred when debris levels were high and could clog the collection chambers or when fish abundance was high. When both debris levels were low and fish entered the collection apparatus at a rate of less than approximately 1 fish per 10 minute period, sampling duration was extended to obtain sufficient numbers of fish to supply the laboratory. Correlation analysis indicated that no significant ($p \leq 0.05$) relationship existed between collection duration and initial survival for striped bass, white perch or rainbow smelt (Table 3-1). Therefore, the length of time fish spent in the collection chamber awaiting transport (to the laboratory) did not affect initial survival values.

Water quality parameters were recorded during each survival collection as previously described (see Section 2). The following observations and/or measurements, most of which are related to screen operation, were also recorded with each survival collection:

1. Screen speed - nearest foot per minute.
2. Main low pressure spray: nearest 1 psi.
3. Secondary low pressure spray: nearest 1 psi.
4. High pressure spray: nearest 1 psi.
5. Relative debris loading: high, moderate, low.
6. Air temperature (°C).

At the conclusion of a survival collection, sluice water was rediverted to the abundance collection tanks. The survival collection trailer was hitched to a vehicle for transport to the laboratory. Fish from the debris sluice were removed from the debris sluice collection pit in the following manner. The pit was drained to a water depth of approximately 10 cm (4 inches) and entered by a biologist, who gathered all fish with a water-filled scoop. Each fish was carefully released into 95 liter (25 gallon) coolers containing ambient water. After all debris sluice fish were put in coolers, the coolers were loaded onto the vehicle used to transport the fish collection trailer and promptly moved to the on-site laboratory and holding facility simultaneously with the trailer. Typical transit duration between collection at the Ristroph screen and specimen transfer to aquaria was under 30 minutes. Upon arrival at the laboratory, the fish sluice transport trailer was drained and all fish were gently herded into a series of 11 liter (3 gallon) capacity trays. The trays were promptly carried by hand into the aquarium area of the laboratory, along with the coolers containing fish from the debris sluice collection. All fish were given a minimum acclimation time of three minutes and then sorted by condition category for "initial survival" assessment, using the following criteria:

> Alive - No visible signs of physical damage; active swimming and orientation behavior.
>
> Damaged - Fish with visible external damage (missing scales, mutilations, or hemorrhage) or showing abnormal or weak swimming and orientation behavior.
>
> Dead - No obvious external signs of life or severe physical mutilation with only slight opercular motion and no other body movement.

While sorting, "Alive" and "Damaged" fish were gently spooned into aquaria using water-filled scoops so that they could be held to determine latent (96 hour) survival. Most damaged fish (all after February 11) were held in separate aquaria from alive members of the same species; individuals from fish sluice collections were also held separately from those originating in debris sluice collections. Only compatible sizes and species were combined within aquaria to minimize predation or other behaviorally-induced factors that might influence survival. Since the number of holding tanks was limited by the available space in the laboratory and some aquaria were occasionally reserved for certain less abundant species, not all fish collected for survival study were able to undergo latent survival testing (Table 3-2).

All aquaria were glass-sided and either 75 or 115 liters (20 or 30 gallons) in volume. The aquarium system had 50 tanks and approximately a 3.8 liter per minute per tank (1 gallon per minute) flow through of ambient river water derived from service water pumped from Indian Point Unit 1. The density of fish in aquaria was held to approximately 1 g biomass to 1 liter of water. Given the average size of fish impinged during the study, approximately 10 fish could be held at a time in the 75 liter (20 gallon) tanks and 15 fish could be held in the 115 liter (30 gallon) tanks.

"Latent survival" evaluations were performed after the test fish had been held for 96 hours. Between hour 0 and hour 96 fish in each aquarium were periodically observed (at hours 6, 12 and every 12 hours thereafter) and their condition and the water temperature (°C) were recorded. Any dead fish were removed, weighed and measured to the nearest mm (TL). At hour 96, a final observation was recorded and all remaining fish were removed and processed.

Observation of mortality in a fish group (50 yearling striped bass obtained from the Hudson River striped bass hatchery) that serves somewhat as a control indicated that transport and holding may induce up to 10-15% mortality on striped bass (Figure 3-1). However, it was impractical to obtain adequate control fish from the Hudson River for these studies at this time of year and consequently no adjustments for mortality induced by handling were made to calculated survivals for striped bass, or any other species.

Analytical Methods

Survival data basically consisted of numbers of fish alive, dead, and damaged after collection from the Ristroph screen. Although the calculations involved for computing survival rates are relatively straightforward, the primary consideration complicating the assessment was whether those individuals showing various signs and degrees of stress, ranging from temporary disorientation and minor amounts of scale loss to obvious physical damage, should be regarded as alive or dead.

Three methods were used to calculate survival. In the first, damaged fish were considered to be survivors and were treated in the same fashion as those characterized as alive. In the second, fish damaged at the time of collection or after 96 hours were considered to be dead. To simplify what can develop into confusing terminologies, the "damaged fish as alive" technique is hereafter identified as the "standard" method because survival is, within the narrowly defined context that a fish is either alive or dead, nothing more than the number of fish which did not die at the study's endpoint. The second method, in which damaged fish are considered to be dead, is hereafter referred to as the "dfe" method, damaged fish excluded from the survivor group. The survival study results calculated by these two techniques represent extremes in the assessment of Ristroph screen survival. The third method computes survival for an intermediate assessment position in which initially damaged fish are considered to be alive, but those classified as damaged after the latent holding period are considered to be dead.

Survival calculations are provided for each of the two major survival assessment points, initially following collection from the Ristroph screen (initial survival) and at the end of the 96 hour latent survival holding period (latent survival). Total percent survival is calculated as the product of the initial and latent survival rate and is provided for each sluice.

The sluice-specific total survivals rates are combined by weighting the relative abundances from each sluice to produce a value called overall survival. It is calculated as:

$$\text{Overall Survival (\%)} = \frac{(S_f \cdot N_f) + (S_d \cdot N_d)}{N_f + N_d} \times 100 \qquad \text{(Equation 1)}$$

where,

S_f = Total percent survival from fish sluice
S_d = Total percent survival from debris sluice
N_f = Number of fish collected from fish sluice for survival collections
N_d = Number of fish collected from debris sluice for survival collections

Values for the initial and latent survivals could be calculated either as the arithmetic mean of the samples (observations/tests) or as a cumulative statistic. In the latter case, the final value is weighted by the number of fish in each sample. However, survival samples frequently consisted of only a few fish, especially using the dfe method (Table 3-3). These small sample sizes tended to make the arithmetic mean method generally less reliable than the cumulative appproach. Therefore, survival samples from all tests were amalgamated for computation of the summary values presented here and were not treated as independent observations. Survival rates calculated using the alternative arithmetic mean procedure are presented elsewhere (Appendix A).

Results

A total of 7,850 fish, representing 22 species, were collected for survival analysis (Table 3-4). Survival analyses are presented for the ten most abundant species that were collected during that January - April study period (see also Appendix A). Nearly 80% of the fish collected were white perch and about 14% were striped bass. No other species contributed more than 2% to the total. Approximately 69% of the total were recovered in the fish sluice. More than three times as many striped bass were collected in the fish sluice than in the debris sluice; the ratio for white perch was about 2:1.

Initial and latent survival of fish collected from the fish sluice, calculated by both the standard method and the dfe method, was generally better than that of fish collected from the debris sluice (Table 3-5). The difference in the initial survival values between the standard and dfe methods is primarily a reflection of whether damaged fish were considered alive or dead, but may also be due to the difference between the sizes of the standard and dfe data sets, the latter approximately 18% smaller because alive and damaged fish were not held separately until early February (see Field Methods). The difference between the two methods for the latent survival values additionally reflects differences in the types of fish (i.e. alive or damaged) each method considered pertinent for latent examination.

Total percent survival, expressed as the product of initial and latent survival percentages for each species in each sluice, showed, as expected, that fish sluice survival was generally higher than debris sluice survival, whether damaged fish were excluded (dfe method) or not (Table 3-6). Total percent survivals for striped bass and white perch in the fish sluice were 76.4% and 82.1%, respectively, based on the standard method, and 60.2% and 62.9%, based on the dfe method. For the debris sluice, corresponding striped bass and white perch values were 48.2% and

53.7%, respectively, based on the standard method, and 35.5% and 36.9% based on the dfe method.

To obtain overall Ristroph screen survival values, by species, the survival rates for each sluice were weighted by the numbers of fish collected in each sluice (Table 3-4; see also preceding section, Analytical Methods, Equation 1). Calculations were made using the proportions of fish collected from each of the sluices, both during survival collections and all Ristroph screen collections.

When based upon the distribution of fish found in survival collections, overall survival for both striped bass and white perch were approximately 70% when damaged fish were considered as survivors (Table 3-7). Among the other fish species, survival rates for alewife and red hake were 12.6% and 35.3%, respectively, whereas rates for spottail shiner, tesselated darter, white catfish, pumpkinseed and rainbow smelt were generally excellent (>85%). Atlantic tomcod survival was 79.5% for post-spawning adults. When damaged fish were considered dead, overall survival was lower than that noted above, although the distinctions between the species that survived relatively well and relatively poorly remained consistent. When based upon the distribution of fish from all Ristroph screen collections, results were similar (Table 3-8).

Discussion

Survival rates were determined for the ten most abundant species collected during the mid-January through mid-April study. For five of those species, projections of survival were presented in the August 1984 report. A substantial portion of the annual impingement of three of these five species (striped bass, 45%; white perch, 60%; and rainbow smelt, 25%) at Indian Point has been collected during the January - April period. Two of the species (Atlantic tomcod; alewife) for which survival determinations are presented herein, however are not commonly collected at Indian Point from January through April (less than 1% of the total annual impingement).

Impingement of four others of the ten listed in the August report is generally extremely low (american shad and blueback herring) or non-existent (bay anchovy and weakfish) during the winter and no survival data were collected for them. The tenth species, hogchoker, although present in impingement samples during this study, were not collected in survival samples. This species, however, is extremely hardy and their survival rate, had it been evaluated, would have been expected to be greater than 95%.

The values of survival obtained during this study by both the standard and the dfe methods probably underestimate levels of survival which can be expected if a full complement of Ristroph screens were to be installed. The poor physical condition (i.e rigid, partially decomposed, fungused) of some of the fish which were classified as dead or damaged at the time of collection for the survival studies was clearly not consistent with the trauma that would be expected as a result of impingement on the Ristroph screen. In addition to whatever fish may have been dead or dying from natural stresses (e.g. spent Atlantic tomcod) observations made during the screen washing procedures made it obvious that some of these fish had probably been previously impinged on the fixed screens at the other intakes or at intake 26 during a previous fixed screen period and not collected. Fish impinged on these fixed screens are largely dead or heavily damaged by the time the screens are washed because they are generally washed only once per day.

Collection efficiency tests at intake 26 during these studies showed that on occasion almost 40% of the fish impinged on the fixed screen at intake 26 may be collected during a subsequent Ristroph screen test interval (Section 4). To investigate the potential of fish impinged on other intake screens at Unit 2 to be collected on the Ristroph screen at intake 26 (during survival collections), marked dead fish were released at each of the other screens and the degree to which they were recovered at intake bay 26 up through 96 subsequent hours was assessed. The results indicated that a contribution of fish to intake bay 26 did occur, and on occasion it was substantial (Table 3-9). In the case of releases at screen 25, 16.8% of the fish released at intake 25 were recovered in collections at intake 26. These results indicate that intake bay 26, more than any other intake bay, apparently because of hydrodynamic influences in the vicinity of IP 2 intakes, is the (net) recipient of fish first impinged at the other bays' screens. Once Ristroph screens are installed at all of the intakes, this source of mortality will be largely eliminated.

Estimates of survival are also biased downward by the absence of data with which to make adjustments for the stresses imposed by handling and confinement. Fish which could be considered representative controls were not generally available for use. However, the results obtained using a small number of hatchery-reared striped bass indicated that stresses other than those imposed by the Ristroph screen may impose 10% to 15% mortality during a 96 hour holding period.

Although the two factors described above result in survival being underestimated, their effects on the estimates are offset to some extent by the fact that the efficiency with which fish impinged on the Ristroph screen were collected was less than 100%. Data and discussion presented in Section 4 indicate that generally 85% to 95% of marked fish placed directly into the screen basket trays were recovered. Since only some of the uncollected fish might have survived, in the absence of the offsetting factors previously mentioned, it might be appropriate to reduce the estimates to 85-90% of those presented.

To evaluate the assumption upon which the dfe method is based; i.e. all fish collected in a damaged condition will die, recovery during the 96 hour holding period of striped bass and white perch considered damaged in initial collections was examined. Change in condition of these fish from damaged to either alive or dead was plotted against time at 6 and 12 hour intervals up to 96 hours. Results showed that many damaged individuals recovered during the first 6 hours of the latent survival test period, and that number remained constant throughout the duration of the test; the remaining damaged individuals gradually died. Approximately 35% of all damaged white perch collected in the fish sluice (N=333) quickly recovered (Figure 3-2). The same trend existed for white perch collected from the debris sluice (N=470), with about 25% recovering rapidly (Figure 3-2). Damaged striped bass collected in the fish sluice (N=80) had a relatively high recovery rate (68%), while approximately 30% of those from the debris sluice (N=88) recovered (Fig 3-3). It thus appears that to consider all damaged fish to be dead is inappropriate and unrealistically conservative.

Since some damaged fish recover rapidly, the primary question, is whether these fish would have the same capability to recover under actual conditions as they did under these experimental conditions. The only obvious direct source of mortality present in the river that would not also exist for fish held in the aquaria is predation. Since the fish collected from the Ristroph screen at Indian Point would be returned to the river near the bottom, predation by birds seems unlikely. Fish predation during the colder months is also likely to be lower than levels found at other times because metabolic rates and therefore food consumption (of predatory fish) are slowed. Furthermore, predators such as bluefish are not present in significant numbers during the winter. It thus seems unlikely that the aquaria presented a less hostile environment for damaged fish recovery than would the river itself.

Since some fish undoubtedly will recover under field conditions, the most appropriate approach may be to calculate overall survival by assuming that fish initially damaged are alive, but those in that condition after the 96 hour holding period are dead. The survival rates based on this (intermediate) method for most species (Table 3-10) are quite similar to those based on the standard method (Table 3-8).

The survival rates attained during the January through early April study period were consistent with attaining those projections of survival for the entire year made in the August 1984 report (Table 1-1). The white perch annual overall survival rate of 71% projected in the August report was based upon application of data from the Salem generating station which reflected an average of approximately 58% survival for the period January through April. The white perch survival rate achieved in this study, based on the intermediate method described above, was 66.1% (Table 3-10).

The striped bass survival rate observed during the present study (68.7%, based on the standard method, 68.6% based on the intermediate method) was higher than that (61%) projected in the August 1984 report. The report projection was based on data collected during June (59% survival based on 51 fish) and during September-December (67% survival based on 14 fish) at Indian Point. Since more than 80% of striped bass impingement at Indian Point occurs from September through April, it is likely that the annual survival rate for striped bass can be expected to exceed the level projected in the August 1984 report.

The annual survival rate of 40% (Standard Method) projected for rainbow smelt in the August 1984 report was based on data from the Mystic generating station and reflected an average survival for the period of January through April of about 40%. The survival of 85.7% (87.7% Standard Method) obtained in this study suggests that survival for the entire year at Indian Point would equal or exceed the 40% projection.

The projected annual survival rate for Atlantic tomcod of 40% (Standard Method) reflected survival rates of 95% (Standard Method) for the winter period, including January through April, and 35% (Standard Method) for the late spring and summer, reported from previous Indian Point studies. The survival rate of approximately 59.0% (Intermediate Method; 79.9%, Standard Method) obtained during these studies is somewhat lower than that previously noted for winter collected fish. However, those winter data were collected in early to mid-December and probably reflected pre-spawning fish, whereas the data collected in the current study were largely from post-spawning fish which showed evidence of poor physical condition. However, with respect to overall annual survival rate projections, the number of Atlantic tomcod impinged from January through April at Indian Point generally represents less than 1% of the total number impinged annually, and accordingly, results from the present study may provide little information on expected survival throughout the year.

The projected annual survival of alewife at Indian Point (13% Standard Method) was based on Salem Generating Station data, which reflected for the January - April period a survival rate of approximately 10%. The survival obtained during the current study (8.4% Intermediate Method) is consistent with those data. However, as with tomcod, the number of alewife impinged during this period are less than 1% of the annual total and accordingly, these results can not fully reflect overall survival rates that may be achieved.

Several other species collected during the present study, but not reviewed in the August 1984 report, included pumpkinseed, spottail shiner, tessellated darter, and white catfish. All experienced very high overall rates of survival.

Red hake, which is generally present at Indian Point only during the winter months (January - March), is a marine species. Its overall survival during this study (5%) was much lower than the only other data available for it (Mystic Generating Station) where overall survival ranged from 67 to 100%.

Although this study generally provided survival rates comparable to those projected, there appears to be substantial potential for improvement. Tests of survival during the study were conducted over a range of low pressure spray wash system position setting and pressures (5 to 20 psi), and flap seal positions. Insufficient data were collected to identify optimum settings, and some settings were observed to be clearly inappropriate. For example, the flap seal which extends from the fish sluice into the plane of the descending screen baskets to maximize the number of fish transferred to the fish sluice could not be positioned properly because of excessive wear in the roller assemblies of the chain baskets. As a result, a gap, at times approaching 1½ inches in width existed, and fish were observed to drop past this flap to be deflected by the high pressure wash into the debris sluice.

With the completion of the recent repairs to the Ristroph screen, minor adjustments to the flap seal are expected to largely eliminate this problem. This, in turn, would improve the levels of survival observed because fish sluice survival rates are substantially higher than those from the debris sluice (Table 3-6). Additionally, adjustments to the position of the inside and outside low pressure spray wash headers to optimize the direction of wash spray is expected to more efficiently transfer fish into the fish sluice, also resulting in enhanced survival rates.

Although mechanical difficulties precluded the collection of sufficient data on screen speed, this factor is likely to influence survival. Travel speeds during most of the study were generally less that 10 fpm, but the higher speeds for which the system is designed (15-20 fpm) would likely help to reduce the extent of impingement-induced traumas by reducing the duration of impingement. Studies at the Mystic station indicated that survival was increased by operating at faster screen travel speeds (Con Edison and NYPA, 1984).

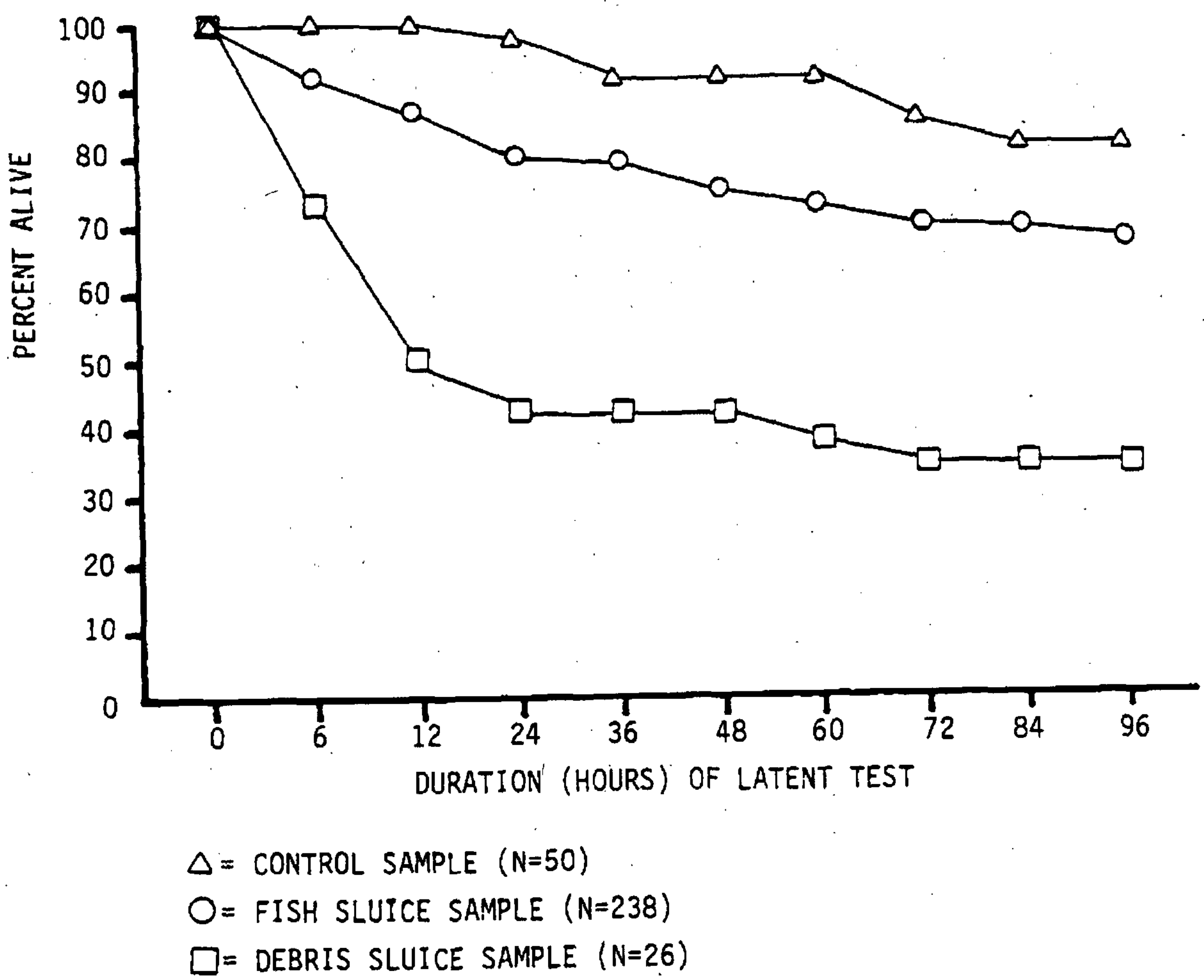


Figure 3-1. Percent of Striped Bass Alive Throughout 96 Hour Duration of Latent Holding Period. Sluice samples consist of fish initially categorized as alive from Ristroph screen collections; controls from the Hudson River Striped Bass Hatchery.

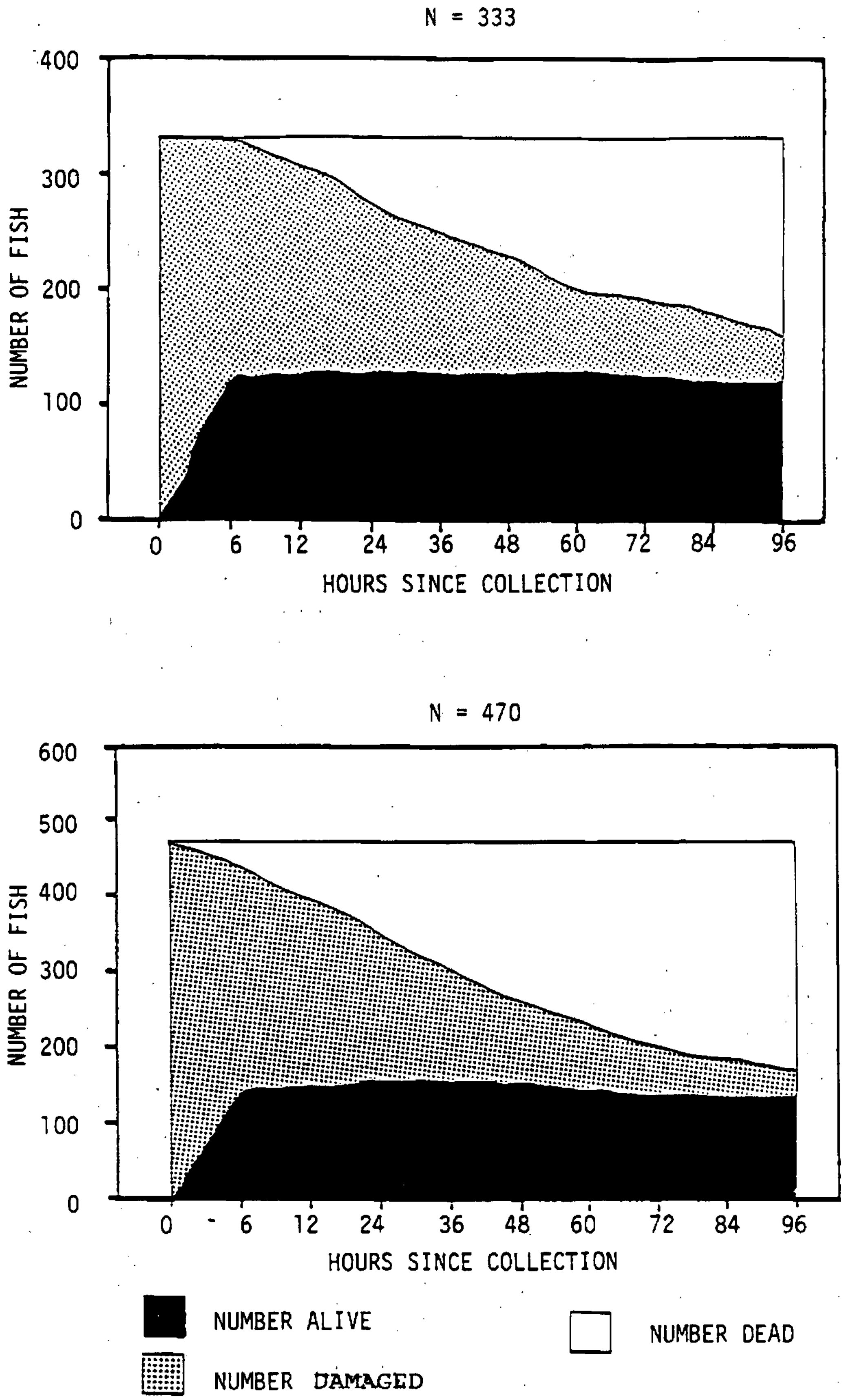


Figure 3-2. Cumulative latent survival of initially damaged white perch collected from the Indian Point Unit 2 Ristroph screen fish sluice (top) and debris sluice (bottom), January-April, 1985.

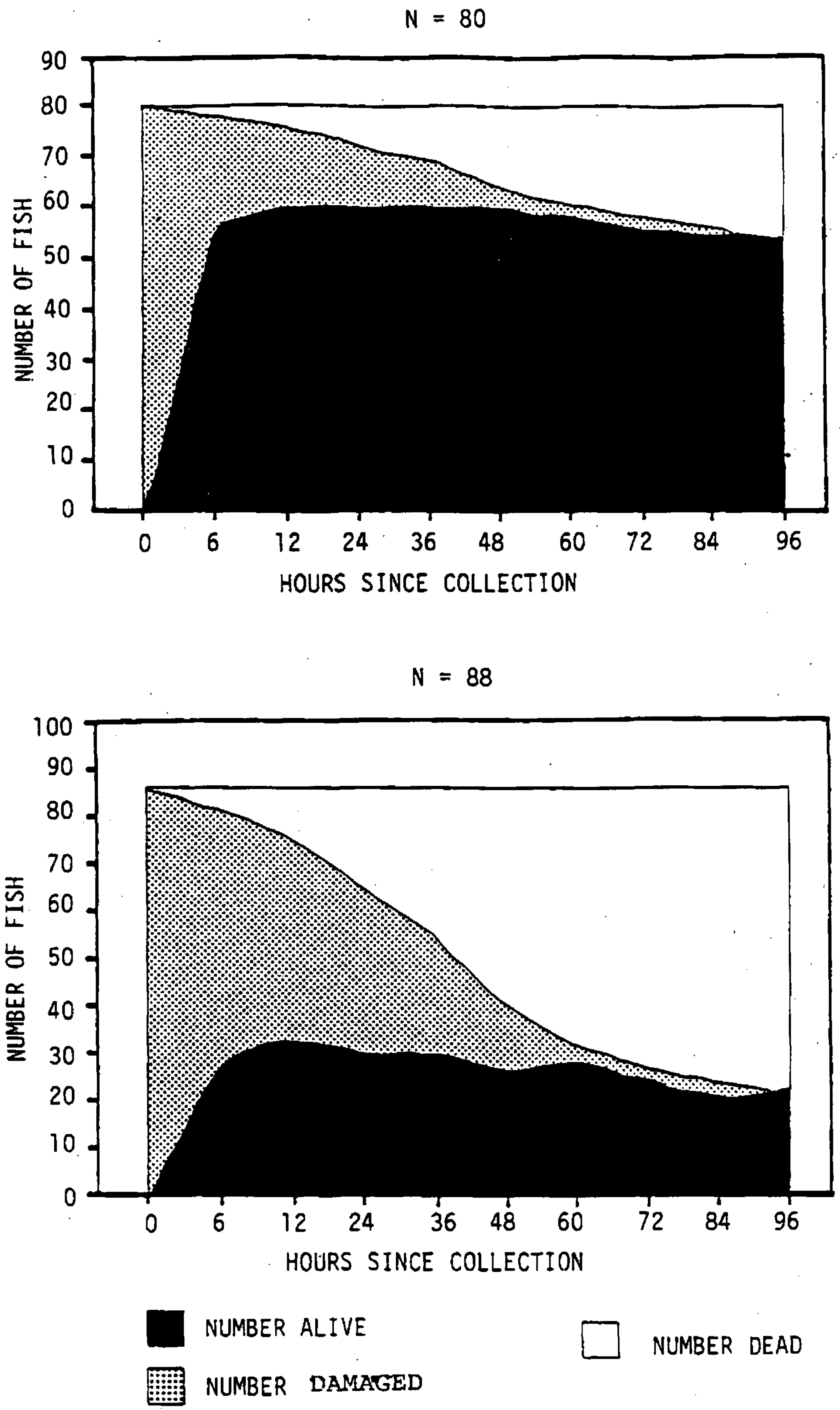


Figure 3-3 Cumulative latent survival of initially damaged striped bass collected from the Indian Point Unit 2 Ristroph Screen Fish Sluice (top) and Debris Sluice (bottom), January-April, 1985.

Table 3-1. Correlation between survival collection duration (hours) and initial survival for selected fish species from the Indian Point Unit 2 Ristroph screen, January - April, 1985.

Fish Sluice

Species	Standard Method[a]		dfe Method[b]		No. of Observations
	r	p	r	p	
Rainbow smelt	-0.50	0.17	-0.50	0.17	9
Striped bass	0.32	0.10	-0.04	0.83	28
White perch	0.01	0.96	-0.10	0.62	27

Debris Sluice

Species	Standard Method[a]		dfe Method[b]		No. of Observations
	r	p	r	p	
Rainbow smelt	-0.03	0.92	-0.08	0.81	12
Striped bass	-0.13	0.53	-0.14	0.52	25
White perch	-0.29	0.12	-0.02	0.92	30

r = Pearson's product - moment correlation coefficient

p = probability of obtaining the given correlation coefficient. If $p \leq 0.05$, the correlation coefficient was significant.

[a] Standard method = $\frac{\text{no. fish alive + no. fish damaged following collection}}{\text{no. fish alive, damaged and dead}}$

[b] dfe method = $\frac{\text{no. fish alive following collection}}{\text{no. fish alive, damaged and dead}}$

Table 3-2. Numbers of fish (ten most abundant species) collected in survival samples from the Indian Point Unit 2 Ristroph Screen and held for latent effects (96 hours) analysis, January - April, 1985.

Fish Sluice

Species	Total No. of Fish Collected in Survival Samples	No. of Alive and Damaged Fish Collected in Survival Samples		No. of Fish Used in Latent Survival Tests	
		Alive	Damaged	Alive	Damaged
Alewife	22	4	17	4	16
Atlantic tomcod	32	22	10	22	9
Pumpkinseed	17	11	6	12	5
Rainbow smelt	76	73	1	72	1
Red hake	17	10	7	6	7
Spottail shiner	34	32	2	32	1
Striped bass	860	605	217	561	185
Tesselated darter	25	25	0	24	0
White catfish	85	77	7	66	7
White perch	4,227	2,906	1,135	1,279	619
Total	5,395	3,765	1,402	2,078	850

Debris Sluice

Species	Total No. of Fish Collected in Survival Samples	No. of Alive and Damaged Fish Collected in Survival Samples		No. of Fish Used in Latent Survival Tests	
		Alive	Damaged	Alive	Damaged
Alewife	3	0	3	0	3
Atlantic tomcod	8	6	2	6	2
Pumpkinseed	NS	NS	NS	NS	NS
Rainbow smelt	59	49	5	37	4
Red hake	8	2	6	2	5
Spottail shiner	5	4	1	3	1
Striped bass	264	118	102	99	100
Tesselated darter	1	1	0	1	0
White catfish	25	21	3	20	3
White perch	2,051	980	824	666	580
Total	2,424	1,181	946	834	698

NS = No sample

Table 3-3. Frequency distribution of alive striped bass and white perch entering the 96 hour latent period (dfe method).

	Fish Sluice			Debris Sluice		
Species	No. of Fish in Test	Test Frequency	Percent of All Tests	No. of Fish in Test	Test Frequency	Percent of All Tests
Striped bass	1	16	20.5	1	14	45.2
	2	7	9.0	2	7	22.6
	3	3	3.9	3	1	3.2
	4	5	6.4	4	3	9.7
	5	6	7.7	5	1	3.2
	6	3	3.9	6	3	9.7
	7	3	3.9	7	1	3.2
	8	3	3.9			
	9	5	6.4			
	10	26	33.3	10	1	3.2
	15	1	1.3			

	Fish Sluice			Debris Sluice		
Species	No. of Fish in Test	Test Frequency	Percent of All Tests	No. of Fish in Test	Test Frequency	Percent of All Tests
White perch	1	8	6.3	1	5	6.5
	2	4	3.2	2	4	5.2
	3	2	1.6	3	8	10.4
	4	4	3.2	4	3	3.9
	5	8	6.3	5	2	2.6
	6	8	6.3	6	6	7.8
	7	7	5.5	7	3	3.9
	8	9	7.1	8	8	10.4
	9	12	9.5	9	4	5.2
	10	59	46.5	10	30	39.0
	11	1	0.8	11	2	2.6
				14	1	1.3
	15	5	3.9	15	1	1.3

Table 3-4. Total numbers of fish collected for survival analysis from the Indian Point Unit 2 Ristroph screen, January - April, 1985.

Species	Fish Sluice	Debris Sluice	Total
Alewife	22	3	25
Atlantic silverside	1	0	1
Atlantic tomcod	32	8	40
Banded killifish	2	0	2
Blueback herring	7	1	8
Bluegill	3	0	3
Brown bullhead	1	0	1
Four-bearded rockling	1	1	2
Gizzard shad	2	2	4
Golden shiner	1	0	1
Northern pipefish	0	1	1
Pumpkinseed	17	0	17
Rainbow smelt	76	59	135
Red hake	17	8	25
Spottail shiner	34	5	39
Spotted hake	3	1	4
Striped bass	860	264	1,124
Tesselated darter	25	1	26
Three-spine stickleback	1	1	2
White catfish	85	25	110
White perch	4,227	2,051	6,278
Winter flounder	1	1	2
Total	5,418	2,432	7,850

Table 3-5. Initial and latent percent survival of selected fish species collected from Indian Point Unit 2 Ristroph screen, January - April, 1985.

Fish Sluice

Species	Initial Survival (%) Standard Method	Initial Survival (%) dfe Method	Latent Survival (%) Standard Method	Latent Survival (%) dfe Method
Alewife	95.5	18.1	15.0	50.0
Atlantic tomcod	100.0	68.8	80.6	80.0
Pumpkinseed	100.0	68.8	94.1	91.7
Rainbow smelt	97.4	96.1	95.9	95.7
Red hake	100.0	58.8	38.5	0.0
Spottail shiner	100.0	94.1	100.0	96.8
Striped bass	95.6	70.3	79.9	85.6
Tesselated darter	100.0	100.0	100.0	100.0
White catfish	98.8	90.6	95.9	91.1
White perch	95.6	68.7	85.9	91.5

Debris Sluice

Species	Initial Survival (%) Standard Method	Initial Survival (%) dfe Method	Latent Survival (%) Standard Method	Latent Survival (%) dfe Method
Alewife	100.0	0.0	0.0	NS
Atlantic tomcod	100.0	75.0	75.0	83.3
Pumpkinseed	NS	NS	NS	NS
Rainbow smelt	91.5	83.1	82.9	94.1
Red hake	100.0	25.0	28.6	0.0
Spottail shiner	100.0	80.0	100.0	100.0
Striped bass	83.3	44.7	57.8	79.5
Tesselated darter	100.0	100.0	100.0	100.0
White catfish	96.0	84.0	100.0	85.0
White perch	88.0	47.8	61.0	77.2

NS = No sample

Table 3-6. Total percent survival of selected fish species collected from Indian Point Unit 2 Ristroph screen, January - April, 1985.

Species	Fish Sluice: Standard Method	Fish Sluice: dfe Method	Debris Sluice: Standard Method	Debris Sluice: dfe Method
Alewife	14.3	9.1	0.0	NS
Atlantic tomcod	80.6	55.0	75.0	62.5
Pumpkinseed	94.1	63.0	NS	NS
Rainbow smelt	93.4	91.9	75.9	78.2
Red hake	38.5	0.0	28.6	0.0
Spottail shiner	100.0	91.1	100.0	80.0
Striped bass	76.4	60.2	48.2	35.5
Tesselated darter	100.0	100.0	100.0	100.0
White catfish	94.8	82.5	96.0	71.4
White perch	82.1	62.9	53.7	36.9

NS = No sample

Table 3-7. Overall survival for selected species collected from Indian Point Unit 2 Ristroph screen, January - April, 1985 (based on total number of fish collected for survival analysis).

Species	Survival (%) Standard Method	dfe Method
Alewife N=25	12.6	8.0
Atlantic tomcod 40	79.5	56.5
Pumpkinseed 17	94.1	63.0
Rainbow smelt 135	85.7	85.7
Red hake 25	35.3	0.0
Spottail shiner 39	100.0	89.7
Striped bass 1124	69.7	54.4
Tesselated darter 26	100.0	100.0
White catfish 110	95.0	80.0
White perch 6228	72.8	54.4

7819 = 99.61% of Total

7850 Total

Table 3-8. Overall survival for selected fish species collected from Indian Point Unit 2 Ristroph screen, January - April, 1985 (based on total number of fish collected from all recessed position intervals).

Species	Survival (%) Standard Method	dfe Method
Alewife	11.1	7.0
Atlantic tomcod	79.9	56.0
Pumpkinseed	87.3	58.5
Rainbow smelt	87.7	87.4
Red hake	36.5	0.0
Spottail shiner	100.0	89.7
Striped bass	68.7	53.5
Tesselated darter	100.0	100.0
White catfish	95.0	80.1
White perch	72.8	54.4

Table 3-9. Recapture of marked fish classified by release intake screen and recapture intake screen at Indian Point Unit No. 2, January - April, 1985.

Recapture Screen	N	Mean Percent Return	Standard Error of Mean
		Release Screen 21	
21	11	14.8	5.6
22	11	0.9	0.4
23	11	1.1	0.4
24	11	0.6	0.3
25	11	0.1	0.1
26	11	2.5	0.9
		Release Screen 22	
21	11	1.6	0.5
22	11	7.6	4.9
23	11	0.9	0.4
24	11	0.7	0.3
25	11	1.2	0.9
26	11	2.5	0.7
		Release Screen 23	
21	11	1.8	0.8
22	11	0.7	0.2
23	11	15.8	6.5
24	11	0.6	0.2
25	11	0.1	0.1
26	11	1.5	0.9
		Release Screen 24	
21	9	0.4	0.4
22	9	1.0	0.9
23	9	0.1	0.1
24	9	4.8	1.4
25	9	1.1	0.9
26	9	9.4	3.4

Table 3-9. (Continued)

Recapture Screen	N	Mean Percent Return	Standard Error of Mean
		Release Screen 25	
21	11	0.5	0.3
22	11	0.3	0.2
23	11	0.2	0.1
24	11	2.7	1.2
25	11	1.5	0.6
26	11	16.8	4.4

N = Number of releases of marked fish.

Table 3-10. Overall survival for selected fish species from the Indian Point Unit 2 Ristroph screen, January - April, 1985 (based on method in which damaged fish are considered alive in calculating initial survival and dead in calculating latent survival).

Species	Survival (%)
Alewife	8.4
Atlantic tomcod	59.0
Pumpkinseed	88.2
Rainbow smelt	85.7
Red hake	5.2
Spottail shiner	97.4
Striped bass	68.6
Tesselated darter	100.0
White catfish	85.1
White perch	66.1

Section 4

THE EFFECT OF SCREEN POSITION ON IMPINGEMENT

Introduction

The potential installation of Ristroph screens at a point within the intake forebays at IP 2 raised the question of whether more fish would be impinged on screens at that point than on screens installed at the entrance to the intakes. The behavioral and physiological factors influencing impingement are not understood, but the possibility was thought to exist that, a) more fish would be attracted into the forebay and become exposed to impingement, or b) a smaller proportion of fish exposed to impingement on a recessed screen would be behaviorally inclined or physically capable of escaping than fish exposed to a screen at the front or, c) a combination of the two would occur.

Recessing the screen also seemed to introduce the potential for impinging more larger fish than installing screens at the entrance to the intakes. Larger fish, stronger swimmers than smaller fish of the same species, might be able to avoid impingement on flush mounted screens, but could conceivably be unable or disinclined to swim the 10 to 12 ft against the incurrent water flow required to avoid impingement on the recessed screen.

This section describes the results of studies carried out to address the questions related to the influence of screen location on impingement.

Analytical Methods

In order to determine whether the location of the screens in the intake at Indian Point Unit 2 might materially affect the number of fish impinged, comparisons were made between impingement rates (fish impinged per hour) on the fixed screen which was located at the entrance to intake bay 26 and impingement rates on the Ristroph screen which was recessed within the forebay at intake 26.

Calculation of an impingement rate requires knowledge of the number of fish impinged and the length of time during which that impingement occurred. The number of fish collected during, or at the end of, an impingement interval may not reflect the number of fish impinged during that interval because of inefficiencies in collection. Accurate estimates of the impingement rate during each interval may require two adjustments to the numbers collected. The more obvious adjustment is that which scales the count of fish collected upward to account for losses of fish impinged during or prior to the collection process. There may also be a need to adjust the counts of fish collected downward to remove the contribution of fish impinged and killed, but not collected, during a previous interval.

The following example serves to illustrate the applicability of both such adjustments. Consider two consecutive 12-hour impingement intervals. At the start of each, 100 marked dead fish are released immediately in front of the screens. It is assumed that these become impinged and that the proportion subsequently collected provide a measure of the efficiency with which all impinged fish are collected. At the end of the first interval 1000 fish are collected, in addition to 50 marked fish. At the end of the second interval 1000 fish are also collected. In addition, 100 marked fish released at the start of the second interval and 25 marked fish from the previous interval are also collected.

If only the unmarked fish actually collected during each interval (1000) are considered, no apparent difference in impingement rate exists between the two intervals. However, in light of the data on collection efficiency, a better estimate of the number of fish impinged during the first interval is 2000 because fish were collected with only 50% efficiency. For the second interval, the estimated number of fish impinged remains 1000 because collection efficiency was 100%. Impingement rates for intervals one and two are therefore 167 fish/hr (2000/12) and 83 fish/hr (1000/12), respectively.

However, another adjustment should be made to the number of fish collected at the end of the second interval to reflect the contribution of fish first impinged, but not collected, during the previous interval. Twenty-five percent of the marked fish released during the first interval were recovered in the collection made at the end of the second interval. Presumably unmarked fish are collected with the same efficiency as marked fish, and therefore, 25% (500) of all (2000) fish impinged during the first interval were apparently among the 1000 fish collected at the end of the second interval. Therefore, only 500 of the 1000 fish collected at the end of the second interval should properly be considered to have been impinged during that interval. (In this example it was assumed that there was no contribution of fish from a previous impingement interval to the collection made at the end of the first interval). The best estimate of the impingement rates for intervals one and two are 167 fish/hr and 41 fish/hr, respectively.

The best estimates of impingement rate can be made for impingement intervals with collections meeting the following criteria:

a. The collection was made during (Ristroph screen) or at the end of (fixed and Ristroph screens) an interval unaffected by interruptions in pump operation or other operating or sampling problems; the fish collected could therefore be accurately assigned to an impingement interval of known duration.

b. Collection efficiency data are available for the collection to enable appropriate scaling to be done.

c. The collection is preceded by at least one collection meeting criteria a and b so that the contribution of fish, if any, from that preceding interval can be accounted for.

By design, data from approximately 180 impingement intervals of 12-hour duration (2 per day from January 16 through April 17) were expected to be available. Those samples were to be equally divided between the fixed (front location) and Ristroph (recessed location) screens and between night and day. However, because of operating problems with both the fixed and Ristroph screens, irregular wash schedules necessitated by the heavy debris loads in the river, the need on occasion to turn off the circulating water pump at intake 26 to relieve head loss pressures across the fixed screen, and miscellaneous minor changes to the original design, data from considerably fewer representative 12-hour collections were available for analysis. Valid fish collections were available for 131 twelve-hour impingement intervals. Of those, 84 had associated collection efficiency tests and 58 were immediately preceded by a good collection with associated collection efficiency data.

Impingement rates were calculated for selected species of fish and for all species combined using two data subsets. The first subset consisted of 58 samples for which adjustments could be made for both collection efficiency and any contribution of fish from the preceding collection. The second subset consisted of 84 samples for which adjustments could be made for collection efficiency, but the contribution of fish from the preceding collection could not be estimated. These 84 samples included the 58 samples from the first subset; therefore, the two are not independent.

Species examined individually were white perch, striped bass, Atlantic tomcod, rainbow smelt, white catfish and spottail shiner. These were the species impinged in the greatest numbers and collectively accounted for almost 98% of the fish collected from the Ristroph and fixed screen collections at intake 26 during this study (Table 4-1).

Impingement rates were calculated by dividing adjusted counts of fish collected by the duration (hr) of the sampling interval and compared statistically using two way analysis of variance (ANOVA) with an alpha level of 0.05. Rates were transformed logarithmically prior to ANOVA to ensure normality. Factors tested in the model were screen position (front vs. recessed) and time of day (day vs. night). Collection intervals ending in the evening (typically between 2000 hr and 2200 hr) were considered to represent daytime impingement. Intervals ending in the morning (typically 0800 hr to 1000 hr) were considered to represent nighttime impingement. ANOVA was carried out individually for all six species for which rates were calculated, as well as for all species combined. However, results are discussed only for striped bass, white perch and all species combined. For the other four species the ANOVA model almost invariably proved to be non-significant ($p = .05$), due principally to the relatively high number of samples in which those species were absent; therefore no conclusions could be drawn concerning the effects of screen position or time of day on impingement. ANOVA summaries for all species appear in Appendix B.

Impingement rates at Indian Point are known to vary widely, sometimes by as much as two orders of magnitude from day to day. In an attempt to determine whether differences in impingement rates detected between the fixed (front) and Ristroph (recessed) screens might be due to coincidental differences in fish abundance near the intakes, an independent index of fish abundance was established. Data were examined from collections made at intakes 21-25 and at intake 26 to identify periods corresponding approximately in time. Since screens were washed sequentially, exact overlap in the duration of the impingement intervals represented by the collections was impossible to attain. Therefore, a collection made at intakes 21-25 was considered to correspond with a collection made at intake 26 if the impingement interval at that intake included within ± 4 hours, the interval at intake 26.

Corresponding collections at intakes 21-25 were found for 22 fixed screen intervals (each interval was comprised of two 12 hour collections) and 26 Ristroph screen intervals at intake 26. Average impingement rates (fish/hr) were calculated for all species combined and for striped bass, white perch, Atlantic tomcod, spottail shiner, rainbow smelt and white catfish. No adjustments were made to collections from intake 21-25 for collection efficiency. Impingement rates at intakes 21-25 (pooled) for periods corresponding with Ristroph screen collection intervals at intake 26 were compared with rates for periods corresponding with fixed screen collection intervals using one-way ANOVA.

Impingement rates were also calculated for the corresponding fixed and Ristroph screen collections at intake 26. For comparative purposes, rates at intake 26 were adjusted using the empirical average collection efficiency for fixed screens and an assumed collection efficiency of 90% for the Ristroph screen (see below).

In order to determine whether there was a difference between the sizes of fish impinged at the two screen locations, length frequency distributions were plotted and comparisons were made between the mean lengths of individuals of selected species collected from the fixed and Ristroph screens. The average lengths of the six species considered previously were compared using one-way ANOVA.

Results

1. Collection Efficiency

Based upon data for all (84) collections for which collection efficiency data were available, the percentage of marked fish recovered during the first collection made after their release was higher for fish released at the start of a Ristroph screen collection interval (70.8%) than for fish released at the start of a fixed screen collection interval (50.2%). The potential contribution of fish from a fixed screen impingement interval to a subsequent collection was also greater than from a Ristroph screen collection. A mean of approximately 9.5% of the fish from a fixed screen interval were recovered in the collection at the end of the next impingement interval, whereas an average of approximately 1.9% of the fish from a Ristroph interval contributed to the next collection (Table 4-2). The contribution from a fixed screen collection to the next collection (from either the fixed or the Ristroph screen) ranged from 0% to 39%. For Ristroph collections the contribution to the next collection ranged from 0% to 31%. Contributions to later collections (after the second collection) were about 2.7% and 1.7% for fish from fixed and Ristroph screens, respectively (Table 4-2).

The collection efficiency reported here from the fixed screen at intake 26 was comparable to that reported previously from the fixed screens at IP 2 (Normandeau, 1984a), but the collection efficiency from the Ristroph screen was lower than expected and was probably not representative of true collection efficiency. It was anticipated when the study was designed that marked fish with which to determine collection efficiency from the Ristroph screen would be dropped immediately in front of that screen so as to ensure that they would become impinged. However, when the studies were initiated in mid-January it was discovered that there was no access point through which to release fish immediately in front of the screen because the forebay is covered by a concrete deck. It was assumed at that time that if fish were released at the entrance to the forebay they would be carried by the water flow to the screen (a distance of about 11 feet) and become impinged.

After several weeks of highly variable collection efficiency results it was realized that some fish released at the forebay entrance probably never reached the Ristroph screen. Eddy currents caused by structures in the water flowpath within the intake bay could have trapped marked fish and prevented them from becoming impinged on the Ristroph screen. Failure of fish to reach the traveling screen for collection is appropriately reflected in the collection efficiency adjustment for the fixed screen collections. However, fish which actually become impinged on the Ristroph screen are not ordinarily exposed to entanglement in the forebay after impingement, and collection efficiency corrections applied to Ristroph screen collections should not reflect such losses.

Since estimates of collection efficiency from the Ristroph screen based on fish released at the entrance to the intake were biased, efforts were made to find a means of releasing marked fish closer to the Ristroph screen. By late March, an unused drain in the concrete forebay decking approximately 2 feet in front of the screen was dismantled and a length of PVC pipe was inserted to convey fish to the area in front of the screen. However, even this position was felt not to be fully suitable for the release of marked fish because they had to be released at the water surface rather than below the surface where fish are ordinarily impinged; surface eddies may prevent some of these fish from ever being impinged. Only a single representative collection efficiency test was successfully completed before the Ristroph screen failed completely in early April, but results suggested that earlier efficiencies were under-estimated and that true efficiency for Ristroph screen collections was more on the order of 80-90%.

Support for the estimate of 90% collection efficiency was provided by the results of five tests in each of which 50 dead dyed fish were dropped into the trays at the lower edge of the Ristroph screen panels as they emerged from the water. Recovery rates from the fish and debris sluices for these fish ranged for 78% to 94% and averaged 89.2%. Therefore, for some analyses a collection efficiency adjustment of 90% was used to adjust collections from the Ristroph screen.

The same sampling artifacts which resulted in probable underestimates of collection efficiency from the Ristroph screen would also exaggerate the estimate of the contribution of fish from a Ristroph screen collection interval to a subsequent collection. Therefore for some analyses it was assumed that Ristroph screen impingement intervals contributed no fish to the subsequent collection.

2. <u>Impingement Rates at Intake Bay 26</u>

Data from those collections (58) for which adjustments for both collection efficiency and the contribution of fish from a preceding impingement interval could be made were examined first. Average overall (day and night) impingement rates were 19.3 fish/hr on the fixed screen and 76.2 fish/hr on the Ristroph screen prior to adjustment for collection efficiency.

After adjustments were made using collection-specific correction efficiency factors, the impingement rate for all species combined from the Ristroph screen (107.7 fish/hr) was approximately 3.4 times the rate from the fixed screen (32.0 fish/hr). Adjusted rates from the Ristroph screen exceeded rates from the fixed screen by factors ranging from 1.5 for the spottail shiner to 3.5 for white perch (Table 4-3). Differences for striped bass, white perch and all species combined were significant at the p = .05 level (Appendix B).

Impingement rates on the fixed screen differed little between day and night; although the Ristroph screen apparently impinged more striped bass and white perch at night, differences between day and night were not significant at the p = .05 level (Appendix B).

Because there was evidence supporting the premise that collection efficiency from the Ristroph screens was underestimated by the procedures used throughout most of the study and that true collection efficiency was closer to 90% an additional analysis was carried out. A collection efficiency of 90% was assigned to all Ristroph collections and the contribution from Ristroph collections to subsequent collections was assumed to be zero. The empirical values for collection efficiency and contribution of fish to succeeding collections used in the preceding analyses were retained for fixed screen collections.

When impingement rates were calculated in this fashion, (Table 4-4) the average hourly rate for all species combined from the Ristroph screen (82.9 fish/hr) was approximately 2.5 times the rate from the fixed screen (33.2 fish/hr). With the exception of the spottail shiner, the Ristroph screen impingement rates exceeded rates from the fixed screen for every species by factors ranging from 1.25 for Atlantic tomcod to 2.6 for white perch (Table 4-5). The difference in overall impingement rates between the Ristroph and fixed screens for all species combined and for striped bass and white perch was significant at p = .05, but the difference between daytime and nighttime rates was not (Appendix B).

Similar analyses were carried out using the larger subset of collections (84) for which collection efficiency data existed but the data needed to make adjustments for the contribution of fish from a preceding collection were lacking. Average overall impingement rates for all species combined were 16.8 fish/hr on the fixed screen and 59.8 fish/hr on the Ristroph screen prior to adjustment for collection efficiency.

After rates were adjusted using collection-specific collection efficiency factors, the rate of impingement of all species combined on the Ristroph screen (88.0 fish/hr) was approximately 2.4 times the rate on the fixed screen (36.1 fish/hr). The adjusted overall rate for the spottail shiner on the fixed screen exceeded the rate on Ristroph screen by a factor of 1.5. For the other species rates on the Ristroph screen exceeded rates on the fixed screen by factors ranging from 1.4 for the white catfish to 2.5 for the white perch (Table 4-5).

After the impingement rates on the Ristroph screen were adjusted to reflect 90% collection efficiency, the overall rate for all species combined on the Ristroph screen (66.4 fish/hr) was 1.8 times the rate on the fixed screen. The impingement rate of spottail shiner on the fixed screen exceeded that on the Ristroph screen by a factor of 1.5, while no difference existed for rainbow smelt. For the other species, impingement rates on the Ristroph screen exceeded rates on the fixed screen by factors ranging from 1.25 for white catfish to 1.9 for white perch (Table 4-5).

Differences in impingement rates between the fixed and Ristroph screens were significant ($p = .05$) for white perch, striped bass and all species combined regardless of which collection efficiency adjustment was used. Similarly nighttime impingement rates of white perch, striped bass, and consequently of all species combined, were significantly greater than daytime rates on both screens.

Average unadjusted impingement rates for all species combined at intakes 21-25 for collections corresponding to Ristroph

(8.2 fish/hr) and fixed (7.4 fish/hr) screen periods at intake 26 were very similar, as were rates for each species examined individually (Table 4-6). No differences were found to be significant (p = .05). During these periods, the rate of impingement on the Ristroph screen at intake 26 (59.0 fish/hr) was 1.7 times the impingement rate on the fixed screen (34.9 fish/hr). Assuming that the average impingement rates at intakes 21-25 reflect fish abundance (or vulnerability to impingement) near intake 26, the similarity in impingement rates at intakes 21-25 during periods coinciding with collections from the fixed and Ristroph screens at intake 26 indicate that differences between impingement rates on those screens at intake 26 were not due to coincidental differences in fish abundance near the intake.

3. Sizes of fish impinged

No substantial differences were found to exist between the length frequency distributions of fish collected from the fixed and Ristroph screens for any of the six species examined (Figs 4-1 through 4-6). Although the average lengths of striped bass, white perch and white catfish impinged on the Ristroph screen were found to be significantly (p = .05) greater than those impinged on the fixed screen, the differences for striped bass and white perch were less than 2mm; that for white catfish (approximately 20mm) was somewhat greater but did not appear to be reflective of any real size-related difference in behavior. Average lengths of Atlantic tomcod, rainbow smelt and spottail shiner did not differ significantly between screens (Table 4-8).

Discussion

Data collected from mid-January through early April suggest that if Ristroph screens were installed 10 to 12 ft behind the entrances to the intake forebays at Indian Point more fish would be impinged than if the screens were installed at the entrances to the intake bays. However, the magnitude of the difference remains uncertain and apparently varies among species. Estimates of the difference for all species combined ranged from about 80% to nearly 200% depending upon the time periods for which data were available and adjustments made to correct for differences in collection efficiency between the two screens.

Estimates of impingement rates based on those collections for which all appropriate adjustments can be made using collection specific data were expected to be the most accurate, but in retrospect may not be because collection-specific collection efficiency correction factors probably underestimated collection efficiency from the Ristroph screen. Attempts to collect supplementary data were limited by the mechanical problems which beset the Ristroph screen, but a collection efficiency on the order of 90% appears more realistic than the empirical average of about 71%. Therefore, comparisons based upon impingement rates with Ristroph screen collections adjusted with a 90% collection efficiency factor seem to be more appropriate.

Collections included within the smaller data subset are not well distributed throughout the study interval, but are largely concentrated in late January and February. Fifty-one of 58 samples (88%) were taken between January 24 and February 28; none after March 21. Samples from the larger subset are distributed more equitably. Approximately three-quarters of the collections were made in January and February and one-quarter in March and early April; collections are approximately equally distributed between the fixed and Ristroph screens over this period. Therefore, the analyses using the larger subset may more accurately reflect the range of environmental conditions which occurred during the test period.

These more comprehensive data suggest that positioning the screen in the recessed position used during this study may result in the impingement of 80% to 100% more fish than if the screens were placed at the forebay entrance, at least during the winter.

However, this difference cannot be attributed entirely to differences in screen position. Much of the difference may be attributable to an apparent bias in the sampling procedures which reduced the number of fish impinged on the fixed screen.

As described in Section 2, each 24 hour fixed screen sampling period began with lowering of the fixed screen at the end of a Ristroph screen period and ended with the raising of the fixed screen to begin another Ristroph-screen period. At the mid-point of the period the fixed screen was raised and washed, thereby producing two 12 hour sampling intervals. During the time that the fixed screen was down, fish in the forebay between the fixed and Ristroph screens continued to be collected on the Ristroph screen. These collections were referred to as "entrapment" collections and the fish kept separate from the other collections because their proper assignment is uncertain. However, it appears that many of these fish are most properly assignable to the fixed screen collections.

Three sources of origin exist for those fish collected as entrapped fish. Some of those fish may be individuals which moved around or under the fixed screen or through the gap between the upper and lower halves of the screen. Although the gap between the two screen halves was supposed to be covered by a rubber flap, the tightness of fit is uncertain. Another portion of the fish are probably individuals which were in the area of the fixed screen when it was raised and washed after the first 12 hours of a 24 hour fixed screen collection period. The third category are those fish which were in the forebay when the fixed screen was lowered at the end of a Ristroph screen collection period. An example may serve to demonstrate the bias introduced by excluding these fish from the preceding analyses.

Of fish exposed to impingement (i.e. approaching a screen, either fixed or Ristroph) during any fixed time interval some will be impinged, some will presumably swim away and escape, and some will remain in front of the screen. Those which are disinclined or unable to swim away will eventually become fatigued and be impinged during a subsequent interval. The number of fish actually impinged during any interval may consist largely of fish which were first exposed to impingement and became fatigued during a preceding interval. Assume a sequence of five days (24 hours) during each of which 100 fish approach an intake screen. Of those 100 fish, 25 swim away, 50 become impinged during that day and the other 25 remain, for whatever reason, in front of the screen and become fatigued to the point that they are impinged the next day. After the first day on which only 50 fish would be impinged, 75 fish would be impinged each day.

We can now impose the sampling protocol used at Indian Point on the above scenario by assuming that days 1 , 3 and 5 were fixed screen collection days and days 2 and 4 were Ristroph screen collection days. On day 1, 50 fish would be impinged on the fixed screen, 25 would escape and 25 "fatigued" fish would remain in front of the fixed screen at the time it was raised and washed. Those 25 fatigued fish which would presumably move passively into the now unobstructed forebay would be impinged on day 2 along with 50 "fresh" fish to produce a total impingement count of 75 fish. However, at the end of the second day when the fixed screen was lowered to begin another fixed screen collection interval, the 25 "fatigued" fish would remain in front of the Ristroph screen and when eventually impinged on day 3 would be considered "entrapped" fish; only 50 fish would be impinged on the fixed screen during day 3. Similar circumstances would occur on days 4 and 5; the 25 fish fatigued on day 3 would be collected on day 4 from the Ristroph screen and be considered Ristroph screen fish, but the 25 fish fatigued on day 4 would be collected on day 5 and be considered "entrapped" fish. Over this period the impingement rate on the fixed screen would be estimated to be 50 fish/day and that on the Ristroph screen 75 fish/day. The difference (25 fish/day) is reflected in the entrapped fish.

This bias toward reducing the number of fish impinged on the fixed screen was increased to some extent by raising and washing the fixed screen at the midpoint of a fixed screen period (i.e. after 12 hours). This undoubtedly allowed some fish which would have been impinged on the fixed screen during the second 12 hour interval an opportunity to enter the forebay and be collected during those 12 hours as "entrapped" fish rather than fixed screen fish. Similarly, any fish which managed to pass around or under the fixed screen would also be subsequently collected as "entrapped" or Ristroph screen fish, even though had they not found such an escape route, they may well have been impinged on the fixed screen.

It cannot be determined what proportion of those fish fatigued at the end of a Ristroph screen collection period would have remained in front of the screen if it were located at the intake entrance and what proportion remained only because they were entrapped by the side walls of the forebay and the fixed screen. However, it is clear that a definite bias existed to reduce the number of fish collected from the fixed screen.

The maximum degree to which this bias in the sampling design may have contributed to the apparent differences in impingement can be evaluated by examining the impingement rates during the "entrapment" periods. If one assumes that all of the fish impinged during each entrapment interval (corresponding to a fixed screen interval) would have remained in front of the fixed screen (i.e. behaviorally trapped) and been impinged had they not had an opportunity to get behind it, then fish collected during entrapment intervals should be added to the fixed screen collections to more accurately determine impingement rate on a screen at the entrance to an intake.

Since the average impingement rate of entrapped fish was high (15 fish/hr for the larger data set) and, therefore, the potential effect of the bias was great, data were analyzed to assess the maximum effect of the bias on conclusions regarding the effect of screen position on the number of fish impinged. The numbers of fish collected during the entrapment interval corresponding to each fixed screen collection in the larger data set were added to the numbers of fish collected from the fixed screen. Before being added the numbers of entrapped fish collected were adjusted to reflect the expected 90% collection efficiency from the Ristroph screen. The impingement rates for all species combined (52.8 fish/hr) resulting from adding adjusted fixed screen (36.1 fish/hr) and entrapment (16.7 fish/hr) collections were compared with adjusted (90% collection efficiency) impingement rates from the Ristroph screen (66.4 fish /hr).

Under the assumption that all entrapped fish would have been impinged on the fixed screen, the Ristroph screen in the recessed position had an average impingement rate approximately 1.3 times that of the fixed screen, but the difference was not statistically significant ($p = .05$) when tested with two-way ANOVA (Table 4-7.

Another factor which was not considered in the study design and for which no adjustment could be made in the data analysis is the possibility that at least some of the differences in impingement found between the fixed screen and Ristroph screens in this study may be due to an inherently greater "fishing" efficiency of the Ristroph screen when rotated continuously. It has been suggested based on observations elsewhere that a Ristroph screen may actually pick up fish poised in front of it as the buckets rotate up from below them. If this phenomenon occurs, it would be expected to have its greatest effect when water temperatures are lowest and fish of at least certain species, such as white perch, are most lethargic. The more rapidly the screen is rotated, the greater the fishing efficiency would be expected to be. Although this higher fishing efficiency may have contributed to some extent to the apparently higher impingement rate on the Ristroph screen in this study, its influence on screen efficiencies would be trivial because an extremely high proportion of fish collected in this fashion would be subjected to very little stress and survival would be high.

Because of the bias introduced by the sampling program, the uncertainty as to the true collection efficiency from the Ristroph screen, and the possibility that a continuously rotating screen fishes more efficiently than a fixed screen, the influence of screen position on the number of fish impinged was not conclusively determined by these studies. If the suggestion that true collection efficiency from the Ristroph screen was approximately 90% and the assumption that all entrapped fish would have been impinged on the fixed screen had it remained down are correct, then screen position did not significantly influence the numbers of fish impinged. If collection efficiency from the Ristroph screen was less than 90% or if some of the entrapped fish would have escaped impingement on the fixed screen, then installing the screens in the recessed position in the forebay may result in an increase in the numbers of fish impinged.

Table 4-1 Numbers of Fish Collected from the Ristroph and fixed Screens at Indian Point Unit No. 2, Intake 26, during the Period from January 16 through April 19, 1985

Species	FIXED SCREENS Total Count	RISTROPH SCREENS Total Count	Total
Alewife	26	117	143
American shad	1	1	2
Bluegill	3	9	12
Brown bullhead	7	15	22
Pumpkinseed	46	144	190
Black crappie	1	-	1
American eel	36	131	167
Golden shiner	3	8	11
Hogchoker	65	198	263
Tesselated darter	16	61	77
Banded killifish	2	13	15
Largemouth bass	1	-	1
Mummichog	-	6	6
Blueback herring	6	29	35
Atlantic silverside	-	1	1
Rainbow smelt	150	373	523
Spottail shiner	100	217	317
Striped bass	1719	5546	7265
Four spine stickleback	3	-	3
Atlantic tomcod	120	413	533
White catfish	149	443	592
White perch	11749	37536	49285
Yellow perch	2	11	13
Northern pipefish	5	4	9
Redbreast sunfish	-	1	1
Sea Horse	-	1	1
Four bearded rockling	-	4	4
Striped cuskeel	2	-	2
Winter flounder	3	4	7
Tide water silverside	2	2	4
Sea lamprey	1	7	8
Gizzard shad	49	105	154
Silver hake	5	9	14
Three spine stickleback	51	90	141
Centrarchid unid.	-	2	2
Red hake	29	88	117
Grubby	1	1	2
Windowpane flounder	1	3	4
Spotted hake	4	12	16
Rock gunnel	-	3	3
TOTAL	14,358	45,608	59,966

Table 4-2 Efficiency (%) with which Marked Dead Fish Were Collected from the Ristroph and Fixed Screens at Indian Point Unit 2, Intake 26 during Initial and Subsequent Collection Periods after their Release in front of Intake 26.

	FIXED SCREEN			RISTROPH SCREEN		
	Mean	Standard Error	(Number of Releases)	Mean	Standard Error	(Number of Releases)
Percent return to 1st collection after release (≅12-hour).	50.2%	3.4	(39)	70.8%	2.5	(45)
Percent return to 2nd collection after release (≅12-hour).	9.5%	1.4	(39)	1.9%	0.7	(45)
Percent return to 3rd and all subsequent collections after release.	2.7%	0.4	(39)	1.7%	0.3	(45)

Table 4-3 Average Adjusted[1] Impingement Rates (No. of fish/hour) on the Fixed and Ristroph Screens at Indian Point Unit 2, Intake 26, January 16 through April 19, 1985[2].

Species	FIXED SCREEN			RISTROPH SCREEN		
	Overall	Day	Night	Overall	Day	Night
Number of Samples	27	13	14	31	14	17
All species						
Mean	32.0	28.5	35.2	107.7	84.2	127.0
Standard Error	9.1	14.6	11.8	21.3	26.8	32.0
Striped bass						
Mean	3.6	2.0	5.1	11.8	7.8	15.1
Standard Error	1.4	0.6	2.6	2.3	1.7	3.9
White perch						
Mean	26.3	25.0	27.5	91.6	71.9	107.7
Standard Error	8.2	14.1	9.6	19.6	25.7	29.0
Atlantic tomcod						
Mean	0.4	0.2	0.5	0.7	0.5	0.8
Standard Error	0.1	0.1	0.2	0.2	0.2	0.2
Rainbow smelt						
Mean	0.4	0.3	0.5	0.9	1.4	0.5
Standard Error	0.2	0.1	0.3	0.3	0.5	0.2
White catfish						
Mean	0.3	0.1	0.5	0.7	0.7	0.7
Standard Error	0.1	<0.1	0.2	0.1	0.2	0.2
Spottail shiner						
Mean	0.2	0.2	0.1	0.3	0.3	0.3
Standard Error	<0.1	0.1	0.1	0.1	0.1	0.1

[1] Rates for both screens were adjusted using empirical collection-specific efficiency and the contribution of fish from one preceding collection.

[2] Data from 58 collections for which both collection efficiency and the contribution of fish from a precding interval could be estimated.

Table 4-4 Average Adjusted[1] Impingement Rates (No. of fish/hour) on the Fixed and Ristroph Screens at Indian Point Unit 2, Intake 26, January 16 through April 19, 1985[2].

Species	FIXED SCREENS Overall	Day	Night	RISTROPH SCREENS Overall	Day	Night
Number of Samples	27	13	14	31	14	17
All species						
Mean	33.2	34.2	32.3	82.9	64.8	97.8
Standard Error	8.7	14.8	10.3	17.6	23.1	26.0
Striped bass						
Mean	3.7	2.8	4.6	8.8	5.7	11.3
Standard Error	1.2	0.9	2.2	1.7	1.3	2.8
White perch						
Mean	27.4	29.9	25.1	70.9	55.8	83.3
Standard Error	8.0	14.2	8.7	16.4	22.3	23.8
Atlantic tomcod						
Mean	0.4	0.2	0.5	0.5	0.3	0.7
Standard Error	0.1	0.1	0.2	0.1	0.1	0.2
Rainbow smelt						
Mean	0.4	0.3	0.5	0.7	1.0	0.4
Standard Error	0.2	0.1	0.3	0.2	0.4	0.2
White catfish						
Mean	0.3	0.1	0.5	0.5	0.5	0.5
Standard Error	0.1	<0.1	0.2	0.1	0.1	0.1
Spottail shiner						
Mean	0.2	0.2	0.1	0.2	0.2	0.2
Standard Error	<0.1	0.1	0.1	<0.1	<0.1	<0.1

1 Rates were adjusted using an assumed collection efficiency of 90% with no contribution to a subsequent collection for collections from the Ristroph screen and empirical collection-specific factors for collections from the fixed screen.

2 Data from 58 collections for which both collection efficiency and the contribution of fish from a preceding interval could be estimated.

Table 4-5 Average Adjusted Impingement Rates (No. of fish/hour) on the Fixed and Ristroph Screens at Indian Point Unit 2, Intake 26, January 16 through April 19, 1985[1].

	FIXED SCREENS			RISTROPH SCREENS					
	Actual Collection Efficiency[2]			Actual Collection Efficiency[2]			90% Collection Efficiency[3]		
Species	Overall	Day	Night	Overall	Day	Night	Overall	Day	Night
Number of Samples	39	23	16	45	26	19	45	26	19
All species									
Mean	36.1	27.9	47.9	88.0	63.2	122.1	66.4	49.2	90.0
Standard Error	7.5	8.9	13.0	16.4	16.2	30.8	13.0	13.8	23.8
Striped bass									
Mean	4.4	3.3	6.0	10.1	6.9	14.4	7.5	5.2	10.5
Standard Error	1.2	1.0	2.5	1.8	1.2	3.6	1.3	1.0	2.6
White perch									
Mean	29.3	22.7	38.7	74.1	52.6	103.5	56.0	41.2	76.3
Standard Error	6.8	8.4	11.2	15.0	15.3	27.9	12.1	13.1	21.8
Atlantic tomcod									
Mean	0.3	0.2	0.5	0.6	0.5	0.8	0.5	0.3	0.7
Standard Error	0.1	0.1	0.2	0.1	0.1	0.2	0.1	0.1	0.2
Rainbow smelt									
Mean	0.5	0.4	0.6	0.7	0.9	0.5	0.5	0.7	0.4
Standard Error	0.1	0.1	0.3	0.2	0.3	0.2	0.2	0.2	0.1
White catfish									
Mean	0.4	0.2	0.6	0.6	0.6	0.7	0.5	0.4	0.5
Standard Error	0.1	0.1	0.2	0.1	0.1	0.2	0.1	0.1	0.1
Spottail shiner									
Mean	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2
Standard Error	0.1	0.1	0.1	<0.1	0.1	0.1	<0.1	<0.1	<0.1

[1] Data from 84 collections for which collection efficiency, but not the contribution of fish from a preceeding collection, could be estimated.

[2] Rates were adjusted using empirical collection specific factors for collection efficiency.

[3] Rates were adjusted using an assumed collection efficiency of 90%.

Table 4-6 Average Impingement Rates (No. of fish/hour) at Intakes 21-25[1] (unadjusted) and 26 (adjusted[2]) during Periods of Fixed or Ristroph Screen Operation at Indian Point Unit No. 2, January 16 through April 19, 1985.

Species	INTAKE LOCATION 21 Through 25 Pooled: Fixed Screen Periods	INTAKE LOCATION 21 Through 25 Pooled: Ristroph Screen Periods	INTAKE LOCATION 26: Fixed Screen	INTAKE LOCATION 26: Ristroph Screen
All Species				
Mean	7.4	8.2	34.9	59.0
Standard Error	1.5	1.4	10.5	15.6
Striped bass				
Mean	0.9	1.0	4.0	6.5
Standard Error	0.2	0.2	1.1	1.4
White perch				
Mean	6.2	7.0	28.4	49.4
Standard Error	1.4	1.2	10.1	14.5
Atlantic tomcod				
Mean	0.1	0.1	0.2	0.4
Standard Error	<0.1	<0.1	0.2	0.1
Rainbow smelt				
Mean	<0.1	<0.1	0.6	0.6
Standard Error	<0.1	<0.1	0.2	0.2
White catfish				
Mean	<0.1	<0.1	0.4	0.6
Standard Error	<0.1	<0.1	0.1	0.1
Spottail shiner				
Mean	<0.1	<0.1	0.2	0.2
Standard Error	<0.1	<0.1	0.1	0.1

[1] At intakes 21-25 a total of 99 individual screen collections corresponding to 22 fixed screen collection periods and 105 individual screen collections corresponding to 26 Ristroph screen collection periods were pooled for analysis.

[2] Impingement rates adjusted assuming 90% collection efficiency for the Ristroph screen and 50.2% for the fixed screen.

Table 4-7 Two-way Analysis of Variance Comparing Impingement Rates* for All Species Combined between Screen Positions (fixed screen plus entrapped and Ristroph screen) and Daylight Period (Night or Day) at Indian Point Unit No. 2, Intake 2-6 between 16 January and 19 April 1985.

Source	Degrees of Freedom	Sum of Squares	Mean Square	Calculated F-Ratio	P>F**
Model	3	2.1210	0.7070	3.69	0.0151
Screen Position	1	0.0759		0.40	0.5307
Daylight Period	1	1.9598		10.24	0.0020
Screen Position x Daylight Period	1	0.0929		0.49	0.4882
Error	80	15.3176	0.1915		
Total	83	17.4386			

Statistical Model:
Rate = Screen Position + Daylight Period + Screen Position x Daylight Period + Error

Responsive
Variable = Log_{10} (X+1), where X = Hourly Impingement Rate for <u>All Species Combined</u>

Fixed Screen Collection Efficiency = Empirical Values
Entrapment Collection Efficiency = 90%
Ristroph Collection Efficiency = 90%

Coefficient of Determination (R^2) = 0.12

* Based upon 84 collections for which data were available with which to make adjustments for collection efficiency only.

** p>F = Probability of obtaining the calculated F-Ratio by chance.

Table 4-8. Average length (mm) of selected species collected from the fixed and Ristroph screens at Indian Point Unit 2, January 16 through April 19, 1985.

	Length, (Standard Deviation)	
Species	Fixed Screen	Ristroph Screen
White perch	73.3 (21.8)	74.3 (22.4)
Striped bass	89.2 (13.6)	90.7 (11.9)
Atlantic tomcod	140.8 (30.5)	134.6 (24.3)
Spottail shiner	86.2 (19.2)	89.4 (19.7)
Rainbow smelt	77.0 (5.3)	77.4 (5.7)
White catfish	109.6 (48.7)	124.1 (60.7)

FIGURE 4-1A LENGTH FREQUENCY DISTRIBUTION FOR WHITE PERCH
IMPINGED ON THE FIXED SCREEN AT INTAKE 26,
INDIAN POINT STATION FROM JANUARY 16 THROUGH APRIL 18, 1985

LENGTH (MM) INTERVALS		FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
000-010		0	0	0.00	0.00
011-020		0	0	0.00	0.00
021-030		0	0	0.00	0.00
031-040		2	2	0.02	0.02
041-050	*	64	66	0.55	0.57
051-060	***********************************	2037	2103	17.58	18.15
061-070	***	4598	6701	39.69	57.84
071-080	***	3391	10092	29.27	87.11
081-090	**********	581	10673	5.01	92.12
091-100	*	40	10713	0.35	92.47
101-110	**	123	10836	1.06	93.53
111-120	***	145	10981	1.25	94.78
121-130	**	118	11099	1.02	95.80
131-140	**	90	11189	0.78	96.57
141-150	**	108	11297	0.93	97.51
151-160	**	88	11385	0.76	98.27
161-170	*	66	11451	0.57	98.83
171-180	*	51	11502	0.44	99.27
181-190	*	47	11549	0.41	99.68
191-200		21	11570	0.18	99.86
201-210		10	11580	0.09	99.95
211-220		3	11583	0.03	99.97
221-230		2	11585	0.02	99.99
231-240		0	11585	0.00	99.99
241-250		1	11586	0.01	100.00
251-260		0	11586	0.00	100.00
261-270		0	11586	0.00	100.00
271-280		0	11586	0.00	100.00
281-290		0	11586	0.00	100.00
291-+++		0	11586	0.00	100.00

2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38
PERCENT

FIGURE 4-18 LENGTH FREQUENCY DISTRIBUTION FOR WHITE PERCH
IMPINGED ON THE RISTROPH SCREEN AT INTAKE 26,
INDIAN POINT STATION FROM JANUARY 16 THROUGH APRIL 18,1985

LENGTH (MM) INTERVALS		FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
000-010		0	0	0.00	0.00
011-020		0	0	0.00	0.00
021-030		0	0	0.00	0.00
031-040		0	0	0.00	0.00
041-050	*	101	101	0.27	0.27
051-060	**************************	4888	4989	13.16	13.43
061-070	***	14618	19607	39.35	52.78
071-080	**	12675	32282	34.12	86.90
081-090	************	2257	34539	6.08	92.98
091-100	*	235	34774	0.63	93.61
101-110	**	286	35060	0.77	94.38
111-120	**	381	35441	1.03	95.40
121-130	*	241	35682	0.65	96.05
131-140	*	202	35884	0.54	96.60
141-150	*	180	36064	0.48	97.08
151-160	*	171	36235	0.46	97.54
161-170	*	192	36427	0.52	98.06
171-180	*	219	36646	0.59	98.65
181-190	*	241	36887	0.65	99.30
191-200	*	127	37014	0.34	99.64
201-210		74	37088	0.20	99.84
211-220		39	37127	0.10	99.94
221-230		13	37140	0.03	99.98
231-240		3	37143	0.01	99.99
241-250		3	37146	0.01	99.99
251-260		1	37147	0.00	100.00
261-270		1	37148	0.00	100.00
271-280		0	37148	0.00	100.00
281-290		0	37148	0.00	100.00
291-+++		0	37148	0.00	100.00

2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38
PERCENT

FIGURE 4-2A LENGTH FREQUENCY DISTRIBUTION FOR ATLANTIC TOMCOD
IMPINGED ON THE FIXED SCREEN AT INTAKE 26,
INDIAN POINT STATION FROM JANUARY 16 THROUGH APRIL 18,1985

LENGTH (MM) INTERVALS		FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
000-010		0	0	0.00	0.00
011-020		0	0	0.00	0.00
021-030		0	0	0.00	0.00
031-040		0	0	0.00	0.00
041-050		0	0	0.00	0.00
051-060		0	0	0.00	0.00
061-070		0	0	0.00	0.00
071-080		0	0	0.00	0.00
081-090		0	0	0.00	0.00
091-100	*****	3	3	2.56	2.56
101-110	**************	8	11	6.84	9.40
111-120	***************************	16	27	13.68	23.08
121-130	**	28	55	23.93	47.01
131-140	************************************	21	76	17.95	64.96
141-150	*****************	10	86	8.55	73.50
151-160	************************	14	100	11.97	85.47
161-170	*****	3	103	2.56	88.03
171-180	**	1	104	0.85	88.89
181-190	**	1	105	0.85	89.74
191-200		0	105	0.00	89.74
201-210	*******	4	109	3.42	93.16
211-220	*******	4	113	3.42	96.58
221-230	*****	3	116	2.56	99.15
231-240	**	1	117	0.85	100.00
241-250		0	117	0.00	100.00
251-260		0	117	0.00	100.00
261-270		0	117	0.00	100.00
271-280		0	117	0.00	100.00
281-290		0	117	0.00	100.00
291-+++		0	117	0.00	100.00

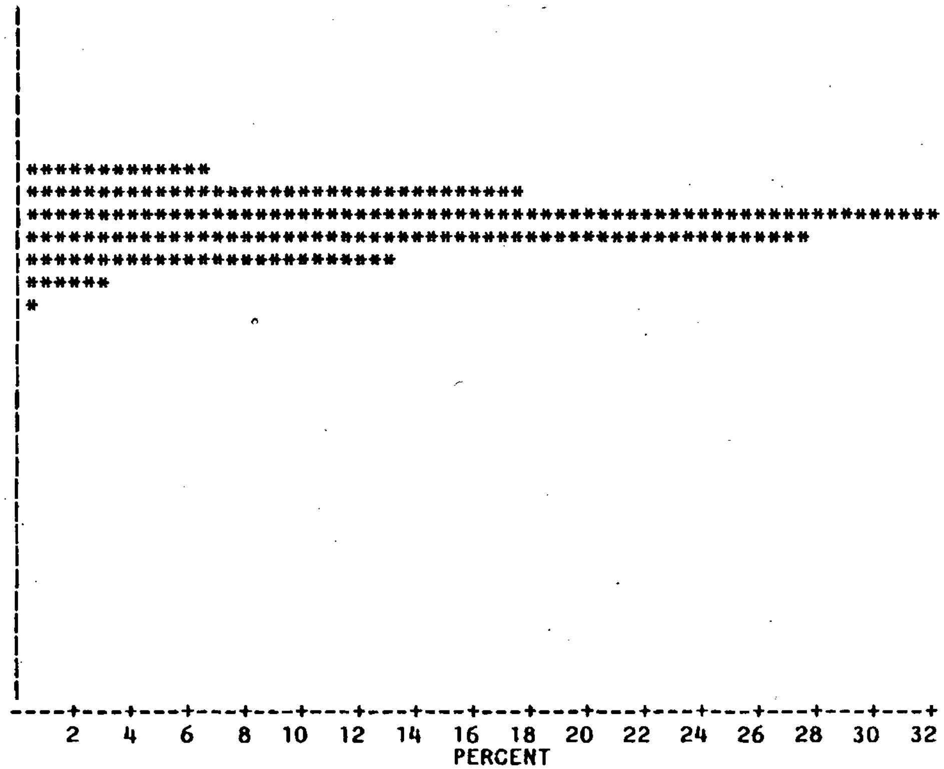
----+---+---+---+---+---+---+---+---+---+---+---+
2 4 6 8 10 12 14 16 18 20 22 24
PERCENT

FIGURE 4-2B LENGTH FREQUENCY DISTRIBUTION FOR ATLANTIC TOMCOD IMPINGED ON THE RISTROPH SCREEN AT INTAKE 26, INDIAN POINT STATION FROM JANUARY 16 THROUGH APRIL 18, 1985

LENGTH (MM) INTERVALS		FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
000-010		0	0	0.00	0.00
011-020		0	0	0.00	0.00
021-030		0	0	0.00	0.00
031-040		0	0	0.00	0.00
041-050		0	0	0.00	0.00
051-060		0	0	0.00	0.00
061-070		0	0	0.00	0.00
071-080		0	0	0.00	0.00
081-090		0	0	0.00	0.00
091-100	****	8	8	1.99	1.99
101-110	****************	33	41	8.21	10.20
111-120	*********************************	66	107	16.42	26.62
121-130	**	100	207	24.88	51.49
131-140	*************************************	74	281	18.41	69.90
141-150	*****************************	59	340	14.68	84.58
151-160	***********	22	362	5.47	90.05
161-170	*****	10	372	2.49	92.54
171-180	**	4	376	1.00	93.53
181-190	**	5	381	1.24	94.78
191-200	****	8	389	1.99	96.77
201-210	***	6	395	1.49	98.26
211-220	*	2	397	0.50	98.76
221-230	*	2	399	0.50	99.25
231-240	*	2	401	0.50	99.75
241-250		1	402	0.25	100.00
251-260		0	402	0.00	100.00
261-270		0	402	0.00	100.00
271-280		0	402	0.00	100.00
281-290		0	402	0.00	100.00
291-+++		0	402	0.00	100.00

2 4 6 8 10 12 14 16 18 20 22 24
PERCENT

FIGURE 4-3A LENGTH FREQUENCY DISTRIBUTION FOR STRIPED BASS IMPINGED ON THE FIXED SCREEN AT INTAKE 26, INDIAN POINT STATION FROM JANUARY 16 THROUGH APRIL 18,1985



LENGTH (MM) INTERVALS	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
000-010	0	0	0.00	0.00
011-020	0	0	0.00	0.00
021-030	0	0	0.00	0.00
031-040	0	0	0.00	0.00
041-050	0	0	0.00	0.00
051-060	2	2	0.12	0.12
061-070	107	109	6.32	6.43
071-080	293	402	17.30	23.73
081-090	540	942	31.88	55.61
091-100	469	1411	27.69	83.29
101-110	218	1629	12.87	96.16
111-120	53	1682	3.13	99.29
121-130	9	1691	0.53	99.82
131-140	0	1691	0.00	99.82
141-150	0	1691	0.00	99.82
151-160	0	1691	0.00	99.82
161-170	0	1691	0.00	99.82
171-180	0	1691	0.00	99.82
181-190	0	1691	0.00	99.82
191-200	0	1691	0.00	99.82
201-210	1	1692	0.06	99.88
211-220	0	1692	0.00	99.88
221-230	1	1693	0.06	99.94
231-240	0	1693	0.00	99.94
241-250	0	1693	0.00	99.94
251-260	0	1693	0.00	99.94
261-270	0	1693	0.00	99.94
271-280	0	1693	0.00	99.94
281-290	1	1694	0.06	100.00
291-+++	0	1694	0.00	100.00

FIGURE 4-3B LENGTH FREQUENCY DISTRIBUTION FOR STRIPED BASS
IMPINGED ON THE RISTROPH SCREEN AT INTAKE 26,
INDIAN POINT STATION FROM JANUARY 16 THROUGH APRIL 18,1985

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LENGTH (MM)                                                                          FREQ   CUM.   PERCENT    CUM.
INTERVALS                                                                                   FREQ              PERCENT
               |
000-010        |                                                                        0      0      0.00      0.00
011-020        |                                                                        0      0      0.00      0.00
021-030        |                                                                        0      0      0.00      0.00
031-040        |                                                                        0      0      0.00      0.00
041-050        |                                                                        0      0      0.00      0.00
051-060        |                                                                        6      6      0.11      0.11
061-070        |********                                                              216    222      3.94      4.05
071-080        |*****************************                                         802   1024     14.62     18.67
081-090        |**************************************************************       1701   2725     31.01     49.68
091-100        |***************************************************************      1737   4462     31.67     81.35
101-110        |*****************************                                         791   5253     14.42     95.77
111-120        |*******                                                               197   5450      3.59     99.36
121-130        |*                                                                      26   5476      0.47     99.84
131-140        |                                                                        3   5479      0.05     99.89
141-150        |                                                                        2   5481      0.04     99.93
151-160        |                                                                        1   5482      0.02     99.95
161-170        |                                                                        1   5483      0.02     99.96
171-180        |                                                                        0   5483      0.00     99.96
181-190        |                                                                        0   5483      0.00     99.96
191-200        |                                                                        0   5483      0.00     99.96
201-210        |                                                                        0   5483      0.00     99.96
211-220        |                                                                        0   5483      0.00     99.96
221-230        |                                                                        0   5483      0.00     99.96
231-240        |                                                                        0   5483      0.00     99.96
241-250        |                                                                        0   5483      0.00     99.96
251-260        |                                                                        1   5484      0.02     99.98
261-270        |                                                                        0   5484      0.00     99.98
271-280        |                                                                        0   5484      0.00     99.98
281-290        |                                                                        0   5484      0.00     99.98
291-+++        |                                                                        1   5485      0.02    100.00
               ----+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---
                   2   4   6   8  10  12  14  16  18  20  22  24  26  28  30
                                          PERCENT
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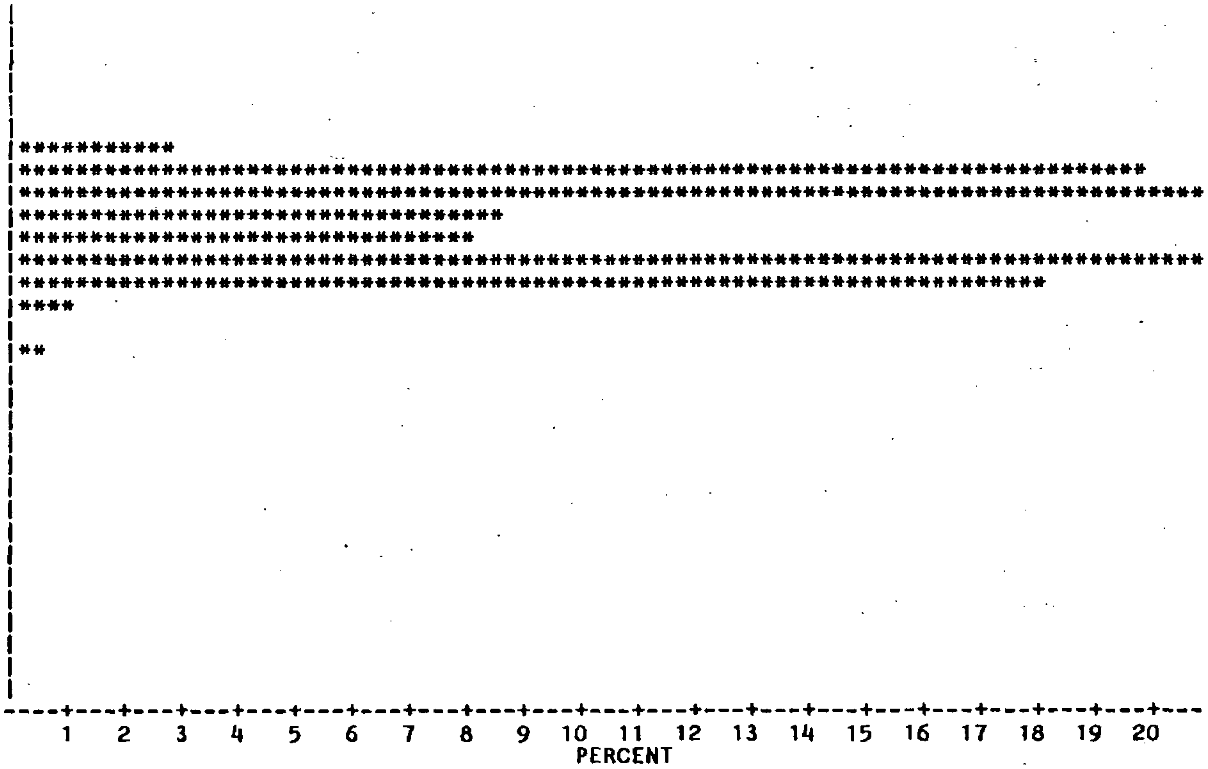
FIGURE 4-4A LENGTH FREQUENCY DISTRIBUTION FOR SPOTTAIL SHINER
IMPINGED ON THE FIXED SCREEN AT INTAKE 28,
INDIAN POINT STATION FROM JANUARY 16 THROUGH APRIL 18,1985

LENGTH (MM) INTERVALS		FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
000-010		0	0	0.00	0.00
011-020		0	0	0.00	0.00
021-030		0	0	0.00	0.00
031-040		0	0	0.00	0.00
041-050		0	0	0.00	0.00
051-060	**	1	1	1.04	1.04
061-070	**	24	25	25.00	26.04
071-080	**	30	55	31.25	57.29
081-090	**********	5	60	5.21	62.50
091-100	****	2	62	2.08	64.58
101-110	**	20	82	20.83	85.42
111-120	************************	12	94	12.50	97.92
121-130	****	2	96	2.08	100.00
131-140		0	96	0.00	100.00
141-150		0	96	0.00	100.00
151-160		0	96	0.00	100.00
161-170		0	96	0.00	100.00
171-180		0	96	0.00	100.00
181-190		0	96	0.00	100.00
191-200		0	96	0.00	100.00
201-210		0	96	0.00	100.00
211-220		0	96	0.00	100.00
221-230		0	96	0.00	100.00
231-240		0	96	0.00	100.00
241-250		0	96	0.00	100.00
251-260		0	96	0.00	100.00
261-270		0	96	0.00	100.00
271-280		0	96	0.00	100.00
281-290		0	96	0.00	100.00
291-+++		0	96	0.00	100.00

2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
PERCENT

FIGURE 4-4B LENGTH FREQUENCY DISTRIBUTION FOR SPOTTAIL SHINER
IMPINGED ON THE RISTROPH SCREEN AT INTAKE 26,
INDIAN POINT STATION FROM JANUARY 16 THROUGH APRIL 18,1985



LENGTH (MM) INTERVALS	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
000-010	0	0	0.00	0.00
011-020	0	0	0.00	0.00
021-030	0	0	0.00	0.00
031-040	0	0	0.00	0.00
041-050	0	0	0.00	0.00
051-060	6	6	2.83	2.83
061-070	42	48	19.81	22.64
071-080	44	92	20.75	43.40
081-090	18	110	8.49	51.89
091-100	17	127	8.02	59.91
101-110	44	171	20.75	80.66
111-120	38	209	17.92	98.58
121-130	2	211	0.94	99.53
131-140	0	211	0.00	99.53
141-150	1	212	0.47	100.00
151-160	0	212	0.00	100.00
161-170	0	212	0.00	100.00
171-180	0	212	0.00	100.00
181-190	0	212	0.00	100.00
191-200	0	212	0.00	100.00
201-210	0	212	0.00	100.00
211-220	0	212	0.00	100.00
221-230	0	212	0.00	100.00
231-240	0	212	0.00	100.00
241-250	0	212	0.00	100.00
251-260	0	212	0.00	100.00
261-270	0	212	0.00	100.00
271-280	0	212	0.00	100.00
281-290	0	212	0.00	100.00
291-+++	0	212	0.00	100.00

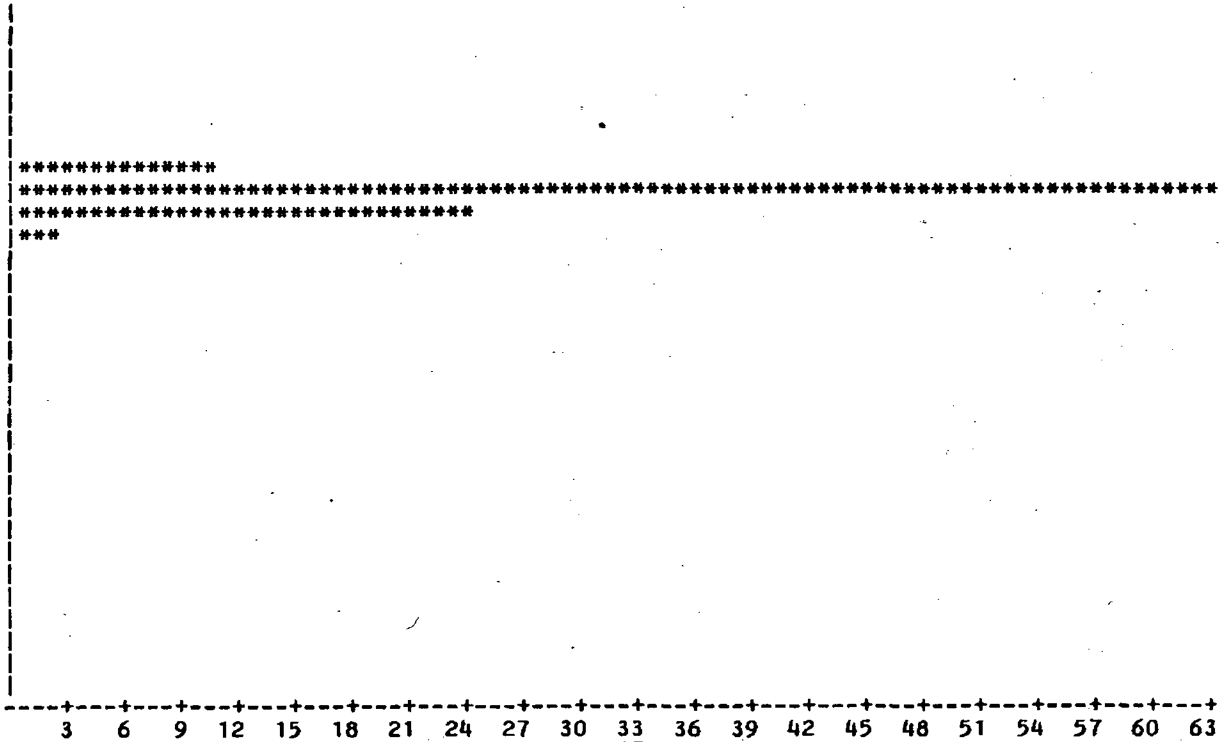
FIGURE 4-5A LENGTH FREQUENCY DISTRIBUTION FOR RAINBOW SMELT IMPINGED ON THE FIXED SCREEN AT INTAKE 26, INDIAN POINT STATION FROM JANUARY 16 THROUGH APRIL 18,1985

LENGTH (MM) INTERVALS		FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
000-010		0	0	0.00	0.00
011-020		0	0	0.00	0.00
021-030		0	0	0.00	0.00
031-040		0	0	0.00	0.00
041-050		0	0	0.00	0.00
051-060		0	0	0.00	0.00
061-070	************	12	12	8.63	8.63
071-080	***	95	107	68.35	76.98
081-090	******************************	30	137	21.58	98.56
091-100	**	2	139	1.44	100.00
101-110		0	139	0.00	100.00
111-120		0	139	0.00	100.00
121-130		0	139	0.00	100.00
131-140		0	139	0.00	100.00
141-150		0	139	0.00	100.00
151-160		0	139	0.00	100.00
161-170		0	139	0.00	100.00
171-180		0	139	0.00	100.00
181-190		0	139	0.00	100.00
191-200		0	139	0.00	100.00
201-210		0	139	0.00	100.00
211-220		0	139	0.00	100.00
221-230		0	139	0.00	100.00
231-240		0	139	0.00	100.00
241-250		0	139	0.00	100.00
251-260		0	139	0.00	100.00
261-270		0	139	0.00	100.00
271-280		0	139	0.00	100.00
281-290		0	139	0.00	100.00
291-+++		0	139	0.00	100.00

3 6 9 12 15 18 21 24 27 30 33 36 39 42 45 48 51 54 57 60 63 66

PERCENT

FIGURE 4-5B LENGTH FREQUENCY DISTRIBUTION FOR RAINBOW SMELT
IMPINGED ON THE RISTROPH SCREEN AT INTAKE 26,
INDIAN POINT STATION FROM JANUARY 16 THROUGH APRIL 18,1985



LENGTH (MM) INTERVALS	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
000-010	0	0	0.00	0.00
011-020	0	0	0.00	0.00
021-030	0	0	0.00	0.00
031-040	0	0	0.00	0.00
041-050	0	0	0.00	0.00
051-060	0	0	0.00	0.00
061-070	37	37	10.34	10.34
071-080	226	263	63.13	73.46
081-090	87	350	24.30	97.77
091-100	7	357	1.96	99.72
101-110	1	358	0.28	100.00
111-120	0	358	0.00	100.00
121-130	0	358	0.00	100.00
131-140	0	358	0.00	100.00
141-150	0	358	0.00	100.00
151-160	0	358	0.00	100.00
161-170	0	358	0.00	100.00
171-180	0	358	0.00	100.00
181-190	0	358	0.00	100.00
191-200	0	358	0.00	100.00
201-210	0	358	0.00	100.00
211-220	0	358	0.00	100.00
221-230	0	358	0.00	100.00
231-240	0	358	0.00	100.00
241-250	0	358	0.00	100.00
251-260	0	358	0.00	100.00
261-270	0	358	0.00	100.00
271-280	0	358	0.00	100.00
281-290	0	358	0.00	100.00
291-+++	0	358	0.00	100.00

FIGURE 4-6A LENGTH FREQUENCY DISTRIBUTION FOR WHITE CATFISH
IMPINGED ON THE FIXED SCREEN AT INTAKE 26,
INDIAN POINT STATION FROM JANUARY 16 THROUGH APRIL 18,1985

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LENGTH (MM)                                                                FREQ  CUM.  PERCENT   CUM.
INTERVALS                                                                        FREQ            PERCENT
          |
000-010   |                                                                  0     0     0.00      0.00
011-020   |                                                                  0     0     0.00      0.00
021-030   |                                                                  0     0     0.00      0.00
031-040   |                                                                  0     0     0.00      0.00
041-050   |                                                                  0     0     0.00      0.00
051-060   |                                                                  0     0     0.00      0.00
061-070   |***********                                                       8     8     5.44      5.44
071-080   |************************                                         18    26    12.24     17.69
081-090   |**************************************                           28    54    19.05     36.73
091-100   |******************************************************           40    94    27.21     63.95
101-110   |*****************************                                    21   115    14.29     78.23
111-120   |*                                                                 1   116     0.68     78.91
121-130   |****                                                              3   119     2.04     80.95
131-140   |                                                                  0   119     0.00     80.95
141-150   |                                                                  0   119     0.00     80.95
151-160   |**********                                                        7   126     4.76     85.71
161-170   |************                                                      9   135     6.12     91.84
171-180   |*****                                                             4   139     2.72     94.56
181-190   |***                                                               2   141     1.36     95.92
191-200   |                                                                  0   141     0.00     95.92
201-210   |****                                                              3   144     2.04     97.96
211-220   |                                                                  0   144     0.00     97.96
221-230   |                                                                  0   144     0.00     97.96
231-240   |                                                                  0   144     0.00     97.96
241-250   |                                                                  0   144     0.00     97.96
251-260   |                                                                  0   144     0.00     97.96
261-270   |                                                                  0   144     0.00     97.96
271-280   |                                                                  0   144     0.00     97.96
281-290   |                                                                  0   144     0.00     97.96
291-+++   |****                                                              3   147     2.04    100.00
          ----+---+---+---+---+---+---+---+---+---+---+---+---+--
              2   4   6   8  10  12  14  16  18  20  22  24  26
                               PERCENT
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FIGURE 4-6B LENGTH FREQUENCY DISTRIBUTION FOR WHITE CATFISH
IMPINGED ON THE RISTROPH SCREEN AT INTAKE 26,
INDIAN POINT STATION FROM JANUARY 16 THROUGH APRIL 18, 1985

LENGTH (MM) INTERVALS		FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
000-010		0	0	0.00	0.00
011-020		0	0	0.00	0.00
021-030		0	0	0.00	0.00
031-040		0	0	0.00	0.00
041-050		0	0	0.00	0.00
051-060	*****	5	5	1.15	1.15
061-070	*************************	25	30	5.76	6.91
071-080	***	49	79	11.29	18.20
081-090	**	70	149	16.13	34.33
091-100	***	95	244	21.89	56.22
101-110	**************************	26	270	5.99	62.21
111-120	*	1	271	0.23	62.44
121-130	*****	5	276	1.15	63.59
131-140	*******	7	283	1.61	65.21
141-150	*****	5	288	1.15	66.36
151-160	**************************	26	314	5.99	72.35
161-170	**	48	362	11.06	83.41
171-180	**********************************	34	396	7.83	91.24
181-190	************	12	408	2.76	94.01
191-200	**	2	410	0.46	94.47
201-210	**	2	412	0.46	94.93
211-220	*	1	413	0.23	95.16
221-230		0	413	0.00	95.16
231-240	***	3	416	0.69	95.85
241-250	*	1	417	0.23	96.08
251-260	**	2	419	0.46	96.54
261-270	*	1	420	0.23	96.77
271-280		0	420	0.00	96.77
281-290	***	3	423	0.69	97.47
291-+++	***********	11	434	2.53	100.00

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
PERCENT

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APPENDIX A

Appendix Table A-1. Initial and latent percent survival of selected fish species collected from Indian Point Unit 2 Ristroph screen, January - April, 1985 (based on arithmetic mean method).

Fish Sluice

Species	Initial Survival (%) Standard Method	Initial Survival (%) dfe Method	Latent Survival (%) Standard Method	Latent Survival (%) dfe Method	N
Alewife	96.4	16.7	11.3	14.3	14
Atlantic tomcod	100.0	60.7	77.1	41.4	14
Pumpkinseed	100.0	75.0	97.7	72.7	11
Rainbow smelt	96.8	96.5	94.5	94.5	12
Red hake	100.0	48.6	0.0	30.0	7
Spottail shiner	100.0	95.1	100.0	98.6	12
Striped bass	95.6	72.5	76.4	71.4	49
Tesselated darter	100.0	100.0	100.0	100.0	13
White catfish	98.1	83.7	93.2	73.1	27
White perch	93.1	62.2	84.2	67.1	58

Debris Sluice

Species	Initial Survival (%) Standard Method	Initial Survival (%) dfe Method	Latent Survival (%) Standard Method	Latent Survival (%) dfe Method	N
Alewife	100.0	0.0	0.0	0.0	3
Atlantic tomcod	100.0	60.0	60.0	40.0	5
Pumpkinseed	NS	NS	NS	NS	NS
Rainbow smelt	95.3	67.7	69.3	65.0	12
Red hake	100.0	26.7	13.3	0.0	5
Spottail shiner	100.0	66.7	100.0	66.7	3
Striped bass	86.1	58.1	63.6	50.9	37
Tesselated darter	100.0	100.0	100.0	100.0	1
White catfish	96.8	81.3	100.0	68.8	16
White perch	83.3	43.7	65.5	53.4	56

N = Number of survival samples

NS = No sample

Appendix Table A-2. Total percent survival of selected fish species collected from Indian Point Unit 2 Ristroph screen, January - April, 1985 (based on arithmetic mean method).

Species	Fish Sluice Standard Method	Fish Sluice dfe Method	Debris Sluice Standard Method	Debris Sluice dfe Method
Alewife	10.9	2.4	0.0	0.0
Atlantic tomcod	77.1	25.1	60.0	24.0
Pumpkinseed	97.7	54.5	NS	NS
Rainbow smelt	91.5	91.2	65.9	44.0
Red hake	30.0	0.0	13.3	0.0
Spottail shiner	100.0	93.8	100.0	44.5
Striped bass	73.0	51.8	54.8	29.6
Tesselated darter	100.0	100.0	100.0	100.0
White catfish	91.4	61.2	96.8	55.9
White perch	78.4	41.8	54.6	23.3

NS = No sample

APPENDIX TABLE A-3

INITIAL, LATENT AND TOTAL SURVIVAL OF SELECTED FISH SPECIES
IMPINGED ON INDIAN POINT UNIT 2 RISTROPH SCREEN
JANUARY - APRIL 1985.

ALEWIFE

	FISH (LOW PRESSURE) SLUICE				DEBRIS (HIGH PRESSURE) SLUICE			
COLLECTION DATE	% INITIAL SURVIVAL (ALIVE ONLY)	% INITIAL SURVIVAL (ALIVE AND DAMAGED)	% LATENT SURVIVAL (ALIVE AND DAMAGED)	% TOTAL SURVIVAL (ALIVE AND DAMAGED)	% INITIAL SURVIVAL (ALIVE ONLY)	% INITIAL SURVIVAL (ALIVE AND DAMAGED)	% LATENT SURVIVAL (ALIVE AND DAMAGED)	% TOTAL SURVIVAL (ALIVE AND DAMAGED)
03FEB85	0.00	100.00	0.00	0.00	*	*	*	*
05FEB85	0.00	100.00	0.00	0.00	*	*	*	*
08FEB85	0.00	100.00	0.00	0.00	*	*	*	*
13FEB85	0.00	100.00	0.00	0.00	*	*	*	*
13FEB85	*	*	*	*	0.00	100.00	0.00	0.00
13FEB85	0.00	100.00	25.00	25.00	*	*	*	*
20FEB85	0.00	100.00	0.00	0.00	*	*	*	*
22FEB85	33.33	100.00	33.33	33.33	*	*	*	*
23FEB85	0.00	100.00	0.00	0.00	*	*	*	*
25FEB85	*	*	*	*	0.00	100.00	0.00	0.00
26FEB85	50.00	50.00	100.00	50.00	*	*	*	*
27FEB85	0.00	100.00	0.00	0.00	*	*	*	*
04MAR85	100.00	100.00	0.00	0.00	*	*	*	*
05MAR85	0.00	100.00	0.00	0.00	*	*	*	*
06MAR85	*	*	*	*	0.00	100.00	0.00	0.00
30MAR85	50.00	100.00	0.00	0.00	*	*	*	*
05APR85	0.00	100.00	0.00	0.00	*	*	*	*

* -- SAMPLE NOT OBTAINED

APPENDIX TABLE A-4

INITIAL, LATENT AND TOTAL SURVIVAL OF SELECTED FISH SPECIES
IMPINGED ON INDIAN POINT UNIT 2 RISTROPH SCREEN
JANUARY - APRIL 1985.

ATLANTIC TOMCOD

	FISH (LOW PRESSURE) SLUICE				DEBRIS (HIGH PRESSURE) SLUICE			
COLLECTION DATE	% INITIAL SURVIVAL (ALIVE ONLY)	% INITIAL SURVIVAL (ALIVE AND DAMAGED)	% LATENT SURVIVAL (ALIVE AND DAMAGED)	% TOTAL SURVIVAL (ALIVE AND DAMAGED)	% INITIAL SURVIVAL (ALIVE ONLY)	% INITIAL SURVIVAL (ALIVE AND DAMAGED)	% LATENT SURVIVAL (ALIVE AND DAMAGED)	% TOTAL SURVIVAL (ALIVE AND DAMAGED)
18JAN85	100.00	100.00	100.00	100.00	*	*	*	*
28JAN85	100.00	100.00	80.00	80.00	*	*	*	*
01FEB85	100.00	100.00	100.00	100.00	*	*	*	*
05FEB85	0.00	100.00	0.00	0.00	*	*	*	*
05FEB85	*	*	*	*	100.00	100.00	100.00	100.00
06FEB85	*	*	*	*	100.00	100.00	100.00	100.00
10FEB85	100.00	100.00	50.00	50.00	*	*	*	*
10FEB85	*	*	*	*	0.00	100.00	0.00	0.00
13FEB85	50.00	100.00	100.00	100.00	*	*	*	*
13FEB85	0.00	100.00	50.00	50.00	*	*	*	*
14FEB85	0.00	100.00	50.00	50.00	*	*	*	*
18FEB85	0.00	100.00	100.00	100.00	*	*	*	*
18FEB85	*	*	*	*	100.00	100.00	0.00	0.00
20FEB85	0.00	100.00	100.00	100.00	*	*	*	*
23FEB85	*	*	*	*	0.00	100.00	100.00	100.00
21MAR85	100.00	100.00	100.00	100.00	*	*	*	*
27MAR85	100.00	100.00	100.00	100.00	*	*	*	*
06APR85	100.00	100.00	100.00	100.00	*	*	*	*
12APR85	100.00	100.00	50.00	50.00	*	*	*	*

* -- SAMPLE NOT OBTAINED

APPENDIX TABLE A-5.

INITIAL, LATENT AND TOTAL SURVIVAL OF SELECTED FISH SPECIES
IMPINGED ON INDIAN POINT UNIT 2 RISTROPH SCREEN
JANUARY - APRIL 1985.

PUMPKINSEED

COLLECTION DATE	FISH (LOW PRESSURE) SLUICE				DEBRIS (HIGH PRESSURE) SLUICE			
	% INITIAL SURVIVAL (ALIVE ONLY)	% INITIAL SURVIVAL (ALIVE AND DAMAGED)	% LATENT SURVIVAL (ALIVE AND DAMAGED)	% TOTAL SURVIVAL (ALIVE AND DAMAGED)	% INITIAL SURVIVAL (ALIVE ONLY)	% INITIAL SURVIVAL (ALIVE AND DAMAGED)	% LATENT SURVIVAL (ALIVE AND DAMAGED)	% TOTAL SURVIVAL (ALIVE AND DAMAGED)
30JAN85	100.00	100.00	100.00	100.00	*	*	*	*
01FEB85	100.00	100.00	100.00	100.00	*	*	*	*
05FEB85	100.00	100.00	100.00	100.00	*	*	*	*
08FEB85	100.00	100.00	100.00	100.00	*	*	*	*
13FEB85	25.00	100.00	75.00	75.00	*	*	*	*
14FEB85	0.00	100.00	100.00	100.00	*	*	*	*
18FEB85	100.00	100.00	100.00	100.00	*	*	*	*
22FEB85	0.00	100.00	100.00	100.00	*	*	*	*
25FEB85	100.00	100.00	100.00	100.00	*	*	*	*
04APR85	100.00	100.00	100.00	100.00	*	*	*	*
12APR85	100.00	100.00	100.00	100.00	*	*	*	*

* -- SAMPLE NOT OBTAINED

APPENDIX TABLE A-6

INITIAL, LATENT AND TOTAL SURVIVAL OF SELECTED FISH SPECIES
IMPINGED ON INDIAN POINT UNIT 2 RISTROPH SCREEN
JANUARY - APRIL 1985.

RAINBOW SMELT

	FISH (LOW PRESSURE) SLUICE				DEBRIS (HIGH PRESSURE) SLUICE			
COLLECTION DATE	% INITIAL SURVIVAL (ALIVE ONLY)	% INITIAL SURVIVAL (ALIVE AND DAMAGED)	% LATENT SURVIVAL (ALIVE AND DAMAGED)	% TOTAL SURVIVAL (ALIVE AND DAMAGED)	% INITIAL SURVIVAL (ALIVE ONLY)	% INITIAL SURVIVAL (ALIVE AND DAMAGED)	% LATENT SURVIVAL (ALIVE AND DAMAGED)	% TOTAL SURVIVAL (ALIVE AND DAMAGED)
18JAN85	100.00	100.00	50.00	50.00	*	*	*	*
30JAN85	*	*	*	*	100.00	100.00	100.00	100.00
01FEB85	95.45	95.45	95.24	90.91	*	*	*	*
01FEB85	*	*	*	*	71.43	85.71	100.00	85.71
03FEB85	100.00	100.00	100.00	100.00	*	*	*	*
03FEB85	*	*	*	*	100.00	100.00	100.00	100.00
05FEB85	66.67	66.67	100.00	66.67	*	*	*	*
06FEB85	*	*	*	*	83.33	83.33	100.00	83.33
08FEB85	96.43	100.00	100.00	100.00	*	*	*	*
08FEB85	*	*	*	*	90.91	90.91	100.00	90.91
10FEB85	*	*	*	*	66.67	83.33	50.00	41.67
13FEB85	100.00	100.00	100.00	100.00	*	*	*	*
24FEB85	*	*	*	*	0.00	100.00	0.00	0.00
26FEB85	*	*	*	*	100.00	100.00	100.00	100.00
27FEB85	100.00	100.00	100.00	100.00	*	*	*	*
27FEB85	*	*	*	*	100.00	100.00	100.00	100.00
28FEB85	100.00	100.00	88.89	88.89	*	*	*	*
28FEB85	*	*	*	*	100.00	100.00	80.00	80.00
04MAR85	100.00	100.00	100.00	100.00	*	*	*	*
05MAR85	*	*	*	*	0.00	100.00	0.00	0.00
10MAR85	100.00	100.00	100.00	100.00	*	*	*	*
27MAR85	*	*	*	*	0.00	100.00	0.00	0.00
03APR85	100.00	100.00	100.00	100.00	*	*	*	*
03APR85	100.00	100.00	100.00	100.00	*	*	*	*

* -- SAMPLE NOT OBTAINED

APPENDIX TABLE A-7

INITIAL, LATENT AND TOTAL SURVIVAL OF SELECTED FISH SPECIES
IMPINGED ON INDIAN POINT UNIT 2 RISTROPH SCREEN
JANUARY - APRIL 1985.

RED HAKE

	FISH (LOW PRESSURE) SLUICE				DEBRIS (HIGH PRESSURE) SLUICE			
COLLECTION DATE	% INITIAL SURVIVAL (ALIVE ONLY)	% INITIAL SURVIVAL (ALIVE AND DAMAGED)	% LATENT SURVIVAL (ALIVE AND DAMAGED)	% TOTAL SURVIVAL (ALIVE AND DAMAGED)	% INITIAL SURVIVAL (ALIVE ONLY)	% INITIAL SURVIVAL (ALIVE AND DAMAGED)	% LATENT SURVIVAL (ALIVE AND DAMAGED)	% TOTAL SURVIVAL (ALIVE AND DAMAGED)
01FEB85	50.00	100.00	0.00	0.00	*	*	*	*
01FEB85	*	*	*	*	0.00	100.00	0.00	0.00
03FEB85	0.00	100.00	0.00	0.00	*	*	*	*
05FEB85	40.00	100.00	60.00	60.00	*	*	*	*
05FEB85	*	*	*	*	33.33	100.00	66.67	66.67
06FEB85	*	*	*	*	100.00	100.00	0.00	0.00
08FEB85	100.00	100.00	0.00	0.00	*	*	*	*
13FEB85	100.00	100.00	100.00	100.00	*	*	*	*
14FEB85	50.00	100.00	50.00	50.00	*	*	*	*
14FEB85	*	*	*	*	0.00	100.00	0.00	0.00
18FEB85	0.00	100.00	0.00	0.00	*	*	*	*
20FEB85	*	*	*	*	0.00	100.00	0.00	0.00

* -- SAMPLE NOT OBTAINED

APPENDIX TABLE A-8

INITIAL, LATENT AND TOTAL SURVIVAL OF SELECTED FISH SPECIES
IMPINGED ON INDIAN POINT UNIT 2 RISTROPH SCREEN
JANUARY - APRIL 1985.

SPOTTAIL SHINER

COLLECTION DATE	FISH (LOW PRESSURE) SLUICE				DEBRIS (HIGH PRESSURE) SLUICE			
	% INITIAL SURVIVAL (ALIVE ONLY)	% INITIAL SURVIVAL (ALIVE AND DAMAGED)	% LATENT SURVIVAL (ALIVE AND DAMAGED)	% TOTAL SURVIVAL (ALIVE AND DAMAGED)	% INITIAL SURVIVAL (ALIVE ONLY)	% INITIAL SURVIVAL (ALIVE AND DAMAGED)	% LATENT SURVIVAL (ALIVE AND DAMAGED)	% TOTAL SURVIVAL (ALIVE AND DAMAGED)
30JAN85	*	*	*	*	100.00	100.00	100.00	100.00
01FEB85	100.00	100.00	100.00	100.00	*	*	*	*
03FEB85	100.00	100.00	100.00	100.00	*	*	*	*
05FEB85	100.00	100.00	100.00	100.00	*	*	*	*
06FEB85	*	*	*	*	100.00	100.00	100.00	100.00
08FEB85	75.00	100.00	100.00	100.00	*	*	*	*
10FEB85	100.00	100.00	100.00	100.00	*	*	*	*
13FEB85	100.00	100.00	100.00	100.00	*	*	*	*
13FEB85	*	*	*	*	0.00	100.00	100.00	100.00
14FEB85	66.67	100.00	100.00	100.00	*	*	*	*
18FEB85	100.00	100.00	100.00	100.00	*	*	*	*
22FEB85	100.00	100.00	100.00	100.00	*	*	*	*
25FEB85	100.00	100.00	100.00	100.00	*	*	*	*
15MAR85	100.00	100.00	100.00	100.00	*	*	*	*
21MAR85	100.00	100.00	100.00	100.00	*	*	*	*

* -- SAMPLE NOT OBTAINED

APPENDIX TABLE A-9.

INITIAL, LATENT AND TOTAL SURVIVAL OF SELECTED FISH SPECIES
IMPINGED ON INDIAN POINT UNIT 2 RISTROPH SCREEN
JANUARY - APRIL 1985.

STRIPED BASS

COLLECTION DATE	FISH (LOW PRESSURE) SLUICE: % INITIAL SURVIVAL (ALIVE ONLY)	FISH (LOW PRESSURE) SLUICE: % INITIAL SURVIVAL (ALIVE AND DAMAGED)	FISH (LOW PRESSURE) SLUICE: % LATENT SURVIVAL (ALIVE AND DAMAGED)	FISH (LOW PRESSURE) SLUICE: % TOTAL SURVIVAL (ALIVE AND DAMAGED)	DEBRIS (HIGH PRESSURE) SLUICE: % INITIAL SURVIVAL (ALIVE ONLY)	DEBRIS (HIGH PRESSURE) SLUICE: % INITIAL SURVIVAL (ALIVE AND DAMAGED)	DEBRIS (HIGH PRESSURE) SLUICE: % LATENT SURVIVAL (ALIVE AND DAMAGED)	DEBRIS (HIGH PRESSURE) SLUICE: % TOTAL SURVIVAL (ALIVE AND DAMAGED)
18JAN85	100.00	100.00	0.00	0.00	*	*	*	*
18JAN85	*	*	*	*	100.00	100.00	0.00	0.00
21JAN85	66.67	66.67	50.00	33.33	*	*	*	*
22JAN85	0.00	100.00	0.00	0.00	*	*	*	*
23JAN85	43.86	80.70	13.89	11.21	*	*	*	*
23JAN85	*	*	*	*	50.00	62.50	0.00	0.00
26JAN85	50.00	80.77	25.00	20.19	*	*	*	*
27JAN85	18.75	87.50	40.00	35.00	*	*	*	*
28JAN85	100.00	100.00	17.65	17.65	*	*	*	*
30JAN85	73.33	93.33	71.43	66.67	*	*	*	*
01FEB85	59.52	90.48	89.19	80.69	*	*	*	*
01FEB85	*	*	*	*	33.33	33.33	100.00	33.33
03FEB85	0.00	100.00	100.00	100.00	*	*	*	*
05FEB85	54.55	100.00	90.91	90.91	*	*	*	*
05FEB85	*	*	*	*	75.00	100.00	100.00	100.00
06FEB85	*	*	*	*	86.36	90.91	77.78	70.71
06FEB85	*	*	*	*	50.00	50.00	100.00	50.00
08FEB85	22.22	97.22	94.12	91.50	*	*	*	*
10FEB85	92.31	100.00	100.00	100.00	*	*	*	*
10FEB85	*	*	*	*	50.00	90.00	60.00	54.00
13FEB85	100.00	100.00	0.00	0.00	*	*	*	*
13FEB85	*	*	*	*	9.52	47.62	20.00	9.52
13FEB85	80.95	100.00	100.00	100.00	*	*	*	*
13FEB85	*	*	*	*	100.00	100.00	66.67	66.67
14FEB85	27.78	94.44	100.00	94.44	*	*	*	*
14FEB85	*	*	*	*	33.33	83.33	100.00	83.33
18FEB85	72.73	100.00	95.45	95.45	*	*	*	*
18FEB85	*	*	*	*	18.18	90.91	60.00	54.55
19FEB85	69.70	100.00	90.91	90.91	*	*	*	*

* -- SAMPLE NOT OBTAINED

APPENDIX TABLE A-9 (cont'd)

INITIAL, LATENT AND TOTAL SURVIVAL OF SELECTED FISH SPECIES
IMPINGED ON INDIAN POINT UNIT 2 RISTROPH SCREEN
JANUARY - APRIL 1985.

STRIPED BASS

COLLECTION DATE	FISH (LOW PRESSURE) SLUICE				DEBRIS (HIGH PRESSURE) SLUICE			
	% INITIAL SURVIVAL (ALIVE ONLY)	% INITIAL SURVIVAL (ALIVE AND DAMAGED)	% LATENT SURVIVAL (ALIVE AND DAMAGED)	% TOTAL SURVIVAL (ALIVE AND DAMAGED)	% INITIAL SURVIVAL (ALIVE ONLY)	% INITIAL SURVIVAL (ALIVE AND DAMAGED)	% LATENT SURVIVAL (ALIVE AND DAMAGED)	% TOTAL SURVIVAL (ALIVE AND DAMAGED)
19FEB85	*	*	*	*	0.00	100.00	62.50	62.50
20FEB85	65.22	95.65	94.12	90.03	*	*	*	*
20FEB85	*	*	*	*	0.00	100.00	40.00	40.00
22FEB85	100.00	100.00	100.00	100.00	*	*	*	*
22FEB85	*	*	*	*	50.00	50.00	100.00	50.00
23FEB85	100.00	100.00	92.31	92.31	*	*	*	*
23FEB85	*	*	*	*	100.00	100.00	100.00	100.00
24FEB85	52.94	100.00	88.24	88.24	*	*	*	*
24FEB85	*	*	*	*	50.00	100.00	100.00	100.00
25FEB85	100.00	100.00	100.00	100.00	*	*	*	*
25FEB85	*	*	*	*	100.00	100.00	100.00	100.00
26FEB85	68.00	100.00	100.00	100.00	*	*	*	*
26FEB85	*	*	*	*	87.50	87.50	100.00	87.50
27FEB85	95.00	100.00	90.00	90.00	*	*	*	*
27FEB85	*	*	*	*	83.33	83.33	100.00	83.33
28FEB85	100.00	100.00	90.00	90.00	*	*	*	*
28FEB85	*	*	*	*	66.67	100.00	33.33	33.33
04MAR85	62.50	87.50	100.00	87.50	*	*	*	*
04MAR85	*	*	*	*	50.00	87.50	71.43	62.50
05MAR85	82.76	100.00	100.00	100.00	*	*	*	*
05MAR85	*	*	*	*	66.67	66.67	100.00	66.67
06MAR85	44.44	66.67	100.00	66.67	*	*	*	*
06MAR85	*	*	*	*	0.00	35.29	20.00	7.06
07MAR85	100.00	100.00	94.44	94.44	*	*	*	*
07MAR85	*	*	*	*	50.00	100.00	66.67	66.67
10MAR85	82.50	97.50	79.49	77.50	*	*	*	*
10MAR85	*	*	*	*	0.00	100.00	0.00	0.00
11MAR85	75.71	100.00	77.93	77.93	*	*	*	*
11MAR85	*	*	*	*	15.79	100.00	33.33	33.33

* -- SAMPLE NOT OBTAINED

APPENDIX TABLE A-9. (cont'd)

INITIAL, LATENT AND TOTAL SURVIVAL OF SELECTED FISH SPECIES
IMPINGED ON INDIAN POINT UNIT 2 RISTROPH SCREEN
JANUARY - APRIL 1985.

STRIPED BASS

COLLECTION DATE	FISH (LOW PRESSURE) SLUICE % INITIAL SURVIVAL (ALIVE ONLY)	% INITIAL SURVIVAL (ALIVE AND DAMAGED)	% LATENT SURVIVAL (ALIVE AND DAMAGED)	% TOTAL SURVIVAL (ALIVE AND DAMAGED)	DEBRIS (HIGH PRESSURE) SLUICE % INITIAL SURVIVAL (ALIVE ONLY)	% INITIAL SURVIVAL (ALIVE AND DAMAGED)	% LATENT SURVIVAL (ALIVE AND DAMAGED)	% TOTAL SURVIVAL (ALIVE AND DAMAGED)
12MAR85	58.33	58.33	85.71	50.00	*	*	*	*
12MAR85	*	*	*	*	0.00	28.57	100.00	28.57
15MAR85	100.00	100.00	75.00	75.00	*	*	*	*
20MAR85	100.00	100.00	100.00	100.00	*	*	*	*
21MAR85	100.00	100.00	66.67	66.67	*	*	*	*
21MAR85	*	*	*	*	33.33	100.00	0.00	0.00
27MAR85	*	*	*	*	93.75	100.00	76.92	76.92
31MAR85	61.11	100.00	100.00	100.00	*	*	*	*
31MAR85	*	*	*	*	100.00	100.00	100.00	100.00
02APR85	88.89	88.89	100.00	88.89	*	*	*	*
03APR85	100.00	100.00	100.00	100.00	*	*	*	*
03APR85	*	*	*	*	100.00	100.00	100.00	100.00
03APR85	100.00	100.00	100.00	100.00	*	*	*	*
03APR85	100.00	100.00	100.00	100.00	*	*	*	*
03APR85	100.00	100.00	100.00	100.00	*	*	*	*
03APR85	*	*	*	*	100.00	100.00	100.00	100.00
04APR85	100.00	100.00	100.00	100.00	*	*	*	*
04APR85	*	*	*	*	100.00	100.00	0.00	0.00
04APR85	100.00	100.00	100.00	100.00	*	*	*	*
05APR85	100.00	100.00	100.00	100.00	*	*	*	*
05APR85	*	*	*	*	100.00	100.00	0.00	0.00
06APR85	100.00	100.00	100.00	100.00	*	*	*	*
06APR85	*	*	*	*	100.00	100.00	50.00	50.00
10APR85	83.33	100.00	33.33	33.33	*	*	*	*
11APR85	0.00	100.00	0.00	0.00	*	*	*	*
11APR85	*	*	*	*	0.00	100.00	100.00	100.00
12APR85	0.00	100.00	0.00	0.00	*	*	*	*

* -- SAMPLE NOT OBTAINED

APPENDIX TABLE A-10

INITIAL, LATENT AND TOTAL SURVIVAL OF SELECTED FISH SPECIES IMPINGED ON INDIAN POINT UNIT 2 RISTROPH SCREEN JANUARY - APRIL 1985.

TESSELLATED DARTER

COLLECTION DATE	FISH (LOW PRESSURE) SLUICE				DEBRIS (HIGH PRESSURE) SLUICE			
	% INITIAL SURVIVAL (ALIVE ONLY)	% INITIAL SURVIVAL (ALIVE AND DAMAGED)	% LATENT SURVIVAL (ALIVE AND DAMAGED)	% TOTAL SURVIVAL (ALIVE AND DAMAGED)	% INITIAL SURVIVAL (ALIVE ONLY)	% INITIAL SURVIVAL (ALIVE AND DAMAGED)	% LATENT SURVIVAL (ALIVE AND DAMAGED)	% TOTAL SURVIVAL (ALIVE AND DAMAGED)
01FEB85	100.00	100.00	100.00	100.00	*	*	*	*
05MAR85	*	*	*	*	100.00	100.00	100.00	100.00
15MAR85	100.00	100.00	100.00	100.00	*	*	*	*
21MAR85	100.00	100.00	100.00	100.00	*	*	*	*
26MAR85	100.00	100.00	100.00	100.00	*	*	*	*
31MAR85	100.00	100.00	100.00	100.00	*	*	*	*
02APR85	100.00	100.00	100.00	100.00	*	*	*	*
03APR85	100.00	100.00	100.00	100.00	*	*	*	*
04APR85	100.00	100.00	100.00	100.00	*	*	*	*
06APR85	100.00	100.00	100.00	100.00	*	*	*	*
10APR85	100.00	100.00	100.00	100.00	*	*	*	*
11APR85	100.00	100.00	100.00	100.00	*	*	*	*
12APR85	100.00	100.00	100.00	100.00	*	*	*	*
12APR85	100.00	100.00	100.00	100.00	*	*	*	*

* -- SAMPLE NOT OBTAINED

APPENDIX TABLE A-11

INITIAL, LATENT AND TOTAL SURVIVAL OF SELECTED FISH SPECIES
IMPINGED ON INDIAN POINT UNIT 2 RISTROPH SCREEN
JANUARY - APRIL 1985.

WHITE CATFISH

COLLECTION DATE	FISH (LOW PRESSURE) SLUICE				DEBRIS (HIGH PRESSURE) SLUICE			
	% INITIAL SURVIVAL (ALIVE ONLY)	% INITIAL SURVIVAL (ALIVE AND DAMAGED)	% LATENT SURVIVAL (ALIVE AND DAMAGED)	% TOTAL SURVIVAL (ALIVE AND DAMAGED)	% INITIAL SURVIVAL (ALIVE ONLY)	% INITIAL SURVIVAL (ALIVE AND DAMAGED)	% LATENT SURVIVAL (ALIVE AND DAMAGED)	% TOTAL SURVIVAL (ALIVE AND DAMAGED)
21JAN85	*	*	*	*	100.00	100.00	100.00	100.00
01FEB85	92.86	100.00	100.00	100.00	*	*	*	*
03FEB85	100.00	100.00	100.00	100.00	*	*	*	*
05FEB85	100.00	100.00	100.00	100.00	*	*	*	*
05FEB85	*	*	*	*	100.00	100.00	100.00	100.00
06FEB85	*	*	*	*	100.00	100.00	100.00	100.00
08FEB85	100.00	100.00	100.00	100.00	*	*	*	*
08FEB85	*	*	*	*	100.00	100.00	100.00	100.00
10FEB85	100.00	100.00	100.00	100.00	*	*	*	*
13FEB85	50.00	100.00	50.00	50.00	*	*	*	*
13FEB85	*	*	*	*	50.00	100.00	100.00	100.00
18FEB85	0.00	100.00	100.00	100.00	*	*	*	*
24FEB85	100.00	100.00	100.00	100.00	*	*	*	*
24FEB85	*	*	*	*	100.00	100.00	100.00	100.00
27FEB85	100.00	100.00	100.00	100.00	*	*	*	*
04MAR85	100.00	100.00	100.00	100.00	*	*	*	*
05MAR85	100.00	100.00	100.00	100.00	*	*	*	*
05MAR85	*	*	*	*	0.00	100.00	100.00	100.00
06MAR85	50.00	50.00	100.00	50.00	*	*	*	*
06MAR85	*	*	*	*	100.00	100.00	100.00	100.00
07MAR85	100.00	100.00	100.00	100.00	*	*	*	*
07MAR85	*	*	*	*	100.00	100.00	100.00	100.00
10MAR85	100.00	100.00	100.00	100.00	*	*	*	*
11MAR85	*	*	*	*	50.00	50.00	100.00	50.00
15MAR85	100.00	100.00	100.00	100.00	*	*	*	*
15MAR85	*	*	*	*	100.00	100.00	100.00	100.00
30MAR85	*	*	*	*	100.00	100.00	100.00	100.00
31MAR85	50.00	100.00	100.00	100.00	*	*	*	*
02APR85	100.00	100.00	100.00	100.00	*	*	*	*

* -- SAMPLE NOT OBTAINED

APPENDIX TABLE A-11 (cont'd)

INITIAL, LATENT AND TOTAL SURVIVAL OF SELECTED FISH SPECIES
IMPINGED ON INDIAN POINT UNIT 2 RISTROPH SCREEN
JANUARY - APRIL 1985.

WHITE CATFISH

COLLECTION DATE	FISH (LOW PRESSURE) SLUICE: % INITIAL SURVIVAL (ALIVE ONLY)	FISH (LOW PRESSURE) SLUICE: % INITIAL SURVIVAL (ALIVE AND DAMAGED)	FISH (LOW PRESSURE) SLUICE: % LATENT SURVIVAL (ALIVE AND DAMAGED)	FISH (LOW PRESSURE) SLUICE: % TOTAL SURVIVAL (ALIVE AND DAMAGED)	DEBRIS (HIGH PRESSURE) SLUICE: % INITIAL SURVIVAL (ALIVE ONLY)	DEBRIS (HIGH PRESSURE) SLUICE: % INITIAL SURVIVAL (ALIVE AND DAMAGED)	DEBRIS (HIGH PRESSURE) SLUICE: % LATENT SURVIVAL (ALIVE AND DAMAGED)	DEBRIS (HIGH PRESSURE) SLUICE: % TOTAL SURVIVAL (ALIVE AND DAMAGED)
03APR85	0.00	100.00	0.00	0.00	*	*	*	*
03APR85	50.00	100.00	100.00	100.00	*	*	*	*
03APR85	66.67	100.00	66.67	66.67	*	*	*	*
04APR85	100.00	100.00	100.00	100.00	*	*	*	*
04APR85	100.00	100.00	100.00	100.00	*	*	*	*
05APR85	100.00	100.00	100.00	100.00	*	*	*	*
05APR85	*	*	*	*	100.00	100.00	100.00	100.00
06APR85	100.00	100.00	100.00	100.00	*	*	*	*
06APR85	*	*	*	*	100.00	100.00	100.00	100.00
10APR85	100.00	100.00	100.00	100.00	*	*	*	*
10APR85	*	*	*	*	0.00	100.00	100.00	100.00
11APR85	100.00	100.00	100.00	100.00	*	*	*	*
11APR85	*	*	*	*	100.00	100.00	100.00	100.00
12APR85	100.00	100.00	100.00	100.00	*	*	*	*

* -- SAMPLE NOT OBTAINED

APPENDIX TABLE A-12

INITIAL, LATENT AND TOTAL SURVIVAL OF SELECTED FISH SPECIES
IMPINGED ON INDIAN POINT UNIT 2 RISTROPH SCREEN
JANUARY - APRIL 1985.

WHITE PERCH

	FISH (LOW PRESSURE) SLUICE				DEBRIS (HIGH PRESSURE) SLUICE			
COLLECTION DATE	% INITIAL SURVIVAL (ALIVE ONLY)	% INITIAL SURVIVAL (ALIVE AND DAMAGED)	% LATENT SURVIVAL (ALIVE AND DAMAGED)	% TOTAL SURVIVAL (ALIVE AND DAMAGED)	% INITIAL SURVIVAL (ALIVE ONLY)	% INITIAL SURVIVAL (ALIVE AND DAMAGED)	% LATENT SURVIVAL (ALIVE AND DAMAGED)	% TOTAL SURVIVAL (ALIVE AND DAMAGED)
18JAN85	60.00	100.00	100.00	100.00	*	*	*	*
18JAN85	*	*	*	*	100.00	100.00	100.00	100.00
21JAN85	7.14	78.57	100.00	78.57	*	*	*	*
21JAN85	*	*	*	*	10.00	100.00	47.37	47.37
22JAN85	50.00	100.00	80.00	80.00	*	*	*	*
23JAN85	51.67	79.90	71.55	57.17	*	*	*	*
23JAN85	*	*	*	*	50.00	66.67	62.50	41.67
26JAN85	71.43	100.00	85.00	85.00	*	*	*	*
26JAN85	*	*	*	*	73.68	100.00	50.00	50.00
27JAN85	54.79	99.32	95.83	95.18	*	*	*	*
27JAN85	*	*	*	*	38.89	91.67	26.00	23.83
28JAN85	87.59	97.08	87.50	84.95	*	*	*	*
28JAN85	*	*	*	*	63.64	96.97	50.00	48.48
30JAN85	22.73	63.64	78.57	50.00	*	*	*	*
01FEB85	52.35	97.32	85.71	83.41	*	*	*	*
01FEB85	*	*	*	*	9.09	45.45	83.33	37.88
03FEB85	57.14	85.71	100.00	85.71	*	*	*	*
03FEB85	*	*	*	*	0.00	40.00	100.00	40.00
05FEB85	64.15	100.00	96.23	96.23	*	*	*	*
05FEB85	*	*	*	*	35.71	64.29	88.89	57.14
06FEB85	*	*	*	*	32.56	88.37	97.14	85.85
06FEB85	*	*	*	*	50.00	50.00	100.00	50.00
08FEB85	35.42	97.92	94.87	92.90	*	*	*	*
08FEB85	*	*	*	*	0.00	90.00	100.00	90.00
10FEB85	70.18	98.25	98.21	96.49	*	*	*	*
10FEB85	*	*	*	*	55.00	75.00	93.33	70.00
13FEB85	28.00	80.00	80.00	64.00	*	*	*	*
13FEB85	*	*	*	*	9.09	65.91	46.15	30.42
13FEB85	54.65	98.84	100.00	98.84	*	*	*	*

* -- SAMPLE NOT OBTAINED

APPENDIX TABLE A-12 (cont'd)

INITIAL, LATENT AND TOTAL SURVIVAL OF SELECTED FISH SPECIES
IMPINGED ON INDIAN POINT UNIT 2 RISTROPH SCREEN
JANUARY - APRIL 1985.

WHITE PERCH

COLLECTION DATE	FISH (LOW PRESSURE) SLUICE				DEBRIS (HIGH PRESSURE) SLUICE			
	% INITIAL SURVIVAL (ALIVE ONLY)	% INITIAL SURVIVAL (ALIVE AND DAMAGED)	% LATENT SURVIVAL (ALIVE AND DAMAGED)	% TOTAL SURVIVAL (ALIVE AND DAMAGED)	% INITIAL SURVIVAL (ALIVE ONLY)	% INITIAL SURVIVAL (ALIVE AND DAMAGED)	% LATENT SURVIVAL (ALIVE AND DAMAGED)	% TOTAL SURVIVAL (ALIVE AND DAMAGED)
13FEB85	*	*	*	*	75.00	95.00	100.00	95.00
14FEB85	29.33	100.00	100.00	100.00	*	*	*	*
14FEB85	*	*	*	*	60.29	80.88	100.00	80.88
18FEB85	39.72	96.45	80.28	77.43	*	*	*	*
18FEB85	*	*	*	*	14.13	79.35	63.01	50.00
19FEB85	84.67	98.61	100.00	98.61	*	*	*	*
19FEB85	*	*	*	*	94.05	94.05	33.33	31.35
20FEB85	21.43	96.94	96.30	93.35	*	*	*	*
20FEB85	*	*	*	*	48.08	82.69	85.29	70.53
22FEB85	74.55	94.55	89.80	84.90	*	*	*	*
22FEB85	*	*	*	*	37.04	77.78	88.24	68.63
23FEB85	77.10	97.20	71.15	69.16	*	*	*	*
23FEB85	*	*	*	*	87.10	93.55	80.00	74.84
24FEB85	78.18	94.55	89.41	84.53	*	*	*	*
24FEB85	*	*	*	*	64.10	92.31	92.59	85.47
25FEB85	84.59	98.63	100.00	98.63	*	*	*	*
25FEB85	*	*	*	*	28.57	93.65	30.43	28.50
26FEB85	87.44	97.31	78.57	76.46	*	*	*	*
26FEB85	*	*	*	*	56.76	81.08	59.09	47.91
27FEB85	85.95	98.38	62.79	61.77	*	*	*	*
27FEB85	*	*	*	*	76.67	93.33	80.49	75.12
28FEB85	74.49	97.96	93.62	91.71	*	*	*	*
28FEB85	*	*	*	*	50.98	84.31	57.14	48.18
04MAR85	93.75	100.00	100.00	100.00	*	*	*	*
04MAR85	*	*	*	*	50.00	83.33	100.00	83.33
05MAR85	90.48	95.24	100.00	95.24	*	*	*	*
05MAR85	*	*	*	*	70.00	80.00	74.19	59.35
06MAR85	19.44	30.56	90.91	27.78	*	*	*	*
06MAR85	*	*	*	*	0.00	100.00	35.29	35.29

* -- SAMPLE NOT OBTAINED

APPENDIX TABLE A-12 (cont'd)

INITIAL, LATENT AND TOTAL SURVIVAL OF SELECTED FISH SPECIES
IMPINGED ON INDIAN POINT UNIT 2 RISTROPH SCREEN
JANUARY - APRIL 1985.

WHITE PERCH

COLLECTION DATE	FISH (LOW PRESSURE) SLUICE				DEBRIS (HIGH PRESSURE) SLUICE			
	% INITIAL SURVIVAL (ALIVE ONLY)	% INITIAL SURVIVAL (ALIVE AND DAMAGED)	% LATENT SURVIVAL (ALIVE AND DAMAGED)	% TOTAL SURVIVAL (ALIVE AND DAMAGED)	% INITIAL SURVIVAL (ALIVE ONLY)	% INITIAL SURVIVAL (ALIVE AND DAMAGED)	% LATENT SURVIVAL (ALIVE AND DAMAGED)	% TOTAL SURVIVAL (ALIVE AND DAMAGED)
07MAR85	61.76	85.29	100.00	85.29	*	*	*	*
07MAR85	*	*	*	*	5.56	83.33	57.14	47.62
10MAR85	61.17	90.29	63.10	56.97	*	*	*	*
10MAR85	*	*	*	*	8.82	73.53	10.00	7.35
11MAR85	60.30	98.49	42.86	42.21	*	*	*	*
11MAR85	*	*	*	*	2.67	96.67	21.28	20.57
12MAR85	64.15	92.45	64.00	59.17	*	*	*	*
12MAR85	*	*	*	*	39.73	68.49	51.06	34.98
14MAR85	94.12	100.00	73.33	73.33	*	*	*	*
14MAR85	*	*	*	*	40.00	100.00	25.00	25.00
15MAR85	94.74	100.00	90.74	90.74	*	*	*	*
15MAR85	*	*	*	*	69.05	100.00	40.54	40.54
20MAR85	80.00	90.00	77.78	70.00	*	*	*	*
20MAR85	*	*	*	*	64.29	78.57	36.36	28.57
21MAR85	79.31	93.10	88.89	82.76	*	*	*	*
21MAR85	*	*	*	*	54.55	100.00	36.36	36.36
26MAR85	0.00	100.00	50.00	50.00	*	*	*	*
26MAR85	*	*	*	*	0.00	55.56	0.00	0.00
27MAR85	90.13	100.00	86.87	86.87	*	*	*	*
27MAR85	*	*	*	*	62.62	98.60	53.37	52.62
30MAR85	78.57	92.86	100.00	92.86	*	*	*	*
30MAR85	*	*	*	*	75.00	91.67	90.91	83.33
31MAR85	80.95	96.83	97.30	94.21	*	*	*	*
31MAR85	*	*	*	*	85.19	88.89	100.00	88.89
01APR85	70.00	80.00	80.00	64.00	*	*	*	*
01APR85	*	*	*	*	60.00	80.00	100.00	80.00
02APR85	90.00	100.00	93.33	93.33	*	*	*	*
02APR85	*	*	*	*	75.00	91.67	100.00	91.67
03APR85	85.71	100.00	100.00	100.00	*	*	*	*

* -- SAMPLE NOT OBTAINED

APPENDIX TABLE A-12 (cont'd)

INITIAL, LATENT AND TOTAL SURVIVAL OF SELECTED FISH SPECIES
IMPINGED ON INDIAN POINT UNIT 2 RISTROPH SCREEN
JANUARY - APRIL 1985.

WHITE PERCH

COLLECTION DATE	FISH (LOW PRESSURE) SLUICE				DEBRIS (HIGH PRESSURE) SLUICE			
	% INITIAL SURVIVAL (ALIVE ONLY)	% INITIAL SURVIVAL (ALIVE AND DAMAGED)	% LATENT SURVIVAL (ALIVE AND DAMAGED)	% TOTAL SURVIVAL (ALIVE AND DAMAGED)	% INITIAL SURVIVAL (ALIVE ONLY)	% INITIAL SURVIVAL (ALIVE AND DAMAGED)	% LATENT SURVIVAL (ALIVE AND DAMAGED)	% TOTAL SURVIVAL (ALIVE AND DAMAGED)
03APR85	*	*	*	*	16.67	100.00	83.33	83.33
03APR85	100.00	100.00	100.00	100.00	*	*	*	*
03APR85	100.00	100.00	100.00	100.00	*	*	*	*
03APR85	*	*	*	*	100.00	100.00	100.00	100.00
03APR85	76.92	100.00	96.00	96.00	*	*	*	*
03APR85	*	*	*	*	100.00	100.00	100.00	100.00
04APR85	33.33	66.67	100.00	66.67	*	*	*	*
04APR85	0.00	75.00	100.00	75.00	*	*	*	*
04APR85	*	*	*	*	0.00	50.00	100.00	50.00
04APR85	100.00	100.00	100.00	100.00	*	*	*	*
05APR85	80.70	100.00	92.98	92.98	*	*	*	*
05APR85	*	*	*	*	45.45	100.00	72.73	72.73
06APR85	100.00	100.00	100.00	100.00	*	*	*	*
06APR85	*	*	*	*	100.00	100.00	92.86	92.86
10APR85	55.00	85.00	64.71	55.00	*	*	*	*
10APR85	*	*	*	*	50.00	62.50	14.29	8.93
11APR85	73.47	100.00	70.11	70.11	*	*	*	*
11APR85	*	*	*	*	0.00	75.81	51.06	38.71
12APR85	*	*	*	*	0.00	33.33	50.00	16.67
12APR85	0.00	100.00	37.50	37.50	*	*	*	*
12APR85	*	*	*	*	0.00	50.00	33.33	16.67
12APR85	0.00	100.00	60.00	60.00	*	*	*	*
12APR85	*	*	*	*	0.00	100.00	0.00	0.00
12APR85	0.00	100.00	25.00	25.00	*	*	*	*
12APR85	*	*	*	*	0.00	100.00	100.00	100.00

* -- SAMPLE NOT OBTAINED

APPENDIX B

Table B-1 List of 58 Fish Collections for Which Data Were Available to Estimate Collection Efficiency and the Contribution of Fish From One Previous Impingement Interval

Sample	Sample Date	Sample Mode	Sample PERIOD	Sample Time	Rainbow Smelt	Spottail Shiner	Striped Bass	Atlantic Tomcod	White Catfish	White Perch	All Species Combined
42	01/24/85	Ristroph	Night	1015	2	0	253	8	1	1489	1764
52	01/25/85	Ristroph	Day	2115	4	0	238	14	14	1590	1874
54	01/26/85	Ristroph	Night	755	2	1	237	18	5	1044	1316
58	01/26/85	Fixed	Day	2030	2	1	16	8	0	125	156
62	01/27/85	Fixed	Night	840	0	2	19	26	0	238	298
64	01/27/85	Ristroph	Day	2040	0	1	85	12	2	1013	1122
66	01/28/85	Ristroph	Night	800	2	2	206	19	6	2151	2390
70	01/28/85	Fixed	Day	2050	5	0	45	5	1	1287	1344
74	01/29/85	Fixed	Night	830	7	1	27	1	4	1292	1333
76	01/29/85	Ristroph	Day	2000	22	0	111	5	14	3381	3540
78	01/30/85	Ristroph	Night	800	12	3	196	24	10	4161	4418
82	01/30/85	Fixed	Day	2030	10	1	4	2	2	63	85
86	01/31/85	Fixed	Night	900	38	1	35	4	4	227	311
88	01/31/85	Ristroph	Day	2030	27	1	21	0	3	177	234
98	02/02/85	Fixed	Night	930	7	2	16	0	11	121	164
100	02/02/85	Ristroph	Day	2030	8	2	9	2	10	50	94
110	02/04/85	Fixed	Night	850	3	4	3	2	5	14	47
112	02/04/85	Ristroph	Day	2030	4	4	22	2	10	46	119
114	02/05/85	Ristroph	Night	900	9	5	27	5	14	78	173
118	02/05/85	Fixed	Day	2150	3	1	3	2	2	29	50
126	02/07/85	Ristroph	Night	800	7	1	29	32	9	84	173
130	02/07/85	Fixed	Day	2200	7	4	9	0	2	21	45
134	02/08/85	Fixed	Night	845	5	6	61	4	9	183	282
136	02/08/85	Ristroph	Day	2045	59	5	112	6	9	258	480
138	02/09/85	Ristroph	Night	830	29	1	333	11	23	1512	1962
146	02/10/85	Ristroph	Day	2000	9	4	42	6	6	178	256
148	02/11/85	Ristroph	Night	830	4	8	57	3	7	321	423
152	02/11/85	Fixed	Day	2120	2	3	4	2	1	20	35
156	02/12/85	Fixed	Night	815	1	1	15	1	3	64	87
168	02/14/85	Fixed	Night	910	0	5	15	3	1	97	137
170	02/14/85	Ristroph	Day	2300	0	5	29	2	2	225	287
234	02/19/85	Ristroph	Night	850	0	4	80	2	3	762	866
238	02/19/85	Fixed	Day	2045	0	0	4	0	0	45	51

List of 58 (Cont'd)

Sample	Sample Date	Sample Mode	Sample Period	Sample Time	Rainbow Smelt	Spottail Shiner	Striped Bass	Atlantic Tomcod	White Catfish	White Perch	All Species Combined
242	02/20/85	Fixed	Night	915	0	0	11	0	0	100	114
244	02/20/85	Ristroph	Day	2115	0	1	48	3	3	361	424
246	02/21/85	Ristroph	Night	840	0	2	29	1	0	346	387
252	02/21/85	Fixed	Day	2100	0	0	11	1	0	102	116
256	02/22/85	Fixed	Night	920	0	0	11	0	0	111	123
258	02/22/85	Ristroph	Day	2000	0	3	29	0	0	210	258
260	02/23/85	Ristroph	Night	855	0	1	40	2	1	500	555
264	02/23/85	Fixed	Day	2205	0	1	7	0	0	73	83
268	02/24/85	Fixed	Night	900	1	1	14	0	0	257	275
270	02/24/85	Ristroph	Day	2000	1	1	42	0	2	452	510
272	02/25/85	Ristroph	Night	845	0	2	58	0	0	603	682
276	02/25/85	Fixed	Day	2120	1	1	9	0	0	51	68
280	02/26/85	Fixed	Night	900	0	0	4	1	0	61	71
282	02/26/85	Ristroph	Day	2030	2	0	54	0	0	399	463
284	02/27/85	Ristroph	Night	845	3	0	47	1	3	425	489
288	02/27/85	Fixed	Day	2100	0	1	5	0	0	5	14
292	02/28/85	Fixed	Night	935	4	1	42	1	0	93	148
294	02/28/85	Ristroph	Day	2325	34	0	82	2	2	415	541
370	03/07/85	Ristroph	Night	30	0	0	24	0	3	51	82
394	03/11/85	Ristroph	Night	900	1	0	424	4	9	1467	1915
398	03/11/85	Fixed	Day	2120	0	0	42	0	1	176	225
402	03/12/85	Fixed	Night	1020	0	1	150	5	11	450	633
454	03/15/85	Ristroph	Night	900	1	2	5	0	3	134	154
458	03/15/85	Fixed	Day	2130	0	1	2	0	0	15	24
482	03/21/85	Ristroph	Night	900	0	1	17	1	2	97	123

Table B-2 List of 84 Fish Collections for Which Data Were Available to Estimate Collection Efficiency but not the Contribution of Fish from One Previous Impingement Interval

Sample	Sample Date	Sample Mode	Sample Period	Sample Time	Rainbow Smelt	Spottail Shiner	Striped Bass	Atlantic Tomcod	White Catfish	White Perch	All Species Combined
40	01/23/85	Ristroph	Day	2230	0	2	165	7	2	953	1141
42	01/24/85	Ristroph	Night	1015	2	0	253	8	1	1489	1764
50	01/25/85	Fixed	Night	915	3	0	84	3	4	738	844
52	01/25/85	Ristroph	Day	2115	4	0	238	14	14	1590	1874
54	01/26/85	Ristroph	Night	755	2	1	237	18	5	1044	1316
58	01/26/85	Fixed	Day	2030	2	1	16	8	0	125	156
62	01/27/85	Fixed	Night	840	0	2	19	26	0	238	298
64	01/27/85	Ristroph	Day	2040	0	1	85	12	2	1013	1122
66	01/28/85	Ristroph	Night	800	2	2	206	19	6	2151	2390
70	01/28/85	Fixed	Day	2050	5	0	45	5	1	1287	1344
74	01/29/85	Fixed	Night	830	7	1	27	1	4	1292	1333
76	01/29/85	Ristroph	Day	2000	22	0	111	5	14	3381	3540
78	01/30/85	Ristroph	Night	800	12	3	196	24	10	4161	4418
82	01/30/85	Fixed	Day	2030	10	1	4	2	2	63	85
86	01/31/85	Fixed	Night	900	38	1	35	4	4	227	311
88	01/31/85	Ristroph	Day	2030	27	1	21	0	3	177	234
94	02/01/85	Fixed	Day	2100	11	2	28	0	6	92	145
98	02/02/85	Fixed	Night	930	7	2	16	0	11	121	164
100	02/02/85	Ristroph	Day	2030	8	2	9	2	10	50	94
106	02/03/85	Fixed	Day	2100	5	6	1	0	3	7	27
110	02/04/85	Fixed	Night	850	3	4	3	2	5	14	47
112	02/04/85	Ristroph	Day	2030	4	4	22	2	10	46	119
114	02/05/85	Ristroph	Night	900	9	5	27	5	14	78	173
118	02/05/85	Fixed	Day	2150	3	1	3	2	2	29	50
124	02/06/85	Ristroph	Day	2030	8	3	18	7	13	88	161
126	02/07/85	Ristroph	Night	800	7	1	29	32	9	84	173
130	02/07/85	Fixed	Day	2200	7	4	9	0	2	21	45
134	02/08/85	Fixed	Night	845	5	6	61	4	9	183	282
136	02/08/85	Ristroph	Day	2045	59	5	112	6	9	258	480
138	02/09/85	Ristroph	Night	830	29	1	333	11	23	1512	1962

List of 84 (Cont'd)

Sample	Sample Date	Sample Mode	Sample Period	Sample Time	Rainbow Smelt	Spottail Shiner	Striped Bass	Atlantic Tomcod	White Catfish	White Perch	All Species Combined
144	02/10/85	Fixed	Night	915	0	0	3	0	0	16	21
146	02/10/85	Ristroph	Day	2000	9	4	42	6	6	178	256
148	02/11/85	Ristroph	Night	830	4	8	57	3	7	321	423
152	02/11/85	Fixed	Day	2120	2	3	4	2	1	20	35
156	02/12/85	Fixed	Night	815	1	1	15	1	3	64	87
164	02/13/85	Fixed	Day	2220	0	2	8	0	1	69	83
168	02/14/85	Fixed	Night	910	0	5	15	3	1	97	137
170	02/14/85	Ristroph	Day	2300	0	5	29	2	2	225	287
176	02/15/85	Fixed	Day	2045	0	1	2	0	1	13	19
192	02/16/85	Ristroph	Day	2055	0	9	33	5	2	129	194
204	02/17/85	Ristroph	Night	855	0	0	29	2	2	200	253
232	02/18/85	Ristroph	Day	2110	0	2	39	2	1	301	355
234	02/19/85	Ristroph	Night	850	0	4	80	2	3	762	866
238	02/19/85	Fixed	Day	2045	0	0	4	0	0	45	51
242	02/20/85	Fixed	Night	915	0	0	11	0	0	100	114
244	02/20/85	Ristroph	Day	2115	0	1	48	3	3	361	424
246	02/21/85	Ristroph	Night	840	0	2	29	1	0	346	387
252	02/21/85	Fixed	Day	2100	0	0	11	1	0	102	116
256	02/22/85	Fixed	Night	920	0	0	11	0	0	111	123
258	02/22/85	Ristroph	Day	2000	0	3	29	0	0	210	258
260	02/23/85	Ristroph	Night	855	0	1	40	2	1	500	555
264	02/23/85	Fixed	Day	2205	0	1	7	0	0	73	83
268	02/24/85	Fixed	Night	900	1	1	14	0	0	257	275
270	02/24/85	Ristroph	Day	2000	1	1	42	0	2	452	510
272	02/25/85	Ristroph	Night	845	0	2	58	0	0	603	682
276	02/25/85	Fixed	Day	2120	1	1	9	0	0	51	68
280	02/26/85	Fixed	Night	900	0	0	4	1	0	61	71
282	02/26/85	Ristroph	Day	2030	2	0	54	0	0	399	463
284	02/27/85	Ristroph	Night	845	3	0	47	1	3	425	489
288	02/27/85	Fixed	Day	2100	0	1	5	0	0	5	14
292	02/28/85	Fixed	Night	935	4	1	42	1	0	93	148
294	02/28/85	Ristroph	Day	2325	34	0	82	2	2	415	541

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Sample	Sample Date	Sample Mode	Sample Period	Sample Time	Rainbow Smelt	Spottail Shiner	Striped Bass	Atlantic Tomcod	White Catfish	White Perch	All Species Combined
310	03/01/85	Fixed	Day	2300	11	2	50	0	3	205	275
334	03/02/85	Ristroph	Day	2100	9	0	55	1	3	213	286
346	03/03/85	Ristroph	Night	900	2	0	57	3	4	165	240
350	03/03/85	Fixed	Day	2130	0	1	7	0	2	8	21
356	03/04/85	Ristroph	Day	2200	1	0	17	0	1	34	58
362	03/05/85	Fixed	Day	2130	1	0	13	0	2	25	44
368	03/06/85	Ristroph	Day	1700	1	0	27	1	3	135	171
370	03/07/85	Ristroph	Night	30	0	0	24	0	3	51	82
386	03/09/85	Fixed	Day	2130	0	2	36	0	1	72	114
392	03/10/85	Ristroph	Day	2000	1	2	130	0	5	319	460
394	03/11/85	Ristroph	Night	900	1	0	424	4	9	1467	1915
398	03/11/85	Fixed	Day	2120	0	0	42	0	1	176	225
402	03/12/85	Fixed	Night	1020	0	1	150	5	11	450	633
452	03/14/85	Ristroph	Day	2015	0	0	3	1	0	44	56
454	03/15/85	Ristroph	Night	900	1	2	5	0	3	134	154
458	03/15/85	Fixed	Day	2130	0	1	2	0	0	15	24
480	03/20/85	Ristroph	Day	2000	0	0	15	2	1	172	197
482	03/21/85	Ristroph	Night	900	0	1	17	1	2	97	123
494	03/21/85	Fixed	Day	1830	0	1	2	1	1	9	15
552	04/01/85	Ristroph	Day	2030	0	0	2	1	4	21	35
570	04/03/85	Ristroph	Day	2030	2	0	11	0	6	78	120
596	04/04/85	Fixed	Day	2130	3	0	0	1	0	11	19

Table B-. [illegible]ntrapment Period collections corresponding to fixed screen co[illegible]ections from the 84 fish collections for which data were avail[illegible]le to estimate collection efficiency but not the contribution of fish from one previous period.

Sample	*Corresponding Sample	Sample Date	Sample Time	Sample Period	Rainbow Smelt	Spottail Shiner	Striped Bass	Atlantic Tomcod	White Catfish	White Perch	All Species Combined
48	50	01/25/85	830	Night	1	0	119	3	1	482	607
56	58	01/26/85	2000	Day	1	0	68	7	2	259	340
60	62	01/27/85	800	Night	0	3	19	9	1	141	178
68	70	01/28/85	2020	Day	0	0	78	3	1	923	1005
72	74	01/29/85	800	Day	2	0	18	3	0	296	322
80	82	01/30/85	2030	Day	9	0	20	4	0	100	135
84	86	01/31/85	830	Night	4	0	17	0	3	102	128
92	94	02/01/85	2030	Day	2	4	18	5	4	88	123
96	98	02/02/85	900	Night	6	1	2	1	6	26	44
104	106	02/03/85	2030	Day	7	1	0	2	2	11	26
108	110	02/04/85	830	Night	6	4	7	3	9	28	66
116	118	02/05/85	2130	Day	0	0	8	1	1	33	46
128	130	02/07/85	2130	Day	2	4	18	9	4	65	113
132	134	02/08/85	815	Night	2	2	24	4	3	111	150
142	144	02/10/85	845	Night	8	4	39	5	4	180	256
150	152	02/11/85	2050	Day	0	1	4	3	1	13	24
154	156	02/12/85	800	Night	2	2	18	1	0	55	81
162	164	02/13/85	2155	Day	0	4	13	1	1	37	58
166	168	02/14/85	755	Night	0	1	3	1	1	14	20
174	176	02/15/85	2015	Day	0	4	2	2	0	38	49
236	238	02/19/85	2030	Day	0	2	15	0	0	74	93
240	242	02/20/85	845	Night	0	1	22	0	1	107	135
250	252	02/21/95	2130	Day	0	0	13	1	1	92	108
254	256	02/22/85	850	Night	0	0	21	0	1	97	121
262	264	02/23/85	2150	Day	0	0	6	0	0	120	126
266	268	02/24/85	845	Night	2	0	25	0	1	540	570
274	276	02/25/85	2055	Day	1	0	11	0	0	44	60
278	280	02/26/85	830	Night	1	3	74	1	2	963	1051
286	288	02/27/85	2045	Day	2	0	5	0	0	21	36
290	292	02/28/85	915	Night	0	1	29	0	2	59	96
308	310	03/01/85	2100	Day	6	0	18	0	0	126	152
348	350	03/03/85	2100	Day	1	0	6	0	0	24	31
360	362	03/05/85	2100	Day	0	0	11	0	2	35	49
384	386	03/09/85	2100	Day	0	1	24	0	0	57	88
396	398	03/11/85	2025	Day	0	0	70	0	3	131	206
400	402	03/12/85	945	Night	1	0	105	3	1	154	274
456	458	03/15/85	2100	Day	1	1	3	0	0	6	11
492	494	03/21/85	1800	Day	0	0	1	1	0	13	16
594	596	04/04/85	2030	Day	1	0	5	0	1	13	25

*Entrapment period collections corresponded to the following fixed screen period collections.

Table B-4 Collection Efficiency for the 58 Fish collections for Which Data Were Available to Estimate Collection Efficiency and the Contribution of Fish from One Previous Impingement Interval.

Sample	Sample Date	Sample Mode	Sample Period	Fractional percent Returns in first 12 hour period	Fractional percent Returns in second 12 hour period	Fractional percent Return Subsequent To second period and up to 96 hours after release
42	01/24/85	Ristroph	Night	0.76	0.02	0.04
52	01/25/85	Ristroph	Day	0.83	0.02	0.00
54	01/26/85	Ristroph	Night	0.84	0.01	0.01
58	01/26/85	Fixed	Day	0.54	0.06	0.03
62	01/27/85	Fixed	Night	0.62	0.08	0.00
64	01/27/85	Ristroph	Day	0.45	0.31	0.02
66	01/28/85	Ristroph	Night	0.90	0.02	0.01
70	01/28/85	Fixed	Day	0.53	0.13	0.06
74	01/29/85	Fixed	Night	0.77	0.05	0.01
76	01/29/85	Ristroph	Day	0.81	0.04	0.02
78	01/30/85	Ristroph	Night	0.71	0.02	0.00
82	01/30/85	Fixed	Day	0.87	0.05	0.00
86	01/31/85	Fixed	Night	0.75	0.07	0.05
88	01/31/85	Ristroph	Day	0.78	0.08	0.00
98	02/02/85	Fixed	Night	0.56	0.09	0.00
100	02/02/85	Ristroph	Day	0.88	0.01	0.06
110	02/04/85	Fixed	Night	0.44	0.09	0.04
112	02/04/85	Ristroph	Day	0.72	0.01	0.05
114	02/05/85	Ristroph	Night	0.79	0.00	0.00
118	02/05/85	Fixed	Day	0.71	0.05	0.03
126	02/07/85	Ristroph	Night	0.92	0.04	0.00
130	02/07/85	Fixed	Day	0.61	0.10	0.00
134	02/08/85	Fixed	Night	0.58	0.19	0.01
136	02/08/85	Ristroph	Day	0.87	0.02	0.01
138	02/09/85	Ristroph	Night	0.61	0.03	0.05
146	02/10/85	Ristroph	Day	0.25	0.00	0.00
148	02/11/85	Ristroph	Night	0.72	0.00	0.05
152	02/11/85	Fixed	Day	0.83	0.02	0.01
156	02/12/85	Fixed	Night	0.63	0.00	0.06
168	02/14/85	Fixed	Night	0.73	0.01	0.00
170	02/14/85	Ristroph	Day	0.81	0.00	0.01
234	02/19/85	Ristroph	Night	0.29	0.04	0.04
238	02/19/85	Fixed	Day	0.29	0.16	0.02
242	02/20/85	Fixed	Night	0.71	0.04	0.02
244	02/20/85	Ristroph	Day	0.70	0.00	0.00
246	02/21/85	Ristroph	Night	0.71	0.00	0.02
252	02/21/85	Fixed	Day	0.19	0.14	0.06
256	02/22/85	Fixed	Night	0.68	0.01	0.04
258	02/22/85	Ristroph	Day	0.84	0.02	0.02
260	02/23/85	Ristroph	Night	0.50	0.01	0.06
264	02/23/85	Fixed	Day	0.13	0.24	0.09
268	02/24/85	Fixed	Night	0.36	0.09	0.05
270	02/24/85	Ristroph	Day	0.84	0.00	0.00

Table B-4 (Cont'd) Collection Efficiency for the 58 Fish Collections for Which Data Were Available to Estimate Collection Efficiency and the Contribution of Fish from One Previous Impingement Interval.

Sample	Sample Date	Sample Mode	Sample Period	Fractional Percent Returns in First 12 Hour Period	Fractional Percent Returns in Second 12 Hour Period	Fractional Percent Return Subsequent to Second Period and Up to 96 Hours after Release
272	02/25/85	Ristroph	Night	0.75	0.00	0.01
276	02/25/85	Fixed	Day	0.42	0.19	0.04
280	02/26/85	Fixed	Night	0.71	0.05	0.00
282	02/26/85	Ristroph	Day	0.89	0.01	0.01
284	02/27/85	Ristroph	Night	0.84	0.00	0.01
288	02/27/85	Fixed	Day	0.28	0.02	0.01
292	02/28/85	Fixed	Night	0.27	0.04	0.02
294	02/28/85	Ristroph	Day	0.55	0.02	0.10
370	03/07/85	Ristroph	Night	0.64	0.00	0.02
394	03/11/85	Ristroph	Night	0.59	0.04	0.02
398	03/11/85	Fixed	Day	0.32	0.29	0.02
402	03/12/85	Fixed	Night	0.29	0.02	0.00
454	03/15/85	Ristroph	Night	0.64	0.00	0.00
458	03/15/85	Fixed	Day	0.35	0.00	0.00
482	03/21/85	Ristroph	Night	0.33	0.01	0.00

Table B-5 Collection Efficiency for the 84 Fish Collections for Which Data Were Available to Estimate Collection Efficiency but not the Contribution of Fish from One Previous Impingement Interval.

Sample	Sample Date	Sample Mode	Sample Period	Fractional Percent Returns in First 12 Hour Period	Fractional Percent Returns in Second 12 Hour Period	Fractional Percent Return Subsequent to Second Period and Up to 96 Hours after Release
40	01/23/85	Ristroph	Day	0.74	0.01	0.01
42	01/24/85	Ristroph	Night	0.76	0.02	0.04
50	01/25/85	Fixed	Night	0.64	0.21	0.02
52	01/25/85	Ristroph	Day	0.83	0.02	0.00
54	01/26/85	Ristroph	Night	0.84	0.01	0.01
58	01/26/85	Fixed	Day	0.54	0.06	0.03
62	01/27/85	Fixed	Night	0.62	0.08	0.00
64	01/27/85	Ristroph	Day	0.45	0.31	0.02
66	01/28/85	Ristroph	Night	0.90	0.02	0.01
70	01/28/85	Fixed	Day	0.53	0.13	0.06
74	01/29/85	Fixed	Night	0.77	0.05	0.01
76	01/29/85	Ristroph	Day	0.81	0.04	0.02
78	01/30/85	Ristroph	Night	0.71	0.02	0.00
82	01/30/85	Fixed	Day	0.87	0.05	0.00
86	01/31/85	Fixed	Night	0.75	0.07	0.05
88	01/31/85	Ristroph	Day	0.78	0.08	0.00
94	02/01/85	Fixed	Day	0.65	0.09	0.01
98	02/02/85	Fixed	Night	0.56	0.09	0.00
100	02/02/85	Ristroph	Day	0.88	0.01	0.06
106	02/03/85	Fixed	Day	0.25	0.13	0.04
110	02/04/85	Fixed	Night	0.44	0.09	0.04
112	02/04/85	Ristroph	Day	0.72	0.01	0.05
114	02/05/85	Ristroph	Night	0.79	0.00	0.00
118	02/05/85	Fixed	Day	0.71	0.05	0.03
124	02/06/85	Ristroph	Day	0.51	0.04	0.00
126	02/07/85	Ristroph	Night	0.92	0.04	0.00
130	02/07/85	Fixed	Day	0.61	0.10	0.00
134	02/08/85	Fixed	Night	0.58	0.19	0.01
136	02/08/85	Ristroph	Day	0.87	0.02	0.01
138	02/09/85	Ristroph	Night	0.61	0.03	0.05
144	02/10/85	Fixed	Night	0.74	0.03	0.01
146	02/10/85	Ristroph	Day	0.25	0.00	0.00
148	02/11/85	Ristroph	Night	0.72	0.00	0.05
152	02/11/85	Fixed	Day	0.83	0.02	0.01
156	02/12/85	Fixed	Night	0.63	0.00	0.06
164	02/13/85	Fixed	Day	0.11	0.39	0.04
168	02/14/85	Fixed	Night	0.73	0.01	0.00
170	02/14/85	Ristroph	Day	0.81	0.00	0.01
176	02/15/85	Fixed	Day	0.52	0.17	0.04
192	02/16/85	Ristroph	Day	0.82	0.00	0.01
204	02/17/85	Ristroph	Night	0.85	0.01	0.02
232	02/18/85	Ristroph	Day	0.67	0.00	0.02
234	02/19/85	Ristroph	Night	0.29	0.04	0.04

Table B-5 (Cont'd) Collection Efficiency for the 84 Fish Collections for Which Data Were Available to Estimate Collection efficiency but not the Contribution of Fish from One Previous Impingement Interva

Sample	Sample Date	Sample Mode	Sample Period	Fractional Percent Returns in First 12 hour Period	Fractional Percent Returns in Second 12-Hour Period	Fractional Percent Return Subsequent to Second Period and Up to 96 Hours after Release
238	02/19/85	Fixed	Day	0.29	0.16	0.02
242	02/20/85	Fixed	Night	0.71	0.04	0.02
244	02/20/85	Ristroph	Day	0.70	0.00	0.00
246	02/21/85	Ristroph	Night	0.71	0.00	0.02
252	02/21/85	Fixed	Day	0.19	0.14	0.06
256	02/22/85	Fixed	Night	0.68	0.01	0.04
258	02/22/85	Ristroph	Day	0.84	0.02	0.02
260	02/23/85	Ristroph	Night	0.50	0.01	0.06
264	02/23/85	Fixed	Day	0.13	0.24	0.09
268	02/24/85	Fixed	Night	0.36	0.09	0.05
270	02/24/85	Ristroph	Day	0.84	0.00	0.00
272	02/25/85	Ristroph	Night	0.75	0.00	0.01
276	02/25/85	Fixed	Day	0.42	0.19	0.04
280	02/26/85	Fixed	Night	0.71	0.05	0.00
282	02/26/85	Ristroph	Day	0.89	0.01	0.01
284	02/27/85	Ristroph	Night	0.84	0.00	0.01
288	02/27/85	Fixed	Day	0.28	0.02	0.01
292	02/28/85	Fixed	Night	0.27	0.04	0.02
294	02/28/85	Ristroph	Day	0.55	0.02	0.10
310	03/01/85	Fixed	Day	0.61	0.06	0.01
334	03/02/85	Ristroph	Day	0.48	0.00	0.00
346	03/03/85	Ristroph	Night	0.62	0.00	0.01
350	03/03/85	Fixed	Day	0.44	0.09	0.04
356	03/04/85	Ristroph	Day	0.61	0.01	0.02
362	03/05/85	Fixed	Day	0.50	0.10	0.04
368	03/06/85	Ristroph	Day	0.85	0.00	0.01
370	03/07/85	Ristroph	Night	0.64	0.00	0.02
386	03/09/85	Fixed	Day	0.14	0.07	0.09
392	03/10/85	Ristroph	Day	0.83	0.00	0.01
394	03/11/85	Ristroph	Night	0.59	0.04	0.02
398	03/11/85	Fixed	Day	0.32	0.29	0.02
402	03/12/85	Fixed	Night	0.29	0.02	0.00
452	03/14/85	Ristroph	Day	0.66	0.00	0.00
454	03/15/84	Ristroph	Night	0.64	0.00	0.00
458	03/15/85	Fixed	Day	0.35	0.00	0.00
480	03/20/85	Ristroph	Day	0.85	0.00	0.00
482	03/21/85	Ristroph	Night	0.33	0.01	0.00
494	03/21/85	Fixed	Day	0.53	0.05	0.00
552	04/01/85	Ristroph	Day	0.77	0.00	0.00
570	04/03/85	Ristroph	Day	0.83	0.00	0.00
596	04/04/85	Fixed	Day	0.27	0.02	0.03

Appendix Table B-6. Two-way Analysis of Variance Comparing Impingement Rates* for All Species Combined between Screen Positions (fixed or Ristroph) and Daylight Period (Night or Day) at Indian Point Unit No. 2, Intake 2-6 between 16 January and 19 April 1985.

Source	Degrees of Freedom	Sum of Squares	Mean Square	Calculated F-Ratio	P>F**
Model	3	4.0692	1.3564	5.96	0.0015
Screen Position	1	3.4893		15.34	0.0003
Daylight Period	1	0.5102		2.24	0.1402
Screen Position x Daylight Period	1	0.0095		0.04	0.8391
Error	52	11.8259	0.2274		
Total	55	15.8951			

Statistical Model:
Rate = Screen Position + Daylight Period + Screen Position x Daylight Period + Error

Responsive
Variable = Log_{10} (X+1), where X = Hourly Impingement Rate for All Species Combined

Fixed Screen Collection Efficiency = Empirical Values
Ristroph Collection Efficiency = Empirical Values

Coefficient of Determination (R^2) = 0.26

* Based upon 58 collections for which data were available with which to make adjustments for collection efficiency and the contribution of fish from a preceding impingement interval.

** $p_{>}F$ = Probability of obtaining the calculated F-Ratio by chance.

Appendix Table B-7. Two-way Analysis of Variance Comparing Impingement Rates * for Striped Bass between Screen Positions (fixed or Ristroph) and Daylight Period (Night or Day) at Indian Point Unit No. 2, Intake 2-6 between 16 January and 19 April 1985.

Source	Degrees of Freedom	Sum of Squares	Mean Square	Calculated F-Ratio	P>F**
Model	3	2.7568	0.9189	6.32	0.0011
Screen Position	1	2.3927		16.45	0.0002
Daylight Period	1	0.2688		1.85	0.1799
Screen Position x Daylight Period	1	0.0070		0.05	0.8267
Error	52	7.5638	0.1454		
Total	55	10.3207			

Statistical Model:
Rate = Screen Position + Daylight Period + Screen Position x Daylight Period + Error

Responsive
Variable = Log_{10} (X+1), where X = Hourly Impingement Rate for Striped Bass

Fixed Screen Collection Efficiency = Empirical Values
Ristroph Collection Efficiency = Empirical Values

Coefficient of Determination (R^2) =

* Based upon 58 collections for which data were available with which to make adjustments for collection efficiency and the contribution of fish from a preceding impingement interval.

** $p_{>}F$ = Probability of obtaining the calculated F-Ratio by chance.

Appendix Table B-8. Two-way Analysis of Variance Comparing Impingement Rates * for White Perch between Screen Positions (fixed or Ristroph) and Daylight Period (Night or Day) at Indian Point Unit No. 2, Intake 2-6 between 16 January and 19 April 1985.

Source	Degrees of Freedom	Sum of Squares	Mean Square	Calculated F-Ratio	P>F **
Model	3	4.4675	1.4892	5.20	0.0033
Screen Position	1	3.7049		12.94	0.0007
Daylight Period	1	0.6838		2.39	0.1283
Screen Position x Daylight Period	1	0.0152		0.05	0.8186
Error	52	14.8868	0.2863		
Total	55	19.3543			

Statistical Model:
Rate = Screen Position + Daylight Period + Screen Position x Daylight Period + Error

Responsive
Variable = Log_{10} (X+1), where X = Hourly Impingement Rate for White Perch

Fixed Screen Collection Efficiency = Empirical Values
Ristroph Collection Efficiency = Empirical Values

Coefficient of Determination (R^2) = 0.23

* Based upon 58 collections for which data were available with which to make adjustments for collection efficiency and the contribution of fish from a preceding impingement interval.

** $p_{>}F$ = Probability of obtaining the calculated F-Ratio by chance.

Appendix Table B-9. Two-way Analysis of Variance Comparing Impingement Rates * for White Catfish between Screen Positions (fixed or Ristroph) and Daylight Period (Night or Day) at Indian Point Unit No. 2, Intake 2-6 between 16 January and 19 April 1985.

Source	Degrees of Freedom	Sum of Squares	Mean Square	Calculated F-Ratio	P>F **
Model	3	0.2759	0.0920	3.96	0.0127
Screen Position	1	0.2030		8.74	0.0046
Daylight Period	1	0.0509		2.19	0.1444
Screen Position x Daylight Period	1	0.0301		1.30	0.2601
Error	54	1.2542	0.0232		
Total	57	1.5301			

Statistical Model:
Rate = Screen Position + Daylight Period + Screen Position x Daylight Period + Error

Responsive
Variable = Log_{10} (X+1), where X = Hourly Impingement Rate for White Catfish

Fixed Screen Collection Efficiency = Empirical Values
Ristroph Collection Efficiency = Empirical Values

Coefficient of Determination (R^2) = 0.18

* Based upon 58 collections for which data were available with which to make adjustments for collection efficiency and the contribution of fish from a preceding impingement interval.

** $p_>F$ = Probability of obtaining the calculated F-Ratio by chance.

Appendix Table B-10. Two-way Analysis of Variance Comparing Impingement Rates * for Atlantic Tomcod between Screen Positions (fixed or Ristroph) and Daylight Period (Night or Day) at Indian Point Unit No. 2, Intake 2-6 between 16 January and 19 April 1985.

Source	Degrees of Freedom	Sum of Squares	Mean Square	Calculated F-Ratio	P>F **
Model	3	0.1500	0.0500	1.76	0.1650
Screen Position	1	0.0826		2.90	0.0943
Daylight Period	1	0.0624		2.19	0.1446
Screen Position x Daylight Period	1	0.0000		0.00	0.9981
Error	54	1.5379	0.0285		
Total	57	1.6879			

Statistical Model:
Rate = Screen Position + Daylight Period + Screen Position x Daylight Period + Error

Responsive
Variable = Log_{10} (X+1), where X = Hourly Impingement Rate for Atlantic Tomcod

Fixed Screen Collection Efficiency = Empirical Values
Ristroph Collection Efficiency = Empirical Values

Coefficient of Determination (R^2) = 0.09

* Based upon 58 collections for which data were available with which to make adjustments for collection efficiency and the contribution of fish from a preceding impingement interval.

** $p_{>}F$ = Probability of obtaining the calculated F-Ratio by chance.

Appendix Table B-11. Two-way Analysis of Variance Comparing Impingement Rates * for Rainbow Smelt between Screen Positions (fixed or Ristroph) and Daylight Period (Night or Day) at Indian Point Unit No. 2, Intake 2-6 between 16 January and 19 April 1985.

Source	Degrees of Freedom	Sum of Squares	Mean Square	Calculated F-Ratio	P>F**
Model	3	0.2892	0.0964	2.20	0.0975
Screen Position	1	0.1170		2.67	0.1083
Daylight Period	1	0.0393		0.90	0.3482
Screen Position x Daylight Period	1	0.1423		3.24	0.0773
Error	54	2.3687	0.0439		
Total	57	2.6579			

Statistical Model:
Rate = Screen Position + Daylight Period + Screen Position x Daylight Period + Error

Responsive
Variable = Log_{10} (X+1), where X = Hourly Impingement Rate for Rainbow Smelt

Fixed Screen Collection Efficiency = Empirical Values
Ristroph Collection Efficiency = Empirical Values

Coefficient of Determination (R^2) = 0.11

* Based upon 58 collections for which data were available with which to make adjustments for collection efficiency and the contribution of fish from a preceding impingement interval.

** $p_{>}F$ = Probability of obtaining the calculated F-Ratio by chance.

Appendix Table B-12 Two-way Analysis of Variance Comparing Impingement Rates * for Spottail Shiner between Screen Positions (fixed or Ristroph) and Daylight Period (Night or Day) at Indian Point Unit No. 2, Intake 2-6 between 16 January and 19 April 1985.

Source	Degrees of Freedom	Sum of Squares	Mean Square	Calculated F-Ratio	P>F **
Model	3	0.0182	0.0061	0.71	0.5556
Screen Position	1	0.0146		1.70	0.1976
Daylight Period	1	0.0013		0.15	0.6989
Screen Position x Daylight Period	1	0.0019		0.23	0.6358
Error	54	0.4642	0.0086		
Total	57	0.4824			

Statistical Model:
Rate = Screen Position + Daylight Period + Screen Position x Daylight Period + Error

Responsive
Variable = Log_{10} (X+1), where X = Hourly Impingement Rate for Spottail Shiner

Fixed Screen Collection Efficiency = Empirical Values
Ristroph Collection Efficiency = Empirical Values

Coefficient of Determination (R^2) = 0.04

* Based upon 58 collections for which data were available with which to make adjustments for collection efficiency and the contribution of fish from a preceding impingement interval.

** $p_{>}F$ = Probability of obtaining the calculated F-Ratio by chance.

Appendix Table B-13. Two-way Analysis of Variance Comparing Impingement Rates * for All Species Combined between Screen Positions (fixed or Ristroph) and Daylight Period (Night or Day) at Indian Point Unit No. 2, Intake 2-6 between 16 January and 19 April 1985.

Source	Degrees of Freedom	Sum of Squares	Mean Square	Calculated F-Ratio	P>F **
Model	3	2.4078	0.8026	3.60	0.0191
Screen Position	1	1.9960		8.96	0.0042
Daylight Period	1	0.3222		1.45	0.2345
Screen Position x Daylight Period	1	0.0000		0.00	0.9992
Error	53	11.8064	0.2228		
Total	56	14.2142			

Statistical Model:
Rate = Screen Position + Daylight Period + Screen Position x Daylight Period + Error

Responsive
Variable = Log_{10} (X+1), where X = Hourly Impingement Rate for All Species Combined

Fixed Screen Collection Efficiency = Empirical Values
Ristroph Collection Efficiency = 90%

Coefficient of Determination (R^2) = 0.17

* Based upon 58 collections for which data were available with which to make adjustments for collection efficiency and the contribution of fish from a preceding impingement interval.

** $p_{>}F$ = Probability of obtaining the calculated F-Ratio by chance.

Appendix Table B-14. Two-way Analysis of Variance Comparing Impingement Rates * for Striped Bass between Screen Positions (fixed or Ristroph) and Daylight Period (Night or Day) at Indian Point Unit No. 2, Intake 2-6 between 16 January and 19 April 1985.

Source	Degrees of Freedom	Sum of Squares	Mean Square	Calculated F-Ratio	P>F **
Model	3	1.7132	0.5711	4.05	0.0115
Screen Position	1	1.4216		10.08	0.0025
Daylight Period	1	0.1868		1.32	0.2549
Screen Position x Daylight Period	1	0.0199		0.14	0.7089
Error	53	7.4725	0.1410		
Total	56	9.1857			

Statistical Model:
Rate = Screen Position + Daylight Period + Screen Position x Daylight Period + Error

Responsive
Variable = Log_{10} (X+1), where X = Hourly Impingement Rate for Striped Bass

Fixed Screen Collection Efficiency = Empirical Values
Ristroph Collection Efficiency = 90%

Coefficient of Determination (R^2) = 0.19

* Based upon 58 collections for which data were available with which to make adjustments for collection efficiency and the contribution of fish from a preceding impingement interval.

** $p_>F$ = Probability of obtaining the calculated F-Ratio by chance.

Appendix Table B-15. Two-way Analysis of Variance Comparing Impingement Rates * for White Perch between Screen Positions (fixed or Ristroph) and Daylight Period (Night or Day) at Indian Point Unit No. 2, Intake 2-6 between 16 January and 19 April 1985.

Source	Degrees of Freedom	Sum of Squares	Mean Square	Calculated F-Ratio	P>F **
Model	3	2.5770	0.8590	3.12	0.0331
Screen Position	1	2.0617		7.49	0.0084
Daylight Period	1	0.4093		1.49	0.2280
Screen Position x Daylight Period	1	0.0002		0.00	0.9771
Error	53	14.5855	0.2752		
Total	56	17.1625			

Statistical Model:
Rate = Screen Position + Daylight Period + Screen Position x Daylight Period + Error

Responsive
Variable = Log_{10} (X+1), where X = Hourly Impingement Rate for White Perch

Fixed Screen Collection Efficiency = Empirical Values
Ristroph Collection Efficiency = 90%

Coefficient of Determination (R^2) = 0.15

* Based upon 58 collections for which data were available with which to make adjustments for collection efficiency and the contribution of fish from a preceding impingement interval.

** $p_{>}F$ = Probability of obtaining the calculated F-Ratio by chance.

Appendix Table B-16. Two-way Analysis of Variance Comparing Impingement Rates * for Atlantic Tomcod between Screen Positions (fixed or Ristroph) and Daylight Period (Night or Day) at Indian Point Unit No. 2, Intake 2-6 between 16 January and 19 April 1985.

Source	Degrees of Freedom	Sum of Squares	Mean Square	Calculated F-Ratio	P>F**
Model	3	0.1060	0.0353	1.41	0.2493
Screen Position	1	0.0242		0.96	0.3306
Daylight Period	1	0.0753		3.00	0.0890
Screen Position x Daylight Period	1	0.0014		0.05	0.8160
Error	54	1.3548	0.0251		
Total	57	1.4608			

Statistical Model:
Rate = Screen Position + Daylight Period + Screen Position x Daylight Period + Error

Responsive
Variable = Log_{10} (X+1), where X = Hourly Impingement Rate for Atlantic Tomcod

Fixed Screen Collection Efficiency = Empirical Values
Ristroph Collection Efficiency = 90%

Coefficient of Determination (R^2) = 0.07

* Based upon 58 collections for which data were available with which to make adjustments for collection efficiency and the contribution of fish from a preceding impingement interval.

** $p_{>}F$ = Probability of obtaining the calculated F-Ratio by chance.

Appendix Table B-17. Two-way Analysis of Variance Comparing Impingement Rates * for White Catfish between Screen Positions (fixed or Ristroph) and Daylight Period (Night or Day) at Indian Point Unit No. 2, Intake 2-6 between 16 January and 19 April 1985.

Source	Degrees of Freedom	Sum of Squares	Mean Square	Calculated F-Ratio	P>F**
Model	3	0.1504	0.0501	2.65	0.0573
Screen Position	1	0.0866		4.57	0.0371
Daylight Period	1	0.0459		2.42	0.1255
Screen Position x Daylight Period	1	0.0238		1.26	0.2670
Error	54	1.0230	0.0189	-	
Total	57	1.1734			

Statistical Model:
Rate = Screen Position + Daylight Period + Screen Position x Daylight Period + Error

Responsive
Variable = Log_{10} (X+1), where X = Hourly Impingement Rate for White Catfish

Fixed Screen Collection Efficiency = Empirical Values
Ristroph Collection Efficiency = 90%

Coefficient of Determination (R^2) = 0.13

* Based upon 58 collections for which data were available with which to make adjustments for collection efficiency and the contribution of fish from a preceding impingement interval.

** $p_>F$ = Probability of obtaining the calculated F-Ratio by chance.

Appendix Table B-18 Two-way Analysis of Variance Comparing Impingement Rates * for Spottail Shiner between Screen Positions (fixed or Ristroph) and Daylight Period (Night or Day) at Indian Point Unit No. 2, Intake 2-6 between 16 January and 19 April 1985.

Source	Degrees of Freedom	Sum of Squares	Mean Square	Calculated F-Ratio	P>F**
Model	3	0.0043	0.0014	0.28	0.8432
Screen Position	1	0.0008		0.16	0.6926
Daylight Period	1	0.0013		0.25	0.6197
Screen Position x Daylight Period	1	0.0023		0.44	0.5119
Error	54	2.2831	0.0052		
Total	57	2.2874			

Statistical Model:
Rate = Screen Position + Daylight Period + Screen Position x Daylight Period + Error

Responsive
Variable = Log_{10} (X+1), where X = Hourly Impingement Rate for Spottail Shiner

Fixed Screen Collection Efficiency = Empirical Values
Ristroph Collection Efficiency = 90%

Coefficient of Determination (R^2) = 0.02

* Based upon 58 collections for which data were available with which to make adjustments for collection efficiency and the contribution of fish from a preceding impingement interval.

** $p_{>}F$ = Probability of obtaining the calculated F-Ratio by chance.

Appendix Table B-19. Two-way Analysis of Variance Comparing Impingement Rates * for Rainbow Smelt between Screen Positions (fixed or Ristroph) and Daylight Period (Night or Day) at Indian Point Unit No. 2, Intake 2-6 between 16 January and 19 April 1985.

Source	Degrees of Freedom	Sum of Squares	Mean Square	Calculated F-Ratio	P>F **
Model	3	0.1637	0.0546	1.53	0.2155
Screen Position	1	0.0511		1.43	0.2362
Daylight Period	1	0.0193		0.54	0.4646
Screen Position x Daylight Period	1	0.0976		2.74	0.1037
Error	54	1.9229	0.0356		
Total	57	2.0866			

Statistical Model:
Rate = Screen Position + Daylight Period + Screen Position x Daylight Period + Error

Responsive
Variable = Log_{10} (X+1), where X = Hourly Impingement Rate for Rainbow Smelt

Fixed Screen Collection Efficiency = Empirical Values
Ristroph Collection Efficiency = 90%

Coefficient of Determination (R^2) = 0.08

* Based upon 58 collections for which data were available with which to make adjustments for collection efficiency and the contribution of fish from a preceding impingement interval.

** $p_>F$ = Probability of obtaining the calculated F-Ratio by chance.

Appendix Table B-20. Two-way Analysis of Variance Comparing Impingement Rates* for All Species Combined between Screen Positions (fixed or Ristroph) and Daylight Period (Night or Day) at Indian Point Unit No. 2, Intake 2-6 between 16 January and 19 April 1985.

Source	Degrees of Freedom	Sum of Squares	Mean Square	Calculated F-Ratio	P>F**
Model	3	4.9992	1.6664	7.53	0.0002
Screen Position	1	3.1475		14.23	0.0003
Daylight Period	1	1.6607		7.51	0.0076
Screen Position x Daylight Period	1	0.0044		0.02	0.8882
Error	80	17.6998	0.2212		
Total	83	22.6990			

Statistical Model:
Rate = Screen Position + Daylight Period + Screen Position x Daylight Period + Error

Responsive
Variable = Log_{10} (X+1), where X = Hourly Impingement Rate for All Species

Fixed Screen Collection Efficiency = Empirical Values
Ristroph Collection Efficiency = Empirical Values

Coefficient of Determination (R^2) = 0.22

* Based upon 84 collections for which data were available with which to make adjustments for collection efficiency only.

** $p_{>}F$ = Probability of obtaining the calculated F-Ratio by chance.

Appendix Table B-21 Two-way Analysis of Variance Comparing Impingement Rates* for Striped Bass between Screen Positions (fixed or Ristroph) and Daylight Period (Night or Day) at Indian Point Unit No. 2, Intake 2-6 between 16 January and 19 April 1985.

Source	Degrees of Freedom	Sum of Squares	Mean Square	Calculated F-Ratio	P>F**
Model	3	2.9241	0.9747	6.57	0.0006
Screen Position	1	2.1130		14.24	0.0003
Daylight Period	1	0.7464		5.03	0.0277
Screen Position x Daylight Period	1	0.0219		0.15	0.7020
Error	80	11.8708	0.1484		
Total	83	14.7950			

Statistical Model:
Rate = Screen Position + Daylight Period + Screen Position x Daylight Period + Error

Responsive
Variable = Log_{10} (X+1), where X = Hourly Impingement Rate for Striped Bass

Fixed Screen Collection Efficiency = Empirical Values
Ristroph Collection Efficiency = Empirical Values

Coefficient of Determination (R^2) = 0.20

* Based upon 84 collections for which data were available with which to make adjustments for collection efficiency only.

** $p_>F$ = Probability of obtaining the calculated F-Ratio by chance.

Appendix Table B-22. Two-way Analysis of Variance Comparing Impingement Rates* for White Perch between Screen Positions (fixed or Ristroph) and Daylight Period (Night or Day) at Indian Point Unit No. 2, Intake 2-6 between 16 January and 19 April 1985.

Source	Degrees of Freedom	Sum of Squares	Mean Square	Calculated F-Ratio	P>F**
Model	3	5.7841	1.9280	7.14	0.0003
Screen Position	1	3.4887		12.91	0.0006
Daylight Period	1	2.0550		7.61	0.0072
Screen Position x Daylight Period	1	0.0121		0.04	0.8332
Error	80	21.6107	0.2701		
Total	83	27.3948			

Statistical Model:
Rate = Screen Position + Daylight Period + Screen Position x Daylight Period + Error

Responsive
Variable = Log_{10} (X+1), where X = Hourly Impingement Rate for White Perch

Fixed Screen Collection Efficiency = Empirical Values
Ristroph Collection Efficiency = Empirical Values

Coefficient of Determination (R^2) = 0.21

* Based upon 84 collections for which data were available with which to make adjustments for collection efficiency only.

** $p_>F$ = Probability of obtaining the calculated F-Ratio by chance.

Appendix Table B-23 Two-way Analysis of Variance Comparing Impingement Rates* for Atlantic Tomcod between Screen Positions (fixed or Ristroph) and Daylight Period (Night or Day) at Indian Point Unit No. 2, Intake 2-6 between 16 January and 19 April 1985.

Source	Degrees of Freedom	Sum of Squares	Mean Square	Calculated F-Ratio	P>F**
Model	3	0.2656	0.0885	3.76	0.0140
Screen Position	1	0.1335		5.67	0.0196
Daylight Period	1	0.1240		5.26	0.0244
Screen Position x Daylight Period	1	0.0000		0.00	0.9834
Error	80	1.8838	0.0235		
Total	83	2.1494			

Statistical Model:
Rate = Screen Position + Daylight Period + Screen Position x Daylight Period + Error

Responsive
Variable = Log_{10} (X+1), where X = Hourly Impingement Rate for Atlantic Tomcod

Fixed Screen Collection Efficiency = Empirical Values
Ristroph Collection Efficiency = Empirical Values

Coefficient of Determination (R^2) = 0.12

* Based upon 84 collections for which data were available with which to make adjustments for collection efficiency only.

** $p_{>}F$ = Probability of obtaining the calculated F-Ratio by chance.

Appendix Table B-24 Two-way Analysis of Variance Comparing Impingement Rates* for White Catfish between Screen Positions (fixed or Ristroph) and Daylight Period (Night or Day) at Indian Point Unit No. 2, Intake 2-6 between 16 January and 19 April 1985.

Source	Degrees of Freedom	Sum of Squares	Mean Square	Calculated F-Ratio	P>F**
Model	3	0.1784	0.0595	2.92	0.0385
Screen Position	1	0.1128		5.54	0.0211
Daylight Period	1	0.0429		2.10	0.1508
Screen Position x Daylight Period	1	0.0090		0.44	0.5072
Error	80	1.6293	0.0204		
Total	83	1.8077			

Statistical Model:
Rate = Screen Position + Daylight Period + Screen Position x Daylight Period + Error

Responsive
Variable = Log_{10} (X+1), where X = Hourly Impingement Rate for White Catfish

Fixed Screen Collection Efficiency = Empirical Values
Ristroph Collection Efficiency = Empirical Values

Coefficient of Determination (R^2) = 0.10

* Based upon 84 collections for which data were available with which to make adjustments for collection efficiency only.

** $p_>F$ = Probability of obtaining the calculated F-Ratio by chance.

Appendix Table B-25. Two-way Analysis of Variance Comparing Impingement Rates* for Spottail Shiner between Screen Positions (fixed or Ristroph) and Daylight Period (Night or Day) at Indian Point Unit No. 2, Intake 2-6 between 16 January and 19 April 1985.

Source	Degrees of Freedom	Sum of Squares	Mean Square	Calculated F-Ratio	P>F**
Model	3	0.0104	0.0035	0.32	0.8155
Screen Position	1	0.0060		0.55	0.4597
Daylight Period	1	0.0008		0.07	0.7873
Screen Position x Daylight Period	1	0.0022		0.20	0.6572
Error	80	0.8736	0.0109		
Total	83	0.8839			

Statistical Model:
Rate = Screen Position + Daylight Period + Screen Position x Daylight Period + Error

Responsive
Variable = Log_{10} (X+1), where X = Hourly Impingement Rate for Spottail Shiner

Fixed Screen Collection Efficiency = Empirical Values
Ristroph Collection Efficiency = Empirical Values

Coefficient of Determination (R^2) = 0.01

* Based upon 84 collections for which data were available with which to make adjustments for collection efficiency only.

** $p_{>}F$ = Probability of obtaining the calculated F-Ratio by chance.

Appendix Table B-26. Two-way Analysis of Variance Comparing Impingement Rates* for Rainbow Smelt between Screen Positions (fixed or Ristroph) and Daylight Period (Night or Day) at Indian Point Unit No. 2, Intake 2-6 between 16 January and 19 April 1985.

Source	Degrees of Freedom	Sum of Squares	Mean Square	Calculated F-Ratio	P>F**
Model	3	0.0930	0.0310	0.75	0.5279
Screen Position	1	0.0147		0.36	0.5528
Daylight Period	1	0.0079		0.19	0.6638
Screen Position x Daylight Period	1	0.0554		1.34	0.2498
Error	80	3.3004	0.0413		
Total	83	3.3934			

Statistical Model:
Rate = Screen Position + Daylight Period + Screen Position x Daylight Period + Error

Responsive
Variable = Log_{10} (X+1), where X = Hourly Impingement Rate for Rainbow Smelt

Fixed Screen Collection Efficiency = Empirical Values
Ristroph Collection Efficiency = Empirical Values

Coefficient of Determination (R^2) = 0.03

* Based upon 84 collections for which data were available with which to make adjustments for collection efficiency only.

** p>F = Probability of obtaining the calculated F-Ratio by chance.

Appendix Table B-27. Two-way Analysis of Variance Comparing Impingement Rates* for All *Species Combined between Screen Positions (fixed or Ristroph) and* Daylight Period (Night or Day) at Indian Point Unit No. 2, Intake 2-6 between 16 January and 19 April 1985.

Source	Degrees of Freedom	Sum of Squares	Mean Square	Calculated F-Ratio	P>F**
Model	3	8.6931	2.8977	15.68	0.0001
Screen Position	1	5.6934		30.81	0.0001
Daylight Period	1	2.2918		12.40	0.0007
Screen Position x Daylight Period	1	0.1788		0.97	0.3282
Error	80	14.7848	0.1848		
Total	83	23.4779			

Statistical Model:
Rate = Screen Position + Daylight Period + Screen Position x Daylight Period + Error

Responsive
Variable = Log_{10} (X+1), where X = Hourly Impingement Rate for All Species Combined

Fixed Screen Collection Efficiency = Empirical Values
Ristroph Collection Efficiency = 90%

Coefficient of Determination (R^2) = 0.37

* Based upon 84 collections for which data were available with which to make adjustments for collection efficiency only.

** $p_{>}F$ = Probability of obtaining the calculated F-Ratio by chance.

Appendix Table B-28 Two-way Analysis of Variance Comparing Impingement Rates* for Striped Bass between Screen Positions (fixed or Ristroph) and Daylight Period (Night or Day) at Indian Point Unit No. 2, Intake 2-6 between 16 January and 19 April 1985.

Source	Degrees of Freedom	Sum of Squares	Mean Square	Calculated F-Ratio	P>F**
Model	3	1.7077	0.5692	4.14	0.0089
Screen Position	1	1.0210		7.42	0.0079
Daylight Period	1	0.6451		4.69	0.0334
Screen Position x Daylight Period	1	0.0076		0.06	0.8148
Error	80	11.0090	0.1376		
Total	83	12.7167			

Statistical Model:
Rate = Screen Position + Daylight Period + Screen Position x Daylight Period + Error

Responsive
Variable = Log_{10} (X+1), where X = Hourly Impingement Rate for Striped Bass

Fixed Screen Collection Efficiency = Empirical Values
Ristroph Collection Efficiency = 90%

Coefficient of Determination (R^2) = 0.13

* Based upon 84 collections for which data were available with which to make adjustments for collection efficiency only.

** p>F = Probability of obtaining the calculated F-Ratio by chance.

Appendix Table B-29. Two-way Analysis of Variance Comparing Impingement Rates* for White Perch between Screen Positions (fixed or Ristroph) and Daylight Period (Night or Day) at Indian Point Unit No. 2, Intake 2-6 between 16 January and 19 April 1985.

Source	Degrees of Freedom	Sum of Squares	Mean Square	Calculated F-Ratio	P>F**
Model	3	3.8619	1.2873	4.89	0.0037
Screen Position	1	1.8046		6.86	0.0105
Daylight Period	1	1.8702		7.11	0.0093
Screen Position x Daylight Period	1	0.0309		0.12	0.7328
Error	80	21.0464	0.2631		
Total	83	24.9083			

Statistical Model:
Rate = Screen Position + Daylight Period + Screen Position x Daylight Period + Error

Responsive
Variable = Log_{10} (X+1), where X = Hourly Impingement Rate for White Perch

Fixed Screen Collection Efficiency = Empirical Values
Ristroph Collection Efficiency = 90%

Coefficient of Determination (R^2) = 0.16

* Based upon 84 collections for which data were available with which to make adjustments for collection efficiency only.

** $p_{>}F$ = Probability of obtaining the calculated F-Ratio by chance.

Appendix Table B-30. Two-way Analysis of Variance Comparing Impingement Rates* for Atlantic Tomcod between Screen Positions (fixed or Ristroph) and Daylight Period (Night or Day) at Indian Point Unit No. 2, Intake 2-6 between 16 January and 19 April 1985.

Source	Degrees of Freedom	Sum of Squares	Mean Square	Calculated F-Ratio	P>F**
Model	3	0.1795	0.0598	3.09	0.0315
Screen Position	1	0.0487		2.51	0.1171
Daylight Period	1	0.1268		6.54	0.0125
Screen Position x Daylight Period	1	0.0000		0.00	0.9956
Error	80	1.5517	0.0194		
Total	83	1.7313			

Statistical Model:
Rate = Screen Position + Daylight Period + Screen Position x Daylight Period + Error

Responsive
Variable = Log_{10} (X+1), where X = Hourly Impingement Rate for Atlantic Tomcod

Fixed Screen Collection Efficiency = Empirical Values
Ristroph Collection Efficiency = 90%

Coefficient of Determination (R^2) = 0.10

* Based upon 84 collections for which data were available with which to make adjustments for collection efficiency only.

** $p_>F$ = Probability of obtaining the calculated F-Ratio by chance.

Appendix Table B-31 Two-way Analysis of Variance Comparing Impingement Rates* for Spottail Shiner between Screen Positions (fixed or Ristroph) and Daylight Period (Night or Day) at Indian Point Unit No. 2, Intake 2-6 between 16 January and 19 April 1985.

Source	Degrees of Freedom	Sum of Squares	Mean Square	Calculated F-Ratio	P>F**
Model	3	0.0353	0.0118	1.42	0.2408
Screen Position	1	0.0295		3.57	0.0625
Daylight Period	1	0.0015		0.18	0.6712
Screen Position x Daylight Period	1	0.00013		0.16	0.6926
Error	80	0.6615	0.0083		
Total	83	0.6969			

Statistical Model:
Rate = Screen Position + Daylight Period + Screen Position x Daylight Period + Error

Responsive
Variable = Log_{10} (X+1), where X = Hourly Impingement Rate for Spottail Shiner

Fixed Screen Collection Efficiency = Empirical Values
Ristroph Collection Efficiency = 90%

Coefficient of Determination (R^2) = 0.05

* Based upon 84 collections for which data were available with which to make adjustments for collection efficiency only.

** $p_>F$ = Probability of obtaining the calculated F-Ratio by chance.

Appendix Table B-32 Two-way Analysis of Variance Comparing Impingement Rates* for White Catfish between Positions (fixed or Ristroph) and Daylight Period (Night or Day) at Indian Point Unit No. 2, Intake 2-6 between 16 January and 19 April 1985.

Source	Degrees of Freedom	Sum of Squares	Mean Square	Calculated F-Ratio	P>F**
Model	3	0.0814	0.0271	1.66	0.1813
Screen Position	1	0.0271		1.66	0.2018
Daylight Period	1	0.0367		2.24	0.1381
Screen Position x Daylight Period	1	0.0122		0.75	0.3906
Error	80	1.3098	0.0164		
Total	83	1.3912			

Statistical Model:
Rate = Screen Position + Daylight Period + Screen Position x Daylight Period + Error

Responsive
Variable = Log_{10} (X+1), where X = Hourly Impingement Rate for White Catfish

Fixed Screen Collection Efficiency = Empirical Values
Ristroph Collection Efficiency = 90%

Coefficient of Determination (R^2) = 0.06

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* Based upon 84 collections for which data were available with which to make adjustments for collection efficiency only.

** p>F = Probability of obtaining the calculated F-Ratio by chance.

Appendix Table B-33. Two-way Analysis of Variance Comparing Impingement Rates* for Rainbow Smelt between Screen Positions (fixed or Ristroph) and Daylight Period (Night or Day) at Indian Point Unit No. 2, Intake 2-6 between 16 January and 19 April 1985.

Source	Degrees of Freedom	Sum of Squares	Mean Square	Calculated F-Ratio	P>F**
Model	3	0.0411	0.0137	0.42	0.7449
Screen Position	1	0.0000		0.00	0.9978
Daylight Period	1	0.0020		0.06	0.8072
Screen Position x Daylight Period	1	0.0366		1.11	0.2948
Error	80	2.6313	0.0329		
Total	83	2.6724			

Statistical Model:
Rate = Screen Position + Daylight Period + Screen Position x Daylight Period + Error

Responsive
Variable = Log_{10} (X+1), where X = Hourly Impingement Rate for Rainbow Smelt

Fixed Screen Collection Efficiency = Empirical Values
Ristroph Collection Efficiency = 90%

Coefficient of Determination (R^2) = 0.02

* Based upon 84 collections for which data were available with which to make adjustments for collection efficiency only.

** p>F = Probability of obtaining the calculated F-Ratio by chance.

EVALUATION OF ALTERNATIVES TO ANGLED SCREENS FOR MITIGATION OF FISH IMPINGEMENT AT INDIAN POINT

Prepared by:
Consolidated Edison Company of New York, Inc.
and The New York Power Authority

August, 1984

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I. INTRODUCTION

At a meeting of the Parties to the Cooling Tower Settlement Agreement on June 5, 1984, it was agreed that Ristroph screens, cylindrical wedgewire (Johnson) screens, and fish by-pass systems, including horizontal travelling screens, were the technologies which warranted further consideration as alternatives to angled screens for mitigating impingement at Indian Point at this time. This consensus reflected the fact that the Parties shared a desire to take action consistent with the Agreement to reduce impingement from current levels as early as possible.

Con Edison and the Power Authority were asked to evaluate the potential merits of each of these alternatives for application at Indian Point Units 2 and 3, and to determine the need for further studies. Evaluation of each alternative was to include:

- a summary review of the information available from existing installations or prototype studies
- projections as to the degree to which each might be expected to reduce impingement at Indian Point
- a discussion of any factors constraining their use at Indian Point
- estimates of the schedule and cost of installation at Indian Point;

II. EXISTING ENVIRONMENT

A. Indian Point

The Indian Point Station consists of three nuclear generating units. Unit No. 2 is northernmost (upstream) in position at the site, followed in a southerly direction by Units Nos. 1 and 3 (Figure 1). Unit No. 1, owned by Con Edison has not operated since October 31, 1974. Unit No. 2, also owned by Con Edison, has been operated since September 28, 1973 and has a net rated capacity of 850 MWe. Unit No. 3, which is owned by the New York Power Authority, has been operated since August 30, 1976, and has a net rated capacity of 965 MWe.

Units 2 and 3 are operated with once through flow cooling systems, the water for each of which is drawn from the Hudson River through separate shoreline positioned intake structures. From mid spring until mid fall the circulating water flow is 840,000 gpm into each plant and is provided by six circulating water pumps rated at 140,000 gpm per pump, full flow. During the remainder of the year the combined flow through the condenser boxes is reduced to 504,000 gpm. Previously the reduced flow rate was achieved by partially blocking the condenser outlet water boxes (6, one for each pump) and opening recirculation lines that allowed 40% of the water pumped to be returned to the intake bay of its respective pump. The volume pumped into a condenser by each pump in the reduced flow mode is 84,000 gpm.

As a condition of the Settlement Agreement two speed circulating water pumps are being installed (and will become operational at Unit 2 by September 1984) to facilitate the transition from full flow (140,000 gpm) to reduced flow (84,000 gpm). Reduced flow at Unit 3 will continue to be achieved by the previously described method until new pumps can be installed.

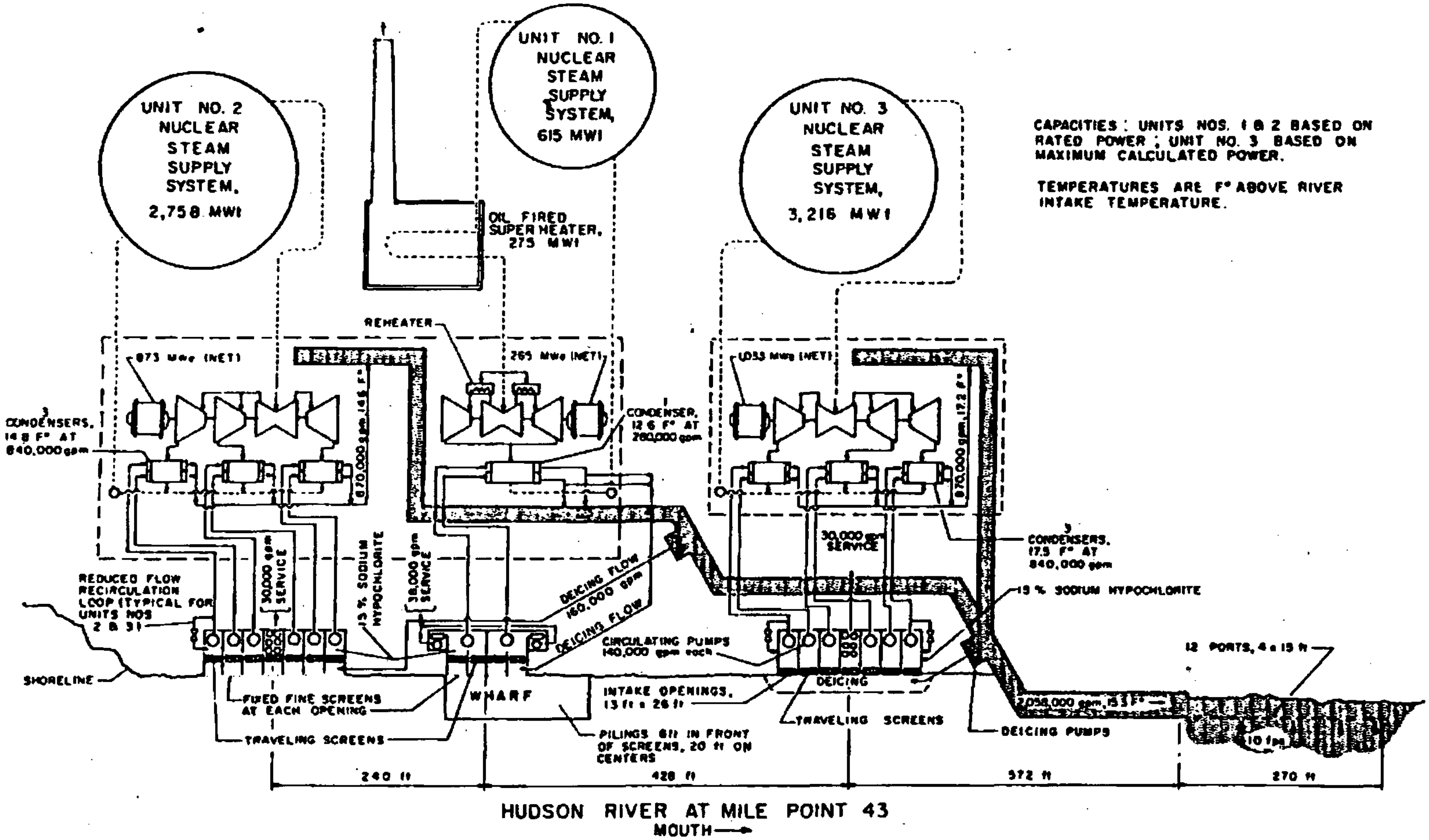

Figure 1. Schematic representation of Indian Point Station

Source: USNRC 1975. FES for Indian Point Nuclear Generating Unit No. 3.

The intake structures (Figures 2 to 5) in which the circulating water pumps are located each consist of seven pump bays. Each of the circulating water pump bays is 53' 5" ft. long. The width of the bays at Unit 2 is 13'4" from the back wall to a point 8'4" behind the front of the ice curtain wall. From this point the intake bay walls taper outward to a width of 14'10" at the entrance. At Unit 3 the forebay width is 13'4" for its entire length. The bottom of the intakes are at -27' MSL, and the decks are at elevation +15'. An ice curtain wall extends to -1' MSL at the entrance to each of the forebays and serves to prevent floating debris as well as ice from entering the bays. The circulating water pumps are positioned approximately 47' 6" from the entrance to the forebays.

Deicing systems have been installed to return heated water from the discharge canal back to the pump intake bays during periods of ice buildup. The two 54 in. headers are provided with downpipes which distribute the flow to the individual pump bays. These systems, however, have only occasionally been operated.

The intake structures for Units 2 and 3 while similar in overall appearance do differ in certain other respects, in addition to forebay entrance widths. At Unit 2 vertical rotating front entry travelling water screens, (3/8" square mesh) are positioned within the forebay approximately 24' 10" feet from the entrance. A bar rack comprised of 1/2" wide bars spaced 3" apart, is located 11' feet riverward of the travelling screen and 13' 10" feet from the entrance to the forebay. A fixed screen, (3/8" square mesh) is positioned at the entrance to the intake and is immediately riverward of the ice curtain wall. The average intake water approach velocity at to the fixed screen at Unit 2 is 0.82 fps at mean sea level during full flow operation and is 0.49 fps during reduced flow operation. This velocity is dynamic, however, and changes slightly depending on the stage of the tide. Clogging of portions of the screen face by debris also results in increased velocity through the remaining unclogged

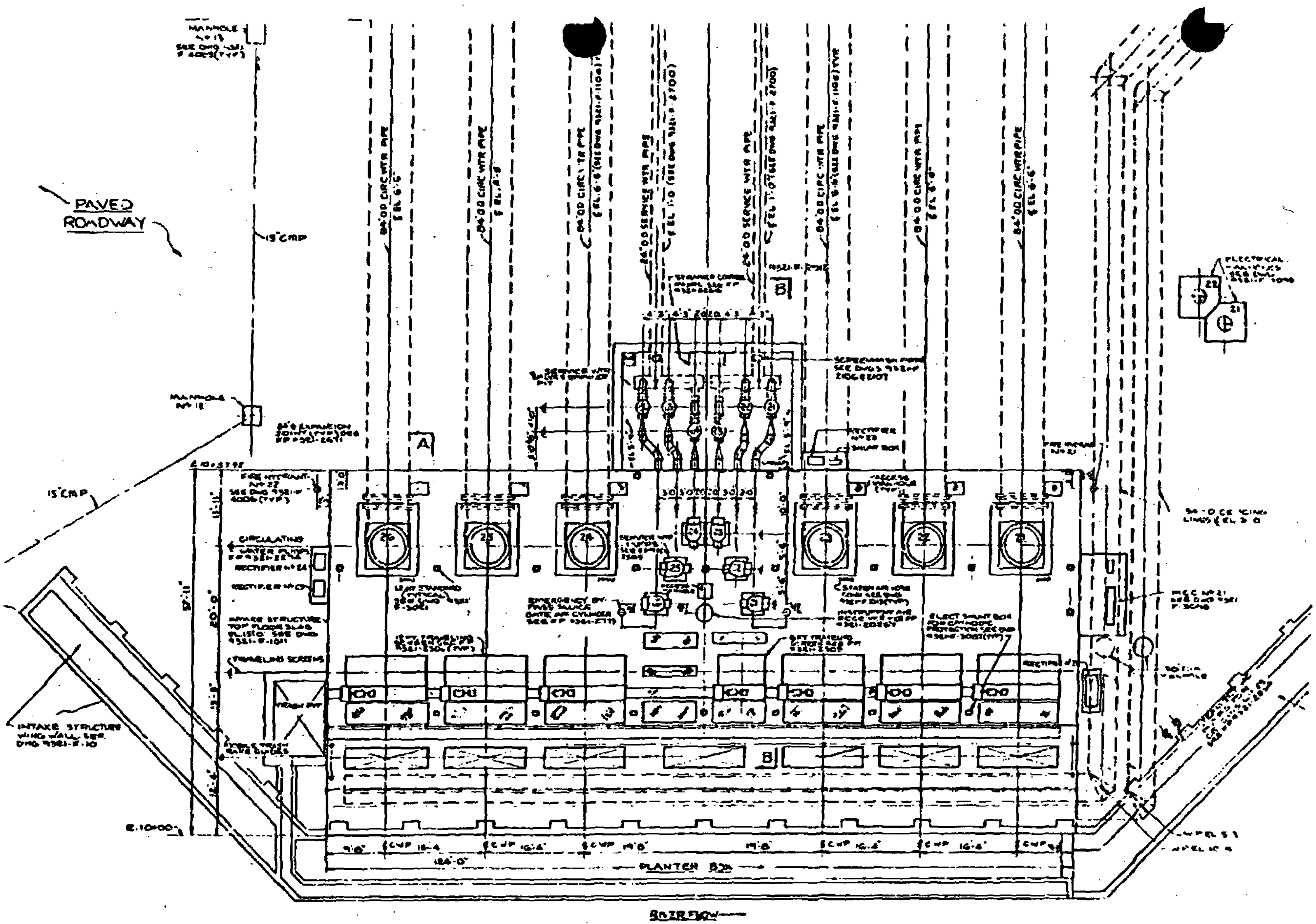

Figure 2. Plan View Circulating Water and Service Water Intake Structure at Indian Point 2

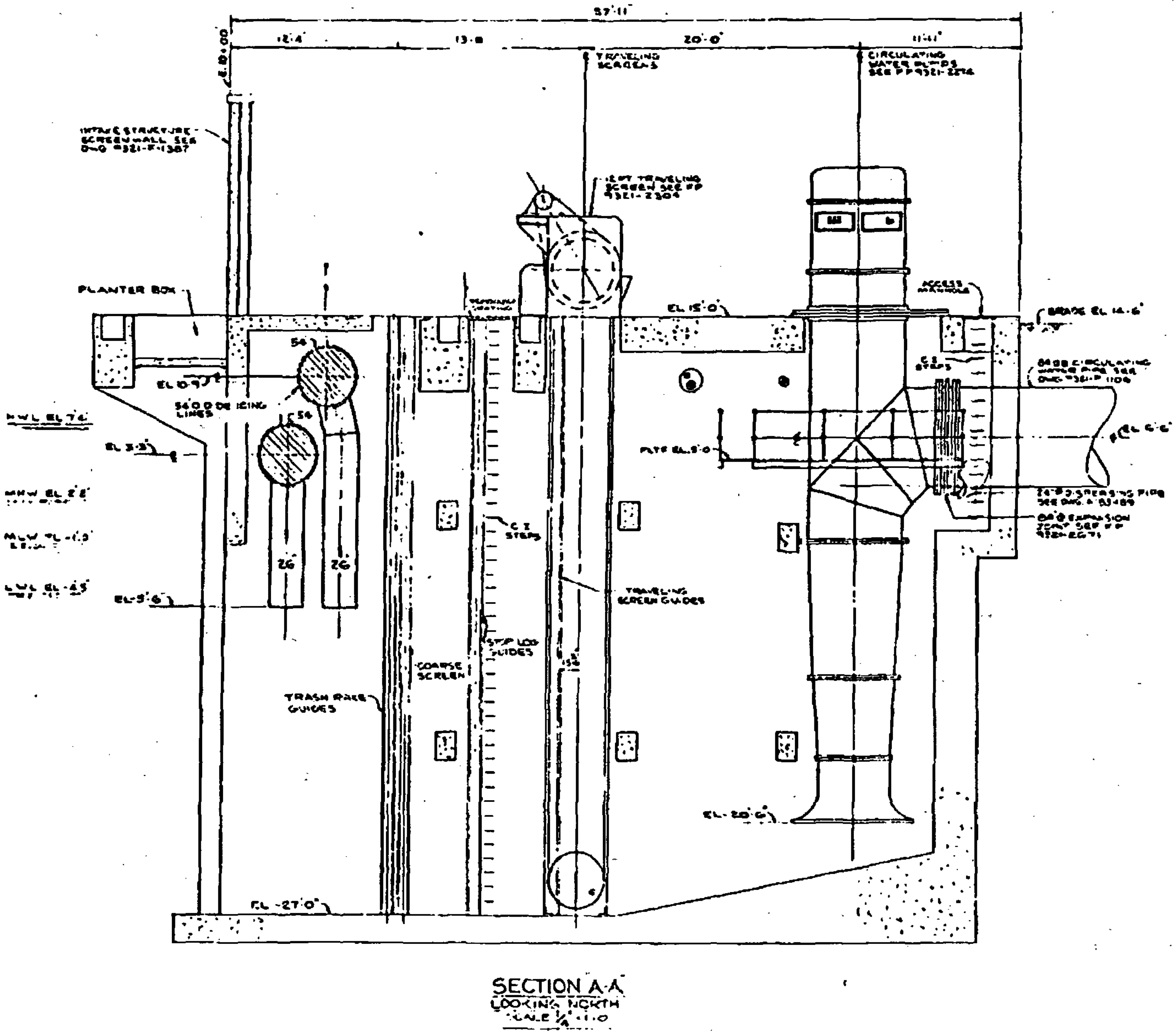

Figure 3. Section View Circulating Water Pump Intake at Indian Point 2

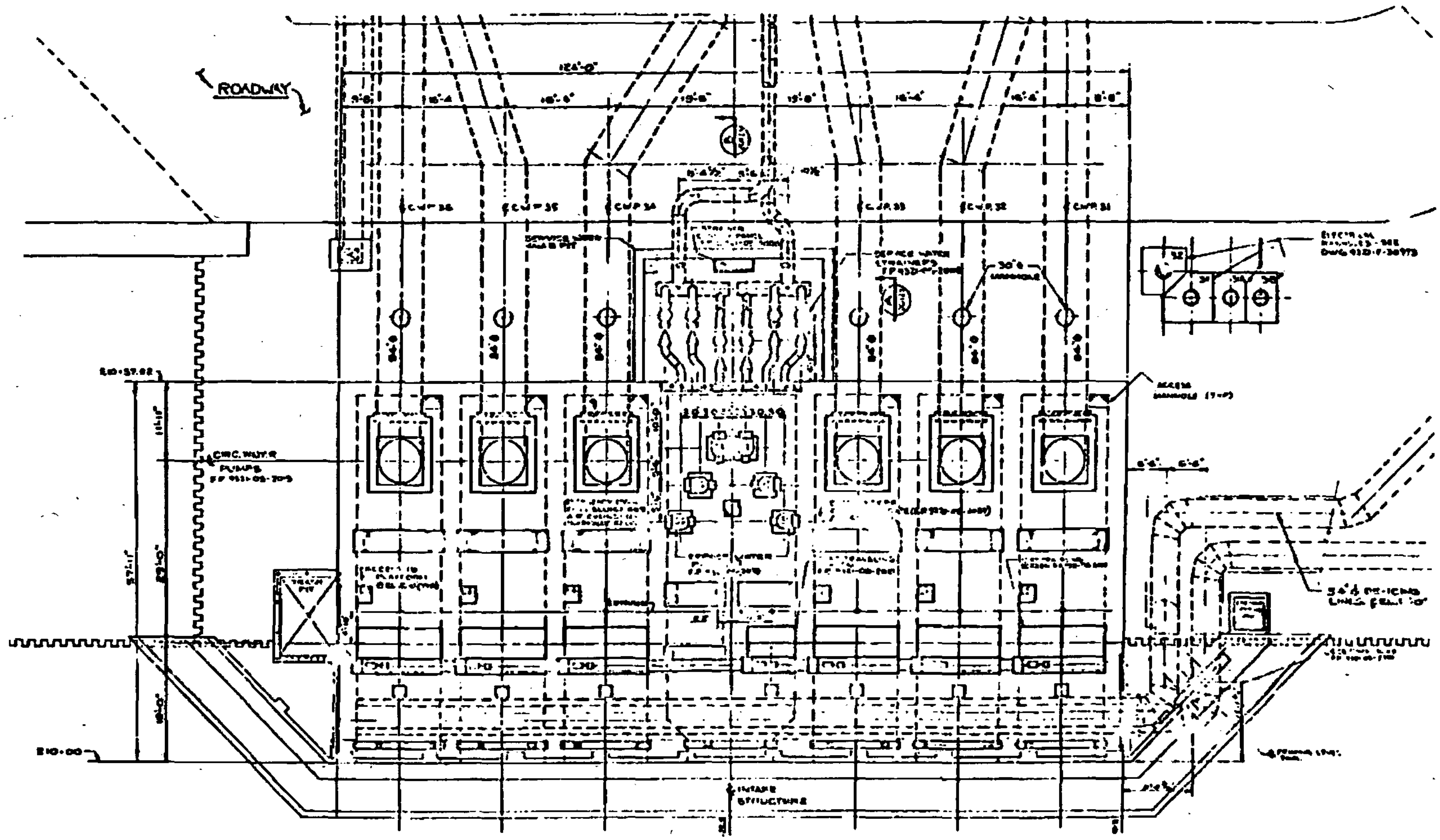

Figure 4. Plan View. Circulating Water and Service Water Intake Structure at Indian Point 3

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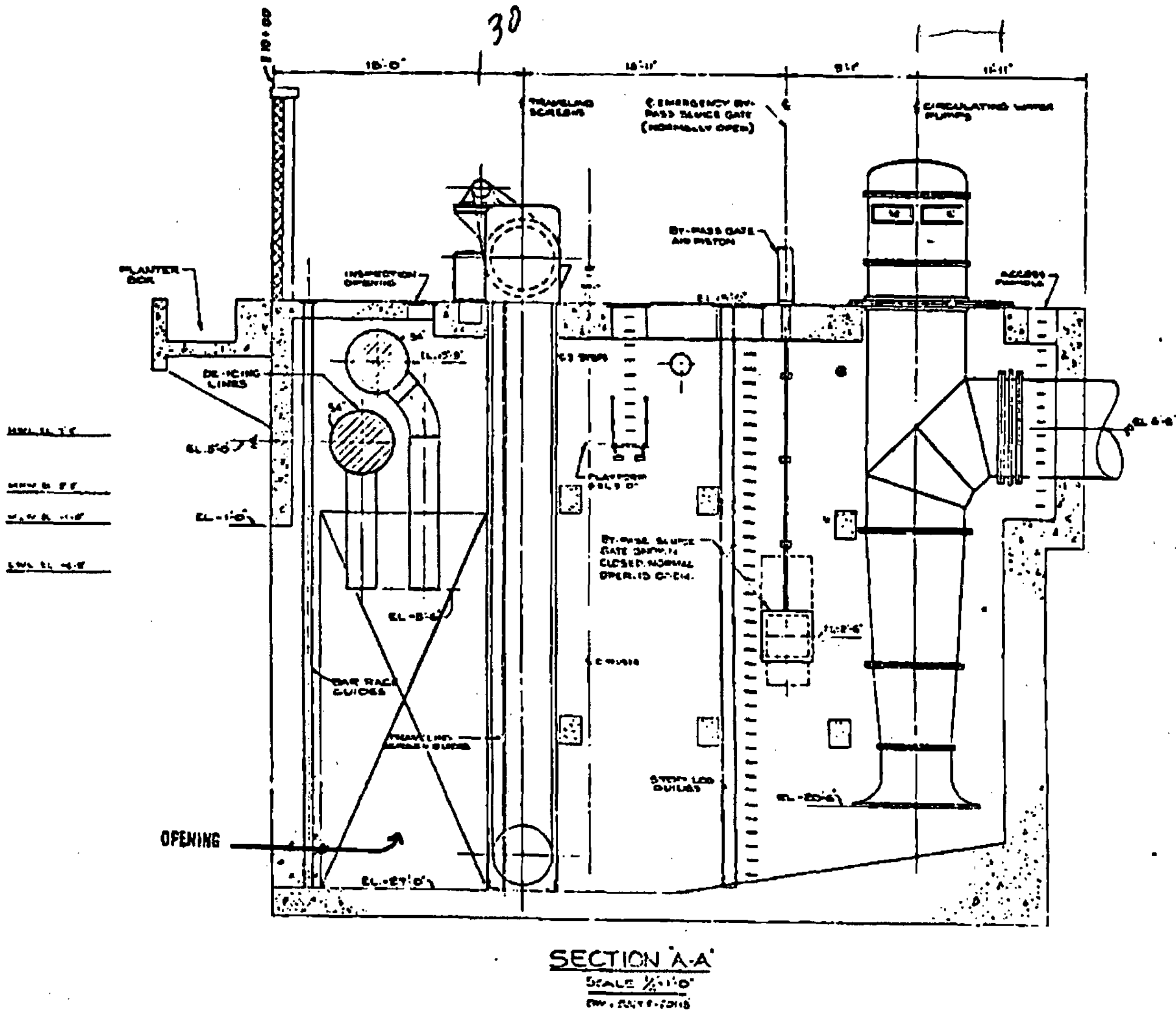


Figure 5. Section View. Circulating Water Pump Intake at Indian Point 3

areas and velocity may vary considerably from one area to another. At the Unit 3 intake structure, which was constructed after the Unit 2 intake was built, travelling water screens (3/8" square mesh) similar to those at Unit 2 are positioned at the entrance of the forebays. No fixed screens are present. Bar racks, similar in design to those at Unit 2 are positioned about 11 feet in front of the travelling screens to prevent heavy debris from striking them. The Unit 3 intake is also protected by an ice curtain wall which is positioned riverward of the bar racks and extends to -1 ft MSL. The average approach velocity at mean sea level to the travelling water screens at Unit 3 is 0.96 fps at full flow, and 0.58 fps at reduced flow. This velocity is dynamic, however, and changes depending on the stage of the tide.

Centrally located within each of the intake structures at Units 2 and 3 is a service water intake bay (Figures 2 and 4). Six service water pumps (5000 gpm/pump) draw water from each of these bays and provide cooling water flow for various equipment, including that required for safe shutdown of each unit. The service water intake bay for each unit is 20' wide by 27' deep. For safety purposes the service water forebay leading to the sump for the pumps is divided into two sections. A 6' wide travelling water screen (3/8" mesh) removes debris from the intake water of one section, and two 8' 9" wide fixed screens (3/8" mesh) are present parallel to one another in the other section of the forebay channel. This channel is normally blocked with a stop log which may be removed as necessary. The intake approach velocity to the service water bay travelling screen when all six service water pumps are operating is 0.41 fps.

Intake travelling screens at Units 2 and 3 are washed once per day, using the internally mounted high pressure spray system, or more frequently if debris loads become excessive. Each washing is for approximately 15 minutes. At Unit 2 the fixed screens are also washed once each day, or more frequently as required, by raising them past a spray wash system located a few feet above mean high water level. Debris which is washed from the screen, falls into the water and is drawn into the forebay where it is collected by the rotating travelling screen. Debris and impinged fish that are washed from the travelling screen enter a sluice on the deck that leads to a collection pit at one end of the intake. All materials including fish are presently removed from the site and disposed of in a sanitary landfill.

B. Hudson River At Indian Point

The Hudson River near the Indian Point Station is approximately 5,000 feet wide and averages over 30 feet in depth. The nearshore water in the vicinity of the Station is approximately 25 to 28 feet deep, and within 300 feet of the shoreline, it extends to a depth of 55 feet or more (Figure 6). Mean tidal flows at Indian Point are approximately 180,000 cfs, and average monthly freshwater flows range from approximately 5,500 cfs in August to 31,500 cfs in April (Table 1). At Indian Point, the salinity ranges from less than 0.1 ppt (defined here as the salt front concentration) when freshwater flows are greater than about 20,000 cfs to about 4 ppt when fresh water flows are less than 6000 cfs (Table 2). For extremely low freshwater flows in the range of 2,000 to 3,000 cfs, mean monthly salinity (ppt) at Indian Point can approach 10 ppt. The salt front is generally south or downriver of Indian Point during March, April and May and north or upriver during the remainder of the year. Ambient river water temperatures seasonally follow changes in air temperature and range from near 1°C to about 26°C (Table 2).

The mean tide range at Indian Point is approximately 3 feet and extends from -1.ft. MSL to +2 ft. MSL. Tidal currents during flood tides approach 2.2 fps at mid channel, when tidal flows are approximately 300,000 cfs. During ebb tide the current velocities approach 2.8 fps when flow is 350,000 cfs (LHL, 1976).

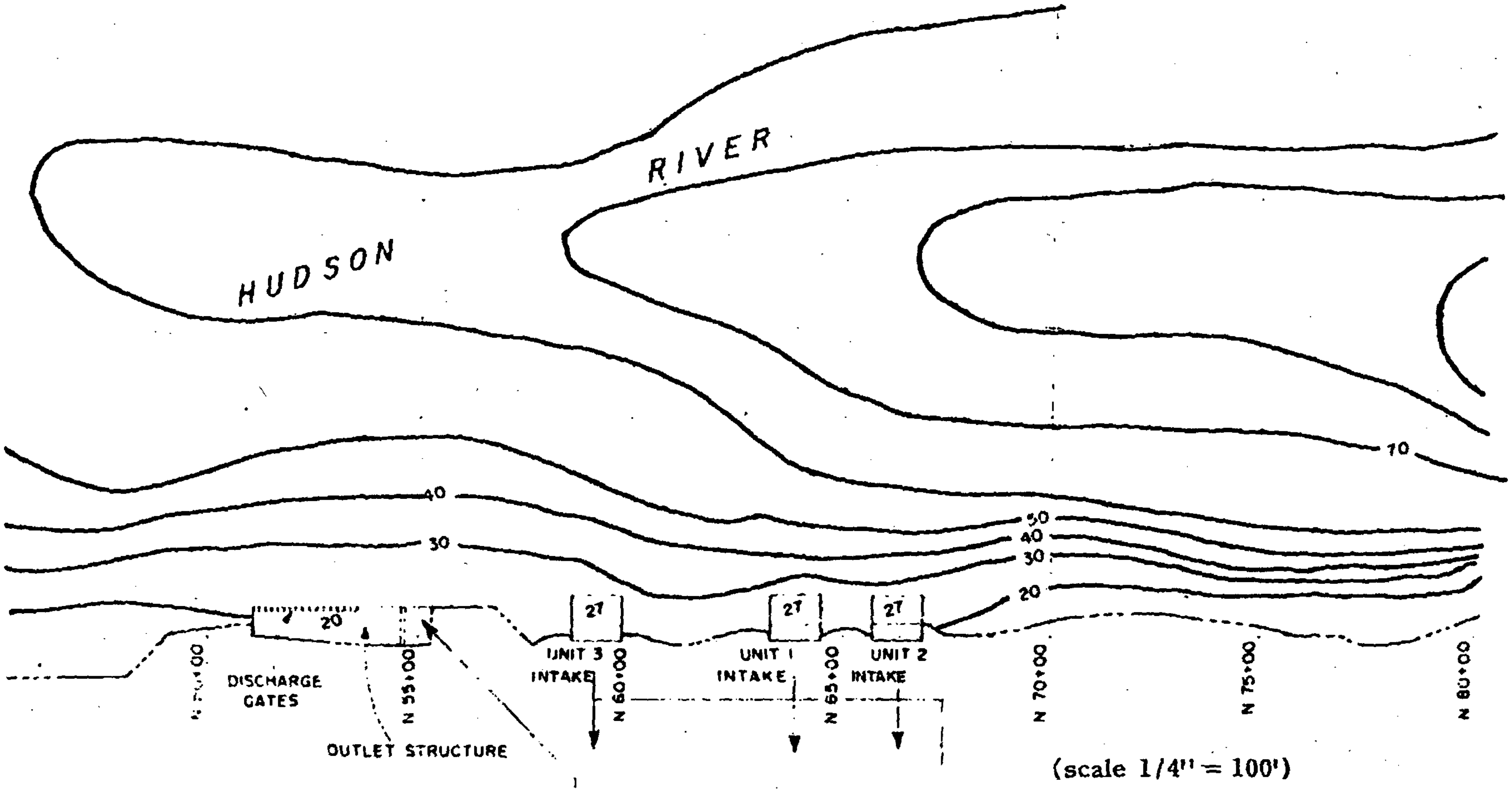


Figure 6. Morphometry of the Hudson River in the Vicinity of the Indian Point Station. (Source: LHL 1976, Figure 2)

Table 1. Monthly Mean Freshwater Flow (cfs) at Green Is., NY 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: Texas Instruments Incorporated. 1976. A Synthesis of Available Data Pertaining to Major Physiochemical Variables Within the Hudson River Estuary.

Table 2 MEAN MONTHLY SALINITY (ppt) AND MEAN MONTHLY WATER TEMPERATURE (°C) AT INDIAN POINT.

MONTH	MEAN MONTHLY SALINITY (ppt)*	MEAN MONTHLY WATER TEMPERATURE (°C)**
January	1.6	1.6
February	1.7	1.6
March	0.8	3.8
April	0.2	8.9
May	0.5	15.4
June	1.1	21.6
July	2.8	25.5
August	4.2	26.4
September	3.9	24.2
October	2.6	17.1
November	1.6	10.8
December	0.5	4.7

* Data years 1977 and 1979 to 1983

** Data years 1976 to 1982

Results of hydraulic model studies conducted by LaSalle Hydraulic Lab (1976) indicated that the extent of the zone of withdrawal and the amount of discharge water recirculated were dependent upon the tide condition. Intake water during the flood and slack tide conditions as well as during the ebb tide (Figures 7, 8, and 9) tends to flow into the intake area of both Units 2 and 3 from the north. This apparently occurs during flood tide because the water discharged from the plant south of the intakes for Units 2 and 3 forces the upstream flowing tidal water to move in an offshore direction. The discharged stream of water moving channelward, also "drags" water on its right side (north side) channelward as well. This creates a southerly drift in front of the intakes as water flows in to replace that pulled offshore. These flows, coupled with the withdrawal of water into the intakes, establishes a large clockwise moving gyre in front of the station, and causes the intake flow stream lines for each plant during flood tide to extend upriver. During average flood tide conditions, the zone of withdrawal for Units 2 and 3 combined (Figure 7) is about 300-350' wide. During ebb tide, it is about 250' wide (Figure 8). During slack tide it enters a broader area in front of the plant with intake streamlines extending upriver (Figure 9).

C. Indian Point Impingement

Numerous methods for reducing impingement have been investigated and are reported elsewhere (USNRC, 1975). The causes of impingement have been investigated but no definite conclusions have been reached (TI, 1979; 1980). Estimates of impingement impact developed for the Cooling Tower Case have been published (ORNL, 1982).

Although from 43 to 76 fish species have been collected annually at the Indian Point Station since 1976, four species (white perch, Atlantic tomcod, blueback herring and bay anchovy) have made up approximately 90% of the total. Other species of

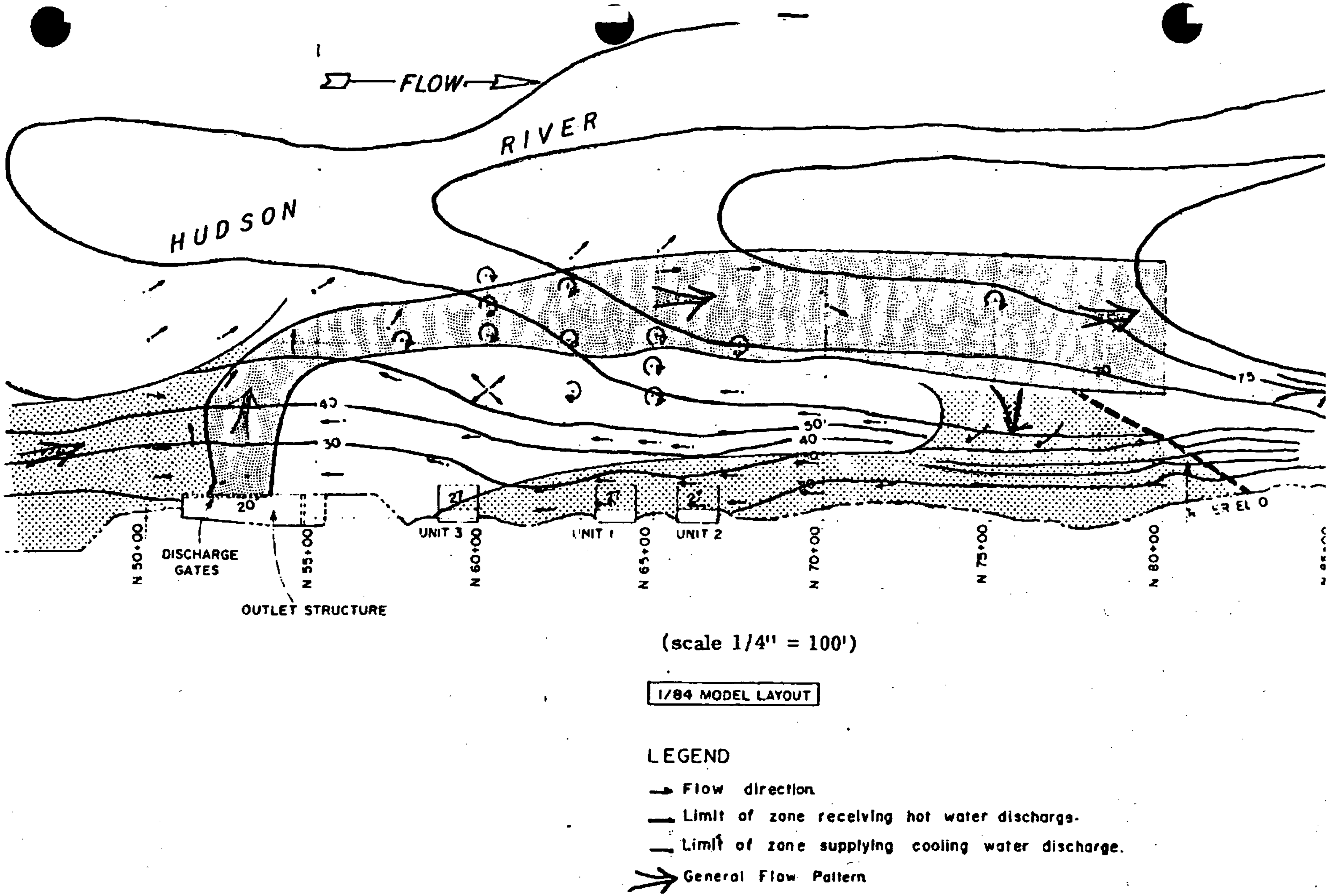


Figure 7. Zone of withdrawal at Indian Point Station, avèrage flood tide.
(Source: LaSalle Hydraulic Lab 1976)

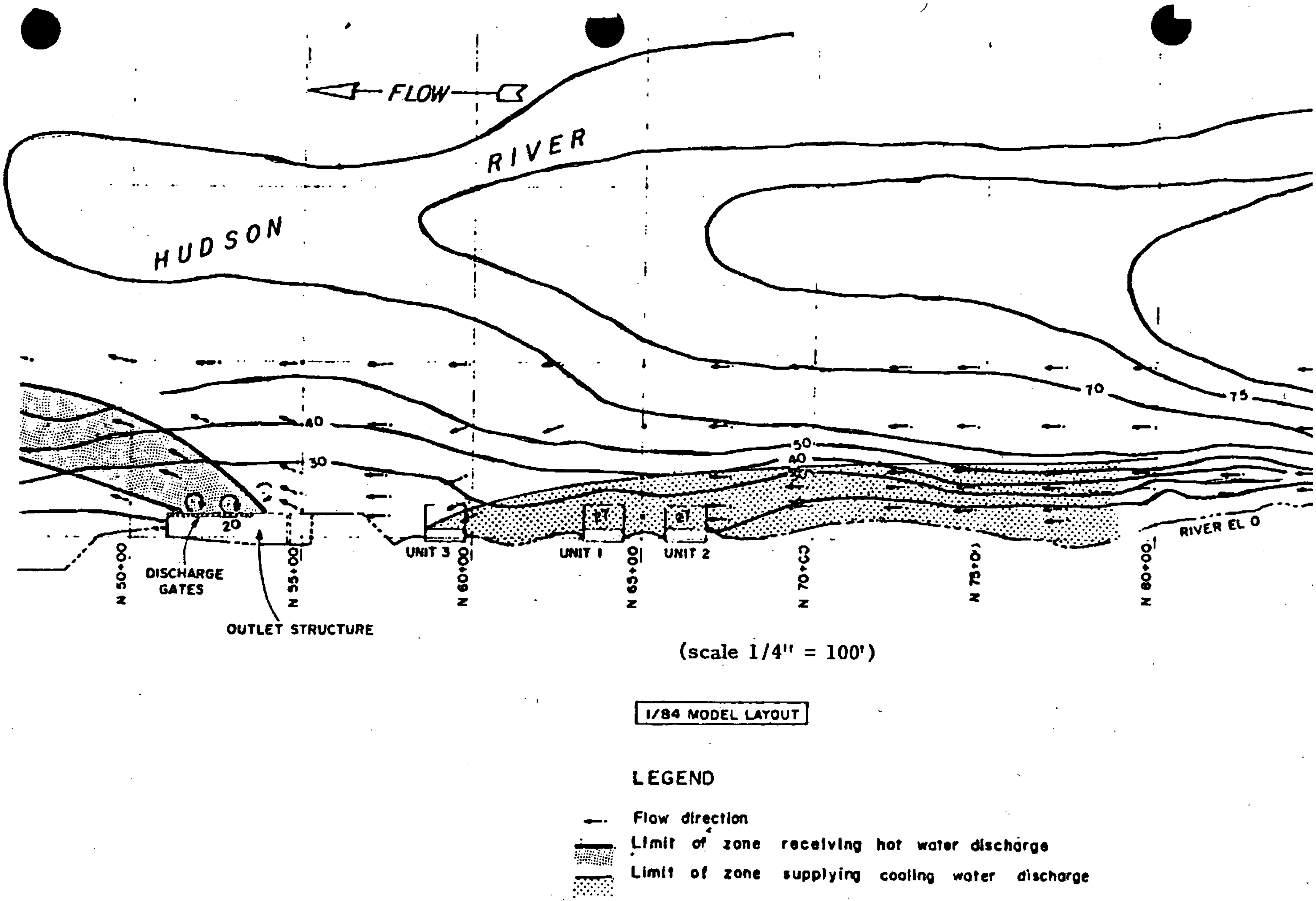


Figure 8. Zone of withdrawal at Indian Point Station, average ebb tide.
(Source: LaSalle Hydraulic Lab 1976)

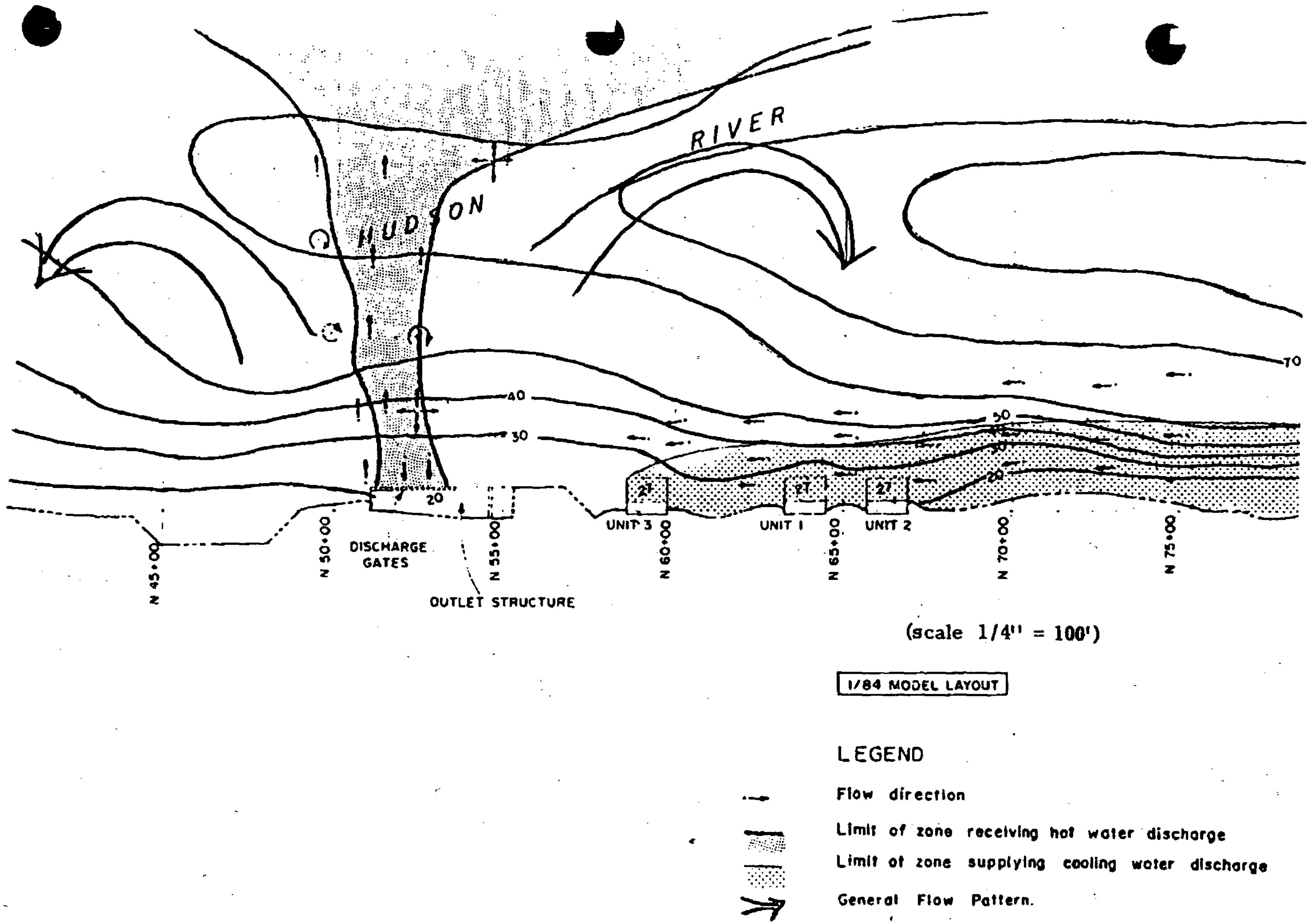


Figure 9. Zone of withdrawal at Indian Point Station, average slack tide. (Source: LaSalle Hydraulic Lab 1976)

interest such as striped bass and American shad have each contributed from 1 to 2% to the average annual total during these eight years. The total number of fish impinged annually during this period has ranged from 0.85 X 10^6 in 1983 to 6.47 X 10^6 in 1977 (NAI, 1984), with a mean of 3.3 X 10^6 (Table 3).

The number of fish impinged within any one year is primarily influenced by those environmental and biological factors (e.g. temperature, salinity, food availability) that determine fish movement patterns and, to a lesser extent, by the volume of water circulated by each unit's pumps. Significant yearly changes in the number impinged are generally attributable to fluctuations in the number of white perch impinged; however, variations in the numbers of bay anchovy, blueback herring and/or Atlantic tomcod impinged can also help produce a relative increase or decline.

Most fish are impinged during the fall months from October through December. It is during this time that many impingeable juvenile fish are actively migrating. Summer (July through September) and winter (January through March) impingement totals are nearly equal, while the fewest numbers (on average about half that impinged during summer or winter) are impinged from April through June.

<u>White Perch</u>

White perch, represented approximately 48% of all the fish that were impinged during this time period (Table 3). Peak impingement of white perch (Table 4) generally occurs between December and March when they presumably overwinter in the lower estuary (TI 1976, 1980). Nearly all of these fish are less than 12 months old. The proportion of these that are young-of-the-year vs. those that are considered yearlings varies broadly among years.

Table 3. Mean, Minimum and Maximum Annual Impingement Estimates and Percent of the Total for the Ten Most Abundant Species of Fish Impinged at Indian Point Units 2 and 3 Combined During the Period 1976 - 1983

SPECIES	MEAN NO.	%	MIN No.	MAX No.
All Species Combined	3340047	100.00	850076	6472532
White perch	1605292	48.06	286531	3154563
Atlantic tomcod	495844	14.84	69591	1726632
Blueback herring	494683	14.81	1193	1601614
Bay anchovy	371112	11.11	26317	1332622
Striped bass	57510	1.72	12462	96550
American shad	57135	1.71	1497	229307
Hogchoker	53676	1.60	22993	107089
Weakfish	48913	1.46	1199	174991
Alewife	37840	1.13	2223	126098
Rainbow smelt	30472	0.91	1280	83996

Table 4. Percent of the Mean Annual Numbers of Ten Species of Fish Impinged Each Month at Indian Point Units 2 and 3 Combined

	SPECIES									
Month	White Perch	Atlantic Tomcod	Blueback Herring	Bay Anchovy	Striped Bass	American Shad	Hogchoker	Weakfish	Alewife	Rainbow Smelt
January	24.7	0.5	<0.1	<0.1	23.7	<0.1	0.1	0.0	0.1	7.4
February	16.5	0.1	<0.1	<0.1	11.5	<0.1	<0.1	0.0	0.1	4.9
March	12.9	0.1	<0.1	0.0	9.6	<0.1	<0.1	0.0	<0.1	4.2
April	6.5	0.1	<0.1	<0.1	1.4	<0.1	4.9	0.0	0.2	7.4
May	3.8	6.4	0.3	1.5	1.2	<0.1	19.5	0.0	1.5	15.0
June	0.9	32.8	0.2	2.2	0.4	0.4	2.0	<0.1	1.2	10.6
July	0.7	30.0	3.1	32.4	6.9	35.8	3.1	17.5	26.1	13.8
August	2.4	24.9	2.3	39.0	10.0	27.8	11.2	42.8	28.6	4.6
September	1.5	3.3	4.7	16.4	4.6	4.6	21.1	35.5	9.2	2.3
October	4.8	0.5	70.0	8.0	6.3	13.5	27.9	2.8	13.6	9.8
November	10.8	0.2	18.6	0.4	5.3	16.7	8.4	1.1	18.6	8.1
December	14.5	1.1	0.7	<0.1	19.1	1.1	1.7	0.3	0.8	11.9

Atlantic Tomcod

Atlantic tomcod, represented approximately 15% of the total number of fish impinged annually from 1976 through 1983 (Table 3). More than 87% of the Atlantic tomcod were impinged from June through August (Table 4). Virtually all (more than 99%) were young- of-the-year fish. Peak impingement of Atlantic tomcod corresponds to the downstream migration of the young-of-the-year fish during the summer months from middle estuary spawning areas to the regions near Indian Point (TI 1979, 1980). A secondary period of impingement occurs from December through February associated with spawning movements of adult fish; however, impingement during this winter period contributes less than 2% of the annual total.

Blueback Herring

Blueback herring represented approximately 15% of all the fish impinged from 1976 through 1983 (Table 3). More than 88% of those were impinged during October and November (Table 4). During these months, young-of-the-year blueback herring characteristically migrate downstream from their nursery grounds to more saline overwintering areas (TI 1980). These movements generally bring large numbers of these fish past the Indian Point Station. Virtually all (more than 99%) of the blueback herring impinged annually are young-of-the-year fish.

Bay Anchovy

Bay anchovy represented approximately 11% of all the fish impinged from 1976-1983 (Table 3). They enter the Hudson River during the spring and utilize the estuary as a spawning and nursery area (McFadden et al 1978). Peak impingement (approximately 87% of the annual total) of young-of-the-year and adult bay anchovy occurs throughout the summer months (July through

September; Table 4). Approximately 84% of the bay anchovy impinged during these months are yearling fish.

Striped Bass

Striped bass represented approximately 1.7% of all the fish impinged at Indian Point from 1976-1983 (Table 3) Most striped bass impingement occurred from December through March (Table 9) and was primarily associated with overwintering of young-of-the-year and yearling fish in the vicinity of the Indian Point Station.

American Shad

American shad represented approximately 1.7% of the total number of fish impinged at the Indian Point Station from 1976 through 1983.(Table 3). More than 60% of the American shad impinged annually at both units were impinged during July and August (Table 4), when this species utilizes the nursery areas of the estuary (TI 1980). More than 99% of these were young-of-the-year fish.

Hogchoker

Hogchoker represented approximately 1.6% of all the fish impinged from 1976 through 1983 at Indian Point (Table 3).

Hogchoker generally exhibit bimodal peaks in impingement. More than 55% of the hogchoker impinged annually at both units, were impinged between September and November (Table 4), coinciding with peak seasonal abundance of juvenile hogchoker in the Indian Point region (TI 1976). A less prominent peak in impingement occurs in early spring. Approximately 20% of impinged hogchoker are impinged during May, reflecting increased activity associated with increased water temperature (TI 1980) and coinciding with the occurrence of peak catches of yearling and older hogchoker in the Indian Point region (TI 1976).

Weakfish

Weakfish represented approximately 1.5% of the total number of fish impinged at the Indian Point Station from 1976 through 1983 (Table 3) More than 95% of the weakfish impinged annually at both units were impinged from July through September (Table 4) when young weakfish utilize the nursery areas of the Hudson River estuary (TI 1980). More than 99% of the weakfish impinged during the summer months are young-of-the-year fish.

Alewife

Alewife represented approximately 1.1% of the total number of fish impinged at the Indian Point Station from 1976 through 1983 (Table 3). Approximately 55% of the alewife impinged annually at both units were impinged during July and August (Table 4) when young-of-the-year of this species used the nursery areas of the estuary and begin to emigrate (TI 1980). More than 93% of those impinged were young-of-the-year fish.

Rainbow smelt

Rainbow smelt represented less than 1% of all the fish impinged at the Indian Point Station from 1976 through 1983 (Table 3). Impingement of rainbow smelt during spring is comprised of about 99% adults that are migrating into freshwater areas of the lower and middle estuary to spawn (TI, 1976). During the early summer period, impingement consists of approximately 50% adults and 50% juveniles. Bimodal increases in rainbow smelt impingement have occurred during the summer when impingeable sized young-of-the-year become abundant in the Indian Point region and again in the fall as these young-of-the-year fish move downriver (TI, 1980; Table 4).

III. ALTERNATIVE IMPINGEMENT MITIGATION TECHNOLOGIES

Preliminary conceptual designs for bypass systems, wedge wire screen systems and horizontal travelling screens applicable to Indian Point were prepared for comparison with more detailed plans for Ristroph screens. In developing conceptual designs for each of the selected technologies those factors found to be of importance in mitigating impingement effects in previous studies or applications of each technology at other locations were considered. An attempt was made to optimize each design given the configuration of the existing intakes and the operating requirements of each unit. Designs that minimized the interruption of condenser cooling water flows and avoided interruptions of service water flows during installation and operation were sought. Interference with cooling water flows can result in outages with consequent high costs for replacement power. Interference with service water flows would contravene NRC safety standards.

Although cost estimates for Ristroph screens are believed to be accurate, estimates for the designs prepared for all other alternatives must be considered to be only approximations. The degree of uncertainty is greatest for those technologies requiring extensive further development and/or offshore construction, particularly in deep waters, i.e. horizontal travelling screens and Johnson screens. For all of the alternatives other than Ristroph screens additional information must be obtained before optimum designs can be developed. Detailed estimates of the cost of more appropriate designs might differ substantially from the estimates proposed herein.

A. Ristroph Modified Vertical Travelling Water Screens

1. Review of Technology

Vertical travelling water screens are standard equipment for exclusion of debris at water intake structures. These machines consist of a continuous series of mesh covered panels mounted between two endless chains that are rotated by operation of a supporting sprocketed head shaft. A steel frame is used to support the screens in a position normal to the water flow path and extending from the bottom of the intake to the deck above the water surface. Floating and suspended debris is collected on the mesh and basket frame lips and is carried by the rotation of the chains to a sluice for disposal. A spray system washes the debris from the mesh into the sluice (ASCE 1982).

The design and operation of these machines may be readily modified to enhance the survival of fish that become impinged on the screen mesh. The principle features of a modified travelling screen include the following: 1) a travelling screen designed for continuous operation; 2) fish collection buckets mounted on screen baskets; 3) a dual low pressure fish spray, high pressure debris spray wash system; 4) fish return trough; and 5) debris trough (Figure 10).

The principle upon which these modified travelling screens operate is to collect impinged fish, and carry them to a sluice for return to the water body from which they came with a minimum of trauma. As the screens are rotated out of the water, fish drop off the mesh and collect in the pool of water in the bucket. As the basket rotates past a low pressure spray system, the fish are gently washed into a sluice mounted on the intake deck. The sluice carries the fish to a pipeline which then carries them to a point of discharge from which recirculation into the intake is expected to be minimal. Screens modified in this fashion are generally referred to as Ristroph screens (Figure 10). Thorough reviews of this technology can be found elsewhere (Cada et al 1979; Cannon et al 1979; ASCE, 1982; Santoro, 1984).

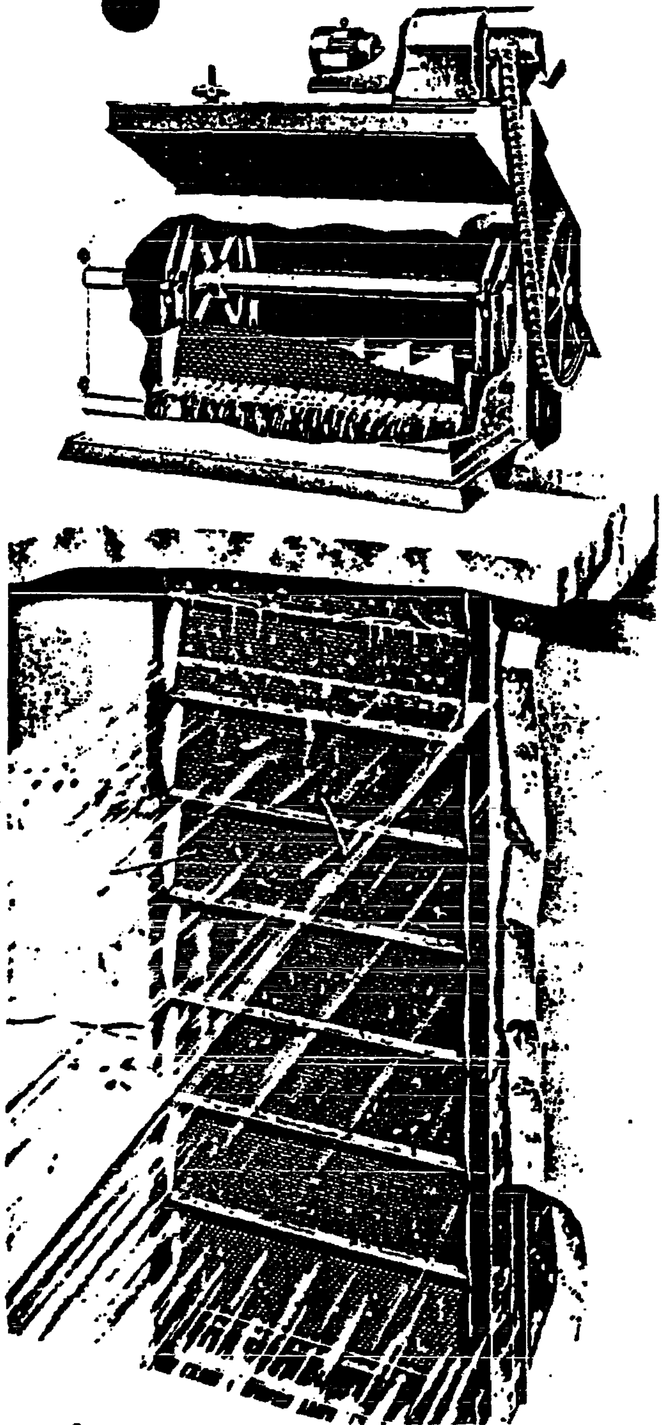
Continuous or frequently intermittent rotation of Ristroph screens, whereby impingement time is reduced to a matter of minutes (Table 8), will appreciably reduce the debilitation and trauma currently imposed on fish impinged at Indian Point where screens have generally been washed only once every 24 hours. Prolonged impingement increases the likelihood of abrasion and exhaustion as fish struggle against the screen meshes. Ionic imbalances in blood and tissue fluid may result from disruption of the skin surface and interference with active salt transport mechanisms across the gill surface as opercular movement becomes difficult or impossible. Physiological effects of exhaustion are exacerbated by interference with oxygen exchange across the gills.

The addition of baskets to the lower end of each screen panel largely eliminates any chance of fish falling from the screen surface and back into the water with subsequent reimpingement and consequent trauma which is likely with the conventional screen design which now exists.

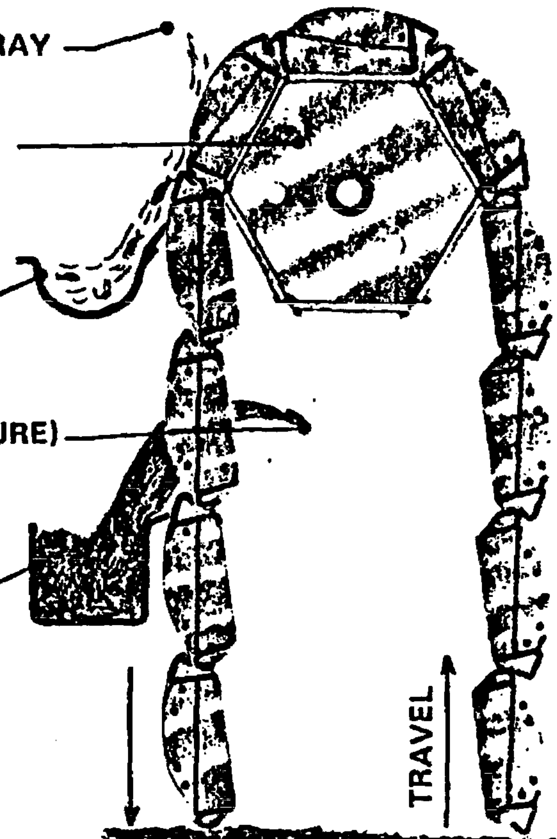
Three vendors of vertical travelling screens offer fish recovery systems (buckets, low pressure spray wash systems, and collection troughs) as optional available equipment. Over 140 of these screens have been or are being installed at 30 water intake facilities and have been formally approved as best technology for fish protection at 24 of these installations. (Appendix A)

2. Survival of Fish Collected from Ristroph Screens

The survival of fish collected on modified vertical travelling water screens has been investigated at four East Coast generating Stations situated on estuarine waters (Surry, Salem,



A. Schematic Drawing of a Ristroph Type Screen



B. Schematic Drawing of Components of Ristroph Screen

Figure 10. <u>RISTROPH MODIFIED VERTICAL TRAVELING SCREEN</u>

Danskammer and Indian Point) and at one seashore (Mystic) location.

The Surry Generating Station is situated on a tidal portion of the James River, (Virginia) approximately 29 miles upstream of its entrance into the chesapeake Bay. Salinity of the estuarine water at the site varies from 0 to approximately 10 ppt. Water temperatures range from approximately 35°F in February to about 80°F in August. In May, 1974, travelling screens modified to enhance survival of impinged fish were placed into operation at Surry. This installation was a rear wash system (fish and debris are removed on the plant side of the screen) and utilized a deflector plate mounted in the screen basket to facilitate the transfer of fish from the screen to a sluice. A modification of this screen basket design, which was made by angling a slotted (1/8" x 1/2") mesh screen from the back of the lower rail to the front of the top rail to eliminate the need for the deflector plate, was incorporated on two traveling screens and was evaluated for enhancement of fish survival rates (ANON). Two low pressure spray washes were used to remove fish from the screens. One spray was directed outward through the screens and the other was directed downward from a position above and to one side of the screens.

The Salem Nuclear Generating Station is situated on the eastern shore of Delaware Bay approximately 50 miles upstream from Cape May, New Jersey. Salinity in the vicinity of the Salem Station varies from 0 to 20 ppt depending on freshwater discharge from the Delaware River. Temperatures range from near 35°F in February to approximately 80°F in August. Ristroph screens were installed and testing was initiated in 1976. These screens were designed after the Surry installation which included a rear wash system with deflector plates in the screen baskets, a low pressure wash mounted within the screen frame work washed outward through the screen to remove the fish.

The Danskammer generating Station is located on the Hudson River approximately 65 miles upstream of the Battery at New York City. The estuarine water at Danskammer is fresh except during periods of extreme low freshwater flow. Temperatures range from near 32°F in February to approximately 80°F in August. A Ristroph-type screen was installed for test purposes in 1979. This was a front wash system. Low pressure wash system mounted outside the screen frame sprayed downward toward the back side of the bucket to wash the fish over the front edge of the bucket into the sluice. Deflector plates were not installed. Standard 3/8" mesh screening was installed. The screens were operated at a central travel speed, 5 fpm. Constant

The Mystic generating Station is located on the Mystic River, approximately 2 miles upstream of Boston Harbor, Boston, Massachusetts and withdraws nearly full strength sea water (30 ppt). Water temperatures range from near 32°F in February to approximately 70°F in August. Modified traveling screens were installed for test purposes in 1980. These screens utilized a rear wash system and the free slide basket design which was tested at Surry. A slotted screen mesh (1/4" x 1") was also installed on these screens.

A traveling water screen at Indian Point Unit 1 was retrofitted to a Ristroph screen in 1977. This screen employed a rear wash system with both internal and external low pressure sprays similar to those used at Surry, and 2.5mm synthetic screening. A deflector plate was installed to facilitate the transfer of fish to the sluice. Testing with this screen was hampered by mechanical difficulties, and performance was never fully optimized.

Because of the similarity of the fish species collected at these five Stations (Table 5) to those commonly collected on Indian Point Units 2 and 3 intake screens (Table 3) and the fact that many of the design characteristics at those Stations are analogous to those of Indian Point (Table 6), results of these

Table 5. Stations at which the ten most abundant species in Indian Point Units 2 and 3 Impingement Collections Are Also Present

Species	Indian Point[1]	Salem[2]	Surry[3]	Mystic[4]	Danskammer[5]
White perch	X	X	X	X	X
Blueback herring	X	X	X	X	X
Atlantic tomcod	X			X	X
Bay anchovy	X	X	X		X
American shad	X	X	X		X
Striped bass	X	X	X		X
Hogchoker	X		X		X
Rainbow smelt	X			X	X
Alewife	X	X	X	X	X
Weakfish	X	X	X		X

Sources: (1) Normandeau Associates, 1984; (2) Public Service Electric and Gas, 1984; (3) White and Brehmer in Jensen, 1976; (4) SWEC, 1981; (5) Ecological Analysts, Inc., 1982.

Table 6

DESIGN CHARACTERISTICS FOR SELECTED INTAKE STRUCTURES

Station	Status*	TWS** Dimensions	Screen Mesh Size	Approach Velocity Range	Water Depth Range	TWS Position	Intake Flow	Salinity	Screen Travel Speed
Indian Point Unit 2	-	12' Wide 47' C to C	3/8"	0.5 - .8 fps	26' - 29'	25' from front of forebay	84,000 - 140,000 GPM/pump	0-4 ppt	-
Indian Point Unit 3	-	12' wide 47' C to C	3/8"	0.6 - 1.0 fps	26' - 29'	<1' from front of forebay	84,000 - 140,000 GPM/pump	0-4 ppt	-
Indian Point Unit 1	T	10" wide (46' approx. C to C)	2.5mm (1/10")	0.4 to .71 fps	25' - 28'	28'	70,000 GPM/pump	0-4 ppt	5 fpm
Salem	O	10' wide 56' C to C	0.4"	1.1 to 1.5 fps	31' to 42' Approx.	22+' from front of forebay to fish escape slot at screen face	185,000 GPM/pump	0.5 - 20 ppt	4.5 to 1.25 fpm
Surry	O	14' wide 38' C to C	3/8" sq. 1/8" x 1/2"	1.3 fps	24' to 28' Approx.	14±' from front of forebay	220,000 GPM/pump	0 - 10 ppt	10 to 20 fpm
Danskammer	T	8' wide (15' C to C Approx.)	3/8" sq.	1.5 fps	8 to 12' Approx.	4+' from front of forebay (Intake canal ±500' long)	50,000 GPM/pump	0 ppt	5.3 fpm
Mystic	O	8' wide (48' C to C)	1/4" x 1" (smooth top)	2 to 3 fps	28' - 38' Approx.	26' from front of forebay	145,000 GPM/pump	30 ppt	3.3 to 15 fpm

* A dash (-) means Ristroph screens are not present; T means Ristroph test screen; O means operating Ristroph screen TWC = Traveling Water Screen;

** C to C means distance from head sprocket shaft to foot sprocket shaft.

studies should be generally applicable for projecting fish survival rates at Indian Point should the intakes be equipped with modified travelling screens. Data summaries extracted from reports of the studies at each of these sites are presented in Appendix B. Listed below are brief discussions of the survival rates for the ten species of fish commonly collected at Indian Point for which survival rates at these facilities was also evaluated.

Three types of survival rates are commonly identified among these Ristroph screen studies: initial survival latent survival and total survival. The initial survival rate is that portion of the fish that are alive immediately following removal from the screens. Latent or extended survival is that portion of the live fish that live for an extended period of time, usually 84 to 96 hours for the studies described here. Total survival is the product of the initial survival rate times the latent survival rate, and represents the portion of the total number of fish that survive for 84 to 96 hours following removal from the screens. Of these various rates, total survival rates might be most representative of what ultimately happens to the fish following collection. Initial rates do not account for possible mortality among fish that are damaged or stunned in the collection process, and latent mortality rates, which do account for at least some of the mortality occurring shortly after collection, do not take into consideration those fish that were dead upon collection. However, when both rates are combined, the number of fish surviving for the extended period of time reflects the level of survival of all the fish collected. (It is important to note here that some additional mortality may be incurred in the discharge of the fish to the water from which they came. Assessments of total mortality presented here do not take into account this potential mortality. However, it is discussed in section III. 4. b. entitled Fish Return Systems.)

a. White Perch

The initial, latent and total survival rates of white perch following collection from Ristroph screens were investigated at the Salem Nuclear Generating Station during the period 1976 through 1982. Initial survival of the 36,238 perch examined was 91.6% and ranged from a low of 74.8% to 95.6% (Appendix B: PSE&G, 1984(a), Table 7-6). Ninety two percent of the fish were age class 2 or younger, and 75% were young-of-the-year. White perch at Salem were impinged predominantly in the months of November through April, (PSE&G, 1984(a), Table 7-7) similar to the season of white perch impingement at Indian Point (Table 5).

PSE&G evaluated latent survival of white perch as a step in the process of determining total survival following collection from the Ristroph screens. During these tests with 3021 fish, it was observed that some fish showed signs of a loss of equilibrium (LOE) for intervals of time during the 96 hour tests. This condition was highly seasonal and occurred predominantly when water temperatures were below 10°C. For those fish collected live and undamaged (43% of the impingement collection) approximately 24% demonstrated this condition, and of the fish that showed signs of damage (missing scales, hemorrhages, etc.; 49% of the fish collected) 80% demonstrated loss of equilibrium. This condition was considered important since it could enhance mortality through predation following return to the water body, and was applied in the assessment of total survival in two ways.

First, those fish showing a loss of equilibrium at the end of the 96 hour test were considered dead. Monthly estimates of total survival under this assumption ranged from 47% in May to 89% in December (PSE&G, 1984(a), Table 7-17). Second, it was assumed that any fish demonstrating a loss of equilibrium sometime during the 96-hour test was dead. Based on this assumption, monthly total survival ranged from 17% in February to 70% in September (PSE&G, 1984(a), Table 7-18).

PSE&G investigated the potential for loss through predation, and found no predatory fish to be present at Salem during the winter. They did observe bird predation on the surface discharged fish, and through computations of bird feeding rates and numbers of fish discharged in an LOE condition, estimated that bird predation to be 29%. (It is doubtful that bird predation would occur for fish discharged well below the water surface.)

Mortality associated with handling and holding white perch was assessed using 857 fish. Survival rates were uniformly high (>95%) and accordingly PSE&G elected not to adjust test data for control mortality (PSE&G, 1984(a)).

At the Danskammer Generating Station (CHG&E Corp.) fish collected from a continuously rotating Ristroph test screen in the fall and winter averaged 72-98mm in length; and spring-captured fish were approximately 127mm in length (EA 1982). Initial survival of all sizes ranged from 92 to 98% and was comparable among fall, winter and spring sampling periods. Total survival (84 hours) ranged from 42 to 67% in the fall, 55% in the winter and 51% in the spring (EA, 1982). Data were unadjusted for control survival.

At Indian Point Unit 1 in October and November 1978, all of the 37 white perch collected on a 2.5mm mesh modified travelling screen survived through 96 hours. These fish were primarily juveniles (33 of 37 fish). In a series of tests conducted during the fall in 1977 at Indian Point Unit 1 a total of 228 young-of-the-year white perch were collected; 44% survived initially, but only 18% survived through 84 hours. During the same tests, 37 yearling and older white perch had similar survival rates (40% initial and 16% total survival). However, these data were believed to have been biased by the results of one test in December (TI, 1978). Initial survival of 178 fish (of all ages) was only 25% and was believed due to a high spray wash pressure (unmeasured), and a five-hour long collection period, neither of which condition is reflective of standard operating procedures for Ristroph type screens. When this sample was deleted from the computations, average initial survival of all age fish was 88% and total survival (84 hr.) was 78%. (Indian Point data were not adjusted for control survival). In a spring 1978 study at Indian Point 14 juvenile white perch survived the 96 hours (EA, 1978).

In two separate studies, at the Surry Nuclear Generating Station, (VEPCO) white perch initial survival collected on Ristroph screens ranged from 96 to 99 percent (White and Brehmer in Jensen, 1976). These survival rates were determined after an approximately 15 minute retention period following removal from the screens and collection in a 17,000 gallon pool of water. (The number of fish involved in one of the tests was 140 but was unspecified for the other. Latent survival was not investigated, and control survival data were not obtained).

b. Atlantic Tomcod

Atlantic tomcod were collected from a Ristroph screen at Indian Point, and survival was observed to vary with the season. In tests during June, 86 fish showed 38% total survival (range 0 - 69%; EA, 1977, 1979; TI, 1978), whereas during December a collection of 41 fish showed 95% total survival (TI 1978). Total survival of 38 Atlantic tomcod collected during winter at the Mystic Station averaged 86%. Too few fish were collected to evaluate fall and spring survival rates at Mystic.

In a test of 30 adult fish collected at Danskammer during the winter, initial survival was 97% and total survival was 83%. (None were collected during warmer seasons). Atlantic tomcod and were not collected at the Salem or Surry generating Stations. ?

c. Blueback Herring

A total of 14249 blueback herring collected from the Ristroph screens at the Salem Nuclear Generating Station during the period 1977-1982 were evaluated for initial survival. Average initial survival was 81.9% and was typically greater than 75% (PSE&G, 1984 (b)). Blueback herring less than one year in age contributed 96.2% of the numbers impinged at Salem. Two peaks in impingement occurred: November - December, and March - April (PSE&G, Table 7-4). Initial survival of age class 0 blueback herring during March and April averaged 81.0%, and during November and December, it averaged 85.6 to 88% (PSE&G, 1984 (b); Table 7-12 revised). Total survival of young-of-the- year blueback herring was 24.2% in October, 29.1% in November and 25.1% in December. Survival of yearling fish in the Spring was nearly 0 (PSE&G, 1984(a); Table 7-12 revised).

Initial survival of 45 blueback herring collected at Danskammer during the fall was 64%, but total survival of 185 herrings (blueback herring and alewife combined) after 84 hours was only 4% (EA, 1982). Total survival for blueback herring collected during the winter or spring was not determined at Danskammer.

Texas Instruments (1978, 1979) noted initial survival rates for 529 blueback herring to be high (84%) and total survival of 444 fish to be 19% in studies conducted at Indian Point Unit 1 in the fall (1977 and 1978). Survival during latent mortality tests was observed to decline steadily over the 84 hour test period.

In two studies at VEPCO's Surry generating Station blueback herring initial survival rates were uniformly high 90 to 94%. Long term survival (i.e. 96 hours) was not evaluated.

At the Mystic Generating Station blueback herring and alewife were combined in the assessment of survival. Initial survival of 5210 juvenile and adult herring was 96%, collected during the fall, winter and spring. Total survival was 29% based on 1835 fish held for latent survival tests. However, total survival for 4635 young-of-the-year herring collected in fall testing was 43% following an initial survival of 98%.

At Salem where salinity ranges from near 0 to about 15 ppt, PSE&G (1984 (b)) found it to explain 84% of the variability in mortality rates observed. Highest survival occurred in the fall when salinities were approximately 10-15 ppt. Lowest survival occurred in the spring (0%) when salinities were near 0. Total survival of herring at the Mystic station which is also located in a high salinity (30 ppt) region was observed to be 29 to 43%. At Danskammer the low total survival observed may have been related to the absence of saline water at the station since it is located well upstream of the salt front.

At Indian Point, the salt front was generally downstream of the Station during the fall, 1977 (TI, 1979), yet blueback herring total survival was nearly 22% (TI, 1978). Salinity may enhance survival but at low salinities other localized conditions may be important in determining survival rates [i.e. reduced approach velocity]. ~~may be important in determining survival rates.~~

d. Bay Anchovy

The initial survival of 167,410 bay anchovy evaluated at Salem averaged 60% and ranged from 80.3% in October to 47.9% in March (PSE&G,1984 (c); Table 7-14). Anchovy were most abundant from April through July at Salem during which period the collected fish were age class 1 or older and initial survival ranged from 47.9% to 65%.

A total of 3,153 bay anchovy were held for latent survival tests, and 1,302 seine-collected fish were evaluated for handling and holding mortality. Ninety six hour survival for control fish averaged 80.6% and ranged from 52.2 in May to 98.2% in November. Unadjusted latent survival of bay anchovy collected in an undamaged condition was 14.9% and ranged from 0 to 31.9% in November. Unadjusted overall survival of anchovies collected in a damaged condition was 4.4% and ranged from 0 to 13.8%. Following correction for control survival, the adjusted total survival for undamaged as well as damaged fish, all ages combined averaged 9.6% and ranged from 4.9 to 23% (PSE&G, 1984(c); Table 7-14).

Initial survival of bay anchovy at Indian Point was moderate to low depending on age. Initial survival of 2415 young-of-the-year anchovy was 25% while that for 65 yearling and adults was 55% (TI 1978). Adult total survival after 84 hours was also higher (14%) than it was for YOY (<1%).

Initial survival of 22 young-of-the-year bay anchovy collected at Danskammer was 14% (EA, 1982). Initial survival rates observed at the Surry generating Station ranged from 82 to 86%. (White and Brehmer in Jensen 1976; Anon.) Latent survival was not evaluated at either Station.

e. Striped Bass

At the Salem Station, the initial survival rate for 969 striped bass collected was 94.6%. A total of 49% (478) were collected in an undamaged condition, while (45%) 439 showed signs of damage. Latent survival studies were conducted on only 16 striped bass. Of the 13 collected in an undamaged condition, 12 (92%) lived 96 hours. Only 1 (33%) of the 3 damaged fish however survived 96 hours. A total survival rate using both these estimates, was computed to be 60%. Latent survival of 23 fish held as controls was 100% and accordingly, no adjustments were made.

Initial survival of 65 striped bass juveniles collected from a Ristroph screen at Indian Point was 85% and total survival after 84-96 hours was 78%. (TI 1978, 1979, EA 1977, 1979). Total survival of 14 striped bass collected in the fall at Indian Point was 67% and for 51 spring collected fish it was 59%.

Striped bass survival immediately following collection from the Surry Ristroph screens was 100% during one 18 month series of tests, and 95% (75 of 79 fish were alive) in another test. (No latent mortality tests were conducted at Surry).

Initial survival of 17 juveniles and 3 yearling striped bass collected at Danskammer in the fall and 2 older bass collected in the winter was 100%. No latent survival tests were conducted.

f. American shad

The initial survival of 204 American shad collected from the Ristroph screens at Salem averaged 86.8%. American shad were seasonally abundant through December and again in March through May. Initial survival ranged from 80% to 95.8% for fall collected fish, and 80 to 100% for spring collected age class 0 fish. (PSE&G, 1984(e); Table 7-6).

In fall latent survival tests, 4 of 7 American shad survived. Total survival (average annual initial survival X latent survival) was estimated to be 49%.

Initial survival of 4 American shad were collected at Indian Point during the fall 1977 was 100%. Total survival after 84 hours-was 0 (TI, 1978). Initial survival of 23 American shad collected in late spring-early summer at Indian Point was 87% but total survival was also 0 (EA, 1979).

American shad were not collected at the Mystic or the Surry Station.

g. Hogchoker

The initial survival of 79 hogchokers collected from Ristroph screens at Surry (52), Danskammer (22), and Indian Point (5) was 100% in all studies (EA, 1982; TI, 1978; Anon). In an earlier study at Surry, initial survival of an unspecified number of hogchoker was 96% (White and Brehmer in Jensen 1976). Among the studies, however, total survival was evaluated for only the five hogchokers collected at Indian Point and was observed to be 100% (TI, 1977; 1978). No data on hogchoker survival at Salem was reported and none were collected at Mystic.

h. Weakfish

At Salem weakfish were impinged from June through December and are most abundant during July and August. Initial survival rates for weakfish collected at the Salem Station showed December survival to be 90% whereas that for June was 63.6%. Total survival also varied seasonally, ranging from 34.5% in June to 52.7% in December (PSE&G, 1984).

Initial survival rates of weakfish collected at Surry ranged from 59.2 to 100%, and initial survival of 19 weakfish collected at Danskammer was 87%. At Indian Point, 11 of 13 were collected alive, but total survival was 11%.

i. Alewife

The initial survival rate for 1850 alewife collected from the Salem Ristroph screens averaged 82.8% (PSE&G, 1984 (f); Table 7-7). Age class 0 fish contributed 91% of the total (PSE&G, 1984 (f); Table 7-4). As with blueback herring, late fall and mid-spring peaks in abundance of alewife occur at Salem. Relatively few alewife were caught during other seasons. Initial survival of age class 0 fish ranged from 93.7% in October to 91.7% in December. Spring survivals ranged from 83.1% in March to 73.1%

in June (PSE&G, 1984 (f); Table 7-6). No latent survival tests were conducted on alewife collected at Salem.

The initial survival of 129 alewife collected at the Danskammer generating Station averaged 74% among all age classes. Survival of young-of-the-year alewife collected in the fall averaged 71.8% (EA 1982). No latent survival tests were conducted for alewife alone rather, all herrings were combined to assess latent and total survival. Results presented for blueback herring (Section C, above) include alewife, are considered generally applicable for alewife.

The initial survival of 116 alewife collected at Indian Point during the fall periods in 1977 and 1978 averaged 68%. Total survival through 96 hours for these fish was only 5%. (TI 1978, 1979, respectively; EA, 1979).

Alewife were collected at the Mystic generating Station but were combined with blueback herring for initial and latent survival). The total survival rate for blueback herring (29%); Section C, above), is considered generally applicable to alewife.

Initial survival of alewife (number unspecified) collected at the Surry generating Station (White and Brehmer in Jensen 1976) averaged 90.7%. However, seasonal effects were not identified, and latent survival tests were not conducted for alewife collected at Surry.

j. Rainbow Smelt

Rainbow Smelt are impinged at Indian Point in relatively uniform numbers throughout the year (Table 4). Initial survival of 150 smelt of (all ages combined) following collection from the Ristroph screen averaged 27% but total survival after 96 hours was nearly 0%.

At Danskammer 8 adult rainbow smelt were captured (2 in the fall, 1 in the winter, 5 in the spring) and initial survival among all fish was 100% extended survival was not evaluated.

At Mystic initial survival of 964 young-of-the-year and older smelt was 96%. Total survival was 32%. During winter tests, however, young-of-the-year total survival was 46% following an initial collections survival of 97%. Total survival of older fish was 25% following an initial survival of 97%.

3. Projected Reductions in Impingement at Indian Point

As noted in the discussion of the facilities at which Ristroph travelling screens have been installed, results of survival studies at these generating Stations can be used to approximate reductions in impingement levels expected at Indian Point if similar modified travelling screens were to be installed there.

Total survival rates observed at the various generating facilities discussed above have been applied to impingement numbers from Indian Point to estimate the numbers of fish that might be saved if Ristroph screens were to be installed. The bases for the rates selected and the projected numbers of each of the species that might be returned to the river alive are as follows:

a. <u>White Perch</u>.

Evaluation of white perch survival following collection from the Ristroph screens at Salem was the most extensive and detailed of the studies reviewed. The Salem data were sufficient to allow estimation of survival on a monthly basis, and since white perch impingement varies substantially across months, the application of monthly survival estimates might be expected to provide a better approximation of the potential numbers of fish that could be saved, than might be provided by application of a single annual survival rate. Accordingly, Salem monthly total survival rates completed for all age classes of white perch combined based on differential survival rates for live fish and damaged fish, and on the assumption that only those fish showing a loss of equilibrium at the end of the 96 hour latent survival test would die, (PSE&G 1984(a); Table 7-17) were applied to the average number of white perch impinged at Indian Point Units 2 and 3 combined each month (Table 4) to provide a weighted estimate of survival with Ristroph screens. This analysis indicated that approximately 71% of the white perch impinged annually might be expected to ~~be returned alive to the~~ Hudson River. This level of total survival is comparable to the range of survivals observed at Danskammer and at Indian Point. Since these data in general were from screens operated without optimum designs for screen baskets, meshes, or travel speeds, it is likely that survival rates at Indian Point could be higher with an optimized Ristroph installation. To the extent that the reduced approach velocities at Indian point relative to the intake velocity at Salem may reduce the incidence of damage among the fish impinged, the projected return rate may be higher based on this parameter alone.

Not [illegible] slide, sq mesh. 5 fpm.

b. Atlantic Tomcod.

Total survival at Danskammer and at Indian Point was generally high during winter months (83% Danskammer, EA 1977; 95% Indian Point, TI 1978) but averaged 35% during the spring (Indian Point, TI 1978; EA, 1979). 39%.

To estimate the percentage of Atlantic tomcod that may be returned alive to the Hudson River following collection on Ristroph Screens at Indian Point, the total survival rate for the spring (35%) was applied to the May through September impingement num-

39%.

40% is correct

bers, and the 95% survival rate was applied to the impingement levels observed from October through April (Table 4). This analysis indicated that approximately 30% Atlantic tomcod impinged annually may be returned alive. The only data with which to project survival for Atlantic tomcod in the summer were collected from the test facility at Indian Point Unit 1. This installation was operated as a test facility, and it is believed that its operation was not fully optimized. A fully optimized system may significantly enhance the survival of this species.

c. Blueback Herring.

Evaluations of blueback herring total survival following collection from Ristroph screens at the Mystic Stations were based on the largest numbers of fish of any of the latent survival studies conducted. However, since the Mystic Station is in a high salinity environment (Table 6), which may enhance the hardiness of the species (PSE&G, 1984(b)) survival data from this site might overestimate survival at Indian Point. Further, blueback herring data from Mystic are confounded with the inclusion of alewife in the survival estimates as are data from Danskammer data. Also, Danskammer is situated in a predominantly freshwater environment, and therefore any benefits provided by saline water toward the enhancement of herring survival would not be present, as they would at Indian Point. Therefore, these results may underestimate levels of impingement survival to be expected at Indian Point.

Therefore, data from Salem for age class 0 fish (PSE&G 1984 (b);Table 7-12), which is the age class of 99% of the blueback herring impinged at Indian Point, were applied to the average monthly numbers impinged (Table 4) to project the numbers of blueback herring which might be returned to the river alive if Ristroph screens were installed. (Sufficient data were not available for age class 0 fish for the months of July, August and September. Data for age class 1 fish (PSE&G, 1984(b); Table

7-12) were substituted. This analysis indicated that approximately 23% of the blueback herring impinged annually might be returned alive to the Hudson River. This level of survival is substantially higher than that observed at Danskammer, comparable to that observed at Indian Point, but substantially less than that at Mystic for young-of-the-year fish. It may be that the spray wash water from the front wash system at Danskammer, which could strike the fish directly, in addition to the totally freshwater environment, contributed to the observed low survival. The freeslide screen basket design at Mystic, on the other hand, may have significantly reduced the trauma of the transit from the basket to the sluice and enhanced the survival observed there. An optimized screen basket design and spray wash system at Indian Point, coupled with the low salinity at Indian Point during the periods of peak herring impingement, may produce survival rates approaching rates observed at Mystic.

d. Bay anchovy.

Evaluations of bay anchovy survival following collection from the Ristroph screens at the Salem generating Station were the most detailed of any of the studies conducted at the five facilities discussed. These data allow assessment of projected total survival levels on a monthly basis. Total survival, corrected for control survival, for bay anchovy, all age groups combined, (PSE&G, 1984 (c); Table 7-14) were applied to mean monthly impingement numbers for Indian Point. Since no estimate for February was available, a survival value of 5%, the average of January and March survival rates, was utilized as a February survival estimate. This analysis indicated that approximately 10% of the bay anchovy impinged annually at Indian Point may be returned to the Hudson River alive. The total survival rates of bay anchovy collected at Indian Point are comparable to the rates observed at Salem. Since both facilities utilized comparable screen system designs, improvements in design, (freeslide baskets), and operation may increase the percentage of bay anchovy that are returned alive.

e. Striped Bass.

Limited assessments of total survival of striped bass have been made. Estimates made for Salem are based on only 16 fish, whereas those for Indian Point are based on 65 fish. Total survival rate for 51 spring collected striped bass at Indian Point was 59%, whereas survival of 14 fish collected in the fall was 67%. The overall weighted average of these estimates is 61% which can be used as the best estimate of the percentage of striped bass impinged at Indian Point which might be returned alive to the Hudson River if Ristroph screens were to be installed. For the reasons noted for white perch (and other species) it is likely that the level of return could be improved through optimization of screen design and system operation.

f. American Shad.

Limited assessments of the total survival of American shad have been made at the facilities at which fish survival following collection from Ristroph screens have been studied because few shad have been collected. At Salem the total survival estimate based on the latent survival studies with 7 fish was 48.5%. At Indian Point, the total survival of 27 fish was 0. A best estimate of expected survival at Indian Point might be provided by the average (25%) of the Indian Point and Salem data. However, with optimization of the proposed Indian Point system survival might approximate that reported for Salem.

g. Hogchoker.

Results of initial survival studies show hogchoker survival following collection from Ristroph screens to be nearly 100% and based on extremely limited data, extended survival also appears to be at or near 100%. Accordingly it is believed that 95 to 100% of the hogchokers impinged annually would be returned to the river alive.

h. Weakfish.

Total survival of weakfish collected in June at Salem was 34.5%, and was 52.7% for those collected in December. Weakfish impingement at Indian Point occurs predominantly during July through September with substantially fewer numbers being collected in October through December. The June survival rate for Salem was applied to Indian Point impingement numbers for the months of June through October and the winter rate was applied to the months of November and December. This analysis indicated that approximately 35% of the weakfish impinged at Indian Point might be returned to the Hudson River alive if Ristroph screens were installed. Weakfish total survival at Salem and Indian Point differs substantially, and the low survival at Indian Point is believed due primarily to the paucity of data. Improvements in screen design and operation over that at Salem would be expected to increase the percentage of weakfish returned to the river alive.

i. Alewife.

The only estimates of total survival for alewife following collection from a Ristroph screen are from data collected at Indian Point. Total survival of alewife collected in the fall was 5%. This value is similar to the total survival of alewife and blueback herring combined (4.5%) observed at Danskammer and might represent the approximate percentage of alewife that would be returned alive to the Hudson River. However, on the assumption that alewife and blueback herring are comparably sensitive to impingement trauma the survival rates referred to above may be low, given the total survival rates observed for blueback herring at Salem and Indian Point (Section 2.c). On the assumption that total survival rates for blueback herring observed at Salem are applicable to alewife, about 13% of the alewife impinged might survive if Ristroph screens were installed at Indian Point. This percentage may still be low for the same reasons noted for blueback herring survival, and with improved screen design and operation, could be substantially greater, approaching that observed at Mystic for blueback herring and alewife combined.

j. Rainbow Smelt.

Only limited numbers of rainbow smelt have been evaluated for total survival following collection from Ristroph screens. Total survival of 309 rainbow smelt at Indian Point was less than 1%. (Total survival at Danskammer was not assessed.) At Mystic where the water is nearly full strength seawater, total survival was 32%. If the survival of rainbow smelt at Mystic was a function of screen design and operation, and which was an improvement over the Indian Point design, it is quite likely that the percent of tomcod returned alive with Ristroph screens at Indian Point Smelt will be higher than that observed during the 1977-1978 tests, and may approximate that observed at Mystic.

Summary

Survival of fish handled on Ristroph screen systems has been found to vary among species and sites. Many of the studies were conducted experimentally early in the development of Ristroph technology. Parameter values, such as screen wash pressure and panel design, were varied and results reported reflect these variations.

Recognizing that significant improvements have been made recently in Ristroph screen design, the performance of the Ristroph screens proposed for installation at Indian Point will potentially provide mitigation equal to or better than that found in the studies reported herein. This may result in the successful return of 50% or more of all fish impinged at Indian Point to the Hudson River. Survival of species of particular interest, such as white perch and striped bass should be higher than that overall average.

4. Design considerations for a Ristroph Screen System for Indian Point

Several major considerations are necessary regarding the Ristroph system: These include such items as: 1) front wash or rear wash system; 2) screen basket design; 3) screen mesh size and pattern; 4) screen travel speeds; 5) fish discharge location, and 6) operation and maintenance considerations including the need for cold weather protection. Through field inspections of other installations and discussions with engineers, station operators and biologists at Utilities which have installed Ristroph screens, and screen vendors, these and other design elements have been reviewed with respect to the design of an optimized system for Indian Point. The following discussions of the principle screen components review the alternative designs available and indicate those considered best for Indian Point or alternatives which must be further evaluated to determine the best overall design. After installation of an optimum design, spray wash angles, pressures and screen speeds would be adjusted to achieve optimum survival rates.

a. Screen Design

The design of the screen basket, fish bucket, and spray wash system must be integrated to achieve the operating principle of the system.

The selection of the spray wash system establishes the basic design of the system. Two types of wash systems are available: One washes the screen as it is ascending out of the water on the front side (front-wash), and the second washes the screen as it rotates over the headshaft and begins to descend toward the water on the back side of the screen support frame (rear-wash). For a rear wash system, a screen basket frame that angles the screen mesh from the rear side of the lower rail to the front side of the top rail provides the least interference in the discharge of fish into the sluice. An alternate design in which the screen mesh is fastened at the rear of the top rail as well as the bottom rail of the screen basket, requires that a deflector plate be mounted within the screen basket to prevent fish from being caught behind the top rail as they are washed across the mesh when the screen rotates over the headshaft. Whereas the deflector plate is functional, it does increase the potential for damage to fish as they strike it when sliding into the sluice. The former design provides a uninterrupted "free-slide" into the sluice, minimizing the potential for damage. In addition the free-slide design does not reduce the open area of the screen basket as occurs with the deflector plate design. Reduced screen open area results in increased through screen water velocities which may be potentially harmful to fish, particularly soft bodied species such as herrings or anchovies.

In front wash systems, orientation of the screen mesh within the basket frame is less important, but the angle of the low pressure spray wash, however, is a very important consideration. Low pressure wash water must enter the fish bucket at a correct angle to effectively wash fish over the front lip of the bucket into the sluice. The exactness required in positioning the spray angle as well as the maintenance of the correct spray pressure to achieve the washing effect required make the front wash system less desirable than the rear wash system. Whereas the rear wash system requires the fish to be carried further (over the top of the headshaft) the fact that they are carried in a trough of water minimizes the adverse effects, if any, of additional time spent out of the water body from which they came.

The favored design for Indian Point is the backwash system with the screen mesh oriented in the basket from the lower rear edge of the bottom rail to the front of the top rail. This design is favored over the front wash system because fish removal is more positive and is aided, rather than opposed, by gravity, as is the condition for the front wash design. Also, baskets in which deflector plates are installed to assist the transfer of fish to the sluice represent an unmeasured but potential source of injury which can be avoided by use of the "free slide" basket design. Two elements of the low pressure spray wash system that are important in fish recovery and fish survival are spray wash angle of contact with the screen baskets and spray pressure. Screens are designed to allow adjustment of these elements to obtain optimum fish collection and survival. These adjustments are made in the field in tandem to "float" fish off the screen into the return trough.

Two types of screen mesh are available for Ristroph screen systems: A.) conventional square mesh weave, and B.) rectangular mesh smooth surface weave. The latter type of mesh has been tested at the Surry Generating Station, and survival of fish collected on it was approximately 13 percent higher than for fish collected on conventional square mesh screen (Anon.). However, cleanability has not been fully evaluated under Hudson River debris conditions. Filamentous algae is abundant in the intake water at Indian Point, becomes entangled in the screen mesh, and is difficult to remove. It is unknown whether the algae would become entangled in the mesh of the smooth surfaced screen. Studies to evaluate cleanability of various types of screen meshes are currently in progress at the Roseton Generating Station (Central Hudson Gas and Electric Corporation). Results, however, are not expected to be available before 1985. At present, because of the unknown cleanability of the rectangular mesh screening, Con Edison prefers a standard square mesh weave for Indian Point Ristroph screens.

Screen mesh dimension is another consideration in a Ristroph installation. Very fine mesh screen (1.0mm as opposed to standard 3/8 inch mesh) has been proposed at several installations (Somerset, New York State Electric & Gas Co; Prairie Island, Northern State Power Co.) for potential reduction of entrainment related mortalities. The benefits of a fine mesh Ristroph installation for reduction of entrainment mortalities at Indian Point are unknown. Entrained organisms have been reported to have relatively high survival at Indian Point in contrast to the lower survival rates observed for fish collected from fine mesh screens at Indian Point Unit 1 (EA 1979). Other investigations underway (Roseton Screen Study) suggest that intermediate mesh sizes (i.e. 3/16) might be desirable, particularly with respect to cleanability (Mussalli, Pers.Comm. 1984). Conventional 3/8 inch mesh has been proposed for use with Ristroph screens at Indian Point, although finer mesh could be easily incorporated in the future if data warrant.

The duration of time spent removed from the water body that a fish experiences is a function of the screen travel speed. This speed also determines the length of time fish might spend impinged against the screen. Screen travel speed at Indian Point 1 was 10 fpm, and the maximum impingement duration was approximately 2.6 minutes. At Salem, maximum impingement duration was approximately 6 minutes at the 5 fpm screen travel speed, and at Danskammer, maximum impingement duration was approximately 2 minutes, again with a screen travel speed of 5 fpm. Data (Table 7) from the Mystic Generating Station on herring and rainbow smelt, two sensitive species, indicated that survival rates for juveniles were increased when travel speed was increased and impingement duration was decreased. The maximum duration of impingement at Mystic for a screen travel speed of 3.3 fpm, measured from the time the screen panels leave the boot section of the screen frame until the screen clears the water at high tide, is 11 minutes and at a speed of 15 fpm it is 2.4 minutes.

At Indian Point, the Unit 2 and 3 intakes extend to 26 feet below mean low water, or -29 feet at mean high water. Table 8 lists the approximate duration of impingement in minutes during high water stages for various screen travel speeds. These times represent maximum durations and would require a fish to be impinged on the screen basket as it rotates out of the boot section

Table 7. MEAN % SURVIVAL BY SCREEN TRAVEL SPEED AT MYSTIC GENERATING STATION - UNIT 7

		Mean % Survival by Screen Speed		
		Low (3.3 fpm)	Medium (7.5 fpm)	High (15 fpm)
Rainbow smelt	Adult	11	31	40
	Juv.	22	58	67
herring	Adult	1	0	0
	Juv.	7	23	48

Source: SWEC 1981

at the bottom of the travelling screen frame. It also assumes the fish becomes unimpinged and is collected in the bucket when it leaves the water. (The boot extends to about 1.5 feet above the intake bottom.)

Table 8. IMPINGEMENT DURATION BY SCREEN TRAVEL SPEED FOR INDIAN POINT

Screen Travel Speed FPM	Impingement Duration (Minutes)
5	5.7
7	4.1
10	2.9
15	1.9

The time that fish may be in the bucket on the screen basket until it slides into the sluice in a rear wash system would range from 4 minutes at a screen speed of 5 fpm to 1.3 minutes at a screen speed of 15 fpm assuming the distance of travel is 20 feet,the approximate distance from the water surface to the screen position when it has tipped downward after passing over the headshaft. Since the transport from impingement to the sluice is in water, adverse effects of exposure to air would be expected to be minimal. Con Edison's proposed design would accommodate rotation at speeds up to 20 fpm. Actual rotating speeds and frequency of rotation would be optimized based on studies conducted after installation.

b. Fish Return System

The principle requirements for any fish return system are that 1) minimal mortality be induced by passage through the system 2) minimal recirculation of fish back to the intake occur, and 3) minimal potential for predation in the region of discharge be introduced.

A fish return system for a Ristroph screen equipped intake generally consists of a trough or pipe that extends from the sluice at the screens to a discharge point in the water body from which recirculation of fish to the intake would be expected to be minimal. Since the fish are removed from the screens at an elevation above the water, the return line flow is usually gravity induced. A supplemental flow may be added to the sluice to maintain adequate depth of water for the fish. Santoro (1984) reports that fish return systems are in general in the stage of ongoing development and cites Cada et al (1979) regarding several environmental considerations that should be addressed in designing a return line. These include:

- o sharp bends (greater than 30°) should be avoided
- o only smooth, non abrasive materials should be used for the interior surface

- protection from bird predation should be provided if an open sluice way is used

- multiple discharge points should be used to reduce potentials for predation

- discharge points should be selected to minimize recirculation of fish to the intake

- water velocities within the return line should be sufficient to prevent fish from residing within the line

- the return of debris with fish should be minimized.

With respect to fish survival through a return line, studies at the Alden Research Laboratory (SWEC 1977) demonstrated (Table 9) that survival can be expected to be high for sensitive species (alewife, rainbow smelt) following passage through a 10" diameter pipe containing small radius (1 pipe diameter) 90 degree bends.

The return line proposed for installation at Unit 2 would be approximately 1.5 to 2. feet in diameter, made of fiberglass, and would be operated with a volume of approximately 1000 gpm (6 X 150 gpm ≈ 1000 gpm spray wash water). A supplemental flow of water would be provided as necessary to optimize ~~flow through~~ the fish return system. Through pipe velocity would be designed to be about 4 to 5 fps. up to 1000 gpm

The use of multiple discharge points for release of fish is conceptually desirable, but studies to demonstrate its importance are not available. For return lines with multiple discharge ports, debris buildup at the juncture of the discharge orifice

yes. west coast 2013. see Cada et al

pred was high

Tracy Skinner 1972

Hood & Horseshoe bend Sacramento River Cal Fish & Game 1978

p 115 of Cada et al.

Table 9. INFLUENCE OF WATER VELOCITY ON FISH SURVIVAL PASSING THROUGH A RETURN LINE

Alewife	Through Pipe Velocity (fps)	No. of fish Tested	Number Surviving 96 hrs.	% Survival	Control Mortality %
	2	30	29	96.6	15.0
	4	37	36	97.2	20.0
	6	30	17	56.6	40.0
	8	90	76	84.4	14.4
Smelt	6	75	67	89.3	1.3
	8	75	54	72.0	46.6
	8.5	100	22	22.0	76.0
	8.6	100	78	78.0	24.0
	9.0	95	31	32.6	46.3
	9.4	100	81	81.0	7.0
	9.5	50	13	26.0	52.0

Source: SWEC, 1977

could cause blockages to the flow, and the pipe forms needed to bifurcate flow into a discharge port could cause injuries to fish that strike edges or corners that may exist there.

The ability to prevent debris from passing through the fish return line may be a function of the degree to which it can be removed by the low pressure spray wash. Based on observations at operating Ristroph screen installations, there appears to be no practical way to exclude all debris from the fish return line.

It appears that the other considerations noted in Cada et al (1979) or Santoro (1984), which are presented above, can be addressed with minimal difficulties.

The fish sluice proposed for Indian Point would be constructed with smooth interior surfaces to minimize abrasion to fish as they pass through it. In addition a cover would be placed over it to minimize bird predation, as has been observed at other installations (Surry; White, Pers. Comm.) and large radius bends would be used to minimize turbulance during passage. The sluice would discharge into a pipe that would carry the fish to a discharge point at a distance away from the intake to minimize the potential for recirculation.

The currently proposed location for the point of discharge of the return line for unit 2 is a position located approximately 300 feet riverward of the Unit 2 intake at a depth of approximately 50 feet. (The water depth in this areas is about 55 feet (Figure 11). The discharge would be from a single orifice and would be directed westward and upward at a low angle (≈10°). This would result in the fish being returned at a depth below the depth from which water is withdrawn into the intake (LHL, 1976) and at a depth that will not interfere with the navigation of barges up to the Unit 1 wharf. Tidal currents in this area are expected to approach 2 fps and should rapidly move fish away from the area. This route would be expected to contain minimal directional changes, and any that would be required (bends to conform with the river bottom, etc.) would be expected to be less than 30° as recommended by Cada et al (1979).

Alternative areas for the point of discharge include a position north of the Indian Point Station and a point some distance south of the discharge structure for the Station. Based on results of model studies of intake water flow paths, a discharge point north of the Station could result in recirculation of fish toward the intakes unless the return line extended

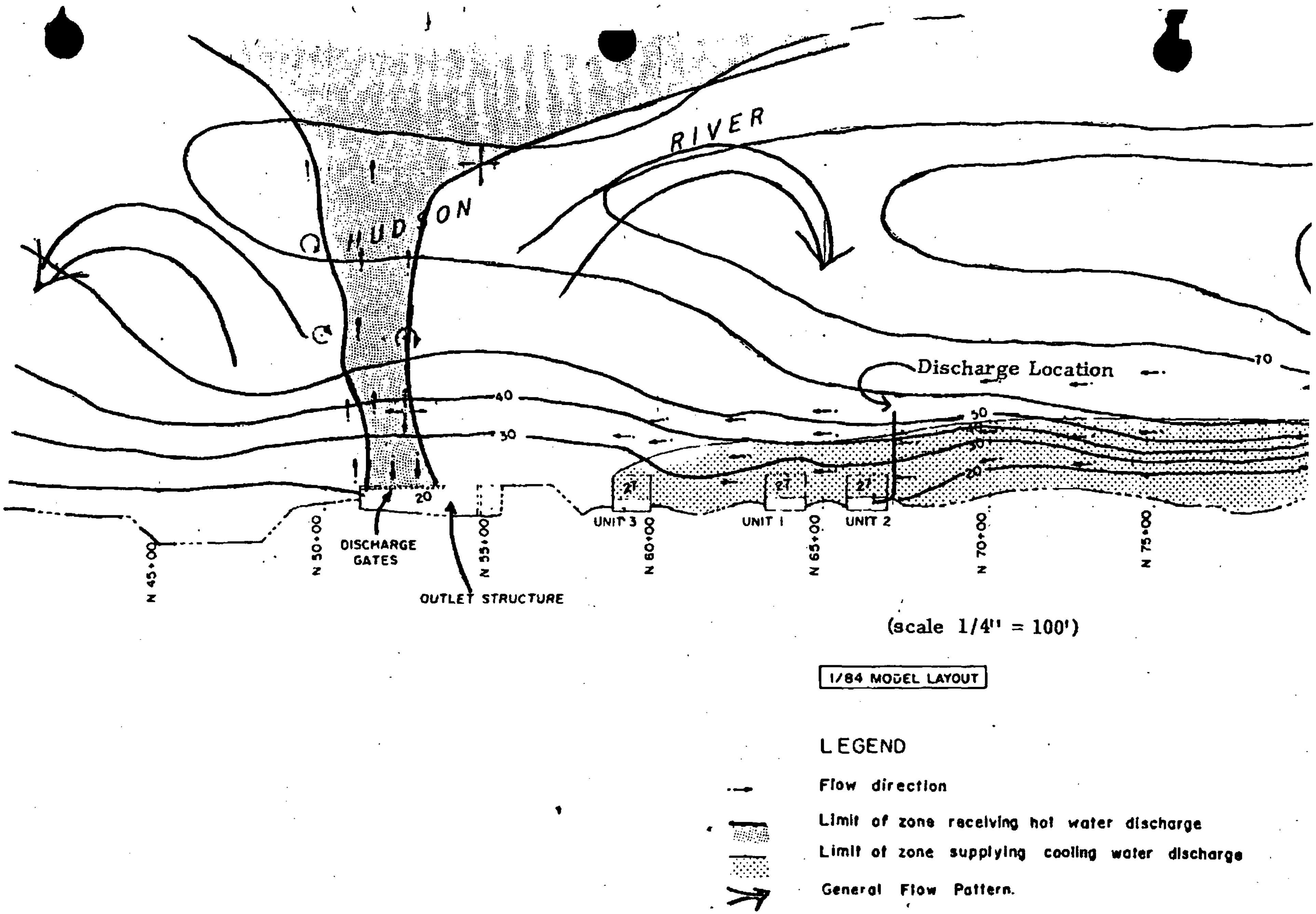


Figure 11. Proposed Route and Discharge Location for the Unit 2 Fish Return Line.

several hundred feet offshore at which location water depths are approximately 60'. This return line would be about 500 feet in length from Unit 2. This location is considered undesirable because of the excessive length of the line.

A fish return location south of the cooling water discharge structure for the station has also been considered. Water depths in this area are comparable to impingement depths, but the water in this area consists of a relatively narrow band between shore and the region of the thermal plume during ebb tide. Whereas the thermal plume is a surface phenomenon, it does extend to -10 to -15 feet within several hundred feet of shore. Strong westerly winds could drive the thermally enriched water onto shore during ebb tides and could create undesirable conditions for fish if they were to be released in this area. The length of a return line to this general area would be approximately 1800 feet from Unit 2.

Final selection of the fish return location for both Units 2 and 3 will be made after an assessment of the distribution and movement of fish within and across the major hydraulic boundaries (currents and eddies) in the vicinity of Indian Point. A concurrent assessment of the distribution and movement of fish within and near the intakes will be used to fine tune the operation of the Ristroph screens themselves e.g. to determine the frequency and speed at which the screens should be rotated to optimize fish survival and minimize breakdown of the screen drive system.

5. Schedule

Con Edison has pursued arrangements to install one Ristroph modified travelling screen at Indian Point unit 2 this forthcoming winter. The purpose of this installation is to evaluate the mechanical reliability of this impingement mitigation system. Principle features to be evaluated include: 1) mechanical reliability during extended periods of continuous operation; 2) areas for improvement of design to enhance operational reliability, 3) impact of cold weather on operation and 4) maintenance requirements.

It is anticipated that some assessment of survival rates will be possible during these tests which are expected to continue for six months from start up of operation. This test program should not be construed as a basis for delaying a decision on the installation of Ristroph screens at the five other forebays, but rather a logical step in the optimization of the final design of the screen system.

It is expected that a full complement of Ristroph screens could be installed by summer, 1986. The principle elements of this schedule are presented in Table 10.

This schedule takes into consideration the interests of the Settlement Parties to see action taken at the earliest practical date. It further recognizes the most practicable schedule for installation of new screens to minimize impacts on plant operations and to facilitate working conditions during installation.

The next refueling outage is presently scheduled to begin in early spring 1986. It is anticipated that the screens would be installed during this outage.

An alternate schedule for installation might be developed should an early decision be made to proceed with the installation of five more screens. This could advance the schedule by approximately six months. Commencement of screen installation could begin in the fall of 1985. However, with the approach of winter undesirable working conditions could be encountered and extreme delays may be incurred due to cold weather conditions. Further, the advanced schedule would not be advantageous because it

Table 10. RISTROPH SCREEN INSTALLATION SCHEDULE FOR INDIAN POINT UNIT 2.

I	Install one Ristroph Screen	November - December, 1984
II	Evaluate Mechanical Reliability	January - May, 1985
III	Develop Specifications and Purchase Six Screens	June - August, 1985
IV	Obtain Vendor Drawings for Con Edison Approval	October, 1985
V	Fabricate and Deliver	Nov., 1985 - March, 1986
VI	Install and Test Run Screens	April - July, 1986
VII	Commence Operation with Ristroph Screens	August 1986

would provide no time for enhancement of the screen design for optimum operational reliability and maximum fish survival. Modifications to all screens, should a feature of the design need to be enhanced, would require substantially more funds than if made following evaluation of one screen.

The Power Authority has completed conceptual design work for Ristroph screens at Indian Point Unit 3 but proposed to wait for the testing results from Unit 2 before allocating additional money for design, engineering or procurement.

Should the testing of Ristroph screens at Unit (2) confirm that the level of impingement reduction is acceptable the Authority would be prepared to plan for the installation of Ristroph ?

screens at Unit 3 within 1.8 years after their installation at Unit 2. The Authority's approach is consistent with the schedule in Attachment 2 of the Hudson River Cooling Tower Settlement Agreement and would wisely utilize the available funding for impingement mitigation.

6. Costs

The estimated total cost to Con Edison for the installation of a Ristroph screen system specifically designed for year around operation at the Indian Point site is $6 million in 1980 dollars. Cost if the project were to be completed in 1986 as proposed by Con Edison is estimated to be $8.5 million. This cost includes the purchase of seven 12 foot wide Ristroph travelling screens (six for installation, one to serve as a spare for use during required periodic maintenance on the installed screens,) and one 6 foot wide Ristroph screen for placement in the service water intake bay. (Since fixed screens are available in the second half of the service water intake channel a back-up travelling screen would not be required.) Also included in this cost is the purchase and installation of a fish return line and up to $300,000 for studies of the distribution and movement of fish in the vicinity of the Indian Point intakes.

Because the Ristroph screens and the spray wash systems will be operated continuously during the winter, the cost of an enclosure and a heating system similar to that installed at the Salem Generating Station on Delaware Bay has also been included. This structure is essential to prevent icing problems, as well as to facilitate the routine maintenance required to keep the screens operational during the period when numbers of impinged fish are expected to be high.

The estimated costs (in 1980 dollars) for installing Ristroph screens at Unit 3 are comparable to those for Unit 2.

B. Fish Diversion Systems (Bypasses)

1. Review of Technology

Physical structures, such as louvers, angled screens, and horizontal traveling screens have been used to shunt fish across intake channels into bypasses from which they can be returned to the waterway. Reviews of the history and status of these diversion technologies can be found in ASCE, (1982); Cannon et al, (1979); Santoro, (1984) and LMS (1984).

Whereas louvers are thought to induce fish avoidance by creating a strong local turbulence between the louver slats, the mechanism by which horizontal traveling screens and angled screens divert fish is not well understood (Cannon et al 1979; Fletcher 1984; Santoro, 1984). Fletcher (1984) has hypothesized that the relatively high diversion efficiency (i.e. percent of fish exposed to the system which enter the bypass) reported for angled screen test systems may be explained with little or no recourse to a guidance mechanism. Rather, diversion may largely reflect random movement by a segment of the population which avoid impingement long enough to encounter the bypasses by chance. These fish may be augmented by those fish which become impinged along the face of the screen and moved into the bypass by the force of the flow vector directed along the face of the screen.

The percentage of the fish which might avoid impingement long enough to randomly encounter the bypass, and thus avoid trauma, is expected to be a function of the dimensions of the screenwell, the velocity of the incoming water, and the swimming capability and behavioral characteristics of the species. Data with which to make projections of the percentage of fish that might enter a bypass unscathed under any particular set of circumstances do not exist. Fletcher (1984) suggested a series of experiments from which data to make such projections might be obtained. To date those studies have not been undertaken, but preparations are currently underway (Fletcher, personal communication).

a. Bypasses

Fish bypass channels which have been used in conjunction with louvers, angled screens or horizontal travelling screens generally consist of slots in a wall that extend vertically over a portion or all of the distance from the bottom of an intake to the water surface at the downstream end of a louver or screen array (ASCE, 1982). The entrance to the slot may be oriented normal to the direction of water flow or as in the case of one laboratory test (Schuler, 1973) parallel to it. The slots provided entrance to a funnel that tapers downward to the dimension of the fish return line or a chamber from which the fish are removed by some physical means. Slot widths ranging from 6 inches to 3 feet (ASCE, 1982) have been examined. The width of the entrances into the Danskammer and Oswego angled screen bypasses is 6 inches (ASCE, 1982). The bypass at the Danskammer facility tapers vertically at 30° until it enters an 18 inch fish return line and that at Oswego tapers at a 45° angle until it enters a 24" return line. These bypasses widen horizontally from 6 inches at the entrance to the dimensions of the respective return lines.

A variation of a bypass system was investigated at the Monroe Power Plant. This system consisted of a vacuum cleaner type suction device positioned horizontally a few inches in front of a conventional travelling screen. As the travelling screen was rotated, water was withdrawn through the device collecting the fish in the vicinity of the bypass. This system was marginally effective and has not been developed or utilized further (ASCE, 1982). Not conver

The willingness of fish to enter a bypass has been found to be related to the ratio of the bypass water flow velocity to approach channel velocity, particularly in the region near the entrance to the bypass. Bates and Visonhaler (1957) reported that "if a reduction in velocity occurs just ahead of or within the bypass, the fish [salmon, striped bass] usually stall in their movement and swim back upstream." Schuler (1973) reported that "test species [ocean fishes, including one species anchovy] moved into and through a bypass channel only if the flow were smooth and free from turbulance. Any abrupt changes in direction prompted a backwelling and fishes moving through the channel oriented to these areas turned tail and proceded to swim back out of the [bypass] channel into the main flume." Schuler (1973) reported excellent diversion of northern anchovy in a louver system with a 2 fps approach channel velocity and a bypass velocity of 2.5 fps. Bates and Visonhaler (1957) indicated that "a gradual increase in velocity as flow approaches and enters the bypass is desirable in the diversion of fish".

Bypass width may also influence the willingness of fish to enter the diversion channel. Bates and Visonhaler (1957) indicated that striped bass (8-34mm standard length) were successfully diverted through a bypass as narrow as 2 1/2 inches. However, steelhead trout were more successfully diverted when the channel width was increased from 6 to 18 inches.

Because of the potential for clogging, Bates and Visonhaler (1957) recommended against narrow (2 1/2", 4") bypasses and selected 6" wide bypass for the louvered intake at the Tracy Pumping Station, Troy, California. Stone and Webster designed 6" bypasses for the Danskammer angled screen test facility (Holsapple et al 1981) and for the Oswego Unit 6 angled screen intake structure (LMS, 1984).

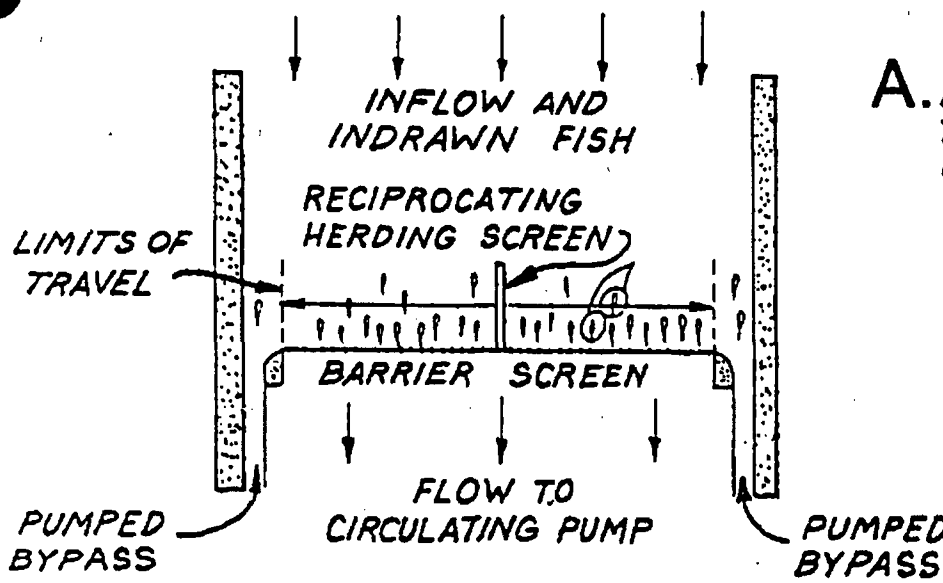
In recognition of the uncertainty with which fish can be expected to encounter bypass entrances through undirected swimming, Dr. Fletcher conceived of and applied for a patent for, a mechanical device which is intended to move across the face of an intake barrier screen and in so doing herd those fish swimming immediately in front of the screen toward adjacent bypass channels. Figure 12, taken from Dr. Fletcher's U. S. patent application, depicts one conceptual application at Indian Point.

Whereas, conceptually, such a herding device has merit, both biological and engineering studies are required to determine conditions under which it may be applicable. Considerable variation in response might be expected among species and life stages as environmental conditions varied. Some species, particularly pelagic schooling fish, may scatter rather than allowing themselves to be herded toward the bypass. Whether such scattering, if it should occur, would remove them from the influence of the intakes is unknown. White perch and, perhaps other species, subject to impingement largely in the winter when they appear to be extremely lethargic at Indian Point (Section II.c), may not respond to the herder.

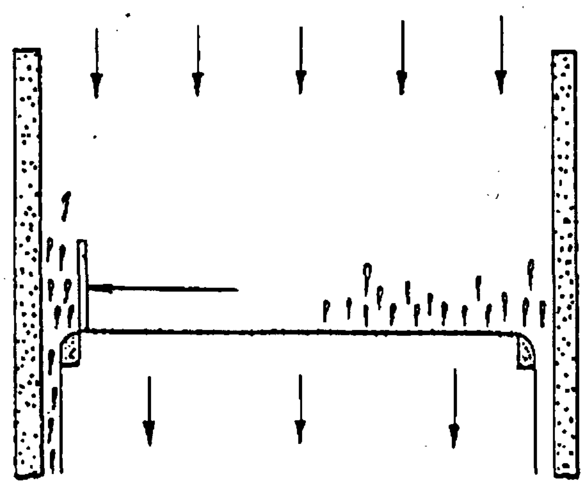
In addition to the biological uncertainties which exist there are mechanical problems which may require considerable ingenuity to overcome. It may be difficult to suspend the herder several feet above the water surface in such a fashion that it will be able to effectively sweep back and forth in a water column nearly 30 feet deep moving at 1 fps. Hydraulic forces on the 30 ft. plus herder vane can be expected to be substantial.

b. Bypass Pumps

Pumps are ordinarily required to create a flow of water through an intake bypass system to return fish to the water body. Two types of pumps, centrifugal and water jet, have been used with success. In the Danskammer angled screen intake system, water is drawn into the bypass by operation of an enclosed



A. ENTRAPPED FISH STAND AGAINST THE FLOW IN REGION JUST AHEAD OF BARRIER SCREEN. RECIPROCATING SCREEN HERDS THE FISH ALTERNATELY BETWEEN LEFT AND RIGHT BYPASSING ZONES, BYPASSES PUMPING CONTINUOUS



B. FISH THAT WERE SWIMMING UPSTRE OF BARRIER SCREEN IN A ARE NOW HERDED BY RECIPROCATING SCREE TO LEFTMOST BYPASSING ZONE.

Figure 12. Plan views of fish herding device situated within a water intake channel.

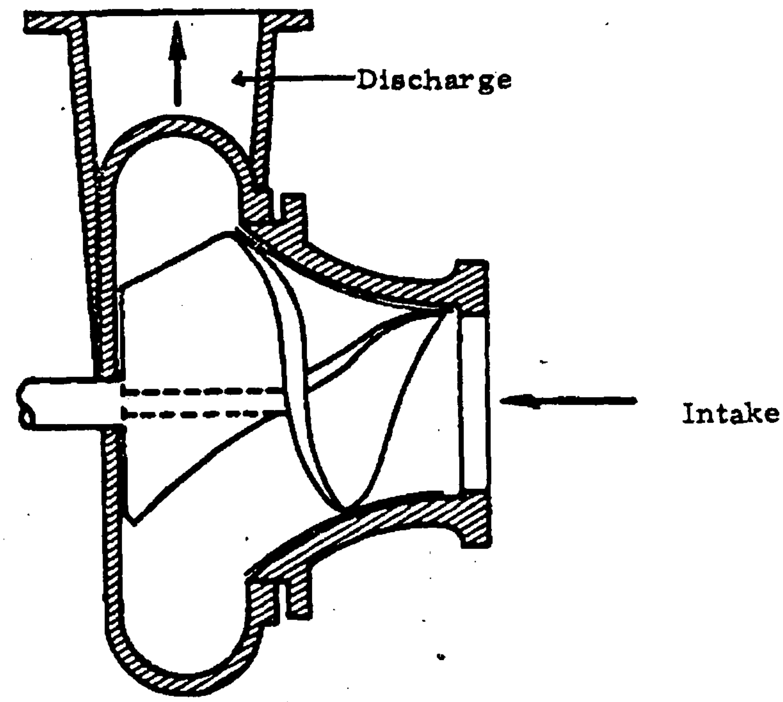
Source; R. Ian Fletcher, Patent Office Serial No. 508,600 screwtype impeller centrifugal pump (hidrostal, Figure 13), and in the Oswego Unit 6 angled screen system, the bypass water flow is induced by a peripheral-type water jet pump (Figure 13). In the latter pump a high velocity jet of water is formed at a nozzle surrounding a suction pipe. The water jet induces a flow through the suction pipe by creating a partial vacuum at its orifice.

At the Alden Research Laboratory, survival rates for menhaden, alewife, striped bass and white perch following passage through a 3" diameter jet pump were determined. In these tests a 34 fps water velocity through the jet pump induced a 8.2 fps suction pipe water velocity, and the combination of the two flows resulted in a mixing tube velocity of 12.3 fps. Survival of 450 menhaden passed through the suction pipe averaged 91%; 100 alewife averaged 100% survival, and survival of 1050 white perch averaged 78%. The survival of the white perch appeared to be related to water temperature. Survival of 200 fish tested at 12.6°C averaged 88%, whereas survival of 850 fish tested at temperatures of 6°C or less averaged 75% (ESEERCO, 1981).

Laboratory tests conducted in 1977 at Alden Research Laboratories on alewife survival following passage through a 12" enclosed impeller hidrostal pump operated at 430 rpm averaged 98.5% (96 hour total survival) and ranged from 90% to 100% (ESEERCO, 1981). In preliminary tests conducted in 1978 with an open impeller hidrostal pump operated at a high rpm (>900, Taft, Pers. Comm.) mortality ranged from 10.6 to 66.0% in menhaden, 22 to 42% in striped bass and 3 to 66% for white perch (ESEERCO, 1981).

In studies conducted at Ontario Hydro Research facilities in Toronto, survival of seven species of fish including smelt and alewife were investigated following passage through a 5" hidrostal pump operated at speeds of 400 to 1200 rpm, and two alternative 12" diameter return lines. One line was 15.5 m long and

Cut Away View of Screw Impeller
Pump Hidrostal Type



Cut Away View of Jet Pump

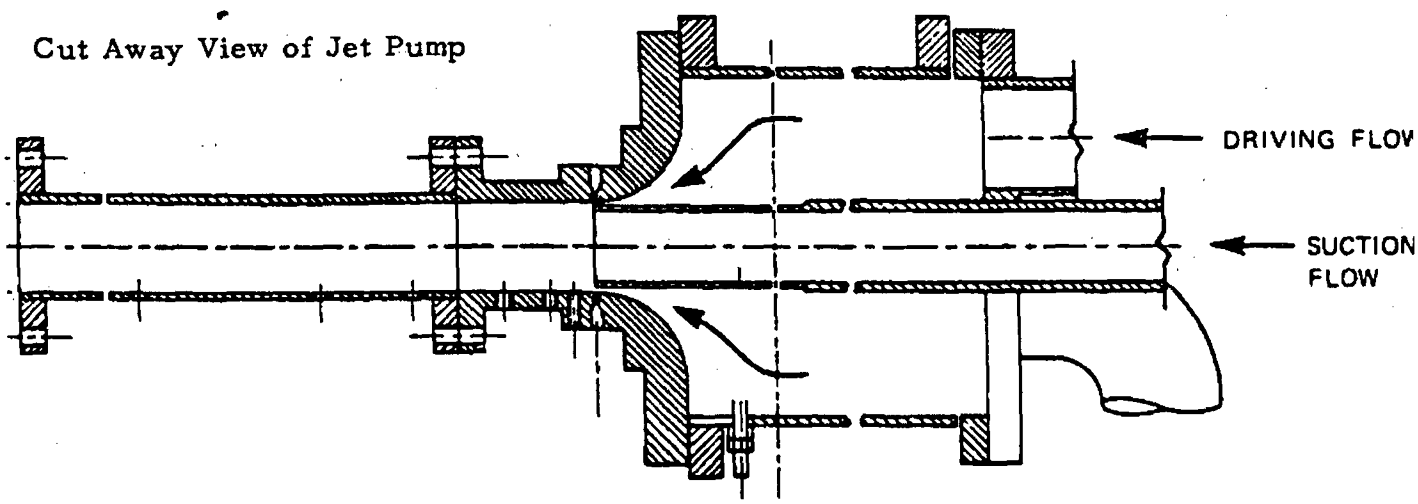


Figure 13. Cut Away View of a Hidrostal Pump and Jet Pump

Source: ESEERCO 1981

contained two small radius (one pipe diameter) 45° and two 90° bends. The second was 2.1 m long and contained one small radius (one pipe diameter) 45° bend. Fish were examined for signs of physical damage including hemorrhages, bulging eyes, cuts, loss of scales, bruises and fungus.

Alewife survival after 48 hours following passage through the 15.5 m return line averaged 91.2% and was found to decrease as pump speed increased (Patrick, 1982). The numbers of fish injured during passage through the hidrostal pump was generally small, but tended to increase with increasing pump speed. In one series of tests, at 436 rpm only 1 out of 125 fish passed through the pump was injured; at 604 rpm 8 of 125 were injured, and at 944 rpm 16 of 125 were injured. The most frequently observed damage was hemorrhages (76%).

Rainbow smelt survival after 48 hours following passage through the 15.5 m return line averaged 90% over the pump speeds tested, and also decreased as the speed increased (Patrick 1982). Injuries were lowest at the lowest pump speed and, without explanation, were highest at an intermediate speed. The most frequent sign of injury to smelt was the formation of fungus patches (49%), with hemorrhages next most frequent (37%). Water flow velocities through the 15.5m return pipe were 0.85 m/s at 436 rpm, 1.25 m/s at 604 rpm and 1.80 fps at 944 rpm.

Alewife survival through the short return line averaged 84.6%. Reduced survival rate relative to the long return line survival was attributed to the generally poorer overall condition of the fish used in the short return line test. Smelt survival through the short return line was not evaluated. Other types of centrifugal pumps have been evaluated for moving fish safely from one location to another, but of the two types discussed above the hidrostal pump appears to be the best available at the present time.

2. Design Considerations

In the absence of any proven mechanism for guiding fish into a bypass channel, all of the uncertainties identified by Fletcher (1984) relative to optimization of an angled screen system apply to the design of other bypass configurations. It is not possible to predict for any given combination of intake dimensions and approach flow velocities the distance over which fish of a particular size and species might be expected to move to randomly encounter a bypass entrance before being impinged. Therefore, effective optimization of relevant intake design parameters is impossible.

Con Edison considered two approaches to installing bypasses at the Unit 2 intake. One approach involves the installation of bypass slots immediately in front of each end of the existing travelling screen (Figure 14A). The second involves the installation of bypass slots at each end of newly-installed Ristroph screens located near the position of the existing traveling screens (Figure 14B).

In both cases the critical design parameters are the number and size of the bypasses relative to the width of the screenwell and the ratio of approach flow velocity to bypass flow velocity. Other intake parameters (flow volume and approach velocity) are fixed by the design and operating requirements of the plant. Whereas one might expect the proportion of fish encountering the bypass to increase as the ratio of bypass area to screen area increased, practical constraints are imposed on the upper limit of this ratio. The principal constraint from an engineering/cost perspective is the volume of water which must be pumped through the bypass. That volume increases as the size or number of the channels increase, assuming that the ratio of bypass velocity to thru-screen velocity remains relatively constant. For example two 6 inch bypass channels positioned at each end of an intake forebay and extending from the bottom of the forebay to the water

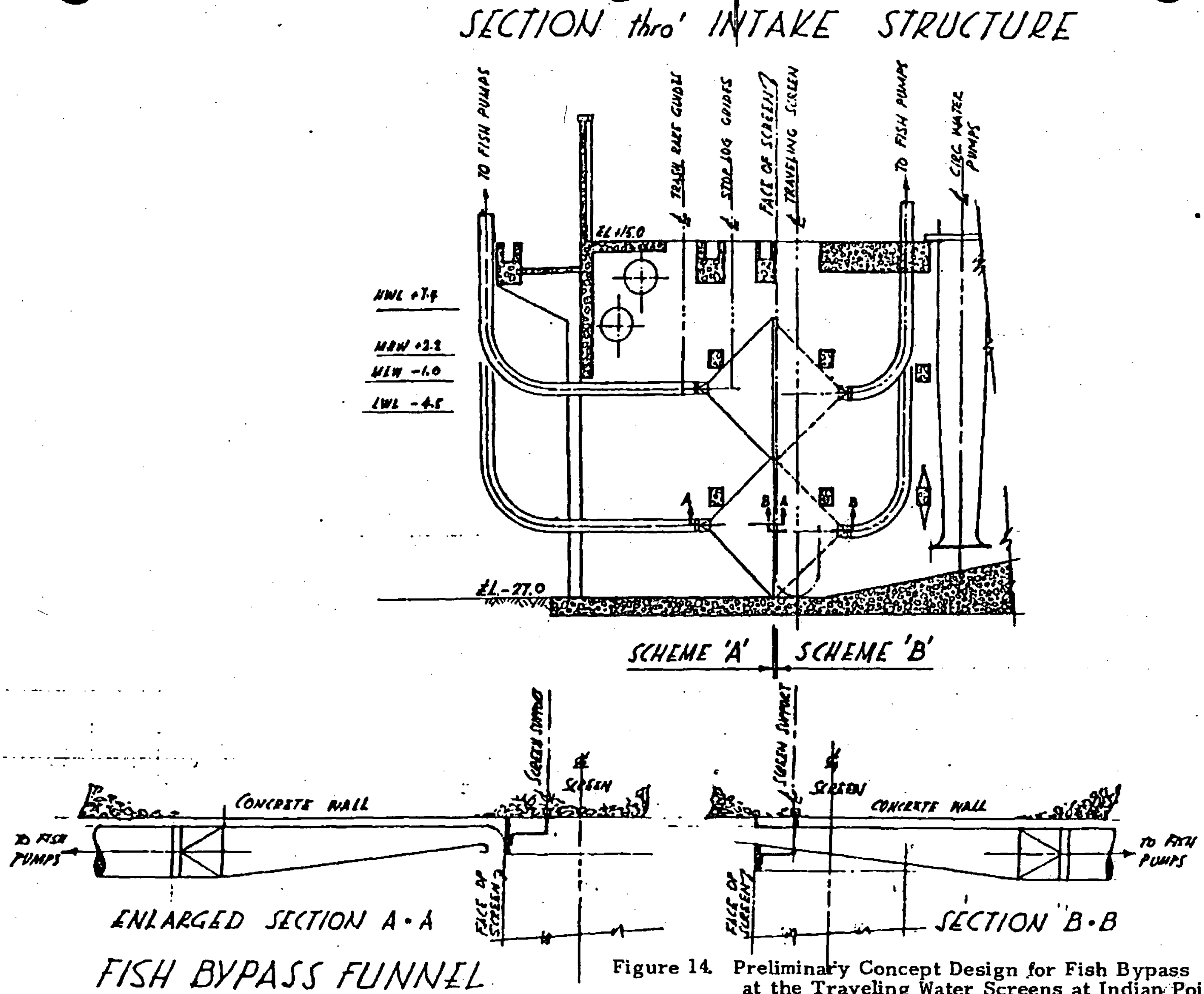


Figure 14. Preliminary Concept Design for Fish Bypass at the Traveling Water Screens at Indian Point 2

surface at Indian Point Unit 2 would pass approximately 76,000 gpm at full flow and a 1:1 ratio of by bypass to thru-screen velocity. Doubling the width of the bypass channels would more than double the flow because thru-screen velocity would increase.

From a biological perspective any increase in the dimension of the bypass channel(s), which must occur at the expense of screen dimension in a system of fixed dimensions such as exists at Indian Point, will result in an increase in the velocity of water approaching the screens. The relationship between velocity and the number of fish impinged is highly uncertain and no detectable changes in numbers of fish impinged would be expected with increases in velocity of only a few tenths of a foot per second over the range of velocities occurring at Indian Point (0.5 to 1.0 fps). More substantial increases in velocity might not only increase the number of fish handled, but also reduce the time that fish could resist impingement while swimming in front of the intakes. Decreased residence in front of the screens time might be of some a physiological advantage to fish eventually impinged on a Ristroph screen, but it would not appear to enhance the probability of a fish randomly encountering a bypass.

Both bypass systems considered by Con Edison were developed in general accordance with criteria established for angled screens. Bypass entrance widths of 6 inches were selected since that width had been successfully employed in laboratory studies (Bates and Visonhaler, 1957; Stone and Webster, 1976; ESEERCO, 1981) and in the two angled screen field installations (Holsapple et al, 1981; LMS, 1984). It is also consistent with the sizes of fish encountered at Indian Point. Since uniform velocities in the vicinity of the juncture of screen and bypass are least likely to deter the entrance of fish into the bypass, a 1:1 ratio of approach to bypass velocities was selected. Two bypasses were included in each screenwell, one at each end of the screen.

The favored type of pump for operation of either type of bypass is the hidrostal pump. Although the preferred enclosed impeller design in a size large enough (20") for operation of the bypasses is not currently made, an open impellar model is available. Subject to confirmation that pump induced mortalities are low (≈<10%) for the proposed operating speed (500 rpm), the hidrostal would be recommended for installation with a bypass system. An alternative to the hidrostal would be the jet pump. This pump would be fully capable of operating the bypass system with low induced mortality. However the jet pump is not recommended because of the size and complexity of the piping system (12 jet pumps, 12 driving flow pumps), the large volume of water required for its operation (300-450 cfs), the large structure (80' x 80' pit below water level) required to house the equipment, and the need for 3 fish return lines fabricated of 5' diameter pipe.

The overall design of the bypass and return line system would be as follows: The 6" wide by about 25' high bypass slot located on each wall of an intake forebay would taper at a 30° to 45° angle to a 12" to 18" pipe that leads to a hidrostal pump. The 6 pumps (one for each set of bypasses within a forebay) would be located in a pump pit that extends to about 10 to 15 ft below mean low water. The volume pumped by each of the hidrostal pumps would be approximately 25 to 30 cfs for a total of 150 to 180 cfs. This volume would be required to create an approximately 1 fps bypass slot intake velocity, an intake velocity of approximately 1 fps. At 60% of full flow the volume would be proportionately less. Upon passage through the hidrostal pumps the water carrying fish would enter a manifold that would connect~~s~~ to 2 to 3 fish return lines 42" in diameter for transport to the river. The point of discharge in the River for either type of bypass would be the same as proposed for the Ristroph screen system.

3. Projected Effectiveness

It is difficult to quantify the expected effectiveness of either of the bypass systems considered above because of uncertainty as to the percentage of fish which might enter the bypass channels in good physical condition; i.e. undamaged by encounters with the screens or exhausted by prolonged swimming in front of the screens.

The results of studies of fish handled by both jet pumps and centrifugal pumps with enclosed impellers (hidrostal) suggest that mortality imposed by these pumps alone on fish in good physical condition upon entering the bypass channel is on the order of 10% to 25%. However, survival of damaged or exhausted fish has only partially been evaluated, and has been found to be much lower (SWEC, 1977; Patrick, 1982).

Reported survival of hardier species of interest at Indian Point (striped bass, white perch and Atlantic tomcod) after passage through an angled screen system is on the order of 60 to 80%, but, survival of many others (herring, bay anchovy and smelt) is on the order of 10 to 20% (Appendix C). These data suggest that some trauma or debilitation, varying among species, occurs prior to the fish entering the bypasses and passing through the pumps. However the cause of the mortality is unknown.

If we assume that angled screens provide little or no behavioral guidance to fish entering those systems (Fletcher, 1984), then bypasses alone, without any guidance devices, might be expected to provide mitigation on the order of that provided by angled screens at Danskammer and Oswego. To the extent that some fish which were impinged on the angled screens and subsequently moved by the force of the water into the bypasses eventually survived, bypasses without Ristroph screens would provide somewhat less mitigation than reported for angled screens. If, on the other hand, angled screens do provide behavioral cues which direct fish to the bypasses with a minimum of truama, bypasses without any such cues and without Ristroph screens will provide substantially less mitigation than angled screens.

Since the survival of fish in Ristroph screen systems differs little (generally no more than 10 to 20%) from that obtained with bypasses in angled screen systems (Appendix C), little, if any, additional benefit beyond that achievable from Ristroph screens would be derived from the substantial additional expense of adding bypasses to a Ristroph screen system. For example, if one assumed that all of the mortality reported for alewife (≅80%) in the angled screen studies (Appendix C) was attributable to fish becoming impinged, at least momentarily, and that all of those fish could be handled on a Ristroph screen system with an estimated survival of 10% then survival from a system in which Ristroph screens were coupled with bypasses might be expected to approach 30% (i.e. .8 x .2 + .1 x 1.0 = 0.~~28~~ .26), rather than the 10% reported for each system alone. In fact, however, the combined survival would be less than ~~28~~ 26% because survival of bypassed fish would be less than 100% (based on studies of survival through pumps). If the mortality reported from angled screens was due largely to fatigue rather than encounters with the screens the percentage of fish bypassed might be more than 20%, but, survival of those fish would be less.

If a guiding device such as that envisioned by Fletcher were developed successfully, then Ristroph screens would be an unwarranted addition to a bypass system. Survival of all species might approach 70 to 90% (i.e. survival reported for pumps), as the % of fish entering the bypass approached 100%. This assumes that the guiding device does not drive fish which would otherwise escape the screens into the bypass where they would become subject to pump induced mortality.

4. Schedule and Cost

Both schedule and cost are contingent upon completion of both biological and engineering studies. Hydraulic model tests of the intake forebay with any bypass designs that are shown in flume tests to be biologically effective must be conducted to ensure that flow requirements of the circulating water pumps are met. Because this is a new concept in retrofitting an intake to enhance fish protection, prototype tests in one at Indian Point forebay would be warranted. Table 11 presents a schedule by which a bypass system might be designed, tested, and installed at Indian Point. This schedule however must be considered tentative because difficulties encountered at any one of the major testing steps could significantly delay following actions until the matter is resolved. Further time might be required for NRC review should final designs encroach on service water flows.

Table 11. BYPASS SYSTEM DESIGN AND INSTALLATION SCHEDULE

I.	Develop Hydraulic and Biological Criteria	October 1984 - March 1985
II.	Conduct Performance Tests	April 1985 - March 1986
III.	Design, Fabricate and Install Prototype Test Bypass	December 1985 - September 1986
IV.	Conduct Prototype Performance Test	October 1986 - September 1987
V.	Design Full Installation	March 1987 - December 1987
VI.	Fabricate and Install	January 1988 - March 1989

Cost estimates for the design, development and installation of two types of bypass systems have been prepared. Each of the two bypass systems would include the following: Twelve bypasses (2 per intake bay); seven hidrostal pumps (one for each pair of bypasses within an intake bay, and one as a spare), a 40' x 60' enclosed pump pit; two 4'diameter by 500' long fish return lines; and piping to connect the bypasses with the hidrostal pumps.

The cost for a bypass system positioned in front of the existing traveling screens at Indian Point Unit 2 is estimated to be $9 million in 1980 dollars. ($16 million at the 1989 service date). The cost of a bypass system positioned adjacent to Ristroph traveling screens is estimated to be $13 million in 1980 dollars ($23 million at the 1989 service date). This latter estimate includes the cost of an enclosure for the Ristroph screen which is needed for cold weather protection.

Both designs considered here were developed for Unit 2. Somewhat different designs would be necessary for Unit 3 but costs and schedules would probably be comparable. Some savings in combined research and development costs might be realized if a decision were made to employ the same concept at both units.

Neither of these estimates include the cost for the installation of a fish herding device. An order of magnitude cost estimate for a herder is $250,000 installed (1980 dollars). However, this estimate does not include design and development costs which are anticipated to be substantially greater.

C. Horizontal Traveling Screens

1. Review of Technology

The development of horizontal traveling screens (HTS) evolved in the mid-1960s from the same observations of fish behavior which led to the development of louvers and angled screens for diversion of fish away from water intakes (Kerr, 1953; Prentice and Ossiander, 1974; Farr and Prentice, 1974). The work was directed toward protection of migrating salmonids at irrigation and hydro-electric installations of modest dimension. A series of essentially seven laboratory test models and small scale prototypes were tested (Bates and Vanderwalker, 1970; Farr and Prentice, 1974). Because HTS development ceased in about 1973 when substantial mechanical problems with model VII were found, the following review of biological and engineering constraints on horizontal screen technology excerpted directly from Cannon et al (1979) is still appropriate:

<u>Biological considerations</u>

The HTS may function as both a behavioral and a physical screening device. For screen orientations angled to the approach flow fish approaching the traveling screen may be diverted downstream to a bypass channel during which impingement may occur either momentarily in an intermittent fashion, continuously during transit to the bypass, or not at all. Organisms unable to avoid total impingement during transit to the bypass channel can be washed off the screen and into the bypass. The underlying cause-and-effect relationships of fish diversions with angled HTS are not well understood. The avoidance response exhibited by fish upon approaching the screen has been attributed to both the flow patterns produced by the screen's movement and the physical extent of the screen itself. For screen orientations normal to the approach flow the HTS functions as a physical screening device impinging organisms and transporting them downstream for removal. Biological data as to the effectiveness of the HTS system are limited to the Model VII HTS test program and to preliminary studies on HTS Models I - VI.

The Model VII HTS was tested under controlled conditions in a flume approximately 6 m wide and 4 m deep. The traveling screen was rotated at a speed of 41 cm sec. with the diversion leg traversing the flume diagonally downstream at 30° to the approach flow. The screen consisted of wire panels with 2.5-mm openings. Screen approach velocities were 30 and 91 cm sec: bypass velocities were not reported (Prentice and Ossiander, 1974). The cleansing action of the approach flow on the screenface at the bypass channel eliminated the need for a jet wash to deflect impinged organisms into the bypass.

Hatchery-reared spring Chinook salmon fry and juveniles in multiple groups of 300 each were released upstream of the screening structure. These fish were separated by size classes into mean total lengths of 26, 35, 70 and 170 mm. Water temperatures ranged from 2 to 16°C of various impingement times. Test fish entering the bypass were collected and held for 48-hr post test mortality determinations.

The diversion efficiencies of the fingerlings ranged from 91.5 to 99.8% with the overall survival rate greater than 97%. With the exception of the lower efficiency of 91.5%, which occurred at night and at the higher velocity of 91 cm sec, no consistent trends in these data can be found. This lower diversion efficiency was attributed to a series of bypass seal failures (Prentice and Ossiander, 1974). No impingement of fingerlings was observed. The subsequent survival of diverted fish after a 48-hr holding period wa uniformly high (97%) for nighttime as well as daytime tests (Table 12). However, this result could be expected even had total impingement occurred because of similar survival rates exhibited by the salmon fry (Table 13) that were impinged for periods much longer than the maximum possible record of 24 sec for the juveniles.

The Model VII HTS diversion studies have demonstrated, under a narrow range of environmental conditions, that the angled HTS can effectively divert and deflect salmonids to a bypass channel. The actual diversion mechanism - whether fish react to the angled screen as a physical barrier or to the flow disturbances associated with the boundary layer of the traveling screen - is not clearly understood. The Model VII tests were performed for one fish species. (O. Tshawytseha) and at temperatures (7 to 16°C) probably near optimal for swimming activity of the diverted fingerlings. However, it is unlikely that disoriented or temperature-stressed fish could be diverted as efficiently without being impinged. The potential effectiveness of the impinge-and-release capability of the Model VII HTS, as demonstrated with salmon fry, can be extended to include angled HTS in general and other relatively hardy species of fish. Because the effectiveness of the impinge-and-release concept depends on the physiological capacity of the organism to survive the impingement force momentarily, under similar test conditions relatively hardy fish species would be expected to exhibit survival characteristics similar to those of the salmon fry.

Applicability of the Model VII HTS design concept to the intakes of steam-electric power plants has not been clearly established. Because the efficient removal of debris is the principal design criterion for such intake systems, the self-cleaning concept of the Model VII HTS design may not be feasible. Thus, inclusion of a jet wash for both trash and fish removal may be necessary. This makes the potentially deleterious effects of high-pressure jets on impinged organisms a concern.

Conceptually, HTS designs with orientations normal to the approach flow contrast with VTS with fish buckets only in that organisms impinged on the HTS are not removed from the source water, thus requiring less mechanical handling. However, the biological significance of this difference is unknown. Presumably, the various factors influencing the biological effectiveness of fish-bucket-type screens, such as impingement duration and velocity, similarly influence the effectiveness of the HTS impingement device.

The prevailing theory for the design of the HTS is that the screen travel speed and direction must be matched with the local velocity component tangent to the screenface to achieve maximum fish protection capabilities. Although this particular design concept is generally believed to minimize the shear forces on impinged fish, the biological significance of this phenomenon has yet to be established. The shear force on organisms impinged against fixed-angled screens diminishes as the screen assumes an orientation normal to the intake flow. For fixed-screen orientations greater than 30°, it is unlikely that the shear force would be significant enough to severely abrade fish that are impinged and held on the angled screen by a much larger normal force. Consequently, in all instances, it may not be necessary to match the screen travel speed with the local tangential approach velocity to enhance the survival of impinged organisms. These conditions, however, do not negate the important biological advantage of a continuously rotating screen in reducing the duration of impingement.

Engineering considerations

Prototype design considerations and operating experience with the HTS system has been limited to applications at hydroelectric power plants and irrigation diversions. Hence, development of HTS system characteristics has been based exclusively on its potential for fish protection and not for debris removal. Consequently, HTS characteristics for application at steam-electric power plant intakes are not well established.

The mechanical performance of the various prototype systems revealed many difficulties that required additional design work. Mechanical wear and maintenance problems have precluded continuous operation of the HTS installation at the Van Arsdale Dam (Ray et al, 1976). The complex mechanical features of the Model VII prototype resulted in numerous shutdowns for maintenance such that maintenance time almost equaled operation time. The manufacturer of the Model VII prototype has noted that future development of this particular system is not likely (Strow, 1978). It has not been established, however, that adaptations of these prototype systems for cooling water intakes would necessarily experience similar problems.

Screenwell design. The physical characteristics of the screenwell are primarily dependent on the biological design concept of the screen - either an impingement (Fig. 39) or a diversion device (Fig. 40) - and the cooling system capacity. In either case, a certain degree of redundancy in the screenwell design - or more than a single HTS structure for an intake - is recommended to ensure system reliability and to permit continuous full load operation during screen maintenance shutdowns. Angled as opposed to normal screen orientation may result in longer screen forebays because the need for a well-conditioned flow upstream of the HTS appears to be necessary. For both normal and angled screen orientations, a bypass system for debris and fish removal must be provided at the downstream end of each HTS.

The physical characteristics of the intake flow near the bypass for HTS have not been studied. For HTS angled to the intake flow, the best information available is the studies conducted for angled VTS. However, the inherent property of HTS that provides for the transport of matter towards the bypass may reduce the bypass flow requirements. For HTS oriented perpendicular to the mean flow, there are no comparable studies that can be extended for interpreting the bypass characteristics. However, these characteristics may not be as critical because the impingement concept provides for fish to be transported passively to the bypass.

The design concept for the HTS system can also influence the magnitude of the screen approach velocity, and thus the cross-sectional area of the screenbay. For angled screen orientations, the approach velocity could possibly be higher than that allowed for normal screen orientation (depending on the species and size of fish) because the impingement force is a function of the normal component of the screen velocity - which is a fraction of the approach velocity for angled screen orientations.

The width of each screen forebay should be based on the proper match of the biological criteria of impingement duration and the mechanical limitations associated with high screen travel speeds. The design impingement times for various species and sizes of fish can be estimated from studies such as the ones conducted by TVA on fine-mesh screening (Tomljanovich et al, 1977; refer to Sect. 3.1.2). Because the biological significance of matching the screen travel speed with the local velocity component tangent to the screenface is not well established, it will not be emphasized in the design here. Consequently, the screen travel speed may be substantially reduced below those of the earlier prototypes. Moreover, by limiting the width of the screen forebays to the range of about 3 to 4 m (as for conventional VTS), the screen travel speed could be kept to a minimum.

The design height of the HTS is an additional concern that limits the system performance capability. The increase of screen height adds a significant weight penalty to the overall structure. This weight penalty can adversely affect the screen suspension and structural supports. A limit in the height of the screen can hinder the HTS's utility for sites with large variations in the elevations of the source water body unless the screen is totally submerged. For totally submerged designs, corrosion, sealing and accessibility for maintenance are additional concerns.

O&M characteristics. Because the development history has been brief, practical features of the HTS such as inspection and maintenance methods have not received proper systematic investigation. Historically, continuous screen operation at high speeds (0.4 to 1.2 m sec) has, in part, resulted in poor mechanical performance of the prototype HTS systems. Moreover, debris and sediment load tend to jam the lower tracks of the system. However, if the operation schedule for HTS shifts toward that of conventional VTS (i.e. intermittent operation during less critical biological periods and slower screen travel speeds), the mechanical reliability of the HTS is likely to improve. In any event, the O&M characteristics of HTS would be site specific.

Summary

Conceptually, the HTS has a number of design and operational features that make it desirable from the standpoint of fish protection at cooling-water intakes. Based on the paucity of biological data for the HTS, additional biological testing for a variety of hydrological conditions and fish species is necessary before conclusions can be drawn concerning its effectiveness as a mitigative device. The lack of mechanical reliability has detracted from the HTS's potential for power plant application. Continued development of the HTS as an impingement device with concentration on improving the mechanical performance may permit its application in the future. Prior to power plant application, the demonstration of the system's effectiveness and reliability will be necessary.

2. Design Considerations

Before horizontal traveling screens could be considered for application at Indian Point, extensive biological and engineering studies would have to be completed. Many of the structural and mechanical problems encountered with earlier prototypes were exacerbated by the perceived need to operate the screen at extremely high speeds to minimize impingement duration and the shear forces on the impinged fish. Studies of the same type needed to optimize the design of other fish bypass systems are needed as a basis for refining HTS technology. These include development of an understanding of the role that screen angle plays, if any, in guiding fish, and identification of critical relationships between system performance and intake dimensions, diversion distance, flow velocity and the swimming performance of species of interest. If guidance, rather than minimization of trauma to impinged fish, is the principal factor contributing to the success reported for prototype systems, then it may be unnecessary to design systems for sustained high speed operation.

Once the biological basis for HTS performance is understood, new prototypes can be designed and tested to operate as necessary. Former problems with wear due to sustained high speed operation might be partially controlled by use of new lighter weight structural components and heavy duty operating mechanisms developed for continuously rotating vertical screens. Other fundamental design problems, such as a cleaning mechanism for use in high debris waters and problems with fluctuating water levels such as occur at Indian Point would also have to be addressed.

A preliminary conceptual design was prepared for Indian Point Unit 2 based on current understanding of system requirements (Figure 15). The design includes four screens angled 25° to the direction of the flow with a 6 inch bypass at the downstream end of each screen, and a 1:1 ratio of bypass to approach velocities. A new offshore screen array was adopted because it

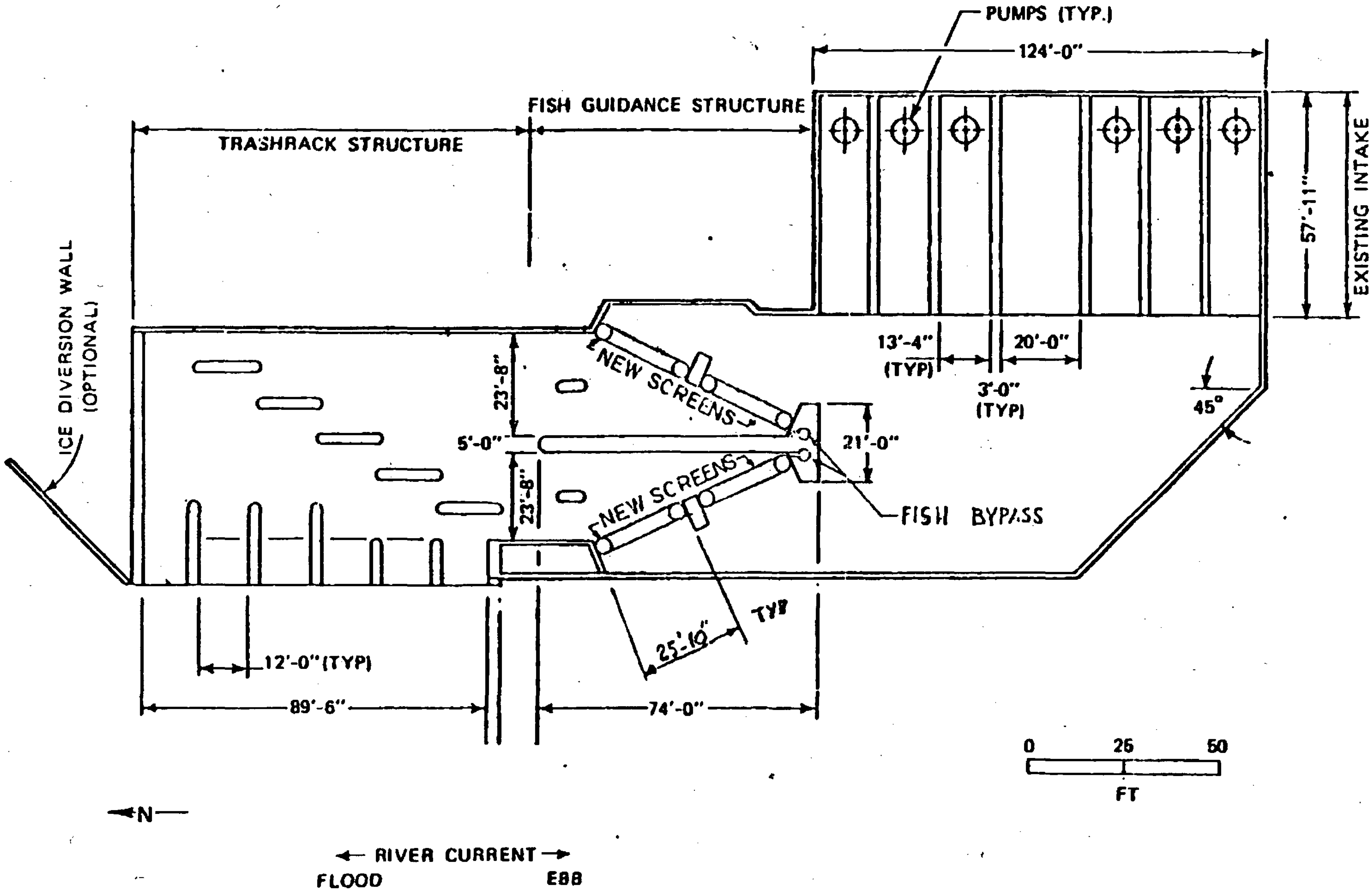


Figure 15. Preliminary Concept Design for a Horizontal Screen Structure at Indian Point 2

does not appear that horizontal angled travelling screens could be accommodated within the existing intakes without seriously affecting flow patterns to the circulating water pumps. In case of failure, the existing screens would also provide back-up for the horizontal travelling screens in the event that the latter suffered chronic operating problems.

3. Projected Effectiveness

It is not possible to quantify the degree of mitigation which might be provided by horizontal travelling screens until questions raised above are answered. One might anticipate effectiveness to approximate that of angled screens or other bypass designs if guidance is an important component of perceived effectiveness. If, on the other hand, effectiveness is due principally to minimizing trauma imposed during impingement on the screens, then effectiveness might be similar to that of Ristroph screens. Survival from angled screen systems has not been found to differ substantially from that reported for Ristroph screens.

4. Schedule and Cost

One might anticipate a period of 6 to 7 years, assuming no insurmountable problems develop, before an HTS system could be installed at Indian Point. This period would encompass at least one year to conduct biological studies and simultaneously evaluate new technology which might be applied to overcoming earlier operating problems. A second year would be required to design a prototype and build a test facility. Two years of testing would then be required to determine mechanical reliability and biological effectiveness under conditions similar to those in the Hudson River. Final design and construction might then require 2 to 3 years, depending upon the complexity of the structure whether an outage were required for construction and a need for NRC review.

Based on current understanding of system requirements as reflected in Figure 15, costs are expected to be comparable to those for one of the more complex angled screen systems developed earlier ($22 million in 1980 dollars; $40 million at the 1991 service date). Research and development costs of several million dollars are anticipated and are included in the projected costs for design and construction of the facility.

Similar considerations would apply to Unit 3 although ultimately, designs might differ between the two units because of their different locations relative to the Unit 1 wharf and the discharge canal, both of which impose structural constraints. Some savings in combined research and development costs might be realized if the decision were made to apply the same concept at both units.

D. Cylindrical Wedge Wire (Johnson) Screens

1. Review of Technology

Cylindrical wedgewire screens have demonstrated a potential to reduce entrainment as well as impingement at water intakes (Cannon et al 1979; ASCE, 1982; Weisberg et al, 1983). Whereas they have been used successfully for many years for withdrawal of ground water, more recent application to surface water intakes has been largely restricted to low volume (<100,000 GPM) withdrawals under circumstances where the potential for clogging is low or the cost of installing redundant systems is modest (ASCE, 1982; Mussalli, 1979). Use by the electric power industry in the United States has been largely restricted to withdrawal of fresh make-up water for closed cycle cooling systems. The only large scale application to date has been at the J H Campbell Plant on Lake Michigan where withdrawal of up to 370,000 GPM for once through cooling began in late 1980.

Studies are currently underway in Maryland to evaluate the use of this technology on a large scale and under estuarine conditions where the potential for flow interruption due to debris accumulation and growth of biofouling organisms is great (Weisberg et al 1983). However, data with which to project the biological effectiveness and the operating reliability of a large array of screens under environmental conditions which exist at Indian Point (high debris loading and biofouling potential and varying current direction and velocity) are unavailable.

Cylindrical wedge-wire screening systems are generally designed to provide sufficient surface area to accommodate the required flow volumes at thru-slot velocities of 0.5 fps (15 cm/s) or less. The velocity of water approaching the slots declines rapidly with increasing distance from the screen and becomes negligible at several inches from the surface (Cannon et al 1979; ASCE, 1982). These low approach velocities apparently are largely responsible for enabling even some weakly swimming organisms to avoid entrainment and impingement. Other parameters which apparently influence the effectiveness of these systems are the size of the slots, the orientation of the cylinders relative to the direction of the ambient currents, and the relative velocities of thru-slot and ambient currents (Cannon et al 1979; Hanson, 1979; Hanson, 1981; Weisberg, 1983). However the relationships among those parameters and system effectiveness are not yet thoroughly understood (Cannon et al, 1979; Otto et al, 1981; Zeitoun et al, 1981; Weisberg et al, 1983), and since those same parameters also influence the hydraulic performance, the potential for clogging and ultimately the cost of the system, further information is required.

Most of the data available for evaluation of the biological effectiveness of cylindrical wedge wire screens are from laboratory and flume studies (Hanson, et al, 1978; Hanson, 1979; Hanson, 1981; Heuer and Tomljanovich, 1978). A few <u>in situ</u> studies using prototype screens have been conducted (Brown, 1979; Lifton, 1979; Brown et al, 1981; Otto et al, 1981; Weisberg et al, 1983), but the only data available for a large full scale installation are those from the Campbell Station (Zeitoun et al, 1981; University of Michigan, 1982). Studies have largely been directed toward evaluating the potential for these screens to reduce entrainment of ichthyoplankton, and have therefore tested mostly small slot dimensions (1 or 2mm) and low (<0.5 fps) thru-slot velocities with eggs, larvae and small (<25mm) juvenile fish.

Observations in all test systems suggest that at the low velocities tested to date impingement of fish larger than 10-15mm in length seldom occurs (Brown, 1979; Lifton, 1979; Hanson, 1981; Brown et al 1981; University of Michigan, 1982; Weisberg, 1983). Although data on impingement are difficult to obtain under field condition, SCUBA observers at the Campbell Station reported no fish impinged during several dives made in 1980 (University of

Michigan, 1982). Divers observing a test intake at the Oyster Creek Nuclear Power Plant off Barnegat Bay in New Jersey reported impingement of only a few pipefish (100mm) and elvers of the American eel (25-50mm). In both cases impingeable fish were reported in the vicinity of the intakes (Brown et al, 1981).

Results of studies on the influence of differences in mesh size and thru-slot velocity on numbers of organisms entrained are equivocal. Laboratory studies have suggested that the numbers of plankton entrained are directly related to thru-slot velocity and slot width. Avoidance was also influenced by ambient currents (Heuer and Tomljanovich 1979; Hanson 1981, Cannon et al, 1979). The occurrence of bypassing currents of greater velocity than thru-slot currents appears to be important in carrying organisms and debris past the screens (Weisberg et al, 1983; ASCE, 1982). However results of field studies have been inconsistent. Tests were conducted at the Campbell Station to compare the densities of plankton entrained through screens with 2mm and 9.5mm slots and through an unscreened pipe, with densities collected in towed plankton nets. Thru-screen velocities were 0.5 fps. Few differences were found between the 2mm and 9.5mm screens, and often, densities entrained through the screens did not differ from densities passing through the unscreened pipe. All three usually had significantly lower densities than the plankton nets towed nearby (Zeitoun et al, 1981). Brown et al (1981) using a floating test facility at the Oyster Creek Station reported few differences among the densities of organisms entrained at a velocity of 0.5 fps through 1 and 2mm screens and an open pipe. They also found that densities entrained through all three were lower than background densities established by net tows. Weisberg et al (1983) using a similar test apparatus at Chalk Point examined both slot size (1mm and 2mm and no screen) and thru-slot velocity (7 and 14 cm/s) by comparing densities of organisms entrained with background densities. They reported that relative to an unscreened port, entrainment could be progressively reduced with 2mm and 1mm screens. The degree of difference varied among species. For bay anchovy larvae screening efficiencies of 98% and 70% were found for 1mm and 2mm screens, respectively, relative to the unscreened part. For goby larvae relative effectiveness was 84 and 48% for 1 and 2mm screens. No conclusions could be drawn as to the effects of velocity differences. The authors concluded that additional studies are needed to more fully evaluate the relationship between slot size, thru-slot velocity and the swimming capability of fish of various species and sizes before the degree of entrainment mitigation to be achieved at any site can be predicted.

The principal concern relative to the use of cylindrical wedge wire screens at large volume water intakes in general has been the potential for loss of intake water flow due to clogging by debris, biological growths, and under certain conditions, frazil ice formation (Cannon et al 1979; Mussalli, 1979; ASCE, 1982; Weisberg et al, 1983; McGroddy et al, 1981). The potential for biofouling is greater in an estuarine or coastal environment than in fresh waters where these screens have been used to date (Weisberg, et al 1983). McGroddy et al (1981) concluded that installation of fine mesh cylindrical screens was not feasible at off-shore marine locations because of the propensity for clogging by marine growth and debris and the difficulty in providing an effective cleaning mechanism.

At the Campbell Station, the 28 Tee shaped screens are located nearly 3000 ft offshore where they are well away from significant quantities of debris. No provision was made for cleaning other than manually by divers, but an alternate intake source exists (McGroddy et al, 1981). To date no serious problems related to debris or biofouling have occurred but on occasion growth of organisms has been substantial (University of Michigan, 1982).

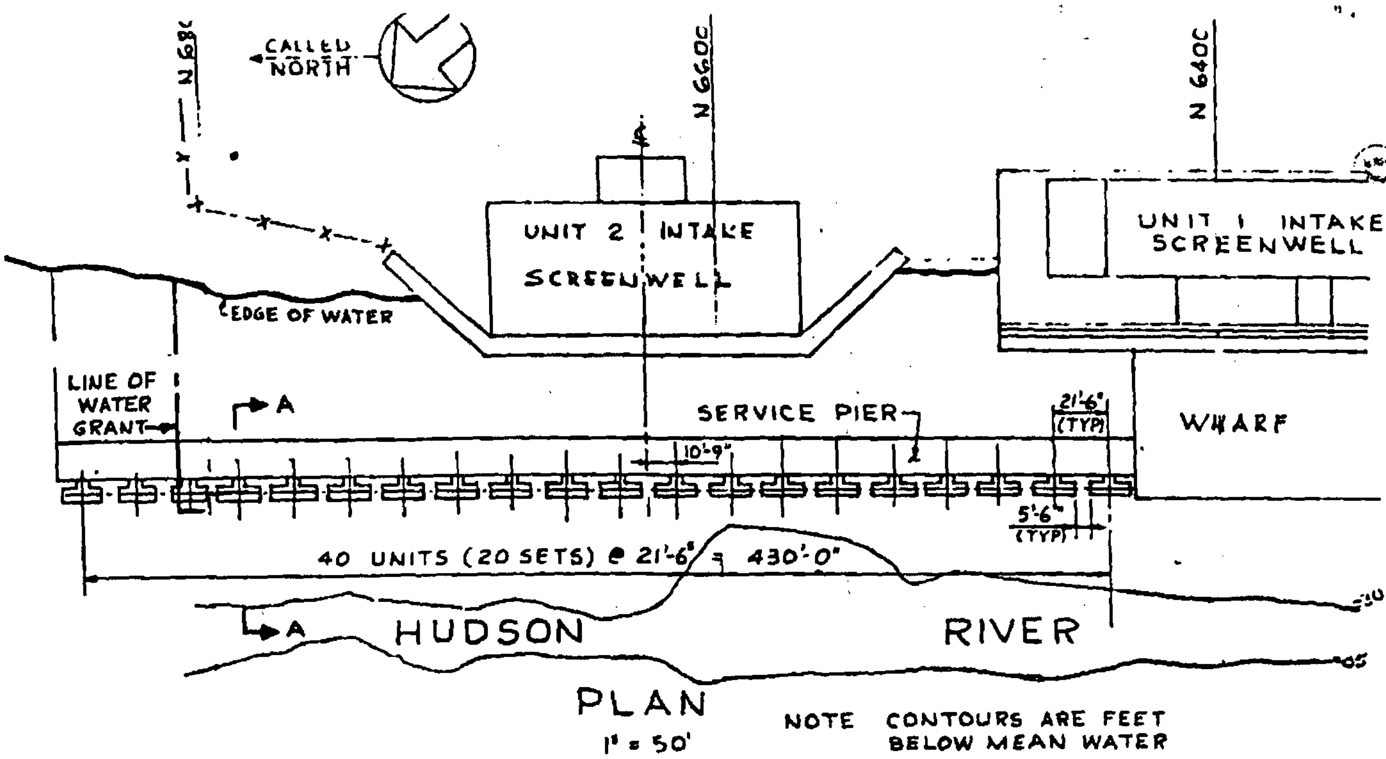
Where screens can be located close to shore, air back wash systems have been used effectively to remove debris (McGroddy et al, 1981; ASCE, 1982). In these systems a large volume of air under high pressure (100 psi) is discharged periodically into the interior of each screen. The burst of air removes debris accumulated on the outer surface. However, biological growth or debris accumulation on the inner surface as well as fine materials wrapped around the screen mesh may not be effectively removed by the air burst. The frequency of cleaning must be evaluated site-specifically before an appropriate system can be designed.

Frazil ice must also be considered a potential source of flow interruption. Frazil ice may form very rapidly during cold, clear, windy nights in water bodies with no ice cover. Wedge wire screens with small slot dimensions might be particularly vulnerable (ASCE, 1982; Mussali, 1979). A single incident of total flow interruption at the Campbell plant has been attributed to frazil ice formation (Johans, Pers. Comm.).

2. Design Considerations

Two orientations of wedge wire screening systems have been considered. One involves installation of the array of screens on a bulkhead constructed along the shoreline. The second involves installation of the screens offshore on a header system. Conceptual designs for both such arrays have been developed for Indian Point (Fig 16 and 17). Both have been designed to provide up to 840,000 GPM through 9.5 mm slots at an average thru-slot velocity of 0.35 fps and a maximum velocity of 0.5 fps. Any reduction in slot dimension or thru-slot velocity would increase the size of the installation and the cost. Conversely an increase in either parameter would decrease cost.

From an operating point of view the bulkhead mounted configuration appears to be preferable at this point because of the greater accessibility of the screens for cleaning and repair. However, in the absence of specific hydraulic modeling informa-



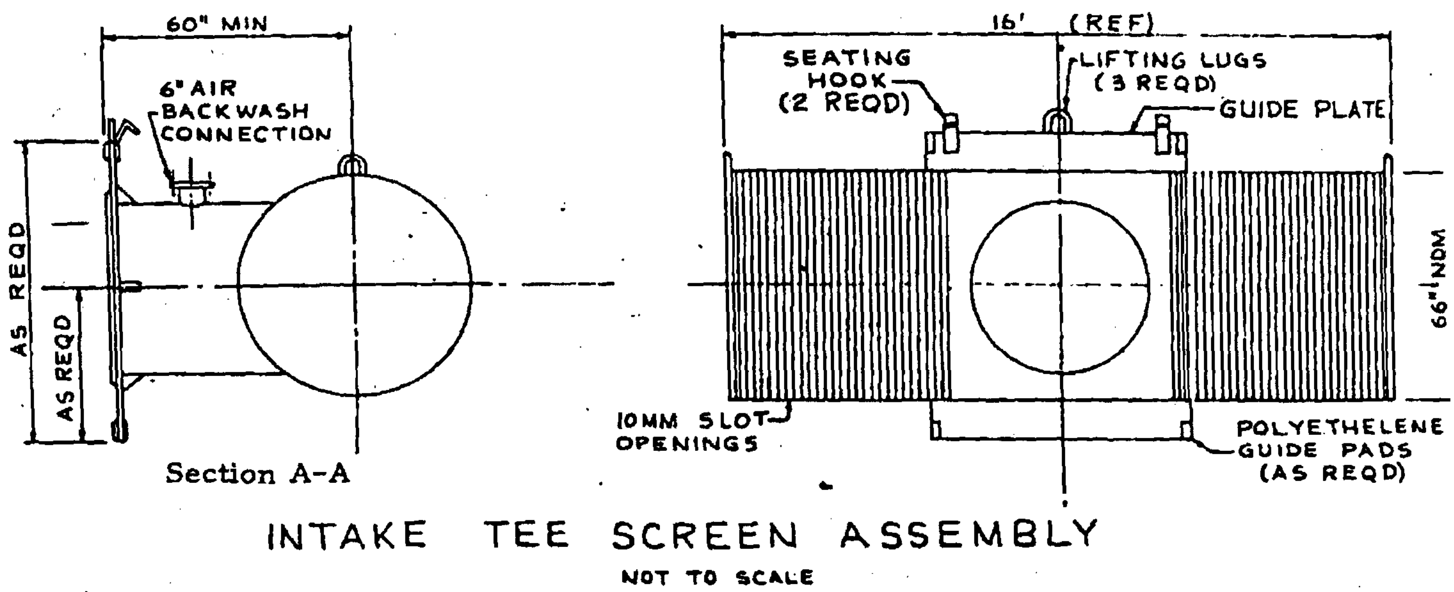


Figure 16. Preliminary Concept Design for a Bulkhead Mounted Wedgewire Screen Intake

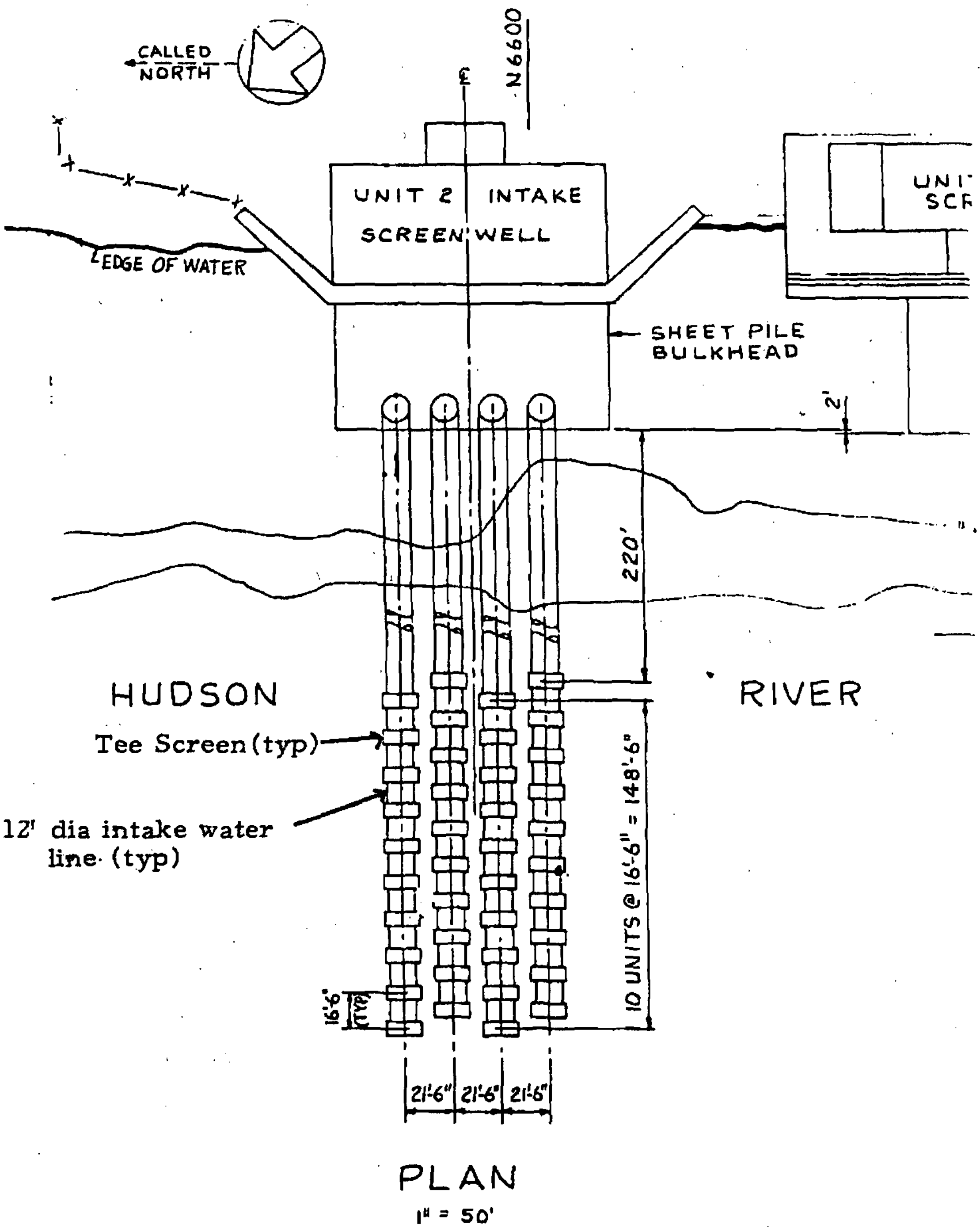


Figure 17. Preliminary Concept Design for an Offshore Wedgewire Screen Intake Structure

tion, the header array may provide superior biological protection as well as enhanced cleanability. This design allows for a staggered arrangement of screen cylinders which should reduce the likelihood of organisms encountering multiple screens, and debris flushed from one screen moving to an adjacent screen. For the bulkhead design in which up to 20 Tee-shaped screens would be aligned in a single row fish are more likely to encounter multiple screens, and debris flushed from one screen is more likely to be carried to the next.

Before either system could be adopted, substantial modeling of flow characteristics would be required. Considerable variation in flow patterns might be expected because of the tidal nature of the Hudson River. Short periods of slack tide might produce particularly troublesome conditions both from a biologial and an engineering perspective. <u>In situ</u> studies of debris loading and biofouling would be required and the cleansing characteristics of the proposed pneumatic cleaning system would have to be evaluated in <u>In situ</u>. Some information on the potential for clogging should become available from the small scale installation which recently began operation near Peekskill, NY.

3. <u>Projected Effectiveness</u>

A cylindrical screen installation appears to offer the potential to substantially reduce impingement of most species. However, some uncertainty exists as the degree to which impingement of white perch, and perhaps some other species which become similarly lethargic in the winter might be reduced. Commonwealth Edison has noted that at installations on the Mississippi River freshwater drum appear to be unable to resist currents as low as 0.1 fps at temperatures below 5°C (Howe, Pers. Comm.). Uncertainty appears to be greatest in this regard with the bulkhead mounted configuration. Site specific evaluation of flow patterns approaching the screens at various thru-slot velocities would be necessary to insure protection of that species. If Johnson screens were to be installed principally to reduce impingement and white perch proved to be capable of avoiding the screens at low temperatures much higher velocities than those tested to date may be appropriate.

There appears to be a potential to reduce entrainment using 9.5 mm mesh screen. However, additional studies would be required to determine whether the density of organisms entrained through such a system would be less than the densities currently entrained. Previous studies at Indian Point have suggested that densities currently entrained are less than average densities in the river either because of avoidance or distributional differences (ORNL, 1982). Relocation of the intake to a point offshore might inadvertently increase the number of individuals exposed to entrainment if ichthyoplankton abundance offshore is greater than in the vicinity of the existing intakes. This factor would have to be examined before selecting a location and a depth for a screen array.

The biological merits of decreasing mesh size below 9.5mm to further reduce entrainment are uncertain; studies would be required to determine whether the extent to which small slot widths reduced entrainment, if at all, warranted the greater cost and potential for clogging of finer mesh. Since greater clogging might be expected to occur, resultant increases in velocity through unclogged slots might offset some or all of the advantages anticipated. Furthermore, survival of organisms entrained may be reduced by trauma imposed during passage thru the slots.

4. Schedule and Costs

The design, model testing, prototype testing and final installation of a wedgewire screen intake at Indian Point Unit 2 or 3 is anticipated to take approximately 4 1/2 to 5 years (spring to fall, 1989) depending on which of the two arrangements evaluated were selected as the favored concept. (The duration of schedule is commensurate with that for angled screens as was specified in the Settlement Agreement).

The time estimates provided for various phases of the wedgewire screen installation are believed to be the minimum required, particularly for testing and construction. Adequate test programs are required to fully evaluate seasonal fouling problems and cleaning techniques, and construction of a facility might have to be coordinated with a refueling outage. Should unanticipated difficulties arise, however, particularly with respect to debris and fouling condition, the service date for final installation could be delayed substantially. Some delay may also accrue to a need for NRC review.

The cost of developing and installing the bulkhead mounted wedge wire screen system is projected to cost $12 million in 1980 dollars. Cost in real time dollars at the service date (March, 1989) is $22 million. The cost of developing and installing the offshore design in 1980 dollars is $16 million. The September 1989 service date cost in real time dollars is $27 million.

These costs include 40 Tee-shaped screens, bulkhead materials to construct the intake plenum, access roadway for servicing the bulkhead mounted screens (not included for the offshore array) and air cleaning systems. The offshore design cost includes the placement of a four 12 foot diameter intake lines which extend for a distance of about 3~~1~~75 feet offshore.

IV. AVAILABLE FUNDS

The cooling tower Settlement Agreement provides as follows for the use of the monies ($20 million in 1980 dollars), allocated for angled screen installation at Indian Point Units 2 and 3 in the event that a decision were to be made to abandon angled screens.

> "To the extent that at that point the amounts expended by Con Edison and NYPA for the design and installation of the screens, plus the amounts required to dismantle and terminate the project, are less than $20 million in 1980 dollars, the difference in 1980 dollars shall be applied to such alternative mitigation measures as the parties to this Agreement may mutually agree upon or, absent such agreement, shall be contributed to the research fund established pursuant to Section 2.I below. For the purpose of this Section 2.F, 1980 dollars will be escalated in accordance with the Con Edison Construction Cost Index."

Con Edison and NYPA have incurred costs of $812,919 through June 30, 1984 for work related to the angled screen projects. Costs incurred by year have been as follows: 1981 $89,754; 1982 $463,593; 1983 $244,419; 1984 $15,153.

Con Edison's Construction Cost Index escalation factors for the years 1981, 1982 and 1983, were 7.0%, 7.1%, and 6.5%, respectively. A forecast of 6.3% has been made for 1984.

Reducing the actual expenses to 1980 dollars and subtracting from the $20 million allocation shows an unexpended balance of $19.3 million in 1980 dollars.

V. CONCLUSIONS

Based on the foregoing evaluation, Con Edison recommends that Ristroph screens be installed promptly at Indian Point Unit 2 in general accordance with the schedule presented in section 3.A.5.

Among the alternatives to angled screens, only Ristroph screens have been proven to provide effective mitigation of impingement and acceptable operating performance under environmental and operating conditions similar to those existing at Indian Point. Some of the other alternatives show promise for impingement mitigation based on the results of laboratory studies and small scale installations, however those results cannot be extrapolated to Indian Point and none can be implemented at the site in the near future.

All require considerable further research and development to establish either the level of mitigation which might be provided at Indian Point or to ensure that they would not jeopardize the continuous operation of the plants or both. Such work would result in significant delays in the in-service dates if any mitigation technology other than Ristroph screens were to be selected. Furthermore, all of the other alternatives are anticipated to cost substantially more than Ristroph screens. That additional cost is not commensurate with the uncertain benefits which might eventually be achieved.

The Authority concurs with Con Edison's recommendation to install Ristroph screens at Indian Point Unit 2. In addition, the Authority proposes that an assessment of the distribution and movement of fish within and across the major hydraulic boundaries in the vicinity of Indian Point and within and near the intakes should be conducted to help select the fish return location for both Units 2 and 3 and to help fine tune the operation of the Ristroph screens themselves, e.g., to determine the frequency and speed at which the screens should be rotated to optimize fish survival and minimize breakdown of the screen drive system. The Authority proposes that the results of these studies be examined before Ristroph screens are designed for and installed at Unit 3.

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PSE&G. 1984 c. Salem Generating Station 316(b) Demonstration. Appendix , Bay Anchovy (Anchoa mitchillis). Public Service Electric & Gas Corporation.

PSE&G. 1984 d. Salem Generating Station 316(b) Demonstration. Appendix IX, Striped Bass (Morone saxatilis). Public Service Electric & Gas Corporation.

PSE&G. 1984 e. Salem Generating Station 316(b) Demonstration. Appendix III, American shad (Alosa sapidissima). Public Service Electric & Gas Corporation.

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APPENDIX A

Modified Traveling Screen Installations for Fish Protection

Vendor	Facility	No. of Screens	Installation Date	Agency Approved
Royce Equipment	Hope Creek Generating Station Public Service Elec. & Gas Newark, New Jersey	6*	1983	-
	Department of Energy Farrell Construction Contractor Amistad Dam Del Rio, Texas	4	1979	-
	Somerset Station Unit 1 New York State Electric Somerset, New York	4	1983	Yes
	Oyster Creek Nuclear Generating Station Jersey Central Power & Light Co Forked River, New Jersey	1 5	1977 1979	Pending Completion of Studies
	Pacific Gas & Electric Pittsbury Power Plant Pittsbury, California	1	1982	Yes
	Salem Nuclear Generating Station Public Service Electric & Gas Salem, New Jersey	6**	1976	Under Review
	Tennessee Valley Authority Yellow Creek Nuclear Plant Yellow Creek, Mississippi	4	1981	Project Cancelled
	Portsmouth Power Station Virginia Electric and Power Co. Chesapeake, Virginia	4	1981	-

*Eight screens have been purchased. Only 6 are used at one time.

**Sixteen screens have been purchased. Only 12 are used at one time.

APPENDIX A

Modified Traveling Screen Installations for Fish Protection

Vendor	Facility	No. of Screens	Installation Date	Agency Approved
Royce Equipment	Hope Creek Generating Station Public Service Elec. & Gas Newark, New Jersey	6*	1983	-
	Department of Energy Farrell Construction Contractor Amistad Dam Del Rio, Texas	4	1979	-
	Somerset Station Unit 1 New York State Electric Somerset, New York	4	1983	Yes
	Oyster Creek Nuclear Generating Station Jersey Central Power & Light Co Forked River, New Jersey	1 5	1977 1979	Pending Completion of Studies
	Pacific Gas & Electric Pittsbury Power Plant Pittsbury, California	1	1982	Yes
	Salem Nuclear Generating Station Public Service Electric & Gas Salem, New Jersey	6**	1976	Under Review
	Tennessee Valley Authority Yellow Creek Nuclear Plant Yellow Creek, Mississippi	4	1981	Project Cancelled
	Portsmouth Power Station Virginia Electric and Power Co. Chesapeake, Virginia	4	1981	-

* Eight screens have been purchased. Only 6 are used at one time.

** Sixteen screens have been purchased. Only 6 are used at one time.

FMC

Millstone Nuclear Generating Station Northeast Utilities Waterford, Connecticut	6	1973	Yes
Shoreham Nuclear Generating Station Long Island Lighting Co. Shoreham, New York	4	1974	Yes
Wm. F. Wyman Station Central Maine Power Co. Yarmouth, Maine	4	1975	Yes
Geo. Neal Station Iowa Public Service Sargeant Bluff, Iowa	6	1975	Yes
Council Bluffs Power Station Iowa Power & Light Co. Council Bluffs, Iowa	4	1975	Yes
Alma Station Dairyland Power Co-Op. Lacrosse, Wisconsin	4	1977	Yes
Indian River #4 Delmarva Power & Light Co. Millsboro, Delaware	2	1977	Yes
Northside Plant Jacksonville El Authority Jacksonville, Florida	8	1977	Yes
Ottomwa Generating Station Iowa Southern Utilities Co. Centerville, Iowa	2	1977	Yes
Gerald Gentleman Station Nebraska Public Power Dist. North Platt, Nebraska	9	1977	Yes
Northwest River Water Project City of Chesapeake, Va.	2	1978	Yes
Prairie Island Nuclear Generating Station Northern States Power Co. Welch, Minnesota	8	1981	Yes

	Brunswick Nuclear Generating Station Carolina Power & Light Co. Southport, N. Carolina	8	1981	Yes
Envirex	Surry Nuclear Generating Station Virginia Electric Power Co. Surry, Virginia	8	1974	Yes
	Portage Generating Station Wisconsin Power & Light Portage, Wisconsin	6	1976	Yes
	Humboldt Bay Water Co. Eureka, California	2	1976	Yes
	Inland Steel Co. East Chicago, Indiana	7	1978	Yes
	Muscatine Power & Light Muscatine, Iowa	4	1981	Yes
	Cajun No. 2 Cajun Electric Power New Orleans, Louisiana	6	1982	Yes
	Lower Sheboygan Power Station Wisconsin Power & Light Sheboygan Wisconsin	2	1983	Yes
	Refuse Power Station Saugus, Massachusetts	2	1983	Yes
	Mystic Generating Station Boston Edison Company Boston, Massachusetts	2	1984	Yes

Sources: Royce Equipment Company, FMC, Envirex (A Rexnord Company).

Personal Communication

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APPENDIX B

Data Summary Tables for Ristroph Screen Studies at

Surry Nuclear Generating Station,

Salem Nuclear Generating Station,

Danskammer Point Generating Station,

Mystic Station - Unit 7,

Indian Point Unit 1

Eighteen-Month Evaluation of the Ristroph Traveling Fish Screens

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INTRODUCTION

On May 1, 1974, a new concept in vertical traveling screens for power station intakes was declared to be in commercial operation at the Virginia Electric and Power Company (VEPCO) Surry Power Station. The new screens include basic modifications to and departures from the design and operation of conventional traveling screens, changes specifically designed to protect fish that might become impinged on the screens during the cooling water withdrawal phase of power generation.

This paper will describe the modified screens and will give an assessment of their performance during the first 18 months of operation. The screens, manufactured by Envirex Inc., are popularly known as the Ristroph traveling fish screens, sc named for their basic designer Mr. J.D. Ristroph, retired Executive Manager of VEPCO's Environmental Services Department.

SITE DLSCRIPTION

The Surry Power Station is located on Gravel Neck peninsula adjacent to Hog Island on the James River, Virginia, about 25 nautical miles upstream from the confluence of the river with Chesapeake Bay (Figure 1). The station consists of twin nuclear units (Westinghouse pressurized water reactors), each rated at 788 MW_e. Cooling water is withdrawn from the James River on the downstream side of the peninsula through a shoreline intake structure by eight pumps, each rated at 220,000 gal/min (13.88 m^3/sec). The water is pumped into a 1.7-mile (2.74 km) long elevated concrete-lined canal, where it flows by gravity through the condensers of both units, and is then discharged at a velocity of 6 ft/sec (1.8 m/sec) on the upstream side of the peninsula.

Table 5
Impinged Fish by Family and Species, Showing Percentage Alive and Percentage of Total Taken within Family

Family	Species	Percentage Survival	Percentage of Total within Family
Clupeidae, herrings			
	Dorosoma petenense	93.6	44.9
	Brevoortia tyrannus	94.9	29.3
	Alosa aestivalis	90.4	14.0
	Alosa pseudoharengus	90.7	5.5
	Dorosoma cepedianum	93.1	5.0
	Alosa sapidissima	93.5	1.2
	Alosa mediocris	82.3	< 1.0
Sciaenidae, drums			
	Leiostomus xanthurus	96.7	76.6
	Micropogon undulatus	82.7	23.0
	Cynoscion regalis	59.2	<1.0
	Bairdiella chrysura	100.0	<1.0
	Cynoscion nebulosus	60.0	<1.0
Engraulidae, anchovies			
	Anchoa mitchilli	82.0	100.0
Ictaluridae, freshwater catfishes			
	Ictalurus catus	99.2	54.3
	Ictalurus punctatus	98.8	28.9
	Ictalurus nebulosus	96.8	16.8
Cyprinidae, minnows and carps			
	Notropis hudsonius	96.6	87.0
	Notemigonus crysoleucas	100.0	9.9
	Cyprinus carpio	92.9	2.2
	Hybognathus nuchalis	100.0	<1.0
	Semotilus atromaculatus	100.0	<1.0
Atherinidae, silversides			
	Menidia menidia	94.0	72.9
	Membras martinica	81.7	18.8
	Menidia beryllina	94.6	8.3
Percichthyidae, temperate basses			
	Morone americana	99.4	99.7
	Morone saxatilis	100.0	<1.0

Table 5 (Continued)

Family	Species	Percentage Survival	Percentage of Total within Family
Anguillidae, freshwater eels			
	Anguilla rostrata	98.9	100.0
Centrarchidae, sunfishes			
	Lepomis gibbosus	99.5	91.4
	Lepomis macrochirus	100.0	3.5
	Enneacanthus gloriosus	100.0	3.1
	Lepomis auritus	100.0	<1.0
	Pomoxis nigromaculatus	100.0	<1.0
	Lepomis sp.	100.0	<1.0
	Centrarchus macropterus	100.0	<1.0
Gobiidae, gobies			
	Gobiosoma bosci	99.7	97.4
	Gobiosoma ginsburgi	100.0	2.6
Cyprinodontidae, killifishes			
	Fundulus heteroclitus	100.0	71.0
	Fundulus diaphanus	100.0	16.0
	Cyprinodon variegatus	100.0	11.7
	Fundulus majalis	100.0	<1.0
	Fundulus confluentus	100.0	<1.0
Percidae, perches			
	Perca flavescens	100.0	50.0
	Etheostoma olmstedi	100.0	50.0
Soleidae, soles			
	Trinectes maculatus	96.5	100.0
Pomotomidae, bluefishes			
	Pomotomus saltatrix	85.3	100.0
Bothidae, lefteye flounders			
	Paralichthys dentatus	97.2	100.0
Amiidae, bowfins			
	Amia calva	100.0	100.0
Scombridae, mackerels and tunas			
	Scomberomorus maculatus	64.7	100.0

Table 5 (Continued)

Family	Species	Percentage Survival	Percentage of Total within Family
Carangidae, jacks and pompanos			
	Caranx hippos	85.7	100.0
Lutjanidae, snappers			
	Lutjanus griseus	100.0	100.0
Petromyzontidae, lampreys			
	Petromyzon marinus	100.0	100.0
Mugilidae, mullets			
	Mugil cephalus	100.0	100.0
Cynoglossidae, tonguefishes			
	Symphurus plagiusa	66.7	100.0
Stromateidae, butterfishes			
	Peprilus alepidotus	66.7	100.0
Gasterosteidae, sticklebacks			
	Gasterosteus aculeatus	100.0	100.0
Elopidae, tarpons			
	Elops saurus	100.0	100.0
Trichiuridae, cutlassfishes			
	Trichiurus lepturus	0.0	100.0
Salmonidae, trouts			
	Salmo gairdneri	100.0	100.0

COMPARISON OF TWO TRAVELLING SCREEN TYPES AT THE SURRY NUCLEAR POWER STATION LOW LEVEL INTAKES

Abstract

A comparative study of Royce and Envirex screens installed at the Surry Nuclear Power Station Low Level Intake structure was begun in 1982. Results thus far indicate that catch rate and survival of impinged fish were greater for the Royce screens incorporating "Smooth-tex" mesh as opposed to the woven square mesh utilized on the Envirex screens.

INTRODUCTION

Surry Nuclear Power Station in Surry, Virginia is located on a peninsula approximately 25 nautical miles upstream from the confluence of the James River estuary with the Chesapeake Bay. This area lies on the transition zone between fresh and salt water, and may be classed as oligohaline, although salinities have ranged from 0 to 16.8 parts per thousand during extreme conditions of rainfall and drought. In addition to the local euryhaline and freshwater populations, the stretch of river around the station is visited by a number of migratory species, and is a nursery area for both anadromous and marine fishes.

When unit one went into commercial operation in 1972, only the conventional travelling screens located at the power station end of the intake canal (Fig. 1) had been installed. These are a pressure-differential operated, high pressure screen wash system, which produces high mortality among impinged fish. After commercial operation began, relatively large numbers of juvenile fish were found in the intake canal; in order to reduce mortality of these and other fishes, it was decided that the travelling screens to be retrofitted at the intakes area at the river (Fig. 1) would be specifically designed to promote the maximum possible survival of impinged fish. The result was the Ristroph travelling screen system, manufactured by the Envirex Corporation. These have operated until the present with an average survival rate of impinged fish in excess of 94% for all fish sampled.

In early 1982, an alternate type of travelling screen system was ordered from the Royce Corporation to be installed in two of the eight screen bays on a trial basis (Fig. 2). It was felt that the basic similarity of the two systems indicated that the Royce system would produce survival rates which would meet federal technical specification requirements, and that several aspects of the Royce system would be mechanically advantageous. A comparative study was initiated which would assess the difference between the two screen types in terms of catch rate, survival, and size selectivity.

Table 1. Survival of sample fish by species and screen type.

	SCREEN			
	ROYCE		ENVIREX	
	.		.	
	LIVE	DEAD	LIVE	DEAD
	.	.	.	.
	%	%	%	%
SPECIES				
TRINECTES MACULATUS	100	.	100	.
POMATOMUS SALTATRIX	100	.	100	.
PARALICHTHYS DENTATUS	100	.	.	.
MORONE SAXATILIS	96	4	50	50
MORONE AMERICANA	98	2	89	11
MICROPOGONIAS UNDULATUS	97	3	96	4
MENIDIA MENIDIA	100	.	.	.
MENIDIA BERYLLINA	100	.	.	.
MEMBRAS MARTINICA	100	.	.	.
LEPOMIS GIBBOSUS	100	.	.	.
LEIOSTOMUS XANTHURUS	94	6	86	14
ICTALURUS NEBULOSUS	100	.	100	.
ICTALURUS CATUS	100	.	100	.
GOBIOSOMA BOSCI	100	.	.	.
DOROSOMA CEPEDIANUM	92	8	100	.
CYNOSCION REGALIS	100	.	100	.
BREVOORTIA TYRANNUS	84	16	69	31
ANGUILLA ROSTRATA	100	.	.	.
ANCHOA MITCHILLI	87	13	77	23
ALOSA PSEUDOHARENGUS	100	.	.	.
ALOSA AESTIVALIS	95	5	83	17
TOTAL	92	8	82	18

Table 2. Numbers of fish sampled by species and screen type.

	SCREEN			
	ROYCE		ENVIREX	
	LIVE	DEAD	LIVE	DEAD
	.	.	.	.
	.	.	.	.
SPECIES				
TRINECTES MACULATUS	37	.	15	.
POMATOMUS SALTATRIX	2	.	1	.
PARALICHTHYS DENTATUS	1	.	.	.
MORONE SAXATILIS	74	3	1	1
MORONE AMERICANA	110	2	25	3
MICROPOGONIAS UNDULATUS	34	1	23	1
MENIDIA MENIDIA	2	.	.	.
MENIDIA BERYLLINA	1	.	.	.
MEMBRAS MARTINICA	1	.	.	.
LEPOMIS GIBBOSUS	1	.	.	.
LEIOSTOMUS XANTHURUS	959	64	452	76
ICTALURUS NEBULOSUS	1	.	1	.
ICTALURUS CATUS	4	.	2	.
GOBIOSOMA BOSCI	1	.	.	.
DOROSOMA CEPEDIANUM	11	1	5	.
CYNOSCION REGALIS	2	.	2	.
BREVOORTIA TYRANNUS	174	32	136	61
ANGUILLA ROSTRATA	3	.	.	.
ANCHOA MITCHILLI	448	65	30	9
ALOSA PSEUDOHARENGUS	1	.	.	.
ALOSA AESTIVALIS	41	2	5	1
TOTAL	1908	170	698	152

Table 3. Mean length of fish sampled by species, month, and screen type.

YEAR=82 MONTH=6

OBS	SPECIES	ENVIREX	ROYCE
1	ANCHOA MITCHILLI	75.2	66.7
2	ANGUILLA ROSTRATA	.	193.7
3	BREVOORTIA TYRANNUS	70.8	78.2
4	CYNOSCION REGALIS	147.5	.
5	DOROSOMA CEPEDIANUM	.	321.5
6	GOBIOSOMA BOSCI	.	38.0
7	ICTALURUS CATUS	239.0	113.8
8	ICTALURUS NEBULOSUS	.	242.0
9	LEIOSTOMUS XANTHURUS	62.7	57.0
10	MICROPOGONIAS UNDULATUS	74.1	60.3
11	MORONE AMERICANA	123.4	64.6
12	MORONE SAXATILIS	49.5	36.1
13	POMATOMUS SALTATRIX	.	87.0
14	TRINECTES MACULATUS	55.6	53.7

YEAR=82 MONTH=8

OBS	SPECIES	ENVIREX	ROYCE
15	ANCHOA MITCHILLI	61.5	47.6
16	BREVOORTIA TYRANNUS	135.0	128.7
17	LEIOSTOMUS XANTHURUS	84.9	82.5
18	MICROPOGONIAS UNDULATUS	115.0	132.0
19	MORONE AMERICANA	.	110.0
20	NO FISH TAKEN	.	.
21	POMATOMUS SALTATRIX	.	148.0

YEAR=82 MONTH=9

OBS	SPECIES	ENVIREX	ROYCE
22	ANCHOA MITCHILLI	65.0	65.1
23	BREVOORTIA TYRANNUS	140.6	.
24	CYNOSCION REGALIS	.	176.0
25	DOROSOMA CEPEDIANUM	182.0	164.0
26	ICTALURUS NEBULOSUS	248.0	.
27	LEIOSTOMUS XANTHURUS	92.1	93.7
28	MEMBRAS MARTINICA	.	55.0
29	MICROPOGONIAS UNDULATUS	.	158.0
30	MORONE AMERICANA	.	144.0
31	NO FISH TAKEN	.	.
32	PARALICHTHYS DENTATUS	.	128.0
33	POMATOMUS SALTATRIX	203.0	.
34	TRINECTES MACULATUS	95.0	100.8

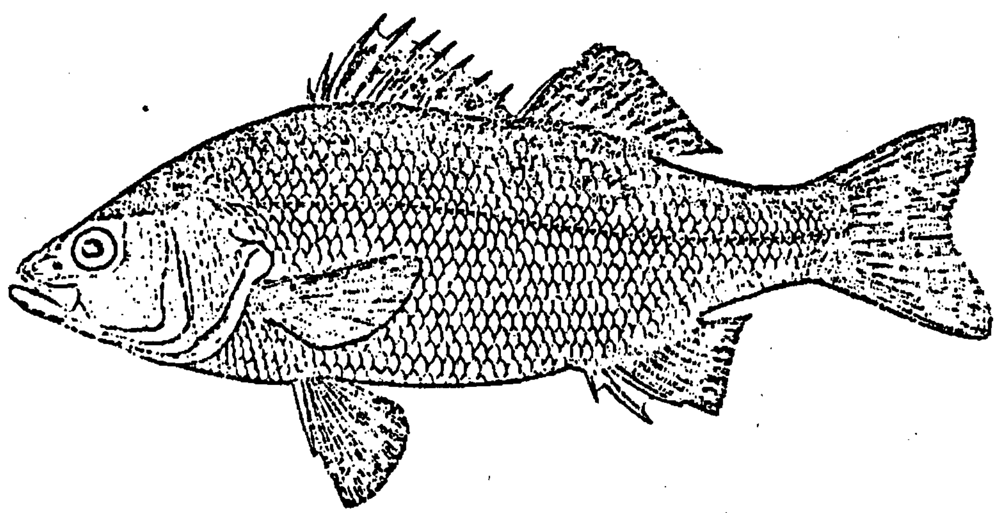
YEAR=83 MONTH=1

OBS	SPECIES	ENVIREX	ROYCE
35	ALOSA AESTIVALIS	88	90.0
36	ALOSA PSEUDOHARENGUS	.	96.0
37	ANCHOA MITCHILLI	.	50.3
38	BREVOORTIA TYRANNUS	98	39.4
39	DOROSOMA CEPEDIANUM	183	147.4
40	LEIOSTOMUS XANTHURUS	.	114.0
41	LEPOMIS GIBBOSUS	.	130.0
42	MENIDIA BERYLLINA	.	67.0
43	MENIDIA MENIDIA	.	75.0
44	MICROPOGONIAS UNDULATUS	.	28.4
45	MORONE AMERICANA	82	86.0
46	NO FISH TAKEN	.	.
47	TRINECTES MACULATUS	.	80.0

WHITE PERCH (MORONE AMERICANA): A SYNTHESIS OF INFORMATION ON NATURAL HISTORY, WITH REFERENCE TO OCCURRENCE IN THE DELAWARE RIVER AND ESTUARY AND INVOLVEMENT WITH THE SALEM GENERATING STATION

SALEM GENERATING STATION
316(b) DEMONSTRATION
APPENDIX X

NPDES Permit No. NJ00056222
NRC Operating Licensing DPR-70 & DPR-75
NRC Docket Numbers 50-272 & 50-311



Public Service Electric and Gas Company
80 Park Plaza
Newark, N.J. 07101

May 1984

Table 7-6

Monthly number and percentage mortality of white perch, all ages combined, taken in Salem impingement samples, 1977-1982.

		MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	Total
Number live	1977	30	1					574	853					
	1978		11	3	2		1	244	1,895	36	59	59	55	
	1979	51	9	2	1	36	366	633	539	440	87	1,904	345	
	1980	314	20	7	1	1	24	261	227	494	598	594	881	
	1981	115	7	3		2	16	76	288	28	366	613	293	
	1982	55	12	7	3		4	362	1,064	117	27	150	172	
Total		565	60	22	7	39	411	2,150	4,866	1,115	1,137	3,320	1,746	15,438
Number dead	1977	7	4	1				94	286					
	1978		4	1	1	1		6	157	41	204	25	5	
	1979	8	2			2	113	131	61	127	95	392	14	
	1980	257	12	5				6	11	122	140	92	122	
	1981	22	3			1	1	5	24	9	79	41	11	
	1982	9	13	9				38	118	28	13	23	33	
Total		303	38	16	1	4	114	280	657	327	531	573	185	3,029
Number damaged	1977	5	2			1		107	496					
	1978		4	4	2	1	2	294	614	121	825	191	11	
	1979	2	2			41	532	628	347	1,244	2,655	1,317	97	
	1980	352	22	5	4	2	4	31	210	656	1,509	909	642	
	1981	104	4	2	1	2	7	12	368	157	725	394	69	
	1982	69	19	23	2		3	252	639	459	182	172	214	
Total		533	53	34	9	47	548	1,324	2,674	2,637	5,896	2,983	1,033	17,771
Initial Mortality (%)		21.6	25.2	22.2	5.9	4.4	10.6	7.5	8.0	8.0	7.0	8.3	6.2	
Upper 95% C.I.		23.8	32.1	31.8	28.2	10.7	12.5	8.3	8.6	8.9	7.6	9.0	7.1	
Lower 95% C.I.		19.5	18.2	12.6	0.1	1.2	8.8	6.6	7.4	7.2	6.4	7.7	5.4	

Table 7-7

Monthly number and percentage mortality by age of white perch taken in Salem impingement samples, 1977-1982.

0+ Age in Months*		MAY 1	JUN 2	JUL 3	AUG 4	SEP 5	OCT 6	NOV 7	DEC 8	JAN 9	FEB 10	MAR 11	APR 12
Number live	1977							574	853				
	1978							111	1,870	36	59	59	55
	1979						104	244	537	418	84	1,752	308
	1980						10	187	227	475	574	401	487
	1981							67	288	19	312	329	179
	1982							239	1,064	117	27	89	124
	Total	0	0	0	0	0	114	1,422	4,839	1,065	1,056	2,630	1,153
Number dead	1977							94	286				
	1978							3	153	41	204	23	5
	1979						3	29	61	113	93	360	13
	1980							4	11	122	94	54	70
	1981							3	24	9	59	26	4
	1982							17	99	28	13	15	18
	Total	0	0	0	0	0	3	150	634	313	463	478	110
Number damaged	1977							107	496				
	1978							26	577	121	825	181	11
	1979						34	82	300	1,216	2,614	1,215	67
	1980							12	201	624	1,106	505	218
	1981							7	358	156	475	178	29
	1982							95	547	459	182	85	79
	Total	0	0	0	0	0	34	329	2,479	2,576	5,202	2,164	404
Mortality (%)													
Initial													
Mean							2.0	7.9	8.0	7.9	6.9	9.1	6.6
Upper 95% C.I.							5.7	9.1	8.6	8.8	7.5	9.8	7.8
Lower 95% C.I.							0.4	6.7	7.4	7.1	6.3	8.3	5.4

Table 7-7

Continued.

1+ Age in Months*		MAY 13	JUN 14	JUL 15	AUG 16	SEP 17	OCT 18	NOV 19	DEC 20	JAN 21	FEB 22	MAR 23	APR 24
Number live	1977	15											
	1978		3					65					
	1979	43	6			4	131	280				25	14
	1980	51	3	1				34				118	209
	1981	37		3			4	8			32	183	64
	1982	5	2	1				48				11	2
	Total	151	14	5	0	4	135	435	0	0	32	337	289
Number dead	1977		1										
	1978							2					
	1979	8	2				32	62				3	
	1980	9						2			21	25	20
	1981		1					2			9	9	5
	1982		1					3	8			6	4
	Total	17	5	0	0	0	32	71	8	0	30	43	29
Number damaged	1977												
	1978		1	2				133					
	1979	1	1			6	101	314	21			3	10
	1980	22	1			1		8			201	219	204
	1981	11	1			1		4			165	124	22
	1982	2		1				64	32			7	36
	Total	36	4	3	0	8	101	523	53	0	366	353	272
Mortality (%) Initial													
Mean		8.3	21.7	I.S.		0.0	11.9	6.9	13.1		7.0	5.9	4.9
Upper 95% C.I.		12.1	42.7			25.7	15.8	8.5	23.9		9.4	7.6	6.7
Lower 95% C.I.		4.5	7.6			0.0	8.1	5.4	5.9		4.6	4.2	3.2

Table 7-7

Continued.

2+ Age in Months*		MAY 25	JUN 26	JUL 27	AUG 28	SEP 29	OCT 30	NOV 31	DEC 32	JAN 33	FEB 34	MAR 35	APR 36
Number live	1977	3											
	1978			1			1	40	25				
	1979	4		1		3	72	72	2	5	2	119	13
	1980	105	4				4	13		14	19	40	120
	1981	45	3				1	1			11	44	11
	1982	14					2	28				36	29
	Total	171	7	2	0	3	80	154	27	19	32	239	173
Number dead	1977	3											
	1978								4			1	
	1979						35	12		3	2	18	
	1980	46	5	1							16	6	20
	1981	6									4		
	1982			3				9	3				3
	Total	55	5	4	0	0	35	21	7	3	22	25	23
Number damaged	1977	1	1										
	1978		1					85	27			5	
	1979					2	193	150	23	13	36	84	17
	1980	93		2	2		2	10	5	26	98	107	132
	1981	29			1		2		8		17	48	2
	1982	27					1	26	38			46	54
	Total	130	2	2	3	2	198	271	101	39	151	290	205
Mortality (%) Initial													
Mean		15.4	35.7	I.S.	I.S.	I.S.	11.2	4.7	5.2	4.9	10.7	4.5	5.7
Upper 95% C.I.		19.2	58.1				14.7	6.7	10.3	13.6	15.0	6.2	8.0
Lower 95% C.I.		11.7	13.4				7.7	2.7	2.1	1.0	6.5	2.8	3.5

Table 7-7

Continued.

3+ Age in Months*		MAY 37	JUN 38	JUL 39	AUG 40	SEP 41	OCT 42	NOV 43	DEC 44	JAN 45	FEB 46	MAR 47	APR 48
Number live	1977	6	1										
	1978		3					11					
	1979	2	2			5	13			3			6
	1980	56	4	2				12				25	35
	1981	14					11				2	26	18
	1982	6	3	1				9					7
	Total	84	13	3	0	5	24	32	0	3	2	51	66
Number dead	1977		1										
	1978		3										
	1979						23	14		2		3	
	1980	59									2	2	
	1981	2	1				1					6	
	1982	2	4					1				2	3
	Total	63	9	0	0	0	24	15	0	2	2	13	3
Number damaged	1977												
	1978							16				5	
	1979					5	50	45		3			
	1980	82	9	1					4		34	33	8
	1981	9					1			1	32	17	10
	1982	24	1	4				34					16
	Total	115	10	5	0	5	51	95	4	4	66	55	34
Mortality (%) Initial													
Mean		24.1	28.1	I.S.		0.0	24.2	10.6	I.S.	I.S.	2.9	10.9	2.9
Upper 95% C.I.		29.2	46.3			30.8	32.7	15.6			9.8	17.8	8.3
Lower 95% C.I.		18.9	13.8			0.0	15.8	5.5			0.4	6.0	0.6

Table 7-7
Continued.

4+ Age in Months*		MAY 49	JUN 50	JUL 51	AUG 52	SEP 53	OCT 54	NOV 55	DEC 56	JAN 57	FEB 58	MAR 59	APR 60
Number live	1977												
	1978		5		1			6					
	1979			1			24	12		2		5	3
	1980	29	2				4			1			5
	1981	8	2			1				9	2	4	1
	1982	18			1		1	18				10	8
	Total	55	9	1	2	1	29	36	0	12	2	19	17
Number dead	1977	4											
	1978		1					1					
	1979						14	12					1
	1980	40	6	1							3		4
	1981										4		1
	1982							6	5				5
	Total	44	7	1	0	0	14	19	5	0	7	0	11
Number damaged	1977	3											
	1978			1				21	4				
	1979					12	121	25	3			10	1
	1980	50	5				1			2	16	8	49
	1981	16					4	1	2		8	6	
	1982	1	8	11	2			11	5			31	12
	Total	70	13	12	2	12	126	58	14	2	24	55	62
<u>Mortality (%)</u> Initial													
Mean		26.0	24.1	7.1	I.S.	0.0	8.3	16.8	26.3	0.0	21.2	0.0	12.2
Upper 95% C.I.		32.6	42.6	31.8		23.7	13.2	23.7	48.7	22.0	38.5	4.8	20.0
Lower 95% C.I.		19.4	10.4	0.2		0.0	4.7	9.9	9.4	0.0	9.0	0.0	6.4

Table 7-7

Continued.

5+ Age in Months*		MAY 61	JUN 62	JUL 63	AUG 64	SEP 65	OCT 66	NOV 67	DEC 68	JAN 69	FEB 70	MAR 71	APR 72
Number live	1977	5											
	1978												
	1979		1		1	7		7				3	
	1980	25	2	3		1					3	1	
	1981		2								1		
	1982	7	7	3			1					4	
	Total	37	12	6	1	8	1	7	0	0	4	8	0
Number dead	1977												
	1978				1	1						1	
	1979			1						3		6	
	1980	4		1							1		8
	1981	9				1							1
	1982	1	4	6									
	Total	14	4	8	1	2	0	0	0	3	1	7	9
Number damaged	1977												
	1978							5	6				
	1979					5	17			5	5	5	
	1980	40	4		1		1			2	19	14	23
	1981	11									2		
	1982	24	8				2		5				9
	Total	75	12	0	1	5	20	5	11	7	26	19	32
Mortality (%) Initial													
Mean		11.1	14.3	42.8	I.S.	13.3	0.0	0.0	0.0	30.0	3.2	20.6	22.0
Upper 95% C.I.		17.8	32.2	68.8		40.5	16.1	25.7	28.1	100.0	11.2	37.3	36.2
Lower 95% C.I.		6.2	4.1	17.0		1.7	0.0	0.0	0.0	0.0	0.0	8.8	10.8

Table 7-7
Continued.

6+		MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR
Age in Months*		73	74	75	76	77	78	79	80	81	82	83	84
Number live	1977	1											
	1978			2	1			11					
	1979	2				17	222	18		12	1		1
	1980	48	5	1	1		6	15		4	2	9	25
	1981	11				1					6	27	20
	1982	5		2	2			20					2
	Total	67	5	5	4	18	28	64	0	16	9	36	48
Number dead	1977		2	1									
	1978												
	1979					2	6	2		6		2	
	1980	99	1	2							3	5	
	1981	5	1								3		
	1982	6	4					2	3				
	Total	110	8	3	0	2	6	4	3	6	6	7	0
Number damaged	1977	2	2			1							
	1978		1	1	2	1	2	8					
	1979	1				11	16	12		7			2
	1980	65	3	2	1	1		1		2	35	23	8
	1981	28	3	2		1					26	21	6
	1982	11	2	7				22	12			3	8
	Total	107	11	12	3	15	18	43	12	9	61	47	24
Mortality (%) Initial													
Mean		38.7	33.3	15.0	I.S.	5.7	11.5	3.6	20.0	19.4	7.9	7.8	0.0
Upper 95% C.I.		44.4	53.3	37.9		18.9	23.4	9.0	48.1	37.3	16.0	14.9	5.0
Lower 95% C.I.		33.1	15.9	3.2		0.7	4.4	1.0	4.3	7.5	3.0	3.2	0.0

* Assuming May 1 birthday.

1 I.S. = Insufficient sample size.

Table 7-17

Estimated monthly latent and total mortality of white perch impinged at Salem, 1977-1982, under the assumption of mortality of LOE specimens only at 96 hr (i.e., assumption 1).

	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR
Initial Mortality (%) (M_I)	22.0[1]	22.0[1]	22.0[1]	7.7[2]	7.7[2]	7.7[2]	7.7[2]	7.7[2]	7.7[2]	7.7[2]	7.7[2]	7.7[2]
Latent												
Live Category												
Total number live[3]	565	60	22	7	39	411	2,150	4,866	1,115	1,137	3,320	1,747
Proportion impinged (P_L)[3]	0.5146	0.5310	0.3929	0.4375	0.4535	0.4286	0.6189	0.6454	0.2972	0.1617	0.5267	0.6283
Percent mortality (M_L)[4]	0.0	4.4[5]	4.4[5]	4.4[5]	4.4[5]	2.1	2.5	1.5	0.0	0.0	7.2	13.0
Damaged Category												
Total number damaged[3]	533	53	34	9	47	548	1,324	2,674	2,637	5,896	2,983	1,033
Proportion impinged (P_d)[3]	0.4854	0.4690	0.6071	0.5625	0.5465	0.5714	0.3811	0.3546	0.7028	0.8383	0.4733	0.3717
Percent mortality (M_d)[4]	81.5	75.0	40.5[6]	40.5[6]	40.5[6]	63.9	65.5	8.4	16.8	41.9	38.1	74.6
Weighted Latent Mortality (M_{WL})	39.6	37.5	26.3	24.7	24.1	37.4	26.5	3.9	11.8	35.1	21.8	35.9
Total Mortality (M_T)	52.9	51.2	42.5	30.5	29.9	42.2	32.2	11.4	18.6	40.1	27.9	40.8
	47.1	48.2	57.5	69.5	70.1	57.8	67.8	88.6	81.4	59.9	73.1	59.2

[1] Average mortality May-July.
[2] Average mortality August-April.
[3] Based on initial survival sampling.
[4] Based on 1878-1982 latent mortality studies.
[5] Average 1978-1982 latent mortality for live-category fish.
[6] Average 1978-1982 latent mortality for damaged-category fish.

Table 7-18

Estimated monthly latent and total mortality of white perch impinged at Salem, 1977-1982, under the assumption of mortality of all LOE specimens at onset of LOE (i.e., assumption 2).

	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR
Initial Mortality (%) (M_I)	22.0[1]	22.0[1]	22.0[1]	7.7[2]	7.7[2]	7.7[2]	7.7[2]	7.7[2]	7.7[2]	7.7[2]	7.7[2]	7.7[2]
Latent												
Live Category												
Total number live[3]	565	60	22	7	39	411	2,150	4,866	1,115	1,137	3,320	1,747
Proportion impinged (P_L)[3]	0.5146	0.5310	0.3929	0.4375	0.4535	0.4286	0.6189	0.6454	0.2972	0.1617	0.5267	0.6283
Percent mortality (M_L)[4]	0.0	4.4[5]	4.4[5]	4.4[5]	4.4[5]	2.1	2.5	1.5	0.0	0.0	7.2	13.0
Damaged Category												
Total number damaged[3]	533	53	34	9	47	548	1,324	2,674	2,637	5,896	2,983	1,033
Proportion impinged (P_D)[3]	0.4854	0.4690	0.6071	0.5625	0.5465	0.5714	0.3811	0.3546	0.7028	0.8383	0.4733	0.3717
Percent mortality (M_D)[4]	81.5[6]	75.0[6]	40.5[7]	40.5[7]	40.5[7]	63.9[6]	65.5[6]	84.0[9]	84.0[9]	97.4[8]	67.2[8]	97.0[8]
Weighted Latent Mortality (M_{WL})	39.6	37.5	26.3	24.7	24.1	37.4	26.5	30.8	59.0	81.7	35.6	44.2
Total Mortality (M_T)	52.9	51.2	42.5	30.5	29.9	42.2	32.2	36.1	62.2	83.1	40.6	48.5

[1] Average mortality May-July.

[2] Average mortality August-April.

[3] Based on initial survival sampling.

[4] Monthly 1978-1982 latent mortality for live-category fish except as noted.

[5] Average 1978-1982 latent mortality for live-category fish.

[6] Monthly 1978-1982 latent mortality for damaged-category fish.

[7] Average 1978-1982 latent mortality for damaged-category fish.

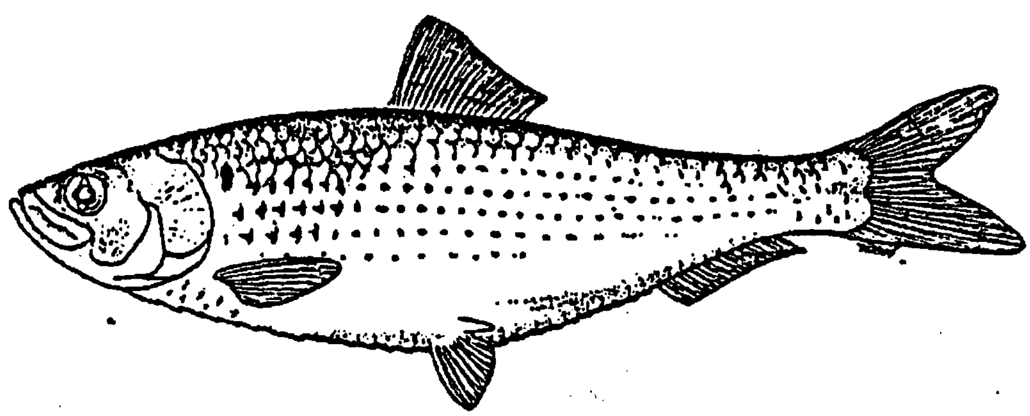
[8] Monthly 1982 latent mortality for damaged-category fish under assumption of LOE death at onset.

[9] Average 1982 latent mortality for damaged-category fish under assumption of LOE death at onset.

BLUEBACK HERRING (ALOSA AESTIVALIS): A SYNTHESIS OF INFORMATION ON NATURAL HISTORY, WITH REFERENCE TO OCCURRENCE IN THE DELAWARE RIVER AND ESTUARY AND INVOLVEMENT WITH THE SALEM NUCLEAR GENERATING STATION.

SALEM NUCLEAR GENERATING STATION
316(b) DEMONSTRATION
APPENDIX VI

NPDES Permit No. NJ0005622
NCR Operating Licensing DPR-70 & DPR-75
NCR Docket Numbers 50-272 & 50-311



Public Service Electric and Gas Company
80 Park Plaza
Newark, N.J. 07101

December 1982

Appendix VI, Table 7-4 (revised)

Age composition of blueback herring taken in Salem impingement samples 1977-1982.

0+ Age in months†	MAY 1	JUN 2	JUL 3	AUG 4	SEP 5	OCT 6	NOV 7	DEC 8	JAN 9	FEB 10	MAR 11	APR 12
1977							136	72				
1978		2		1	1	2	754	2,479	3	1		62
1979		1				69	495	17	18	1	2,142	2,085
1980	10	25	2	1		10	22	15	267	25	1,524	[illegible]
1981	70	13				152	1,696	1,024	1	1	246	116
1982		4				2	497	850	73	71	2,769	[illegible]
Total	80	45	2	2	1	235	3,600	4,497	362	99	6,681	[illegible]
1+ Age in Months†	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
1977	3	2										
1978		8	1	4	1		10	10				
1979	3			1	3	44	50	2				1
1980	126	18	9	11		3	1		1		15	22
1981	26	2									17	[illegible]
1982	14		1				52	6			10	[illegible]
Total	172	30	11	16	4	47	165	18	1	0	42	[illegible]
2+ Age in Months†	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**[illegible]**
1977												
1978												
1979						1					8	
1980	8										7	19
1981	2										13	3
1982	3						5	2	1		27	[illegible]
Total	13	0	0	0	0	1	5	2	1	0	55	[illegible]
3+ Age in Months†	**37**	**38**	**39**	**40**	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**[illegible]**
1977												
1978												
1979												
1980	3											
1981	4										2	[illegible]
1982	13	1					8	4			5	[illegible]
Total	20	1	0	0	0	0	8	4	0	0	7	7

Appendix VI, Table 7-4 (revised)
Continued.

4+ and older Age in Months†	MAY 49+	JUN 49+	JUL 49+	AUG 49+	SEP 49+	OCT 49+	NOV 49+	DEC 49+	JAN 49+	FEB 49+	MAR 49+	APR 49+
1977												
1978		1										
1979						1						2
1980	15	1									1	43
1981	12	1					2				2	4
1982	10											14
Total	37	3	0	0	0	1	2	0	0	0	3	63
Grand Total	322	79	13	18	5	284	3,780	4,521	364	99	6,788	6,196
Percentage 0+	24.8	57.0	15.4	11.1	20.0	82.7	95.2	99.5	99.5	100.0	98.4	97.6
Percentage 1+	53.4	38.0	84.6	88.9	80.0	16.5	4.4	0.4	0.3	0	0.6	0.6
Percentage 2+	0.9	0	0	0	0	0.4	0.1	0	0.2	0	0.8	0.6
Percentage 3+	6.2	1.2	0	0	0	0	0.2	0.1	0	0	0.1	0.1
Percentage 4+ and older	3.1	3.8	0	0	0	0.4	0.1	0	0	0	0.1	1.0

†Assuming May 1 birthday.

Appendix VI, Table 7-12 (revised)
Estimated initial, latent, weighted latent and total mortality by age of blueback herring taken in Salem impingement samples 1977-1982.

0+ Age in Months*	MAY 1	JUN 2	JUL 3	AUG 4	SEP 5	OCT 6	NOV 7	DEC 8	JAN 9	FEB 10	MAR 11	APR 12
Initial Mortality(%)	15.4	19.4	0.0			18.6	12.0	16.4	19.5	20.0	18.1	19.2
Latent												
Live Category Mortality (%)	100.0[a]	100.0[a]	100.0[a]			63.6[b]	63.6[b]	63.6[b]	63.6[b]	63.6[b]	100.0[a]	100.0[a]
Number live	64	25	1			92	1976	2648	111	14	2675	2577
Proportion of impingement live	0.9697	0.8621	1.000			0.8070	0.8724	0.8150	0.4476	0.5000	0.6532	0.6079
Damaged Category Mortality (%)	98.2[c]	98.2[c]	98.2[c]			98.2[c]	98.2[c]	98.2[c]	98.2[c]	98.2[c]	98.2[c]	98.2[c]
Number damaged	2	4	0			22	289	601	1307	14	1420	1662
Proportion of impingement damaged	0.0303	0.1379	0.0000			0.1930	0.1276	0.1850	0.5524	0.5000	0.3468	0.3921
Weighted Latent Mortality (%)	99.9	99.8	I.S.			70.3	68.0	70.0	82.7	80.9	99.4	99.3
Total Mortality	100.0	99.8	I.S.			75.8	71.9	74.9	86.1	84.7	99.5	99.4
	0	0.2	1.4	11.6	10.4	24.2	28.1	25.1	13.9	15.3	0.5	0.6

1+ Age in Months*	MAY 13	JUN 14	JUL 15	AUG 16	SEP 17	OCT 18	NOV 19	DEC 20	JAN 21	FEB 22	MAR 23	APR 24
Initial Mortality(%)	19.2	26.9	0.0	46.2	0.0	8.3	14.0	16.7	0.0		25.0	24.0
Latent												
Live Category Mortality (%)	100.0[a]	100.0[a]	100.0[a]	63.6	63.6	63.6	63.6	63.6				
Number live	92	12	1	4	1	19	33	5	0		5	10
Proportion of impingement live	0.7797	0.6316	0.2000	0.5714	0.2500	0.5758	0.6735	0.4545	0.0000		0.4167	0.5263
Damaged Category Mortality (%)	98.2[c]	98.2[c]	98.2[c]	98.2[c]	98.2[c]	98.2[c]	98.2[c]	98.2[c]				
Number damaged	26	7	4	3	3	14	16	6	1		7	9
Proportion of impingement damaged	0.2203	0.3684	0.8000	0.4286	0.7500	0.4242	0.3265	0.5455	1.0000		0.5833	0.4737
Weighted Latent Mortality (%)	99.6	99.3	98.6	78.4	89.6	78.3	74.9	82.5	I.S.		I.S.	I.S.
Total Mortality	99.7	99.8	98.6	88.4	89.6	80.1	78.4	85.4				

Appendix VI, Table 7-12 (revised)
Continued.

2+ Age in Months*	MAY 25	JUN 26	JUL 27	AUG 28	SEP 29	OCT 30	NOV 31	DEC 32	JAN 33	FEB 34	MAR 35	APR 36
Initial Mortality(%)	25.0					0.0	70.0	0.0			8.7	19.2
Latent Live Category Mortality (%)												
Number live	2					1	3	1			11	7
Proportion of impingement live	0.2222					1.0000	1.0000	0.5000			0.5238	0.3333
Damaged Category Mortality (%)												
Number damaged	7					0	0	1			10	14
Proportion of impingement damaged	0.7778					0.0000	0.0000	0.5000			0.4762	0.6666
Weighted Latent Mortality (%)	I.S.					I.S.	I.S.	I.S.			I.S.	I.S.
Total Mortality (%)	I.S.					I.S.	I.S.	I.S.			I.S.	I.S.

3+ Age in Months*	MAY 37	JUN 38	JUL 39	AUG 40	SEP 41	OCT 42	NOV 43	DEC 44	JAN 45	FEB 46	MAR 47	APR 48
Initial Mortality(%)	7.1						0.0				0.0	0.0
Latent Live Category Mortality (%)												
Number live	2						2				3	0
Proportion of impingement live	0.1538						1.0000				0.7500	0.0000
Damaged Category Mortality (%)												
Number damaged	11						0				1	2
Proportion of impingement damaged	0.8462						0.0000				0.2500	1.0000
Weighted Latent Mortality (%)	I.S.						I.S.				I.S.	I.S.
Total Mortality (%)	I.S.						I.S.				I.S.	I.S.

Appendix VI, Table 7-12 (revised)
Continued.

4+ and older Age in Months*	MAY 49+	JUN 49+	JUL 49+	AUG 49+	SEP 49+	OCT 49+	NOV 49+	DEC 49+	JAN 49+	FEB 49+	MAR 49+	APR 49+
Initial Mortality(%)	45.8	0.0				0.0		0.0			0.0	21.4
Latent Live Category Mortality(%)												
Number live	2	0				1		0			1	8
Proportion of impingement live	0.1538	0.0000				1.0000		0.0000			0.1842	0.1818
Damaged Category Mortality (%)												
Number damaged	11	2				0		4			0	36
Proportion of impingement damaged	0.8462	1.0000				0.0000		1.0000			0.8158	0.8182
Weighted Latent Mortality (%)	I.S.	I.S.				I.S.		I.S.			I.S.	I.S.
Total Mortality(%)	I.S.	I.S.				I.S.		I.S.			I.S.	I.S.

* Assuming May 1 birthday.
a Assumed mortality from live March (Appendix VI, Table 7-10).
b Assumed mortality from live November & December (Appendix VI, Table 7-10).
c Assumed mortality from damaged March & April (Appendix VI, Table 7-10).
I.S. = Insufficient sample size.

Table 7-14
Monthly initial, latent and total mortality of pooled age bay anchovy taken in Salem impingement samples, 1977-82.

	MONTH												
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	AVERAGE
Initial Mortality(%)	39.3	I.S.	52.1	35.0	35.6	42.9	51.8	44.3	29.0	19.7	21.1	21.3	40.0
Latent[1]													
Live Category													
Mortality(%)	81.5[2]		81.5[2]	81.5[2]	71.8	88.4	85.7	80.5	81.0	71.8	67.5	81.5[2]	81.5[2]
Number live	4	0	25	5,812	18,593	22,363	15,302	5,821	4,965	6,458	2,419	34	81,796
Proportion of impinged live	0.2353		0.3676	0.5841	0.6863	0.8745	0.9198	0.9474	0.9594	0.9415	0.8777	0.3542	0.8150
Damaged Category													
Mortality(%)	94.6[3]		94.6[3]	95.3	96.5	90.8	97.5	86.3	94.6[3]	100.0	94.6[3]	94.6[3]	94.6[3]
Number damaged	13	5	43	4,138	8,498	3,208	1,334	323	210	401	337	62	18,572
Proportion of impinged damaged	0.7647		0.6324	0.4159	0.3137	0.1255	0.0802	0.0526	0.0406	0.0585	0.1223	0.6458	0.1850
Weighted Latent Mortality(%)	91.5	I.S.	89.8	87.2	79.5	88.7	86.6	80.8	81.6	73.4	70.8	90.0	83.9
Total Mortality(%)	94.9	I.S.	95.1	91.7	86.8	93.5	93.6	89.3	86.9	78.7	77.0	92.1	90.4

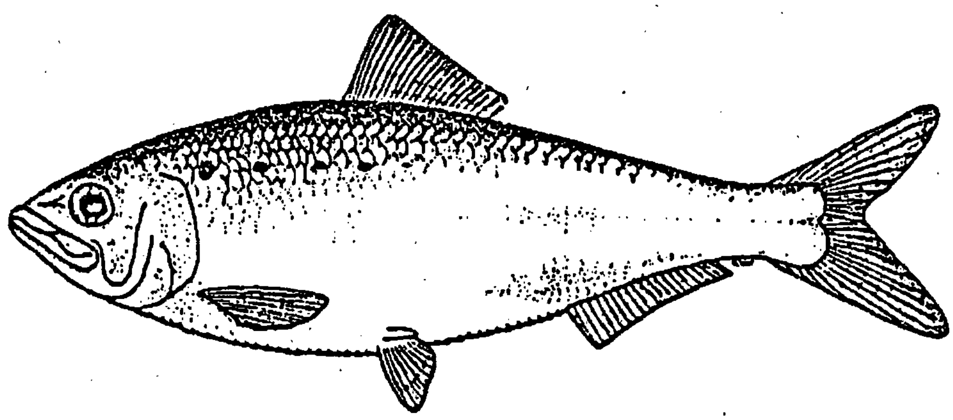
[1] Based on survival test results.
[2] Average live category latent mortality.
[3] Average damaged category latent mortality.

I.S. = insufficient sample size.

AMERICAN SHAD (<u>ALOSA</u> <u>SAPIDISSIMA</u>): A SYNTHESIS OF INFORMATION ON NATURAL HISTORY, WITH REFERENCE TO OCCURRENCE IN THE DELAWARE RIVER AND ESTUARY AND INVOLVEMENT WITH THE SALEM GENERATING STATION

SALEM GENERATING STATION
316(b) DEMONSTRATION
APPENDIX III

NPDES Permit No. NJ0005622
NRC Operating Licensing DPR-70 & DPR-75
NRC Docket Numbers 50-272 & 50-311



Public Service Electric and Gas Company
80 Park Plaza
Newark, N.J. 07101

May 1984

Table 7-6
American shad impingement mortality (%) rate by age (May 1977-December 1981).

	Month												
	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	TOTAL
0+													
Age in months*	1	2	3	4	5	6	7	8	9	10	11	12	
Initial													
Mean					20.0	4.2	11.8			0.0	20.2	0.0	12.4
Upper 95% C.I.					48.1	13.8	35.7			16.9	28.8	100.0	17.1
Lower 95% C.I.					4.3	0.5	1.5			0.0	11.7	0.0	7.8
Latent[1]													
Mean					33.3	17.4	13.3			40.0	61.2	22.2	38.5
Upper 95% C.I.					61.5	29.9	40.5			64.0	72.9	100.0	45.8
Lower 95% C.I.					10.2	8.0	1.7			19.1	49.5	0.0	31.1
Total													
Mean					46.7	20.8	23.5			40.0	69.1	22.2	46.1
Upper 95% C.I.[2]					71.9	32.3	43.7			61.5	78.9	100.0	53.2
Lower 95% C.I.[2]					21.4	9.3	3.4			18.5	59.2	0.0	39.1
1+													
Age in months*	13	14	15	16	17	18	19	20	21	22	23	24	
Initial													
Mean			100.0		0.0						28.6	0.0	27.3
Upper 95% C.I.			100.0		100.0						100.0	100.0	59.3
Lower 95% C.I.			0.0		0.0						0.0	0.0	6.1
Latent[1]													
Mean			-		100.0						100.0	100.0	100.0
Upper 95% C.I.			-		100.0						100.0	100.0	100.0
Lower 95% C.I.			-		0.0						0.0	0.0	0.0
Total													
Mean			100.0		100.0						100.0	100.0	100.0
Upper 95% C.I.[2]			100.0		100.0						100.0	100.0	100.0
Lower 95% C.I.[2]			0.0		0.0						0.0	0.0	0.0

Total mortality heterogeneity test among ages 5, 6, 7, 10, 11, and 12 months χ^2=35.98; df=5; $p \leq 0.01$

Total mortality heterogeneity test among ages 5, 6, 7, 10, and 12 months χ^2=5.50; df=4; not significant

[1]Estimated from damaged category.

[2]Approximate confidence interval.

*Assuming June 1 birthday.

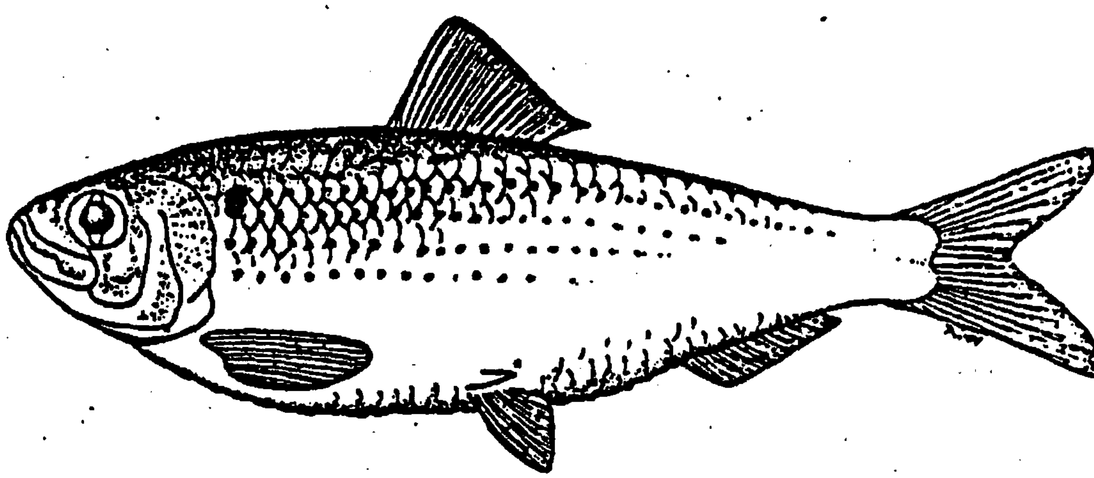
ALEWIFE (ALOSA PSEUDOHARENGUS): A SYNTHESIS OF INFORMATION ON NATURAL HISTORY, WITH REFERENCE TO OCCURRENCE IN THE DELAWARE RIVER AND ESTUARY AND INVOLVEMENT WITH THE SALEM NUCLEAR GENERATING STATION

DRAFT

DATE: ____________

SALEM NUCLEAR GENERATING STATION
316(b) DEMONSTRATION
APPENDIX ~~IV~~ V

NPDES Permit No. NJ0005622
NRC Operating Licensing DPR-70 & DPR-75
NRC Docket Numbers 50-272 & 50-311



Public Service Electric and Gas Company
80 Park Plaza
Newark, N.J. 07101

October 1982

Alewife I

Table 7-4
Alewife age composition in Salem impingement samples 1977-1981.

	Months											
	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR
0+												
Age in Months*	1	2	3	4	5	6	7	8	9	10	11	12
1977				1	1	1			2			
1978					1			4	25		3	
1979							7	69	1			40
1980		17	1		1		6	5	2	1		27
1981		1534	94	1			13	70	38		1	113
Total		1551	95	2	3	1	26	148	68	1	4	180
1+												
Age in Months*	13	14	15	16	17	18	19	20	21	22	23	24
1977												
1978	1				1			1	7			
1979	7						11	19				5
1980	35	7						4		1		5
1981	23	21				1		3				12
Total	66	28	0	0	1	1	11	27	7	1	0	22
2+												
Age in Months*	25	26	27	28	29	30	31	32	33	34	35	36
1977												
1978												
1979	2											
1980	10	1					1					
1981	3	3					1					
Total	15	4	0	0	0	0	2	0	0	0	0	0
3+ and older												
Age in Months*	37+	37+	37+	37+	37+	37+	37+	37+	37+	37+	37+	37+
1977												
1978				1								
1979												2
1980												
1981	5	9										4
Total	5	9	0	1	0	0	0	0	0	0	0	6
Grand Total	86	1592	95	3	4	2	40	174	75	2	4	208
Percentage 0+	0	97.4	100.0	66.7	75.0	50.0	65.0	85.1	90.7	50.0	100.0	86.5
Percentage 1+	76.7	1.8	0	0	25.0	50.0	27.5	15.5	9.3	50.0	0	10.6
Percentage 2+	17.4	0.3	0	0	0	0	5.0	0	0	0	0	0
Percentage 3+ and older	5.8	0.6	0	33.3	0	0	0	0	0	0	0	2.9

* Assuming April 1 birthday.

Table 7-6
Number and percentage mortality by age of alewife taken in Salem impingement samples, 1977-1981.

0+

NUMBER		Apr 1	May 2	Jun 3	Jul 4	Aug 5	Sep 6	Oct 7	Nov 8	Dec 9	Jan 10	Feb 11	Mar 12
Live	1977												
	1978								3	16			
	1979							4	45	1			20
	1980		8	1		1		6	2				9
	1981		854	57	1			3	13	12			12
	Total		862	58	1	1	0	13	63	29	0	0	41
Dead	1977				1	1	1			2			
	1978									1		1	
	1979							1	3				8
	1980		2						1				1
	1981		242	21					3	1			5
	Total		244	21	1	1	1	1	7	4	0	1	14
Damaged	1977												
	1978								1	8		1	
	1979							2	18				12
	1980								2	2	1		8
	1981		269	1					3	5			8
	Total		269	1	0	0	0	2	24	15	1	1	28
MORTALITY (%)													
Initial													
Mean			17.8	26.3	I.S.	I.S.	I.S.	6.3	7.5	8.3	I.S.	I.S.	16.9
Upper 95% C.I.			19.8	35.9				30.0	14.2	19.2			25.6
Lower 95% C.I.			15.7	16.6				0.2	3.1	2.4			9.8
Latent													
Mean			23.8	1.7	I.S.	I.S.	I.S.	13.3	27.6	34.1	I.S.	I.S.	40.6
Upper 95% C.I.			26.3	9.0				40.5	37.0	48.1			52.2
Lower 95% C.I.			21.3	0.0				1.7	18.2	20.1			29.0
Total													
Mean			37.3	27.5	I.S.	I.S.	I.S.	18.8	33.0	39.6	I.S.	I.S.	50.6
Upper 95% C.I.			39.9	37.3				37.9	42.5	53.4			61.4
Lower 95% C.I.			34.8	17.7				0.0	23.5	25.8			39.9

I.S. = Insufficient sample size.

Table 7-6
Continued

14

NUMBER		Apr 13	May 14	Jun 15	Jul 16	Aug 17	Sep 18	Oct 19	Nov 20	Dec 21	Jan 22	Feb 23	Mar 24
Live	1977												
	1978	1								4			
	1979	1						4	10				3
	1980	17	2						4				1
	1981	10	9						1				
	Total	29	11				0	4	15	4	0		4
Dead	1977												
	1978												
	1979	3						1	2				
	1980	7	2								1		
	1981	4					1						
	Total	14	2				1	1	2	0	1		0
Damaged	1977												
	1978								1	3			
	1979	3						2	8				1
	1980	7	2										1
	1981	3	4						1				2
	Total	13	6				0	2	10	3	0		4
MORTALITY (%)													
Initial													
Mean		25.0	10.5				I.S.	I.S.	7.4	I.S.	I.S.		I.S.
Upper 95% C.I.		37.9	32.0						24.1				
Lower 95% C.I.		14.5	1.3						0.9				
Latent													
Mean		31.0	35.3				I.S.	I.S.	40.0	I.S.	I.S.		I.S.
Upper 95% C.I.		44.7	59.8						61.3				
Lower 95% C.I.		18.2	14.4						21.1				
Total													
Mean		48.2	42.1				I.S.	I.S.	44.4	I.S.	I.S.		I.S.
Upper 95% C.I.		61.3	64.3						63.2				
Lower 95% C.I.		35.1	19.9						25.7				

I.S. = Insufficient sample size.

Table 7-6
Continued

NUMBER		2+ Apr 25	May 26	Jun 27	Jul 28	Aug 29	Sep 30	Oct 31	Nov 32	Dec 33	Jan 34	Feb 35	Mar 36	3+ and older Apr 37+	Total
Live	1977														
	1978														
	1979	1												1	
	1980		1												
	1981													1	
	Total	1	1					0						2	1139
Dead	1977													1	
	1978														
	1979														
	1980	1													
	1981		1											1	
	Total	1	1					0						2	320
Damaged	1977														
	1978														
	1979	1						1						1	
	1980	9													
	1981	2												7	
	Total	12	0					1						8	400
MORTALITY (%)															
Initial															
Mean		I.S.	I.S.					I.S.						I.S.	17.2
Upper 95% C.I.															18.9
Lower 95% C.I.															15.5
Latent															
Mean		I.S.	I.S.					I.S.						I.S.	26.0
Upper 95% C.I.															28.2
Lower 95% C.I.															23.8
Total															
Mean		I.S.	I.S.					I.S.						I.S.	38.7
Upper 95% C.I.															40.9
Lower 95% C.I.															36.5

I.S. = Insufficient sample size.

Table 7-7
Alewife monthly total mortality with monthly mean temperature, salinity detritus and number pumps in service, at Salem, 1977-1981.

YEAR	MONTH	AGE* (MONTHS)	TOTAL ALEWIFE IMPINGED (MEASURED)	NUMBER LIVE	MEAN FORK LENGTH (MM)	WATER TEMP. (C)	SALINITY (PPT)	DETRITUS (GRAMS PER 100 CUBIC METERS)	MEAN NO. PUMPS IN SERVICE	TOTAL MORTALITY	LOGIT TOTAL MORTALITY
1977											
	JUL	4	1	0	83	27.4	9.1	85.2	5.5	1.0000	7.6015
	AUG	5	1	0	93	27.1	9.9	66.2	5.3	1.0000	7.6015
	SEP	6	1	0	83	23.5	9.6	54.1	3.3	1.0000	7.6015
	DEC	9	2	0	79	4.8	2.1	141.9	5.3	1.0000	7.6015
SUM			5	0							
1978											
	NOV	8	4	3	96	12.4	10.2	90.4	2.7	.2500	-1.0973
	DEC	9	25	16	94	6.3	4.6	68.9	5.6	.3600	-.5749
	FEB	11	2	0	80	.9	5.3	107.9	5.6	1.0000	7.6015
	APR	13	1	1	93	11.8	3.7	400.7	1.0	0.0	-7.6014
	NOV	20	1	0	165	12.4	10.2	90.4	2.7	1.0000	7.6015
	DEC	21	7	4	133	6.3	4.6	68.9	5.6	.4286	-.2876
	JUL	37	1	0	249	25.6	7.6	131.6	4.9	1.0000	7.6015
SUM			41	24							
1979											
	OCT	7	7	4	104	16.3	3.2	56.9	2.0	.4286	-.2974
	NOV	8	67	45	98	12.7	4.8	149.4	2.1	.3284	-.7149
	DEC	9	1	1	69	6.5	4.0	116.4	2.5	0.0	-7.6014
	MAR	12	39	20	96	7.5	1.3	132.5	5.8	.4872	-.0512
	APR	13	7	1	92	10.9	3.9	54.8	2.3	.8571	1.7389
	OCT	19	7	4	139	16.3	3.2	56.9	2.0	.4286	-.2874
	NOV	20	19	10	153	12.7	4.8	149.4	2.1	.4737	-.1053
	MAR	24	5	3	169	7.5	1.3	132.5	5.8	.4000	-.4055
	APR	25	2	1	165	10.9	3.9	54.8	2.3	.5000	-.0003
	OCT	31	1	0	195	16.3	3.2	56.9	2.0	1.0000	7.6015
	MAR	37	2	1	268	7.5	1.3	132.5	5.8	.5000	-.0003
SUM			157	90							
1980											
	MAY	2	10	8	33	18.9	3.5	49.4	5.8	.2000	-1.3846
	JUN	3	1	1	43	23.1	7.0	32.2	5.6	0.0	-7.6014
	AUG	5	1	1	73	27.7	9.7	18.8	7.0	0.0	-7.6014
	OCT	7	6	6	65	16.5	11.9	28.5	1.3	0.0	-7.6014
	NOV	8	5	2	91	9.3	12.6	33.8	1.0	.6000	.4055
	DEC	9	2	0	98	3.6	12.0	48.5	2.4	1.0000	7.6015
	JAN	10	1	0	115	2.7	5.9	116.1	5.5	1.0000	7.6015
	MAR	12	13	9	101	4.2	8.3	179.8	5.7	.5000	-.0003
	APR	13	31	17	105	11.9	1.6	96.7	5.5	.4516	-.1940
	MAY	14	6	2	127	18.9	3.5	49.4	5.5	.6667	.6924

* 37 = AGE 37 MONTHS OR OLDER

Table 7-7
Continued

YEAR	MONTH	AGE* (MONTHS)	TOTAL ALEWIFE IMPINGED (MEASURED)	NUMBER LIVE	MEAN FORK LENGTH (MM)	WATER TEMP. (C)	SALINITY (PPT)	DETRITUS (GRAMS PER 100 CUBIC METERS)	MEAN NO. PUMPS IN SERVICE	TOTAL MORTALITY	LOGIT TOTAL MORTALITY
1980											
	NOV	20	4	4	141	9.3	12.6	33.8	1.0	0.0	-7.6014
	JAN	22	1	0	138	2.7	5.5	116.1	5.5	1.0000	7.6015
	MAR	24	2	1	141	4.2	8.3	179.8	5.7	.5000	-.0000
	APR	25	10	0	176	11.9	1.6	96.7	5.5	1.0000	7.6015
	MAY	26	1	1	165	18.9	3.5	49.4	5.8	0.0	-7.6014
SUM			99	52							
1981											
	MAY	2	1365	854	35	17.5	7.2	75.1	6.0	.3744	-.5130
	JUN	3	79	57	35	24.2	8.2	64.8	4.1	.2785	-.9509
	JUL	4	1	1	58	26.6	11.1	43.7	8.7	0.0	-7.6314
	OCT	7	3	3	71	14.9	10.2	32.1	8.1	0.0	-7.6314
	NOV	8	20	13	88	10.9	11.2	30.2	8.8	.3500	-.6194
	DEC	9	15	12	81	4.7	10.7	26.6	9.5	.3333	-.6924
	MAR	12	25	12	100	5.9	9.9	72.8	4.5	.5200	.0800
	APR	13	17	10	97	12.3	7.5	73.6	1.6	.4118	-.3563
	APR	14	13	9	98	17.5	7.2	75.1	6.0	.3077	-.8100
	SEP	18	1	0	159	22.4	9.5	30.4	7.9	1.0000	7.6015
	NOV	20	1	1	133	10.9	11.2	30.2	8.8	0.0	-7.6314
	MAR	24	2	0	156	5.9	9.9	72.8	4.5	1.0000	7.6015
	APR	25	2	0	171	12.3	7.5	73.6	1.6	1.0000	7.6015
	MAY	26	1	0	163	17.5	7.2	75.1	6.0	1.0000	7.6015
	APR	37	2	0	266	12.3	7.5	73.6	1.6	1.0000	7.6015
	MAY	37	7	1	261	17.5	7.2	75.1	6.0	.8571	1.7983
SUM			1557	973							

* 37 = AGE 37 MONTHS OR OLDER

EA Report CHG11P

A BIOLOGICAL EVALUATION OF MODIFIED VERTICAL TRAVELING SCREENS

Prepared for

Central Hudson Gas and Electric Corporation
284 South Avenue
Poughkeepsie, New York 12602

Prepared by

Ecological Analysts, Inc.
R.D. 2, Goshen Turnpike
Middletown, New York 10940

April 1982

TABLE 4-7 SUMMARY OF INITIAL SURVIVAL OF FISHES FROM IMPINGEMENT COLLECTIONS AT THE DANSKAMMER POINT PLANT IN THE FALL, 15 SEPTEMBER - 15 NOVEMBER 1979

		Standard Screen				Modified Screen			
		Continuous Wash		2-hr hold		Continuous Wash		2-hr Hold	
Species	Lifestage	No.	Ps	No.	Ps	No.	Ps	No.	Ps
White perch	YOY	280	0.961	346	0.951	48	0.917	211	0.900
	YRL	30	1.000	29	1.000	4	1.00	26	1.000
	ADL	13	1.00	21	0.952	1	1.00	11	1.00
Blueback herring	YOY	103	0.748	117	0.265	21	0.429	56	0.286
	YRL	1	1.00	1	1.00	0	--	1	0.00
Tessellated darter	YOY	0	--	0	--	0	--	1	0.00
Alewife	YOY	64	0.922	67	0.552	33	0.818	48	0.438
	YRL	2	0.500	4	1.00	3	1.00	2	0.500
Largemouth bass	ADL	0	--	0	--	0	--	2	1.00
American shad	YOY	21	0.905	26	0.500	6	0.833	21	0.571
Redbreast sunfish	ADL	0	--	0	--	1	1.00	0	--
Pumpkinseed	YOY	8	1.00	10	0.900	3	1.00	5	1.00
	YRL	0	--	1	1.00	0	--	1	1.00
	ADL	1	1.00	3	0.667	0	--	2	1.00
Spottail shiner	YOY	1	1.00	0	--	1	0.00	0	--
	ADL	5	0.800	12	0.917	2	0.500	3	1.00

(a) YOY = young of the year; YRL = yearling; and ADL = adult.
Ps = Proportion alive initially.

Note: Dashes indicate no data.

TABLE 4-7 (CONT.)

Species	Lifestage	Standard Screen: Continuous Wash No.	Ps	Standard Screen: 2-hr Hold No.	Ps	Modified Screen: Continuous Wash No.	Ps	Modified Screen: 2-hr Hold No.	Ps
Goldfish	YOY	0	--	1	1.00	0	--	0	--
White catfish	YOY	3	1.00	7	1.00	0	--	2	1.00
	YRL	1	1.00	2	1.00	1	1.00	0	--
	ADL	1	1.00	0	--	1	1.00	1	1.00
Unidentified herring	YOY	0	--	1	0.00	0	--	0	--
Gizzard shad	YOY	2	1.00	0	--	1	1.00	2	1.00
	YRL	0	--	0	--	1	1.00	1	0.00
Rainbow smelt	ADL	2	1.00	1	1.00	2	1.00	0	--
Yellow perch	ADL	0	--	1	1.00	0	--	0	--
Hogchocker	YOY		1.00	0	--	0	--	0	--
	YRL	1	1.00	0	--	0	--	0	--
	ADL	0	--	0	--	0	--	1	1.00
Golden shiner	YRL	0	--	2	1.00	0	--	0	--
American eel	YOY	0	--	1	1.00	0	--	2	1.00
	ADL	1	1.00	0	--	1	1.00	1	1.00
Striped bass	YOY	0	--	2	1.00	0	--	1	1.00
	ADL	0	--	0	--	0	--	2	1.00
	YRL	0	--	3	0.667	0	--	0	--
Brown bullhead	YOY	0	--	2	1.00	0	--	0	--
	YRL	0	--	0	--	1	1.00	0	--
	ADL	0	--	3	1.00	1	1.00	0	--

TABLE 4-7 (CONT.)

Species	Lifestage	Standard Screen				Modified Screen			
		Continuous Wash		2-hr Hold		Continuous Wash		2-hr Hold	
		No.	Ps	No.	Ps	No.	Ps	No.	Ps
Atlantic tomcod	YRL	1	1.00	0	--	0	--	0	--
Banded killifish	ADL	1	1.00	0	--	0	--	0	--
Bluegill sunfish	YOY	1	1.00	1	1.00	0	--	0	--
	ADL	0	--	2	1.00	1	1.00	0	--

TABLE 4-8 SUMMARY OF INITIAL SURVIVAL OF FISHES FROM IMPINGEMENT COLLECTIONS AT THE DANSKAMMER POINT PLANT IN THE WINTER, 13 JANUARY - 15 FEBRUARY 1980

		Standard Screen				Modified Screen			
		Continuous Wash		2-hr Hold		Continuous Wash		2-hr Hold	
Species	Lifestage	No.	Ps	No.	Ps	No.	Ps	No.	Ps
Atlantic tomcod	ADL	52	0.827	50	0.840	30	0.967	5	1.00
White perch	YRL	36	0.889	20	0.800	18	0.944	6	0.833
	ADL	3	1.00	6	1.00	2	1.00	0	--
Pumpkinseed	YRL	11	1.00	12	1.00	9	1.00	2	1.00
	ADL	17	0.875	12	0.833	8	0.875	7	1.00
Spottail shiner	YRL	2	0.500	1	1.00	4	0.500	1	1.00
	ADL	8	0.750	10	0.900	18	1.00	6	1.00
Banded killifish	ADL	6	1.00	5	0.800	2	1.00	2	1.00
Carp	YRL	4	1.00	4	1.00	4	0	1	1.00
	ADL	1	1.00	1	1.00	2	1.00	1	1.00
Golden shiner	YRL	1	1.00	0	--	0	--	0	--
	ADL	4	1.00	5	0.800	3	1.00	2	1.00
Largemouth bass	YRL	3	1.00	5	1.00	2	1.00	--	0
	ADL	0	--	0	--	1	1.00		
Gizzard shad	YRL	2	1.00	2	1.00	1	0		
	ADL	3	1.00	0	--	1	1.00	3	1.00

(a) YOY = young of the year; YRL = yearling; and ADL = adult.
Ps = Proportion alive initially.
Note: Dashes indicate no data.

TABLE 4-8 (CONT.)

Species	Lifestage	Standard Screen: Continuous Wash No.	Standard Screen: Continuous Wash Ps	Standard Screen: 2-hr Hold No.	Standard Screen: 2-hr Hold Ps	Modified Screen: Continuous Wash No.	Modified Screen: Continuous Wash Ps	Modified Screen: 2-hr Hold No.	Modified Screen: 2-hr Hold Ps
Yellow perch	YRL	2	0.500	0	--	1	1.00	0	--
Goldfish	YRL	2	1.00	2	1.00	0	--	0	--
	ADL	2	1.00	2	1.00	3	1.00	1	1.00
Striped bass	YRL	0	--	1	1.00				
	ADL	1	1.00	0	--	2	1.00	1	1.00
Bluegill sunfish	YRL	0	--	2	1.00	0	--	1	1.00
	ADL	1	1.00	2	0.500	2	1.00	1	1.00
White catfish	YRL	0	--	0	--	2	1.00	0	--
Brown bullhead	ADL	0	--	0	--	1	1.00	0	--
Rainbow smelt	ADL	0	--	0	--	1	1.00	0	--

TABLE 4-9 SUMMARY OF INITIAL SURVIVAL OF FISHES FROM IMPINGEMENT COLLECTIONS AT THE DANSKAMMER POINT PLANT IN THE SPRING, 6 APRIL - 22 MAY 1980

		Standard Screen				Modified Screen			
		Continuous Wash		2-hr Hold		Continuous Wash		2-hr Hold	
Species	Lifestage	No.	Ps	No.	Ps	No.	Ps	No.	Ps
White perch	YRL	160	0.988	87	0.908	61	0.984	25	1.00
	ADL	213	0.991	321	0.984	216	0.981	84	0.940
Spottail shiner	YRL	24	0.958	5	1.000	4	1.00	0	--
	ADL	27	0.963	71	0.958	53	1.00	22	1.00
Tessellated darter	YRL	0	--	1	1.00	0	--	0	--
	ADL	10	1.00	4	1.00	5	1.00	0	--
Yellow perch	YRL	2	1.00	4	1.00	4	1.00	1	1.00
	ADL	0	--	11	0.909	5	1.00	8	1.00
American eel	YRL	2	1.00	2	1.00	4	0.750	2	1.00
	ADL	5	1.00	4	1.00	1	1.00	0	--
American shad	ADL	4	1.00	4	1.00	2	1.00	0	--
Rainbow smelt	ADL	0	--	8	1.00	5	1.00	4	1.00
Golden shiner	YRL	0	--	1	1.00	0	--	1	1.00
	ADL	1	1.00	5	1.00	3	1.00	0	--
Bluegill sunfish	ADL	2	1.00	3	1.00	1	1.00	1	1.00

(a) YOY = young of the year; YRL = yearling; and ADL = adult.
Ps = Proportion alive initially.

Note: Dashes indicate no data.

TABLE 4-9 (CONT.)

Species	Lifestage	Standard Screen Continuous Wash No.	Ps	Standard Screen 2-hr Hold No.	Ps	Modified Screen Continuous Wash No.	Ps	Modified Screen 2-hr Hold No.	Ps
Alewife	YRL	1	1.00	3	0.333	0	--	1	1.00
	ADL	0	--	4	0.500	1	1.00	1	1.00
Goldfish	YRL	1	1.00	3	1.00	0	--	0	--
	ADL	0	--	0	--	0	--	0	--
Pumpkinseed	YRL	3	1.00	1	1.00	1	1.00	0	--
	ADL	1	1.00	2	0.500	1	1.00	0	--
Atlantic tomcod	YOY	2	1.00	0	--	0	--	0	--
	YRL	0	--	0	--	0	--	1	0
	ADL	0	--	2	1.00	0	--	1	1.00
Threespine stickleback	YRL	0	--	1	0	0	--	0	--
	ADL	1	1.00	0	--	0	--	0	--
Black crappie	ADL	0	--	1	1.00	0	--	0	--
Hogchocker	YRL	0	--	0	--	2	1.00	0	--
	ADL	0	--	1	1.00	0	--	1	1.00
White catfish	YRL	0	--	1	1.00	0	--	1	1.00
	ADL	0	--	0	--	0	--	0	--
Striped bass	ADL	0	--	1	1.00	0	--	0	--
Fourspine stickleback	ADL	1	1.00	0	--	0	--	0	--

TABLE 4-9 (CONT.)

Species	Lifestage	Standard Screen: Continuous Wash No.	Standard Screen: Continuous Wash Ps	Standard Screen: 2-hr Hold No.	Standard Screen: 2-hr Hold Ps	Modified Screen: Continuous Wash No.	Modified Screen: Continuous Wash Ps	Modified Screen: 2-hr Hold No.	Modified Screen: 2-hr Hold Ps
Brown bullhead	YRL	0	--	0	--	1	1.00	0	--
	ADL	1	1.00	0	--	1	1.00	0	--
Redbreast sunfish	ADL	0	--	0	--	0	--	1	1.00
Banded killifish	ADL	0	--	-	--	0	--	1	1.00

TABLE 4-10 SUMMARY OF INITIAL SURVIVAL OF FISHES FROM IMPINGEMENT COLLECTIONS AT THE DANSKAMMER POINT PLANT IN THE FALL, 16 SEPTEMBER TO 28 DECEMBER 1980

		Standard Screen				Modified Screen			
		Continuous Wash		2-hr Hold		Continuous Wash		2-hr Hold	
Species	Lifestage	No.	Ps	No.	Ps	No.	Ps	No.	Ps
White perch	YOY	187	0.952	556	0.860	317	0.981	254	0.937
	YRL	53	1.00	95	0.958	76	0.974	32	0.969
	ADL	41	1.00	135	0.941	40	0.925	72	0.931
Alewife	YOY	68	0.735	276	0.192	77	0.675	174	0.190
	YRL	14	0.857	9	0.444	12	0.917	10	0.200
	ADL	1	1.00	3	0.667	3	0.667	0	--
Blueback herring	YOY	53	0.868	264	0.216	21	0.810	165	0.188
	YRL	1	1.00	6	0.167	3	1.00	6	0.500
	ADL	0	--	1	1.00	0	--	0	--
American shad	YOY	7	0.714	236	0.314	31	0.613	85	0.200
	ADL	1	0	1	0	0	--	0	--
Gizzard shad	YOY	63	0.984	187	0.947	56	0.982	51	0.961
	YRL	8	1.00	36	0.917	21	1.00	33	0.909
	ADL	29	1.00	112	1.00	50	1.00	36	0.972
Bay anchovy	YOY	9	0.111	74	0.027	22	0.136	37	0
	YRL	2	0	14	0	0	--	13	0
Weakfish	YOY	27	0.778	46	0.326	19	0.895	42	0.333

(a) YOY = young of the year; YRL = yearling; and ADL = adult.
Ps = Proportion alive initially.
Note: Dashes indicate no data.

TABLE 4-10 (CONT.)

Species	Lifestage	Standard Screen: Continuous Wash No.	Standard Screen: Continuous Wash Ps	Standard Screen: 2-hr Hold No.	Standard Screen: 2-hr Hold Ps	Modified Screen: Continuous Wash No.	Modified Screen: Continuous Wash Ps	Modified Screen: 2-hr Hold No.	Modified Screen: 2-hr Hold Ps
Pumpkinseed	YOY	8	0.875	44	0.818	25	0.920	21	1.00
	YRL	0	--	4	1.00	2	1.00	3	1.00
	ADL	2	1.00	22	1.00	0	--	3	1.00
Striped bass	YOY	21	1.00	29	0.759	17	1.00	13	0.846
	YRL	3	1.00	6	0.833	3	1.00	6	1.00
	ADL	2	1.00	5	1.00	0	--	4	0.500
White catfish	YOY	5	1.00	29	0.931	10	1.00	3	1.00
	YRL	0	--	2	1.00	3	1.00	2	1.00
	ADL	1	1.00	5	1.00	1	1.00	4	1.00
Spottail shiner	YOY	0	--	4	0.250	2	0.500	0	--
	YRL	12	1.00	25	0.800	14	0.857	5	0.800
Hogchocker	YOY	3	1.00	1	1.00	10	1.00	2	1.00
	YRL	3	1.00	23	1.00	10	1.00	12	1.00
	ADL	0	--	1	1.00	0	--	1	1.00
Brown bullhead	YOY	4	1.00	10	1.00	4	1.00	1	1.00
	YRL	0	--	0	--	3	1.00	2	1.00
	ADL	2	1.00	0	--	1	1.00	0	--
Goldfish	YOY	2	1.00	2	1.00	0	--	0	--
	YRL	0	--	0	--	0	--	1	1.00
	ADL	5	1.00	8	1.00	2	1.00	0	--
Atlantic tomcod	YOY	2	1.00	2	0.500	2	1.00	3	0
	YRL	2	1.00	1	0	0	--	0	--
	ADL	5	1.00	8	1.00	7	1.00	11	1.00

TABLE 4-10 (CONT.)

		Standard Screen				Modified Screen			
		Continuous Wash		2-hr Hold		Continuous Wash		2-hr Hold	
Species	Lifestage	No.	Ps	No.	Ps	No.	Ps	No.	Ps
Golden shiner	YOY	0	--	1	1.00	0	--	0	--
	YRL	1	1.00	1	1.00	1	1.00	3	1.00
	ADL	4	1.00	4	1.00	1	1.00	3	1.00
Yellow perch	YOY	1	1.00	2	1.00	0	--	0	--
	YRL	1	1.00	1	1.00	0	--	0	--
	ADL	5	1.00	2	1.00	0	--	3	1.00
Smallmouth bass	YOY	0	1.00	2	1.00	0	--	1	1.00
	YRL	0	--	0	--	0	--	1	1.00
Banded killifish	YOY	0	1.00	2	1.00	0	--	1	1.00
	YRL	0	--	0	--	0	--	1	1.00
	ADL	0	--	0	--	-	--	2	1.00
American eel	YOY	1	1.00	0	--	1	1.00	0	--
	YRL	0	--	1	1.00	1	1.00	0	--
	ADL	0	--	1	1.00	1	1.00	3	0.667
Carp	ADL	0	--	1	1.00	0	--	0	--
Channel catfish	YOY	0	--	1	1.00	0	--	0	--
Largemouth bass	YOY	0	--	1	1.00	0	--	0	--
	ADL	0	--	1	1.00	0	--	0	--
Rainbow smelt	YRL	0	--	1	0	0	--	0	--
	YOY	0	--	0	--	0	--	1	1.00
Bluegill sunfish	YRL	0	--	1	1.00	0	--	0	--

TABLE 4-10 (CONT.)

Species	Lifestage	Standard Screen				Modified Screen			
		Continuous Wash		2-hr Hold		Continuous Wash		2-hr Hold	
		No.	Ps	No.	Ps	No.	Ps	No.	Ps
Bluefish	YOY	15	0.867	1	0	1	0	1	0
Fourspine stickleback	YRL	0	--	0	--	1	1.00	0	--

TABLE 4-11 PERCENTAGE SURVIVAL OF IMPINGED WHITE PERCH COLLECTED AT STANDARD AND MODIFIED TRAVELING SCREENS AT THE DANSKAMMER POINT PLANT

Sampling Period	Life Stage[a]	Screenwash Mode	Screen Type	Time of Observation: Initial No.	Initial Percentage Survival	84-hour[b] No.	84-hour[b] Percentage Survival
Fall 1979	YOY	Continuous	Standard	280	96.1	269	89.6
			Modified	48	91.7	44	72.7*
		2-hr hold	Standard	346	95.1	329	23.7
			Modified	211	90.1*	190	5.8*
Winter 1980	YRL	Continuous	Standard	36	88.9	32	28.1
			Modified	18	94.4	17	58.8
		2-hr hold	Standard	20	80.0	16	6.3
			Modified	6	83.3	5	80.0
Spring 1980	ADL	Continuous	Standard	213	99.1	211	90.5
			Modified	216	98.1	212	67.9*
		2-hr hold	Standard	321	98.4	316	23.1
			Modified	84	94.0*	79	30.4
	YRL	Continuous	Standard	160	98.8	158	90.5
			Modified	61	98.4	60	51.7*
		2-hr hold	Standard	87	90.8	79	12.7
			Modified	25	100.0	25	16.0

(a) YOY = young of the year; YRL = yearling; and ADL = adult.
(b) Normalized data.
Note: * indicates that a significant ($\alpha = 0.05$) difference between survival proportions for the two screen types was detected.

TABLE 4-11 (CONT.)

Sampling Period	Life Stage[a]	Screenwash Mode	Screen Type	Time of Observation: Initial No.	Initial Percentage Survival	84-hour[b] No.	84-hour[b] Percentage Survival
Fall 1980	YOY	Continuous	Standard	187	95.2	178	82.0
			Modified	317	98.1	311	43.1*
		2-hr hold	Standard	556	86.0	478	16.7
			Modified	254	93.7*	238	16.0

TABLE 4-12 PERCENTAGE SURVIVAL OF OTHER ABUNDANT TAXA COLLECTED FROM STANDARD AND MODIFIED TRAVELING SCREENS AT THE DANSKAMMER POINT PLANT

					Time of Observation			
					Initial		84-hour[b]	
Species	Life Stage	Sampling Period	Screenwash Mode	Screen Type	No.	Percentage Survival	No.	Percentage Survival
Herrings	YOY	Fall 1979	Continuous	Standard	190	82.6	157	1.9
				Modified	61	68.9	42	0
			2-hour hold	Standard	211	38.4	81	0
				Modified	127	40.2	51	0
		Fall 1980	Continuous	Standard	191	85.3	163	21.5
				Modified	185	77.3*	143	8.4
			2-hour hold	Standard	962	37.4	360	0.6
				Modified	475	27.4*	130	0
Atlantic tomcod	ADL	Winter 1980	Continuous	Standard	52	82.7	43	60.5
				Modified	30	96.7*	29	86.2
			2-hour hold	Standard	50	84.0	42	71.4
				Modified	5	100	5	80.0
Spottail shiner	ADL	Spring 1980	Continuous	Standard	27	96.3	26	100
				Modified	53	100	53	98.1
			2-hour hold	Standard	71	95.8	68	60.3
				Modified	22	100	22	54.5

(a) YOY = young of the year; ADL = adult.
(b) Normalized data.
Note: * indicates that a significant ($\alpha = 0.05$) difference between survival proportions for the two screen types was detected.

TABLE 4-13 PERCENTAGE SURVIVAL FOR FISHES SERVING AS CONTROLS AT THE DANSKAMMER POINT PLANT

Sampling Period	Species	Life Stage[(a)]	Screenwash Mode	Time of Observation: Initial No.	Initial Percentage Survival	84-hour[(b)] No.	84-hour Percentage Survival
Fall 1979	White Perch	YOY	Continuous	145	100	145	100
			2-hr hold	137	100	137	95.6
	Herrings	YOY	Continuous	118	98.3	116	19.8
			2-hr hold	131	99.2	130	21.5
Winter 1980	Atlantic tomcod	ADL	Continuous	89	100	89	98.9
			2-hr hold	71	100	71	100
	White Perch	YRL	Continuous	44	100	44	93.2
			2-hr hold	43	100	43	86.0
Spring 1980	White Perch	YRL	Continuous	28	100	28	96.4
			2-hr hold	38	100	38	84.2
		ADL	Continuous	105	100	105	100
			2-hr hold	103	100	103	95.1
	Spottail shiner	ADL	Continuous	123	100	123	100
			2-hr hold	113	100	113	100
Fall 1980	White Perch	YOY	Continuous	90	100	90	95.6
			2-hr hold	141	100	141	94.3
	Herrings	YOY	Continuous	115	100	115	73.9
			2-hr hold	187	100	187	66.3

(a) YOY = young of the year; YRL = yearling; and ADL = adult.
(b) Normalized data.
Note: * indicates that a significant ($\alpha = 0.05$) difference between survival proportions for the two screen-wash modes was detected.

FINAL REPORT

BIOLOGICAL EVALUATION
OF A MODIFIED TRAVELING SCREEN
MYSTIC STATION - UNIT NO. 7

Prepared for

BOSTON EDISON COMPANY

AUGUST 1981

By

STONE & WEBSTER ENGINEERING CORPORATION

TABLE 2

RESULTS OF FALL TESTING

IMPINGEMENT SURVIVAL STUDY
MYSTIC STATION - UNIT NO. 7
BOSTON EDISON COMPANY

SPECIES NAME	SPEED	INITIAL NUMBER LIVE	INITIAL NUMBER DEAD	INITIAL % SURVIVAL	96-HOUR NUMBER LIVE	96-HOUR NUMBER DEAD	LATENT % SURVIVAL	OVERALL % SURVIVAL (INITIAL X LATENT)
ALOSA (ALEWIFE + BLUEBACK)	3.3	108	21	83.72	1	107	0.93	0.78
ALOSA (ALEWIFE + BLUEBACK)	7.5	184	33	84.79	.	184	0.00	0.00
ALOSA (ALEWIFE + BLUEBACK)	15.0	165	24	87.30	1	164	0.61	0.53
ALOSA (ALEWIFE + BLUEBACK) (SMALL)	3.3	8	7	53.33	1	7	12.50	6.67
ALOSA (ALEWIFE + BLUEBACK) (SMALL)	7.5	319	28	91.93	58	170	25.44	23.39
ALOSA (ALEWIFE + BLUEBACK) (SMALL)	15.0	4221	52	98.78	498	525	48.68	48.09
BUTTERFISH	3.3	.	1	0.00	.	.	.	.
BUTTERFISH	7.5	1	.	100.00	.	1	0.00	0.00
BUTTERFISH	15.0	5	.	100.00	.	5	0.00	0.00
CUNNER	3.3	1	.	100.00	1	.	100.00	100.00
CUNNER	7.5	7	.	100.00	7	.	100.00	100.00
CUNNER	15.0	8	.	100.00	7	1	87.50	87.50
WINTER FLOUNDER	3.3	42	.	100.00	23	18	56.10	56.10
WINTER FLOUNDER	7.5	26	.	100.00	24	2	92.31	92.31
WINTER FLOUNDER	15.0	40	.	100.00	34	6	85.00	85.00
WINTER FLOUNDER (SMALL)	3.3	24	1	96.00	12	8	60.00	57.60
WINTER FLOUNDER (SMALL)	7.5	21	.	100.00	18	3	85.71	85.71
WINTER FLOUNDER (SMALL)	15.0	42	4	91.30	38	3	92.68	84.62
SILVER HAKE	3.3	1	.	100.00	1	.	100.00	100.00
SILVER HAKE	7.5	2	1	66.67	1	1	50.00	33.33
SILVER HAKE	15.0	1	.	100.00	1	.	100.00	100.00
CHUB MACKEREL	3.3	1	.	100.00	.	1	0.00	0.00
CHUB MACKEREL	7.5	10	3	76.92	5	5	50.00	38.46
CHUB MACKEREL	15.0	6	.	100.00	2	4	33.33	33.33
ATLANTIC MENHADEN	7.5	1	.	100.00	.	1	0.00	0.00
MUMMICHOG	3.3	6	.	100.00	5	1	83.33	83.33
MUMMICHOG	7.5	1	.	100.00	1	.	100.00	100.00
MUMMICHOG	15.0	32	1	96.97	32	.	100.00	96.97
NORTHERN PIPEFISH	7.5	.	1	0.00	.	.	.	.
POLLOCK	7.5	7	.	100.00	1	6	14.29	14.29
POLLOCK	15.0	.	1	0.00	.	.	.	.
AMERICAN SAND LANCE	3.3	2	.	100.00	1	1	50.00	50.00
SCULPIN (LONGHORN + GRUBBY)	7.5	3	.	100.00	2	1	66.67	66.67
ATLANTIC HERRING	7.5	2	.	100.00	.	2	0.00	0.00
ATLANTIC HERRING	15.0	.	1	0.00	.	.	.	.
RAINBOW SMELT	3.3	18	9	66.67	1	17	5.56	3.70
RAINBOW SMELT	7.5	28	1	96.55	1	26	3.70	3.58
RAINBOW SMELT	15.0	46	3	93.88	2	44	4.35	4.08
NORTHERN SEAROBIN	7.5	2	.	100.00	2	.	100.00	100.00
THREE-SPINE STICKLEBACK	3.3	1	.	100.00	1	.	100.00	100.00
THREE-SPINE STICKLEBACK	15.0	1	.	100.00	1	.	100.00	100.00
TAUTOG	7.5	1	.	100.00	.	1	0.00	0.00
ATLANTIC TOMCOD	3.3	2	1	66.67	.	2	0.00	0.00
ATLANTIC TOMCOD	7.5	2	1	66.67	1	1	50.00	33.33
ATLANTIC TOMCOD	15.0	1	.	100.00	.	1	0.00	0.00
WHITE PERCH	7.5	6	.	100.00	1	5	16.67	16.67

TABLE 3

RESULTS OF WINTER TESTING

IMPINGEMENT SURVIVAL STUDY
MYSTIC STATION - UNIT NO. 7
BOSTON EDISON COMPANY

SPECIES NAME		SPEED	INITIAL NUMBER LIVE	INITIAL NUMBER DEAD	INITIAL % SURVIVAL	96-HOUR NUMBER LIVE	96-HOUR NUMBER DEAD	LATENT % SURVIVAL	OVERALL % SURVIVAL (INITIAL X LATENT)
ALOSA (ALEWIFE + BLUEBACK)		3.3	9	.	100.00	.	9	0.00	0.00
ALOSA (ALEWIFE + BLUEBACK)		10.0	4	.	100.00	.	4	0.00	0.00
ALOSA (ALEWIFE + BLUEBACK)		15.0	2	1	66.67	1	1	50.00	33.33
WINTER FLOUNDER		3.3	126	1	99.21	119	3	97.54	96.77
WINTER FLOUNDER		10.0	301	.	100.00	153	.	100.00	100.00
WINTER FLOUNDER		15.0	144	1	99.31	142	1	99.30	98.62
POLLOCK		3.3	4	.	100.00	1	3	25.00	25.00
POLLOCK		10.0	3	.	100.00	.	3	0.00	0.00
POLLOCK		15.0	19	.	100.00	3	16	15.79	15.79
POLLOCK	(SMALL)	3.3	11	.	100.00	.	10	0.00	0.00
POLLOCK	(SMALL)	10.0	8	.	100.00	.	8	0.00	0.00
POLLOCK	(SMALL)	15.0	47	1	97.92	12	30	28.57	27.98
SCULPIN (LONGHORN + GRUBBY)		3.3	8	1	88.89	8	.	100.00	88.89
SCULPIN (LONGHORN + GRUBBY)		10.0	17	.	100.00	16	.	100.00	100.00
SCULPIN (LONGHORN + GRUBBY)		15.0	16	.	100.00	12	.	100.00	100.00
ATLANTIC HERRING		15.0	1	.	100.00	1	.	100.00	100.00
HICKORY SHAD		3.3	1	.	100.00	.	1	0.00	0.00
ATLANTIC SILVERSIDE		3.3	3	.	100.00	.	3	0.00	0.00
RAINBOW SMELT		3.3	151	4	97.42	17	134	11.26	10.97
RAINBOW SMELT		10.0	31	1	96.88	10	21	32.26	31.25
RAINBOW SMELT		15.0	132	3	97.78	54	78	40.91	40.00
RAINBOW SMELT	(SMALL)	3.3	173	9	95.05	41	132	23.70	22.53
RAINBOW SMELT	(SMALL)	10.0	60	.	100.00	35	25	58.33	58.33
RAINBOW SMELT	(SMALL)	15.0	268	6	97.81	116	54	68.24	66.74
SPOTTED HAKE		3.3	2	1	66.67	2	.	100.00	66.67
THREE-SPINE STICKLEBACK		3.3	3	1	75.00	2	.	100.00	75.00
THREE-SPINE STICKLEBACK		15.0	8	.	100.00	5	.	100.00	100.00
ATLANTIC TOMCOD		3.3	15	.	100.00	13	2	86.67	86.67
ATLANTIC TOMCOD		10.0	8	.	100.00	6	2	75.00	75.00
ATLANTIC TOMCOD		15.0	15	.	100.00	11	1	91.67	91.67
WHITE PERCH		3.3	5	.	100.00	.	5	0.00	0.00
WINDOWPANE		15.0	1	.	100.00	.	.	.	.

TABLE 5

RESULTS OF SPRING TESTING

IMPINGEMENT SURVIVAL STUDY
MYSTIC STATION - UNIT NO. 7
BOSTON EDISON COMPANY

SPECIES NAME	SPEED	INITIAL NUMBER LIVE	INITIAL NUMBER DEAD	INITIAL % SURVIVAL	96-HOUR NUMBER LIVE	96-HOUR NUMBER DEAD	LATENT % SURVIVAL	OVERALL % SURVIVAL (INITIAL X LATENT)
ALOSA (ALEWIFE + BLUEBACK)	3.3	1	.	100.00	.	1	0.00	0.00
ALOSA (ALEWIFE + BLUEBACK)	15.0	3	.	100.00	.	3	0.00	0.00
AMERICAN EEL	15.0	5	.	100.00	3	1	75.00	75.00
WINTER FLOUNDER	3.3	2	.	100.00	.	2	0.00	0.00
WINTER FLOUNDER	15.0	5	.	100.00	4	1	80.00	80.00
ATLANTIC MENHADEN	15.0	1	.	100.00	.	1	0.00	0.00
NORTHERN PIPEFISH	3.3	1	.	100.00	1	.	100.00	100.00
NORTHERN PIPEFISH	15.0	3	.	100.00	2	.	100.00	100.00
RAINBOW SMELT	3.3	8	.	100.00	.	8	0.00	0.00
RAINBOW SMELT	15.0	13	.	100.00	1	12	7.69	7.69
THREE-SPINE STICKLEBACK	3.3	2	.	100.00	2	.	100.00	100.00
THREE-SPINE STICKLEBACK	15.0	11	.	100.00	11	.	100.00	100.00
ATLANTIC TOMCOD	3.3	.	1	0.00	.	.	.	.
WHITE PERCH	15.0	.	1	0.00	.	.	.	.

PRELIMINARY INVESTIGATIONS INTO THE USE OF A CONTINUOUSLY OPERATING FINE MESH TRAVELING SCREEN TO REDUCE ICHTHYOPLANKTON ENTRAINMENT AT INDIAN POINT GENERATING STATION

Prepared for:

Consolidated Edison Company of New York, Inc.
4 Irving Place
New York, New York 10003

Prepared by:

Ecological Analysts, Inc.
R.D. 2 Goshen Turnpike
Middletown, New York 10940

December 1977

TABLE A-1 NUMBERS OF FISH LARVAE AND JUVENILES SURVIVING TO 96 HOURS AFTER IMPINGEMENT ON A CONTINUOUSLY OPERATING FINE MESH TRAVELING SCREEN INCLUDING EFFECTS ASSOCIATED WITH SAMPLE COLLECTION AND HANDLING

Species Name	Initial L[a]	Initial S[b]	Initial D[c]	3-hr L	3-hr S	6-hr L	6-hr S	12-hr L	12-hr S	24-hr L	24-hr S	48-hr L	48-hr S	72-hr L	72-hr S	96-hr L	96-hr S
Larvae																	
Morone saxatilis	53	17	33	52	10	52	10	52	10	51	0	49	0	49	0	48	0
Morone americana	3	0	4	2	0	2	0	2	0	2	0	1	0	1	0	1	0
Morone species	1	4	4	1	4	1	4	1	4	0	1	0	0	0	0	0	0
Clupeidae (family)	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Anchoa mitchilli	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juvenile																	
Morone saxatilis	16	0	0	16	0	16	0	16	0	15	0	15	0	15	0	14	0
Morone americana	1	0	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0
Morone species	1	0	0	1	0	1	0	1	0	1	0	1	0	1	0	0	0
Anchoa mitchilli	5	1	1	5	1	5	1	5	1	0	0	0	0	0	0	0	0
Pomatomus saltatrix	2	0	1	2	0	2	0	2	0	0	0	0	0	0	0	0	0
Microgadus tomcod	38	1	0	38	1	38	1	38	1	38	1	38	1	38	1	26	1
Osmerus mordax	2	4	0	2	3	2	3	2	3	1	1	1	0	1	0	1	0
Clupeidae (family)	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0

(a) L indicates live.
(b) S indicates stunned.
(c) D indicates dead.

INITIAL AND EXTENDED SURVIVAL OF FISH COLLECTED FROM A FINE MESH CONTINUOUSLY OPERATING TRAVELING SCREEN AT THE INDIAN POINT GENERATING STATION

FOR THE PERIOD
15 JUNE - 22 DECEMBER 1977

SEPTEMBER 1978

Prepared for

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.
4 Irving Place
New York, New York 10003

Jointly financed
by
Consolidated Edison Company of New York, Inc.
Orange and Rockland Utilities, Inc.
Central Hudson Gas and Electric Corporation
Power Authority of the State of New York

Prepared by

TEXAS INSTRUMENTS INCORPORATED
Science Services Division
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Dallas, Texas 75222

Table 1

Initital and Extended Survival of Young-of-the-Year Striped Bass Impinged on Continuously Operating Fine Mesh Traveling Screen at Indian Point in 1977

Test Date	Screen Wash Duration (Hrs)	Number Collected	Initial Survival (%)	Extended Survival (%) 0 Hrs	12 Hrs	36 Hrs	60 Hrs	84 Hrs
9/12	1.25	3	100	100	100	100	100	100
10/5	1.00	1	100	100	100	100	100	100
10/25*	0.50	1	100	-	-	-	-	-
11/1*	0.25	1	100	-	-	-	-	-
11/3	0.50	1	100	100	100	100	100	100
11/15	2.00	1	100	100	100	100	100	100
12/13*	1.50	1	100	-	-	-	-	-
12/15	5.00	3	33	100	100	100	100	100
12/21	0.50	1	100	100	0	-	-	-
Total	-	13						
Pooled estimate			85	100	88	88	88	88

*No extended survival tests conducted

Table 2

Initial and Extended Survival of Young-of-the-Year White Perch Impinged on Continuously Operating Fine Mesh Traveling Screen at Indian Point in 1977

Test Date	Screen Wash Duration (Hrs)	Number Collected	Initial Survival (%)	Extended Survival (%)				
				0 Hrs	12 Hrs	36 Hrs	60 Hrs	84 Hrs
10/5	1.00	8	100	100	100	100	100	100
10/25*	0.50	6	100	-	-	-	-	-
11/1*	0.25	1	100	-	-	-	-	-
11/3	0.50	10	100	100	100	100	100	100
11/8	0.50	10	100	100	100	100	100	90
11/17	2.00	7	71	100	100	100	100	100
12/13	1.50	16	69	100	NC	64	64	45
12/15	5.00	164	27	100	100	51	40	33
12/16	1.50	1	100	100	100	100	100	100
12/21	0.50	2	100	100	100	50	50	50
12/22	0.75	3	100	100	100	0	-	-
Total	-	228						
Pooled estimate			45	100	100	68	63	57

NC = Not checked

*No extended survival tests conducted

Table 3

Initial and Extended Survival of Yearling and Older White Perch Impinged on Continuously Operating Fine Mesh Traveling Screen at Indian Point in 1977

Test Date	Screen Wash Duration (Hrs)	Number Collected	Initial Survival (%)	Extended Survival (%) 0 Hrs	12 Hrs	36 Hrs	60 Hrs	84 Hrs
6/15	1.00	1	0	-	-	-	-	-
11/3	0.50	1	100	100	100	100	100	100
12/13	1.50	15	67	100	NC	80	80	50
12/15	5.00	14	0	-	-	-	-	-
12/16	1.50	5	60	100	100	0	-	-
12/22	0.75	1	100	100	100	0	-	-
Total	-	37						
Pooled estimate			41	100	100	60	60	40

NC = Not checked

Table 6

Initial and Extended Survival of Young-of-the-Year and Yearling and Older Atlantic Tomcod Impinged on Continuously Operating Fine Mesh Traveling Screen at Indian Point in 1977

Age Class	Test Date	Screen Wash Duration (Hrs)	Number Collected	Initial Survival (%)	Extended Survival (%) 0 Hrs	12 Hrs	36 Hrs	60 Hrs	84 Hrs
Young-of-the-Year	6/15	1.00	37	84	100	94	87	NC	19
	9/12	1.25	1	100	100	100	100	100	100
	12/13	1.50	3	100	100	NC	67	67	67
	12/16	1.50	1	100	100	100	100	100	100
	12/21	0.50	31	100	100	97	97	97	97
	12/22	0.75	5	100	100	100	100	100	100
	Total		78						
	Pooled estimate			92	100	96	92	92	62
Yearling & Older	9/12*	1.25	1	100	-	-	-	-	-
	12/16	1.50	1	100	100	100	100	100	100
	Total	-	2						
	Pooled estimate			100	100	100	100	100	100

NC = Not checked
*No extended survival tests conducted

Table 7

Initial and Extended Survival of Young-of-the-Year Atlantic Tomcod in June and December, 1977. G-Test Indicated that Survival Was Affected By Month ($p < 0.005$)

Month	Holding Duration	Survival Alive	Dead	%
Jun	Initial	31	6	84
	Extended	6	25	19
Dec	Initial	40	0	100
	Extended	38	2	95

Table 8

Initial and Extended Survival of Young-of-the-Year and Yearling and Older Blueback Herring Impinged on Continuously Operating Fine Mesh Traveling Screen at Indian Point in 1977

Age Class	Test Date	Screen Wash Duration (Hrs)	Number Collected	Initial Survival (%)	Extended Survival (%) 0 Hrs	12 Hrs	36 Hrs	60 Hrs	84 Hrs
Young-of-the-Year	9/12	1.25	11	82	100*	100	50	0	-
	10/25	0.50	152	100	100**	53	38	29	13
	11/1	0.25	40	85	100	2	2	2	2
	11/3	0.50	158	96	100	66	35	22	16
	11/8	0.50	28	100	100	68	54	50	36
	11/15***	2.00	12	100	-	-	-	-	-
	11/17	2.00	78	73	86	NC	82	81	81
	Total	-	479						
	Pooled estimate			93	98	61	42	34	25
Yearling & Older	9/12	1.25	1	100	100	100	0	-	-

NC = Not Checked

*4 fish held for extended survival tests

**100 fish held for extended survival tests

***No extended survival tests conducted

Table 9

Initial and Extended Survival of Young-of-the-Year Bay Anchovy Impinged on Continuously Operating Fine Mesh Traveling Screen at Indian Point in 1977

Test Date	Screen Wash Duration (Hrs)	Number Collected	Initial Survival (%)	Extended Survival (%) 0 Hrs	12 Hrs	36 Hrs	60 Hrs	84 Hrs
9/8	1.00	334	34	91	6	1	0	0
9/12	1.25	330	67	88*	53	20	9	0
9/21	1.80	166	71	92	52	26	20	15
9/26	2.50	986	9	49	0	-	-	-
10/5	1.00	597	11	38	5	5	5	0
10/25	0.50	1	0	-	-	-	-	-
11/3	0.50	1	0	-	-	-	-	-
Total	-	2415						
Pooled estimate			25	76	26	11	8	4

*85 fish held for extended survival tests

Table 10

Initial and Extended Survival of Yearling and Older Bay Anchovy Impinged on Continuously Operating Fine Mesh Traveling Screen at Indian Point in 1977

Test Date	Screen Wash Duration (Hrs)	Number Collected	Initial Survival (%)	Extended Survival (%) 0 Hrs	12 Hrs	36 Hrs	60 Hrs	84 Hrs
6/15	1.00	8	62	100	60	20	20	20
9/8	1.00	3	0	-	-	-	-	-
9/12	1.25	7	86	100*	100	67	67	33
9/21	1.80	23	91	100	86	57	43	29
9/26	2.50	15	13	100	100	100	0	-
10/5	1.00	9	22	100	50	50	50	0
Total	-	65						
Pooled estimate			55	100	82	55	39	24

*3 fish held for extended survival tests

Table 11

Initial and Extended Survival of Impinged Young-of-the-Year and Adult Bay Anchovy for All Tests Combined. G-Test Indicated That Survival Was Affected by Age ($p < .005$)

Age	Holding Duration	Survival Alive	Survival Dead	Survival %
Young-of-the-Year	Initial	600	1815	25
	Extended	18	446	4
Adult	Initial	36	29	55
	Extended	8	25	24

Table 12

Initial and Extended Survival of Young-of-the-Year Alewife Impinged on Continuously Operating Fine Mesh Traveling Screen at Indian Point in 1977

Test Date	Screen Wash Duration (Hrs)	Number Collected	Initial Survival (%)	Extended Survival (%) 0 Hrs	12 Hrs	36 Hrs	60 Hrs	84 Hrs
9/8	1.00	5	40	100	50	50	0	-
9/21	1.80	16	88	93	93	93	86	14
9/26	2.50	23	30	100	71	71	0	-
10/5	1.00	21	62	77	54	54	54	0
10/25	0.50	27	100	100	70	41	15	11
11/1	0.25	4	50	100	0	-	-	-
11/3	0.50	2	100	100	50	0	-	-
11/17	2.00	4	75	67	NC	33	33	33
Total	-	102						
Pooled estimate			69	93	69	54	34	9

NC = Not checked

Table 13

Initial and Extended Survival of Young-of-the-Year American Shad Impinged on Continuously Operating Fine Mesh Traveling Screen at Indian Point in 1977

Test Date	Screen Wash Duration (Hrs)	Number Collected	Initial Survival (%)	Extended Survival (%) 0 Hrs	12 Hrs	36 Hrs	60 Hrs	84 Hrs
10/25	0.50	2	100	100	100	50	0	-
11/1	0.25	1	100	100	100	100	100	0
11/3*	0.50	1	100	-	-	-	-	-
Total	-	4						
Pooled estimate			100	100	100	67	33	0

*No extended survival tests conducted

Table 14

Initial and Extended Survival for Other Species with Relatively High Survival After Impingement on Continuously Operating Fine Mesh Traveling Screen at Indian Point in 1977.

Species	Numbers Collected All Tests	Life Stage*	Initial Survival (%)	Extended Tests No. Tested	Extended Tests Survival (% at 84 hr)
Hogchoker	4	1	100	2	100
American Eel	4	2	100	2	100
Banded Killifish	1	1	100	**	**
White Catfish	29	1	100	29	100
Spottail Shiner	2	1	100	2	100
Centrarchids	5	1	100	5	80
Sea Lamprey	1	1	100	1	100
Largemouth Bass	1	1	100	1	100
Yellow Perch	1	1	100	1	100
Weakfish	3	1	67	1	100
Total	47			44	
Pooled estimate			98		98

*Life Stage 1 = Young-of-the-Year
2 = Yearling and Older
**No extended survival tests conducted

Table 15

Initial and Extended Survival for Other Speces with Relatively Low Survival After Impingement on Continuously Operating Fine Mesh Traveling Screen at Indian Point in 1977.

Species	Numbers Collected All Tests	Life Stage*	Initial Survival (%)	Extended Tests No. Tested	Extended Tests Survival (% at 84 hr)
Bluefish	4	1	100	4	0
Rainbow Smelt	4	2	25	**	**
Rainbow Smelt	20	1	10	2	0
Northern Pipefish	1	1	0	**	**
Menhaden	1	1	100	**	**
Gizzard Shad	5	2	100	5	0
Unidentified Clupeids	80	1	51	**	**
Total	115			11	(For Species
Pooled estimate			47		0 Tested)

*Life Stage 1 = Young-of-the-Year
2 = Yearling and Older

**No extended survival tests conducted

COLLECTION EFFICIENCY AND SURVIVAL ESTIMATES OF FISH IMPINGED ON A FINE MESH CONTINUOUSLY OPERATING TRAVELING SCREEN AT THE INDIAN POINT GENERATING STATION FOR THE PERIOD 8 AUGUST TO 10 NOVEMBER 1978

FEBRUARY 1979

Prepared for

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.
4 Irving Place
New York, New York 10003

Jointly financed
by
Consolidated Edison Company of New York, Inc.
Orange and Rockland Utilities, Inc.
Central Hudson Gas and Electric Corporation
Power Authroity of the State of New York

Prepared by

TEXAS INSTRUMENTS INCORPORATED
Science Services Division
P.O. Box 5621
Dallas, Texas 75222

Table [illegible]

Initial, Extended, and Overall Survival of Juvenile and Yearling and Older Fishes Impinged on Continuously Operating Fine Mesh Traveling Screen in 1978

Species	(Life Stage)*	Test Date†	Number Impinged	Initial Survival(%)	Number Held for Extended Survival Tests	Extended Survival(%) 0Hrs	24Hrs	48Hrs	96Hrs	Overall Survival(%)
Striped Bass	(1)	10/31	1	100	1	100	100	NC	0	0
White Perch	(1)	10/31	22	100	22	100	100	100	100	100
		11/10	11	100	11	100	100	100	100	100
		Pooled Estimate	33	100	33	100	100	100	100	100
White Perch	(2)	10/31	4	100	4	100	100	100	100	100
Blueback Herring	(1)	10/31	44	41	18	100	17	NC	11	5
		11/10	6	67	4	100	75	75	25	17
		Pooled Estimate	50	44	22	100	27	--	14	6
Alewife		10/31	6	67	4	100	50	NC	0	0
		11/10	1	100	1	100	100	100	0	0
		Pooled Estimate	7	71	5	100	60	--	0	0
Bay Anchovy	(1)	10/31	12	0						0
		11/10	4	0						0
		Pooled Estimate	16	0						0
Bay Anchovy	(2)	10/31	1	0						0
Hogchoker	(2)	10/31	1	100	1	100	100	100	100	100
White Catfish	(2)	10/31	2	100	2	100	100	100	100	100
Rainbow Smelt	(2)	10/31	2	50	1	100	100	NC	0	0
Weakfish	(1)	10/31	1	100	1	100	0	--	--	0
Totals (Pooled Estimates)			118	59	70	100	74	--	61	36

*(1) = Juvenile, (2) = Yearling and Older

† = 10/31 - based on 4-hrs of screen washing - 2 tests run for 2-hrs each
11/10 - based on 2-hrs of screen washing

NC = not checked

EA Report CON84G

EVALUATION OF THE EFFECTIVENESS OF A CONTINUOUSLY OPERATING FINE MESH TRAVELING SCREEN FOR REDUCING ICHTHYOPLANKTON ENTRAINMENT AT THE INDIAN POINT GENERATING STATION

Prepared for:

Central Hudson Gas & Electric Corporation
Consolidated Edison Company of New York, Inc.
Orange and Rockland Utilities, Inc.
Power Authority of the State of New York

Prepared by:

Ecological Analysts, Inc.
R.D. 2 Goshen Turnpike
Middletown, New York 10940

April 1979

TABLE A-2 NUMBER AND CONDITION OF WILD FISH LARVAE AND JUVENILES COLLECTED, AND SURVIVAL TO 96 HOURS AFTER IMPINGEMENT, ON A CONTINUOUSLY OPERATING FINE MESH TRAVELING SCREEN, INCLUDING EFFECTS ASSOCIATED WITH SAMPLE COLLECTION AND HOLDING, INDIAN POINT GENERATING STATION, 6 JUNE - 20 JULY 1978

	Initial Survival[a]			Number of Specimens Alive After Indicated Time Period													
				3 Hr		6 Hr		12 Hr		24 Hr		48 Hr		72 Hr		96 Hr	
	L	S	D	L[b]	S[c]	L	S	L	S	L	S	L	S	L	S	L	S
Larvae																	
Morone americana	0	0	13	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M. saxatilis	0	0	15	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Morone spp.	0	0	8	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Alosa spp.	0	0	62	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Anchoa mitchilli	0	0	65	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Conger oceanicus	1	0	0	1	--	1	--	1	--	0	--	0	--	0	--	0	--
Osmerus mordax	0	0	4	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Unidentified	0	0	4	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Juveniles																	
Morone americana	9(5)	2(2)	3	5	2	5	2	5	1	5	1	4	1	4	1	4	1
M. saxatilis	24(23)	3(2)	8	23	2	22	2	19	2	17	0	17	0	15	0	15	0
Alosa aestivalis	167(126)	13(9)	54	60	2	33	1	15	1	3	0	2	0	1	0	1	0
A. sapidissima	16(10)	4(3)	3	3	1	2	0	1	0	0	0	0	0	0	0	0	0
A. pseudoharengus	5(3)	1(0)	1	2	--	1	--	0	--	0	--	0	--	0	--	0	--
Clupeid spp.	0	0	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Microgadus tomcod	6(6)	3(3)	1	6	2	4	2	3	1	1	0	0	0	0	0	0	0
Ictalurus catus	1(1)	0	0	1	--	1	--	1	--	1	--	1	--	1	--	1	--
Osmerus mordax	2(2)	31(25)	87	1	5	0	1	0	0	0	0	0	0	0	0	0	0
Etheostoma olmstedi	7(7)	0	0	7	--	7	--	7	--	7	--	7	--	7	--	7	--
Cynoscion regalis	6(4)	2(2)	1	4	2	3	0	0	0	0	0	0	0	0	0	0	0
Syngnathus fuscus	0	0	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--

(a) Numbers in parentheses indicate the number of specimens used for latent effects determinations.
(b) Data are for specimens that were initially alive.
(c) Data are for specimens that were initially stunned.

Note: Dashes (--) indicate no data.

APPENDIX C

Summary of results from the Oswego and Danskammer angled screen studies.

Table C-1, taken from LMS (1984), summarizes the results of angled screen tests for species of greatest interest at the Oswego Station. Total plant efficiency is calculated as the product of the percentage of fish diverted and the percentage of fish surviving for 96 hours, corrected for initial mortality.

Table C-2 summarizes mortality data from the 1981 and 1982 ESEERCO sponsored studies at Danskammer. These preliminary values were compiled from periodic data summaries prepared by the ESEERCO contractor and do not reflect any adjustments for handling mortality (i.e. controls). The final report on those studies has not yet been completed.

TABLE 5.0-1

MONTHLY TOTAL PLANT EFFICIENCY BY SPECIES

Oswego Steam Station Unit 6 - April 1981 - March 1983

MONTH	AW <10 cm	AW >10 cm	RSM <10 cm	RSM >10 cm	WP <13 cm	WP >13 cm	EMSH	STSH	GSD	YP	SMB	TSB	MOTS
Apr 1981	13.3	22.6	23.8	64.6	45.7	57.2	80.1	76.4	52.0	90.5	88.2	6.6	38.0
May	1.0	1.6	22.1	0									
Jun	1.9	7.4	22.1	20.4									
Jul	2.7	25.7	18.4	20.4									
Aug	1.2	2.5	18.4	20.4									
Sep	1.9	5.5	12.2	17.0									
Oct	15.8	45.2	23.7	32.3									
Nov	16.1	27.4	11.7	20.6									
Dec	13.8	26.6	5.0	20.7									
Jan 1982	0	0	4.2	44.7									
Feb	3.0	7.4	3.1	38.3									
Mar	3.0	3.4	5.0	46.3	45.7	57.2	80.1	76.4	52.0	90.5	88.2	6.6	38.0
Apr	0	6.0	7.6	57.8	43.8	54.8	62.4	67.2	43.5	81.4	78.3	7.5	54.8
May	0	5.9	7.1	32.7									
Jun	0.7	3.1	3.8	17.4									
Jul	0.7	4.3	3.8	14.1									
Aug	1.1	4.2	4.8	17.8									
Sep	0.9	7.5	6.1	24.6									
Oct	0.4	11.8	7.8	20.4									
Nov	2.0	55.8	11.1	21.7									
Dec	1.4	55.8	20.4	21.1									
Jan 1983	1.4	55.8	16.4	16.9									
Feb	1.4	55.8	16.4	16.9									
Mar	1.0	41.5	18.5	19.1	43.8	54.8	62.4	67.2	43.5	81.4	78.3	7.5	54.8

AW - Alewife
RSM - Rainbow smelt
WP - White perch
EMSH - Emerald shiner
STSH - Spottail shiner
GSD - Gizzard shad
YP - Yellow perch
SMB - Smallmouth bass
TSB - Threespine stickleback
MOTS - Mottled sculpin

X ► Combined across months during periods of low abundance.

eason = Spring		NUMBER & CONDITION OF FISH @ OBSERVATION HOUR...							
pecies		0 DEAD	12 DEAD	18 DEAD	36 DEAD	84 DEAD	96 DEAD	CUMULATIVE NUMBER & PERCENT DEAD AT 96 HOURS	TOTAL NUMBER TESTED FOR LATENT EFFECTS
lewife	Number	1	6	4	3	11	1	26	63
	%	1.59	9.52	6.35	4.76	17.46	1.59		
	Cum %	1.59	11.11	17.46	22.22	39.68		41.27	
tlantic omcod	Number	1	20	5	1	3	2	32	76
	%	1.32	26.32	6.58	1.32	3.95	2.64		
	Cum %	1.32	27.62	34.21	35.53	39.47		42.11	
ay nchovy	Number	1	2	0	0	0	0	3	3
	%	33.33	66.67	0	0	0	0		
	Cum %	33.33	100.00	100	100	100		100	
lueback erring	Number	1	2	1	2	1	0	7	7
	%	14.29	28.57	14.29	28.57	14.29	0		
	Cum %	14.29	42.86	57.14	85.71	100.00		100	
umpkin- eed	Number	3	2	1	2	6	1	15	162
	%	1.85	1.23	0.62	1.23	3.70	0.62		
	Cum %	1.85	3.09	3.70	4.94	8.64		9.26	
pottail hiner	Number	0	1	2	1	26	9	39	328
	%	0	0.30	0.61	0.30	7.93	2.74		
	Cum %	0	0.30	0.91	1.22	9.15		11.89	
triped ass	Number	0	0	0	0	0	0	0	31
	%	0	0	0	0	0	0		
	Cum %	0	0	0	0	0		0	
hite erch	Number	23	33	14	31	89	33	223	1383
	%	1.66	2.39	1.01	2.24	6.44	2.39		
	Cum %	1.66	4.05	5.06	7.30	13.74		16.13	
TOTAL		30	66	27	40	136	46	345	2053

SUMMARY OF 1981 AND 1982 DANSKAMMER POINT BYPASSED FISH MORTALITY DATA

Season = Fall		NUMBER & CONDITION OF FISH @ OBSERVATION HOUR....							
Species		0 DEAD	12 DEAD	18 DEAD	36 DEAD	84 DEAD	96 DEAD	CUMULATIVE NUMBER & PERCENT DEAD AT 96 HOURS	TOTAL NUMBER TESTED FOR LATENT EFFECTS
Alewife	Number	8	100	6	10	22	2	148	
	%	4.79	59.88	3.59	5.99	13.17	1.20		167
	Cum %	4.79	64.67	68.26	74.25	87.43		88.62	
Atlantic Tomcod	Number	1	2	2	1	4	1	11	
	%	0.79	1.57	1.57	0.79	3.15	0.79		127
	Cum %	0.79	2.36	3.94	4.72	7.87		8.66	
Bay Anchovy	Number	591	1210	18	5	6	0	1830	
	%	32.24	66.01	0.98	0.27	0.33	0		1833
	Cum %	32.24	198.25	99.24	99.51	99.84		99.84	
Blueback Herring	Number	121	1152	85	60	71	35	1524	
	%	6.84	65.08	4.80	3.39	4.01	1.98		1770
	Cum %	6.84	71.92	76.72	80.11	184.12		86.10	
Pumpkin-seed	Number	0	0	0	0	0	0	0	
	%	0	0	0	0	0	0		21
	Cum %	0	0	0	0	0		0	
Spottail Shiner	Number	0	3	1	0	3	1	8	
	%	0	7.89	2.63	0	7.89	2.63		38
	Cum %	0	7.89	10.53	10.53	18.42		21.05	
Striped Bass	Number	1	3	1	0	4	0	9	
	%	3.23	9.68	3.23	0	12.90	0		31
	Cum %	3.23	12.90	16.13	16.13	29.03		29.03	
White Perch	Number	43	45	15	17	63	10	193	
	%	3.40	3.55	1.18	1.34	4,98	0.78		1266
	Cum %	3.40	6.95	8.14	9.48	14.45		15.24	
TOTAL		765	2515	128	93	173	49	3723	5253

ENCLOSURE 5 TO NL-07-156

Entrainment Abundance Data 1981, 1983, 1985-1987

ENTERGY NUCLEAR OPERATIONS, INC.
INDIAN POINT NUCLEAR GENERATING UNIT NOS. 2 & 3
DOCKET NOS. 50-247 and 50-286

SP_CODE	LIF_STAG	year	WEEK	meandensi	sedensity	startdate	enddate	nsamples	Unit2Flow	Unit3Flow
4007	3	1981	18	0.891742	0.891742	6-May-81	9-May-81	14	0.529958	1.771426
7915	3	1981	18	3.449205	1.969967	6-May-81	9-May-81	14	0.529958	1.771426
7915	5	1981	18	29.78625	12.58308	6-May-81	9-May-81	14	0.529958	1.771426
10501	0	1981	18	0.895095	0.895095	6-May-81	9-May-81	14	0.529958	1.771426
10504	0	1981	18	0.851354	0.851354	6-May-81	9-May-81	14	0.529958	1.771426
10976	1	1981	18	4.30528	2.972839	6-May-81	9-May-81	14	0.529958	1.771426
10976	3	1981	18	0.880747	0.880747	6-May-81	9-May-81	14	0.529958	1.771426
18005	5	1981	18	0.895095	0.895095	6-May-81	9-May-81	14	0.529958	1.771426
99799	9	1981	18	2.59445	1.860328	6-May-81	9-May-81	14	0.529958	1.771426
4000	3	1981	19	19.0888	15.38381	10-May-81	16-May-81	7	0.529958	1.997846
4006	1	1981	19	3.389833	2.188389	10-May-81	16-May-81	7	0.529958	1.997846
4007	0	1981	19	1.632653	1.632653	10-May-81	16-May-81	7	0.529958	1.997846
4007	3	1981	19	15.18545	7.097083	10-May-81	16-May-81	7	0.529958	1.997846
6199	1	1981	19	1.632653	1.632653	10-May-81	16-May-81	7	0.529958	1.997846
7915	3	1981	19	1.755002	1.755002	10-May-81	16-May-81	7	0.529958	1.997846
7915	5	1981	19	20.65786	12.03631	10-May-81	16-May-81	7	0.529958	1.997846
10500	9	1981	19	3.389833	2.188389	10-May-81	16-May-81	7	0.529958	1.997846
10501	1	1981	19	3.427802	2.213527	10-May-81	16-May-81	7	0.529958	1.997846
10501	3	1981	19	1.717033	1.717033	10-May-81	16-May-81	7	0.529958	1.997846
10504	0	1981	19	1.6728	1.6728	10-May-81	16-May-81	7	0.529958	1.997846
10504	1	1981	19	6.868132	6.868132	10-May-81	16-May-81	7	0.529958	1.997846
10943	1	1981	19	5.171133	3.624355	10-May-81	16-May-81	7	0.529958	1.997846
10943	3	1981	19	1.66113	1.66113	10-May-81	16-May-81	7	0.529958	1.997846
10976	1	1981	19	6.853269	3.541646	10-May-81	16-May-81	7	0.529958	1.997846
10976	3	1981	19	1.6728	1.6728	10-May-81	16-May-81	7	0.529958	1.997846
99799	0	1981	19	1.690617	1.690617	10-May-81	16-May-81	7	0.529958	1.997846
99799	9	1981	19	34.34486	17.68513	10-May-81	16-May-81	7	0.529958	1.997846
4000	3	1981	20	47.99252	10.35399	18-May-81	22-May-81	16	0.746304	2.225822
4007	0	1981	20	0.733568	0.733568	18-May-81	22-May-81	16	0.746304	2.225822
4007	3	1981	20	189.6435	41.46286	18-May-81	22-May-81	16	0.746304	2.225822
6199	1	1981	20	2.959271	1.324988	18-May-81	22-May-81	16	0.746304	2.225822
7915	5	1981	20	0.72759	0.72759	18-May-81	22-May-81	16	0.746304	2.225822
10500	3	1981	20	2.923055	1.693606	18-May-81	22-May-81	16	0.746304	2.225822
10500	9	1981	20	30.21614	12.7399	18-May-81	22-May-81	16	0.746304	2.225822
10501	0	1981	20	2.208529	1.187355	18-May-81	22-May-81	16	0.746304	2.225822
10501	1	1981	20	13.27576	3.963179	18-May-81	22-May-81	16	0.746304	2.225822
10501	3	1981	20	184.5533	53.88793	18-May-81	22-May-81	16	0.746304	2.225822
10504	0	1981	20	2.315262	1.686574	18-May-81	22-May-81	16	0.746304	2.225822
10504	1	1981	20	32.30669	10.72306	18-May-81	22-May-81	16	0.746304	2.225822
10504	3	1981	20	10.87672	4.958796	18-May-81	22-May-81	16	0.746304	2.225822
10943	1	1981	20	3.080808	1.787586	18-May-81	22-May-81	16	0.746304	2.225822
10943	3	1981	20	4.579247	1.527527	18-May-81	22-May-81	16	0.746304	2.225822
10976	3	1981	20	2.292172	1.677773	18-May-81	22-May-81	16	0.746304	2.225822
99799	0	1981	20	1.467136	1.467136	18-May-81	22-May-81	16	0.746304	2.225822
99799	9	1981	20	59.31113	9.258194	18-May-81	22-May-81	16	0.746304	2.225822
4000	3	1981	21	53.31887	12.2901	27-May-81	30-May-81	16	2.604679	2.225822
4006	3	1981	21	0.71347	0.71347	27-May-81	30-May-81	16	2.604679	2.225822
4007	3	1981	21	178.7835	60.63165	27-May-81	30-May-81	16	2.604679	2.225822
6199	1	1981	21	1.502439	1.026374	27-May-81	30-May-81	16	2.604679	2.225822
7915	5	1981	21	0.7259	0.7259	27-May-81	30-May-81	16	2.604679	2.225822
10500	3	1981	21	23.93602	11.19271	27-May-81	30-May-81	16	2.604679	2.225822

10500	9	1981	21	88.12513	19.39336	27-May-81	30-May-81	16	2.604679	2.225822
10501	0	1981	21	0.744048	0.744048	27-May-81	30-May-81	16	2.604679	2.225822
10501	1	1981	21	3.652172	1.752687	27-May-81	30-May-81	16	2.604679	2.225822
10501	3	1981	21	402.9024	75.42862	27-May-81	30-May-81	16	2.604679	2.225822
10504	1	1981	21	76.49122	18.59062	27-May-81	30-May-81	16	2.604679	2.225822
10504	3	1981	21	194.0295	36.6815	27-May-81	30-May-81	16	2.604679	2.225822
10943	1	1981	21	2.899338	1.663874	27-May-81	30-May-81	16	2.604679	2.225822
10943	3	1981	21	0.747608	0.747608	27-May-81	30-May-81	16	2.604679	2.225822
10976	3	1981	21	0.744048	0.744048	27-May-81	30-May-81	16	2.604679	2.225822
99799	0	1981	21	0.744048	0.744048	27-May-81	30-May-81	16	2.604679	2.225822
99799	3	1981	21	0.744048	0.744048	27-May-81	30-May-81	16	2.604679	2.225822
99799	9	1981	21	58.06806	8.149595	27-May-81	30-May-81	16	2.604679	2.225822
4000	3	1981	22	21.51697	5.629395	1-Jun-81	4-Jun-81	16	2.572503	2.602281
4006	3	1981	22	1.554726	1.554726	1-Jun-81	4-Jun-81	16	2.572503	2.602281
4007	3	1981	22	88.52264	17.67054	1-Jun-81	4-Jun-81	16	2.572503	2.602281
6199	1	1981	22	1.542357	1.053669	1-Jun-81	4-Jun-81	16	2.572503	2.602281
7915	5	1981	22	0.7414	0.7414	1-Jun-81	4-Jun-81	16	2.572503	2.602281
10500	3	1981	22	74.94421	18.64175	1-Jun-81	4-Jun-81	16	2.572503	2.602281
10500	9	1981	22	54.06245	10.75324	1-Jun-81	4-Jun-81	16	2.572503	2.602281
10501	0	1981	22	2.269517	1.653408	1-Jun-81	4-Jun-81	16	2.572503	2.602281
10501	3	1981	22	164.8519	43.29564	1-Jun-81	4-Jun-81	16	2.572503	2.602281
10504	1	1981	22	31.34545	7.623806	1-Jun-81	4-Jun-81	16	2.572503	2.602281
10504	3	1981	22	501.237	83.51749	1-Jun-81	4-Jun-81	16	2.572503	2.602281
10943	1	1981	22	3.056538	1.786109	1-Jun-81	4-Jun-81	16	2.572503	2.602281
10943	3	1981	22	0.7414	0.7414	1-Jun-81	4-Jun-81	16	2.572503	2.602281
99799	9	1981	22	19.22577	6.134267	1-Jun-81	4-Jun-81	16	2.572503	2.602281
4006	3	1981	23	0.844309	0.844309	9-Jun-81	13-Jun-81	14	2.649788	3.002095
4007	3	1981	23	4.345008	2.025726	9-Jun-81	13-Jun-81	14	2.649788	3.002095
4100	3	1981	23	1.73581	1.73581	9-Jun-81	13-Jun-81	14	2.649788	3.002095
4109	0	1981	23	21.87523	14.86159	9-Jun-81	13-Jun-81	14	2.649788	3.002095
4109	3	1981	23	0.932488	0.932488	9-Jun-81	13-Jun-81	14	2.649788	3.002095
6199	1	1981	23	0.84631	0.84631	9-Jun-81	13-Jun-81	14	2.649788	3.002095
10500	3	1981	23	59.83332	17.82689	9-Jun-81	13-Jun-81	14	2.649788	3.002095
10500	9	1981	23	22.87922	11.06751	9-Jun-81	13-Jun-81	14	2.649788	3.002095
10501	0	1981	23	4.372358	3.518862	9-Jun-81	13-Jun-81	14	2.649788	3.002095
10501	3	1981	23	21.51834	5.866621	9-Jun-81	13-Jun-81	14	2.649788	3.002095
10504	1	1981	23	5.515194	2.239829	9-Jun-81	13-Jun-81	14	2.649788	3.002095
10504	3	1981	23	177.6628	38.54906	9-Jun-81	13-Jun-81	14	2.649788	3.002095
4100	3	1981	24	50.18353	20.81402	14-Jun-81	20-Jun-81	18	2.649788	3.179746
4109	0	1981	24	2141.966	578.3552	14-Jun-81	20-Jun-81	18	2.649788	3.179746
4109	1	1981	24	1.367529	0.940059	14-Jun-81	20-Jun-81	18	2.649788	3.179746
4109	3	1981	24	145.4474	51.26771	14-Jun-81	20-Jun-81	18	2.649788	3.179746
6199	1	1981	24	0.742721	0.742721	14-Jun-81	20-Jun-81	18	2.649788	3.179746
8913	3	1981	24	2.01473	1.095114	14-Jun-81	20-Jun-81	18	2.649788	3.179746
10500	3	1981	24	11.20139	3.941456	14-Jun-81	20-Jun-81	18	2.649788	3.179746
10500	9	1981	24	4.974222	2.614347	14-Jun-81	20-Jun-81	18	2.649788	3.179746
10501	0	1981	24	4.084048	2.184963	14-Jun-81	20-Jun-81	18	2.649788	3.179746
10501	3	1981	24	11.38585	2.621338	14-Jun-81	20-Jun-81	18	2.649788	3.179746
10504	1	1981	24	0.725268	0.725268	14-Jun-81	20-Jun-81	18	2.649788	3.179746
10504	3	1981	24	122.7971	27.31842	14-Jun-81	20-Jun-81	18	2.649788	3.179746
10800	1	1981	24	0.742721	0.742721	14-Jun-81	20-Jun-81	18	2.649788	3.179746
99799	9	1981	24	1.365626	0.938343	14-Jun-81	20-Jun-81	18	2.649788	3.179746

99899	0	1981	24	0.624922	0.624922	14-Jun-81	20-Jun-81	18	2.649788	3.179746
4100	3	1981	25	55.97699	22.83133	23-Jun-81	24-Jun-81	8	2.618243	3.179746
4109	0	1981	25	17.59491	10.93398	23-Jun-81	24-Jun-81	8	2.618243	3.179746
4109	3	1981	25	302.3321	168.2323	23-Jun-81	24-Jun-81	8	2.618243	3.179746
6199	1	1981	25	1.489869	1.489869	23-Jun-81	24-Jun-81	8	2.618243	3.179746
6199	3	1981	25	1.636126	1.636126	23-Jun-81	24-Jun-81	8	2.618243	3.179746
10500	3	1981	25	106.2927	28.05062	23-Jun-81	24-Jun-81	8	2.618243	3.179746
10500	5	1981	25	1.636126	1.636126	23-Jun-81	24-Jun-81	8	2.618243	3.179746
10500	9	1981	25	4.529338	2.21606	23-Jun-81	24-Jun-81	8	2.618243	3.179746
10501	3	1981	25	124.6716	31.03542	23-Jun-81	24-Jun-81	8	2.618243	3.179746
10501	5	1981	25	6.239662	3.421578	23-Jun-81	24-Jun-81	8	2.618243	3.179746
10504	1	1981	25	1.489869	1.489869	23-Jun-81	24-Jun-81	8	2.618243	3.179746
10504	3	1981	25	380.6547	93.83259	23-Jun-81	24-Jun-81	8	2.618243	3.179746
10504	5	1981	25	10.97713	7.361406	23-Jun-81	24-Jun-81	8	2.618243	3.179746
10943	5	1981	25	1.636126	1.636126	23-Jun-81	24-Jun-81	8	2.618243	3.179746
99799	9	1981	25	3.107268	2.037435	23-Jun-81	24-Jun-81	8	2.618243	3.179746
4006	5	1981	26	0.710227	0.710227	29-Jun-81	2-Jul-81	16	2.952464	3.104826
4007	5	1981	26	0.735294	0.735294	29-Jun-81	2-Jul-81	16	2.952464	3.104826
4100	3	1981	26	92.54739	16.13429	29-Jun-81	2-Jul-81	16	2.952464	3.104826
4100	5	1981	26	0.72759	0.72759	29-Jun-81	2-Jul-81	16	2.952464	3.104826
4109	0	1981	26	0.72759	0.72759	29-Jun-81	2-Jul-81	16	2.952464	3.104826
4109	3	1981	26	388.7615	52.03747	29-Jun-81	2-Jul-81	16	2.952464	3.104826
8913	3	1981	26	1.437817	0.982298	29-Jun-81	2-Jul-81	16	2.952464	3.104826
10500	3	1981	26	2.998731	1.754396	29-Jun-81	2-Jul-81	16	2.952464	3.104826
10500	5	1981	26	0.74228	0.74228	29-Jun-81	2-Jul-81	16	2.952464	3.104826
10501	3	1981	26	22.1865	4.195738	29-Jun-81	2-Jul-81	16	2.952464	3.104826
10501	5	1981	26	25.7802	8.115905	29-Jun-81	2-Jul-81	16	2.952464	3.104826
10504	3	1981	26	21.99822	6.837153	29-Jun-81	2-Jul-81	16	2.952464	3.104826
10504	5	1981	26	14.91677	4.396064	29-Jun-81	2-Jul-81	16	2.952464	3.104826
99799	3	1981	26	3.030772	2.381092	29-Jun-81	2-Jul-81	16	2.952464	3.104826
99799	5	1981	26	1.512763	1.035688	29-Jun-81	2-Jul-81	16	2.952464	3.104826
99799	9	1981	26	4.539217	1.516052	29-Jun-81	2-Jul-81	16	2.952464	3.104826
4006	5	1981	27	0.900739	0.900739	8-Jul-81	11-Jul-81	14	2.996679	3.179746
4007	5	1981	27	1.657275	1.657275	8-Jul-81	11-Jul-81	14	2.996679	3.179746
4100	3	1981	27	25.35933	9.500966	8-Jul-81	11-Jul-81	14	2.996679	3.179746
4109	3	1981	27	172.2411	87.8974	8-Jul-81	11-Jul-81	14	2.996679	3.179746
6199	1	1981	27	0.900739	0.900739	8-Jul-81	11-Jul-81	14	2.996679	3.179746
10320	5	1981	27	0.900739	0.900739	8-Jul-81	11-Jul-81	14	2.996679	3.179746
10501	5	1981	27	6.194799	2.473157	8-Jul-81	11-Jul-81	14	2.996679	3.179746
10504	3	1981	27	1.736017	1.179474	8-Jul-81	11-Jul-81	14	2.996679	3.179746
12512	3	1981	27	12.88167	6.580714	8-Jul-81	11-Jul-81	14	2.996679	3.179746
99799	9	1981	27	0.933707	0.933707	8-Jul-81	11-Jul-81	14	2.996679	3.179746
4007	5	1981	28	0.662164	0.662164	13-Jul-81	16-Jul-81	18	2.918973	2.907039
4100	3	1981	28	107.0523	23.39691	13-Jul-81	16-Jul-81	18	2.918973	2.907039
4109	0	1981	28	1407.138	449.1426	13-Jul-81	16-Jul-81	18	2.918973	2.907039
4109	3	1981	28	714.4305	129.6727	13-Jul-81	16-Jul-81	18	2.918973	2.907039
4109	5	1981	28	2.059434	1.119555	13-Jul-81	16-Jul-81	18	2.918973	2.907039
6199	3	1981	28	0.710429	0.710429	13-Jul-81	16-Jul-81	18	2.918973	2.907039
8913	1	1981	28	0.710429	0.710429	13-Jul-81	16-Jul-81	18	2.918973	2.907039
10320	5	1981	28	0.700574	0.700574	13-Jul-81	16-Jul-81	18	2.918973	2.907039
10501	5	1981	28	0.646747	0.646747	13-Jul-81	16-Jul-81	18	2.918973	2.907039
10800	3	1981	28	2.085236	1.13177	13-Jul-81	16-Jul-81	18	2.918973	2.907039

12512	3	1981	28	1.322605	0.907547	13-Jul-81	16-Jul-81	18	2.918973	2.907039
12512	5	1981	28	0.662164	0.662164	13-Jul-81	16-Jul-81	18	2.918973	2.907039
18005	1	1981	28	4.054734	2.435979	13-Jul-81	16-Jul-81	18	2.918973	2.907039
18005	3	1981	28	7.405908	4.214505	13-Jul-81	16-Jul-81	18	2.918973	2.907039
99799	9	1981	28	0.72338	0.72338	13-Jul-81	16-Jul-81	18	2.918973	2.907039
4000	5	1981	29	0.766871	0.766871	20-Jul-81	23-Jul-81	16	3.057351	2.596845
4001	5	1981	29	1.431844	1.431844	20-Jul-81	23-Jul-81	16	3.057351	2.596845
4100	3	1981	29	625.1706	191.0882	20-Jul-81	23-Jul-81	16	3.057351	2.596845
4100	5	1981	29	0.715922	0.715922	20-Jul-81	23-Jul-81	16	3.057351	2.596845
4100	9	1981	29	2.147766	2.147766	20-Jul-81	23-Jul-81	16	3.057351	2.596845
4109	0	1981	29	7871.155	3024.628	20-Jul-81	23-Jul-81	16	3.057351	2.596845
4109	3	1981	29	3528.173	1128.877	20-Jul-81	23-Jul-81	16	3.057351	2.596845
4109	5	1981	29	4.310594	2.053113	20-Jul-81	23-Jul-81	16	3.057351	2.596845
8913	3	1981	29	0.715922	0.715922	20-Jul-81	23-Jul-81	16	3.057351	2.596845
10320	5	1981	29	1.492771	1.020196	20-Jul-81	23-Jul-81	16	3.057351	2.596845
10501	5	1981	29	1.482793	1.013624	20-Jul-81	23-Jul-81	16	3.057351	2.596845
10504	5	1981	29	0.7259	0.7259	20-Jul-81	23-Jul-81	16	3.057351	2.596845
12512	3	1981	29	5.803982	2.583657	20-Jul-81	23-Jul-81	16	3.057351	2.596845
12512	5	1981	29	17.59693	4.175236	20-Jul-81	23-Jul-81	16	3.057351	2.596845
17828	5	1981	29	0.773515	0.773515	20-Jul-81	23-Jul-81	16	3.057351	2.596845
18005	3	1981	29	33.57885	17.35297	20-Jul-81	23-Jul-81	16	3.057351	2.596845
99799	0	1981	29	0.759417	0.759417	20-Jul-81	23-Jul-81	16	3.057351	2.596845
99899	0	1981	29	0.766871	0.766871	20-Jul-81	23-Jul-81	16	3.057351	2.596845
4001	5	1981	30	0.703037	0.703037	28-Jul-81	1-Aug-81	16	3.078802	2.784749
4100	3	1981	30	176.5886	43.23914	28-Jul-81	1-Aug-81	16	3.078802	2.784749
4100	5	1981	30	1.502326	1.026606	28-Jul-81	1-Aug-81	16	3.078802	2.784749
4109	0	1981	30	11.18568	11.18568	28-Jul-81	1-Aug-81	16	3.078802	2.784749
4109	3	1981	30	909.3681	129.0381	28-Jul-81	1-Aug-81	16	3.078802	2.784749
4109	5	1981	30	3.601268	2.312475	28-Jul-81	1-Aug-81	16	3.078802	2.784749
8723	5	1981	30	0.733568	0.733568	28-Jul-81	1-Aug-81	16	3.078802	2.784749
8913	3	1981	30	0.768758	0.768758	28-Jul-81	1-Aug-81	16	3.078802	2.784749
10320	3	1981	30	0.73616	0.73616	28-Jul-81	1-Aug-81	16	3.078802	2.784749
10501	5	1981	30	5.696119	2.30073	28-Jul-81	1-Aug-81	16	3.078802	2.784749
12512	3	1981	30	3.637744	1.733504	28-Jul-81	1-Aug-81	16	3.078802	2.784749
12512	5	1981	30	5.754135	2.911144	28-Jul-81	1-Aug-81	16	3.078802	2.784749
18005	3	1981	30	2.872051	2.230624	28-Jul-81	1-Aug-81	16	3.078802	2.784749
4100	3	1981	31	164.788	28.22617	2-Aug-81	8-Aug-81	16	3.109821	3.179746
4109	0	1981	31	3.74711	1.813503	2-Aug-81	8-Aug-81	16	3.109821	3.179746
4109	3	1981	31	766.138	116.2768	2-Aug-81	8-Aug-81	16	3.109821	3.179746
4109	5	1981	31	2.090306	1.515145	2-Aug-81	8-Aug-81	16	3.109821	3.179746
8700	3	1981	31	0.794155	0.794155	2-Aug-81	8-Aug-81	16	3.109821	3.179746
8723	5	1981	31	0.799233	0.799233	2-Aug-81	8-Aug-81	16	3.109821	3.179746
10501	5	1981	31	0.725058	0.725058	2-Aug-81	8-Aug-81	16	3.109821	3.179746
12512	3	1981	31	2.180041	1.172513	2-Aug-81	8-Aug-81	16	3.109821	3.179746
12512	5	1981	31	2.175174	2.175174	2-Aug-81	8-Aug-81	16	3.109821	3.179746
18005	3	1981	31	2.93518	2.2951	2-Aug-81	8-Aug-81	16	3.109821	3.179746
99799	9	1981	31	2.24314	1.620644	2-Aug-81	8-Aug-81	16	3.109821	3.179746
4100	3	1981	32	132.1836	37.7316	10-Aug-81	15-Aug-81	16	3.106404	3.179746
4100	5	1981	32	0.702247	0.702247	10-Aug-81	15-Aug-81	16	3.106404	3.179746
4109	0	1981	32	378.774	155.1649	10-Aug-81	15-Aug-81	16	3.106404	3.179746
4109	3	1981	32	617.0815	79.85759	10-Aug-81	15-Aug-81	16	3.106404	3.179746
4109	5	1981	32	2.842658	2.207736	10-Aug-81	15-Aug-81	16	3.106404	3.179746

8700	3	1981	32	0.770654	0.770654	10-Aug-81	15-Aug-81	16	3.106404	3.179746
8700	5	1981	32	0.75392	0.75392	10-Aug-81	15-Aug-81	16	3.106404	3.179746
10320	5	1981	32	1.459823	0.998067	10-Aug-81	15-Aug-81	16	3.106404	3.179746
18005	3	1981	32	2.803727	1.615136	10-Aug-81	15-Aug-81	16	3.106404	3.179746
4001	5	1981	33	0.680828	0.680828	17-Aug-81	21-Aug-81	16	2.8348	2.99016
4007	9	1981	33	0.797194	0.797194	17-Aug-81	21-Aug-81	16	2.8348	2.99016
4100	3	1981	33	39.20574	12.32986	17-Aug-81	21-Aug-81	16	2.8348	2.99016
4100	5	1981	33	0.710227	0.710227	17-Aug-81	21-Aug-81	16	2.8348	2.99016
4109	0	1981	33	25.37224	15.10291	17-Aug-81	21-Aug-81	16	2.8348	2.99016
4109	3	1981	33	212.4989	37.59364	17-Aug-81	21-Aug-81	16	2.8348	2.99016
4109	5	1981	33	0.680828	0.680828	17-Aug-81	21-Aug-81	16	2.8348	2.99016
8700	3	1981	33	0.729288	0.729288	17-Aug-81	21-Aug-81	16	2.8348	2.99016
8913	3	1981	33	0.891583	0.891583	17-Aug-81	21-Aug-81	16	2.8348	2.99016
10320	5	1981	33	2.078481	1.117588	17-Aug-81	21-Aug-81	16	2.8348	2.99016
12512	3	1981	33	0.797194	0.797194	17-Aug-81	21-Aug-81	16	2.8348	2.99016
18005	3	1981	33	0.797194	0.797194	17-Aug-81	21-Aug-81	16	2.8348	2.99016
4100	3	1981	34	120.3381	37.98911	29-Aug-81	29-Aug-81	4	0	2.763508
4109	3	1981	34	5.783727	3.343113	29-Aug-81	29-Aug-81	4	0	2.763508
10320	5	1981	34	6.031793	3.482706	29-Aug-81	29-Aug-81	4	0	2.763508
4100	3	1981	35	117.3222	19.92334	30-Aug-81	30-Aug-81	4	0	2.568507
4109	3	1981	35	100.2697	64.84099	30-Aug-81	30-Aug-81	4	0	2.568507
10320	5	1981	35	3.052503	3.052503	30-Aug-81	30-Aug-81	4	0	2.568507
99799	3	1981	35	2.834467	2.834467	30-Aug-81	30-Aug-81	4	0	2.568507
3001	5	1983	18	0.837419	0.483487	3-May-83	7-May-83	4	2.530611	0
4000	1	1983	18	0.62967	0.62967	3-May-83	7-May-83	4	2.530611	0
4007	3	1983	18	0.62967	0.62967	3-May-83	7-May-83	4	2.530611	0
10501	1	1983	18	0.20989	0.20989	3-May-83	7-May-83	4	2.530611	0
10900	9	1983	18	0.41871	0.241744	3-May-83	7-May-83	4	2.530611	0
10976	1	1983	18	0.417639	0.417639	3-May-83	7-May-83	4	2.530611	0
99799	9	1983	18	0.20989	0.20989	3-May-83	7-May-83	4	2.530611	0
3001	5	1983	19	6.185236	1.917205	8-May-83	14-May-83	35	3.17554	0
4000	1	1983	19	37.61111	11.70095	8-May-83	14-May-83	35	3.17554	0
4000	3	1983	19	19.81194	7.179208	8-May-83	14-May-83	35	3.17554	0
4006	3	1983	19	0.184059	0.184059	8-May-83	14-May-83	35	3.17554	0
4007	0	1983	19	1.149336	0.510886	8-May-83	14-May-83	35	3.17554	0
4007	3	1983	19	74.76596	12.77503	8-May-83	14-May-83	35	3.17554	0
4406	3	1983	19	0.024087	0.024087	8-May-83	14-May-83	35	3.17554	0
7915	5	1983	19	1.543633	0.560496	8-May-83	14-May-83	35	3.17554	0
10501	0	1983	19	5.796834	1.789469	8-May-83	14-May-83	35	3.17554	0
10501	1	1983	19	6.589669	2.412124	8-May-83	14-May-83	35	3.17554	0
10501	3	1983	19	19.70055	5.364	8-May-83	14-May-83	35	3.17554	0
10504	0	1983	19	0.393246	0.273977	8-May-83	14-May-83	35	3.17554	0
10504	1	1983	19	1.729402	0.734895	8-May-83	14-May-83	35	3.17554	0
10508	9	1983	19	9.380538	2.589659	8-May-83	14-May-83	35	3.17554	0
10900	1	1983	19	1.872447	0.947217	8-May-83	14-May-83	35	3.17554	0
10900	3	1983	19	7.10523	1.891298	8-May-83	14-May-83	35	3.17554	0
10900	9	1983	19	4.050742	1.328264	8-May-83	14-May-83	35	3.17554	0
10943	1	1983	19	0.760693	0.363333	8-May-83	14-May-83	35	3.17554	0
10943	3	1983	19	1.165369	0.642533	8-May-83	14-May-83	35	3.17554	0
10976	1	1983	19	2.513741	0.737859	8-May-83	14-May-83	35	3.17554	0
10976	3	1983	19	13.52836	2.448139	8-May-83	14-May-83	35	3.17554	0
18005	5	1983	19	0.194512	0.194512	8-May-83	14-May-83	35	3.17554	0

99799	1	1983	19	0.186121	0.186121	8-May-83	14-May-83	35	3.17554	0
99799	3	1983	19	0.185809	0.185809	8-May-83	14-May-83	35	3.17554	0
99799	9	1983	19	20.87593	3.741066	8-May-83	14-May-83	35	3.17554	0
99899	0	1983	19	1.168601	0.523959	8-May-83	14-May-83	35	3.17554	0
3001	5	1983	20	3.839603	0.993149	15-May-83	21-May-83	48	3.176854	0
4000	1	1983	20	34.07238	8.291819	15-May-83	21-May-83	48	3.176854	0
4000	3	1983	20	21.10984	5.414898	15-May-83	21-May-83	48	3.176854	0
4006	0	1983	20	0.140352	0.140352	15-May-83	21-May-83	48	3.176854	0
4006	3	1983	20	0.143682	0.143682	15-May-83	21-May-83	48	3.176854	0
4007	0	1983	20	0.149721	0.149721	15-May-83	21-May-83	48	3.176854	0
4007	3	1983	20	64.79476	10.63595	15-May-83	21-May-83	48	3.176854	0
7915	5	1983	20	2.408823	0.586985	15-May-83	21-May-83	48	3.176854	0
10501	0	1983	20	5.252988	1.241092	15-May-83	21-May-83	48	3.176854	0
10501	1	1983	20	4.530714	1.356019	15-May-83	21-May-83	48	3.176854	0
10501	3	1983	20	93.26043	16.23409	15-May-83	21-May-83	48	3.176854	0
10504	0	1983	20	0.716863	0.420619	15-May-83	21-May-83	48	3.176854	0
10504	1	1983	20	2.544837	0.850736	15-May-83	21-May-83	48	3.176854	0
10504	3	1983	20	0.41719	0.41719	15-May-83	21-May-83	48	3.176854	0
10508	1	1983	20	0.428758	0.316924	15-May-83	21-May-83	48	3.176854	0
10508	3	1983	20	0.29175	0.204146	15-May-83	21-May-83	48	3.176854	0
10508	9	1983	20	24.58057	7.87509	15-May-83	21-May-83	48	3.176854	0
10900	1	1983	20	0.435471	0.246619	15-May-83	21-May-83	48	3.176854	0
10900	3	1983	20	2.824496	0.779036	15-May-83	21-May-83	48	3.176854	0
10900	9	1983	20	3.235412	1.075822	15-May-83	21-May-83	48	3.176854	0
10943	1	1983	20	8.320185	2.20289	15-May-83	21-May-83	48	3.176854	0
10943	3	1983	20	1.29755	0.443691	15-May-83	21-May-83	48	3.176854	0
10976	1	1983	20	1.972668	0.813484	15-May-83	21-May-83	48	3.176854	0
10976	3	1983	20	11.57376	2.030044	15-May-83	21-May-83	48	3.176854	0
99799	9	1983	20	24.8691	3.174348	15-May-83	21-May-83	48	3.176854	0
99899	0	1983	20	1.286008	0.564577	15-May-83	21-May-83	48	3.176854	0
3001	5	1983	21	2.219664	0.636126	22-May-83	28-May-83	56	3.132796	0
4000	1	1983	21	27.28081	5.509069	22-May-83	28-May-83	56	3.132796	0
4000	3	1983	21	21.96319	4.205148	22-May-83	28-May-83	56	3.132796	0
4006	0	1983	21	0.494599	0.240518	22-May-83	28-May-83	56	3.132796	0
4006	3	1983	21	0.765821	0.298216	22-May-83	28-May-83	56	3.132796	0
4007	0	1983	21	2.769461	1.000615	22-May-83	28-May-83	56	3.132796	0
4007	3	1983	21	59.78664	8.488228	22-May-83	28-May-83	56	3.132796	0
4109	0	1983	21	1.098661	0.775159	22-May-83	28-May-83	56	3.132796	0
6199	1	1983	21	0.616322	0.316927	22-May-83	28-May-83	56	3.132796	0
6199	3	1983	21	1.892156	0.525204	22-May-83	28-May-83	56	3.132796	0
6199	9	1983	21	0.12889	0.12889	22-May-83	28-May-83	56	3.132796	0
7915	5	1983	21	0.119747	0.119747	22-May-83	28-May-83	56	3.132796	0
10501	0	1983	21	15.96914	5.136476	22-May-83	28-May-83	56	3.132796	0
10501	1	1983	21	2.112783	0.682916	22-May-83	28-May-83	56	3.132796	0
10501	3	1983	21	234.6891	23.68845	22-May-83	28-May-83	56	3.132796	0
10504	0	1983	21	0.375463	0.280386	22-May-83	28-May-83	56	3.132796	0
10504	1	1983	21	2.01023	0.58978	22-May-83	28-May-83	56	3.132796	0
10504	3	1983	21	0.618473	0.31874	22-May-83	28-May-83	56	3.132796	0
10508	1	1983	21	0.25746	0.25746	22-May-83	28-May-83	56	3.132796	0
10508	3	1983	21	0.387878	0.286702	22-May-83	28-May-83	56	3.132796	0
10508	9	1983	21	26.48395	3.641687	22-May-83	28-May-83	56	3.132796	0
10900	1	1983	21	0.61627	0.320862	22-May-83	28-May-83	56	3.132796	0

10900	3	1983	21	0.874253	0.356855	22-May-83	28-May-83	56	3.132796	0
10900	9	1983	21	3.228841	0.899767	22-May-83	28-May-83	56	3.132796	0
10943	1	1983	21	20.42957	2.415673	22-May-83	28-May-83	56	3.132796	0
10943	3	1983	21	5.219826	0.943878	22-May-83	28-May-83	56	3.132796	0
10976	1	1983	21	0.368421	0.208862	22-May-83	28-May-83	56	3.132796	0
10976	3	1983	21	2.800074	0.674073	22-May-83	28-May-83	56	3.132796	0
99799	0	1983	21	0.122647	0.122647	22-May-83	28-May-83	56	3.132796	0
99799	9	1983	21	21.91219	2.464761	22-May-83	28-May-83	56	3.132796	0
99899	0	1983	21	2.170252	0.73402	22-May-83	28-May-83	56	3.132796	0
3001	5	1983	22	0.429901	0.24293	29-May-83	4-Jun-83	48	3.146992	1.142669
4000	1	1983	22	292.8332	48.13101	29-May-83	4-Jun-83	48	3.146992	1.142669
4000	3	1983	22	248.2566	39.58953	29-May-83	4-Jun-83	48	3.146992	1.142669
4006	0	1983	22	0.149076	0.149076	29-May-83	4-Jun-83	48	3.146992	1.142669
4006	1	1983	22	0.885566	0.503062	29-May-83	4-Jun-83	48	3.146992	1.142669
4006	3	1983	22	1.474423	0.419354	29-May-83	4-Jun-83	48	3.146992	1.142669
4006	9	1983	22	0.152645	0.152645	29-May-83	4-Jun-83	48	3.146992	1.142669
4007	0	1983	22	1.26854	0.637414	29-May-83	4-Jun-83	48	3.146992	1.142669
4007	3	1983	22	575.1301	81.769	29-May-83	4-Jun-83	48	3.146992	1.142669
4109	0	1983	22	0.590321	0.41296	29-May-83	4-Jun-83	48	3.146992	1.142669
6199	1	1983	22	5.108182	1.353029	29-May-83	4-Jun-83	48	3.146992	1.142669
6199	3	1983	22	4.535647	0.871772	29-May-83	4-Jun-83	48	3.146992	1.142669
10501	0	1983	22	21.5096	5.070171	29-May-83	4-Jun-83	48	3.146992	1.142669
10501	1	1983	22	2.487466	0.799779	29-May-83	4-Jun-83	48	3.146992	1.142669
10501	3	1983	22	283.3811	24.06641	29-May-83	4-Jun-83	48	3.146992	1.142669
10501	5	1983	22	0.150933	0.150933	29-May-83	4-Jun-83	48	3.146992	1.142669
10504	0	1983	22	0.578122	0.279787	29-May-83	4-Jun-83	48	3.146992	1.142669
10504	1	1983	22	5.855913	1.654294	29-May-83	4-Jun-83	48	3.146992	1.142669
10504	3	1983	22	4.969299	1.33693	29-May-83	4-Jun-83	48	3.146992	1.142669
10508	1	1983	22	0.443761	0.250721	29-May-83	4-Jun-83	48	3.146992	1.142669
10508	3	1983	22	4.555121	3.714403	29-May-83	4-Jun-83	48	3.146992	1.142669
10508	9	1983	22	52.25279	7.453758	29-May-83	4-Jun-83	48	3.146992	1.142669
10800	3	1983	22	0.149076	0.149076	29-May-83	4-Jun-83	48	3.146992	1.142669
10900	9	1983	22	10.39502	4.177959	29-May-83	4-Jun-83	48	3.146992	1.142669
10943	1	1983	22	9.214802	1.758029	29-May-83	4-Jun-83	48	3.146992	1.142669
10943	3	1983	22	4.277676	0.833618	29-May-83	4-Jun-83	48	3.146992	1.142669
10976	3	1983	22	0.888987	0.508173	29-May-83	4-Jun-83	48	3.146992	1.142669
99799	9	1983	22	56.76517	7.123152	29-May-83	4-Jun-83	48	3.146992	1.142669
99899	0	1983	22	1.338009	0.626996	29-May-83	4-Jun-83	48	3.146992	1.142669
3001	5	1983	23	0.132268	0.132268	5-Jun-83	11-Jun-83	54	3.111504	1.838816
4000	1	1983	23	178.2633	52.89728	5-Jun-83	11-Jun-83	54	3.111504	1.838816
4000	3	1983	23	806.7957	98.29631	5-Jun-83	11-Jun-83	54	3.111504	1.838816
4001	5	1983	23	0.133829	0.133829	5-Jun-83	11-Jun-83	54	3.111504	1.838816
4006	3	1983	23	2.001781	0.747021	5-Jun-83	11-Jun-83	54	3.111504	1.838816
4007	0	1983	23	1.14794	0.671059	5-Jun-83	11-Jun-83	54	3.111504	1.838816
4007	3	1983	23	968.3602	178.3215	5-Jun-83	11-Jun-83	54	3.111504	1.838816
4109	0	1983	23	0.661914	0.342043	5-Jun-83	11-Jun-83	54	3.111504	1.838816
6199	1	1983	23	23.62555	3.103433	5-Jun-83	11-Jun-83	54	3.111504	1.838816
6199	3	1983	23	15.14879	2.204737	5-Jun-83	11-Jun-83	54	3.111504	1.838816
7915	5	1983	23	0.260179	0.182272	5-Jun-83	11-Jun-83	54	3.111504	1.838816
10501	0	1983	23	32.42368	5.322435	5-Jun-83	11-Jun-83	54	3.111504	1.838816
10501	1	1983	23	3.05132	2.164024	5-Jun-83	11-Jun-83	54	3.111504	1.838816
10501	3	1983	23	202.6185	20.55142	5-Jun-83	11-Jun-83	54	3.111504	1.838816

10504	1	1983	23	9.539074	2.304931	5-Jun-83	11-Jun-83	54	3.111504	1.838816
10504	3	1983	23	69.16346	10.88874	5-Jun-83	11-Jun-83	54	3.111504	1.838816
10504	9	1983	23	0.952719	0.673382	5-Jun-83	11-Jun-83	54	3.111504	1.838816
10508	3	1983	23	4.36394	1.608614	5-Jun-83	11-Jun-83	54	3.111504	1.838816
10508	9	1983	23	63.41479	11.1782	5-Jun-83	11-Jun-83	54	3.111504	1.838816
10900	1	1983	23	0.12734	0.12734	5-Jun-83	11-Jun-83	54	3.111504	1.838816
10900	3	1983	23	0.12734	0.12734	5-Jun-83	11-Jun-83	54	3.111504	1.838816
10900	9	1983	23	0.134666	0.134666	5-Jun-83	11-Jun-83	54	3.111504	1.838816
10943	1	1983	23	12.11959	2.157942	5-Jun-83	11-Jun-83	54	3.111504	1.838816
10943	3	1983	23	6.994114	1.220776	5-Jun-83	11-Jun-83	54	3.111504	1.838816
18005	5	1983	23	0.132839	0.132839	5-Jun-83	11-Jun-83	54	3.111504	1.838816
99799	1	1983	23	0.12674	0.12674	5-Jun-83	11-Jun-83	54	3.111504	1.838816
99799	9	1983	23	104.8405	12.04535	5-Jun-83	11-Jun-83	54	3.111504	1.838816
99899	0	1983	23	4.910517	3.060841	5-Jun-83	11-Jun-83	54	3.111504	1.838816
99899	9	1983	23	0.140281	0.140281	5-Jun-83	11-Jun-83	54	3.111504	1.838816
3001	5	1983	24	0.328613	0.229691	12-Jun-83	18-Jun-83	44	3.252352	2.555574
4000	1	1983	24	5.393049	2.856854	12-Jun-83	18-Jun-83	44	3.252352	2.555574
4000	3	1983	24	1175.004	167.4329	12-Jun-83	18-Jun-83	44	3.252352	2.555574
4001	5	1983	24	0.165376	0.165376	12-Jun-83	18-Jun-83	44	3.252352	2.555574
4006	3	1983	24	1.301602	0.536636	12-Jun-83	18-Jun-83	44	3.252352	2.555574
4007	0	1983	24	0.32114	0.224544	12-Jun-83	18-Jun-83	44	3.252352	2.555574
4007	3	1983	24	490.5109	97.63337	12-Jun-83	18-Jun-83	44	3.252352	2.555574
4109	0	1983	24	1.676961	0.955343	12-Jun-83	18-Jun-83	44	3.252352	2.555574
6199	0	1983	24	0.501274	0.371907	12-Jun-83	18-Jun-83	44	3.252352	2.555574
6199	1	1983	24	9.329427	1.340986	12-Jun-83	18-Jun-83	44	3.252352	2.555574
6199	3	1983	24	10.63396	2.598238	12-Jun-83	18-Jun-83	44	3.252352	2.555574
8720	0	1983	24	0.322281	0.322281	12-Jun-83	18-Jun-83	44	3.252352	2.555574
10501	0	1983	24	25.88239	6.247285	12-Jun-83	18-Jun-83	44	3.252352	2.555574
10501	1	1983	24	0.477098	0.268993	12-Jun-83	18-Jun-83	44	3.252352	2.555574
10501	3	1983	24	109.8197	20.55115	12-Jun-83	18-Jun-83	44	3.252352	2.555574
10504	1	1983	24	7.719754	3.775766	12-Jun-83	18-Jun-83	44	3.252352	2.555574
10504	3	1983	24	151.5231	21.38164	12-Jun-83	18-Jun-83	44	3.252352	2.555574
10508	1	1983	24	0.502097	0.502097	12-Jun-83	18-Jun-83	44	3.252352	2.555574
10508	3	1983	24	51.29695	7.388371	12-Jun-83	18-Jun-83	44	3.252352	2.555574
10508	9	1983	24	77.38949	13.06311	12-Jun-83	18-Jun-83	44	3.252352	2.555574
10800	0	1983	24	1.330617	0.870956	12-Jun-83	18-Jun-83	44	3.252352	2.555574
10800	1	1983	24	0.320231	0.223789	12-Jun-83	18-Jun-83	44	3.252352	2.555574
10800	3	1983	24	0.324333	0.226865	12-Jun-83	18-Jun-83	44	3.252352	2.555574
10900	9	1983	24	0.165376	0.165376	12-Jun-83	18-Jun-83	44	3.252352	2.555574
10943	1	1983	24	6.888049	1.562125	12-Jun-83	18-Jun-83	44	3.252352	2.555574
10943	3	1983	24	4.70227	0.962567	12-Jun-83	18-Jun-83	44	3.252352	2.555574
18005	5	1983	24	0.161141	0.161141	12-Jun-83	18-Jun-83	44	3.252352	2.555574
99799	3	1983	24	0.322281	0.322281	12-Jun-83	18-Jun-83	44	3.252352	2.555574
99799	9	1983	24	85.8068	8.849276	12-Jun-83	18-Jun-83	44	3.252352	2.555574
99899	0	1983	24	1.772826	1.155544	12-Jun-83	18-Jun-83	44	3.252352	2.555574
99899	9	1983	24	0.165791	0.165791	12-Jun-83	18-Jun-83	44	3.252352	2.555574
3001	5	1983	25	0.169966	0.169966	20-Jun-83	25-Jun-83	43	3.13369	0.919382
4000	0	1983	25	0.170717	0.170717	20-Jun-83	25-Jun-83	43	3.13369	0.919382
4000	3	1983	25	446.9991	65.3088	20-Jun-83	25-Jun-83	43	3.13369	0.919382
4007	3	1983	25	230.181	36.72582	20-Jun-83	25-Jun-83	43	3.13369	0.919382
4007	5	1983	25	0.328654	0.229712	20-Jun-83	25-Jun-83	43	3.13369	0.919382
4109	0	1983	25	0.169966	0.169966	20-Jun-83	25-Jun-83	43	3.13369	0.919382

6199	1	1983	25	7.912792	1.363977	20-Jun-83	25-Jun-83	43	3.13369	0.919382
6199	3	1983	25	15.53828	2.302487	20-Jun-83	25-Jun-83	43	3.13369	0.919382
8720	0	1983	25	0.17018	0.17018	20-Jun-83	25-Jun-83	43	3.13369	0.919382
8720	1	1983	25	0.339402	0.23712	20-Jun-83	25-Jun-83	43	3.13369	0.919382
10501	0	1983	25	6.433923	2.096353	20-Jun-83	25-Jun-83	43	3.13369	0.919382
10501	1	1983	25	0.167544	0.167544	20-Jun-83	25-Jun-83	43	3.13369	0.919382
10501	3	1983	25	64.32864	9.940286	20-Jun-83	25-Jun-83	43	3.13369	0.919382
10501	5	1983	25	0.172901	0.172901	20-Jun-83	25-Jun-83	43	3.13369	0.919382
10504	1	1983	25	0.650387	0.313405	20-Jun-83	25-Jun-83	43	3.13369	0.919382
10504	3	1983	25	235.0977	26.28694	20-Jun-83	25-Jun-83	43	3.13369	0.919382
10504	5	1983	25	0.169116	0.169116	20-Jun-83	25-Jun-83	43	3.13369	0.919382
10508	3	1983	25	96.22252	15.5198	20-Jun-83	25-Jun-83	43	3.13369	0.919382
10508	9	1983	25	58.04047	12.15893	20-Jun-83	25-Jun-83	43	3.13369	0.919382
10800	3	1983	25	1.859245	0.690242	20-Jun-83	25-Jun-83	43	3.13369	0.919382
10900	3	1983	25	0.170717	0.170717	20-Jun-83	25-Jun-83	43	3.13369	0.919382
10943	1	1983	25	5.279387	2.120826	20-Jun-83	25-Jun-83	43	3.13369	0.919382
10943	3	1983	25	3.013605	0.846628	20-Jun-83	25-Jun-83	43	3.13369	0.919382
10943	5	1983	25	0.166615	0.166615	20-Jun-83	25-Jun-83	43	3.13369	0.919382
99799	9	1983	25	54.78709	7.836781	20-Jun-83	25-Jun-83	43	3.13369	0.919382
99899	0	1983	25	1.376982	0.781038	20-Jun-83	25-Jun-83	43	3.13369	0.919382
99899	9	1983	25	0.326985	0.326985	20-Jun-83	25-Jun-83	43	3.13369	0.919382
3001	5	1983	26	0.2445	0.171309	26-Jun-83	2-Jul-83	56	3.179483	0.529958
4000	3	1983	26	34.92941	5.562784	26-Jun-83	2-Jul-83	56	3.179483	0.529958
4006	5	1983	26	0.247813	0.173668	26-Jun-83	2-Jul-83	56	3.179483	0.529958
4007	3	1983	26	31.3068	4.794853	26-Jun-83	2-Jul-83	56	3.179483	0.529958
4007	5	1983	26	0.251594	0.176329	26-Jun-83	2-Jul-83	56	3.179483	0.529958
4100	3	1983	26	1.631345	0.99472	26-Jun-83	2-Jul-83	56	3.179483	0.529958
4109	3	1983	26	1.241542	0.53231	26-Jun-83	2-Jul-83	56	3.179483	0.529958
6199	1	1983	26	0.747572	0.291088	26-Jun-83	2-Jul-83	56	3.179483	0.529958
6199	3	1983	26	2.85422	0.704982	26-Jun-83	2-Jul-83	56	3.179483	0.529958
8720	1	1983	26	0.127701	0.127701	26-Jun-83	2-Jul-83	56	3.179483	0.529958
10501	0	1983	26	4.382475	2.005459	26-Jun-83	2-Jul-83	56	3.179483	0.529958
10501	3	1983	26	49.05773	8.110983	26-Jun-83	2-Jul-83	56	3.179483	0.529958
10501	5	1983	26	0.372897	0.211419	26-Jun-83	2-Jul-83	56	3.179483	0.529958
10504	1	1983	26	0.626717	0.323641	26-Jun-83	2-Jul-83	56	3.179483	0.529958
10504	3	1983	26	172.5411	27.49385	26-Jun-83	2-Jul-83	56	3.179483	0.529958
10504	5	1983	26	0.361209	0.204724	26-Jun-83	2-Jul-83	56	3.179483	0.529958
10508	3	1983	26	61.89016	8.542218	26-Jun-83	2-Jul-83	56	3.179483	0.529958
10508	9	1983	26	13.75292	2.798225	26-Jun-83	2-Jul-83	56	3.179483	0.529958
10800	1	1983	26	0.242571	0.242571	26-Jun-83	2-Jul-83	56	3.179483	0.529958
10800	3	1983	26	0.369533	0.209454	26-Jun-83	2-Jul-83	56	3.179483	0.529958
10800	9	1983	26	0.12207	0.12207	26-Jun-83	2-Jul-83	56	3.179483	0.529958
10943	1	1983	26	0.495717	0.299988	26-Jun-83	2-Jul-83	56	3.179483	0.529958
10943	3	1983	26	0.124262	0.124262	26-Jun-83	2-Jul-83	56	3.179483	0.529958
10943	5	1983	26	0.249692	0.174991	26-Jun-83	2-Jul-83	56	3.179483	0.529958
99799	9	1983	26	20.34593	3.293932	26-Jun-83	2-Jul-83	56	3.179483	0.529958
99899	0	1983	26	0.25741	0.180365	26-Jun-83	2-Jul-83	56	3.179483	0.529958
3001	5	1983	27	0.128411	0.128411	3-Jul-83	9-Jul-83	56	3.159873	0.529958
4000	1	1983	27	0.130264	0.130264	3-Jul-83	9-Jul-83	56	3.159873	0.529958
4000	3	1983	27	1.292509	1.052288	3-Jul-83	9-Jul-83	56	3.159873	0.529958
4001	3	1983	27	3.833757	3.833757	3-Jul-83	9-Jul-83	56	3.159873	0.529958
4007	3	1983	27	0.38267	0.285721	3-Jul-83	9-Jul-83	56	3.159873	0.529958

4007	5	1983	27	0.629313	0.271103	3-Jul-83	9-Jul-83	56	3.159873	0.529958
4100	3	1983	27	570.9165	80.0958	3-Jul-83	9-Jul-83	56	3.159873	0.529958
4109	0	1983	27	63.52532	36.9377	3-Jul-83	9-Jul-83	56	3.159873	0.529958
4109	3	1983	27	379.0585	79.9059	3-Jul-83	9-Jul-83	56	3.159873	0.529958
6120	5	1983	27	0.245439	0.245439	3-Jul-83	9-Jul-83	56	3.159873	0.529958
6199	1	1983	27	0.381474	0.21635	3-Jul-83	9-Jul-83	56	3.159873	0.529958
6208	3	1983	27	0.129695	0.129695	3-Jul-83	9-Jul-83	56	3.159873	0.529958
6498	3	1983	27	0.124336	0.124336	3-Jul-83	9-Jul-83	56	3.159873	0.529958
7900	3	1983	27	0.129776	0.129776	3-Jul-83	9-Jul-83	56	3.159873	0.529958
8909	3	1983	27	0.369338	0.209373	3-Jul-83	9-Jul-83	56	3.159873	0.529958
8913	1	1983	27	0.126456	0.126456	3-Jul-83	9-Jul-83	56	3.159873	0.529958
8913	3	1983	27	0.124187	0.124187	3-Jul-83	9-Jul-83	56	3.159873	0.529958
10320	5	1983	27	0.500517	0.243364	3-Jul-83	9-Jul-83	56	3.159873	0.529958
10501	0	1983	27	0.492067	0.295996	3-Jul-83	9-Jul-83	56	3.159873	0.529958
10501	3	1983	27	19.43031	2.821958	3-Jul-83	9-Jul-83	56	3.159873	0.529958
10501	5	1983	27	1.755586	0.520661	3-Jul-83	9-Jul-83	56	3.159873	0.529958
10504	3	1983	27	44.93635	8.411696	3-Jul-83	9-Jul-83	56	3.159873	0.529958
10504	5	1983	27	3.27905	1.274687	3-Jul-83	9-Jul-83	56	3.159873	0.529958
10508	3	1983	27	17.62169	3.921583	3-Jul-83	9-Jul-83	56	3.159873	0.529958
10508	9	1983	27	0.506061	0.246115	3-Jul-83	9-Jul-83	56	3.159873	0.529958
10800	0	1983	27	0.121998	0.121998	3-Jul-83	9-Jul-83	56	3.159873	0.529958
10800	1	1983	27	0.125996	0.125996	3-Jul-83	9-Jul-83	56	3.159873	0.529958
10800	3	1983	27	1.151684	0.355071	3-Jul-83	9-Jul-83	56	3.159873	0.529958
10943	1	1983	27	0.124859	0.124859	3-Jul-83	9-Jul-83	56	3.159873	0.529958
10943	5	1983	27	0.253788	0.177826	3-Jul-83	9-Jul-83	56	3.159873	0.529958
10976	3	1983	27	0.12367	0.12367	3-Jul-83	9-Jul-83	56	3.159873	0.529958
12500	3	1983	27	0.120163	0.120163	3-Jul-83	9-Jul-83	56	3.159873	0.529958
18005	3	1983	27	1.129813	0.394468	3-Jul-83	9-Jul-83	56	3.159873	0.529958
99799	3	1983	27	0.619829	0.503169	3-Jul-83	9-Jul-83	56	3.159873	0.529958
99799	9	1983	27	40.71092	5.839764	3-Jul-83	9-Jul-83	56	3.159873	0.529958
99899	0	1983	27	0.121998	0.121998	3-Jul-83	9-Jul-83	56	3.159873	0.529958
4000	5	1983	28	0.172829	0.172829	10-Jul-83	16-Jul-83	40	3.179746	0.415607
4001	5	1983	28	0.168228	0.168228	10-Jul-83	16-Jul-83	40	3.179746	0.415607
4005	5	1983	28	0.346275	0.346275	10-Jul-83	16-Jul-83	40	3.179746	0.415607
4100	3	1983	28	681.454	76.9428	10-Jul-83	16-Jul-83	40	3.179746	0.415607
4109	0	1983	28	146.38	87.18286	10-Jul-83	16-Jul-83	40	3.179746	0.415607
4109	3	1983	28	650.4897	108.3967	10-Jul-83	16-Jul-83	40	3.179746	0.415607
4109	5	1983	28	0.169899	0.169899	10-Jul-83	16-Jul-83	40	3.179746	0.415607
8909	3	1983	28	0.90074	0.38179	10-Jul-83	16-Jul-83	40	3.179746	0.415607
8913	3	1983	28	0.182714	0.182714	10-Jul-83	16-Jul-83	40	3.179746	0.415607
10320	5	1983	28	0.370316	0.370316	10-Jul-83	16-Jul-83	40	3.179746	0.415607
10501	3	1983	28	21.73885	4.586861	10-Jul-83	16-Jul-83	40	3.179746	0.415607
10501	5	1983	28	11.76179	2.907004	10-Jul-83	16-Jul-83	40	3.179746	0.415607
10504	3	1983	28	30.22581	8.040621	10-Jul-83	16-Jul-83	40	3.179746	0.415607
10504	5	1983	28	5.146317	1.254098	10-Jul-83	16-Jul-83	40	3.179746	0.415607
10508	3	1983	28	2.653331	1.041173	10-Jul-83	16-Jul-83	40	3.179746	0.415607
10800	1	1983	28	0.183174	0.183174	10-Jul-83	16-Jul-83	40	3.179746	0.415607
10800	3	1983	28	0.905124	0.527887	10-Jul-83	16-Jul-83	40	3.179746	0.415607
10943	5	1983	28	0.169899	0.169899	10-Jul-83	16-Jul-83	40	3.179746	0.415607
12512	3	1983	28	1.737462	0.696194	10-Jul-83	16-Jul-83	40	3.179746	0.415607
12512	5	1983	28	4.272371	1.222668	10-Jul-83	16-Jul-83	40	3.179746	0.415607
18005	3	1983	28	1.764073	0.704515	10-Jul-83	16-Jul-83	40	3.179746	0.415607

99799	3	1983	28	1.997662	0.938743	10-Jul-83	16-Jul-83	40	3.179746	0.415607
99799	9	1983	28	22.35457	3.283323	10-Jul-83	16-Jul-83	40	3.179746	0.415607
4000	5	1983	29	0.685103	0.330138	18-Jul-83	23-Jul-83	43	3.179746	0
4001	5	1983	29	1.160885	0.466551	18-Jul-83	23-Jul-83	43	3.179746	0
4005	5	1983	29	0.67018	0.397672	18-Jul-83	23-Jul-83	43	3.179746	0
4100	3	1983	29	1031.926	92.24899	18-Jul-83	23-Jul-83	43	3.179746	0
4109	0	1983	29	631.0982	249.7934	18-Jul-83	23-Jul-83	43	3.179746	0
4109	1	1983	29	0.826962	0.826962	18-Jul-83	23-Jul-83	43	3.179746	0
4109	3	1983	29	707.78	119.5114	18-Jul-83	23-Jul-83	43	3.179746	0
4109	5	1983	29	1.325834	0.677228	18-Jul-83	23-Jul-83	43	3.179746	0
8909	3	1983	29	0.341927	0.238905	18-Jul-83	23-Jul-83	43	3.179746	0
8913	1	1983	29	0.175254	0.175254	18-Jul-83	23-Jul-83	43	3.179746	0
10320	5	1983	29	0.859543	0.445912	18-Jul-83	23-Jul-83	43	3.179746	0
10501	3	1983	29	2.174071	0.989326	18-Jul-83	23-Jul-83	43	3.179746	0
10501	5	1983	29	3.855216	1.05334	18-Jul-83	23-Jul-83	43	3.179746	0
10504	3	1983	29	2.323932	0.70231	18-Jul-83	23-Jul-83	43	3.179746	0
10504	5	1983	29	2.352256	0.865981	18-Jul-83	23-Jul-83	43	3.179746	0
10508	3	1983	29	0.162608	0.162608	18-Jul-83	23-Jul-83	43	3.179746	0
12500	3	1983	29	2.510373	1.092643	18-Jul-83	23-Jul-83	43	3.179746	0
12500	5	1983	29	0.81461	0.416971	18-Jul-83	23-Jul-83	43	3.179746	0
12500	9	1983	29	0.168694	0.168694	18-Jul-83	23-Jul-83	43	3.179746	0
12512	3	1983	29	6.98302	2.273395	18-Jul-83	23-Jul-83	43	3.179746	0
12512	5	1983	29	24.05693	4.169295	18-Jul-83	23-Jul-83	43	3.179746	0
18005	3	1983	29	0.99422	0.559621	18-Jul-83	23-Jul-83	43	3.179746	0
99799	3	1983	29	5.443504	2.21626	18-Jul-83	23-Jul-83	43	3.179746	0
99799	9	1983	29	23.48156	4.855498	18-Jul-83	23-Jul-83	43	3.179746	0
4000	5	1983	30	0.842557	0.516689	24-Jul-83	30-Jul-83	48	3.153669	0
4001	5	1983	30	4.239024	0.931248	24-Jul-83	30-Jul-83	48	3.153669	0
4005	5	1983	30	1.118641	0.98067	24-Jul-83	30-Jul-83	48	3.153669	0
4100	3	1983	30	843.3926	81.74899	24-Jul-83	30-Jul-83	48	3.153669	0
4100	5	1983	30	0.822806	0.689522	24-Jul-83	30-Jul-83	48	3.153669	0
4109	0	1983	30	726.7085	127.1495	24-Jul-83	30-Jul-83	48	3.153669	0
4109	1	1983	30	6.291969	3.259603	24-Jul-83	30-Jul-83	48	3.153669	0
4109	3	1983	30	827.8663	73.70025	24-Jul-83	30-Jul-83	48	3.153669	0
4109	5	1983	30	7.635625	2.43864	24-Jul-83	30-Jul-83	48	3.153669	0
8720	3	1983	30	0.152549	0.152549	24-Jul-83	30-Jul-83	48	3.153669	0
8909	3	1983	30	0.292352	0.204819	24-Jul-83	30-Jul-83	48	3.153669	0
8913	3	1983	30	0.145146	0.145146	24-Jul-83	30-Jul-83	48	3.153669	0
10320	5	1983	30	3.694526	0.637686	24-Jul-83	30-Jul-83	48	3.153669	0
10501	5	1983	30	1.000227	0.406221	24-Jul-83	30-Jul-83	48	3.153669	0
10504	5	1983	30	0.984034	0.398428	24-Jul-83	30-Jul-83	48	3.153669	0
10800	3	1983	30	0.145407	0.145407	24-Jul-83	30-Jul-83	48	3.153669	0
12500	3	1983	30	0.717285	0.369655	24-Jul-83	30-Jul-83	48	3.153669	0
12500	5	1983	30	0.430737	0.243397	24-Jul-83	30-Jul-83	48	3.153669	0
12500	9	1983	30	0.139463	0.139463	24-Jul-83	30-Jul-83	48	3.153669	0
12512	3	1983	30	9.318584	1.817022	24-Jul-83	30-Jul-83	48	3.153669	0
12512	5	1983	30	23.19416	3.984906	24-Jul-83	30-Jul-83	48	3.153669	0
16814	5	1983	30	0.57715	0.279243	24-Jul-83	30-Jul-83	48	3.153669	0
17818	5	1983	30	0.138983	0.138983	24-Jul-83	30-Jul-83	48	3.153669	0
18005	0	1983	30	0.145757	0.145757	24-Jul-83	30-Jul-83	48	3.153669	0
18005	3	1983	30	16.48433	5.633328	24-Jul-83	30-Jul-83	48	3.153669	0
99799	3	1983	30	7.148207	3.948963	24-Jul-83	30-Jul-83	48	3.153669	0

99799	5	1983	30	0.145757	0.145757	24-Jul-83	30-Jul-83	48	3.153669	0
99799	9	1983	30	32.76471	3.696854	24-Jul-83	30-Jul-83	48	3.153669	0
4000	5	1983	31	1.457054	0.451798	31-Jul-83	6-Aug-83	56	3.113186	0
4001	5	1983	31	4.957848	1.012828	31-Jul-83	6-Aug-83	56	3.113186	0
4005	5	1983	31	0.243019	0.170279	31-Jul-83	6-Aug-83	56	3.113186	0
4006	5	1983	31	0.115807	0.115807	31-Jul-83	6-Aug-83	56	3.113186	0
4100	1	1983	31	0.123449	0.123449	31-Jul-83	6-Aug-83	56	3.113186	0
4100	3	1983	31	1021.582	73.09153	31-Jul-83	6-Aug-83	56	3.113186	0
4100	5	1983	31	1.890977	1.414131	31-Jul-83	6-Aug-83	56	3.113186	0
4109	0	1983	31	315.871	89.37625	31-Jul-83	6-Aug-83	56	3.113186	0
4109	1	1983	31	14.60884	11.85531	31-Jul-83	6-Aug-83	56	3.113186	0
4109	3	1983	31	579.1862	62.5861	31-Jul-83	6-Aug-83	56	3.113186	0
4109	5	1983	31	5.488276	1.820292	31-Jul-83	6-Aug-83	56	3.113186	0
6199	0	1983	31	0.119747	0.119747	31-Jul-83	6-Aug-83	56	3.113186	0
8720	3	1983	31	0.249578	0.17487	31-Jul-83	6-Aug-83	56	3.113186	0
8909	1	1983	31	0.249282	0.174664	31-Jul-83	6-Aug-83	56	3.113186	0
8909	3	1983	31	0.244681	0.171476	31-Jul-83	6-Aug-83	56	3.113186	0
8913	1	1983	31	0.739574	0.337757	31-Jul-83	6-Aug-83	56	3.113186	0
10320	5	1983	31	1.958277	0.712584	31-Jul-83	6-Aug-83	56	3.113186	0
10501	5	1983	31	0.589332	0.30377	31-Jul-83	6-Aug-83	56	3.113186	0
10504	5	1983	31	0.116652	0.116652	31-Jul-83	6-Aug-83	56	3.113186	0
10800	3	1983	31	0.123083	0.123083	31-Jul-83	6-Aug-83	56	3.113186	0
12500	3	1983	31	0.357341	0.202552	31-Jul-83	6-Aug-83	56	3.113186	0
12500	5	1983	31	0.726308	0.282825	31-Jul-83	6-Aug-83	56	3.113186	0
12512	3	1983	31	2.032537	0.633569	31-Jul-83	6-Aug-83	56	3.113186	0
12512	5	1983	31	21.26647	3.66554	31-Jul-83	6-Aug-83	56	3.113186	0
18005	3	1983	31	35.05263	6.136849	31-Jul-83	6-Aug-83	56	3.113186	0
99799	3	1983	31	7.671222	3.325504	31-Jul-83	6-Aug-83	56	3.113186	0
99799	5	1983	31	0.117179	0.117179	31-Jul-83	6-Aug-83	56	3.113186	0
99799	9	1983	31	38.55744	10.89351	31-Jul-83	6-Aug-83	56	3.113186	0
99899	0	1983	31	0.125539	0.125539	31-Jul-83	6-Aug-83	56	3.113186	0
4000	5	1983	32	0.447079	0.25222	7-Aug-83	13-Aug-83	45	3.162659	0
4001	5	1983	32	0.294374	0.205862	7-Aug-83	13-Aug-83	45	3.162659	0
4005	5	1983	32	0.301893	0.211041	7-Aug-83	13-Aug-83	45	3.162659	0
4100	3	1983	32	438.6097	77.9449	7-Aug-83	13-Aug-83	45	3.162659	0
4100	5	1983	32	3.198443	1.497565	7-Aug-83	13-Aug-83	45	3.162659	0
4109	0	1983	32	82.33898	20.54927	7-Aug-83	13-Aug-83	45	3.162659	0
4109	1	1983	32	5.499908	2.75002	7-Aug-83	13-Aug-83	45	3.162659	0
4109	3	1983	32	368.6881	52.42257	7-Aug-83	13-Aug-83	45	3.162659	0
4109	5	1983	32	4.709885	1.459535	7-Aug-83	13-Aug-83	45	3.162659	0
6199	0	1983	32	0.156321	0.156321	7-Aug-83	13-Aug-83	45	3.162659	0
7915	5	1983	32	0.448215	0.252946	7-Aug-83	13-Aug-83	45	3.162659	0
8909	1	1983	32	0.306175	0.214063	7-Aug-83	13-Aug-83	45	3.162659	0
8913	1	1983	32	0.147825	0.147825	7-Aug-83	13-Aug-83	45	3.162659	0
8913	3	1983	32	0.145658	0.145658	7-Aug-83	13-Aug-83	45	3.162659	0
10320	5	1983	32	1.788941	0.447597	7-Aug-83	13-Aug-83	45	3.162659	0
10501	5	1983	32	0.881194	0.338774	7-Aug-83	13-Aug-83	45	3.162659	0
12500	5	1983	32	2.868371	1.16257	7-Aug-83	13-Aug-83	45	3.162659	0
12512	3	1983	32	0.305363	0.21366	7-Aug-83	13-Aug-83	45	3.162659	0
12512	5	1983	32	21.85627	3.215457	7-Aug-83	13-Aug-83	45	3.162659	0
18005	1	1983	32	0.150231	0.150231	7-Aug-83	13-Aug-83	45	3.162659	0
18005	3	1983	32	6.625099	1.220138	7-Aug-83	13-Aug-83	45	3.162659	0

99799	5	1983	32	0.596505	0.471229	7-Aug-83	13-Aug-83	45	3.162659	0
99799	9	1983	32	24.05572	3.339813	7-Aug-83	13-Aug-83	45	3.162659	0
4100	3	1983	33	181.1271	41.22208	14-Aug-83	14-Aug-83	4	3.179746	0
4100	5	1983	33	3.350982	3.350982	14-Aug-83	14-Aug-83	4	3.179746	0
4109	0	1983	33	3.350982	3.350982	14-Aug-83	14-Aug-83	4	3.179746	0
4109	3	1983	33	354.2204	153.3337	14-Aug-83	14-Aug-83	4	3.179746	0
4109	5	1983	33	26.08183	14.91761	14-Aug-83	14-Aug-83	4	3.179746	0
6199	0	1983	33	1.732406	1.732406	14-Aug-83	14-Aug-83	4	3.179746	0
8909	3	1983	33	1.732406	1.732406	14-Aug-83	14-Aug-83	4	3.179746	0
10320	5	1983	33	1.603407	1.603407	14-Aug-83	14-Aug-83	4	3.179746	0
10501	5	1983	33	1.628558	1.628558	14-Aug-83	14-Aug-83	4	3.179746	0
12512	3	1983	33	1.675491	1.675491	14-Aug-83	14-Aug-83	4	3.179746	0
12512	5	1983	33	12.99658	6.921117	14-Aug-83	14-Aug-83	4	3.179746	0
18005	3	1983	33	5.09337	3.300812	14-Aug-83	14-Aug-83	4	3.179746	0
99799	5	1983	33	1.732406	1.732406	14-Aug-83	14-Aug-83	4	3.179746	0
99799	9	1983	33	9.767981	4.180493	14-Aug-83	14-Aug-83	4	3.179746	0
3001	5	1984	18	2.550165	1.057766	3-May-84	5-May-84	19	2.068128	2.131671
4000	1	1984	18	0.325193	0.325193	3-May-84	5-May-84	19	2.068128	2.131671
4000	3	1984	18	1.329237	0.776355	3-May-84	5-May-84	19	2.068128	2.131671
4007	0	1984	18	3.247522	1.2043	3-May-84	5-May-84	19	2.068128	2.131671
4007	3	1984	18	3.272969	1.287581	3-May-84	5-May-84	19	2.068128	2.131671
7915	3	1984	18	24.34359	24.34359	3-May-84	5-May-84	19	2.068128	2.131671
7915	5	1984	18	80.92718	32.25716	3-May-84	5-May-84	19	2.068128	2.131671
10501	0	1984	18	0.38951	0.38951	3-May-84	5-May-84	19	2.068128	2.131671
10501	9	1984	18	0.629571	0.432674	3-May-84	5-May-84	19	2.068128	2.131671
10504	0	1984	18	0.320995	0.320995	3-May-84	5-May-84	19	2.068128	2.131671
10508	3	1984	18	0.333369	0.333369	3-May-84	5-May-84	19	2.068128	2.131671
10900	3	1984	18	0.653592	0.653592	3-May-84	5-May-84	19	2.068128	2.131671
10900	9	1984	18	3.209674	1.081399	3-May-84	5-May-84	19	2.068128	2.131671
10943	3	1984	18	0.612345	0.612345	3-May-84	5-May-84	19	2.068128	2.131671
10976	1	1984	18	0.329503	0.329503	3-May-84	5-May-84	19	2.068128	2.131671
10976	3	1984	18	3.887518	1.399712	3-May-84	5-May-84	19	2.068128	2.131671
17826	3	1984	18	0.332997	0.332997	3-May-84	5-May-84	19	2.068128	2.131671
18005	5	1984	18	0.327514	0.327514	3-May-84	5-May-84	19	2.068128	2.131671
99799	3	1984	18	0.65199	0.448039	3-May-84	5-May-84	19	2.068128	2.131671
99799	9	1984	18	1.301869	0.594433	3-May-84	5-May-84	19	2.068128	2.131671
99899	0	1984	18	0.306172	0.306172	3-May-84	5-May-84	19	2.068128	2.131671
3001	5	1984	19	1.755139	0.487227	6-May-84	12-May-84	56	2.649263	2.700786
4000	1	1984	19	2.199923	0.637292	6-May-84	12-May-84	56	2.649263	2.700786
4000	3	1984	19	2.113909	0.632919	6-May-84	12-May-84	56	2.649263	2.700786
4000	9	1984	19	0.112918	0.112918	6-May-84	12-May-84	56	2.649263	2.700786
4001	5	1984	19	0.115429	0.115429	6-May-84	12-May-84	56	2.649263	2.700786
4007	0	1984	19	0.772218	0.394755	6-May-84	12-May-84	56	2.649263	2.700786
4007	1	1984	19	0.216599	0.151762	6-May-84	12-May-84	56	2.649263	2.700786
4007	3	1984	19	6.299368	1.612836	6-May-84	12-May-84	56	2.649263	2.700786
7915	5	1984	19	6.738037	2.640104	6-May-84	12-May-84	56	2.649263	2.700786
10501	0	1984	19	0.890566	0.294275	6-May-84	12-May-84	56	2.649263	2.700786
10501	3	1984	19	0.110514	0.110514	6-May-84	12-May-84	56	2.649263	2.700786
10501	9	1984	19	0.114127	0.114127	6-May-84	12-May-84	56	2.649263	2.700786
10504	0	1984	19	0.227678	0.1598	6-May-84	12-May-84	56	2.649263	2.700786
10900	9	1984	19	1.002718	0.378641	6-May-84	12-May-84	56	2.649263	2.700786
10943	1	1984	19	0.109439	0.109439	6-May-84	12-May-84	56	2.649263	2.700786

10943	3	1984	19	0.329901	0.241706	6-May-84	12-May-84	56	2.649263	2.700786
10976	3	1984	19	3.55055	0.899037	6-May-84	12-May-84	56	2.649263	2.700786
18005	5	1984	19	0.111734	0.111734	6-May-84	12-May-84	56	2.649263	2.700786
18005	9	1984	19	0.327501	0.241928	6-May-84	12-May-84	56	2.649263	2.700786
99799	9	1984	19	0.786221	0.280705	6-May-84	12-May-84	56	2.649263	2.700786
99899	0	1984	19	0.113044	0.113044	6-May-84	12-May-84	56	2.649263	2.700786
3001	5	1984	20	1.518702	0.495298	13-May-84	19-May-84	56	2.645425	3.176802
4000	1	1984	20	6.137067	1.533543	13-May-84	19-May-84	56	2.645425	3.176802
4000	3	1984	20	11.82362	1.859691	13-May-84	19-May-84	56	2.645425	3.176802
4006	0	1984	20	0.115495	0.115495	13-May-84	19-May-84	56	2.645425	3.176802
4006	3	1984	20	2.878683	0.99452	13-May-84	19-May-84	56	2.645425	3.176802
4007	0	1984	20	1.38626	0.872939	13-May-84	19-May-84	56	2.645425	3.176802
4007	1	1984	20	0.112981	0.112981	13-May-84	19-May-84	56	2.645425	3.176802
4007	3	1984	20	29.06938	4.168482	13-May-84	19-May-84	56	2.645425	3.176802
4007	5	1984	20	0.235262	0.164952	13-May-84	19-May-84	56	2.645425	3.176802
7915	5	1984	20	1.602001	0.521015	13-May-84	19-May-84	56	2.645425	3.176802
8720	0	1984	20	0.11445	0.11445	13-May-84	19-May-84	56	2.645425	3.176802
10501	0	1984	20	3.307357	1.037676	13-May-84	19-May-84	56	2.645425	3.176802
10501	1	1984	20	0.475207	0.231218	13-May-84	19-May-84	56	2.645425	3.176802
10501	3	1984	20	8.146482	1.955443	13-May-84	19-May-84	56	2.645425	3.176802
10504	0	1984	20	4.62143	1.358063	13-May-84	19-May-84	56	2.645425	3.176802
10504	1	1984	20	0.814979	0.373188	13-May-84	19-May-84	56	2.645425	3.176802
10504	3	1984	20	0.114644	0.114644	13-May-84	19-May-84	56	2.645425	3.176802
10508	9	1984	20	3.514559	1.27662	13-May-84	19-May-84	56	2.645425	3.176802
10900	3	1984	20	0.347961	0.197236	13-May-84	19-May-84	56	2.645425	3.176802
10900	9	1984	20	3.561984	0.760697	13-May-84	19-May-84	56	2.645425	3.176802
10943	1	1984	20	3.685565	0.974601	13-May-84	19-May-84	56	2.645425	3.176802
10943	3	1984	20	1.399421	0.431514	13-May-84	19-May-84	56	2.645425	3.176802
10976	1	1984	20	0.346815	0.19658	13-May-84	19-May-84	56	2.645425	3.176802
10976	3	1984	20	8.655311	1.306765	13-May-84	19-May-84	56	2.645425	3.176802
18005	5	1984	20	0.22787	0.159657	13-May-84	19-May-84	56	2.645425	3.176802
18005	9	1984	20	0.117301	0.117301	13-May-84	19-May-84	56	2.645425	3.176802
99799	9	1984	20	3.287485	0.601503	13-May-84	19-May-84	56	2.645425	3.176802
99899	0	1984	20	0.124286	0.124286	13-May-84	19-May-84	56	2.645425	3.176802
3001	5	1984	21	0.827664	0.295413	20-May-84	26-May-84	56	2.730071	3.178274
4000	0	1984	21	0.238471	0.238471	20-May-84	26-May-84	56	2.730071	3.178274
4000	1	1984	21	12.00046	1.985982	20-May-84	26-May-84	56	2.730071	3.178274
4000	3	1984	21	32.45765	4.894675	20-May-84	26-May-84	56	2.730071	3.178274
4000	5	1984	21	0.119588	0.119588	20-May-84	26-May-84	56	2.730071	3.178274
4006	0	1984	21	0.723522	0.408319	20-May-84	26-May-84	56	2.730071	3.178274
4006	3	1984	21	1.932138	0.68357	20-May-84	26-May-84	56	2.730071	3.178274
4007	0	1984	21	3.840301	1.067444	20-May-84	26-May-84	56	2.730071	3.178274
4007	3	1984	21	100.8345	15.54954	20-May-84	26-May-84	56	2.730071	3.178274
4007	5	1984	21	1.544968	0.556349	20-May-84	26-May-84	56	2.730071	3.178274
4406	3	1984	21	7.671807	1.80497	20-May-84	26-May-84	56	2.730071	3.178274
6199	3	1984	21	0.241413	0.169198	20-May-84	26-May-84	56	2.730071	3.178274
7915	5	1984	21	2.099452	0.755837	20-May-84	26-May-84	56	2.730071	3.178274
10501	0	1984	21	4.872742	1.810002	20-May-84	26-May-84	56	2.730071	3.178274
10501	1	1984	21	1.074329	0.406437	20-May-84	26-May-84	56	2.730071	3.178274
10501	3	1984	21	72.00801	9.145125	20-May-84	26-May-84	56	2.730071	3.178274
10501	9	1984	21	0.122112	0.122112	20-May-84	26-May-84	56	2.730071	3.178274
10504	0	1984	21	8.791161	2.179887	20-May-84	26-May-84	56	2.730071	3.178274

10504	1	1984	21	3.093845	0.586677	20-May-84	26-May-84	56	2.730071	3.178274
10504	3	1984	21	3.043638	0.708066	20-May-84	26-May-84	56	2.730071	3.178274
10508	9	1984	21	7.632888	1.833412	20-May-84	26-May-84	56	2.730071	3.178274
10800	1	1984	21	0.229325	0.160697	20-May-84	26-May-84	56	2.730071	3.178274
10900	3	1984	21	0.465479	0.36392	20-May-84	26-May-84	56	2.730071	3.178274
10900	9	1984	21	1.317959	0.550809	20-May-84	26-May-84	56	2.730071	3.178274
10943	1	1984	21	7.987445	1.607127	20-May-84	26-May-84	56	2.730071	3.178274
10943	3	1984	21	1.550166	0.620844	20-May-84	26-May-84	56	2.730071	3.178274
10976	1	1984	21	0.122186	0.122186	20-May-84	26-May-84	56	2.730071	3.178274
10976	3	1984	21	6.487023	1.158441	20-May-84	26-May-84	56	2.730071	3.178274
17818	5	1984	21	0.121453	0.121453	20-May-84	26-May-84	56	2.730071	3.178274
18005	5	1984	21	0.114837	0.114837	20-May-84	26-May-84	56	2.730071	3.178274
99799	3	1984	21	0.113225	0.113225	20-May-84	26-May-84	56	2.730071	3.178274
99799	9	1984	21	2.139642	0.655793	20-May-84	26-May-84	56	2.730071	3.178274
99899	0	1984	21	0.828491	0.38202	20-May-84	26-May-84	56	2.730071	3.178274
3001	5	1984	22	0.230978	0.161809	27-May-84	2-Jun-84	55	2.628758	3.134794
4000	1	1984	22	502.8779	143.3383	27-May-84	2-Jun-84	55	2.628758	3.134794
4000	3	1984	22	430.3338	133.7289	27-May-84	2-Jun-84	55	2.628758	3.134794
4000	5	1984	22	0.110296	0.110296	27-May-84	2-Jun-84	55	2.628758	3.134794
4005	5	1984	22	0.105986	0.105986	27-May-84	2-Jun-84	55	2.628758	3.134794
4006	1	1984	22	1.198588	0.569874	27-May-84	2-Jun-84	55	2.628758	3.134794
4006	3	1984	22	154.8155	40.71624	27-May-84	2-Jun-84	55	2.628758	3.134794
4006	5	1984	22	0.11488	0.11488	27-May-84	2-Jun-84	55	2.628758	3.134794
4007	0	1984	22	0.753213	0.407155	27-May-84	2-Jun-84	55	2.628758	3.134794
4007	1	1984	22	7.31197	2.718423	27-May-84	2-Jun-84	55	2.628758	3.134794
4007	3	1984	22	1782.385	421.6109	27-May-84	2-Jun-84	55	2.628758	3.134794
4007	5	1984	22	0.517506	0.228423	27-May-84	2-Jun-84	55	2.628758	3.134794
4100	5	1984	22	0.243854	0.170835	27-May-84	2-Jun-84	55	2.628758	3.134794
4109	0	1984	22	3.235234	1.978989	27-May-84	2-Jun-84	55	2.628758	3.134794
4109	3	1984	22	0.247976	0.247976	27-May-84	2-Jun-84	55	2.628758	3.134794
4109	9	1984	22	0.644143	0.327136	27-May-84	2-Jun-84	55	2.628758	3.134794
4406	1	1984	22	0.3225	0.238214	27-May-84	2-Jun-84	55	2.628758	3.134794
4406	3	1984	22	5.720743	0.910915	27-May-84	2-Jun-84	55	2.628758	3.134794
4406	9	1984	22	0.221778	0.221778	27-May-84	2-Jun-84	55	2.628758	3.134794
6199	1	1984	22	7.241889	3.109081	27-May-84	2-Jun-84	55	2.628758	3.134794
6199	3	1984	22	6.869614	1.750274	27-May-84	2-Jun-84	55	2.628758	3.134794
6208	3	1984	22	0.647738	0.292747	27-May-84	2-Jun-84	55	2.628758	3.134794
7915	5	1984	22	1.56818	0.597093	27-May-84	2-Jun-84	55	2.628758	3.134794
10501	0	1984	22	10.32243	2.428817	27-May-84	2-Jun-84	55	2.628758	3.134794
10501	1	1984	22	9.79414	2.157527	27-May-84	2-Jun-84	55	2.628758	3.134794
10501	3	1984	22	77.14247	10.73165	27-May-84	2-Jun-84	55	2.628758	3.134794
10501	5	1984	22	0.227823	0.159617	27-May-84	2-Jun-84	55	2.628758	3.134794
10504	0	1984	22	0.66677	0.66677	27-May-84	2-Jun-84	55	2.628758	3.134794
10504	1	1984	22	3.053877	1.111024	27-May-84	2-Jun-84	55	2.628758	3.134794
10504	3	1984	22	8.506704	2.830677	27-May-84	2-Jun-84	55	2.628758	3.134794
10508	1	1984	22	0.208541	0.208541	27-May-84	2-Jun-84	55	2.628758	3.134794
10508	9	1984	22	8.234871	1.868528	27-May-84	2-Jun-84	55	2.628758	3.134794
10800	3	1984	22	0.968578	0.426769	27-May-84	2-Jun-84	55	2.628758	3.134794
10900	9	1984	22	0.427776	0.207872	27-May-84	2-Jun-84	55	2.628758	3.134794
10943	1	1984	22	15.35816	3.390341	27-May-84	2-Jun-84	55	2.628758	3.134794
10943	3	1984	22	8.082898	2.365766	27-May-84	2-Jun-84	55	2.628758	3.134794
10976	1	1984	22	0.771251	0.470436	27-May-84	2-Jun-84	55	2.628758	3.134794

10976	3	1984	22	2.463816	0.628082	27-May-84	2-Jun-84	55	2.628758	3.134794
18005	5	1984	22	0.338204	0.191831	27-May-84	2-Jun-84	55	2.628758	3.134794
36250	9	1984	22	7166.182	2096.119	27-May-84	2-Jun-84	55	2.628758	3.134794
99799	9	1984	22	5.309293	1.898481	27-May-84	2-Jun-84	55	2.628758	3.134794
99899	0	1984	22	1.523376	0.54369	27-May-84	2-Jun-84	55	2.628758	3.134794
3001	5	1984	23	0.768871	0.440624	3-Jun-84	9-Jun-84	49	0.216105	3.175856
4000	0	1984	23	0.134214	0.134214	3-Jun-84	9-Jun-84	49	0.216105	3.175856
4000	1	1984	23	918.8664	181.1448	3-Jun-84	9-Jun-84	49	0.216105	3.175856
4000	3	1984	23	626.9749	120.8043	3-Jun-84	9-Jun-84	49	0.216105	3.175856
4001	5	1984	23	0.129121	0.129121	3-Jun-84	9-Jun-84	49	0.216105	3.175856
4006	1	1984	23	2.804104	1.538439	3-Jun-84	9-Jun-84	49	0.216105	3.175856
4006	3	1984	23	251.0693	55.49545	3-Jun-84	9-Jun-84	49	0.216105	3.175856
4007	0	1984	23	2.839755	0.773272	3-Jun-84	9-Jun-84	49	0.216105	3.175856
4007	1	1984	23	1.23074	0.658845	3-Jun-84	9-Jun-84	49	0.216105	3.175856
4007	3	1984	23	1930.288	321.5355	3-Jun-84	9-Jun-84	49	0.216105	3.175856
4007	5	1984	23	0.393155	0.222258	3-Jun-84	9-Jun-84	49	0.216105	3.175856
4109	0	1984	23	2.961963	1.301119	3-Jun-84	9-Jun-84	49	0.216105	3.175856
4109	5	1984	23	0.123208	0.123208	3-Jun-84	9-Jun-84	49	0.216105	3.175856
4109	9	1984	23	0.247207	0.172971	3-Jun-84	9-Jun-84	49	0.216105	3.175856
4406	3	1984	23	0.401484	0.226919	3-Jun-84	9-Jun-84	49	0.216105	3.175856
6199	0	1984	23	0.123208	0.123208	3-Jun-84	9-Jun-84	49	0.216105	3.175856
6199	1	1984	23	14.4297	3.079982	3-Jun-84	9-Jun-84	49	0.216105	3.175856
6199	3	1984	23	6.572102	1.593605	3-Jun-84	9-Jun-84	49	0.216105	3.175856
7915	5	1984	23	1.278382	0.447614	3-Jun-84	9-Jun-84	49	0.216105	3.175856
10501	0	1984	23	7.250949	1.734385	3-Jun-84	9-Jun-84	49	0.216105	3.175856
10501	1	1984	23	2.919019	0.837862	3-Jun-84	9-Jun-84	49	0.216105	3.175856
10501	3	1984	23	25.74337	4.907837	3-Jun-84	9-Jun-84	49	0.216105	3.175856
10501	5	1984	23	0.126371	0.126371	3-Jun-84	9-Jun-84	49	0.216105	3.175856
10504	0	1984	23	0.373526	0.211132	3-Jun-84	9-Jun-84	49	0.216105	3.175856
10504	1	1984	23	0.625089	0.316724	3-Jun-84	9-Jun-84	49	0.216105	3.175856
10504	3	1984	23	0.628481	0.26918	3-Jun-84	9-Jun-84	49	0.216105	3.175856
10508	9	1984	23	2.04417	0.695281	3-Jun-84	9-Jun-84	49	0.216105	3.175856
10800	1	1984	23	0.123405	0.123405	3-Jun-84	9-Jun-84	49	0.216105	3.175856
10800	3	1984	23	0.123802	0.123802	3-Jun-84	9-Jun-84	49	0.216105	3.175856
10900	9	1984	23	0.258016	0.180687	3-Jun-84	9-Jun-84	49	0.216105	3.175856
10943	1	1984	23	19.39063	2.103648	3-Jun-84	9-Jun-84	49	0.216105	3.175856
10943	3	1984	23	10.67587	1.914999	3-Jun-84	9-Jun-84	49	0.216105	3.175856
10943	5	1984	23	0.12548	0.12548	3-Jun-84	9-Jun-84	49	0.216105	3.175856
10976	1	1984	23	1.88933	0.543227	3-Jun-84	9-Jun-84	49	0.216105	3.175856
10976	3	1984	23	2.260171	0.844048	3-Jun-84	9-Jun-84	49	0.216105	3.175856
18005	9	1984	23	0.135949	0.135949	3-Jun-84	9-Jun-84	49	0.216105	3.175856
36250	9	1984	23	56957.14	5409.871	3-Jun-84	9-Jun-84	49	0.216105	3.175856
99799	9	1984	23	10.08534	3.068285	3-Jun-84	9-Jun-84	49	0.216105	3.175856
99899	0	1984	23	0.771889	0.348872	3-Jun-84	9-Jun-84	49	0.216105	3.175856
99899	9	1984	23	0.123802	0.123802	3-Jun-84	9-Jun-84	49	0.216105	3.175856
3001	5	1984	24	1.580763	0.487219	10-Jun-84	16-Jun-84	56	0	3.113554
4000	1	1984	24	36.94784	12.0806	10-Jun-84	16-Jun-84	56	0	3.113554
4000	3	1984	24	29.31969	6.821264	10-Jun-84	16-Jun-84	56	0	3.113554
4006	3	1984	24	2.756175	1.07047	10-Jun-84	16-Jun-84	56	0	3.113554
4007	0	1984	24	4.908489	1.125968	10-Jun-84	16-Jun-84	56	0	3.113554
4007	1	1984	24	0.113999	0.113999	10-Jun-84	16-Jun-84	56	0	3.113554
4007	3	1984	24	47.47971	11.37965	10-Jun-84	16-Jun-84	56	0	3.113554

4109	0	1984	24	14.29148	4.135283	10-Jun-84	16-Jun-84	56	0	3.113554
4406	3	1984	24	0.712016	0.277557	10-Jun-84	16-Jun-84	56	0	3.113554
6199	0	1984	24	0.12138	0.12138	10-Jun-84	16-Jun-84	56	0	3.113554
6199	1	1984	24	4.407901	1.156162	10-Jun-84	16-Jun-84	56	0	3.113554
6199	3	1984	24	1.728579	0.611305	10-Jun-84	16-Jun-84	56	0	3.113554
7915	5	1984	24	4.813815	0.829509	10-Jun-84	16-Jun-84	56	0	3.113554
10501	0	1984	24	5.763991	1.492983	10-Jun-84	16-Jun-84	56	0	3.113554
10501	1	1984	24	1.639484	0.598607	10-Jun-84	16-Jun-84	56	0	3.113554
10501	3	1984	24	9.129336	1.733308	10-Jun-84	16-Jun-84	56	0	3.113554
10501	5	1984	24	0.112416	0.112416	10-Jun-84	16-Jun-84	56	0	3.113554
10504	1	1984	24	7.379779	2.92473	10-Jun-84	16-Jun-84	56	0	3.113554
10504	3	1984	24	24.32819	5.02872	10-Jun-84	16-Jun-84	56	0	3.113554
10508	1	1984	24	0.245557	0.245557	10-Jun-84	16-Jun-84	56	0	3.113554
10508	3	1984	24	1.524041	0.819595	10-Jun-84	16-Jun-84	56	0	3.113554
10508	9	1984	24	19.43694	3.432285	10-Jun-84	16-Jun-84	56	0	3.113554
10800	3	1984	24	0.368705	0.271255	10-Jun-84	16-Jun-84	56	0	3.113554
10900	1	1984	24	0.221633	0.221633	10-Jun-84	16-Jun-84	56	0	3.113554
10900	9	1984	24	0.955036	0.526642	10-Jun-84	16-Jun-84	56	0	3.113554
10943	1	1984	24	4.380254	0.968439	10-Jun-84	16-Jun-84	56	0	3.113554
10943	3	1984	24	1.719568	0.477819	10-Jun-84	16-Jun-84	56	0	3.113554
10976	1	1984	24	0.115363	0.115363	10-Jun-84	16-Jun-84	56	0	3.113554
10976	3	1984	24	0.115297	0.115297	10-Jun-84	16-Jun-84	56	0	3.113554
18005	5	1984	24	0.12037	0.12037	10-Jun-84	16-Jun-84	56	0	3.113554
99799	9	1984	24	5.17273	1.629588	10-Jun-84	16-Jun-84	56	0	3.113554
99899	0	1984	24	3.742317	3.049389	10-Jun-84	16-Jun-84	56	0	3.113554
99899	1	1984	24	0.115297	0.115297	10-Jun-84	16-Jun-84	56	0	3.113554
99899	9	1984	24	0.122779	0.122779	10-Jun-84	16-Jun-84	56	0	3.113554
3001	5	1984	25	1.068217	0.404396	17-Jun-84	23-Jun-84	53	0	3.077172
4000	1	1984	25	0.481469	0.292097	17-Jun-84	23-Jun-84	53	0	3.077172
4000	3	1984	25	4.096864	0.96337	17-Jun-84	23-Jun-84	53	0	3.077172
4000	5	1984	25	0.129807	0.129807	17-Jun-84	23-Jun-84	53	0	3.077172
4007	0	1984	25	0.602495	0.312671	17-Jun-84	23-Jun-84	53	0	3.077172
4007	3	1984	25	7.286195	1.031395	17-Jun-84	23-Jun-84	53	0	3.077172
4007	5	1984	25	0.354217	0.200709	17-Jun-84	23-Jun-84	53	0	3.077172
4100	3	1984	25	0.120587	0.120587	17-Jun-84	23-Jun-84	53	0	3.077172
4109	0	1984	25	65.1729	24.12703	17-Jun-84	23-Jun-84	53	0	3.077172
4109	3	1984	25	0.970091	0.469832	17-Jun-84	23-Jun-84	53	0	3.077172
4109	5	1984	25	0.590211	0.420209	17-Jun-84	23-Jun-84	53	0	3.077172
4406	3	1984	25	0.3783	0.28073	17-Jun-84	23-Jun-84	53	0	3.077172
4406	5	1984	25	0.494766	0.301359	17-Jun-84	23-Jun-84	53	0	3.077172
6199	1	1984	25	2.706692	0.627502	17-Jun-84	23-Jun-84	53	0	3.077172
6199	3	1984	25	0.608287	0.319798	17-Jun-84	23-Jun-84	53	0	3.077172
7915	5	1984	25	2.16472	0.590369	17-Jun-84	23-Jun-84	53	0	3.077172
8913	3	1984	25	0.116199	0.116199	17-Jun-84	23-Jun-84	53	0	3.077172
10501	0	1984	25	9.331766	3.054811	17-Jun-84	23-Jun-84	53	0	3.077172
10501	1	1984	25	3.00984	0.91017	17-Jun-84	23-Jun-84	53	0	3.077172
10501	3	1984	25	138.3683	24.94305	17-Jun-84	23-Jun-84	53	0	3.077172
10504	0	1984	25	0.115012	0.115012	17-Jun-84	23-Jun-84	53	0	3.077172
10504	1	1984	25	5.465277	1.815918	17-Jun-84	23-Jun-84	53	0	3.077172
10504	3	1984	25	427.2813	45.91867	17-Jun-84	23-Jun-84	53	0	3.077172
10508	3	1984	25	6.826193	1.891356	17-Jun-84	23-Jun-84	53	0	3.077172
10508	9	1984	25	53.32795	7.242052	17-Jun-84	23-Jun-84	53	0	3.077172

10800	3	1984	25	0.360519	0.204137	17-Jun-84	23-Jun-84	53	0	3.077172
10900	9	1984	25	0.248142	0.173836	17-Jun-84	23-Jun-84	53	0	3.077172
10943	1	1984	25	2.075952	0.48647	17-Jun-84	23-Jun-84	53	0	3.077172
10943	3	1984	25	0.363054	0.205722	17-Jun-84	23-Jun-84	53	0	3.077172
99799	9	1984	25	2.167536	0.7755	17-Jun-84	23-Jun-84	53	0	3.077172
99899	0	1984	25	2.463793	0.960539	17-Jun-84	23-Jun-84	53	0	3.077172
99899	9	1984	25	1.004919	1.004919	17-Jun-84	23-Jun-84	53	0	3.077172
3001	5	1984	26	1.008722	0.496086	24-Jun-84	30-Jun-84	56	0	3.128643
4007	0	1984	26	0.120729	0.120729	24-Jun-84	30-Jun-84	56	0	3.128643
4007	3	1984	26	0.461928	0.272324	24-Jun-84	30-Jun-84	56	0	3.128643
4100	1	1984	26	2.65603	2.65603	24-Jun-84	30-Jun-84	56	0	3.128643
4100	3	1984	26	118.6542	21.8425	24-Jun-84	30-Jun-84	56	0	3.128643
4109	0	1984	26	1020.543	155.8934	24-Jun-84	30-Jun-84	56	0	3.128643
4109	1	1984	26	54.37145	16.64524	24-Jun-84	30-Jun-84	56	0	3.128643
4109	3	1984	26	593.1578	116.9476	24-Jun-84	30-Jun-84	56	0	3.128643
4109	5	1984	26	0.675582	0.376966	24-Jun-84	30-Jun-84	56	0	3.128643
4109	9	1984	26	0.109855	0.109855	24-Jun-84	30-Jun-84	56	0	3.128643
4406	3	1984	26	0.448863	0.266796	24-Jun-84	30-Jun-84	56	0	3.128643
4406	5	1984	26	3.090791	0.764325	24-Jun-84	30-Jun-84	56	0	3.128643
6199	1	1984	26	2.781431	0.809845	24-Jun-84	30-Jun-84	56	0	3.128643
6199	3	1984	26	8.116675	1.475921	24-Jun-84	30-Jun-84	56	0	3.128643
6199	9	1984	26	0.122779	0.122779	24-Jun-84	30-Jun-84	56	0	3.128643
7915	5	1984	26	4.128428	1.335839	24-Jun-84	30-Jun-84	56	0	3.128643
8909	3	1984	26	0.696552	0.316521	24-Jun-84	30-Jun-84	56	0	3.128643
8913	3	1984	26	0.589465	0.299995	24-Jun-84	30-Jun-84	56	0	3.128643
10501	0	1984	26	5.354638	2.501084	24-Jun-84	30-Jun-84	56	0	3.128643
10501	1	1984	26	7.662867	4.609491	24-Jun-84	30-Jun-84	56	0	3.128643
10501	3	1984	26	242.7184	26.78691	24-Jun-84	30-Jun-84	56	0	3.128643
10504	1	1984	26	14.00049	7.515021	24-Jun-84	30-Jun-84	56	0	3.128643
10504	3	1984	26	503.4242	53.99553	24-Jun-84	30-Jun-84	56	0	3.128643
10504	9	1984	26	0.85789	0.85789	24-Jun-84	30-Jun-84	56	0	3.128643
10508	3	1984	26	5.63152	1.870892	24-Jun-84	30-Jun-84	56	0	3.128643
10508	9	1984	26	21.71728	4.179983	24-Jun-84	30-Jun-84	56	0	3.128643
10800	0	1984	26	0.127656	0.127656	24-Jun-84	30-Jun-84	56	0	3.128643
10800	1	1984	26	0.349911	0.198722	24-Jun-84	30-Jun-84	56	0	3.128643
10800	3	1984	26	1.220717	0.394699	24-Jun-84	30-Jun-84	56	0	3.128643
10943	1	1984	26	0.351678	0.263233	24-Jun-84	30-Jun-84	56	0	3.128643
18005	0	1984	26	0.823062	0.536699	24-Jun-84	30-Jun-84	56	0	3.128643
18005	5	1984	26	0.126539	0.126539	24-Jun-84	30-Jun-84	56	0	3.128643
99799	9	1984	26	1.358709	0.562192	24-Jun-84	30-Jun-84	56	0	3.128643
99899	0	1984	26	1.59403	0.944024	24-Jun-84	30-Jun-84	56	0	3.128643
99899	3	1984	26	0.109557	0.109557	24-Jun-84	30-Jun-84	56	0	3.128643
3001	5	1984	27	0.235173	0.165251	1-Jul-84	7-Jul-84	56	0	3.179746
4007	3	1984	27	0.114385	0.114385	1-Jul-84	7-Jul-84	56	0	3.179746
4100	3	1984	27	338.4172	73.2986	1-Jul-84	7-Jul-84	56	0	3.179746
4109	0	1984	27	54.48409	17.47231	1-Jul-84	7-Jul-84	56	0	3.179746
4109	1	1984	27	4.281903	4.172609	1-Jul-84	7-Jul-84	56	0	3.179746
4109	3	1984	27	1082.487	226.6385	1-Jul-84	7-Jul-84	56	0	3.179746
4109	5	1984	27	0.55832	0.365068	1-Jul-84	7-Jul-84	56	0	3.179746
4109	9	1984	27	1.032392	0.359853	1-Jul-84	7-Jul-84	56	0	3.179746
6199	1	1984	27	3.08698	0.95503	1-Jul-84	7-Jul-84	56	0	3.179746
6199	3	1984	27	4.527428	1.330808	1-Jul-84	7-Jul-84	56	0	3.179746

7915	5	1984	27	4.716614	0.748996	1-Jul-84	7-Jul-84	56	0	3.179746
8909	1	1984	27	0.188162	0.188162	1-Jul-84	7-Jul-84	56	0	3.179746
8909	3	1984	27	4.917099	1.704274	1-Jul-84	7-Jul-84	56	0	3.179746
8913	3	1984	27	1.591047	0.541944	1-Jul-84	7-Jul-84	56	0	3.179746
8913	9	1984	27	0.108734	0.108734	1-Jul-84	7-Jul-84	56	0	3.179746
10501	0	1984	27	1.978059	0.797271	1-Jul-84	7-Jul-84	56	0	3.179746
10501	1	1984	27	0.229079	0.160522	1-Jul-84	7-Jul-84	56	0	3.179746
10501	3	1984	27	45.35845	6.5705	1-Jul-84	7-Jul-84	56	0	3.179746
10501	5	1984	27	0.567443	0.290529	1-Jul-84	7-Jul-84	56	0	3.179746
10504	1	1984	27	0.225584	0.158056	1-Jul-84	7-Jul-84	56	0	3.179746
10504	3	1984	27	344.1567	45.40861	1-Jul-84	7-Jul-84	56	0	3.179746
10504	5	1984	27	1.981843	0.689987	1-Jul-84	7-Jul-84	56	0	3.179746
10508	3	1984	27	7.613255	2.236862	1-Jul-84	7-Jul-84	56	0	3.179746
10508	9	1984	27	1.528013	0.658241	1-Jul-84	7-Jul-84	56	0	3.179746
10800	1	1984	27	0.304386	0.219357	1-Jul-84	7-Jul-84	56	0	3.179746
10800	3	1984	27	0.814874	0.335423	1-Jul-84	7-Jul-84	56	0	3.179746
10943	1	1984	27	0.225263	0.15785	1-Jul-84	7-Jul-84	56	0	3.179746
18005	0	1984	27	0.112855	0.112855	1-Jul-84	7-Jul-84	56	0	3.179746
18005	5	1984	27	0.250882	0.250882	1-Jul-84	7-Jul-84	56	0	3.179746
99799	9	1984	27	0.823371	0.413845	1-Jul-84	7-Jul-84	56	0	3.179746
3001	5	1984	28	0.128384	0.128384	8-Jul-84	14-Jul-84	56	0	3.174594
4007	3	1984	28	0.255737	0.179395	8-Jul-84	14-Jul-84	56	0	3.174594
4100	3	1984	28	6.623305	1.203072	8-Jul-84	14-Jul-84	56	0	3.174594
4109	3	1984	28	12.50669	2.36885	8-Jul-84	14-Jul-84	56	0	3.174594
4109	5	1984	28	0.584404	0.376099	8-Jul-84	14-Jul-84	56	0	3.174594
4109	9	1984	28	0.90969	0.338868	8-Jul-84	14-Jul-84	56	0	3.174594
6199	1	1984	28	0.469333	0.2868	8-Jul-84	14-Jul-84	56	0	3.174594
6402	3	1984	28	0.110153	0.110153	8-Jul-84	14-Jul-84	56	0	3.174594
6407	5	1984	28	0.119588	0.119588	8-Jul-84	14-Jul-84	56	0	3.174594
7915	5	1984	28	1.037615	0.358845	8-Jul-84	14-Jul-84	56	0	3.174594
8909	3	1984	28	0.350885	0.199081	8-Jul-84	14-Jul-84	56	0	3.174594
8913	3	1984	28	0.111182	0.111182	8-Jul-84	14-Jul-84	56	0	3.174594
10501	0	1984	28	0.120729	0.120729	8-Jul-84	14-Jul-84	56	0	3.174594
10501	3	1984	28	5.088675	1.201543	8-Jul-84	14-Jul-84	56	0	3.174594
10501	5	1984	28	0.239378	0.168074	8-Jul-84	14-Jul-84	56	0	3.174594
10504	1	1984	28	0.122112	0.122112	8-Jul-84	14-Jul-84	56	0	3.174594
10504	3	1984	28	65.3533	10.45536	8-Jul-84	14-Jul-84	56	0	3.174594
10504	5	1984	28	3.136174	0.721953	8-Jul-84	14-Jul-84	56	0	3.174594
10508	3	1984	28	8.804353	3.464993	8-Jul-84	14-Jul-84	56	0	3.174594
10508	9	1984	28	0.230063	0.161332	8-Jul-84	14-Jul-84	56	0	3.174594
10800	3	1984	28	0.354822	0.201211	8-Jul-84	14-Jul-84	56	0	3.174594
99799	3	1984	28	0.236953	0.166052	8-Jul-84	14-Jul-84	56	0	3.174594
99899	9	1984	28	0.111182	0.111182	8-Jul-84	14-Jul-84	56	0	3.174594
4100	3	1984	29	19.24244	3.733796	15-Jul-84	21-Jul-84	56	0	3.177275
4109	3	1984	29	90.44738	22.22162	15-Jul-84	21-Jul-84	56	0	3.177275
4109	5	1984	29	0.462474	0.279974	15-Jul-84	21-Jul-84	56	0	3.177275
4109	9	1984	29	0.243195	0.170711	15-Jul-84	21-Jul-84	56	0	3.177275
7915	0	1984	29	0.122039	0.122039	15-Jul-84	21-Jul-84	56	0	3.177275
7915	5	1984	29	0.707456	0.364193	15-Jul-84	21-Jul-84	56	0	3.177275
8909	3	1984	29	0.454206	0.221058	15-Jul-84	21-Jul-84	56	0	3.177275
8913	3	1984	29	0.110514	0.110514	15-Jul-84	21-Jul-84	56	0	3.177275
10501	3	1984	29	3.310928	0.779934	15-Jul-84	21-Jul-84	56	0	3.177275

10501	5	1984	29	1.341536	0.379747	15-Jul-84	21-Jul-84	56	0	3.177275
10504	3	1984	29	6.04323	1.054118	15-Jul-84	21-Jul-84	56	0	3.177275
10504	5	1984	29	1.943332	0.562632	15-Jul-84	21-Jul-84	56	0	3.177275
10508	3	1984	29	0.356041	0.2022	15-Jul-84	21-Jul-84	56	0	3.177275
10508	5	1984	29	0.107009	0.107009	15-Jul-84	21-Jul-84	56	0	3.177275
12512	3	1984	29	12.56936	6.806707	15-Jul-84	21-Jul-84	56	0	3.177275
12512	5	1984	29	1.462445	0.900736	15-Jul-84	21-Jul-84	56	0	3.177275
3001	5	1984	30	0.244081	0.171017	22-Jul-84	28-Jul-84	56	0	3.179746
4006	5	1984	30	0.122556	0.122556	22-Jul-84	28-Jul-84	56	0	3.179746
4100	3	1984	30	308.6632	79.0229	22-Jul-84	28-Jul-84	56	0	3.179746
4100	5	1984	30	0.339222	0.192302	22-Jul-84	28-Jul-84	56	0	3.179746
4109	0	1984	30	2946.848	571.6296	22-Jul-84	28-Jul-84	56	0	3.179746
4109	1	1984	30	3.518892	3.518892	22-Jul-84	28-Jul-84	56	0	3.179746
4109	3	1984	30	1554.294	210.7091	22-Jul-84	28-Jul-84	56	0	3.179746
4109	5	1984	30	1.148095	0.368879	22-Jul-84	28-Jul-84	56	0	3.179746
4109	9	1984	30	0.339358	0.192363	22-Jul-84	28-Jul-84	56	0	3.179746
4406	3	1984	30	0.440374	0.440374	22-Jul-84	28-Jul-84	56	0	3.179746
4406	5	1984	30	0.22073	0.154677	22-Jul-84	28-Jul-84	56	0	3.179746
6199	1	1984	30	0.232902	0.163226	22-Jul-84	28-Jul-84	56	0	3.179746
6199	3	1984	30	0.241824	0.169436	22-Jul-84	28-Jul-84	56	0	3.179746
8720	3	1984	30	0.114127	0.114127	22-Jul-84	28-Jul-84	56	0	3.179746
8913	3	1984	30	0.335413	0.190181	22-Jul-84	28-Jul-84	56	0	3.179746
10320	5	1984	30	0.475701	0.289254	22-Jul-84	28-Jul-84	56	0	3.179746
10501	3	1984	30	0.347749	0.197234	22-Jul-84	28-Jul-84	56	0	3.179746
10501	5	1984	30	1.829932	0.528213	22-Jul-84	28-Jul-84	56	0	3.179746
10504	3	1984	30	0.457968	0.357187	22-Jul-84	28-Jul-84	56	0	3.179746
10504	5	1984	30	1.852094	0.615606	22-Jul-84	28-Jul-84	56	0	3.179746
10800	3	1984	30	0.244668	0.171427	22-Jul-84	28-Jul-84	56	0	3.179746
12500	3	1984	30	2.546461	0.806568	22-Jul-84	28-Jul-84	56	0	3.179746
12500	5	1984	30	0.342382	0.342382	22-Jul-84	28-Jul-84	56	0	3.179746
12512	3	1984	30	51.08136	8.704585	22-Jul-84	28-Jul-84	56	0	3.179746
12512	5	1984	30	23.42334	5.852099	22-Jul-84	28-Jul-84	56	0	3.179746
17110	3	1984	30	0.111182	0.111182	22-Jul-84	28-Jul-84	56	0	3.179746
17830	5	1984	30	0.121526	0.121526	22-Jul-84	28-Jul-84	56	0	3.179746
18005	1	1984	30	0.970518	0.76824	22-Jul-84	28-Jul-84	56	0	3.179746
18005	3	1984	30	15.72365	6.168344	22-Jul-84	28-Jul-84	56	0	3.179746
99799	9	1984	30	0.110999	0.110999	22-Jul-84	28-Jul-84	56	0	3.179746
3001	5	1984	31	0.58537	0.252099	29-Jul-84	4-Aug-84	55	0	2.858354
4001	5	1984	31	0.464563	0.325493	29-Jul-84	4-Aug-84	55	0	2.858354
4100	3	1984	31	270.988	37.85859	29-Jul-84	4-Aug-84	55	0	2.858354
4100	5	1984	31	0.426333	0.281104	29-Jul-84	4-Aug-84	55	0	2.858354
4109	0	1984	31	3090.099	950.8284	29-Jul-84	4-Aug-84	55	0	2.858354
4109	1	1984	31	46.39506	28.70253	29-Jul-84	4-Aug-84	55	0	2.858354
4109	3	1984	31	1927.696	286.382	29-Jul-84	4-Aug-84	55	0	2.858354
4109	5	1984	31	4.561457	1.646529	29-Jul-84	4-Aug-84	55	0	2.858354
4109	9	1984	31	2.433357	0.922382	29-Jul-84	4-Aug-84	55	0	2.858354
4406	5	1984	31	1.119164	0.464435	29-Jul-84	4-Aug-84	55	0	2.858354
7915	5	1984	31	0.17209	0.127427	29-Jul-84	4-Aug-84	55	0	2.858354
8909	3	1984	31	1.985426	0.682341	29-Jul-84	4-Aug-84	55	0	2.858354
8913	1	1984	31	0.241952	0.241952	29-Jul-84	4-Aug-84	55	0	2.858354
8913	3	1984	31	0.58622	0.252345	29-Jul-84	4-Aug-84	55	0	2.858354
10320	5	1984	31	0.249569	0.174831	29-Jul-84	4-Aug-84	55	0	2.858354

10501	5	1984	31	1.130818	0.370523	29-Jul-84	4-Aug-84	55	0	2.858354
10504	5	1984	31	1.047519	0.39728	29-Jul-84	4-Aug-84	55	0	2.858354
10800	3	1984	31	0.369225	0.209236	29-Jul-84	4-Aug-84	55	0	2.858354
12500	3	1984	31	5.578414	3.249164	29-Jul-84	4-Aug-84	55	0	2.858354
12512	3	1984	31	58.59598	15.20162	29-Jul-84	4-Aug-84	55	0	2.858354
12512	5	1984	31	93.79293	12.34537	29-Jul-84	4-Aug-84	55	0	2.858354
18005	1	1984	31	0.437223	0.383324	29-Jul-84	4-Aug-84	55	0	2.858354
18005	3	1984	31	8.8779	2.399993	29-Jul-84	4-Aug-84	55	0	2.858354
99899	0	1984	31	0.123291	0.123291	29-Jul-84	4-Aug-84	55	0	2.858354
99899	3	1984	31	0.126701	0.126701	29-Jul-84	4-Aug-84	55	0	2.858354
4000	5	1984	32	0.114063	0.114063	5-Aug-84	11-Aug-84	56	0	3.179746
4100	3	1984	32	240.8166	29.37613	5-Aug-84	11-Aug-84	56	0	3.179746
4100	5	1984	32	0.711035	0.276908	5-Aug-84	11-Aug-84	56	0	3.179746
4109	0	1984	32	132.1814	46.11171	5-Aug-84	11-Aug-84	56	0	3.179746
4109	1	1984	32	0.345498	0.345498	5-Aug-84	11-Aug-84	56	0	3.179746
4109	3	1984	32	1126.683	115.5911	5-Aug-84	11-Aug-84	56	0	3.179746
4109	5	1984	32	4.519835	1.913818	5-Aug-84	11-Aug-84	56	0	3.179746
4109	9	1984	32	0.828001	0.336524	5-Aug-84	11-Aug-84	56	0	3.179746
4406	5	1984	32	0.24094	0.168913	5-Aug-84	11-Aug-84	56	0	3.179746
6102	3	1984	32	0.123982	0.123982	5-Aug-84	11-Aug-84	56	0	3.179746
6120	5	1984	32	0.122704	0.122704	5-Aug-84	11-Aug-84	56	0	3.179746
7915	5	1984	32	0.801419	0.327552	5-Aug-84	11-Aug-84	56	0	3.179746
8909	3	1984	32	0.830621	0.296447	5-Aug-84	11-Aug-84	56	0	3.179746
8913	3	1984	32	0.113935	0.113935	5-Aug-84	11-Aug-84	56	0	3.179746
10320	5	1984	32	0.382134	0.216963	5-Aug-84	11-Aug-84	56	0	3.179746
10501	5	1984	32	0.124515	0.124515	5-Aug-84	11-Aug-84	56	0	3.179746
10504	3	1984	32	0.115891	0.115891	5-Aug-84	11-Aug-84	56	0	3.179746
10504	5	1984	32	0.347763	0.258936	5-Aug-84	11-Aug-84	56	0	3.179746
11301	5	1984	32	0.120945	0.120945	5-Aug-84	11-Aug-84	56	0	3.179746
12500	5	1984	32	0.112167	0.112167	5-Aug-84	11-Aug-84	56	0	3.179746
12512	3	1984	32	8.450842	2.299124	5-Aug-84	11-Aug-84	56	0	3.179746
12512	5	1984	32	61.96545	11.57469	5-Aug-84	11-Aug-84	56	0	3.179746
18005	3	1984	32	0.717333	0.329663	5-Aug-84	11-Aug-84	56	0	3.179746
3001	5	1985	17	0.21585	0.21585	1-May-85	4-May-85	24	1.900845	1.728534
4006	0	1985	17	0.648821	0.648821	1-May-85	4-May-85	24	1.900845	1.728534
4007	0	1985	17	5.902768	2.011999	1-May-85	4-May-85	24	1.900845	1.728534
4010	3	1985	17	1.467719	0.645076	1-May-85	4-May-85	24	1.900845	1.728534
4109	0	1985	17	0.211292	0.211292	1-May-85	4-May-85	24	1.900845	1.728534
7915	3	1985	17	1.478751	0.566906	1-May-85	4-May-85	24	1.900845	1.728534
7915	5	1985	17	58.50183	17.32175	1-May-85	4-May-85	24	1.900845	1.728534
7915	9	1985	17	0.217987	0.217987	1-May-85	4-May-85	24	1.900845	1.728534
10501	0	1985	17	0.644336	0.355515	1-May-85	4-May-85	24	1.900845	1.728534
10504	0	1985	17	0.204997	0.204997	1-May-85	4-May-85	24	1.900845	1.728534
10976	1	1985	17	0.636326	0.351178	1-May-85	4-May-85	24	1.900845	1.728534
10976	3	1985	17	1.305497	0.709173	1-May-85	4-May-85	24	1.900845	1.728534
17930	3	1985	17	3.697771	0.750249	1-May-85	4-May-85	24	1.900845	1.728534
99799	9	1985	17	0.212107	0.212107	1-May-85	4-May-85	24	1.900845	1.728534
99899	0	1985	17	2.417278	0.833738	1-May-85	4-May-85	24	1.900845	1.728534
3001	5	1985	18	0.328091	0.163977	5-May-85	11-May-85	68	1.902043	2.145459
4000	3	1985	18	0.195098	0.136711	5-May-85	11-May-85	68	1.902043	2.145459
4000	5	1985	18	0.112473	0.112473	5-May-85	11-May-85	68	1.902043	2.145459
4007	0	1985	18	10.5191	2.453079	5-May-85	11-May-85	68	1.902043	2.145459

4010	3	1985	18	0.197576	0.116731	5-May-85	11-May-85	68	1.902043	2.145459
4010	5	1985	18	0.075254	0.054427	5-May-85	11-May-85	68	1.902043	2.145459
4109	0	1985	18	0.204776	0.121431	5-May-85	11-May-85	68	1.902043	2.145459
4109	3	1985	18	0.188903	0.188903	5-May-85	11-May-85	68	1.902043	2.145459
7915	5	1985	18	98.93457	14.58935	5-May-85	11-May-85	68	1.902043	2.145459
7915	9	1985	18	0.097075	0.097075	5-May-85	11-May-85	68	1.902043	2.145459
10501	0	1985	18	0.45691	0.185168	5-May-85	11-May-85	68	1.902043	2.145459
10504	0	1985	18	0.098443	0.098443	5-May-85	11-May-85	68	1.902043	2.145459
10800	0	1985	18	0.092313	0.092313	5-May-85	11-May-85	68	1.902043	2.145459
10800	3	1985	18	0.048828	0.048828	5-May-85	11-May-85	68	1.902043	2.145459
10900	3	1985	18	0.062247	0.062247	5-May-85	11-May-85	68	1.902043	2.145459
10943	3	1985	18	0.074136	0.053877	5-May-85	11-May-85	68	1.902043	2.145459
10976	1	1985	18	0.401137	0.182147	5-May-85	11-May-85	68	1.902043	2.145459
10976	3	1985	18	0.590316	0.216638	5-May-85	11-May-85	68	1.902043	2.145459
17818	5	1985	18	0.092663	0.092663	5-May-85	11-May-85	68	1.902043	2.145459
17930	3	1985	18	0.738124	0.237949	5-May-85	11-May-85	68	1.902043	2.145459
99799	0	1985	18	0.094634	0.094634	5-May-85	11-May-85	68	1.902043	2.145459
99799	9	1985	18	0.385486	0.235032	5-May-85	11-May-85	68	1.902043	2.145459
99899	0	1985	18	2.858999	1.117089	5-May-85	11-May-85	68	1.902043	2.145459
4007	0	1985	19	4.527599	2.04318	12-May-85	18-May-85	72	1.992399	2.543797
4010	3	1985	19	0.520964	0.247519	12-May-85	18-May-85	72	1.992399	2.543797
4010	5	1985	19	0.246606	0.144725	12-May-85	18-May-85	72	1.992399	2.543797
4109	0	1985	19	0.26083	0.210781	12-May-85	18-May-85	72	1.992399	2.543797
6100	0	1985	19	0.047732	0.047732	12-May-85	18-May-85	72	1.992399	2.543797
7915	5	1985	19	42.59458	9.263455	12-May-85	18-May-85	72	1.992399	2.543797
10501	0	1985	19	0.358373	0.179626	12-May-85	18-May-85	72	1.992399	2.543797
10501	1	1985	19	0.049967	0.049967	12-May-85	18-May-85	72	1.992399	2.543797
10501	3	1985	19	0.890706	0.430826	12-May-85	18-May-85	72	1.992399	2.543797
10504	0	1985	19	0.876836	0.528881	12-May-85	18-May-85	72	1.992399	2.543797
10504	1	1985	19	0.10378	0.10378	12-May-85	18-May-85	72	1.992399	2.543797
10504	3	1985	19	1.386494	0.481287	12-May-85	18-May-85	72	1.992399	2.543797
10508	9	1985	19	0.482038	0.245733	12-May-85	18-May-85	72	1.992399	2.543797
10943	1	1985	19	0.292314	0.213172	12-May-85	18-May-85	72	1.992399	2.543797
10943	3	1985	19	0.102008	0.102008	12-May-85	18-May-85	72	1.992399	2.543797
10976	1	1985	19	0.095118	0.095118	12-May-85	18-May-85	72	1.992399	2.543797
17930	3	1985	19	0.098783	0.098783	12-May-85	18-May-85	72	1.992399	2.543797
99799	0	1985	19	0.144894	0.106718	12-May-85	18-May-85	72	1.992399	2.543797
99799	9	1985	19	0.835511	0.534539	12-May-85	18-May-85	72	1.992399	2.543797
99899	0	1985	19	2.602597	1.108246	12-May-85	18-May-85	72	1.992399	2.543797
3001	5	1985	20	0.053105	0.053105	19-May-85	25-May-85	72	2.268902	2.543797
4000	3	1985	20	2.479613	0.757158	19-May-85	25-May-85	72	2.268902	2.543797
4000	9	1985	20	0.290992	0.218758	19-May-85	25-May-85	72	2.268902	2.543797
4006	0	1985	20	0.046776	0.046776	19-May-85	25-May-85	72	2.268902	2.543797
4007	0	1985	20	0.607079	0.259355	19-May-85	25-May-85	72	2.268902	2.543797
4010	3	1985	20	0.155604	0.117849	19-May-85	25-May-85	72	2.268902	2.543797
4010	5	1985	20	0.287481	0.163339	19-May-85	25-May-85	72	2.268902	2.543797
4109	0	1985	20	1.962317	1.059869	19-May-85	25-May-85	72	2.268902	2.543797
4109	3	1985	20	0.08937	0.08937	19-May-85	25-May-85	72	2.268902	2.543797
6100	0	1985	20	0.049288	0.049288	19-May-85	25-May-85	72	2.268902	2.543797
6100	1	1985	20	0.151578	0.111027	19-May-85	25-May-85	72	2.268902	2.543797
6100	3	1985	20	0.149982	0.085059	19-May-85	25-May-85	72	2.268902	2.543797
6100	9	1985	20	0.091043	0.091043	19-May-85	25-May-85	72	2.268902	2.543797

7915	3	1985	20	0.049402	0.049402	19-May-85	25-May-85	72	2.268902	2.543797
7915	5	1985	20	24.63492	6.365327	19-May-85	25-May-85	72	2.268902	2.543797
8720	0	1985	20	0.053563	0.053563	19-May-85	25-May-85	72	2.268902	2.543797
10501	0	1985	20	0.437841	0.231868	19-May-85	25-May-85	72	2.268902	2.543797
10501	3	1985	20	31.34383	5.284432	19-May-85	25-May-85	72	2.268902	2.543797
10501	9	1985	20	0.094433	0.094433	19-May-85	25-May-85	72	2.268902	2.543797
10504	0	1985	20	0.095368	0.095368	19-May-85	25-May-85	72	2.268902	2.543797
10504	1	1985	20	3.033438	0.84245	19-May-85	25-May-85	72	2.268902	2.543797
10504	3	1985	20	43.93669	8.094215	19-May-85	25-May-85	72	2.268902	2.543797
10508	1	1985	20	1.219456	1.17247	19-May-85	25-May-85	72	2.268902	2.543797
10508	3	1985	20	6.366823	2.124809	19-May-85	25-May-85	72	2.268902	2.543797
10508	9	1985	20	16.75394	3.387962	19-May-85	25-May-85	72	2.268902	2.543797
10943	3	1985	20	1.299516	0.359089	19-May-85	25-May-85	72	2.268902	2.543797
10976	1	1985	20	0.383609	0.268777	19-May-85	25-May-85	72	2.268902	2.543797
10976	3	1985	20	0.285955	0.145863	19-May-85	25-May-85	72	2.268902	2.543797
17930	3	1985	20	0.109973	0.109973	19-May-85	25-May-85	72	2.268902	2.543797
99799	0	1985	20	0.224908	0.134891	19-May-85	25-May-85	72	2.268902	2.543797
99799	9	1985	20	7.996616	1.893229	19-May-85	25-May-85	72	2.268902	2.543797
99899	0	1985	20	0.547536	0.206237	19-May-85	25-May-85	72	2.268902	2.543797
99899	9	1985	20	0.050243	0.050243	19-May-85	25-May-85	72	2.268902	2.543797
3502	3	1985	21	0.297185	0.156228	26-May-85	1-Jun-85	72	2.561315	2.543797
4000	3	1985	21	4.278475	0.819332	26-May-85	1-Jun-85	72	2.561315	2.543797
4000	5	1985	21	0.115182	0.115182	26-May-85	1-Jun-85	72	2.561315	2.543797
4000	9	1985	21	0.187354	0.131427	26-May-85	1-Jun-85	72	2.561315	2.543797
4007	0	1985	21	0.313898	0.198992	26-May-85	1-Jun-85	72	2.561315	2.543797
4010	5	1985	21	0.404756	0.278053	26-May-85	1-Jun-85	72	2.561315	2.543797
4109	0	1985	21	120.1723	34.08356	26-May-85	1-Jun-85	72	2.561315	2.543797
4109	3	1985	21	0.049042	0.049042	26-May-85	1-Jun-85	72	2.561315	2.543797
4109	9	1985	21	0.144998	0.104168	26-May-85	1-Jun-85	72	2.561315	2.543797
6100	3	1985	21	0.599993	0.239855	26-May-85	1-Jun-85	72	2.561315	2.543797
6100	9	1985	21	0.049257	0.049257	26-May-85	1-Jun-85	72	2.561315	2.543797
6102	9	1985	21	0.085114	0.085114	26-May-85	1-Jun-85	72	2.561315	2.543797
7915	5	1985	21	6.974456	1.939883	26-May-85	1-Jun-85	72	2.561315	2.543797
8913	1	1985	21	0.093981	0.093981	26-May-85	1-Jun-85	72	2.561315	2.543797
8913	3	1985	21	0.144739	0.106299	26-May-85	1-Jun-85	72	2.561315	2.543797
10501	0	1985	21	0.950003	0.373915	26-May-85	1-Jun-85	72	2.561315	2.543797
10501	1	1985	21	0.087987	0.087987	26-May-85	1-Jun-85	72	2.561315	2.543797
10501	3	1985	21	60.8714	8.007919	26-May-85	1-Jun-85	72	2.561315	2.543797
10504	0	1985	21	0.292793	0.217188	26-May-85	1-Jun-85	72	2.561315	2.543797
10504	1	1985	21	3.712925	1.114341	26-May-85	1-Jun-85	72	2.561315	2.543797
10504	3	1985	21	132.1235	12.3879	26-May-85	1-Jun-85	72	2.561315	2.543797
10508	3	1985	21	25.96687	5.516494	26-May-85	1-Jun-85	72	2.561315	2.543797
10508	9	1985	21	19.39159	3.661507	26-May-85	1-Jun-85	72	2.561315	2.543797
10800	0	1985	21	0.052761	0.052761	26-May-85	1-Jun-85	72	2.561315	2.543797
10800	3	1985	21	0.150396	0.085502	26-May-85	1-Jun-85	72	2.561315	2.543797
10943	1	1985	21	0.230552	0.136634	26-May-85	1-Jun-85	72	2.561315	2.543797
10943	3	1985	21	0.856834	0.244715	26-May-85	1-Jun-85	72	2.561315	2.543797
99799	0	1985	21	0.102802	0.072054	26-May-85	1-Jun-85	72	2.561315	2.543797
99799	9	1985	21	26.3985	3.53264	26-May-85	1-Jun-85	72	2.561315	2.543797
99899	0	1985	21	0.275489	0.156227	26-May-85	1-Jun-85	72	2.561315	2.543797
3502	3	1985	22	0.085005	0.085005	2-Jun-85	8-Jun-85	70	2.731028	2.293592
3502	5	1985	22	0.089989	0.089989	2-Jun-85	8-Jun-85	70	2.731028	2.293592

4000	3	1985	22	1.493613	0.490824	2-Jun-85	8-Jun-85	70	2.731028	2.293592
4000	9	1985	22	0.082452	0.082452	2-Jun-85	8-Jun-85	70	2.731028	2.293592
4007	0	1985	22	0.094578	0.094578	2-Jun-85	8-Jun-85	70	2.731028	2.293592
4010	5	1985	22	0.092218	0.092218	2-Jun-85	8-Jun-85	70	2.731028	2.293592
4010	9	1985	22	0.093456	0.093456	2-Jun-85	8-Jun-85	70	2.731028	2.293592
4109	0	1985	22	6.320252	1.808605	2-Jun-85	8-Jun-85	70	2.731028	2.293592
4109	3	1985	22	5.864013	2.188548	2-Jun-85	8-Jun-85	70	2.731028	2.293592
6100	3	1985	22	0.528567	0.211836	2-Jun-85	8-Jun-85	70	2.731028	2.293592
7915	5	1985	22	3.202014	0.894372	2-Jun-85	8-Jun-85	70	2.731028	2.293592
8909	3	1985	22	0.094578	0.094578	2-Jun-85	8-Jun-85	70	2.731028	2.293592
8913	3	1985	22	0.136252	0.100827	2-Jun-85	8-Jun-85	70	2.731028	2.293592
10501	0	1985	22	0.357983	0.174105	2-Jun-85	8-Jun-85	70	2.731028	2.293592
10501	3	1985	22	47.48605	6.927598	2-Jun-85	8-Jun-85	70	2.731028	2.293592
10504	0	1985	22	0.251915	0.150184	2-Jun-85	8-Jun-85	70	2.731028	2.293592
10504	1	1985	22	0.257702	0.154104	2-Jun-85	8-Jun-85	70	2.731028	2.293592
10504	3	1985	22	101.5766	13.81444	2-Jun-85	8-Jun-85	70	2.731028	2.293592
10504	9	1985	22	0.336154	0.336154	2-Jun-85	8-Jun-85	70	2.731028	2.293592
10508	3	1985	22	12.23479	2.013426	2-Jun-85	8-Jun-85	70	2.731028	2.293592
10508	9	1985	22	1.744033	0.692284	2-Jun-85	8-Jun-85	70	2.731028	2.293592
10800	0	1985	22	0.376549	0.264203	2-Jun-85	8-Jun-85	70	2.731028	2.293592
10943	3	1985	22	0.424918	0.190487	2-Jun-85	8-Jun-85	70	2.731028	2.293592
12512	5	1985	22	0.085352	0.085352	2-Jun-85	8-Jun-85	70	2.731028	2.293592
36250	9	1985	22	4077.232	616.8512	2-Jun-85	8-Jun-85	70	2.731028	2.293592
99799	9	1985	22	5.332847	1.402589	2-Jun-85	8-Jun-85	70	2.731028	2.293592
99899	0	1985	22	0.085005	0.085005	2-Jun-85	8-Jun-85	70	2.731028	2.293592
99899	3	1985	22	0.097953	0.097953	2-Jun-85	8-Jun-85	70	2.731028	2.293592
99899	9	1985	22	0.044519	0.044519	2-Jun-85	8-Jun-85	70	2.731028	2.293592
4000	3	1985	23	0.094908	0.094908	9-Jun-85	15-Jun-85	70	3.12858	0.03022
4109	0	1985	23	74.09649	22.65208	9-Jun-85	15-Jun-85	70	3.12858	0.03022
4109	3	1985	23	74.73191	15.55106	9-Jun-85	15-Jun-85	70	3.12858	0.03022
6100	0	1985	23	0.08825	0.08825	9-Jun-85	15-Jun-85	70	3.12858	0.03022
6100	3	1985	23	0.053636	0.053636	9-Jun-85	15-Jun-85	70	3.12858	0.03022
6102	3	1985	23	0.086582	0.086582	9-Jun-85	15-Jun-85	70	3.12858	0.03022
7915	5	1985	23	0.329382	0.165018	9-Jun-85	15-Jun-85	70	3.12858	0.03022
8913	3	1985	23	0.288845	0.164108	9-Jun-85	15-Jun-85	70	3.12858	0.03022
10320	3	1985	23	0.09644	0.09644	9-Jun-85	15-Jun-85	70	3.12858	0.03022
10501	0	1985	23	0.368223	0.368223	9-Jun-85	15-Jun-85	70	3.12858	0.03022
10501	3	1985	23	43.46621	7.923589	9-Jun-85	15-Jun-85	70	3.12858	0.03022
10504	3	1985	23	79.20078	16.56556	9-Jun-85	15-Jun-85	70	3.12858	0.03022
10504	5	1985	23	0.09644	0.09644	9-Jun-85	15-Jun-85	70	3.12858	0.03022
10508	3	1985	23	9.84639	2.128701	9-Jun-85	15-Jun-85	70	3.12858	0.03022
10508	9	1985	23	0.475053	0.230424	9-Jun-85	15-Jun-85	70	3.12858	0.03022
10800	3	1985	23	0.302026	0.135891	9-Jun-85	15-Jun-85	70	3.12858	0.03022
10943	3	1985	23	0.23468	0.137388	9-Jun-85	15-Jun-85	70	3.12858	0.03022
10976	3	1985	23	0.134368	0.098452	9-Jun-85	15-Jun-85	70	3.12858	0.03022
12512	3	1985	23	0.09045	0.09045	9-Jun-85	15-Jun-85	70	3.12858	0.03022
12520	5	1985	23	0.09531	0.09531	9-Jun-85	15-Jun-85	70	3.12858	0.03022
36250	9	1985	23	2709.243	561.8933	9-Jun-85	15-Jun-85	70	3.12858	0.03022
99799	0	1985	23	0.094225	0.094225	9-Jun-85	15-Jun-85	70	3.12858	0.03022
99799	9	1985	23	17.54141	2.775375	9-Jun-85	15-Jun-85	70	3.12858	0.03022
99899	9	1985	23	0.09531	0.09531	9-Jun-85	15-Jun-85	70	3.12858	0.03022
3001	5	1985	24	0.047283	0.047283	16-Jun-85	22-Jun-85	72	3.149936	0

4000	3	1985	24	0.137783	0.100049	16-Jun-85	22-Jun-85	72	3.149936	0
4109	0	1985	24	243.6209	34.34425	16-Jun-85	22-Jun-85	72	3.149936	0
4109	3	1985	24	237.0773	20.29512	16-Jun-85	22-Jun-85	72	3.149936	0
4406	5	1985	24	0.334242	0.168532	16-Jun-85	22-Jun-85	72	3.149936	0
6100	3	1985	24	0.332851	0.13466	16-Jun-85	22-Jun-85	72	3.149936	0
6102	3	1985	24	0.343489	0.17159	16-Jun-85	22-Jun-85	72	3.149936	0
6103	3	1985	24	0.046272	0.046272	16-Jun-85	22-Jun-85	72	3.149936	0
8913	3	1985	24	0.138544	0.102594	16-Jun-85	22-Jun-85	72	3.149936	0
10320	3	1985	24	0.193397	0.11417	16-Jun-85	22-Jun-85	72	3.149936	0
10320	5	1985	24	1.259312	0.379324	16-Jun-85	22-Jun-85	72	3.149936	0
10501	3	1985	24	4.386061	0.8056	16-Jun-85	22-Jun-85	72	3.149936	0
10504	3	1985	24	6.819809	1.214497	16-Jun-85	22-Jun-85	72	3.149936	0
10504	5	1985	24	0.19062	0.19062	16-Jun-85	22-Jun-85	72	3.149936	0
10508	3	1985	24	0.557513	0.205853	16-Jun-85	22-Jun-85	72	3.149936	0
10508	9	1985	24	0.179002	0.1255	16-Jun-85	22-Jun-85	72	3.149936	0
10800	3	1985	24	0.082842	0.082842	16-Jun-85	22-Jun-85	72	3.149936	0
10943	3	1985	24	0.086313	0.086313	16-Jun-85	22-Jun-85	72	3.149936	0
12512	3	1985	24	0.697091	0.30178	16-Jun-85	22-Jun-85	72	3.149936	0
12512	5	1985	24	0.047283	0.047283	16-Jun-85	22-Jun-85	72	3.149936	0
12520	5	1985	24	0.046272	0.046272	16-Jun-85	22-Jun-85	72	3.149936	0
99799	9	1985	24	31.7989	4.117223	16-Jun-85	22-Jun-85	72	3.149936	0
99899	0	1985	24	0.094169	0.094169	16-Jun-85	22-Jun-85	72	3.149936	0
4109	0	1985	25	328.5532	70.1747	23-Jun-85	29-Jun-85	71	2.993577	0
4109	3	1985	25	441.8337	56.4538	23-Jun-85	29-Jun-85	71	2.993577	0
4406	5	1985	25	0.272597	0.13954	23-Jun-85	29-Jun-85	71	2.993577	0
6100	9	1985	25	0.09406	0.09406	23-Jun-85	29-Jun-85	71	2.993577	0
7915	5	1985	25	0.098982	0.069351	23-Jun-85	29-Jun-85	71	2.993577	0
8907	3	1985	25	0.287919	0.163199	23-Jun-85	29-Jun-85	71	2.993577	0
8913	3	1985	25	0.244363	0.201631	23-Jun-85	29-Jun-85	71	2.993577	0
10320	5	1985	25	1.786621	0.395442	23-Jun-85	29-Jun-85	71	2.993577	0
10501	0	1985	25	0.109323	0.109323	23-Jun-85	29-Jun-85	71	2.993577	0
10501	3	1985	25	6.889702	1.042282	23-Jun-85	29-Jun-85	71	2.993577	0
10501	5	1985	25	0.053055	0.053055	23-Jun-85	29-Jun-85	71	2.993577	0
10504	3	1985	25	3.098632	0.557269	23-Jun-85	29-Jun-85	71	2.993577	0
10504	5	1985	25	0.100705	0.100705	23-Jun-85	29-Jun-85	71	2.993577	0
10508	3	1985	25	0.236294	0.138796	23-Jun-85	29-Jun-85	71	2.993577	0
10508	9	1985	25	0.196936	0.118513	23-Jun-85	29-Jun-85	71	2.993577	0
10800	3	1985	25	0.40437	0.19709	23-Jun-85	29-Jun-85	71	2.993577	0
12512	3	1985	25	0.38382	0.186763	23-Jun-85	29-Jun-85	71	2.993577	0
12512	5	1985	25	0.188051	0.131743	23-Jun-85	29-Jun-85	71	2.993577	0
99799	9	1985	25	36.45983	5.62391	23-Jun-85	29-Jun-85	71	2.993577	0
99899	0	1985	25	0.09362	0.09362	23-Jun-85	29-Jun-85	71	2.993577	0
99899	9	1985	25	0.430241	0.430241	23-Jun-85	29-Jun-85	71	2.993577	0
4000	3	1985	26	0.10214	0.10214	30-Jun-85	6-Jul-85	72	3.146624	0
4109	0	1985	26	518.5442	107.1296	30-Jun-85	6-Jul-85	72	3.146624	0
4109	3	1985	26	508.491	41.42165	30-Jun-85	6-Jul-85	72	3.146624	0
4109	5	1985	26	0.092272	0.092272	30-Jun-85	6-Jul-85	72	3.146624	0
4406	5	1985	26	0.476501	0.194804	30-Jun-85	6-Jul-85	72	3.146624	0
6100	3	1985	26	0.088432	0.088432	30-Jun-85	6-Jul-85	72	3.146624	0
7915	5	1985	26	0.35623	0.173242	30-Jun-85	6-Jul-85	72	3.146624	0
8907	3	1985	26	0.146663	0.10893	30-Jun-85	6-Jul-85	72	3.146624	0
8912	3	1985	26	0.094812	0.094812	30-Jun-85	6-Jul-85	72	3.146624	0

8913	3	1985	26	0.094292	0.066086	30-Jun-85	6-Jul-85	72	3.146624	0
10320	5	1985	26	1.69275	0.358097	30-Jun-85	6-Jul-85	72	3.146624	0
10501	3	1985	26	3.512443	0.604804	30-Jun-85	6-Jul-85	72	3.146624	0
10501	5	1985	26	0.224337	0.180071	30-Jun-85	6-Jul-85	72	3.146624	0
10504	3	1985	26	1.262528	0.451125	30-Jun-85	6-Jul-85	72	3.146624	0
10504	5	1985	26	0.182574	0.127931	30-Jun-85	6-Jul-85	72	3.146624	0
10508	3	1985	26	0.238424	0.142199	30-Jun-85	6-Jul-85	72	3.146624	0
10800	3	1985	26	0.048102	0.048102	30-Jun-85	6-Jul-85	72	3.146624	0
12512	3	1985	26	0.133146	0.09821	30-Jun-85	6-Jul-85	72	3.146624	0
12512	5	1985	26	1.178696	0.341955	30-Jun-85	6-Jul-85	72	3.146624	0
15999	3	1985	26	0.143071	0.104432	30-Jun-85	6-Jul-85	72	3.146624	0
18005	3	1985	26	0.049309	0.049309	30-Jun-85	6-Jul-85	72	3.146624	0
99799	9	1985	26	32.7039	8.204931	30-Jun-85	6-Jul-85	72	3.146624	0
4109	0	1985	27	251.6546	45.67396	7-Jul-85	13-Jul-85	71	3.148411	0
4109	1	1985	27	0.08952	0.08952	7-Jul-85	13-Jul-85	71	3.148411	0
4109	3	1985	27	515.3326	72.16757	7-Jul-85	13-Jul-85	71	3.148411	0
4109	5	1985	27	1.005866	0.433487	7-Jul-85	13-Jul-85	71	3.148411	0
4109	9	1985	27	0.765607	0.58519	7-Jul-85	13-Jul-85	71	3.148411	0
4406	5	1985	27	0.047826	0.047826	7-Jul-85	13-Jul-85	71	3.148411	0
6100	0	1985	27	0.043765	0.043765	7-Jul-85	13-Jul-85	71	3.148411	0
6103	3	1985	27	0.096808	0.096808	7-Jul-85	13-Jul-85	71	3.148411	0
8913	3	1985	27	0.198407	0.138994	7-Jul-85	13-Jul-85	71	3.148411	0
8913	9	1985	27	0.096575	0.096575	7-Jul-85	13-Jul-85	71	3.148411	0
10320	3	1985	27	0.094523	0.094523	7-Jul-85	13-Jul-85	71	3.148411	0
10320	5	1985	27	1.88364	0.505142	7-Jul-85	13-Jul-85	71	3.148411	0
10320	9	1985	27	0.046737	0.046737	7-Jul-85	13-Jul-85	71	3.148411	0
10501	3	1985	27	3.246682	0.574132	7-Jul-85	13-Jul-85	71	3.148411	0
10504	3	1985	27	0.092645	0.092645	7-Jul-85	13-Jul-85	71	3.148411	0
10504	5	1985	27	0.045558	0.045558	7-Jul-85	13-Jul-85	71	3.148411	0
10508	9	1985	27	0.0461	0.0461	7-Jul-85	13-Jul-85	71	3.148411	0
12512	3	1985	27	0.767283	0.305599	7-Jul-85	13-Jul-85	71	3.148411	0
12512	5	1985	27	0.286739	0.147936	7-Jul-85	13-Jul-85	71	3.148411	0
12520	5	1985	27	0.097318	0.097318	7-Jul-85	13-Jul-85	71	3.148411	0
15999	3	1985	27	0.691377	0.274652	7-Jul-85	13-Jul-85	71	3.148411	0
15999	5	1985	27	0.291331	0.150195	7-Jul-85	13-Jul-85	71	3.148411	0
17830	3	1985	27	0.091203	0.091203	7-Jul-85	13-Jul-85	71	3.148411	0
99799	9	1985	27	41.87298	6.054496	7-Jul-85	13-Jul-85	71	3.148411	0
99899	0	1985	27	0.336556	0.155612	7-Jul-85	13-Jul-85	71	3.148411	0
4109	0	1985	28	1905.951	296.8234	14-Jul-85	20-Jul-85	71	3.126067	0
4109	1	1985	28	0.33846	0.184161	14-Jul-85	20-Jul-85	71	3.126067	0
4109	3	1985	28	858.032	81.69195	14-Jul-85	20-Jul-85	71	3.126067	0
4109	5	1985	28	6.163571	2.205046	14-Jul-85	20-Jul-85	71	3.126067	0
4109	9	1985	28	24.70156	9.256811	14-Jul-85	20-Jul-85	71	3.126067	0
6103	3	1985	28	0.050664	0.050664	14-Jul-85	20-Jul-85	71	3.126067	0
6208	3	1985	28	0.039566	0.039566	14-Jul-85	20-Jul-85	71	3.126067	0
8913	3	1985	28	0.149193	0.112308	14-Jul-85	20-Jul-85	71	3.126067	0
10320	5	1985	28	1.207553	0.312249	14-Jul-85	20-Jul-85	71	3.126067	0
10501	3	1985	28	0.412409	0.169115	14-Jul-85	20-Jul-85	71	3.126067	0
10504	3	1985	28	0.143415	0.081333	14-Jul-85	20-Jul-85	71	3.126067	0
10800	3	1985	28	0.147767	0.108455	14-Jul-85	20-Jul-85	71	3.126067	0
12512	3	1985	28	2.530182	0.762474	14-Jul-85	20-Jul-85	71	3.126067	0
12512	5	1985	28	2.267847	0.778963	14-Jul-85	20-Jul-85	71	3.126067	0

15999	3	1985	28	1.573202	0.416835	14-Jul-85	20-Jul-85	71	3.126067	0
15999	5	1985	28	0.228704	0.119955	14-Jul-85	20-Jul-85	71	3.126067	0
15999	9	1985	28	0.096421	0.096421	14-Jul-85	20-Jul-85	71	3.126067	0
18005	1	1985	28	0.405088	0.223659	14-Jul-85	20-Jul-85	71	3.126067	0
18005	3	1985	28	2.347926	0.923317	14-Jul-85	20-Jul-85	71	3.126067	0
18005	9	1985	28	0.047617	0.047617	14-Jul-85	20-Jul-85	71	3.126067	0
99799	9	1985	28	31.15745	4.898607	14-Jul-85	20-Jul-85	71	3.126067	0
99899	0	1985	28	0.094206	0.094206	14-Jul-85	20-Jul-85	71	3.126067	0
4001	5	1985	29	0.289477	0.164264	21-Jul-85	27-Jul-85	72	3.118128	0
4109	0	1985	29	1394.12	438.417	21-Jul-85	27-Jul-85	72	3.118128	0
4109	1	1985	29	1.635389	1.066528	21-Jul-85	27-Jul-85	72	3.118128	0
4109	3	1985	29	1252.976	145.3561	21-Jul-85	27-Jul-85	72	3.118128	0
4109	5	1985	29	1.516766	0.449909	21-Jul-85	27-Jul-85	72	3.118128	0
4109	9	1985	29	19.70822	4.853011	21-Jul-85	27-Jul-85	72	3.118128	0
4406	5	1985	29	0.045618	0.045618	21-Jul-85	27-Jul-85	72	3.118128	0
7915	5	1985	29	0.099743	0.099743	21-Jul-85	27-Jul-85	72	3.118128	0
10320	3	1985	29	0.057117	0.057117	21-Jul-85	27-Jul-85	72	3.118128	0
10320	5	1985	29	4.924042	0.706081	21-Jul-85	27-Jul-85	72	3.118128	0
10320	9	1985	29	0.053869	0.053869	21-Jul-85	27-Jul-85	72	3.118128	0
10501	3	1985	29	0.524506	0.196244	21-Jul-85	27-Jul-85	72	3.118128	0
10501	5	1985	29	0.542097	0.246636	21-Jul-85	27-Jul-85	72	3.118128	0
10504	3	1985	29	0.153243	0.111806	21-Jul-85	27-Jul-85	72	3.118128	0
10508	3	1985	29	0.101842	0.07151	21-Jul-85	27-Jul-85	72	3.118128	0
12512	3	1985	29	12.58965	2.146896	21-Jul-85	27-Jul-85	72	3.118128	0
12512	5	1985	29	21.46735	3.071345	21-Jul-85	27-Jul-85	72	3.118128	0
12512	9	1985	29	0.298195	0.169009	21-Jul-85	27-Jul-85	72	3.118128	0
15999	3	1985	29	1.745239	0.407244	21-Jul-85	27-Jul-85	72	3.118128	0
15999	5	1985	29	0.143232	0.103382	21-Jul-85	27-Jul-85	72	3.118128	0
18005	1	1985	29	0.183182	0.183182	21-Jul-85	27-Jul-85	72	3.118128	0
18005	3	1985	29	13.05328	2.548104	21-Jul-85	27-Jul-85	72	3.118128	0
99799	9	1985	29	19.95041	3.731964	21-Jul-85	27-Jul-85	72	3.118128	0
99899	0	1985	29	0.106836	0.106836	21-Jul-85	27-Jul-85	72	3.118128	0
4001	5	1985	30	0.088849	0.088849	28-Jul-85	3-Aug-85	71	3.095521	0
4109	0	1985	30	38.07382	7.169769	28-Jul-85	3-Aug-85	71	3.095521	0
4109	3	1985	30	836.371	57.43405	28-Jul-85	3-Aug-85	71	3.095521	0
4109	5	1985	30	3.819513	0.937827	28-Jul-85	3-Aug-85	71	3.095521	0
4109	9	1985	30	0.206347	0.144589	28-Jul-85	3-Aug-85	71	3.095521	0
6100	0	1985	30	0.052467	0.052467	28-Jul-85	3-Aug-85	71	3.095521	0
6102	3	1985	30	0.052467	0.052467	28-Jul-85	3-Aug-85	71	3.095521	0
7915	5	1985	30	0.233629	0.138472	28-Jul-85	3-Aug-85	71	3.095521	0
8913	3	1985	30	0.107911	0.107911	28-Jul-85	3-Aug-85	71	3.095521	0
10320	3	1985	30	0.198533	0.139136	28-Jul-85	3-Aug-85	71	3.095521	0
10320	5	1985	30	3.764504	0.849844	28-Jul-85	3-Aug-85	71	3.095521	0
10501	3	1985	30	0.6978	0.275602	28-Jul-85	3-Aug-85	71	3.095521	0
10501	5	1985	30	0.256288	0.15016	28-Jul-85	3-Aug-85	71	3.095521	0
10508	3	1985	30	0.05227	0.05227	28-Jul-85	3-Aug-85	71	3.095521	0
12512	3	1985	30	3.877602	0.89603	28-Jul-85	3-Aug-85	71	3.095521	0
12512	5	1985	30	13.0459	2.419286	28-Jul-85	3-Aug-85	71	3.095521	0
15999	3	1985	30	1.479001	0.434287	28-Jul-85	3-Aug-85	71	3.095521	0
15999	5	1985	30	0.1467	0.106273	28-Jul-85	3-Aug-85	71	3.095521	0
18005	3	1985	30	6.687864	1.250283	28-Jul-85	3-Aug-85	71	3.095521	0
99799	9	1985	30	10.66099	1.871649	28-Jul-85	3-Aug-85	71	3.095521	0

4109	0	1985	31	6.333294	1.560243	4-Aug-85	10-Aug-85	69	3.071389	0
4109	3	1985	31	718.228	61.17018	4-Aug-85	10-Aug-85	69	3.071389	0
4109	5	1985	31	2.572318	0.686712	4-Aug-85	10-Aug-85	69	3.071389	0
4109	9	1985	31	0.387931	0.158712	4-Aug-85	10-Aug-85	69	3.071389	0
8913	3	1985	31	0.093872	0.093872	4-Aug-85	10-Aug-85	69	3.071389	0
10320	3	1985	31	0.3636	0.167978	4-Aug-85	10-Aug-85	69	3.071389	0
10320	5	1985	31	2.986513	0.537814	4-Aug-85	10-Aug-85	69	3.071389	0
10501	3	1985	31	0.091536	0.091536	4-Aug-85	10-Aug-85	69	3.071389	0
10501	5	1985	31	0.283966	0.207753	4-Aug-85	10-Aug-85	69	3.071389	0
12512	3	1985	31	1.20475	0.436776	4-Aug-85	10-Aug-85	69	3.071389	0
12512	5	1985	31	4.610409	1.300879	4-Aug-85	10-Aug-85	69	3.071389	0
15999	3	1985	31	1.312584	0.491013	4-Aug-85	10-Aug-85	69	3.071389	0
15999	5	1985	31	0.350392	0.175285	4-Aug-85	10-Aug-85	69	3.071389	0
15999	9	1985	31	0.052642	0.052642	4-Aug-85	10-Aug-85	69	3.071389	0
18005	3	1985	31	0.334454	0.166325	4-Aug-85	10-Aug-85	69	3.071389	0
18005	5	1985	31	0.043888	0.043888	4-Aug-85	10-Aug-85	69	3.071389	0
99799	9	1985	31	18.46608	5.722163	4-Aug-85	10-Aug-85	69	3.071389	0
99899	3	1985	31	0.048146	0.048146	4-Aug-85	10-Aug-85	69	3.071389	0
4109	0	1985	32	26.49488	9.642884	11-Aug-85	11-Aug-85	8	3.008929	0
4109	3	1985	32	476.0089	107.7502	11-Aug-85	11-Aug-85	8	3.008929	0
4109	5	1985	32	3.233955	2.585698	11-Aug-85	11-Aug-85	8	3.008929	0
4109	9	1985	32	1.279722	0.837907	11-Aug-85	11-Aug-85	8	3.008929	0
8720	3	1985	32	0.630008	0.630008	11-Aug-85	11-Aug-85	8	3.008929	0
10320	5	1985	32	2.586835	1.370527	11-Aug-85	11-Aug-85	8	3.008929	0
11301	5	1985	32	0.649715	0.649715	11-Aug-85	11-Aug-85	8	3.008929	0
18005	3	1985	32	0.634974	0.634974	11-Aug-85	11-Aug-85	8	3.008929	0
99799	9	1985	32	28.63363	10.40729	11-Aug-85	11-Aug-85	8	3.008929	0
7915	0	1986	2	0.822368	0.822368	17-Jan-86	18-Jan-86	8	0.718093	1.74129
10501	5	1986	2	3.266859	1.741539	17-Jan-86	18-Jan-86	8	0.718093	1.74129
6402	5	1986	3	0.412541	0.412541	20-Jan-86	24-Jan-86	16	0	1.738897
7915	0	1986	3	0.822368	0.822368	20-Jan-86	24-Jan-86	16	0	1.738897
10501	5	1986	3	0.412541	0.412541	20-Jan-86	24-Jan-86	16	0	1.738897
10501	5	1986	4	1.321309	0.769735	26-Jan-86	1-Feb-86	20	0	1.622369
10501	5	1986	5	0.692315	0.475756	2-Feb-86	8-Feb-86	19	0	1.589873
7915	1	1986	6	0.427497	0.427497	10-Feb-86	14-Feb-86	16	0	1.589295
10501	5	1986	6	0.84631	0.84631	10-Feb-86	14-Feb-86	16	0	1.589295
3001	5	1986	7	0.331345	0.331345	16-Feb-86	22-Feb-86	20	0	1.588822
7915	1	1986	7	2.297529	0.861739	16-Feb-86	22-Feb-86	20	0	1.588822
7915	3	1986	7	1.9851	1.369787	16-Feb-86	22-Feb-86	20	0	1.588822
7915	9	1986	7	1.003247	0.548006	16-Feb-86	22-Feb-86	20	0	1.588822
10501	5	1986	7	0.65703	0.452199	16-Feb-86	22-Feb-86	20	0	1.588822
99799	9	1986	7	0.331345	0.331345	16-Feb-86	22-Feb-86	20	0	1.588822
7915	1	1986	8	8.838343	1.925151	23-Feb-86	1-Mar-86	20	0	1.5797
7915	3	1986	8	2.642402	1.003758	23-Feb-86	1-Mar-86	20	0	1.5797
7915	9	1986	8	4.029419	1.467725	23-Feb-86	1-Mar-86	20	0	1.5797
10501	5	1986	8	0.3367	0.3367	23-Feb-86	1-Mar-86	20	0	1.5797
4406	0	1986	9	12.83881	8.041748	3-Mar-86	7-Mar-86	16	0	1.634602
7915	1	1986	9	13.87053	2.598977	3-Mar-86	7-Mar-86	16	0	1.634602
7915	3	1986	9	1.246788	0.670256	3-Mar-86	7-Mar-86	16	0	1.634602
7915	9	1986	9	10.59675	2.863126	3-Mar-86	7-Mar-86	16	0	1.634602
10501	5	1986	9	1.211776	0.877852	3-Mar-86	7-Mar-86	16	0	1.634602
99799	9	1986	9	0.406901	0.406901	3-Mar-86	7-Mar-86	16	0	1.634602

4406	0	1986	10	49.1781	15.12036	9-Mar-86	15-Mar-86	18	0	1.818905
7915	1	1986	10	32.48948	7.256852	9-Mar-86	15-Mar-86	18	0	1.818905
7915	3	1986	10	1.137177	0.83901	9-Mar-86	15-Mar-86	18	0	1.818905
7915	9	1986	10	9.022006	3.067649	9-Mar-86	15-Mar-86	18	0	1.818905
10501	5	1986	10	0.362161	0.362161	9-Mar-86	15-Mar-86	18	0	1.818905
4406	0	1986	11	57.46928	8.062142	16-Mar-86	22-Mar-86	20	0.583637	1.83858
7915	1	1986	11	18.75578	3.781234	16-Mar-86	22-Mar-86	20	0.583637	1.83858
7915	3	1986	11	0.993176	0.542397	16-Mar-86	22-Mar-86	20	0.583637	1.83858
7915	9	1986	11	1.645906	1.058423	16-Mar-86	22-Mar-86	20	0.583637	1.83858
8723	5	1986	11	0.330033	0.330033	16-Mar-86	22-Mar-86	20	0.583637	1.83858
3001	5	1986	12	2.081649	0.797282	24-Mar-86	28-Mar-86	16	0.481589	1.859385
4406	0	1986	12	65.99496	24.33001	24-Mar-86	28-Mar-86	16	0.481589	1.859385
7915	1	1986	12	19.08556	4.481295	24-Mar-86	28-Mar-86	16	0.481589	1.859385
7915	3	1986	12	2.529028	1.71356	24-Mar-86	28-Mar-86	16	0.481589	1.859385
7915	9	1986	12	5.038458	1.887358	24-Mar-86	28-Mar-86	16	0.481589	1.859385
10501	5	1986	12	0.415559	0.415559	24-Mar-86	28-Mar-86	16	0.481589	1.859385
99899	0	1986	12	0.410105	0.410105	24-Mar-86	28-Mar-86	16	0.481589	1.859385
3001	5	1986	13	1.336952	0.613451	30-Mar-86	5-Apr-86	20	0.500673	1.858762
4007	0	1986	13	1.658933	0.947491	30-Mar-86	5-Apr-86	20	0.500673	1.858762
4406	0	1986	13	84.75301	17.02837	30-Mar-86	5-Apr-86	20	0.500673	1.858762
7915	1	1986	13	2.64647	1.118805	30-Mar-86	5-Apr-86	20	0.500673	1.858762
10501	5	1986	13	0.322997	0.322997	30-Mar-86	5-Apr-86	20	0.500673	1.858762
3001	5	1986	14	1.304163	0.763907	6-Apr-86	12-Apr-86	20	0.517077	1.874171
4406	0	1986	14	35.77872	8.806891	6-Apr-86	12-Apr-86	20	0.517077	1.874171
7915	9	1986	14	0.326797	0.326797	6-Apr-86	12-Apr-86	20	0.517077	1.874171
3001	5	1986	15	2.064715	1.314369	14-Apr-86	18-Apr-86	16	0	1.877141
3001	9	1986	15	0.407166	0.407166	14-Apr-86	18-Apr-86	16	0	1.877141
4007	0	1986	15	0.401413	0.401413	14-Apr-86	18-Apr-86	16	0	1.877141
4406	0	1986	15	6.398906	3.270918	14-Apr-86	18-Apr-86	16	0	1.877141
7915	3	1986	15	10.79418	5.632254	14-Apr-86	18-Apr-86	16	0	1.877141
10501	5	1986	15	1.231161	0.894437	14-Apr-86	18-Apr-86	16	0	1.877141
17826	3	1986	15	0.405318	0.405318	14-Apr-86	18-Apr-86	16	0	1.877141
3001	5	1986	16	1.562958	1.016527	20-Apr-86	26-Apr-86	20	0.111459	1.755906
4007	0	1986	16	1.688246	1.069464	20-Apr-86	26-Apr-86	20	0.111459	1.755906
4007	3	1986	16	0.322373	0.322373	20-Apr-86	26-Apr-86	20	0.111459	1.755906
4010	3	1986	16	1.952487	0.944447	20-Apr-86	26-Apr-86	20	0.111459	1.755906
7915	3	1986	16	27.48106	5.588982	20-Apr-86	26-Apr-86	20	0.111459	1.755906
7915	5	1986	16	1.60883	0.773603	20-Apr-86	26-Apr-86	20	0.111459	1.755906
7929	3	1986	16	0.596659	0.596659	20-Apr-86	26-Apr-86	20	0.111459	1.755906
8913	3	1986	16	0.322373	0.322373	20-Apr-86	26-Apr-86	20	0.111459	1.755906
10501	5	1986	16	0.298329	0.298329	20-Apr-86	26-Apr-86	20	0.111459	1.755906
10800	3	1986	16	0.322373	0.322373	20-Apr-86	26-Apr-86	20	0.111459	1.755906
10976	3	1986	16	0.344116	0.344116	20-Apr-86	26-Apr-86	20	0.111459	1.755906
15006	3	1986	16	0.658548	0.453245	20-Apr-86	26-Apr-86	20	0.111459	1.755906
17111	3	1986	16	0.343879	0.343879	20-Apr-86	26-Apr-86	20	0.111459	1.755906
17400	3	1986	16	0.668896	0.668896	20-Apr-86	26-Apr-86	20	0.111459	1.755906
17499	3	1986	16	0.339213	0.339213	20-Apr-86	26-Apr-86	20	0.111459	1.755906
17826	3	1986	16	0.979782	0.535889	20-Apr-86	26-Apr-86	20	0.111459	1.755906
17930	3	1986	16	0.334448	0.334448	20-Apr-86	26-Apr-86	20	0.111459	1.755906
99899	3	1986	16	1.26784	0.728181	20-Apr-86	26-Apr-86	20	0.111459	1.755906
3001	5	1986	17	0.268298	0.268298	27-Apr-86	3-May-86	32	0.37565	0.746784
4000	3	1986	17	0.835091	0.574756	1-May-86	3-May-86	20	0.37565	0.746784

4010	3	1986	17	0.216263	0.216263	27-Apr-86	3-May-86	32	0.37565	0.746784
4406	3	1986	17	0.862998	0.594027	1-May-86	3-May-86	20	0.37565	0.746784
7915	3	1986	17	26.40751	12.07352	27-Apr-86	3-May-86	32	0.37565	0.746784
7915	5	1986	17	7.739818	3.916276	27-Apr-86	3-May-86	32	0.37565	0.746784
10900	3	1986	17	0.408163	0.408163	1-May-86	3-May-86	20	0.37565	0.746784
10943	3	1986	17	0.432526	0.432526	1-May-86	3-May-86	20	0.37565	0.746784
10976	3	1986	17	0.646304	0.353114	27-Apr-86	3-May-86	32	0.37565	0.746784
17499	3	1986	17	0.566508	0.566508	27-Apr-86	30-Apr-86	12	0.37565	0.746784
17818	3	1986	17	0.416667	0.416667	1-May-86	3-May-86	20	0.37565	0.746784
17826	3	1986	17	0.478029	0.478029	27-Apr-86	3-May-86	32	0.37565	0.746784
99799	9	1986	17	0.408163	0.408163	27-Apr-86	3-May-86	32	0.37565	0.746784
3001	5	1986	18	0.300792	0.21099	4-May-86	10-May-86	55	0.637632	0.114414
4000	3	1986	18	1.6705	0.505374	4-May-86	10-May-86	55	0.637632	0.114414
4010	3	1986	18	3.631098	0.995414	4-May-86	10-May-86	55	0.637632	0.114414
4406	3	1986	18	2.916443	0.703121	4-May-86	10-May-86	55	0.637632	0.114414
7915	3	1986	18	0.313358	0.219521	4-May-86	10-May-86	55	0.637632	0.114414
7915	5	1986	18	13.95166	4.619871	4-May-86	10-May-86	55	0.637632	0.114414
10504	1	1986	18	0.138055	0.138055	4-May-86	10-May-86	55	0.637632	0.114414
10900	3	1986	18	0.446069	0.252969	4-May-86	10-May-86	55	0.637632	0.114414
10943	1	1986	18	0.142827	0.142827	4-May-86	10-May-86	55	0.637632	0.114414
10943	3	1986	18	1.188938	0.450073	4-May-86	10-May-86	55	0.637632	0.114414
10976	1	1986	18	0.142827	0.142827	4-May-86	10-May-86	55	0.637632	0.114414
10976	3	1986	18	3.332273	0.8799	4-May-86	10-May-86	55	0.637632	0.114414
17826	3	1986	18	0.751251	0.385181	4-May-86	10-May-86	55	0.637632	0.114414
17930	3	1986	18	0.428089	0.242621	4-May-86	10-May-86	55	0.637632	0.114414
99799	9	1986	18	4.385386	0.987468	4-May-86	10-May-86	55	0.637632	0.114414
99899	3	1986	18	0.303536	0.303536	4-May-86	10-May-86	55	0.637632	0.114414
3502	3	1986	19	0.098039	0.098039	11-May-86	17-May-86	55	0.810972	0.283968
4000	3	1986	19	1.902034	0.495572	11-May-86	17-May-86	55	0.810972	0.283968
4010	3	1986	19	7.862459	1.794996	11-May-86	17-May-86	55	0.810972	0.283968
4406	3	1986	19	1.593928	0.59383	11-May-86	17-May-86	55	0.810972	0.283968
7915	5	1986	19	0.449663	0.26389	11-May-86	17-May-86	55	0.810972	0.283968
10501	1	1986	19	0.189998	0.189998	11-May-86	17-May-86	55	0.810972	0.283968
10501	3	1986	19	2.246052	0.752607	11-May-86	17-May-86	55	0.810972	0.283968
10504	0	1986	19	0.860767	0.601602	11-May-86	17-May-86	55	0.810972	0.283968
10504	1	1986	19	0.743787	0.333921	11-May-86	17-May-86	55	0.810972	0.283968
10508	9	1986	19	0.163671	0.163671	11-May-86	17-May-86	55	0.810972	0.283968
10900	3	1986	19	0.152709	0.152709	11-May-86	17-May-86	55	0.810972	0.283968
10943	1	1986	19	0.326799	0.22876	11-May-86	17-May-86	55	0.810972	0.283968
10943	3	1986	19	0.039967	0.039967	11-May-86	17-May-86	55	0.810972	0.283968
10976	3	1986	19	1.071749	0.467961	11-May-86	17-May-86	55	0.810972	0.283968
12520	3	1986	19	0.379997	0.379997	11-May-86	17-May-86	55	0.810972	0.283968
17826	3	1986	19	0.160195	0.160195	11-May-86	17-May-86	55	0.810972	0.283968
17930	3	1986	19	0.272686	0.182185	11-May-86	17-May-86	55	0.810972	0.283968
99799	9	1986	19	1.013513	0.371319	11-May-86	17-May-86	55	0.810972	0.283968
99899	0	1986	19	1.790849	0.851457	11-May-86	17-May-86	55	0.810972	0.283968
99899	3	1986	19	0.195883	0.195883	11-May-86	17-May-86	55	0.810972	0.283968
3001	5	1986	20	0.062251	0.062251	18-May-86	24-May-86	137	1.586981	1.717252
4000	3	1986	20	8.045529	3.847146	18-May-86	24-May-86	137	1.586981	1.717252
4000	9	1986	20	0.123153	0.123153	18-May-86	24-May-86	137	1.586981	1.717252
4007	0	1986	20	0.122002	0.085739	18-May-86	24-May-86	137	1.586981	1.717252
4010	3	1986	20	4.487021	1.207116	18-May-86	24-May-86	137	1.586981	1.717252

4010	5	1986	20	0.062375	0.062375	18-May-86	24-May-86	137	1.586981	1.717252
4109	0	1986	20	0.062251	0.062251	18-May-86	24-May-86	137	1.586981	1.717252
4406	3	1986	20	2.638026	0.612139	18-May-86	24-May-86	137	1.586981	1.717252
6100	1	1986	20	0.245419	0.149792	18-May-86	24-May-86	137	1.586981	1.717252
6100	3	1986	20	1.528878	0.640882	18-May-86	24-May-86	137	1.586981	1.717252
7915	5	1986	20	19.81027	4.694788	18-May-86	24-May-86	137	1.586981	1.717252
8912	3	1986	20	0.058907	0.058907	18-May-86	24-May-86	137	1.586981	1.717252
9904	5	1986	20	0.121792	0.085601	18-May-86	24-May-86	137	1.586981	1.717252
10501	0	1986	20	0.121837	0.085628	18-May-86	24-May-86	137	1.586981	1.717252
10501	1	1986	20	1.980226	0.463534	18-May-86	24-May-86	137	1.586981	1.717252
10501	3	1986	20	65.12651	15.42965	18-May-86	24-May-86	137	1.586981	1.717252
10501	9	1986	20	0.062438	0.062438	18-May-86	24-May-86	137	1.586981	1.717252
10504	0	1986	20	0.80241	0.311205	18-May-86	24-May-86	137	1.586981	1.717252
10504	1	1986	20	8.003524	1.94467	18-May-86	24-May-86	137	1.586981	1.717252
10504	3	1986	20	28.51052	8.015161	18-May-86	24-May-86	137	1.586981	1.717252
10504	9	1986	20	0.679105	0.315353	18-May-86	24-May-86	137	1.586981	1.717252
10508	1	1986	20	0.183598	0.136498	18-May-86	24-May-86	137	1.586981	1.717252
10508	3	1986	20	1.209309	0.468423	18-May-86	24-May-86	137	1.586981	1.717252
10508	9	1986	20	2.100328	0.957335	18-May-86	24-May-86	137	1.586981	1.717252
10900	1	1986	20	0.062251	0.062251	18-May-86	24-May-86	137	1.586981	1.717252
10943	1	1986	20	1.666267	0.464561	18-May-86	24-May-86	137	1.586981	1.717252
10943	3	1986	20	1.164754	0.527174	18-May-86	24-May-86	137	1.586981	1.717252
10976	1	1986	20	0.183284	0.183284	18-May-86	24-May-86	137	1.586981	1.717252
10976	3	1986	20	0.185961	0.138203	18-May-86	24-May-86	137	1.586981	1.717252
17826	3	1986	20	0.061943	0.061943	18-May-86	24-May-86	137	1.586981	1.717252
17930	3	1986	20	0.0625	0.0625	18-May-86	24-May-86	137	1.586981	1.717252
99799	0	1986	20	0.248525	0.174623	18-May-86	24-May-86	137	1.586981	1.717252
99799	9	1986	20	1.276601	0.580043	18-May-86	24-May-86	137	1.586981	1.717252
99899	0	1986	20	2.339182	0.971827	18-May-86	24-May-86	137	1.586981	1.717252
99899	9	1986	20	0.246427	0.173144	18-May-86	24-May-86	137	1.586981	1.717252
3001	5	1986	21	0.062375	0.062375	25-May-86	31-May-86	126	2.194088	1.560869
4000	3	1986	21	705.9426	75.77483	25-May-86	31-May-86	126	2.194088	1.560869
4000	9	1986	21	0.124502	0.124502	25-May-86	31-May-86	126	2.194088	1.560869
4006	3	1986	21	0.56088	0.396516	25-May-86	31-May-86	126	2.194088	1.560869
4010	3	1986	21	0.376203	0.173226	25-May-86	31-May-86	126	2.194088	1.560869
4010	5	1986	21	0.623318	0.240838	25-May-86	31-May-86	126	2.194088	1.560869
4109	0	1986	21	0.062313	0.062313	25-May-86	31-May-86	126	2.194088	1.560869
4109	3	1986	21	0.124875	0.124875	25-May-86	31-May-86	126	2.194088	1.560869
4406	3	1986	21	18.32758	2.754193	25-May-86	31-May-86	126	2.194088	1.560869
6100	1	1986	21	0.619464	0.354944	25-May-86	31-May-86	126	2.194088	1.560869
6100	3	1986	21	3.090669	0.733169	25-May-86	31-May-86	126	2.194088	1.560869
6100	9	1986	21	0.492175	0.186538	25-May-86	31-May-86	126	2.194088	1.560869
6103	3	1986	21	0.125	0.125	25-May-86	31-May-86	126	2.194088	1.560869
7915	5	1986	21	4.297618	1.410621	25-May-86	31-May-86	126	2.194088	1.560869
8913	3	1986	21	0.062375	0.062375	25-May-86	31-May-86	126	2.194088	1.560869
9901	3	1986	21	0.062438	0.062438	25-May-86	31-May-86	126	2.194088	1.560869
10501	0	1986	21	0.0625	0.0625	25-May-86	31-May-86	126	2.194088	1.560869
10501	1	1986	21	2.043255	0.653447	25-May-86	31-May-86	126	2.194088	1.560869
10501	3	1986	21	754.4523	60.46331	25-May-86	31-May-86	126	2.194088	1.560869
10501	9	1986	21	0.370079	0.191923	25-May-86	31-May-86	126	2.194088	1.560869
10504	0	1986	21	0.434609	0.201162	25-May-86	31-May-86	126	2.194088	1.560869
10504	1	1986	21	67.51543	8.115677	25-May-86	31-May-86	126	2.194088	1.560869

10504	3	1986	21	538.902	43.82868	25-May-86	31-May-86	126	2.194088	1.560869
10504	9	1986	21	4.708421	1.096723	25-May-86	31-May-86	126	2.194088	1.560869
10508	0	1986	21	0.062313	0.062313	25-May-86	31-May-86	126	2.194088	1.560869
10508	1	1986	21	0.185894	0.138059	25-May-86	31-May-86	126	2.194088	1.560869
10508	3	1986	21	50.02404	8.988724	25-May-86	31-May-86	126	2.194088	1.560869
10508	9	1986	21	54.85527	8.282383	25-May-86	31-May-86	126	2.194088	1.560869
10900	1	1986	21	0.124626	0.124626	25-May-86	31-May-86	126	2.194088	1.560869
10900	3	1986	21	0.114784	0.114784	25-May-86	31-May-86	126	2.194088	1.560869
10943	1	1986	21	0.809556	0.325016	25-May-86	31-May-86	126	2.194088	1.560869
10943	3	1986	21	4.160054	0.681109	25-May-86	31-May-86	126	2.194088	1.560869
12500	9	1986	21	0.062375	0.062375	25-May-86	31-May-86	126	2.194088	1.560869
99799	0	1986	21	0.125	0.125	25-May-86	31-May-86	126	2.194088	1.560869
99799	9	1986	21	117.617	16.52483	25-May-86	31-May-86	126	2.194088	1.560869
99899	0	1986	21	1.853547	0.7485	25-May-86	31-May-86	126	2.194088	1.560869
99899	1	1986	21	0.247782	0.1741	25-May-86	31-May-86	126	2.194088	1.560869
4000	3	1986	22	500.9185	86.65276	1-Jun-86	7-Jun-86	137	1.341844	1.67525
4001	5	1986	22	0.126685	0.126685	1-Jun-86	7-Jun-86	137	1.341844	1.67525
4006	3	1986	22	1.399242	0.460438	1-Jun-86	7-Jun-86	137	1.341844	1.67525
4006	5	1986	22	0.031797	0.031797	1-Jun-86	7-Jun-86	137	1.341844	1.67525
4010	5	1986	22	0.638427	0.278456	1-Jun-86	7-Jun-86	137	1.341844	1.67525
4109	0	1986	22	0.127253	0.089396	1-Jun-86	7-Jun-86	137	1.341844	1.67525
4109	3	1986	22	0.063975	0.063975	1-Jun-86	7-Jun-86	137	1.341844	1.67525
4406	3	1986	22	13.26684	2.351945	1-Jun-86	7-Jun-86	137	1.341844	1.67525
4406	5	1986	22	0.063218	0.063218	1-Jun-86	7-Jun-86	137	1.341844	1.67525
4406	9	1986	22	0.127192	0.089354	1-Jun-86	7-Jun-86	137	1.341844	1.67525
6100	0	1986	22	1.086049	0.647151	1-Jun-86	7-Jun-86	137	1.341844	1.67525
6100	1	1986	22	0.189653	0.189653	1-Jun-86	7-Jun-86	137	1.341844	1.67525
6100	3	1986	22	2.421487	0.606028	1-Jun-86	7-Jun-86	137	1.341844	1.67525
6100	9	1986	22	1.370266	0.509874	1-Jun-86	7-Jun-86	137	1.341844	1.67525
6102	3	1986	22	0.318349	0.22812	1-Jun-86	7-Jun-86	137	1.341844	1.67525
6103	1	1986	22	0.478986	0.208573	1-Jun-86	7-Jun-86	137	1.341844	1.67525
6103	3	1986	22	0.925928	0.284474	1-Jun-86	7-Jun-86	137	1.341844	1.67525
6200	0	1986	22	0.127949	0.127949	1-Jun-86	7-Jun-86	137	1.341844	1.67525
7915	5	1986	22	1.215343	0.377728	1-Jun-86	7-Jun-86	137	1.341844	1.67525
8913	3	1986	22	0.191351	0.14194	1-Jun-86	7-Jun-86	137	1.341844	1.67525
10501	1	1986	22	1.527823	0.515252	1-Jun-86	7-Jun-86	137	1.341844	1.67525
10501	3	1986	22	409.6911	39.85818	1-Jun-86	7-Jun-86	137	1.341844	1.67525
10504	0	1986	22	0.31835	0.188688	1-Jun-86	7-Jun-86	137	1.341844	1.67525
10504	1	1986	22	9.164723	2.698737	1-Jun-86	7-Jun-86	137	1.341844	1.67525
10504	3	1986	22	692.4895	62.07388	1-Jun-86	7-Jun-86	137	1.341844	1.67525
10504	9	1986	22	0.063594	0.063594	1-Jun-86	7-Jun-86	137	1.341844	1.67525
10508	1	1986	22	0.031797	0.031797	1-Jun-86	7-Jun-86	137	1.341844	1.67525
10508	3	1986	22	35.49785	5.438103	1-Jun-86	7-Jun-86	137	1.341844	1.67525
10508	9	1986	22	6.962691	1.674392	1-Jun-86	7-Jun-86	137	1.341844	1.67525
10800	3	1986	22	0.319619	0.166318	1-Jun-86	7-Jun-86	137	1.341844	1.67525
10943	1	1986	22	0.286681	0.202459	1-Jun-86	7-Jun-86	137	1.341844	1.67525
10943	3	1986	22	2.746697	1.141773	1-Jun-86	7-Jun-86	137	1.341844	1.67525
10976	1	1986	22	0.064103	0.064103	1-Jun-86	7-Jun-86	137	1.341844	1.67525
99799	0	1986	22	0.381978	0.284038	1-Jun-86	7-Jun-86	137	1.341844	1.67525
99799	9	1986	22	10.25586	2.444422	1-Jun-86	7-Jun-86	137	1.341844	1.67525
99899	0	1986	22	1.1174	0.441895	1-Jun-86	7-Jun-86	137	1.341844	1.67525
3001	5	1986	23	0.059051	0.059051	8-Jun-86	14-Jun-86	141	2.750596	1.840236

4000	3	1986	23	750.6751	124.6648	8-Jun-86	14-Jun-86	141	2.750596	1.840236
4000	5	1986	23	0.058357	0.058357	8-Jun-86	14-Jun-86	141	2.750596	1.840236
4000	9	1986	23	0.059464	0.059464	8-Jun-86	14-Jun-86	141	2.750596	1.840236
4005	5	1986	23	0.17733	0.131482	8-Jun-86	14-Jun-86	141	2.750596	1.840236
4006	3	1986	23	0.295617	0.153703	8-Jun-86	14-Jun-86	141	2.750596	1.840236
4006	5	1986	23	0.53406	0.253692	8-Jun-86	14-Jun-86	141	2.750596	1.840236
4010	5	1986	23	0.356431	0.164442	8-Jun-86	14-Jun-86	141	2.750596	1.840236
4406	3	1986	23	17.14329	3.163118	8-Jun-86	14-Jun-86	141	2.750596	1.840236
4406	5	1986	23	17.52524	5.59136	8-Jun-86	14-Jun-86	141	2.750596	1.840236
4406	9	1986	23	0.157276	0.091177	8-Jun-86	14-Jun-86	141	2.750596	1.840236
6100	0	1986	23	0.175893	0.130857	8-Jun-86	14-Jun-86	141	2.750596	1.840236
6100	1	1986	23	0.237623	0.144145	8-Jun-86	14-Jun-86	141	2.750596	1.840236
6100	3	1986	23	2.288977	0.619991	8-Jun-86	14-Jun-86	141	2.750596	1.840236
6100	9	1986	23	0.514471	0.184624	8-Jun-86	14-Jun-86	141	2.750596	1.840236
6102	3	1986	23	0.296553	0.154545	8-Jun-86	14-Jun-86	141	2.750596	1.840236
6103	1	1986	23	0.177743	0.101377	8-Jun-86	14-Jun-86	141	2.750596	1.840236
6103	3	1986	23	3.224223	0.752236	8-Jun-86	14-Jun-86	141	2.750596	1.840236
6103	9	1986	23	0.059405	0.059405	8-Jun-86	14-Jun-86	141	2.750596	1.840236
7915	5	1986	23	0.296083	0.175794	8-Jun-86	14-Jun-86	141	2.750596	1.840236
8913	3	1986	23	0.317234	0.183835	8-Jun-86	14-Jun-86	141	2.750596	1.840236
8913	9	1986	23	0.059051	0.059051	8-Jun-86	14-Jun-86	141	2.750596	1.840236
10501	1	1986	23	0.178274	0.132272	8-Jun-86	14-Jun-86	141	2.750596	1.840236
10501	3	1986	23	367.7633	30.60126	8-Jun-86	14-Jun-86	141	2.750596	1.840236
10501	5	1986	23	0.119407	0.083924	8-Jun-86	14-Jun-86	141	2.750596	1.840236
10504	1	1986	23	0.177271	0.13151	8-Jun-86	14-Jun-86	141	2.750596	1.840236
10504	3	1986	23	475.1879	40.62497	8-Jun-86	14-Jun-86	141	2.750596	1.840236
10504	5	1986	23	0.059287	0.059287	8-Jun-86	14-Jun-86	141	2.750596	1.840236
10504	9	1986	23	0.059524	0.059524	8-Jun-86	14-Jun-86	141	2.750596	1.840236
10508	3	1986	23	28.73164	4.485755	8-Jun-86	14-Jun-86	141	2.750596	1.840236
10508	9	1986	23	1.30687	0.574579	8-Jun-86	14-Jun-86	141	2.750596	1.840236
10800	1	1986	23	0.29756	0.244712	8-Jun-86	14-Jun-86	141	2.750596	1.840236
10800	3	1986	23	0.750825	0.256606	8-Jun-86	14-Jun-86	141	2.750596	1.840236
10900	3	1986	23	0.059464	0.059464	8-Jun-86	14-Jun-86	141	2.750596	1.840236
10943	1	1986	23	0.176804	0.131092	8-Jun-86	14-Jun-86	141	2.750596	1.840236
10943	3	1986	23	0.653102	0.219914	8-Jun-86	14-Jun-86	141	2.750596	1.840236
17826	3	1986	23	0.05779	0.05779	8-Jun-86	14-Jun-86	141	2.750596	1.840236
99799	9	1986	23	11.60966	2.598936	8-Jun-86	14-Jun-86	141	2.750596	1.840236
99899	0	1986	23	0.217781	0.137508	8-Jun-86	14-Jun-86	141	2.750596	1.840236
99899	1	1986	23	0.059464	0.059464	8-Jun-86	14-Jun-86	141	2.750596	1.840236
99899	9	1986	23	0.059464	0.059464	8-Jun-86	14-Jun-86	141	2.750596	1.840236
3001	5	1986	24	0.18226	0.135268	15-Jun-86	21-Jun-86	118	3.174962	2.116045
4000	3	1986	24	20.50866	5.661864	15-Jun-86	21-Jun-86	118	3.174962	2.116045
4005	3	1986	24	0.848448	0.550688	15-Jun-86	21-Jun-86	118	3.174962	2.116045
4005	5	1986	24	0.484776	0.381653	15-Jun-86	21-Jun-86	118	3.174962	2.116045
4006	3	1986	24	0.971973	0.476904	15-Jun-86	21-Jun-86	118	3.174962	2.116045
4006	5	1986	24	1.395363	0.475153	15-Jun-86	21-Jun-86	118	3.174962	2.116045
4010	5	1986	24	0.121224	0.121224	15-Jun-86	21-Jun-86	118	3.174962	2.116045
4109	3	1986	24	1.274806	0.455891	15-Jun-86	21-Jun-86	118	3.174962	2.116045
4406	3	1986	24	2.183858	1.143728	15-Jun-86	21-Jun-86	118	3.174962	2.116045
4406	5	1986	24	6.173308	1.237501	15-Jun-86	21-Jun-86	118	3.174962	2.116045
6100	1	1986	24	0.121103	0.121103	15-Jun-86	21-Jun-86	118	3.174962	2.116045
6100	3	1986	24	0.910645	0.261056	15-Jun-86	21-Jun-86	118	3.174962	2.116045

6100	9	1986	24	0.121951	0.121951	15-Jun-86	21-Jun-86	118	3.174962	2.116045
6102	3	1986	24	0.36295	0.36295	15-Jun-86	21-Jun-86	118	3.174962	2.116045
6103	1	1986	24	0.120983	0.120983	15-Jun-86	21-Jun-86	118	3.174962	2.116045
6103	3	1986	24	0.666797	0.269513	15-Jun-86	21-Jun-86	118	3.174962	2.116045
6402	5	1986	24	0.060552	0.060552	15-Jun-86	21-Jun-86	118	3.174962	2.116045
8723	0	1986	24	0.11863	0.11863	15-Jun-86	21-Jun-86	118	3.174962	2.116045
8913	9	1986	24	0.121829	0.121829	15-Jun-86	21-Jun-86	118	3.174962	2.116045
10501	1	1986	24	0.121103	0.121103	15-Jun-86	21-Jun-86	118	3.174962	2.116045
10501	3	1986	24	77.08831	9.327557	15-Jun-86	21-Jun-86	118	3.174962	2.116045
10501	5	1986	24	4.653801	1.534808	15-Jun-86	21-Jun-86	118	3.174962	2.116045
10504	1	1986	24	0.425918	0.232416	15-Jun-86	21-Jun-86	118	3.174962	2.116045
10504	3	1986	24	62.70544	8.747682	15-Jun-86	21-Jun-86	118	3.174962	2.116045
10504	5	1986	24	1.640824	0.58019	15-Jun-86	21-Jun-86	118	3.174962	2.116045
10508	3	1986	24	2.656555	0.672672	15-Jun-86	21-Jun-86	118	3.174962	2.116045
10508	9	1986	24	0.21281	0.138381	15-Jun-86	21-Jun-86	118	3.174962	2.116045
10943	3	1986	24	0.182017	0.103782	15-Jun-86	21-Jun-86	118	3.174962	2.116045
99799	9	1986	24	2.954487	0.634149	15-Jun-86	21-Jun-86	118	3.174962	2.116045
99899	0	1986	24	0.242448	0.146983	15-Jun-86	21-Jun-86	118	3.174962	2.116045
4000	3	1986	25	0.303245	0.157727	22-Jun-86	28-Jun-86	157	3.174436	2.114962
4005	5	1986	25	0.060976	0.060976	22-Jun-86	28-Jun-86	157	3.174436	2.114962
4006	5	1986	25	0.12189	0.12189	22-Jun-86	28-Jun-86	157	3.174436	2.114962
4109	0	1986	25	0.121103	0.121103	22-Jun-86	28-Jun-86	157	3.174436	2.114962
4109	3	1986	25	0.790983	0.202478	22-Jun-86	28-Jun-86	157	3.174436	2.114962
4406	3	1986	25	0.060552	0.060552	22-Jun-86	28-Jun-86	157	3.174436	2.114962
4406	5	1986	25	3.765596	0.644125	22-Jun-86	28-Jun-86	157	3.174436	2.114962
6100	0	1986	25	0.425193	0.177024	22-Jun-86	28-Jun-86	157	3.174436	2.114962
6100	1	1986	25	0.121466	0.085358	22-Jun-86	28-Jun-86	157	3.174436	2.114962
6100	3	1986	25	0.669882	0.189099	22-Jun-86	28-Jun-86	157	3.174436	2.114962
6100	9	1986	25	0.091372	0.067795	22-Jun-86	28-Jun-86	157	3.174436	2.114962
6103	3	1986	25	0.939852	0.27472	22-Jun-86	28-Jun-86	157	3.174436	2.114962
8419	3	1986	25	0.060793	0.060793	22-Jun-86	28-Jun-86	157	3.174436	2.114962
8913	3	1986	25	0.121345	0.085273	22-Jun-86	28-Jun-86	157	3.174436	2.114962
9901	3	1986	25	0.060492	0.060492	22-Jun-86	28-Jun-86	157	3.174436	2.114962
10501	1	1986	25	0.121345	0.085273	22-Jun-86	28-Jun-86	157	3.174436	2.114962
10501	3	1986	25	26.72575	2.533225	22-Jun-86	28-Jun-86	157	3.174436	2.114962
10501	5	1986	25	4.680823	0.756529	22-Jun-86	28-Jun-86	157	3.174436	2.114962
10501	9	1986	25	0.060253	0.060253	22-Jun-86	28-Jun-86	157	3.174436	2.114962
10504	1	1986	25	1.154841	0.315355	22-Jun-86	28-Jun-86	157	3.174436	2.114962
10504	3	1986	25	44.13651	3.85812	22-Jun-86	28-Jun-86	157	3.174436	2.114962
10504	5	1986	25	0.303787	0.158018	22-Jun-86	28-Jun-86	157	3.174436	2.114962
10504	9	1986	25	0.121345	0.085273	22-Jun-86	28-Jun-86	157	3.174436	2.114962
10508	3	1986	25	2.431426	0.625193	22-Jun-86	28-Jun-86	157	3.174436	2.114962
10508	9	1986	25	0.668184	0.224885	22-Jun-86	28-Jun-86	157	3.174436	2.114962
10800	3	1986	25	0.36464	0.144196	22-Jun-86	28-Jun-86	157	3.174436	2.114962
99799	9	1986	25	0.727239	0.230078	22-Jun-86	28-Jun-86	157	3.174436	2.114962
99899	0	1986	25	0.790014	0.219955	22-Jun-86	28-Jun-86	157	3.174436	2.114962
3001	5	1986	26	0.059822	0.059822	29-Jun-86	5-Jul-86	154	2.960876	2.324581
4000	3	1986	26	0.060001	0.060001	29-Jun-86	5-Jul-86	154	2.960876	2.324581
4000	5	1986	26	0.060061	0.060061	29-Jun-86	5-Jul-86	154	2.960876	2.324581
4005	5	1986	26	0.119585	0.084042	29-Jun-86	5-Jul-86	154	2.960876	2.324581
4006	5	1986	26	0.119644	0.084084	29-Jun-86	5-Jul-86	154	2.960876	2.324581
4010	5	1986	26	0.119823	0.08421	29-Jun-86	5-Jul-86	154	2.960876	2.324581

4109	0	1986	26	127.5447	40.51753	29-Jun-86	5-Jul-86	154	2.960876	2.324581
4109	3	1986	26	127.843	17.27146	29-Jun-86	5-Jul-86	154	2.960876	2.324581
4406	5	1986	26	0.600194	0.216012	29-Jun-86	5-Jul-86	154	2.960876	2.324581
6100	0	1986	26	0.240184	0.145642	29-Jun-86	5-Jul-86	154	2.960876	2.324581
6100	1	1986	26	0.239289	0.145037	29-Jun-86	5-Jul-86	154	2.960876	2.324581
6100	3	1986	26	0.478227	0.201552	29-Jun-86	5-Jul-86	154	2.960876	2.324581
6100	9	1986	26	0.059822	0.059822	29-Jun-86	5-Jul-86	154	2.960876	2.324581
6102	3	1986	26	0.059822	0.059822	29-Jun-86	5-Jul-86	154	2.960876	2.324581
6103	0	1986	26	0.060241	0.060241	29-Jun-86	5-Jul-86	154	2.960876	2.324581
6103	3	1986	26	0.059822	0.059822	29-Jun-86	5-Jul-86	154	2.960876	2.324581
6200	0	1986	26	0.060061	0.060061	29-Jun-86	5-Jul-86	154	2.960876	2.324581
8504	3	1986	26	0.060121	0.060121	29-Jun-86	5-Jul-86	154	2.960876	2.324581
8720	1	1986	26	0.059882	0.059882	29-Jun-86	5-Jul-86	154	2.960876	2.324581
8720	3	1986	26	0.059822	0.059822	29-Jun-86	5-Jul-86	154	2.960876	2.324581
8913	0	1986	26	0.060061	0.060061	29-Jun-86	5-Jul-86	154	2.960876	2.324581
8913	3	1986	26	0.300127	0.130907	29-Jun-86	5-Jul-86	154	2.960876	2.324581
8913	9	1986	26	0.120182	0.084461	29-Jun-86	5-Jul-86	154	2.960876	2.324581
9901	3	1986	26	0.059822	0.059822	29-Jun-86	5-Jul-86	154	2.960876	2.324581
10501	1	1986	26	0.060241	0.060241	29-Jun-86	5-Jul-86	154	2.960876	2.324581
10501	3	1986	26	9.95093	1.019056	29-Jun-86	5-Jul-86	154	2.960876	2.324581
10501	5	1986	26	3.357567	0.597545	29-Jun-86	5-Jul-86	154	2.960876	2.324581
10504	1	1986	26	0.359709	0.142303	29-Jun-86	5-Jul-86	154	2.960876	2.324581
10504	3	1986	26	15.71162	1.598993	29-Jun-86	5-Jul-86	154	2.960876	2.324581
10504	5	1986	26	0.538167	0.208469	29-Jun-86	5-Jul-86	154	2.960876	2.324581
10504	9	1986	26	0.059941	0.059941	29-Jun-86	5-Jul-86	154	2.960876	2.324581
10508	3	1986	26	0.479474	0.162123	29-Jun-86	5-Jul-86	154	2.960876	2.324581
10508	9	1986	26	0.180183	0.102753	29-Jun-86	5-Jul-86	154	2.960876	2.324581
10800	3	1986	26	0.179467	0.133112	29-Jun-86	5-Jul-86	154	2.960876	2.324581
18005	3	1986	26	0.060121	0.060121	29-Jun-86	5-Jul-86	154	2.960876	2.324581
99799	9	1986	26	7.863126	1.644943	29-Jun-86	5-Jul-86	154	2.960876	2.324581
99899	0	1986	26	0.539472	0.190895	29-Jun-86	5-Jul-86	154	2.960876	2.324581
4109	0	1986	27	149.8248	26.2555	6-Jul-86	12-Jul-86	140	3.051515	0.907655
4109	3	1986	27	675.2124	91.55545	6-Jul-86	12-Jul-86	140	3.051515	0.907655
4109	9	1986	27	5.911781	2.581476	6-Jul-86	12-Jul-86	140	3.051515	0.907655
4406	5	1986	27	1.356632	0.441769	6-Jul-86	12-Jul-86	140	3.051515	0.907655
6100	0	1986	27	0.18893	0.107672	6-Jul-86	12-Jul-86	140	3.051515	0.907655
6100	3	1986	27	0.505068	0.24763	6-Jul-86	12-Jul-86	140	3.051515	0.907655
6100	9	1986	27	0.126204	0.126204	6-Jul-86	12-Jul-86	140	3.051515	0.907655
6102	3	1986	27	0.062914	0.062914	6-Jul-86	12-Jul-86	140	3.051515	0.907655
6103	3	1986	27	0.915234	0.281388	6-Jul-86	12-Jul-86	140	3.051515	0.907655
8504	3	1986	27	0.126456	0.126456	6-Jul-86	12-Jul-86	140	3.051515	0.907655
8720	0	1986	27	0.063165	0.063165	6-Jul-86	12-Jul-86	140	3.051515	0.907655
8725	0	1986	27	0.063102	0.063102	6-Jul-86	12-Jul-86	140	3.051515	0.907655
8907	3	1986	27	0.252282	0.177243	6-Jul-86	12-Jul-86	140	3.051515	0.907655
8907	5	1986	27	0.063039	0.063039	6-Jul-86	12-Jul-86	140	3.051515	0.907655
8909	3	1986	27	0.063102	0.063102	6-Jul-86	12-Jul-86	140	3.051515	0.907655
8913	3	1986	27	0.79919	0.257151	6-Jul-86	12-Jul-86	140	3.051515	0.907655
8913	9	1986	27	0.126582	0.126582	6-Jul-86	12-Jul-86	140	3.051515	0.907655
10320	5	1986	27	0.692743	0.245338	6-Jul-86	12-Jul-86	140	3.051515	0.907655
10501	3	1986	27	5.257822	1.011229	6-Jul-86	12-Jul-86	140	3.051515	0.907655
10501	5	1986	27	0.662508	0.227741	6-Jul-86	12-Jul-86	140	3.051515	0.907655
10504	3	1986	27	3.491075	0.728595	6-Jul-86	12-Jul-86	140	3.051515	0.907655

10504	5	1986	27	0.126079	0.088578	6-Jul-86	12-Jul-86	140	3.051515	0.907655
10508	3	1986	27	0.693873	0.320596	6-Jul-86	12-Jul-86	140	3.051515	0.907655
12500	0	1986	27	0.167854	0.097215	6-Jul-86	12-Jul-86	140	3.051515	0.907655
12512	3	1986	27	0.945591	0.284911	6-Jul-86	12-Jul-86	140	3.051515	0.907655
13600	0	1986	27	0.126267	0.08871	6-Jul-86	12-Jul-86	140	3.051515	0.907655
15999	3	1986	27	0.442347	0.184144	6-Jul-86	12-Jul-86	140	3.051515	0.907655
18005	3	1986	27	0.50444	0.212294	6-Jul-86	12-Jul-86	140	3.051515	0.907655
99799	9	1986	27	141.9118	28.08044	6-Jul-86	12-Jul-86	140	3.051515	0.907655
99899	0	1986	27	0.12633	0.088754	6-Jul-86	12-Jul-86	140	3.051515	0.907655
4001	5	1986	28	0.120241	0.120241	13-Jul-86	19-Jul-86	142	2.978225	0.47269
4109	0	1986	28	58.044	9.74408	13-Jul-86	19-Jul-86	142	2.978225	0.47269
4109	3	1986	28	1001.554	105.7844	13-Jul-86	19-Jul-86	142	2.978225	0.47269
4109	5	1986	28	0.240304	0.145715	13-Jul-86	19-Jul-86	142	2.978225	0.47269
4109	9	1986	28	9.415195	3.767782	13-Jul-86	19-Jul-86	142	2.978225	0.47269
4406	5	1986	28	0.479652	0.202151	13-Jul-86	19-Jul-86	142	2.978225	0.47269
6100	3	1986	28	0.179706	0.13338	13-Jul-86	19-Jul-86	142	2.978225	0.47269
6102	3	1986	28	0.240723	0.240723	13-Jul-86	19-Jul-86	142	2.978225	0.47269
6103	1	1986	28	0.120241	0.120241	13-Jul-86	19-Jul-86	142	2.978225	0.47269
6103	3	1986	28	0.777093	0.26222	13-Jul-86	19-Jul-86	142	2.978225	0.47269
6200	0	1986	28	0.297745	0.154518	13-Jul-86	19-Jul-86	142	2.978225	0.47269
8504	3	1986	28	0.060241	0.060241	13-Jul-86	19-Jul-86	142	2.978225	0.47269
8720	3	1986	28	0.059763	0.059763	13-Jul-86	19-Jul-86	142	2.978225	0.47269
8725	3	1986	28	0.059822	0.059822	13-Jul-86	19-Jul-86	142	2.978225	0.47269
8907	3	1986	28	0.059586	0.059586	13-Jul-86	19-Jul-86	142	2.978225	0.47269
8913	1	1986	28	0.120122	0.120122	13-Jul-86	19-Jul-86	142	2.978225	0.47269
8913	3	1986	28	1.257901	0.328514	13-Jul-86	19-Jul-86	142	2.978225	0.47269
8913	9	1986	28	0.179118	0.102147	13-Jul-86	19-Jul-86	142	2.978225	0.47269
10320	5	1986	28	0.539892	0.256329	13-Jul-86	19-Jul-86	142	2.978225	0.47269
10501	3	1986	28	3.054185	0.595487	13-Jul-86	19-Jul-86	142	2.978225	0.47269
10501	5	1986	28	0.599299	0.261438	13-Jul-86	19-Jul-86	142	2.978225	0.47269
10504	3	1986	28	3.779254	0.934278	13-Jul-86	19-Jul-86	142	2.978225	0.47269
10504	5	1986	28	0.060061	0.060061	13-Jul-86	19-Jul-86	142	2.978225	0.47269
10508	9	1986	28	0.120122	0.120122	13-Jul-86	19-Jul-86	142	2.978225	0.47269
10800	3	1986	28	0.240066	0.145347	13-Jul-86	19-Jul-86	142	2.978225	0.47269
10900	3	1986	28	0.060061	0.060061	13-Jul-86	19-Jul-86	142	2.978225	0.47269
12512	3	1986	28	2.757017	0.902591	13-Jul-86	19-Jul-86	142	2.978225	0.47269
12512	5	1986	28	0.660613	0.222385	13-Jul-86	19-Jul-86	142	2.978225	0.47269
15999	3	1986	28	4.258915	0.992106	13-Jul-86	19-Jul-86	142	2.978225	0.47269
18005	3	1986	28	1.315717	0.451533	13-Jul-86	19-Jul-86	142	2.978225	0.47269
99799	9	1986	28	115.3029	16.47008	13-Jul-86	19-Jul-86	142	2.978225	0.47269
99899	0	1986	28	0.17692	0.130737	13-Jul-86	19-Jul-86	142	2.978225	0.47269
99899	3	1986	28	0.060241	0.060241	13-Jul-86	19-Jul-86	142	2.978225	0.47269
4109	0	1986	29	6.510887	4.099737	20-Jul-86	26-Jul-86	141	3.152617	0.472
4109	3	1986	29	685.4344	64.51306	20-Jul-86	26-Jul-86	141	3.152617	0.472
4109	5	1986	29	0.54799	0.324205	20-Jul-86	26-Jul-86	141	3.152617	0.472
4109	9	1986	29	6.061279	3.897228	20-Jul-86	26-Jul-86	141	3.152617	0.472
4406	3	1986	29	0.060733	0.060733	20-Jul-86	26-Jul-86	141	3.152617	0.472
4406	5	1986	29	2.329639	0.625859	20-Jul-86	26-Jul-86	141	3.152617	0.472
6100	0	1986	29	0.060733	0.060733	20-Jul-86	26-Jul-86	141	3.152617	0.472
6100	3	1986	29	0.486166	0.204799	20-Jul-86	26-Jul-86	141	3.152617	0.472
6102	3	1986	29	0.18226	0.135268	20-Jul-86	26-Jul-86	141	3.152617	0.472
6103	3	1986	29	1.819382	0.476967	20-Jul-86	26-Jul-86	141	3.152617	0.472

8720	0	1986	29	0.181776	0.13478	20-Jul-86	26-Jul-86	141	3.152617	0.472
8720	3	1986	29	0.181956	0.134969	20-Jul-86	26-Jul-86	141	3.152617	0.472
8723	1	1986	29	0.121406	0.085315	20-Jul-86	26-Jul-86	141	3.152617	0.472
8723	3	1986	29	0.060976	0.060976	20-Jul-86	26-Jul-86	141	3.152617	0.472
8913	1	1986	29	0.121951	0.121951	20-Jul-86	26-Jul-86	141	3.152617	0.472
8913	3	1986	29	1.214821	0.372524	20-Jul-86	26-Jul-86	141	3.152617	0.472
8913	9	1986	29	0.121708	0.121708	20-Jul-86	26-Jul-86	141	3.152617	0.472
10320	5	1986	29	0.213173	0.107967	20-Jul-86	26-Jul-86	141	3.152617	0.472
10501	3	1986	29	3.402815	0.616532	20-Jul-86	26-Jul-86	141	3.152617	0.472
10501	5	1986	29	0.667766	0.269842	20-Jul-86	26-Jul-86	141	3.152617	0.472
10504	1	1986	29	0.060612	0.060612	20-Jul-86	26-Jul-86	141	3.152617	0.472
10504	3	1986	29	0.547327	0.212206	20-Jul-86	26-Jul-86	141	3.152617	0.472
10504	5	1986	29	0.121405	0.085315	20-Jul-86	26-Jul-86	141	3.152617	0.472
10508	3	1986	29	0.121586	0.121586	20-Jul-86	26-Jul-86	141	3.152617	0.472
10800	3	1986	29	0.060733	0.060733	20-Jul-86	26-Jul-86	141	3.152617	0.472
12512	3	1986	29	4.90676	1.339775	20-Jul-86	26-Jul-86	141	3.152617	0.472
12512	5	1986	29	1.894272	0.485104	20-Jul-86	26-Jul-86	141	3.152617	0.472
15999	3	1986	29	1.275517	0.343447	20-Jul-86	26-Jul-86	141	3.152617	0.472
18005	3	1986	29	2.282307	0.471632	20-Jul-86	26-Jul-86	141	3.152617	0.472
99799	9	1986	29	154.1455	15.8762	20-Jul-86	26-Jul-86	141	3.152617	0.472
99899	0	1986	29	0.121708	0.085528	20-Jul-86	26-Jul-86	141	3.152617	0.472
4000	5	1986	30	0.123457	0.123457	27-Jul-86	2-Aug-86	142	3.109926	0.522387
4109	0	1986	30	3.034767	1.306884	27-Jul-86	2-Aug-86	142	3.109926	0.522387
4109	3	1986	30	1035.4	98.08568	27-Jul-86	2-Aug-86	142	3.109926	0.522387
4109	5	1986	30	0.491924	0.207078	27-Jul-86	2-Aug-86	142	3.109926	0.522387
4406	5	1986	30	0.614461	0.253145	27-Jul-86	2-Aug-86	142	3.109926	0.522387
6100	3	1986	30	0.307659	0.182633	27-Jul-86	2-Aug-86	142	3.109926	0.522387
6103	3	1986	30	0.582611	0.262897	27-Jul-86	2-Aug-86	142	3.109926	0.522387
8720	0	1986	30	0.184387	0.136819	27-Jul-86	2-Aug-86	142	3.109926	0.522387
8720	3	1986	30	0.246667	0.149419	27-Jul-86	2-Aug-86	142	3.109926	0.522387
8723	1	1986	30	0.061605	0.061605	27-Jul-86	2-Aug-86	142	3.109926	0.522387
8723	3	1986	30	0.185062	0.105501	27-Jul-86	2-Aug-86	142	3.109926	0.522387
8725	3	1986	30	0.061728	0.061728	27-Jul-86	2-Aug-86	142	3.109926	0.522387
8913	3	1986	30	0.769609	0.250401	27-Jul-86	2-Aug-86	142	3.109926	0.522387
8913	9	1986	30	0.061299	0.061299	27-Jul-86	2-Aug-86	142	3.109926	0.522387
10320	5	1986	30	0.041152	0.041152	27-Jul-86	2-Aug-86	142	3.109926	0.522387
10501	3	1986	30	1.782069	0.562871	27-Jul-86	2-Aug-86	142	3.109926	0.522387
10501	5	1986	30	0.615012	0.221223	27-Jul-86	2-Aug-86	142	3.109926	0.522387
10504	3	1986	30	0.61587	0.238205	27-Jul-86	2-Aug-86	142	3.109926	0.522387
10504	5	1986	30	0.091767	0.068029	27-Jul-86	2-Aug-86	142	3.109926	0.522387
10508	9	1986	30	0.061238	0.061238	27-Jul-86	2-Aug-86	142	3.109926	0.522387
12512	3	1986	30	0.184326	0.136793	27-Jul-86	2-Aug-86	142	3.109926	0.522387
12512	5	1986	30	2.361001	1.205648	27-Jul-86	2-Aug-86	142	3.109926	0.522387
15999	3	1986	30	0.614829	0.23779	27-Jul-86	2-Aug-86	142	3.109926	0.522387
18005	3	1986	30	1.568516	0.387764	27-Jul-86	2-Aug-86	142	3.109926	0.522387
99799	9	1986	30	96.0942	8.352842	27-Jul-86	2-Aug-86	142	3.109926	0.522387
99899	0	1986	30	1.108282	0.991756	27-Jul-86	2-Aug-86	142	3.109926	0.522387
4109	0	1986	31	3.849272	1.024674	3-Aug-86	9-Aug-86	143	3.039844	0.522387
4109	3	1986	31	821.1651	62.69241	3-Aug-86	9-Aug-86	143	3.039844	0.522387
4109	5	1986	31	2.896518	1.103533	3-Aug-86	9-Aug-86	143	3.039844	0.522387
4109	9	1986	31	2.608624	1.508135	3-Aug-86	9-Aug-86	143	3.039844	0.522387
4406	5	1986	31	1.241962	0.427862	3-Aug-86	9-Aug-86	143	3.039844	0.522387

8720	3	1986	31	0.412458	0.15016	3-Aug-86	9-Aug-86	143	3.039844	0.522387
8723	3	1986	31	0.05911	0.05911	3-Aug-86	9-Aug-86	143	3.039844	0.522387
8723	5	1986	31	0.05911	0.05911	3-Aug-86	9-Aug-86	143	3.039844	0.522387
8725	3	1986	31	0.295316	0.175266	3-Aug-86	9-Aug-86	143	3.039844	0.522387
8913	3	1986	31	0.29673	0.154564	3-Aug-86	9-Aug-86	143	3.039844	0.522387
10320	3	1986	31	0.059524	0.059524	3-Aug-86	9-Aug-86	143	3.039844	0.522387
10320	5	1986	31	0.414538	0.150912	3-Aug-86	9-Aug-86	143	3.039844	0.522387
10501	3	1986	31	0.769493	0.24543	3-Aug-86	9-Aug-86	143	3.039844	0.522387
10501	5	1986	31	0.355428	0.184281	3-Aug-86	9-Aug-86	143	3.039844	0.522387
10504	3	1986	31	0.236499	0.116093	3-Aug-86	9-Aug-86	143	3.039844	0.522387
10508	3	1986	31	0.23703	0.116354	3-Aug-86	9-Aug-86	143	3.039844	0.522387
10800	3	1986	31	0.177802	0.131957	3-Aug-86	9-Aug-86	143	3.039844	0.522387
12512	3	1986	31	0.650977	0.300861	3-Aug-86	9-Aug-86	143	3.039844	0.522387
12512	5	1986	31	1.361773	0.493631	3-Aug-86	9-Aug-86	143	3.039844	0.522387
15999	3	1986	31	2.072453	0.527071	3-Aug-86	9-Aug-86	143	3.039844	0.522387
15999	5	1986	31	0.059405	0.059405	3-Aug-86	9-Aug-86	143	3.039844	0.522387
16814	3	1986	31	0.058586	0.058586	3-Aug-86	9-Aug-86	143	3.039844	0.522387
18005	1	1986	31	0.415363	0.19269	3-Aug-86	9-Aug-86	143	3.039844	0.522387
18005	3	1986	31	5.636643	1.175439	3-Aug-86	9-Aug-86	143	3.039844	0.522387
18005	5	1986	31	0.17733	0.131536	3-Aug-86	9-Aug-86	143	3.039844	0.522387
99799	9	1986	31	91.56874	8.843265	3-Aug-86	9-Aug-86	143	3.039844	0.522387
4109	3	1986	32	137.7224	28.01786	10-Aug-86	10-Aug-86	12	3.098833	0.514253
4406	5	1986	32	3.317592	1.414631	10-Aug-86	10-Aug-86	12	3.098833	0.514253
12512	3	1986	32	0.827541	0.827541	10-Aug-86	10-Aug-86	12	3.098833	0.514253
12512	5	1986	32	0.830013	0.830013	10-Aug-86	10-Aug-86	12	3.098833	0.514253
18005	3	1986	32	4.144305	1.918363	10-Aug-86	10-Aug-86	12	3.098833	0.514253
99799	9	1986	32	88.84059	25.54586	10-Aug-86	10-Aug-86	12	3.098833	0.514253
3001	5	1987	18	0.654741	0.302977	6-May-87	9-May-87	95	1.905471	0.170974
4000	3	1987	18	4.487786	1.263525	6-May-87	9-May-87	95	1.905471	0.170974
4000	9	1987	18	0.192988	0.137601	6-May-87	9-May-87	95	1.905471	0.170974
4406	3	1987	18	2.442591	0.56418	6-May-87	9-May-87	95	1.905471	0.170974
6208	3	1987	18	0.113999	0.113999	6-May-87	9-May-87	95	1.905471	0.170974
7915	3	1987	18	0.571424	0.290957	6-May-87	9-May-87	95	1.905471	0.170974
7915	5	1987	18	12.3173	4.109446	6-May-87	9-May-87	95	1.905471	0.170974
10501	1	1987	18	0.539353	0.232087	6-May-87	9-May-87	95	1.905471	0.170974
10501	3	1987	18	0.536856	0.283536	6-May-87	9-May-87	95	1.905471	0.170974
10504	1	1987	18	0.171055	0.126363	6-May-87	9-May-87	95	1.905471	0.170974
10900	3	1987	18	0.113332	0.113332	6-May-87	9-May-87	95	1.905471	0.170974
10943	3	1987	18	0.344478	0.194092	6-May-87	9-May-87	95	1.905471	0.170974
10976	1	1987	18	0.540398	0.330042	6-May-87	9-May-87	95	1.905471	0.170974
10976	3	1987	18	5.112686	1.072534	6-May-87	9-May-87	95	1.905471	0.170974
10976	9	1987	18	0.687534	0.263473	6-May-87	9-May-87	95	1.905471	0.170974
17930	3	1987	18	0.653725	0.252962	6-May-87	9-May-87	95	1.905471	0.170974
99799	9	1987	18	3.557778	0.691942	6-May-87	9-May-87	95	1.905471	0.170974
99899	0	1987	18	0.077442	0.077442	6-May-87	9-May-87	95	1.905471	0.170974
3001	5	1987	19	1.114168	0.33233	10-May-87	16-May-87	154	1.905576	0
4000	3	1987	19	3.600107	0.653114	10-May-87	16-May-87	154	1.905576	0
4406	3	1987	19	0.940964	0.291169	10-May-87	16-May-87	154	1.905576	0
6100	1	1987	19	0.063342	0.063342	10-May-87	16-May-87	154	1.905576	0
7915	5	1987	19	10.56881	1.529735	10-May-87	16-May-87	154	1.905576	0
10501	0	1987	19	0.105785	0.075719	10-May-87	16-May-87	154	1.905576	0
10501	1	1987	19	0.284785	0.127164	10-May-87	16-May-87	154	1.905576	0

10501	3	1987	19	0.768616	0.225634	10-May-87	16-May-87	154	1.905576	0
10504	0	1987	19	0.031765	0.031765	10-May-87	16-May-87	154	1.905576	0
10504	1	1987	19	0.188049	0.107152	10-May-87	16-May-87	154	1.905576	0
10504	3	1987	19	0.064039	0.064039	10-May-87	16-May-87	154	1.905576	0
10943	1	1987	19	0.445812	0.182552	10-May-87	16-May-87	154	1.905576	0
10943	3	1987	19	0.227898	0.142922	10-May-87	16-May-87	154	1.905576	0
10943	9	1987	19	0.104776	0.074944	10-May-87	16-May-87	154	1.905576	0
10976	1	1987	19	0.063975	0.063975	10-May-87	16-May-87	154	1.905576	0
10976	3	1987	19	1.703681	0.32663	10-May-87	16-May-87	154	1.905576	0
10976	9	1987	19	0.127505	0.089572	10-May-87	16-May-87	154	1.905576	0
17930	3	1987	19	0.895444	0.227093	10-May-87	16-May-87	154	1.905576	0
99799	9	1987	19	3.227383	0.611319	10-May-87	16-May-87	154	1.905576	0
3001	5	1987	20	0.554115	0.215134	17-May-87	23-May-87	144	2.163815	0
4000	3	1987	20	2.220998	0.457756	17-May-87	23-May-87	144	2.163815	0
4406	3	1987	20	0.191161	0.097317	17-May-87	23-May-87	144	2.163815	0
7915	5	1987	20	7.487567	1.621843	17-May-87	23-May-87	144	2.163815	0
10501	1	1987	20	0.185604	0.1058	17-May-87	23-May-87	144	2.163815	0
10501	3	1987	20	4.498077	0.757245	17-May-87	23-May-87	144	2.163815	0
10501	9	1987	20	0.12475	0.12475	17-May-87	23-May-87	144	2.163815	0
10504	0	1987	20	0.187251	0.106732	17-May-87	23-May-87	144	2.163815	0
10504	3	1987	20	1.20634	0.366618	17-May-87	23-May-87	144	2.163815	0
10508	3	1987	20	0.061395	0.061395	17-May-87	23-May-87	144	2.163815	0
10508	9	1987	20	0.101415	0.072483	17-May-87	23-May-87	144	2.163815	0
10943	1	1987	20	1.25768	0.362408	17-May-87	23-May-87	144	2.163815	0
10943	3	1987	20	0.760488	0.323705	17-May-87	23-May-87	144	2.163815	0
10976	3	1987	20	0.506797	0.206441	17-May-87	23-May-87	144	2.163815	0
17930	3	1987	20	0.059411	0.059411	17-May-87	23-May-87	144	2.163815	0
99799	9	1987	20	1.113828	0.293949	17-May-87	23-May-87	144	2.163815	0
99899	0	1987	20	0.124875	0.124875	17-May-87	23-May-87	144	2.163815	0
4000	3	1987	21	3.540865	0.597566	24-May-87	30-May-87	144	2.540285	0
4406	3	1987	21	1.760866	0.359894	24-May-87	30-May-87	144	2.540285	0
6100	3	1987	21	0.058529	0.058529	24-May-87	30-May-87	144	2.540285	0
7915	5	1987	21	7.025244	1.395758	24-May-87	30-May-87	144	2.540285	0
10501	1	1987	21	0.178275	0.101679	24-May-87	30-May-87	144	2.540285	0
10501	3	1987	21	19.22061	2.478715	24-May-87	30-May-87	144	2.540285	0
10504	1	1987	21	0.059464	0.059464	24-May-87	30-May-87	144	2.540285	0
10504	3	1987	21	72.31744	11.07502	24-May-87	30-May-87	144	2.540285	0
10508	3	1987	21	6.684412	1.443082	24-May-87	30-May-87	144	2.540285	0
10508	9	1987	21	2.35694	0.570976	24-May-87	30-May-87	144	2.540285	0
10943	1	1987	21	0.177684	0.131691	24-May-87	30-May-87	144	2.540285	0
10943	3	1987	21	0.586795	0.210905	24-May-87	30-May-87	144	2.540285	0
10943	9	1987	21	0.118929	0.118929	24-May-87	30-May-87	144	2.540285	0
10976	3	1987	21	0.118634	0.08338	24-May-87	30-May-87	144	2.540285	0
17930	3	1987	21	0.059228	0.059228	24-May-87	30-May-87	144	2.540285	0
99799	9	1987	21	3.006095	0.762829	24-May-87	30-May-87	144	2.540285	0
99899	0	1987	21	0.11881	0.11881	24-May-87	30-May-87	144	2.540285	0
99899	9	1987	21	0.059464	0.059464	24-May-87	30-May-87	144	2.540285	0
4000	3	1987	22	4.181345	0.630679	31-May-87	6-Jun-87	142	2.652238	0
4007	0	1987	22	0.059169	0.059169	31-May-87	6-Jun-87	142	2.652238	0
4109	0	1987	22	6.240673	2.596501	31-May-87	6-Jun-87	142	2.652238	0
4406	3	1987	22	5.693526	0.981632	31-May-87	6-Jun-87	142	2.652238	0
6100	0	1987	22	0.058644	0.058644	31-May-87	6-Jun-87	142	2.652238	0

6100	1	1987	22	0.11881	0.11881	31-May-87	6-Jun-87	142	2.652238	0
6102	3	1987	22	0.117869	0.117869	31-May-87	6-Jun-87	142	2.652238	0
7915	5	1987	22	0.118634	0.08338	31-May-87	6-Jun-87	142	2.652238	0
9901	3	1987	22	0.058529	0.058529	31-May-87	6-Jun-87	142	2.652238	0
10501	0	1987	22	1.299844	0.484337	31-May-87	6-Jun-87	142	2.652238	0
10501	1	1987	22	0.116828	0.116828	31-May-87	6-Jun-87	142	2.652238	0
10501	3	1987	22	44.47638	4.825804	31-May-87	6-Jun-87	142	2.652238	0
10504	0	1987	22	0.118751	0.083462	31-May-87	6-Jun-87	142	2.652238	0
10504	1	1987	22	0.119048	0.119048	31-May-87	6-Jun-87	142	2.652238	0
10504	3	1987	22	316.254	37.8643	31-May-87	6-Jun-87	142	2.652238	0
10504	9	1987	22	0.119048	0.119048	31-May-87	6-Jun-87	142	2.652238	0
10508	3	1987	22	25.92841	3.665927	31-May-87	6-Jun-87	142	2.652238	0
10508	9	1987	22	3.658048	0.960978	31-May-87	6-Jun-87	142	2.652238	0
10943	1	1987	22	0.059524	0.059524	31-May-87	6-Jun-87	142	2.652238	0
10943	3	1987	22	0.236331	0.143336	31-May-87	6-Jun-87	142	2.652238	0
10976	3	1987	22	0.059346	0.059346	31-May-87	6-Jun-87	142	2.652238	0
99799	9	1987	22	5.810998	1.169464	31-May-87	6-Jun-87	142	2.652238	0
99899	0	1987	22	0.059228	0.059228	31-May-87	6-Jun-87	142	2.652238	0
3001	5	1987	23	0.059464	0.059464	7-Jun-87	13-Jun-87	143	2.985744	0
4000	3	1987	23	11.26157	1.288864	7-Jun-87	13-Jun-87	143	2.985744	0
4109	0	1987	23	103.329	16.40556	7-Jun-87	13-Jun-87	143	2.985744	0
4109	1	1987	23	1.84061	0.860579	7-Jun-87	13-Jun-87	143	2.985744	0
4109	3	1987	23	8.812269	2.232965	7-Jun-87	13-Jun-87	143	2.985744	0
4109	9	1987	23	14.08002	4.067106	7-Jun-87	13-Jun-87	143	2.985744	0
4406	3	1987	23	2.957829	0.602143	7-Jun-87	13-Jun-87	143	2.985744	0
4406	5	1987	23	0.058876	0.058876	7-Jun-87	13-Jun-87	143	2.985744	0
6100	1	1987	23	0.058471	0.058471	7-Jun-87	13-Jun-87	143	2.985744	0
6100	3	1987	23	0.059405	0.059405	7-Jun-87	13-Jun-87	143	2.985744	0
6200	0	1987	23	0.058357	0.058357	7-Jun-87	13-Jun-87	143	2.985744	0
7915	5	1987	23	0.889605	0.349624	7-Jun-87	13-Jun-87	143	2.985744	0
7915	9	1987	23	0.059228	0.059228	7-Jun-87	13-Jun-87	143	2.985744	0
8725	3	1987	23	0.292405	0.173292	7-Jun-87	13-Jun-87	143	2.985744	0
10501	0	1987	23	1.480596	0.419554	7-Jun-87	13-Jun-87	143	2.985744	0
10501	1	1987	23	0.058993	0.058993	7-Jun-87	13-Jun-87	143	2.985744	0
10501	3	1987	23	20.14684	4.359358	7-Jun-87	13-Jun-87	143	2.985744	0
10504	0	1987	23	0.178274	0.101679	7-Jun-87	13-Jun-87	143	2.985744	0
10504	3	1987	23	188.6997	26.88784	7-Jun-87	13-Jun-87	143	2.985744	0
10508	1	1987	23	0.177389	0.131615	7-Jun-87	13-Jun-87	143	2.985744	0
10508	3	1987	23	8.115072	1.24233	7-Jun-87	13-Jun-87	143	2.985744	0
10508	9	1987	23	0.470641	0.259503	7-Jun-87	13-Jun-87	143	2.985744	0
10800	3	1987	23	0.118692	0.118692	7-Jun-87	13-Jun-87	143	2.985744	0
10943	3	1987	23	0.059169	0.059169	7-Jun-87	13-Jun-87	143	2.985744	0
17830	3	1987	23	0.059346	0.059346	7-Jun-87	13-Jun-87	143	2.985744	0
17930	5	1987	23	0.177866	0.132148	7-Jun-87	13-Jun-87	143	2.985744	0
99799	9	1987	23	3.126047	0.838771	7-Jun-87	13-Jun-87	143	2.985744	0
99899	0	1987	23	0.413744	0.192326	7-Jun-87	13-Jun-87	143	2.985744	0
4000	3	1987	24	3.197123	0.599342	14-Jun-87	20-Jun-87	143	3.125909	0
4109	0	1987	24	3.716576	1.65133	14-Jun-87	20-Jun-87	143	3.125909	0
4109	1	1987	24	0.475125	0.288241	14-Jun-87	20-Jun-87	143	3.125909	0
4109	3	1987	24	82.05867	14.08854	14-Jun-87	20-Jun-87	143	3.125909	0
4109	9	1987	24	11.48058	4.167853	14-Jun-87	20-Jun-87	143	3.125909	0
4406	3	1987	24	1.647339	0.393367	14-Jun-87	20-Jun-87	143	3.125909	0

4406	5	1987	24	0.116247	0.081719	14-Jun-87	20-Jun-87	143	3.125909	0
4406	9	1987	24	0.117031	0.082264	14-Jun-87	20-Jun-87	143	3.125909	0
6100	0	1987	24	0.059228	0.059228	14-Jun-87	20-Jun-87	143	3.125909	0
6100	3	1987	24	0.05729	0.05729	14-Jun-87	20-Jun-87	143	3.125909	0
6103	3	1987	24	0.118573	0.118573	14-Jun-87	20-Jun-87	143	3.125909	0
6208	0	1987	24	0.118692	0.118692	14-Jun-87	20-Jun-87	143	3.125909	0
7915	5	1987	24	0.29579	0.154037	14-Jun-87	20-Jun-87	143	3.125909	0
8720	3	1987	24	0.05911	0.05911	14-Jun-87	20-Jun-87	143	3.125909	0
8913	1	1987	24	0.059405	0.059405	14-Jun-87	20-Jun-87	143	3.125909	0
8913	3	1987	24	0.059169	0.059169	14-Jun-87	20-Jun-87	143	3.125909	0
9901	3	1987	24	0.059051	0.059051	14-Jun-87	20-Jun-87	143	3.125909	0
10320	5	1987	24	0.118751	0.083462	14-Jun-87	20-Jun-87	143	3.125909	0
10501	0	1987	24	0.119048	0.119048	14-Jun-87	20-Jun-87	143	3.125909	0
10501	3	1987	24	58.23423	9.059652	14-Jun-87	20-Jun-87	143	3.125909	0
10504	3	1987	24	295.1221	44.32968	14-Jun-87	20-Jun-87	143	3.125909	0
10504	5	1987	24	0.118455	0.118455	14-Jun-87	20-Jun-87	143	3.125909	0
10508	3	1987	24	19.75339	3.738642	14-Jun-87	20-Jun-87	143	3.125909	0
10508	9	1987	24	0.475003	0.374049	14-Jun-87	20-Jun-87	143	3.125909	0
12512	0	1987	24	0.118692	0.118692	14-Jun-87	20-Jun-87	143	3.125909	0
12520	5	1987	24	0.059405	0.059405	14-Jun-87	20-Jun-87	143	3.125909	0
15999	3	1987	24	0.118692	0.118692	14-Jun-87	20-Jun-87	143	3.125909	0
17830	3	1987	24	0.11881	0.083504	14-Jun-87	20-Jun-87	143	3.125909	0
17930	3	1987	24	0.059464	0.059464	14-Jun-87	20-Jun-87	143	3.125909	0
99799	9	1987	24	13.84664	2.541498	14-Jun-87	20-Jun-87	143	3.125909	0
99899	0	1987	24	0.356549	0.264436	14-Jun-87	20-Jun-87	143	3.125909	0
4000	3	1987	25	0.649111	0.183558	21-Jun-87	27-Jun-87	142	3.176066	0
4005	3	1987	25	0.059287	0.059287	21-Jun-87	27-Jun-87	142	3.176066	0
4006	3	1987	25	0.116666	0.082001	21-Jun-87	27-Jun-87	142	3.176066	0
4006	5	1987	25	0.059405	0.059405	21-Jun-87	27-Jun-87	142	3.176066	0
4109	0	1987	25	0.828927	0.289969	21-Jun-87	27-Jun-87	142	3.176066	0
4109	3	1987	25	594.4874	72.73193	21-Jun-87	27-Jun-87	142	3.176066	0
4406	3	1987	25	1.822106	0.560116	21-Jun-87	27-Jun-87	142	3.176066	0
4406	5	1987	25	3.645346	0.793297	21-Jun-87	27-Jun-87	142	3.176066	0
6100	3	1987	25	0.355021	0.163965	21-Jun-87	27-Jun-87	142	3.176066	0
6102	3	1987	25	0.524886	0.204524	21-Jun-87	27-Jun-87	142	3.176066	0
6103	1	1987	25	0.059464	0.059464	21-Jun-87	27-Jun-87	142	3.176066	0
6103	3	1987	25	2.748185	0.871264	21-Jun-87	27-Jun-87	142	3.176066	0
7915	5	1987	25	0.591688	0.297297	21-Jun-87	27-Jun-87	142	3.176066	0
8720	3	1987	25	0.175772	0.130066	21-Jun-87	27-Jun-87	142	3.176066	0
8907	3	1987	25	0.05911	0.05911	21-Jun-87	27-Jun-87	142	3.176066	0
8912	1	1987	25	0.059405	0.059405	21-Jun-87	27-Jun-87	142	3.176066	0
8912	3	1987	25	0.118046	0.082967	21-Jun-87	27-Jun-87	142	3.176066	0
8913	3	1987	25	0.935454	0.388096	21-Jun-87	27-Jun-87	142	3.176066	0
9901	1	1987	25	0.059287	0.059287	21-Jun-87	27-Jun-87	142	3.176066	0
9901	3	1987	25	0.116485	0.116485	21-Jun-87	27-Jun-87	142	3.176066	0
10320	5	1987	25	0.11881	0.11881	21-Jun-87	27-Jun-87	142	3.176066	0
10501	3	1987	25	54.57413	4.645158	21-Jun-87	27-Jun-87	142	3.176066	0
10504	1	1987	25	0.059524	0.059524	21-Jun-87	27-Jun-87	142	3.176066	0
10504	3	1987	25	117.2868	13.30281	21-Jun-87	27-Jun-87	142	3.176066	0
10504	5	1987	25	6.403914	1.417444	21-Jun-87	27-Jun-87	142	3.176066	0
10508	3	1987	25	8.214383	1.102659	21-Jun-87	27-Jun-87	142	3.176066	0
12512	3	1987	25	0.175375	0.100031	21-Jun-87	27-Jun-87	142	3.176066	0

15999	3	1987	25	0.471082	0.198397	21-Jun-87	27-Jun-87	142	3.176066	0
99799	9	1987	25	25.32139	3.921743	21-Jun-87	27-Jun-87	142	3.176066	0
99899	0	1987	25	0.117404	0.117404	21-Jun-87	27-Jun-87	142	3.176066	0
99899	9	1987	25	0.059287	0.059287	21-Jun-87	27-Jun-87	142	3.176066	0
4000	3	1987	26	0.17804	0.132224	28-Jun-87	4-Jul-87	144	2.730018	0
4000	5	1987	26	0.055217	0.055217	28-Jun-87	4-Jul-87	144	2.730018	0
4005	3	1987	26	0.059228	0.059228	28-Jun-87	4-Jul-87	144	2.730018	0
4109	0	1987	26	1.299814	0.492235	28-Jun-87	4-Jul-87	144	2.730018	0
4109	1	1987	26	0.235513	0.16553	28-Jun-87	4-Jul-87	144	2.730018	0
4109	3	1987	26	463.8923	40.70776	28-Jun-87	4-Jul-87	144	2.730018	0
4109	9	1987	26	1.00933	0.531076	28-Jun-87	4-Jul-87	144	2.730018	0
4406	3	1987	26	0.059464	0.059464	28-Jun-87	4-Jul-87	144	2.730018	0
4406	5	1987	26	1.710338	0.480758	28-Jun-87	4-Jul-87	144	2.730018	0
6102	3	1987	26	0.117878	0.082852	28-Jun-87	4-Jul-87	144	2.730018	0
6103	3	1987	26	0.817358	0.261564	28-Jun-87	4-Jul-87	144	2.730018	0
8720	3	1987	26	0.118869	0.083545	28-Jun-87	4-Jul-87	144	2.730018	0
8723	3	1987	26	0.059346	0.059346	28-Jun-87	4-Jul-87	144	2.730018	0
8725	1	1987	26	0.059405	0.059405	28-Jun-87	4-Jul-87	144	2.730018	0
8725	3	1987	26	0.11752	0.11752	28-Jun-87	4-Jul-87	144	2.730018	0
8907	1	1987	26	0.11881	0.11881	28-Jun-87	4-Jul-87	144	2.730018	0
8909	3	1987	26	0.175154	0.099908	28-Jun-87	4-Jul-87	144	2.730018	0
8912	1	1987	26	0.117058	0.117058	28-Jun-87	4-Jul-87	144	2.730018	0
8912	3	1987	26	0.234148	0.141939	28-Jun-87	4-Jul-87	144	2.730018	0
8913	1	1987	26	0.11881	0.11881	28-Jun-87	4-Jul-87	144	2.730018	0
8913	3	1987	26	0.408193	0.190257	28-Jun-87	4-Jul-87	144	2.730018	0
8913	9	1987	26	0.17786	0.131875	28-Jun-87	4-Jul-87	144	2.730018	0
10320	5	1987	26	0.284861	0.150314	28-Jun-87	4-Jul-87	144	2.730018	0
10501	3	1987	26	30.32881	4.031817	28-Jun-87	4-Jul-87	144	2.730018	0
10501	5	1987	26	0.17228	0.0983	28-Jun-87	4-Jul-87	144	2.730018	0
10504	3	1987	26	41.34221	5.242271	28-Jun-87	4-Jul-87	144	2.730018	0
10504	5	1987	26	4.930207	1.166691	28-Jun-87	4-Jul-87	144	2.730018	0
10508	3	1987	26	3.869532	0.644511	28-Jun-87	4-Jul-87	144	2.730018	0
12512	3	1987	26	0.059405	0.059405	28-Jun-87	4-Jul-87	144	2.730018	0
12512	5	1987	26	0.056367	0.056367	28-Jun-87	4-Jul-87	144	2.730018	0
15999	3	1987	26	1.710113	0.555049	28-Jun-87	4-Jul-87	144	2.730018	0
17830	5	1987	26	0.058876	0.058876	28-Jun-87	4-Jul-87	144	2.730018	0
18005	3	1987	26	0.351014	0.20173	28-Jun-87	4-Jul-87	144	2.730018	0
99799	9	1987	26	9.142087	1.847235	28-Jun-87	4-Jul-87	144	2.730018	0
99899	0	1987	26	0.059524	0.059524	28-Jun-87	4-Jul-87	144	2.730018	0
4006	5	1987	27	0.115245	0.115245	5-Jul-87	11-Jul-87	141	3.123491	0
4109	0	1987	27	198.337	34.05524	5-Jul-87	11-Jul-87	141	3.123491	0
4109	1	1987	27	0.591688	0.591688	5-Jul-87	11-Jul-87	141	3.123491	0
4109	3	1987	27	1286.332	93.15658	5-Jul-87	11-Jul-87	141	3.123491	0
4109	9	1987	27	0.352134	0.182661	5-Jul-87	11-Jul-87	141	3.123491	0
4406	5	1987	27	1.635495	0.607669	5-Jul-87	11-Jul-87	141	3.123491	0
6102	3	1987	27	0.118692	0.118692	5-Jul-87	11-Jul-87	141	3.123491	0
6103	3	1987	27	0.059524	0.059524	5-Jul-87	11-Jul-87	141	3.123491	0
7915	5	1987	27	0.118751	0.083463	5-Jul-87	11-Jul-87	141	3.123491	0
8720	0	1987	27	0.118338	0.118338	5-Jul-87	11-Jul-87	141	3.123491	0
8723	1	1987	27	0.116613	0.081964	5-Jul-87	11-Jul-87	141	3.123491	0
8723	3	1987	27	0.17349	0.098953	5-Jul-87	11-Jul-87	141	3.123491	0
8725	3	1987	27	0.119048	0.119048	5-Jul-87	11-Jul-87	141	3.123491	0

8907	3	1987	27	0.236796	0.116239	5-Jul-87	11-Jul-87	141	3.123491	0
8909	0	1987	27	0.057567	0.057567	5-Jul-87	11-Jul-87	141	3.123491	0
8909	3	1987	27	0.178158	0.132275	5-Jul-87	11-Jul-87	141	3.123491	0
8912	3	1987	27	0.11737	0.0825	5-Jul-87	11-Jul-87	141	3.123491	0
8913	3	1987	27	0.234834	0.115282	5-Jul-87	11-Jul-87	141	3.123491	0
10320	5	1987	27	0.236739	0.116212	5-Jul-87	11-Jul-87	141	3.123491	0
10501	3	1987	27	7.665109	1.4394	5-Jul-87	11-Jul-87	141	3.123491	0
10501	5	1987	27	0.058072	0.058072	5-Jul-87	11-Jul-87	141	3.123491	0
10504	3	1987	27	11.52358	2.434229	5-Jul-87	11-Jul-87	141	3.123491	0
10504	5	1987	27	3.279543	0.723019	5-Jul-87	11-Jul-87	141	3.123491	0
10508	3	1987	27	0.995709	0.285705	5-Jul-87	11-Jul-87	141	3.123491	0
12512	3	1987	27	0.05779	0.05779	5-Jul-87	11-Jul-87	141	3.123491	0
12512	5	1987	27	0.058072	0.058072	5-Jul-87	11-Jul-87	141	3.123491	0
15999	3	1987	27	10.46483	1.519078	5-Jul-87	11-Jul-87	141	3.123491	0
15999	5	1987	27	0.178215	0.132192	5-Jul-87	11-Jul-87	141	3.123491	0
18005	3	1987	27	1.476119	0.474934	5-Jul-87	11-Jul-87	141	3.123491	0
99799	9	1987	27	12.97694	2.618141	5-Jul-87	11-Jul-87	141	3.123491	0
4109	0	1987	28	24.48117	15.21825	12-Jul-87	18-Jul-87	143	3.140525	0
4109	3	1987	28	902.8211	136.8981	12-Jul-87	18-Jul-87	143	3.140525	0
4109	5	1987	28	1.007901	0.355711	12-Jul-87	18-Jul-87	143	3.140525	0
4109	9	1987	28	0.293256	0.152711	12-Jul-87	18-Jul-87	143	3.140525	0
4406	5	1987	28	1.915094	0.75238	12-Jul-87	18-Jul-87	143	3.140525	0
6102	3	1987	28	0.059405	0.059405	12-Jul-87	18-Jul-87	143	3.140525	0
7915	5	1987	28	0.708712	0.23951	12-Jul-87	18-Jul-87	143	3.140525	0
8720	0	1987	28	0.059524	0.059524	12-Jul-87	18-Jul-87	143	3.140525	0
8720	3	1987	28	0.115357	0.115357	12-Jul-87	18-Jul-87	143	3.140525	0
8723	3	1987	28	0.059405	0.059405	12-Jul-87	18-Jul-87	143	3.140525	0
8909	3	1987	28	0.233904	0.142686	12-Jul-87	18-Jul-87	143	3.140525	0
8912	3	1987	28	0.058876	0.058876	12-Jul-87	18-Jul-87	143	3.140525	0
8913	3	1987	28	0.763227	0.309079	12-Jul-87	18-Jul-87	143	3.140525	0
10320	5	1987	28	0.352473	0.139501	12-Jul-87	18-Jul-87	143	3.140525	0
10501	3	1987	28	6.423678	1.102954	12-Jul-87	18-Jul-87	143	3.140525	0
10501	5	1987	28	0.825152	0.402885	12-Jul-87	18-Jul-87	143	3.140525	0
10504	3	1987	28	1.765271	0.352229	12-Jul-87	18-Jul-87	143	3.140525	0
10504	5	1987	28	1.703005	0.499636	12-Jul-87	18-Jul-87	143	3.140525	0
10508	3	1987	28	0.059051	0.059051	12-Jul-87	18-Jul-87	143	3.140525	0
12512	3	1987	28	0.05911	0.05911	12-Jul-87	18-Jul-87	143	3.140525	0
12512	5	1987	28	0.117752	0.117752	12-Jul-87	18-Jul-87	143	3.140525	0
15999	3	1987	28	3.361016	0.839381	12-Jul-87	18-Jul-87	143	3.140525	0
15999	5	1987	28	0.175772	0.130066	12-Jul-87	18-Jul-87	143	3.140525	0
18005	1	1987	28	0.059464	0.059464	12-Jul-87	18-Jul-87	143	3.140525	0
18005	3	1987	28	2.001908	0.403231	12-Jul-87	18-Jul-87	143	3.140525	0
99799	9	1987	28	5.431937	1.572193	12-Jul-87	18-Jul-87	143	3.140525	0
4109	0	1987	29	23.74276	6.670785	19-Jul-87	25-Jul-87	143	3.173384	0
4109	3	1987	29	1072.114	104.1697	19-Jul-87	25-Jul-87	143	3.173384	0
4109	5	1987	29	1.29738	0.386364	19-Jul-87	25-Jul-87	143	3.173384	0
4406	5	1987	29	0.118338	0.118338	19-Jul-87	25-Jul-87	143	3.173384	0
6102	3	1987	29	0.118455	0.118455	19-Jul-87	25-Jul-87	143	3.173384	0
7915	5	1987	29	0.355683	0.25069	19-Jul-87	25-Jul-87	143	3.173384	0
8720	3	1987	29	0.059287	0.059287	19-Jul-87	25-Jul-87	143	3.173384	0
8909	1	1987	29	0.059228	0.059228	19-Jul-87	25-Jul-87	143	3.173384	0
8909	3	1987	29	0.119048	0.119048	19-Jul-87	25-Jul-87	143	3.173384	0

8913	3	1987	29	0.237562	0.14412	19-Jul-87	25-Jul-87	143	3.173384	0
10320	5	1987	29	0.586067	0.211912	19-Jul-87	25-Jul-87	143	3.173384	0
10501	3	1987	29	4.177321	0.676409	19-Jul-87	25-Jul-87	143	3.173384	0
10501	5	1987	29	0.117756	0.082765	19-Jul-87	25-Jul-87	143	3.173384	0
10504	3	1987	29	0.589126	0.195242	19-Jul-87	25-Jul-87	143	3.173384	0
10504	5	1987	29	0.473383	0.18117	19-Jul-87	25-Jul-87	143	3.173384	0
10508	3	1987	29	0.057622	0.057622	19-Jul-87	25-Jul-87	143	3.173384	0
12512	3	1987	29	0.234373	0.164735	19-Jul-87	25-Jul-87	143	3.173384	0
12512	5	1987	29	0.059524	0.059524	19-Jul-87	25-Jul-87	143	3.173384	0
15999	1	1987	29	0.058015	0.058015	19-Jul-87	25-Jul-87	143	3.173384	0
15999	3	1987	29	9.36228	1.478041	19-Jul-87	25-Jul-87	143	3.173384	0
15999	5	1987	29	1.716155	0.667076	19-Jul-87	25-Jul-87	143	3.173384	0
18005	3	1987	29	1.287113	0.290753	19-Jul-87	25-Jul-87	143	3.173384	0
99799	9	1987	29	17.22427	4.047007	19-Jul-87	25-Jul-87	143	3.173384	0
4109	0	1987	30	241.6896	38.77385	26-Jul-87	1-Aug-87	143	3.117182	0
4109	1	1987	30	0.877453	0.71228	26-Jul-87	1-Aug-87	143	3.117182	0
4109	3	1987	30	1182.449	84.71941	26-Jul-87	1-Aug-87	143	3.117182	0
4109	5	1987	30	3.877529	1.238463	26-Jul-87	1-Aug-87	143	3.117182	0
4109	9	1987	30	0.237328	0.1872	26-Jul-87	1-Aug-87	143	3.117182	0
4406	5	1987	30	0.23318	0.140801	26-Jul-87	1-Aug-87	143	3.117182	0
6103	3	1987	30	0.232216	0.140693	26-Jul-87	1-Aug-87	143	3.117182	0
7915	5	1987	30	0.236166	0.14352	26-Jul-87	1-Aug-87	143	3.117182	0
8720	0	1987	30	0.176944	0.131695	26-Jul-87	1-Aug-87	143	3.117182	0
8720	1	1987	30	0.059405	0.059405	26-Jul-87	1-Aug-87	143	3.117182	0
8720	3	1987	30	0.118929	0.118929	26-Jul-87	1-Aug-87	143	3.117182	0
8723	3	1987	30	0.176342	0.130997	26-Jul-87	1-Aug-87	143	3.117182	0
8907	1	1987	30	0.237857	0.237857	26-Jul-87	1-Aug-87	143	3.117182	0
8907	3	1987	30	0.059346	0.059346	26-Jul-87	1-Aug-87	143	3.117182	0
8909	3	1987	30	0.11788	0.082855	26-Jul-87	1-Aug-87	143	3.117182	0
8913	3	1987	30	0.23178	0.141126	26-Jul-87	1-Aug-87	143	3.117182	0
10320	3	1987	30	0.118162	0.083048	26-Jul-87	1-Aug-87	143	3.117182	0
10320	5	1987	30	1.821316	0.400456	26-Jul-87	1-Aug-87	143	3.117182	0
10501	3	1987	30	1.351906	0.368824	26-Jul-87	1-Aug-87	143	3.117182	0
10501	5	1987	30	0.056961	0.056961	26-Jul-87	1-Aug-87	143	3.117182	0
10504	3	1987	30	0.115731	0.081374	26-Jul-87	1-Aug-87	143	3.117182	0
10504	5	1987	30	0.412975	0.19145	26-Jul-87	1-Aug-87	143	3.117182	0
10800	3	1987	30	0.059405	0.059405	26-Jul-87	1-Aug-87	143	3.117182	0
12512	3	1987	30	0.531157	0.22281	26-Jul-87	1-Aug-87	143	3.117182	0
12512	5	1987	30	0.058015	0.058015	26-Jul-87	1-Aug-87	143	3.117182	0
15938	5	1987	30	0.116361	0.081799	26-Jul-87	1-Aug-87	143	3.117182	0
15999	3	1987	30	16.07666	2.602393	26-Jul-87	1-Aug-87	143	3.117182	0
15999	5	1987	30	2.118854	0.617219	26-Jul-87	1-Aug-87	143	3.117182	0
18005	3	1987	30	0.236559	0.143278	26-Jul-87	1-Aug-87	143	3.117182	0
18005	5	1987	30	0.237328	0.143978	26-Jul-87	1-Aug-87	143	3.117182	0
99799	9	1987	30	15.77463	2.750204	26-Jul-87	1-Aug-87	143	3.117182	0
4109	0	1987	31	87.84536	15.88	2-Aug-87	8-Aug-87	144	3.175908	0
4109	3	1987	31	807.3732	61.69213	2-Aug-87	8-Aug-87	144	3.175908	0
4109	5	1987	31	8.797612	1.672649	2-Aug-87	8-Aug-87	144	3.175908	0
8720	1	1987	31	0.059524	0.059524	2-Aug-87	8-Aug-87	144	3.175908	0
8720	3	1987	31	0.410435	0.190555	2-Aug-87	8-Aug-87	144	3.175908	0
8723	1	1987	31	0.058993	0.058993	2-Aug-87	8-Aug-87	144	3.175908	0
8723	3	1987	31	0.352879	0.183727	2-Aug-87	8-Aug-87	144	3.175908	0

8725	3	1987	31	0.117814	0.082805	2-Aug-87	8-Aug-87	144	3.175908	0
8907	3	1987	31	0.173656	0.129516	2-Aug-87	8-Aug-87	144	3.175908	0
8909	3	1987	31	0.174956	0.129706	2-Aug-87	8-Aug-87	144	3.175908	0
8913	3	1987	31	0.232897	0.14055	2-Aug-87	8-Aug-87	144	3.175908	0
10320	3	1987	31	0.118692	0.118692	2-Aug-87	8-Aug-87	144	3.175908	0
10320	5	1987	31	0.934114	0.280784	2-Aug-87	8-Aug-87	144	3.175908	0
10501	3	1987	31	0.111251	0.0783	2-Aug-87	8-Aug-87	144	3.175908	0
10504	5	1987	31	0.175668	0.129869	2-Aug-87	8-Aug-87	144	3.175908	0
12512	3	1987	31	0.23253	0.140938	2-Aug-87	8-Aug-87	144	3.175908	0
12512	5	1987	31	0.584579	0.255261	2-Aug-87	8-Aug-87	144	3.175908	0
15999	3	1987	31	14.48768	2.229069	2-Aug-87	8-Aug-87	144	3.175908	0
15999	5	1987	31	2.055421	0.673626	2-Aug-87	8-Aug-87	144	3.175908	0
18005	3	1987	31	0.233857	0.141919	2-Aug-87	8-Aug-87	144	3.175908	0
18506	5	1987	31	0.058993	0.058993	2-Aug-87	8-Aug-87	144	3.175908	0
99799	9	1987	31	9.03044	1.994426	2-Aug-87	8-Aug-87	144	3.175908	0
99899	3	1987	31	0.116828	0.116828	2-Aug-87	8-Aug-87	144	3.175908	0
4109	0	1987	32	55.28539	15.43363	9-Aug-87	10-Aug-87	24	3.098885	0.017484
4109	3	1987	32	328.2462	35.03807	9-Aug-87	10-Aug-87	24	3.098885	0.017484
4109	5	1987	32	17.79491	5.357044	9-Aug-87	10-Aug-87	24	3.098885	0.017484
8723	1	1987	32	0.414594	0.414594	9-Aug-87	10-Aug-87	24	3.098885	0.017484
10501	3	1987	32	0.41625	0.41625	9-Aug-87	10-Aug-87	24	3.098885	0.017484
10501	5	1987	32	0.402188	0.402188	9-Aug-87	10-Aug-87	24	3.098885	0.017484
12512	3	1987	32	0.41542	0.41542	9-Aug-87	10-Aug-87	24	3.098885	0.017484
12512	5	1987	32	0.414594	0.414594	9-Aug-87	10-Aug-87	24	3.098885	0.017484
15999	3	1987	32	4.957969	1.981378	9-Aug-87	10-Aug-87	24	3.098885	0.017484
15999	5	1987	32	1.242958	0.910452	9-Aug-87	10-Aug-87	24	3.098885	0.017484
99799	9	1987	32	8.979603	3.253617	9-Aug-87	10-Aug-87	24	3.098885	0.017484

life_stag	definition
0	EGG
1	YOLK-SAC LARVA
3	POST YOLK-SAC LARVA
5	JUVENILE
9	UNDETERMINED STAGE

SP_CODE	Common_Name
3001	American eel
3502	Conger eel
4000	Herring family
4001	Blueback herring
4005	Alewife
4006	American shad
4007	Alosa species
4010	Atlantic menhaden
4100	Anchovy family
4109	Bay anchovy
4406	Rainbow smelt
6100	Carp and minnow family
6102	Goldfish
6103	Common carp
6120	Spottail shiner
6199	Hybopsis species
6200	Sucker family
6208	White sucker
6402	White catfish
6407	Brown bullhead
6498	Ictalurus species
7900	Cod family
7915	Atlantic tomcod
7929	Urophycis species
8419	Silverstripe halfbeak
8504	Atlantic needlefish
8700	Killifish family
8720	Fundulus species
8723	Banded killifish
8725	Mummichog
8907	Rough silverside
8909	Inland silverside
8912	Atlantic silverside
8913	Menidia species
9901	Fourspine stickleback
9904	Threespine stickleback
10320	Northern pipefish
10500	Temperate bass family
10501	White perch
10504	Striped bass
10508	Morone species
10800	Sunfish family
10900	Perch family
10943	Tessellated darter
10976	Yellow perch
11301	Bluefish
12500	Drum family
12512	Weakfish
12520	Spot
13600	Wrasse family
15006	Rock gunnel

15938 Seaboard goby
15999 Gobiosoma species
16814 Butterfish
17110 Northern searobin
17111 Striped searobin
17400 Sculpin family
17499 Myoxocephalus species
17818 Smallmouth flounder
17826 Summer flounder
17828 Fourspot flounder
17830 Windowpane
17930 Winter flounder
18005 Hogchoker
18506 Northern puffer
36250 Amphipods
99799 Mutilated
99899 Unidentified

TAXON	name
1	ALEWIFE
2	BAY ANCHOVY
3	AMERICAN SHAD
4	BLUEFISH
5	BLUEGILL
6	BROWN BULLHEAD
7	PUMPKINSEED
8	BLACK CRAPPIE
9	CARP
10	AMERICAN EEL
11	GOLDFISH
12	GOLDEN SHINER
13	HOGCHOKER
14	TESSELATED DARTER
15	BANDED KILLIFISH
16	EMERALD SHINER
17	LARGEMOUTH BASS
18	MUMMICHOG
19	ATLANTIC MENHADEN
20	CYPRINIDAE
21	CHAIN PICKEREL
22	BLUEBACK HERRING
23	WHITE SUCKER
24	ATLANTIC SILVERSIDE
25	RAINBOW SMELT
26	SMALLMOUTH BASS
27	SHORTNOSE STURGEON
28	SPOTTAIL SHINER
29	ATLANTIC STURGEON
30	STRIPED BASS
31	FOURSPINE STICKLEBACK
32	ATLANTIC TOMCOD
33	TO BE IDENTIFIED
34	WHITE CATFISH
35	WHITE PERCH
36	YELLOW PERCH
37	SATINFIN SHINER
38	ROCK BASS
39	NORTHERN PIPEFISH
40	REDBREAST SUNFISH
41	ATLANTIC NEEDLEFISH
42	CREVALLE JACK
43	SILVERY MINNOW
44	FALL FISH
45	WEAKFISH
46	COMELY SHINER
47	COMMON SHINER
48	MIMIC SHINER
49	LOOKDOWN
50	ALOSA SPP.
51	CLUPEIDAE LARVAE

52 MORONE LARVAE
53 GRASS PICKEREL
54 LINED SEA HORSE
55 LOGPERCH
56 TROUT PERCH
57 NORTHERN HOG SUCKER
58 FATHEAD MINNOW
59 CYPRINIDAE
60 MORONE UNIDENTIFIED
61 REDFIN PICKEREL
62 TAUTOG
63 FOURBEARD ROCKLING
64 STRIPED CUSKEEL
65 CENTRARCHIDAE LARVAE
66 NORTHERN KINGFISH
67 SPOT
68 MOONFISH
69 BROOK STICKLEBACK
70 ACIPENSERIDAE
71 SCUP
72 WINTER FLOUNDER
73 INLAND SILVERSIDE
74 SEA LAMPREY
75 GIZZARD SHAD
76 SILVER HAKE
77 STRIPED MULLET
78 THREESPINE STICKLEBACK
79 BROWN TROUT
80 BUTTERFISH
81 WHITE CRAPPIE
82 BROOK TROUT
83 NORTHERN PIKE
84 GREEN SUNFISH
85 SILVER PERCH
86 NORTHERN PUFFER
87 BLACKNOSE DACE
88 BRIDLE SHINER
90 CUTLIPS MINNOW
96 CENTRARCHIDAE
97 SPOTFIN SHINER
98 RED HAKE
99 UNIDENTIFIABLE
100 CENTRAL MUDMINNOW
101 GRUBBY
102 EASTERN MUDMINNOW
103 WHITE BASS
104 ROUGH SILVERSIDE
105 LONGEAR SUNFISH
106 SUMMER FLOUNDER
107 LONGNOSE DACE
108 CREEK CHUB
109 BLACK BULLHEAD

110 STRIPED SEAROBIN
111 NORTHERN SEAROBIN
113 ATLANTIC CROAKER
114 LONGHORN SCULPIN
115 ROUND HERRING
116 HICKORY SHAD
117 ATLANTIC HERRING
118 REEF SILVERSIDE
119 STRIPED ANCHOVY
120 CONGER EEL
121 STRIPED KILLIFISH
122 WARMOUTH
123 BLUNTNOSE MINNOW
124 WALLEYE
125 WHITE MULLET
126 YELLOW BULLHEAD
127 CHANNEL CATFISH
128 POLLACK
129 SEABOARD GOBY
130 NAKED GOBY
131 YELLOWTAIL FLOUNDER
132 WINDOWPANE
133 SPOTTED HAKE
134 SEAROBIN
136 NORTHERN STARGAZER
137 AMERICAN SAND LANCE
138 FAT SLEEPER
139 FOURSPOT FLOUNDER
140 ATLANTIC MACKEREL
141 BLACK SEA BASS
142 SMALLMOUTH FLOUNDER
143 ROCK GUNNEL
144 INSHORE LIZARDFISH
145 UMBRIDAE
146 SILVER LAMPREY
147 RAINBOW TROUT
148 ROSYFACE SHINER
149 ESOCIDAE
150 GOBIIDAE
151 FUNDULUS SPP.
152 CYPRINODONTIDAE
153 MYOXOCEPHALUS SPP.
154 COTTIDAE
155 PLEURONECTIFORMES
156 PLEURONECTIDAE
157 ATHERINIDAE
158 MENIDIA SPP.
159 BOTHIDAE
160 SPECKLED WORM EEL
161 SYNGNATHIDAE
162 MACKEREL SCAD
163 AMMODYTES SPP.

164 CUNNER
165 SCIAENIDAE
166 GADIDAE
167 FLYING GURNARD
168 SHIELD DARTER
169 GRAY SNAPPER
170 ATLANTIC COD
171 SEA RAVEN
172 BIGEYE SCAD
173 STRIPED BURRFISH
174 SHEEPSHEAD
175 PERCIDAE
176 SPOTFIN MOJARRA
177 SPOTFIN BUTTERFLYFISH
178 GASTEROSTEIDAE
179 PLANEHEAD FILEFISH
180 ATLANTIC CUTLASSFISH
181 PIGFISH
182 SHORT BIGEYE
183 GUAGUANCHE
184 FRECKLED BLENNY
185 TETRAODONTIDAE
186 ORANGESPOTTED FILEFISH
187 MARGINED MADTOM
188 BLUESPOTTED CORNETFISH
189 BLACK DRUM
190 NORTHERN SENNET
191 SCAMP
192 COBIA
193 LEAST DARTER
194 PERCICHTHYIDAE
195 SCRAWLED COWFISH
196 SPOTFIN FLYINGFISH
197 GULF MENHADEN
198 PUGNOSE SHINER
199 REDFIN SHINER
200 SAND SHINER
201 SWALLOWTAIL SHINER
202 TIGER MUSKELLUNGE
203 GOOSEFISH
204 PERMIT
205 FRESHWATER DRUM
206 KING MACKEREL
207 LONGNOSE GAR
208 SPANISH MACKEREL
209 SHARPTAIL GOBY
210 CATOSTOMIDAE
211 LABRIDAE
212 BLACKCHEEK TONGUEFISH
213 OYSTER TOADFISH
214 FEATHER BLENNY
215 ORANGE FILEFISH

216 LITTLE SKATE
217 SPINY DOGFISH
218 ATLANTIC SEASNAIL
219 GULF STREAM FLOUNDER
220 SPOTTED GOATFISH
221 BROOK SILVERSIDE
222 HARVESTFISH
223 PINFISH
224 WITCH FLOUNDER
225 KOKANEE
226 LADYFISH
227 RADIATED SHANNY
228 CUSK
229 UNIDENTIFIED HAKE
230 AMERICAN PLAICE
231 SLIMY SCULPIN
232 SHEEPSHEAD MINNOW
233 BLENNIIDAE
236 SCUP/WEAKFISH
237 HADDOCK
238 RUDD
239 GRASS CARP
240 BLUE RUNNER
241 UNID. LAMPREY
412 SHORTHORN SCULPIN
422 UNIDENTIFIED MULLET
754 BLUE CRAB
770 AMERICAN LOBSTER