Admin # 482

ATTACHMENT #2

NORMANDEAU ASSOCIATES, INC.

Nashua Road • Bedford, New Hampshire 03102 • (603) 472-5191 • TWX 710-364-6466 NAI BFNH

ENVIRONMENTAL CONSULTING • RESEARCH • SERVICE

December 22, 1978

Mr. Wayne Nelson, Biologist
Public Service Company of New Hampshire
1000 Elm Street
Manchester, New Hampshire 03101

Dear Wayne:

This letter represents a summary of the research conducted by Normandeau Associates, Inc. (NAI) on the possible interactions between Merrimack Station and successful restoration of American shad in the Merrimack River. Included is our recommendation that Public Service Company postpone further study of shad in Hooksett Pond until adequate passage facilities are completed and significant numbers of shad have been restored in the Merrimack River above Hooksett.

The Merrimack River has been selected for restoration of Atlantic salmon (*Salmo salar*) and American shad (*Alosa sapidissima*) through the cooperative efforts of New Hampshire and Massachusetts state agencies, and the U.S. Fish and Wildlife Service. Agency representatives involved in the restoration program have been concerned that the Merrimack Generating Station (PSCoNH), located on the Hooksett Pond reach of the Merrimack River in Bow, New Hampshire, may interfere with the successful reintroduction of salmon and shad to the river. In 1975 Public Service Company's NPDES Permit (No. NH0001465) was modified such that cold-water stream standards would be invoked unless specific research could demonstrate that less-stringent standards would adequately protect the potential for an anadromous fisheries resource. As a result, NAI was contracted by PSCoNH to design and implement studies necessary to meet permit requirements.

During 1975 and 1976, NAI completed American shad studies which included (1) delineation of current velocities near the plant intakes and discharge, (2) numerical modeling of current velocities in Hooksett Pond, (3) determination of temperature distributions throughout Hooksett Pond, (4) determination of downstream transport characteristics of developing shad eggs, (5) characterization of several aspects of early larval behavior including their apparent ability to withstand downstream transport, (6) determination of egg and larvae tolerance to rapid temperature increases through laboratory bioassay, *in situ* bioassay, and literature review; and (7) synthesis of this information into an assessment of potential entrainment and thermal shock mortality for American shad eggs and larvae should the restoration of a spawning adult population within Hooksett Pond be successful. Results of these studies were contained in two reports submitted to PSCoNH in May 1976 and February 1977 and are summarized as follows:

The probability of pump entraining significant numbers of American shad eggs within the Merrimack Station cooling water flow is extremely low. This analysis was based on physical data collected and analyzed as part of the previous investigations, laboratory observations and ongoing entrainment sampling programs at existing powerplants. At low river discharge levels the power plant cooling water volume represents a significant proportion of total river volume; however, near bottom current velocities are generally insufficient to dislodge eggs from the substrate decreasing the probability of egg entrainment. At river discharge levels high enough to dislodge eggs from the substrate, the intake's zone of influence in terms of cross-stream distance and the proportional volume of the cooling water flow, is small, reducing the probability of entrainment. The probability of egg momentum entrainment in the thermal plume is also low; near-bottom velocities are insufficient to effect the suspended load transport necessary for eggs to be elevated into the warmest water layers. Furthermore, temperatures in the warmest regions of the Merrimack Station discharge are not warm enough to be lethal over short exposure periods.

Larval entrainment is considerably more difficult to assess than egg entrainment. Potential pump and momentum entrainment rates depend on downstream transport rates which are, in turn, dependent upon larval responses to environmental variables which have not yet been adequately described. Data from existing powerplants suggest that larval shad entrainment is not likely to be significant. Entrainment, however, cannot be dismissed entirely, due to the apparent surface and streamside orientation of larvae. Similarly, momentum entrainment may be experienced by larvae undergoing downstream transport. Water temperatures within the thermal plume's warmest areas are generally cooler than the lethal levels determined for larvae, but lethal levels may be approached should unusually warm and dry periods occur during late June or early July.

A radio telemetry study was proposed in 1976 to determine the responses of juvenile shad to the thermal discharge. Approximately 4.3 million fertilized shad eggs were stocked in Hooksett Pond during May and June 1976. Subsequent intensive seining from late August through October however failed to capture any juvenile shad which precluded the telemetry study. The unseasonable high river discharge levels and low water temperatures during early August probably induced the downstream migration of any juvenile shad present in Hooksett Pond prior to the initiation of seining.

After reviewing these studies, the agencies involved in shad restoration believed that the inability to collect juvenile shad from Hooksett Pond during 1976 left some question as to the overall effects

of the Merrimack Generating Station on successful rearing of American shad in Hooksett Pond, and whether Hooksett Pond may be viable shad spawning habitat. Therefore, to meet permit requirements and agency requests, PSCoNH funded additional studies to determine whether the Merrimack Station and associated thermal discharge would have adverse effects on American shad rearing in Hooksett Pond. Subsequently, fertilized eggs and spawning adults were stocked in Hooksett Pond during 1978 to assess reproductive success through capture or observation of larvae and/or juveniles within Hooksett or Amoskeag Ponds prior to downstream migration. Results of this study will be detailed in a report that will be submitted to PSCoNH in February 1979, but are summarized as follows:

Six hundred and ninety adult American shad were transported from Holyoke, Massachusetts and introduced into Hooksett Pond, New Hampshire on June 1 and 2, 1978 below the confluence of the Suncook River. Fourteen shad (8 males; 4 females; 2 not sexed) were tagged with 30 MHz radio tags on June 2; one shad died prior to release, five were never relocated, four descended the river and four ascended the river past the generating station, indicating that the plume from the discharge canal was not creating a thermal barrier.

Adult shad were observed regularly throughout June and early July over the sandy flats between the Merrimack generating station intakes and discharge canal. A school of approximately 15 adult shad was observed consistently for several weeks during late July and early August and again from early October through mid-November at Amoskeag Hydroelectric Station.

Following the stocking of adult shad, eggs in early stages of development were collected throughout June, both upstream and downstream of the generating station indicating successful spawning. Ambient water temperatures during this period were optimal for shad spawning and egg survival, ranging from 16°C to 25°C.

Although shad eggs were collected frequently in 1978, larvae were not collected despite sampling throughout June and July by seining, drift netting and trawling with an epibenthic sled. Concurrent entrainment sample collections of the water entering Unit I during June and July (Unit 2 was not operating from June 24 to October 10) were devoid of any shad eggs and larvae. The absence of eggs and larvae in the entrainment samples supports the prediction by NAI in the 1976 study that entrainment of shad eggs and larvae at Merrimack Station should be minimal.

Juvenile shad were subsequently collected from July 24 until late October. Many juveniles were observed in the forebays of Hooksett and Amoskeag Hydroelectric Stations during October and early November. The juvenile shad growth rate in Hooksett and Amoskeag Ponds was typical of other New England shad populations, with juveniles attaining a mean total length of 110 mm by late October. Downstream emigration during October and November appeared to be typical, and was not delayed by the thermal discharge from Merrimack Station.

Only one juvenile shad was impinged at Unit I during entrapment monitoring for 48 hrs each week from late July through October. This was considered to be an insignificant entrapment rate, and a projection of the total number of shad impinged throughout this period was not appropriate.

One aspect of the 1978 study was atypical; Unit 2 was shut down for maintenance from June 24 to October 10. As a result, maximum potential discharge temperatures were lower than would have been observed if both units had been operating. Maximum discharge temperature during July 1978 was 29°C, although in past years a small area of the surface plume has at times exceeded the 34°C lethal temperature for shad larvae. Despite the fact that this is not a normal occurrence, potentially lethal plume conditions could exist during an unusually warm, dry, late June or early July day (ambient t approximately 27°C), when the young shad should be completing their larval phase, if Merrimack Station were operating at or near maximum capacity. However, quantified responses to this question are somewhat irrelevant pending qualification of the following points. First, it is not known whether shad will spawn in the upper reaches of Hooksett Pond or preferentially utilize areas upstream and downstream of this region. Second, the larval drift past Merrimack Station should be quantified to assess the proportion of the year-class that would be subjected to maximum plume temperatures. Both of these points would be answered best after shad migrations are restored and their natural movements monitored. Although maximum power generation may influence the survival of shad spawned and subsequent standing crop in the vicinity of Merrimack Station, the compensatory reserve of the shad fishery should assure continued population success even if exploitation during certain years is high.

Results from observations made during our three years of shad study indicate that the thermal discharge of Merrimack Station would not adversely affect the success of American shad restoration in the Merrimack River. Thermal blockage should not occur to either the upstream migrating adults or the juveniles moving downstream during the fall. Water temperatures in Hooksett Pond typically are conducive to shad spawning and development of the eggs into the larval and juvenile stages. In addition, entrainment of eggs and larvae and entrapment of juveniles should be minimal. The effects of maximum power generation on

larval drift past Merrimack Station for those larvae spawned in the upper reaches of Hooksett Pond must still be assessed.

For these reasons we believe that the restoration of American shad to the Merrimack River will not be adversely affected by operation of Merrimack Station, and further study should be postponed until adequate upstream passage facilities are completed and significant numbers of shad have been restored to the Merrimack River above Hooksett.

Sincerely,

NORMANDEAU ASSOCIATES, INC.

James R. Beltz
Project Director/Fishery Biologist

JRB:je
cc: Weldon Bosworth