NIAGARA MOHAWK POWER CORPORATION

Oswego Unit 6

INTAKE CONSIDERATIONS

NPDES PERMIT #070 0X2 2 000633
NY (0003221)

Vmx -75/0364 9.1.1/029

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316(b) DEMONSTRATION FOR OSWEGO UNIT 6

SUMMARY OF FINDINGS

1. The Oswego Unit 6 station is under construction. It will have a submerged offshore intake with a design and location similar to the operating Unit 5 intake. The flow rate and intake velocity are lower for the Unit 6 intake than for the Unit 1-4 intake and the same as the Unit 5 intake.

2. The frequencies of currents alongshore determined from data collected in the Oswego vicinity leads to a natural selection of the two adjacent water body segments shown in Figure S-1. These segments are used as receiving water body segments for quantitative impact descriptions.

The existing intakes near Oswego Unit 6 include the Nine Mile Point Unit 1, the James A. FitzPatrick, and the Oswego Units 1-5 intakes. A potable water intake is located about a mile offshore at Oswego.

3. Baseline studies have been conducted in the Nine Mile Point - Oswego area since 1963. The studies at Oswego in 1970 through 1974 describe the communities present at the site. There are no ecological features of the area which are unique relative to Lake Ontario as a whole.

4. The representative important species selected by the EPA include Gammarus sp., alewife, coho salmon, brown trout, rainbow smelt, threespine stickleback, smallmouth bass, and yellow perch. Life history information for these species and for spottail shiner and white perch are presented.

5. Studies of mortality of entrained organisms support an assumption of less than 100% mortality of entrainable organisms. To assure an over estimate of potential impart this demonstration assumes 100% mortality.

6. The designated circulating water system, water body segments, and representative species are used to define impact matrices. The matrix elements computed are listed in Tables S-1a and and S-1b and include:

(1) Larvae entrainment by Unit 6 for those representative species whose larvae are found near the site in segment I.

(2) Cumulative larvae entrainment by all stations operating in the Oswego area (water body segment II).

(3) Impingement cropping in the segment near Oswego (segment I) by Oswego Unit 6 intake and cumulative effects of all plants in the area on the larger segment including the Nine Mile Point area.

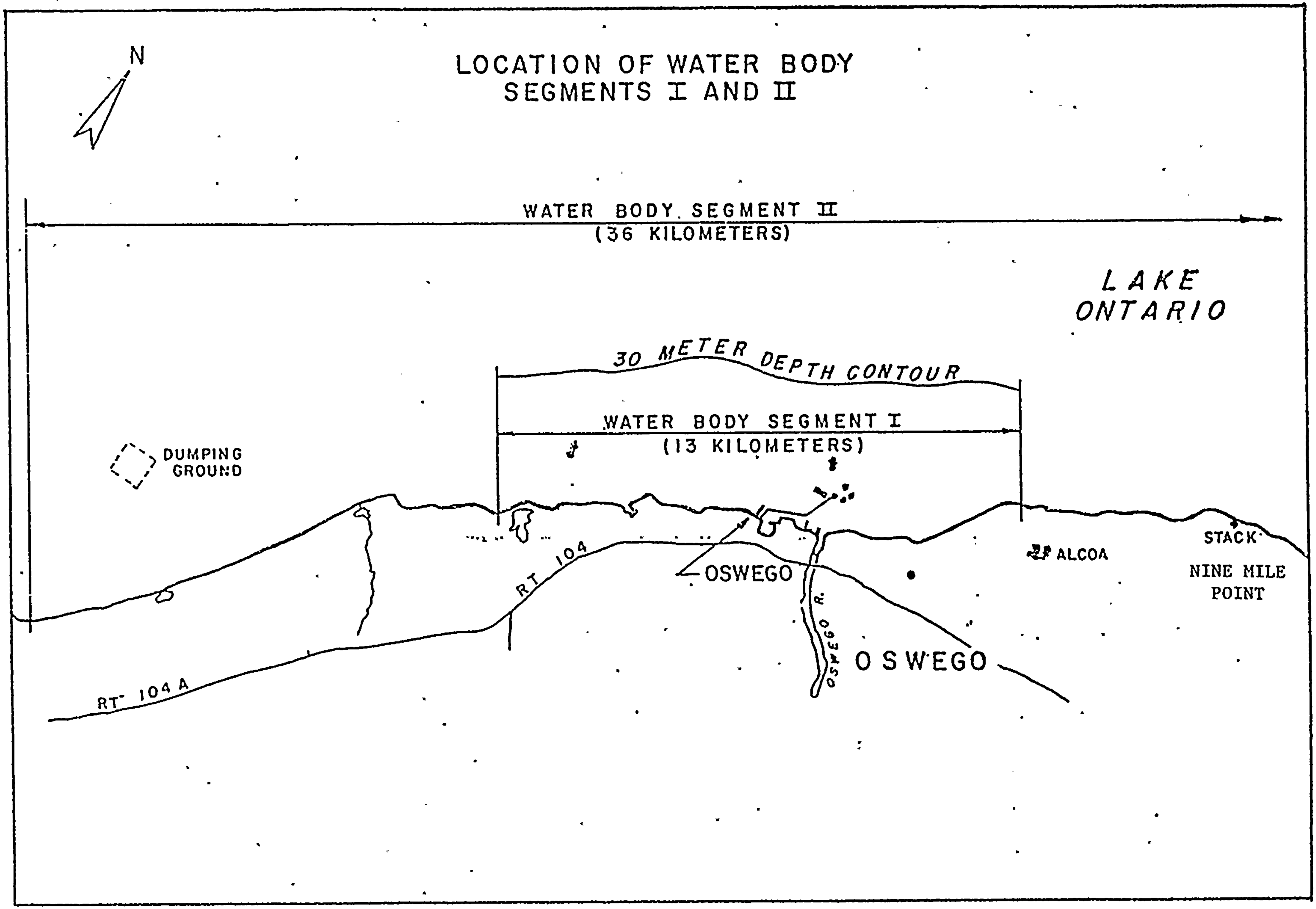

N
LOCATION OF WATER BODY
SEGMENTS I AND II
WATER BODY SEGMENT II
(36 KILOMETERS)
LAKE
ONTARIO
30 METER DEPTH CONTOUR
WATER BODY SEGMENT I
(13 KILOMETERS)
DUMPING
GROUND
ALCOA
STACK
NINE MILE
POINT
OSWEGO
OSWEGO R.
RT 104
RT 104 A
OSWEGO

FIGURE S-1

TABLE S-1a

SUMMARY OF LARVAE ENTRAINMENT CROPPING

All Plants on Segment II

Species	% Cropping Range
Alewife	0.07-0.29
Rainbow smelt	0-1.19
White perch	0-0.13
Yellow perch	0-2.02
Flow basis	0.7

All Plants on Segment I

Species	% Cropping Range
Alewife	1.06-4.32
Rainbow smelt	0-4.74
White perch	0-4.02
Yellow perch	0
Flow basis	2.2

Unit 6 on Segment I

Species	% Cropping Range
Alewife	0.33-1.35
Rainbow smelt	0-1.48
White perch	0-1.25
Yellow perch	0
Flow basis	0.7

TABLE S-1b

SEASONAL IMPINGEMENT CROPPING

SEGMENT I

Species	Spring Unit 6 Cropping	Spring Unit 1-6 Cropping	Summer Unit 6 Cropping	Summer Unit 1-6 Cropping
Alewife	2.69	8.61	0.38	1.22
Rainbow smelt	1.72	5.51	0.25	0.79
Spottail shiner	0.07	0.22	0.34	1.09
White perch	0.04	0.13	0.09	0.28
Yellow perch	0.42	1.36	0.09	0.29
Smallmouth bass	0	0	0	0

SEGMENT II

	Spring All Plants	Summer All Plants
Alewife	4.51	1.95
Rainbow smelt	1.80	3.52
Spottail shiner	0.25	0.18
White perch	0.44	0.24
Yellow perch	0.25	0.12
Smallmouth bass	0.11	0.05

(4) Impingement cropping in the segment near Oswego (segment I) by Oswego Unit 6 intake and cumulative effects of all plants in the area (I) and in the larger segment (II) including the Nine Mile Point area.

7. The cropping of larvae and Gammarus fasciatus ranges from 0 to 2.02% of these planktonic organisms which drift alongshore through segment II with all plants operating. The comparable cropping by all plants in segment I is 0 to 4.74% of the drifting organisms. Cropping of fish by impingement is maximum for alewife and ranges from 1.95% in summer to 4.51% in spring in segment II, and from 1.22% in summer to 8.61% in spring for all plants operating in segment I.

8. It is concluded that intake operation, evaluated assuming 100% mortaility of entrained organisms (larvae, gammarus, or fish) results in minimal removal of these organisms from the flow through the segments. Hence operation of the intake for Unit 6 will not adversely affect the representative aquatic environment even in combination with existing intakes in the area.

I. INTRODUCTION

A. BACKGROUND

The construction of Niagara Mohawk Power Corporation's (NMPC) Oswego Steam Electric Generating Station Unit 6 began in October 1972. The station is scheduled to begin operation by May 1979.

The effects of the discharge of heated effluent from this facility upon Lake Ontario are discussed in detail in the 316(a) demonstration for this plant. Niagara Mohawk submits herein information on the Oswego Unit 6 intake system providing delineation of the potential stresses of entrainment and impingement associated with facility operation and an assessment of these stresses with regard to the selected representative important species.

B. DEMONSTRATION APPROACH AND RATIONALE

Since Unit 6 is not in operation, the impingement and entrainment effects must be predicted. Aquatic studies have been conducted in the Oswego-Nine Mile Point vicinity since 1963. Impingement and entrainment effects must be predicted. However, impingement and entrainment data have been collected from the intakes of Oswego Units 1-4 and Nine Mile Point Unit 1 over a sufficient period of time and in sufficient detail to enable prediction of the effects of Oswego Unit 6. The results of these studies (previously submitted to the EPA) are utilized throughout this document.

The information provided in this document will permit the EPA to evaluate the effects of the operation of the Oswego Unit 6 intake facility. It is demonstrated that the operation of the intake facility will not adversely affect the representative aquatic environment and that the operation of the intake facility, when cumulatively combined with operation of other cooling water systems in the adjacent water body segments, will not cause harmful impact to the aquatic environment.

C. FORMAT OF THE DOCUMENTATION

In the development of the document, Niagara Mohawk has taken a logical step-by-step approach to the demonstration methodology. Sections of the report that were presented in the 316(a) submission for Oswego Unit 6 are not repeated in this document.

Chapters II through V provide the basis for the impact assessment presented in the submission. Chapter II presents a detailed description of Oswego Unit 6.

Chapter III describes the hydrographic characteristics of the near and far field. A description is provided of the temperature structure in the lake and the vicinity of Oswego, the topography and geology of the lake bottom in the vicinity of Oswego, the general lake circulation patterns, and the local currents at the site. The characteristics of the existing major intakes in the vicinity of Oswego are provided in this chapter. Based on these data, a rationale for determining water body segments is developed. This chapter presents this rationale and describes the characteristics and limits of the water body segments.

Chapter IV describes the circulating water system for Oswego Unit 6. Chapter V summarizes the essential characteristics of the biological community found in the Oswego area. The abundance, species composition, and distribution of the biota prior to power plant operation is delineated through the baseline information gathered in studies at the Oswego and other plants in Lake Ontario. Major biological groups present are considered, in conjunction with the factors which have been shown to affect these aquatic populations, in order to assess the operational effects upon the aquatic ecosystem.

Chapter VI presents a discussion of the representative important species selected by the EPA and transmitted to Niagara Mohawk by letter dated August 11, 1975 and other species considered in the demonstration. The basis for selection of each species is discussed and data on the characteristics of each species are provided.

With the data base presented in the previous chapters, Chapter VII considers the thermal, physical, and chemical impacts expected to result from operation of the Oswego Unit 6 intake and circulating water system.

The predicted impacts for Oswego Unit 6 on the aquatic biota within the water body segments is quantified and discussed in Chapter VIII. The basis for the conservative evaluations are presented. Included in this chapter is an evaluation of the effects of impingement and entrainment, including cumulative effects, of Oswego Unit 6.

II. STATION DESCRIPTION

Information relative to the station description is presented in chapter II of the 316(a) submission for Oswego Unit 6. The reader is referred to this document for a detailed description of Oswego Unit 6.

III. BASELINE HYDROGRAPHIC CHARACTERISTICS

A. INTRODUCTION

Most of the information relative to the baseline hydrographic characteristics germane to evaluation of the Oswego Unit 6 circulating water system is presented in Chapter III of the 316(a) submission for that station. This information is not presented herein, and the reader is referenced to the appropriate sections of the 316(a) submission.

B. GENERAL FEATURES OF LAKE ONTARIO

See 316 (a) submission Chapter III, section B.

C. SITE FEATURES

See 316(a) submission Chapter III, section C.

D. OTHER EXISTING WATER INTAKE SRUCTURES IN THE OSWEGO VICINITY

1. Oswego Water Supply

The city of Oswego's water supply intake is located about a mile west of the Unit 6 water intake, and some 1890 m (6200 ft) out into the lake, at a depth of 16.5 m (54 ft). Water withdrawal from the lake in 1970 was 17 mgd (26.30 cfs, 0.746 m^3/sec) for the city of Oswego and 36 mgd (55.70 cfs, 1.581 m^3/sec) for the Metropolitan Water Board of Onondaga County, a combined maximum capacity total of 53 mgd (82 cfs, 2.327 m^3/sec).

2. Oswego Steam Station Units 1-4

The Oswego Power Plant's Units 1-4 have a maximum output of 407 megawatts. These units were constructed during the period 1938 to 1956.

The cooling water for these units is taken from the lake at a point some 250 ft (76.2m) north of the northwestern tip of the Oswego Harbor breakwater and 450 ft (137.2m) southeast of the Oswego Unit 6 intake. A flow of up to 762 cfs, (21.58m^3/sec), when operating at the maximum capacity rating, is circulated through the condensers of the four units. Table III-1 shows some of the hydraulic characteristics of the intake of the existing units compared with Oswego Unit 6.

TABLE III-1

INTAKE CHARACTERISTICS FOR OSWEGO UNITS 1-4, NINE MILE UNIT 1, FITZPATRICK UNIT, OSWEGO UNIT 5, AND OSWEGO UNIT 6

Parameter	Oswego Units 1-4	Nine Mile Unit 1	FitzPatrick Unit	Oswego Unit 5	Oswego Unit 6
Design Flow	762 cfs 21.58m^3/sec	635 cfs 17.98m^3/sec	825 cfs 23.36m^3/sec	635 cfs 17.98m^3/sec	635 cfs 17.98m^3/sec
Maximum approach Velocity to the Intake	1.30-1.75 fps 0.40-0.53m/sec	1.9 fps 0.58m/sec	1.2 fps 0.37m/sec	1.0 fps 0.30m/sec	1.0 fps 0.30m/sec
Maximum Velocity through Intake Bars	3.2 fps 0.98m/sec	2.0 fps 0.61m/sec	1.4 fps 0.43 fps	1.2 fps 0.37m/sec	1.2 fps 0.37m/sec
Maximum Approach Velocity at Travelling Screens	0.94 fps 0.29m/sec	0.85 fps 0.26m/sec	-	0.97 fps 0.30m/sec	0.97 fps 0.30m/sec

3. Nine Mile Point Unit 1

The Nine Mile Point Nuclear Station Unit 1, which has been in operation since 1969, uses a boiling water reactor to provide 610 MWe (net) of electrical power.

The cooling water for Unit 1 is taken from the lake into a hexagonal intake structure located in a water depth of approximately 18 ft (5.5m) about 850 ft (259.1m) from the shoreline. The flow characteristics are outlined in Table III-1, in which they are compared with those of Oswego Units 6.

4. James A. FitzPatrick Nuclear Power Plant

The James A. FizPatrick Nuclear Power Plant, which has been in 50% to 80% operation since July 1975 uses a boiling water reactor to provide 821 MWe (net) of electrical power.

The cooling water for the unit is taken from the lake into a preshaped intake structure located in a water depth of 26 ft (7.92m) about 900 ft (274.3m) from the shoreline. The flow characteristics are outlined in Table III-1 in which they are compared with those of Oswego Unit 6. Due to the distance of about 7 miles (8.6 km) between the Nine Mile Point and Oswego Units, no interacting effects are expected at the intakes.

5. Oswego Steam Station Unit 5

The Oswego Steam Station Unit 5 has a maximum output of 850 MWe (net). This unit began operation during 1975.

The cooling water for this unit is taken from the lake into a hexagonal shaped intake structure located in a water depth of 22 ft (6.71 m) about 365.8 m (1200 ft) from the shoreline. The flow characteristics are outlined in Table III-1 and are the same as those for Oswego Unit 6.

E. WATER BODY SEGMENT IDENTIFICATIONS

See 316(a) submission Chapter III, section E.

IV. LOCATION, DESIGN AND CAPACITY OF INTAKE FACILITY

A. DESIGN OF INTAKE STRUCTURE

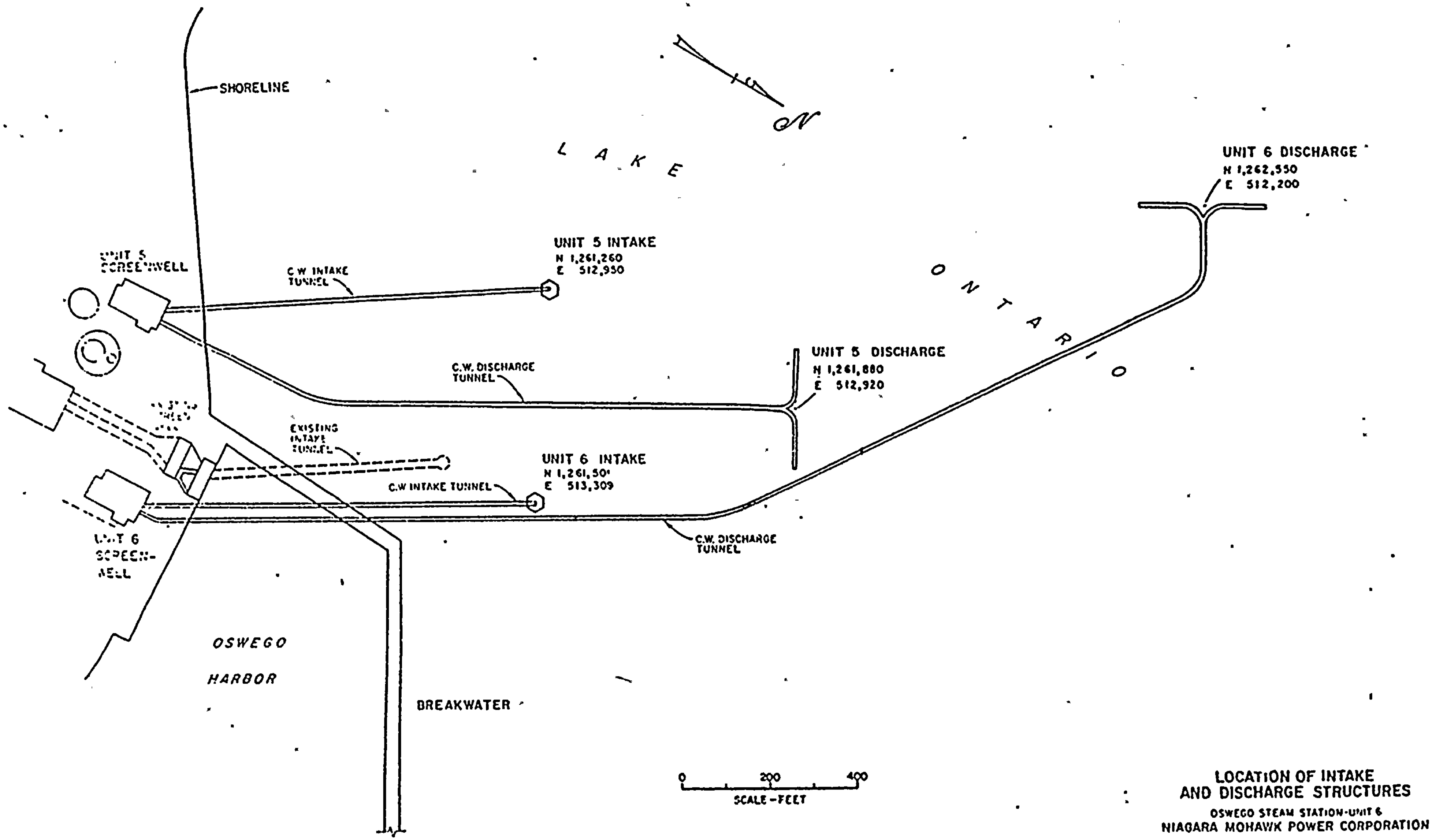
Circulating water for Oswego Unit 6 will be taken from Lake Ontario via a submerged inlet, circulated through the condensers, and returned to the lake through a submerged jet diffuser. Figure IV-1 shows the proposed locations of intake and discharge structures in Lake Ontario. The intake structure is hexagonally shaped and located approximately 1200 ft (365.8 m) from the existing shoreline.

At the low water datum of 243 ft (74 m) (International Great Lakes Datum, 1955), the water will be 22 ft (6.7 m) deep and the clearance between the top of the intake structure and the water surface will be 12 ft (3.66 m). Details of the intake structure are shown in Figure IV-2.

The pertinent dimensions of the intake structure include a 3 ft (0.91 m) sill at the bottom to prevent silting of the intake, a 2 ft (0.61 m) roof thickness, and a 5 ft (1.52 m) high by 21.2 ft (6.45m) aperture on each of the six sides. Each intake aperature will be equipped with heated bar racks to prevent the formation of frazil ice. The intake will be designed so that the horizontal approach velocity will be 1.0 fps (0.3 m/sec) when the generating unit is operated at maximum output. There will be negligible vertical approach velocity.

Oswego Unit 6 will require a total circulating water flow of 635 cfs (17.98 m^3/sec) when the plant is operating at maximum output. The temperature of the condenser cooling flow of 546 cfs (15.46 m^3/sec) will be raised 32.4°F (18°C), while the temperature of the service water flow of 89 cfs (2.52 m^3/sec) will be raised 5°F (2.8°C). Thus, 635 cfs will be discharged from the unit at a maximum temperature rise above lake ambient of 28.6°F (15.9°C). Total heat emission to the lake will be 4.09 billion BTU per hour at full station load.

The circulating water system as described has been analyzed in terms of time required for flow between key operational features. Table IV-1 summarizes the time and the temperature of the flow as it progresses through the circulating water system. An entrained organism will be exposed to significant temperatures above ambient for a maximum of 6.3 minutes under conditions of maximum generation and heat dissipation.

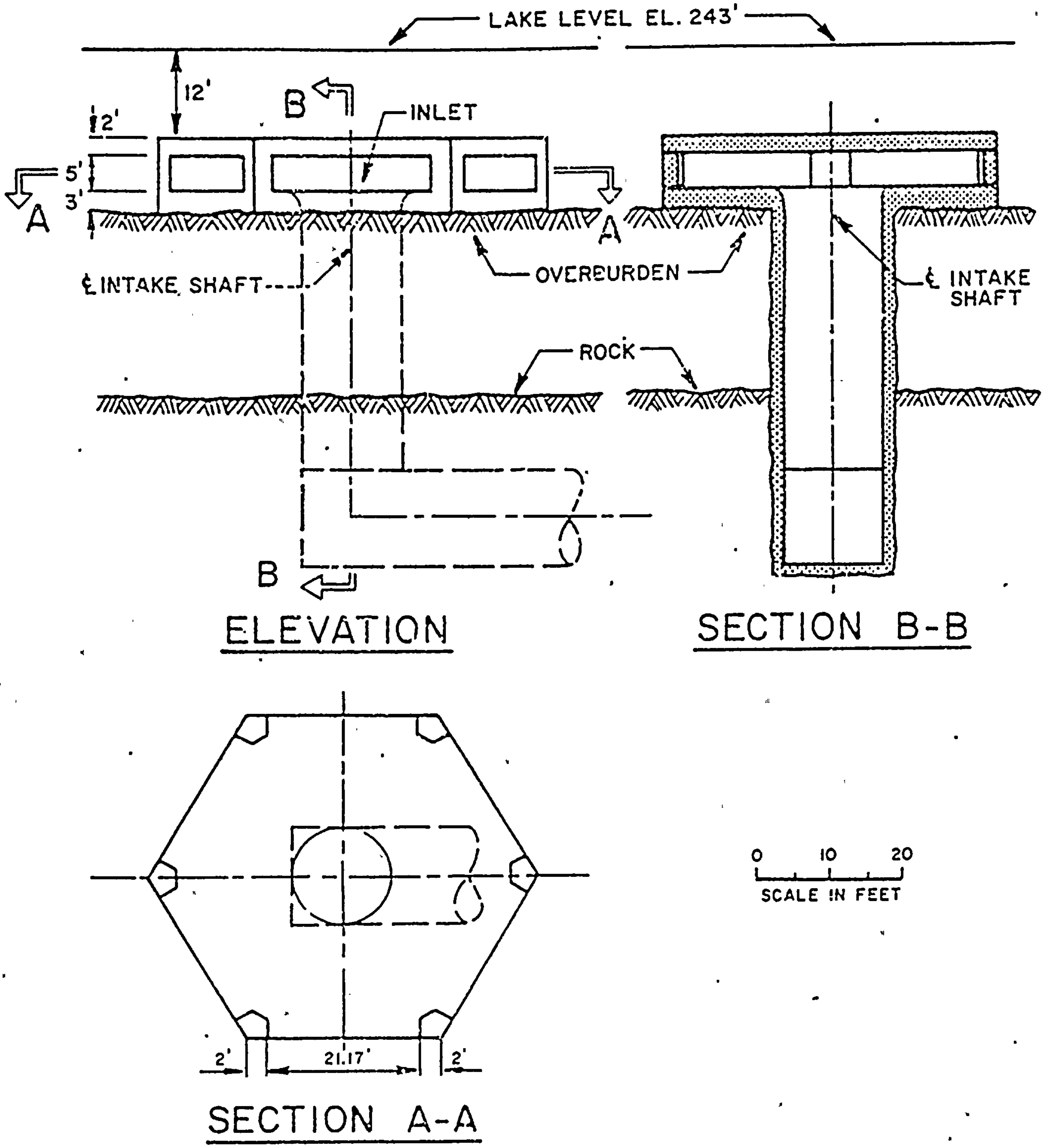


LOCATION OF INTAKE AND DISCHARGE STRUCTURES

OSWEGO STEAM STATION-UNIT 6

NIAGARA MOHAWK POWER CORPORATION

FIGURE IV-1



INTAKE STRUCTURE
NIAGARA MOHAWK POWER CORPORATION

Table IV-1

Time-Temperature Through Circulating Water System, Maximum Heat Rejection

	Seconds	T, Above Ambient °F °F	 °C
Intake to pumps	153	0	0
Pumps to screenwell	27.7	1	0.6
Screenwell to condenser	83.3	1	0.6
Through condenser	8.6	1°-32.4	0.6-18.0
Condenser to screenwell	83.3	32°F	18
Screenwell to diffuser	288	28.6°F	15.9
Total	643.9 (10.73 minutes)		

Total time of exposure to elevated temperatures - 380.5 seconds (6.34 minutes).

B. ENVIRONMENTAL ASPECTS OF THE INTAKE AND SCREENWELL DESIGN AND LOCATION

As described previously, the intake aperture is designed so that water velocities at maximum station output will be 1.0 fps (0.3 m/sec) and the flow into the intake structure will be in the horizontal plane. This latter point is significant because investigations (Adams, 1968; Zeller and Rulifson, 1970) have shown that fish can better avoid horizontal inflows than vertical ones. In addition to controlling the approach velocity to the intake and the flow patterns into the structure, other precautions will be taken in the design and location of the intake structure in order to ensure adequate fish protection. The Oswego Unit 6 intake structure will be fitted with a velocity cap which prevents direct vertical flow and the creation of a vortex or "drawdown" area in the lake. By preventing the vertical flow, the stucture design will increase flow in the horizontal plane, extending somewhat the distance from where horizontal flow will begin. It has been calculated that under calm current conditions (not usually observed in the Oswego area) the intake flow velocity will approach the cbaracteristic current approximately 30 m (100 ft) from the intake port face.

The location of the intake was selected considering potential impacts of the intake operation. No differences in the aquatic community among alternative locations have been discerned, hence, the location of the intake structure relative to the diffuser was selected to minimize recirculation of the Oswego Unit 5 or 6 discharge. Recirculation could decrease plant efficiency as well as attract fish to the intake area. A series of hydraulic model investigations were conducted to determine the optimal locations for the structures in Lake Ontario. The hydraulic model results showed that, with the intake located in relation to the discharge as shown in Figure IV-1, recirculation of heated water from Oswego Unit 6's discharge was negligible (<1°F). The conditions simulated in the model included lake currents from the west and northeast, zero lake current, high and low Oswego River flows, and a range of lake ambient temperature conditions.

The maximum approach velocity to the Oswego Unit 6 intake is estimated to be 1 fps (0.3 m/sec), with a maximum velocity through the intake bars of 1.2 fps (0.37 m/sec). The screenwell of the Oswego Unit 6 intake will be designed so that the maximum approach velocity to the traveling screens will be 0.97 fps (0.30 m/sec).

The Oswego Unit 6 intake is designed to withdraw up to 17.98 m^3/sec (635 cfs) of lake water at full capacity. The water will be drawn from a layer that is between 1.5 m (5 ft) thick (the height of the intake opening) and the total thickness of the water column from surface to bottom (8.6 m, 28 ft). If it assumed that a longshore current is present a a characteristic speed of 5.2 cm/sec (0.17 fps), then in the extreme case of strong stratification, the required net flow will be available from a zone less than 235 m (771 ft) wide.

In addition, the screenwell for Oswego Unit 6 is designed to include a fish diversion system in the intake screenwell. The system will utilize an angled travelling screen-bypass fish diversion and return concept as described in the summary document of the Nine Mile Unit 2 studies previously provided to EPA staff[1].

C. CHEMICAL WASTES

The cooling water condensers for Oswego Unit 6 are expected to be cleansed by the abrasion of suspended solid material within the cooling water. As a result, it will not be necessary to introduce any condenser cleaning chemicals into the cooling water system.

(1) Stone and Webster Engineers Inc., Alden Research Laboratories and Niagara Mohawk Power Corporation, February, 1975, Water Quality Certification Summary Report, Nine Mile Point Nuclear Station-Unit 2, Studies to Alleviate Potential Fish Entrapment Problems.

V. BASELINE STUDIES AND COMMUNITY COMPOSITION

Information relative to the baseline studies and the community composition is presented in Chapter V of the 316(a) submission for Oswego Unit 6. The reader is referred to this document for a detailed discussion of this information.

VI. SELECTION OF REPRESENTATIVE IMPORTANT SPECIES

Information relative to the selection of representative important species is presented in Chapter VI of the 316(a) submission for Oswego Unit 6. The reader is referred to this document for a detailed discussion of this information.

VII. POTENTIAL STRESSES AND IMPACTS OF THE CIRCULATING WATER SYSTEM

A. POTENTIAL ENTRAINMENT IMPACTS

Once-through cooling of steam generating stations requires the use of large amounts of water. Oswego Unit 6 will circulate 635 cfs (17.98m^3/sec). As a result of this process, organisms living within the water body from which the cooling water will be withdrawn may be subjected to a variety of stresses. The analysis of the effects of these stresses on the aquatic community requires a knowledge of three basic parameters of the community. They are:

1. the size and resiliency of the affected population,
2. the life stage, species, and numbers of organisms subjected to the stress, and
3. the survival and viability of entrained organisms after passage through the power plant.

Research on the balanced indigenous communities within the vicinities of power plants has been aimed at describing the size of the individual populations. The quantification of the life stages, species, and numbers of organisms entrained relies on standard biological monitoring of the entrained water. The groups of organisms usually considered during the analyses of entrainment impact are the phytoplankton, zooplankton, and early life stages of fish. Experiments have recently been conducted to determine the survival of entrained organisms, and have shown that stress results from a combination of factors, including:

1. heat dissipated through the condenser tubes into the cooling water,
2. changes in hydrostatic pressure as the cooling water is pumped through the system,
3. mechanical abrasion resulting from contact with pumps and tubing walls,
4. shear stress developed in the moving water,
5. chemical additives to the cooling water, and
6. changes in the partial pressure of gases within the water.

It has at times been assumed that all of the organisms entrained are killed, but this has been shown not to be the case. In fact, for phytoplankton, there is a stimulatory effect during the cooler months. It is only during the summer when the algae are existing near their upper thermal tolerance point that the addition of heat becomes detrimental (Brooks, 1974; Gurtz and Weis, 1974; LMS, 1975;). Analyses of the effects of condenser passage on phytoplankton are usually performed using the uptake of radioactively labeled carbon (^{14}C), a test which measures a community response. That is, this test determines the overall response of all species and individuals within the sample. It is likely that some species are selectively eliminated while the growth of other species is enhanced.

Studies of the effect of entrainment on zooplankton have revealed similar results. Rarely does entrainment cause a 100% mortality and the response of an organism is species-specific. Icanberry and Adams (1974) found a high correlation between the temperature rise through the condenser and the percent mortality of the zooplankton. LMS (1975) has also found a correlation between temperature rise through a power plant and the percent mortality of Bosmina, copepod nauplii, and rotifers. There was also a relationship noted between the length of time the organisms remained in the condenser tubes, the number of abrupt turns in the system, and organism mortality. Usually mortality estimates for zooplankton range from 10 to 30% (Icanberry and Adams, 1974; Heinle et al., 1974; Davies and Jensen, 1973, 1974; LMS, 1975).

For the purposes of this demonstration, the early life stages of fish have been singled out as representing the aquatic community. The studies of fish egg and larval survival after passage through a power plant have not been as useful in determining plant impact as have been the studies with phytoplankton and microzooplankton. The problem is that the observed mortality of fish eggs and larvae can be attributd to any one of three factors:

1. natural mortality within the population,
2. power plant induced mortality, and
3. collection method mortality.

Traditionally, the analysis of power plant induced mortality has been accomplished through the collection of fish larvae with plankton nets from the intake and discharge. This method is subject to a major criticism, which is that the mortality associated with the capture technique has not been factored out (Marcy, 1971; NYU, 1974).

LMS (1975) found a positive correlation between the speed of water through the plankton net and the percent mortality of striped bass larvae. Thus, for power plants with a different water speed in the intake and in the discharge, different mortalities due to water speed alone can be expected.

For this reason laboratory studies have been conducted in which the passage of organisms through the condenser system is simulated. Studies have been performed on time-temperature relationships, pressure effects, and shear and turbulence. NYU (1974) has shown that rapid changes in pressure can adversely effect white perch larvae.

Mortality due to pressure changes is dependent upon the species, age, and time of year as well as the factors previously mentioned. Coutant and Kedl (1975) studied the survival of larval striped bass exposed to fluid-induced and thermal stresses in a simulated condenser tube. They found that the mortality was no greater than would be expected due to temperature alone and that control larvae suffered the same percent mortality as experimentals at ambient temperatures. They concluded that shear stress, turbulence, and mechanical damage encountered within the condenser tube were not the causative factors of mortality and they suggested that further research be done on the effect of mechanical damage due to the circulating pumps.

Mortality associated with passage through entire power plant systems usually ranges from 10 to 30% for fish larvae. Plants with long discharge canals which prolong the exposure of larvae to high temperatures have a more severe effect, with mortalities as high as 100%. No untreated chemical wastes are added to the circulating water of Oswego Unit 6, hence no mortality results from these additions.

B. POTENTIAL IMPINGEMENT IMPACTS

The placement of screening devices within the intakes of power plants was intended to remove large particulates, including fishes, from the cooling water flow. These screening devices effectively collect fish from the intake water flow and carry them upwards and out of the water mass. The fish are then washed off the screens and are either returned to the water body or discarded.

Oswego Unit 6's screenwell will include a fish diversion system which will be utilized to divert fish from the screenwell back to the lake. Since final design of the operational system and data on expected system efficiency are not complete at this time, it is conservatively assumed in the impingement analysis presented in Chapter VIII that all fish entrapped in the screenwell are permanently removed from the present populations.

C. SUMMARY

Due to the many variables that exist one cannot reliably at this time, determine specific species mortality data for organisms entrained in power plant circulating water systems. Lacking this species specific data and reliable methods of obtaining it in the near future Niagara Mohawk has assumed in the analysis presented in Chapter VIII that all organisms passing through the Oswego Unit 6 circulating water system experience 100% mortality. Although this position is probablycontrary to fact, we believe it to result in the highest degree of conservatism when evaluating the effect of the circulating water system upon the aquatic community.

VIII. IMPACTS OF THE INTAKE

A. INTRODUCTION

This chapter presents quantitative evaluations of the intake effects on larval and adult forms of the representative important species described in Chapter VI. The computations lead to cropping factors for the two water body segments described in Chapter III. The assessments presented herein are conservative estimates of impact in that 100% mortality is assumed for all fish and entrainable organisms which enter the lake intake. In chapter VII, however, are cited a number of sources to show that few species of entrainables suffer 100% mortality.

All fish and larval data collected during 1974 were reduced to concentrations [number of organisms per 1000 m^3 (35,288 ft^3)]. Available data include trawl, gill net, and beach seine collections. The fish trawls collected low numbers of fish. The beach seines collected the smaller fish which abound in the nearshore waters. The large numbers of fish and the high species diversity of the gill net collections indicate that they sample a wide spectrum of species and the collections are made in water depths commensurate with the water depth at the intake The larval and Gammarus data were collected by metered plankton tows.

This chapter is organized in a step-wise fashion. The evaluations are presented in the following order:

1. The methods used in determining fish and larval concentrations in the water body segments and in the intake flows.

2. The cropping in water body segment I of entrainable organisms by the Oswego Unit 6 intake and by all six Oswego units.

3. The composite cropping of entrainable organisms in water body segment II by all power stations operating in the area including Oswego Units 1-6, Nine Mile Point Unit 1 and the James A. FitzPatrick plant.

4. The cropping of impingable fish in water body segment I by Oswego Unit 6 and Units 1-5.

5. The composite cropping of fish in water body segment II by all stations.

B. CONCENTRATIONS OF FISH AND LARVAE IN THE ADJACENT WATER BODY SEGMENTS

Catches from gill nets set in the vicinity of Oswego were used to estimate fish concentrations in water body segment I. These data combined with similar data for the Nine Mile Point area were used to estimate concentrations in water body segment II. It is assumed that gill net data are representative for six of the nine species of concern: alewives, rainbow smelt, spottail shiners, white perch, yellow perch, and smallmouth bass. Gill nets did not effectively catch threespine sticklebacks, coho salmon, or brown trout. Threespine stickleback populations were calculated from other data as described later in this section. Very few coho salmon or brown trout were collected in the field sampling programs and, therefore, no reliable estimates of concentrations for these species are available.

Gill net data is recorded as catch per twelve hour effort. The area of each gill net (11.2 m^2, 120 ft^2) and the sample period (12 hrs) is known; however, because fish are swimmers, they are not generally carried through the net by the ambient current. It was, therefore, necessary to estimate swim speeds and to treat this as a flow through the net, that is, the catch is related to the swim speed as water flow is related to velocity.

Two swim speeds were used to provide concentration estimates, 2 cm/sec (0.07 fps) and 12 cm/sec (0.39 fps). These values encompass, within a width of two standard deviations, the average swim speed for yellow perch and white sucker calculated from data collected by Kelso (in press). It is realized that the average speed at which a fish swims is dependent on a number of factors, e.g., the species, size, age, temperature, etc; however, for the purpose of this demonstration the generalization was made that these six species swim at speeds in the range cited. Further, it is realized that gill nets do not catch all fish species with equal efficiency. Nevertheless, the use of swim speed data and gill net catch per effort data allow for a relative abundance estimate that is not available otherwise. The lake concentrations were calculated using a 2 cm/sec swim speed for the six species.

Threespine sticklebacks were not caught in gill nets or trawls and the swim speed approach described above was not possible for this species. This fish is territorial during the spawning period, and this behavior is utilized to estimate its population. Threespine sticklebacks spawn in shallow vegetated zones and occupy an area of about 0.42 m^2 (4.5 ft^2) (Black and Wooten, 1970). Divers working near the Oswego station have reported that vegetation grows over about 50% of the bottom to a depth of about 5-6 m (16-20 ft).

If it is assumed that all of the available suitable area is occupied by threespine sticklebacks, then the population estimate for threespine stickleback would exceed that of alewives by a factor of 25. Therefore, the population is probably conservatively estimated if it is assumed that only 1-10% of the available area is occupied. The method used in this report is to assume that 2% of the area is used and that each territorial male is accompanied by a female.

The calculated concentration of coho salmon and brown trout (Tables VIII-1a and 1b) are zero or near zero due to the small numbers collected in the field studies. New York State is currently stocking these species, although their capacity for self-propagation in Lake Ontario is doubtful and not documented. No concentrations are available for these species but recent annual stocking data are utilized. In the absence of population estimates the stocking program serves as a basis for comparison with the plant impact. In 1974 the state stocked 42,000 brown trout and 500,000 coho salmon in Lake Ontario.

Larval concentrations were calculated by averaging all larval tow data within a segment by month. The larval tows were conducted with flow meters so that, unlike the gill net data, the larvae concentrations were calculated directly from field data. Only alewife, rainbow smelt, white perch, and yellow perch larvae were collected in the ichthyoplankton tows in the Oswego area. The fish and larval concentrations for lake water body segments I and II are presented on Table VIII-1.

C. CONCENTRATIONS OF FISH AND LARVAE IN THE PLANT

Because of the proximity of their intakes, Oswego Unit 6 is expected to have similar species concentrations to those measured for the Oswego Units 1-4 intake. The Oswego Unit 6 intake differs from the Units 1-4 intake in that the approach velocity is nearly 30% lower (1.0 fps versus 1.3 fps), this reduction may reduce the concentrations of impinged fish. In the absence of post operational data however, the assumption is made that concentrations are identical leading to conservative impact estimates. The concentrations calculated for Oswego Units 1-4, and for Oswego Unit 6 are the number of organisms of a species impinged or entrained during a sampling period divided by the volume of water that passed through or will pass through the plant during that period. The daily concentrations are averaged over a month (see Table VIII-2).

The magnitudes of impingement and entrainment are assumed to be the product of flow times concentration where concentrations in Units 1-4 and Unit 6 are assumed to be equal. The flow for Oswego Unit 6 is 18.0 m^3/sec (635 cfs) whereas the Oswego Units 1-4 flow is 21.6 m^3/sec (762 cfs) resulting in a proportionately lesser impact of Oswego Unit 6 as

TABLE VIII-1a

CONCENTRATION OF LARVAE IN THE LAKE

CONCENTRATION OF LARVAE IN THE WATER BODY SEGMENT 1

(UNITS - NO PER THOUSAND CUBIC METERS)

SPEC.	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
ALWF	********	********	********	0.0	0.0	5.8366	21.5784	129.7529	4.0696	0.0	********	********
RBSM	********	********	********	0.0	0.3000	2.5500	1.6432	0.2333	0.5667	0.0	********	********
SPSH	********	********	********	0.0	0.0	0.0	0.0	0.0	0.0	0.0	********	********
TSSB	********	********	********	0.0	0.0	0.0	0.0	0.0	0.0	0.0	********	********
WTPC	********	********	********	0.0	0.0	2.4157	0.5344	1.0500	0.0417	0.0	********	********
YLPC	********	********	********	0.0	1.6000	0.0	0.0	0.0	0.0	0.0	********	********
SMBS	********	********	********	0.0	0.0	0.0	0.0	0.0	0.0	0.0	********	********
CHSL	********	********	********	0.0	0.0	0.0	0.0	0.0	0.0	0.0	********	********
BNTT	********	********	********	0.0	0.0	0.0	0.0	0.0	0.0	0.0	********	********

SPECIAL SYMBOL ******** MEANS NO DATA

CONCENTRATION OF LARVAE IN THE WATER BODY SEGMENT 2

(UNITS - NO PER THOUSAND CUBIC METERS)

SPEC.	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
ALWF	********	********	********	0.0	0.0	17.4203	191.6749	480.3027	6.5237	0.0	********	********
RBSM	********	********	********	9.9971	39.7842	13.3340	7.8914	1.1196	0.2834	0.0	********	********
SPSH	********	********	********	0.0	0.0	0.0	0.0	0.0	0.0	0.0	********	********
TSSB	********	********	********	0.0	0.0	0.0	0.0	0.0	0.0	0.0	********	********
WTPC	********	********	********	0.0	1.0000	10.2137	3.2648	4.5250	0.2209	0.0	********	********
YLPC	********	********	********	0.0	1.3000	0.5000	1.5206	0.0	0.0	0.0	********	********
SMBS	********	********	********	0.0	0.0	0.0	0.1250	0.0	0.0	0.0	********	********
CHSL	********	********	********	0.0	0.0	0.0	0.0	0.0	0.0	0.0	********	********
BNTT	********	********	********	0.0	0.0	0.0	0.0	0.0	0.0	********	********	********

SPECIAL SYMBOL ******** MEANS NO DATA

TABLE VIII-1b

CONCENTRATION OF FISH IN THE LAKE

CONCENTRATION OF FISH IN THE WATER BODY SEGMENT 1

(UNITS - NO PER THOUSAND CUBIC METERS)

ASSUMED SPEED OF FISH IN THE LAKE = 2 CM/SEC

SPEC.	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
ALWF	********	********	********	1.5313	2.2236	2.7773	2.5241	0.3151	0.1855	0.0129	********	********
RBSM	********	********	********	0.5137	0.0112	0.0020	0.0	0.0	0.0060	0.0018	********	********
SPSH	********	********	********	0.0026	0.0066	0.0115	0.0072	0.0116	0.0043	0.0047	********	********
TSSB	********	********	********	0.0	0.0	0.0	0.0544	0.0	0.0	0.0	********	********
WTPC	********	********	********	0.0430	0.0195	0.0517	0.0170	0.0283	0.0244	0.0143	********	********
YLPC	********	********	********	0.0021	0.0046	0.0112	0.0017	0.0069	0.0073	0.0114	********	********
SMBS	********	********	********	0.0021	0.0037	0.0072	0.0	0.0043	0.0004	0.0	********	********
CHSL	********	********	********	0.0	0.0	0.0	0.0	0.0	0.0004	0.0	********	********
BNTT	********	********	********	0.0005	0.0	0.0004	0.0	0.0	0.0004	0.0	********	********

SPECIAL SYMBOL ******** MEANS NO DATA

CONCENTRATION OF FISH IN THE WATER BODY SEGMENT 2

(UNITS - NO PER THOUSAND CUBIC METERS)

ASSUMED SPEED OF FISH IN THE LAKE = 2 CM/SEC

SPEC.	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
ALWF	********	********	********	1.0011	1.3070	1.5924	1.7116	0.3675	0.1597	0.0472	********	********
RBSM	********	********	********	0.4153	0.0303	0.0046	0.0004	0.0004	0.0041	0.0044	********	********
SPSH	********	********	********	0.0079	0.0122	0.0148	0.0182	0.0128	0.0127	0.0233	********	********
TSSB	********	********	********	0.0	0.0	0.0	0.0274	0.0	0.0	0.0	********	********
WTPC	********	********	********	0.0238	0.0159	0.0343	0.0226	0.0198	0.0284	0.0131	********	********
YLPC	********	********	********	0.0040	0.0050	0.0117	0.0120	0.0067	0.0078	0.0092	********	********
SMBS	********	********	********	0.0016	0.0027	0.0039	0.0008	0.0033	0.0026	0.0005	********	********
CHSL	********	********	********	0.0	0.0	0.0	0.0	0.0	0.0002	0.0	********	********
BNTT	********	********	********	0.0003	0.0	0.0002	0.0	0.0	0.0002	0.0	********	********

SPECIAL SYMBOL ******** MEANS NO DATA

TABLE VIII-2a

CONCENTRATION OF LARVAE IN THE INTAKES

CONCENTRATION OF LARVAE ENTRAINED AT THE OSWEGO PLANT - UNITS 1 - 4

(UNITS - NO PER THOUSAND CUBIC METERS)

SPEC.	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
ALWF	********	********	********	0.0	0.0	2.8700	16.2500	260.8750	4.5000	0.0	********	********
RBSM	********	********	********	0.0	0.0	1.6250	3.6250	0.0	0.0	0.0	********	********
SPSH	********	********	********	0.0	0.0	0.0	0.0	0.0	0.0	0.0	********	********
TSSB	********	********	********	0.0	0.0	0.0	0.0	0.0	0.0	0.0	********	********
WTPC	********	********	********	0.0	0.0	0.0	1.0000	0.0	0.0	0.0	********	********
YLPC	********	********	********	0.0	0.0	0.0	3.8750	0.0	0.0	0.0	********	********
SMBS	********	********	********	0.0	0.0	0.0	0.0	0.0	0.0	0.0	********	********
CHSL	********	********	********	0.0	0.0	0.0	0.0	0.0	0.0	0.0	********	********
BNTT	********	********	********	0.0	0.0	0.0	0.0	0.0	0.0	0.0	********	********

SPECIAL SYMBOL ******** MEANS NO DATA

CONCENTRATION OF LARVAE ENTRAINED AT THE NINE MILE POINT PLANT

(UNITS - NO PER THOUSAND CUBIC METERS)

SPEC.	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
ALWF	********	********	********	********	0.0	0.0	146.0000	24.0000	0.0	0.0	********	********
RBSM	********	********	********	********	46.0000	25.0000	27.0000	1.0000	0.0	0.0	********	********
SPSH	********	********	********	********	0.0	0.0	0.0	0.0	0.0	0.0	********	********
TSSB	********	********	********	********	0.0	0.0	0.0	0.0	0.0	0.0	********	********
WTPC	********	********	********	********	0.0	2.0000	0.0	0.0	0.0	0.0	********	********
YLPC	********	********	********	********	0.0	0.0	5.0000	0.0	0.0	0.0	********	********
SMBS	********	********	********	********	0.0	0.0	0.0	0.0	0.0	0.0	********	********
CHSL	********	********	********	********	0.0	0.0	0.0	0.0	0.0	0.0	********	********
BNTT	********	********	********	********	0.0	0.0	0.0	0.0	0.0	0.0	********	********

SPECIAL SYMBOL ******** MEANS NO DATA

TABLE VIII-2b

CONCENTRATION OF FISH IN THE INTAKES

CONCENTRATION OF FISH IMPINGED AT THE OSWEGO PLANT - UNITS 1 - 4

(UNITS - NO PER THOUSAND CUBIC METERS)

SPEC.	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
ALWF	0.0080	0.0013	0.0010	9.5744	10.3791	5.4063	1.9120	0.8960	0.3749	0.1912	0.3959	0.0960
RBSM	0.0169	0.0526	0.1399	0.6142	0.6705	0.0394	0.0011	0.0	0.0011	0.0051	0.0131	0.0780
SPSH	0.0008	0.0008	0.0006	0.0006	0.0	0.0015	0.0072	0.0035	0.0011	0.0013	0.0003	0.0
TSSB	0.0	0.0024	0.0039	0.0019	0.0	0.0113	0.0003	0.0	0.0027	0.0	0.0	0.0
WTPC	0.0048	0.0086	0.0386	0.0054	0.0011	0.0080	0.0005	0.0005	0.0005	0.0003	0.0075	0.0
YLPC	0.0051	0.0038	0.0006	0.0	0.0	0.0111	0.0	0.0013	0.0008	0.0	0.0	0.0
SMBS	0.0013	0.0005	0.0010	0.0	0.0	0.0	0.0	0.0	0.0	0.0003	0.0	0.0
CHSL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BNTT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0003

SPECIAL SYMBOL ******** MEANS NO DATA

CONCENTRATION OF FISH IMPINGED AT THE NINE MILE POINT PLANT

(UNITS - NO PER THOUSAND CUBIC METERS)

SPEC.	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
ALWF	0.0187	0.0101	0.0246	3.3477	13.4154	4.0612	3.5147	4.9977	1.6688	0.5886	0.7431	1.5967
RBSM	0.2644	0.2155	0.3791	0.4638	0.3618	0.0810	0.0097	0.0024	0.0156	0.0072	0.0106	0.0999
SPSH	0.0029	0.0032	0.0115	0.0111	0.0087	0.0066	0.0073	0.0021	0.0024	0.0008	0.0004	0.0022
TSSB	0.0081	0.0268	0.1329	0.0410	0.0215	0.0312	0.0541	0.0	0.0001	0.0002	0.0	0.0014
WTPC	0.0090	0.0391	0.1359	0.0855	0.0028	0.0006	0.0003	0.0002	0.0690	0.0059	0.0011	0.0082
YLPC	0.0054	0.0076	0.0051	0.0042	0.0008	0.0007	0.0022	0.0028	0.0019	0.0008	0.0004	0.0027
SMBS	0.0011	0.0016	0.0008	0.0007	0.0009	0.0013	0.0004	0.0001	0.0	0.0001	0.0002	0.0
CHSL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BNTT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

SPECIAL SYMBOL ******** MEANS NO DATA

compared with Oswego units 1-4. Since the flows and the intake velocities are the same for Oswego Units 5 and 6, the impact of the two units would be similar.

The Oswego and Nine Mile Point intake concentrations are calculated as described above and are presented in Table VIII-2. These values are reported as averages over a month for each of the nine species. The table provides concentrations of fish and larvae in the Oswego Units 1-4, Oswego Unit 5, Oswego Unit 6, FitzPatrick, and the Nine Mile Point Station Unit 1. The concentrations are reported in numbers of organisms per $1000m^3$ of water.

D. ENTRAINMENT CROPPING OF LARVAE

1. General

The impact of power station operation is evaluated in this section with a flux cropping ratio. This ratio relates the number of organisms flowing through the plant to the number of organisms flowing by the plant. It is, in this sense, a ratio of flows or fluxes as distinguished from a ratio that would describe the removal of organisms from a finite population. The flow through the water body segment corresponds to the low flow conditions used to define the segments.

The flux cropping ratio, K, is defined as

$$K = \frac{\text{organisms flowing through the plant}}{\text{organisms flowing by the plant}}$$

$$= \frac{Q_P C_P}{Q_L C_L} \times 100.0 \text{ (in percent)}$$

where Q_P and Q_L are the plant cooling water flow and longshore lake flow in the water body segment, respectively.

If the organism concentrations in the lake (C_L) equals the concentrations in the plant or plants (C_P) the flux cropping ratio would reduce to the ratio of flows, Q_P/Q_L, which leads directly to the result that, for all species,

K (WS I) = 2.2% (for Units 1-6)
= 0.7% (for Unit 6 alone)

K (WS II) = 0.7% (for Units 1-6, Nine Mile 1, FitzPatrick)
= 0.1% (for Unit 6 alone)

Thus, if one assumes similar lake and plant intake concentrations, the maximum cropping occurs in water body segment I at a rate of 2.2% for all power stations.

2. Monthly Larvae Cropping

The predicted cropping rates for each segment are reported for Oswego Unit 6 and for Oswego Units 1-6 in water body segment I, and for all stations in water body segment II. Table VIII-3 presents these results for larvae for each month using 1974 field data. The only larvae entrained by Oswego Units 1-4 in 1974 were alewife, rainbow smelt, white perch, and yellow perch.

The alewife cropping peaked in August when larvae concentrations reached a maximum in both lake and inplant collections. The peak rate predicted for all six units occurred in August with an Oswego Unit 6 contribution of 1.35%. The weighted average of all six Oswego units over the season when larvae are present is 3.80% for water body segment I.

The segment II analysis includes entrainment by all Oswego Units plus Nine Mile Point Unit 1 and the FitzPatrick plant. The rate of alewife cropping reaches a maximum in July of 0.26%, since the Nine Mile Point inplant sampling (Table VIII-1) shows maximum concentrations in July. The Oswego Unit 6 contribution is maximum in September at 0.09% although the July contribution is only 0.01%. The weighted mean impact in water body segment II throughout the alewife larvae season is 0.24%.

The rainbow smelt concentration listed in Table VIII-1 show smooth seasonal trends in concentrations from April through September with higher concentration at Nine Mile Point than Oswego. The entrainment by Oswego Units 1-6 is 1.38 and 4.74% in June and July, respectively, with contributions by Oswego Unit 6 of 0.43 and 1.48% in these months, respectively. The average entrainment over the summer is 1.93% of the flux through water body segment I. The segment II cropping by all Oswego Units, Nine Mile Point Unit 1 and FitzPatrick over the summer is 0.62%. The Oswego Unit 6 contributions are 0.01% for June and 0.06% for July.

The white perch larvae concentrations from the lake are at a maximum during June through August at both sites, with higher concentrations at Nine Mile Point. White perch larvae were collected in the plant only in July at Oswego and in June at Nine Mile Point. The segment I entrainment rate due to all Oswego units is 4.02% in July; the Oswego Unit 6 contribution is 1.26%. No cropping is predicted for other months, since larvae were not collected in those months at the existing Oswego station.

TABLE [illegible]-3

CROPPING RATIOS FOR THE OSWEGO PLANT UNIT 6 WITHIN THE WATER BODY SEGMENT 1

(UNITS - PERCENTAGES)

SPEC	JAN.	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
ALWF	111.1111	111.1111	111.1111	0.0	0.0	0.3303	0.5058	1.3504	0.7427	0.0	111.1111	111.1111
RBSM	111.1111	111.1111	111.1111	0.0	0.0	0.4314	1.4817	0.0	0.0	0.0	111.1111	111.1111
SPSH	111.1111	111.1111	111.1111	0.0	0.0	0.0	0.0	0.0	0.0	0.0	111.1111	111.1111
TSSB	111.1111	111.1111	111.1111	0.0	0.0	0.0	0.0	0.0	0.0	0.0	111.1111	111.1111
WTPC	111.1111	111.1111	111.1111	0.0	0.0	0.0	1.2569	0.0	0.0	0.0	111.1111	111.1111
YLPC	111.1111	111.1111	111.1111	0.0	0.0	0.0	0.0	0.0	0.0	0.0	111.1111	111.1111
SMBS	111.1111	111.1111	111.1111	0.0	0.0	0.0	0.0	0.0	0.0	0.0	111.1111	111.1111
CHSL	111.1111	111.1111	111.1111	0.0	0.0	0.0	0.0	0.0	0.0	0.0	111.1111	111.1111
BNTT	111.1111	111.1111	111.1111	0.0	0.0	0.0	0.0	0.0	0.0	0.0	111.1111	111.1111

LARVAE

COMPOSITE CROPPING RATIOS FOR THE OSWEGO PLANT - UNITS 1 - 4, 5 AND 6 IN THE WATER BODY SEGMENT 1

(UNITS - PERCENTAGES)

SPEC	JAN.	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
ALWF	********	********	********	0.0	0.0	1.0570	1.6187	4.3215	2.3768	0.0	********	********
RBSM	********	********	********	0.0	0.0	1.3806	4.7417	0.0	0.0	0.0	********	********
SPSH	********	********	********	0.0	0.0	0.0	0.0	0.0	0.0	0.0	********	********
TSSB	********	********	********	0.0	0.0	0.0	0.0	0.0	0.0	0.0	********	********
WTPC	********	********	********	0.0	0.0	0.0	4.0224	0.0	0.0	0.0	********	********
YLPC	********	********	********	0.0	0.0	0.0	0.0	0.0	0.0	0.0	********	********
SMBS	********	********	********	0.0	0.0	0.0	0.0	0.0	0.0	0.0	********	********
CHSL	********	********	********	0.0	0.0	0.0	0.0	0.0	0.0	0.0	********	********
BNTT	********	********	********	0.0	0.0	0.0	0.0	0.0	0.0	0.0	********	********

LARVAE

COMPOSITE CROPPING RATIOS FOR THE OSWEGO PLANT - UNITS 1 - 4, 5 AND 6, AND THE NINE MILE POINT AND FITZPATRICK PLANTS IN THE WATER BODY SEGMENT 2

(UNITS - PERCENTAGES)

SPEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
ALWF	********	********	********	********	0.0	0.0687	0.2575	0.2411	0.2876	0.0	********	********
RBSM	********	********	********	********	0.3373	0.5978	1.1896	0.2606	0.0	0.0	********	********
SPSH	********	********	********	********	0.0	0.0	0.0	0.0	0.0	0.0	********	********
TSSB	********	********	********	********	0.0	0.0	0.0	0.0	0.0	0.0	********	********
WTPC	********	********	********	********	0.0	0.0	0.1277	0.0	0.0	0.0	********	********
YLPC	********	********	********	********	0.0	0.0	2.0218	0.0	0.0	0.0	********	********
SMBS	********	********	********	********	0.0	0.0	0.0	0.0	0.0	0.0	********	********
CHSL	********	********	********	********	0.0	0.0	0.0	0.0	0.0	0.0	********	********
BNTT	********	********	********	********	0.0	0.0	0.0	0.0	0.0	0.0	********	********

SPECIAL FIGURES IN THE ABOVE TABLE HAVE THE FOLLOWING INTERPRETATIONS

111.1111 = NO PLANT CONCENTRATION DATA   222.2222 = NO LAKE CONCENTRATION DATA

333.3333 = LAKE CONCENTRATION ESTIMATE = 0.0   ******** = NO DATA FOR THE COMPOSITE CROPPING FACTORS

The composite (all plants) entrainment cropping in water body segment II is 0.09% in June and 0.13% in July. The weighted average is 0.07%. Although the larvae sample sizes are smaller than for smelt or alewife, the impact is predicted to be near the numbers cited above.

Yellow perch estimates are similarly based on low larvae concentrations. Larvae were present in the lake at Oswego only in May although they appeared in the inplant collections in July. The Nine Mile Point lake collections showed higher conentrations than at Oswego and the larvae were present in May, June, and July. The Nine Mile Point inplant collections included yellow perch only in August. Yellow Perch Larvae cropping by the Oswego station for water body segment I could not be calculated, since the Oswego lake collections included no yellow perch larvae. The composite effect of all plants on water body segment II is estimated to be 0.92%, of which 0.33% is attributed to the Oswego Unit 6 intake.

In summary the larvae cropping predicted for Oswego Unit 6 and for all power stations on each water body segment approximate the flow entrainment cited above, independent of the species. These results are summarized in Table VIII-4. With the exceptions of yellow perch, all species average entrainment cropping is consistent with the flow based entrainment rate. This confirms that the plankton larvae of alewife, smelt, white perch and yellow perch are entrained by the intake in similar concentrations to the concentrations present in the lake. Planktonic Gammarus would be cropped at similar rates.

E. FISH CROPPING BY IMPINGEMENT

The fish impingement concentrations shown in Table VIII-1 are based on those gill net collections made within 24 hours of an impingement collection. Similarly, the impingement fish concentrations are only based on the data when gill net collections were available within 24 hours of the impingement sample. Even after taking this precaution, the collections are not precisely comparable due to the schooling tendency of alewife and smelt and consequent large variances in the data sets occur. To smooth out high impingement and high gill net collections, seasonal cropping factors are calculated for spring and summer. The fall gill net collections included fewer fish perhaps resulting from slower swim speeds due to cooler water temperatures in the fall. Table VIII-5 summarizes the calculated impingement cropping for each species for Oswego Unit 6 and for Units 1-6 in water body segment I and for all plants in water body segment II. These calculations do not assess compensatory responses to cropping or the natural dye off rate which would mitigate any possible long-term impact.

The alewife has been the subject of intensive studies yet their behavior remains largely unpredictable. The inplant impingement collections

TABLE VIII - 4

SUMMARY OF LARVAE ENTRAINMENT CROPPING

All Plants on Segment II

Species	% Cropping Range
Alewife	0.07-0.29
Rainbow smelt	0-1.19
White perch	0-0.13
Yellow perch	0-2.02
Flow basis	0.7

All Plants on Segment I

Species	% Cropping Range
Alewife	1.06-4.32
Rainbow smelt	0-4.74
White perch	0-4.02
Yellow perch	0
Flow basis	2.2

Unit 6 on Segment I

Species	% Cropping Range
Alewife	0.33-1.35
Rainbow smelt	0-1.48
White perch	0-1.25
Yellow perch	0
Flow basis	0.7

do indicate, however, that the impingement rate in spring is frequently characterized by a specific period of extremely high alewife concentration during brief time intervals. The concentrations reported in Table VIII-1 and VIII-2 include high values in April, May, and June. The cropping due to Oswego Unit 6 during this period is predicted to be 2.69% of the flux through water body segment I. The composite impact of all six Oswego Units on water body segment I in spring is estimated to be 8.61%. The predicted summer cropping drops to 0.38% for Oswego Unit 6 and 1.21% for the six Oswego Units. The segment II impact for all stations is 4.51% in spring and 1.95% in summer.

Rainbow smelt exhibit similar schooling behavior and abrupt variations in concentration near the site. The estimated spring cropping of smelt by Oswego Unit 6 is 1.72%, with all six units cropping about 5.59% of the flux in the spring. The summer cropping ratios are much smaller. The predicted Oswego Unit 5 effect is 0.25% while all six units are expected to crop 0.79% of the flux through the segment. The effect of all stations in the area on water body segment.

The spottail shiner is present in the area throughout the sampling period but in low concentrations relative to alewife and rainbow smelt. The impingement cropping rates due to Oswego Unit 6 operations are minimal, 0.07% in spring and 0.34% in summer. The composite effects of Oswego Unit 6 with the existing units impact on water body segment I is 0.22% in spring and 1.09% in summer.

The threespine stickleback concentration can be estimated at 0.6/1000 m^3 from their territory size. The threespine was only impinged in July at Oswego, hence this species is not included in Table VIII-5. The cropping during summer of 0.04% by Oswego Unit 6 and 0.12% due to the combined operation of all Oswego Units on water body segment I is estimated.

The white perch are present in the area throughout the sampling period. The predicted impact of Oswego Unit 6 is 0.04% in spring and 0.09% in summer. Composite Oswego station impacts on water body segment I are 0.13% in spring and 0.28% in summer.

Yellow perch are nearly as abundant in all months of collections without strong seasonality in their concentrations. The spring cropping estimate, however, is 0.42% for Oswego Unit 6 as compared to a summer predicted cropping of only 0.09%. Composite impacts on water body segment I are 1.36% in spring and 0.29% in summer.

In summary, alewife and rainbow smelt are predicted to be most highly cropped of all species (8.61% and 5.51%, respectively) by operation of all Oswego Units in the spring. This conclusion is conservative

TABLE VIII-5

SEASONAL IMPINGEMENT CROPPING

SEGMENT I

Species	Spring Unit 6 Cropping	Spring Unit 1-6 Cropping	Summer Unit 6 Cropping	Summer Unit 1-6 Cropping
Alewife	2.69	8.61	0.38	1.22
Rainbow smelt	1.72	5.51	0.25	0.79
Spottail shiner	0.07	0.22	0.34	1.09
White perch	0.04	0.13	0.09	0.28
Yellow perch	0.42	1.36	0.09	0.29
Smallmouth bass	0	0	0	0

SEGMENT II

	Spring All Plants	Summer All Plants
Alewife	4.51	1.95
Rainbow smelt	1.80	3.52
Spottail shiner	0.25	0.18
White Perch	0.44	0.24
Yellow perch	0.25	0.12
Smallmouth bass	0.11	0.05

in that short duration alewife and smelt impingement runs in spring were included in these analyses. If comparable samples were distributed throughout the spring, the cropping estimate would be reduced. By comparison no other specie is cropped by more than 2% in any season. The assumption of passive fish entrainment into the intake longshore migrations would produce an impact prediction of 2.20% cropping in water body segment I. The calculated impacts infer that some fish successfully avoid the intake. An alternative explanation is that the high alewife and smelt concentrations in spring are underestimated by the gill net field procedures (12 hour sets) resulting in overestimation of impact by the flux cropping ratios calculated above.

F. CONCLUSIONS

Cropping of the larval forms of all representative species subject to entrainment has been calculated using lake and inplant data from both the Oswego and Nine Mile Point sites. Of the representative species, only alewife, rainbow smelt, white perch, and yellow perch larvae are subject to entrainment. The flux of entrained organisms into the plant is compared with the ambient longshore flux of larvae for a low flow condition, which is exceeded 90% of the time according to site current measurements. The resulting cropping ratios range above and below the ratio calculated on the basis of intake flow alone. Thus, it has been shown that the Oswego Unit 6 operation will crop only from 0 to 1.48% of the larvae drifting through water body segment I. Operation of all six Oswego Units in water body segment I is predicted to crop 0 to 4.74% of the larvae. Similarly, operation of all Oswego Units plus Nine Mile Point Unit 1 and the FitzPatrick station will crop an estimated 0 to 2.02% of the larvae drifting through water body segment II.

Impacts due to fish impingement have been similarly calculated using plant impingement rates at the existing station and gill net data converted to concentrations in each water body segment. The estimated cropping in spring is biased toward a high impact estimate due to possible overfishing by the gill nets and by use of impingement data collected during an alewife and rainbow smelt run in April at Oswego. The spring ratio of impingement in water body segment I with all Oswego plants operating is 8.61% for alewife and 5.51% for rainbow smelt. Estimates of percentage cropping for all other species are much lower. Cumulative impacts of all power stations at Oswego and Nine Mile Point on water body segment II were also calculated and provided a cropping rate which ranges from 4.51% for alewife in spring to 3.52% for rainbow smelt in summer.

It is concluded that neither entrainment nor impingement rates for Oswego 6 or for all power stations in the area will significantly affect the representative aquatic community.

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