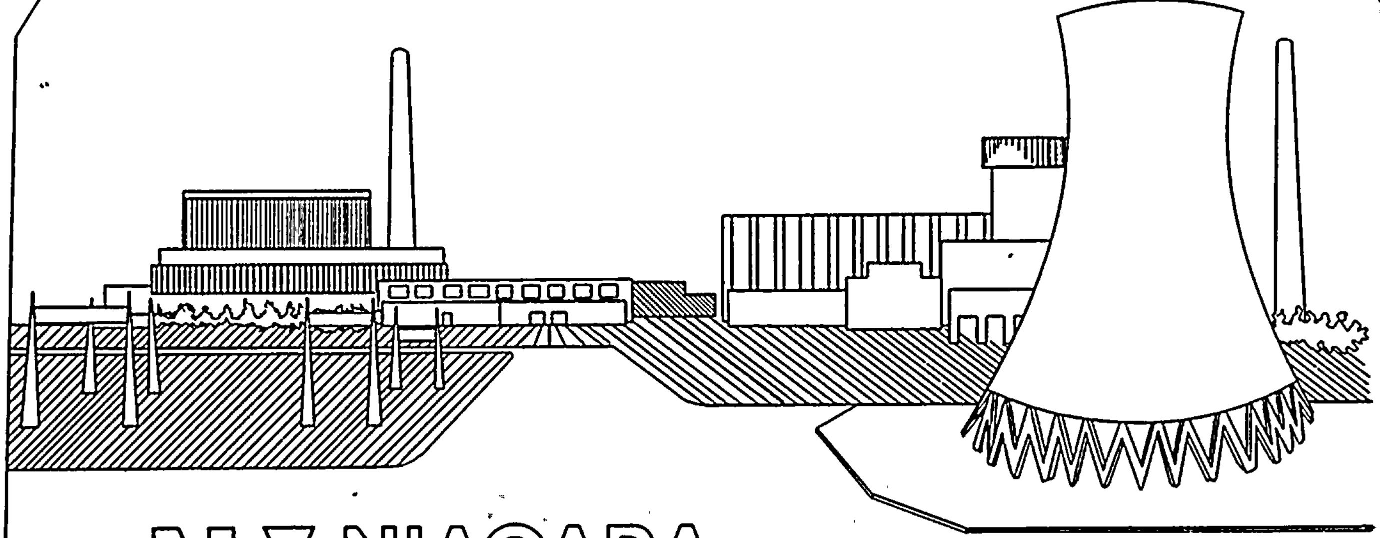
ENVIRONMENTAL REPORT

OPERATING LICENSE STAGE

NINE MILE POINT NUCLEAR STATION — UNIT 2



NIAGARA MOHAWK

SUPPLEMENT 8

Nine Mile Point

Nine Mile Point Unit 2 ER-OLS

50-410 Superseded per suppl. 8 to Environ Rept. OL Stage

INSERTION INSTRUCTIONS

Ltr Dtd. 2/8/85

VOLUME 1

M.M.

Remove	Insert
1.1-1/1.1-2	1.1-1/1.1-2
1.2-3/1.2-4	1.2-3/1.2-4
Table 1.2-1 (Sh 1 of 2)	Table 1.2-1
Table 1.2-1 (Sh 2 of 2)	---
1A-3/1A-4	1A-3/1A-4
2.1-1/2.1-2	2.1-1/2.1-2
Figure 2.1-2	Figure 2.1-2
Figure 2.1-3	Figure 2.1-3
Table 2.2-2	Table 2.2-2
2.3-11/2.3-12	2.3-11/2.3-12

INSERTION INSTRUCTIONS

VOLUME 2

Remove	Insert
Figure 2.10-1	Figure 2.10-1
3.1-1/3.1-2	3.1-1/3.1-2
---	3.1-2a/3.1-2b
Figure 3.1-1	Figure 3.1-1
Figure 3.1-2	Figure 3.1-2
3.5-3/3.5-4	3.5-3/3.5-4
3.7-1/3.7-2	3.7-1/3.7-2
3.7-3/3.7-4	3.7-3/3.7-4
4-1/4-2	4-1/4-2
5.1-1/5.1-2	5.1-1/5.1-2
5.2-1/5.2-2	5.2-1/5.2-2
Figure 5.2-1	Figure 5.2-1
Table 5.4-1	Table 5.4-1

INSERTION INSTRUCTIONS

VOLUME 3

Remove	Insert
6.5-17/6.5-18	6.5-17/6.5-18

INSERTION INSTRUCTIONS

QUESTIONS AND RESPONSES VOLUME

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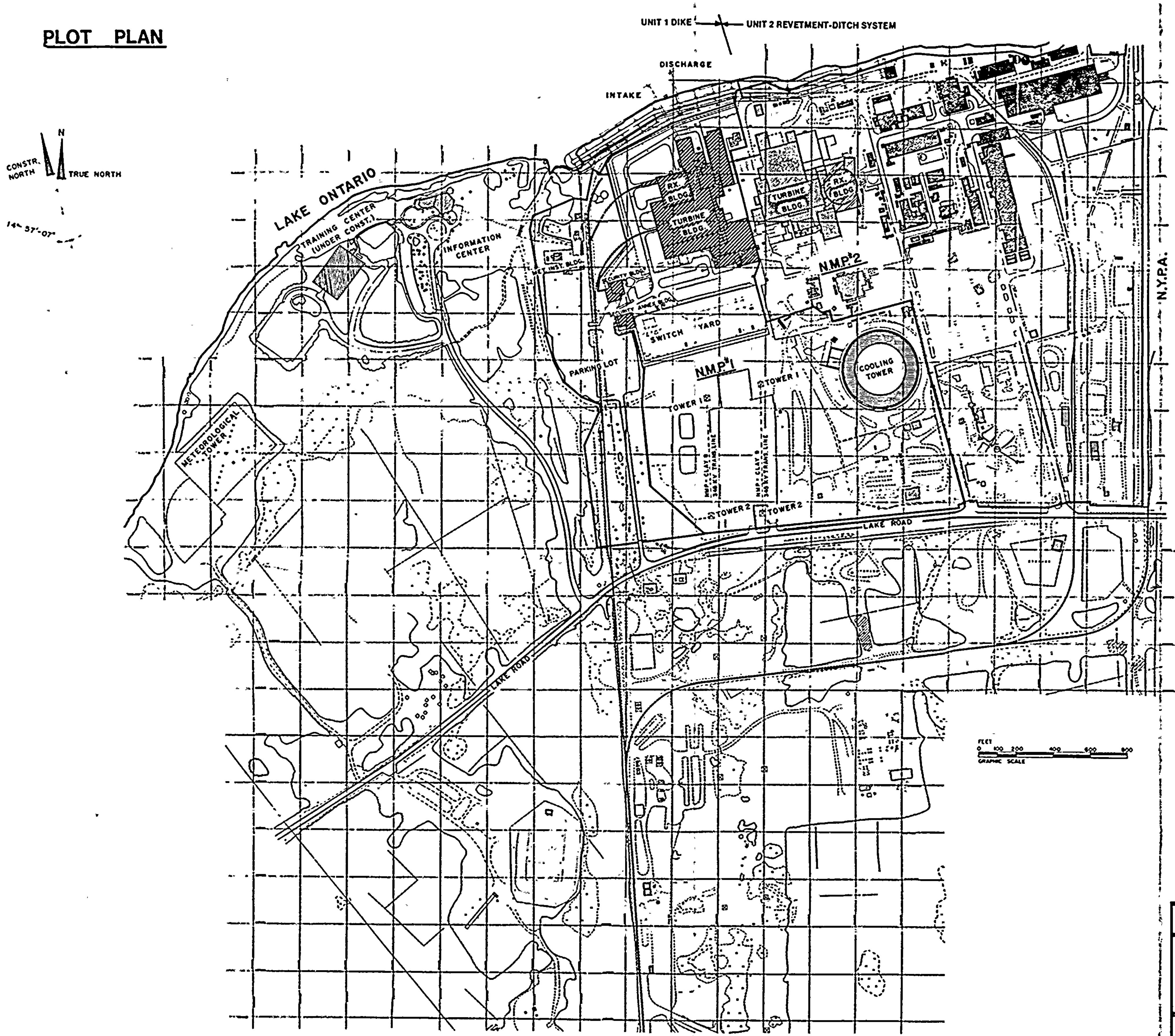

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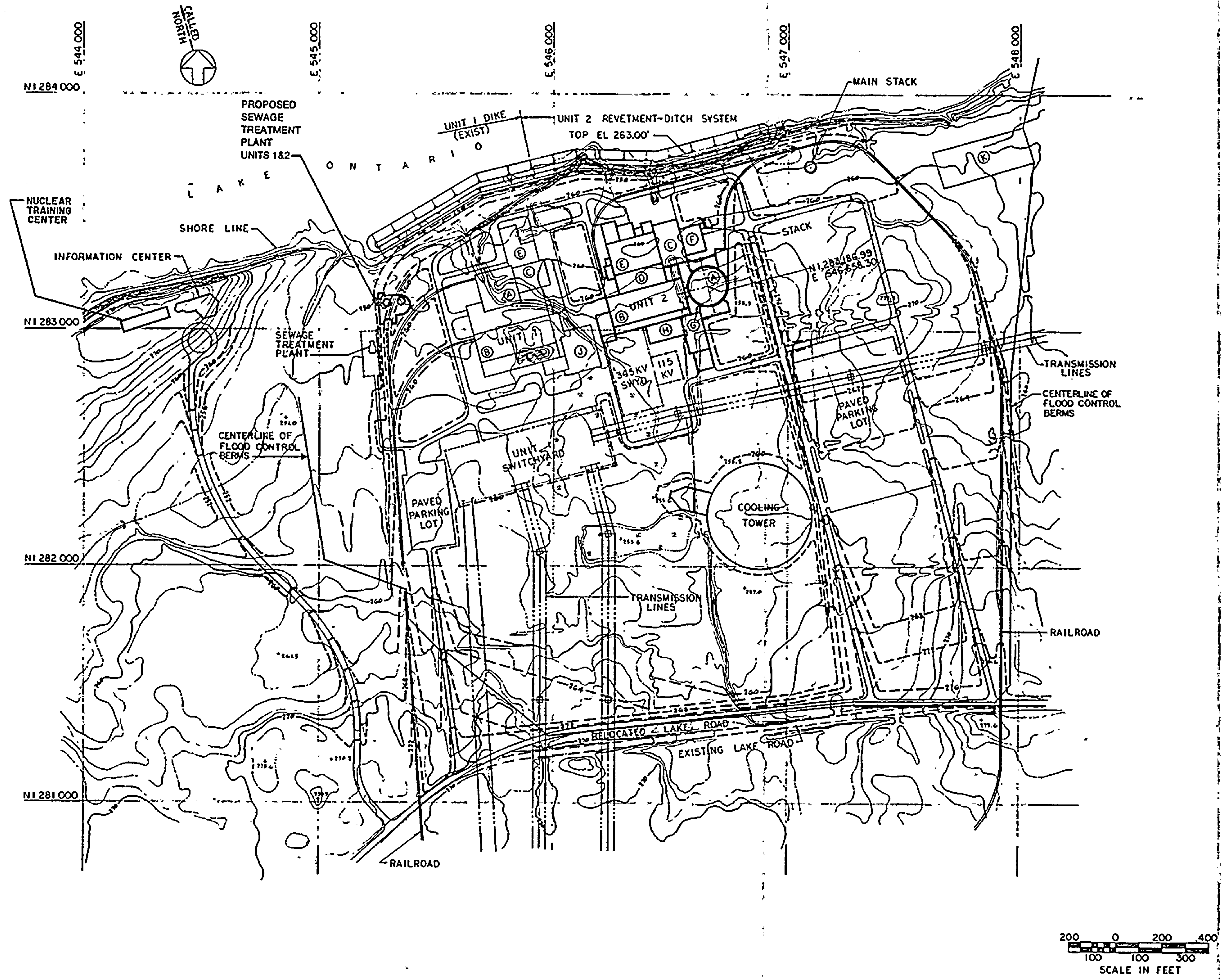
FIGURE 3.1-1

STATION LAYOUT

NIAGARA MOHAWK POWER CORPORATION
NINE MILE POINT-UNIT 2
ENVIRONMENTAL REPORT-OLS



IDENTIFICATION LEGEND

- A REACTOR BUILDING
- B TURBINE BUILDING
- C RADWASTE BUILDING
- D HEATER BAYS
- E SCREENWELL BUILDING
- F CONDENSATE STORAGE TANK BLDG
- G CONTROL BUILDING
- H NORMAL SWITCHGEAR BUILDING
- J ADMINISTRATION BUILDING
- K WAREHOUSE

LEGEND

- ORIGINAL GROUND CONTOUR
- NEW GROUND CONTOUR
- FENCE LINE

TI APERTURE CARD

NOTES

1. GRID COORDINATES REFER TO NEW YORK STATE COORDINATE SYSTEM
2. ELEVATIONS REFER TO MEAN SEA LEVEL
3. ORIGINAL CONTOUR INTERVAL - 2 FEET

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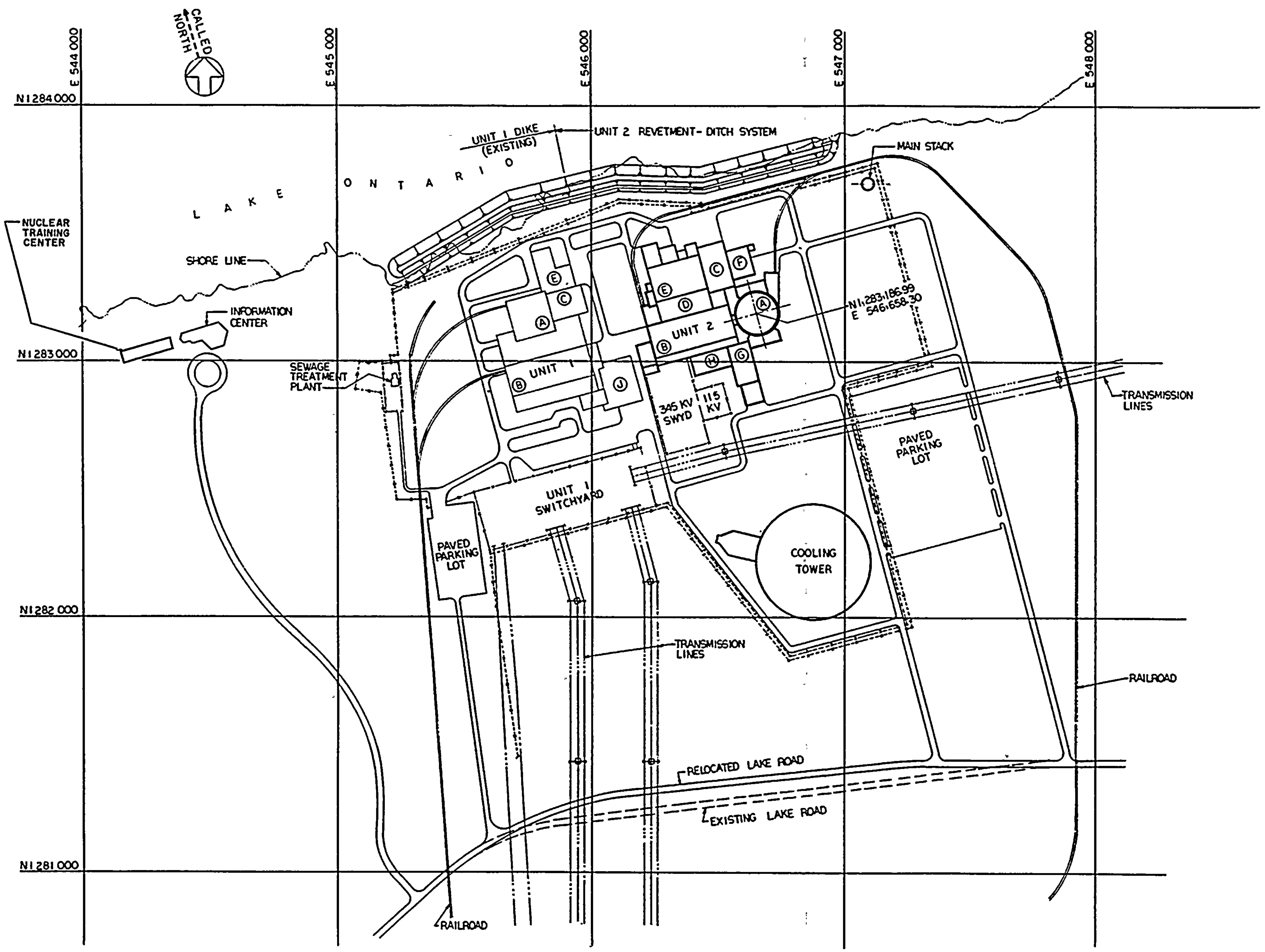
8502130203-02

FIGURE 3.1-2

SITE PLAN

NIAGARA MOHAWK POWER CORPORATION
NINE MILE POINT-UNIT 2
ENVIRONMENTAL REPORT – OLS



IDENTIFICATION LEGEND

- A REACTOR BUILDING
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- C RADWASTE BUILDING
- D HEATER BAYS
- E SCREENWELL BUILDING
- F CONDENSATE STORAGE TANK BLDG
- G CONTROL BUILDING
- H NORMAL SWITCHGEAR BUILDING
- J ADMINISTRATION BUILDING

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NOTES

1 GRID COORDINATES REFER TO NEW YORK STATE COORDINATE SYSTEM

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FIGURE 5.2-1

PLOT PLAN REVETMENT-DITCH

NIAGARA MOHAWK POWER CORPORATION
NINE MILE POINT-UNIT 2
ENVIRONMENTAL REPORT-OLS

5.3 COOLING SYSTEM IMPACTS

5.3.1 Intake System

5.3.1.1 Hydrodynamic Description and Physical Impacts

5.3.1.1.1 Hydrodynamic Description of Affected Area

Cooling water for Unit 2 is withdrawn from Lake Ontario through two hexagonal intake structures. Both intake structures are located at lake bottom contour, el 68.4 m (224.5 ft) (USGS 1935 datum); the west intake is approximately 290 m (950 ft) offshore, and the east intake is approximately 320 m (1,050 ft) offshore. The two intakes are approximately 120 m (400 ft) apart and located on the same bottom contour. The discharge structure is located approximately 146 m (480 ft) offshore of the west intake structure and 450 m (1,500 ft) from the existing shoreline. The locations of the intake and discharge structures are illustrated on Figure 3.4-2.

Each hexagonal intake structure has six intake openings 2.3 m (7.5 ft) wide by 0.9 m (3 ft) high, a 0.6-m (2-ft) roof thickness, and a 3.1-m (10-ft) clearance between the top of the structure and the lake surface at the mean low water level of 74.4 m (244 ft) (USGS 1935 datum). The width of each structure is 6.9 m (22.5 ft) between opposite openings. The total area of the 12 openings is designed to provide a maximum intake velocity approaching the bar racks of 0.15 m/s (0.5 fps) while drawing water through both structures. Section 3.4 provides a complete description of the cooling system and the expected flow rates for alternative operating modes.

5.3.1.1.2 Theoretical Framework of Mathematical Model

A mathematical model was used to simulate the nearfield and intermediate field velocity patterns in Lake Ontario resulting from the operation of the two intakes and one discharge at Unit 2.

The model calculates fluid flow streamlines, equipotential lines and velocity near the intakes, and discharge on the basis of steady potential flow. The intakes are treated as sinks of equal and steady strength and the discharge as a source of steady strength. The model is steady state, two dimensional, depth averaged, and does not account for friction.

The theory of potential flow states that any particle in two-dimensional fluid flow can be expressed as a complex potential [A(z)]. Complex flow patterns can be described by the superposition of flow or the addition of complex potentials.

For Unit 2 intakes and discharge:

$$A(z) = k_1 \ln(z-b) - k_2 \ln(z+a) - k_3 \ln(z-a)$$

Where:

k_1 = Strength of source located at b

k_2 = Strength of sink located at a

k_3 = Strength of sink located at -a

By differentiating the complex potential, the complex velocity is derived:

$$\frac{dA}{dz} = V_x + iV_y = \frac{k_1}{z-b} - \frac{k_2}{z+a} - \frac{k_3}{z-a}$$

Using the following substitutions and solving for the magnitudes of velocity (speed), V_x and V_y:

$$r_1 e^{iC_1} = z-b$$

$$r_2 e^{iC_2} = z+a$$

$$r_3 e^{iC_3} = z-a$$

$k_2 = k_3$ (both intakes have equal flow)

Where:

$$r_1 = \sqrt{(x+a)^2 + (y-b)^2}$$

$$r_2 = \sqrt{(x+a)^2 + y^2}$$

$$r_3 = \sqrt{(x-a)^2 + y^2}$$

$$C_1 = \text{Arctan}\left(\frac{y-b}{x+a}\right)$$

$$C_2 = \text{Arctan}\left(\frac{y}{x+a}\right)$$

$$C_3 = \text{Arctan}\left(\frac{y}{x-a}\right)$$

$$V_x = \frac{k_1 r_2 r_3 \cos C_1 - k_2 r_1 r_3 \cos C_2 - k_2 r_1 r_2 \cos C_3}{r_1 r_2 r_3}$$

$$V_y = -\frac{k_1 r_2 r_3 \sin C_1 + k_2 r_1 r_3 \sin C_2 + k_2 r_1 r_2 \sin C_3}{r_1 r_2 r_3}$$

The complex potential, A(z), describes equipotential lines and streamlines:

$$A(z) = B + iC$$

Where:

B = Function of (x,y) and describes the equipotential lines

C = Function of (x,y) and describes the streamlines

For the Unit 2 arrangement:

$$A(z) = k_1 \ln(z-b) - k_2 \ln(z+a) - k_2 \ln(z-a)$$

Substituting:

$$B = m = k_1 \ln r_1 - k_2 \ln r_2 - k_2 \ln r_3$$

$$C = n = k_1 C_1 - k_2 C_2 - k_2 C_3$$

Since the equations describing magnitudes of velocity, equipotential lines, and streamlines cannot be easily solved numerically, they are solved by the input of a series of x,y coordinates. The calculation of speed is direct for each

x,y; however, for equipotential lines and streamlines, the terms m and n are calculated. Then, by connecting various m and n, the equipotential lines and streamlines are drawn.

5.3.1.1.3 Streamlines and Velocity Distribution

The streamlines and velocity pattern near the intakes and discharge of Unit 2 were calculated by the preceding model using two lake conditions: no current and a 0.15 m/s (0.5 fps) west to east, alongshore current. Historical current data from the site are discussed in Section 2.3.1.1.4 and indicate that currents alongshore from the west-or-east are equally likely to occur and are the dominant currents at the site. The frequency of on- or offshore currents was low and, when present, at low velocities. Approximately 30 percent of the meter readings in the stated survey were below detection limits. West-to-east currents of 0.08 to 0.15 m/s (0.25 to 0.50 fps) occurred approximately 10 percent of the time during the survey. Stillwater condition (low to no current) represents the worst case for an intake/discharge, system since all velocities are induced by the intake/discharge and are not masked by local currents.

The intake/discharge flow model was run for one worst-case situation at high intake and discharge flow in January. The modeled flows are those presented in Table 3.3-1 for a January condition of minimum wet bulb. This case is perceived to be a worst case as it represents the highest discharge flow, a typically high intake flow, and the highest ratio of discharge to intake flow which will cause the highest interaction between the intakes and discharge.

Because the model is two dimensional, the intake/discharge flows are averaged over depth and input as a point source in a two-dimensional plane. Thus, the model describes the depth-averaged streamlines and velocities induced by the intakes and the discharge.

Since the intakes are hexagonal and draw water from all sides, the model's representation of the intakes as point sources is accurate, and with the exception of the immediate nearfield, the intake-induced velocities tend to be uniform with depth.

The discharge is designed to be a double-port diffuser aimed offshore, and the model does not simulate the momentum or directional component of the discharge. However, since the results of the discharge studies (Section 5.3.2.1) indicate that the discharge loses its momentum and initially mixes from top to bottom within 18 m (60 ft) of the diffuser, the

model represents the discharge at that location. By not moving the discharge to this virtual source point in the model, the model results are conservative, with more interaction between the intakes and discharge than in the prototype.

The input terms of the model are as follows:

$$
\begin{aligned}
a &= 59 \text{ m (195 ft)} \\
b &= 146 \text{ m (479 ft)} \\
Q_{intake} &= 3.44 \text{ cu m/s (54,525 gpm)} \\
Q_{discharge} &= 2.21 \text{ cu m/s (35,040 gpm)} \\
k_1 &= 0.0274 \text{ sq m/s (0.295 sq ft/sec)} \\
k_2 &= 0.0450 \text{ sq m/s (0.484 sq ft/sec)}
\end{aligned}
$$

The predicted streamlines with no lake current are illustrated on Figure 5.3-1. Velocity patterns are given on Figure 5.3-2. The directional component of the calculated speed was obtained from the streamlines. With no lake current, almost all streamlines in the area are directed into one or the other intake. The only streamlines not directed into the intakes are the offshore components of the discharge, although the paths of travel for many of the other discharge streamlines are very long before reaching an intake. The magnitudes of the velocities were less than 0.0015 m/s (0.005 fps) for all locations 61 m (200 ft) or more away from either intake or the discharge. The predicted velocities were slightly higher within 61 m (200 ft) of the source or sinks; however, within that region, the special features of the intakes and discharge play an important role and the velocities are not constant with depth as assumed by the model. If a mean velocity of 0.0018 m/s (0.006 fps) from the discharge to the intake is assumed, the shortest possible travel time is 20 hr, during which the plume will thoroughly dissipate by ambient dispersion and atmospheric heat transfer.

The predicted streamlines with a 0.15 m/s (0.5 fps) west-to-east lake current are shown on Figure 5.3-3. These streamlines illustrate that the lake current dominates the flow pattern even immediately near the intakes and discharge. The only noticeable effects of the intake/discharge are a very slight slant to the streamlines and minor deflections at the intakes and discharge. The velocity patterns are not presented because the magnitudes are all 0.15 m/s (0.5 fps), except very near the intake where a speed of 0.16 m/s (0.54 fps) was calculated. The intake/discharge-induced velocities are insignificant when compared to the lake current.

The results of the two model runs indicate that the Unit 2 intakes and discharge will have an insignificant effect on the natural velocity pattern in the area. Theoretically, some recirculation from the discharge to the intakes may occur at stillwater conditions; however, the travel time is long and considerable dilution will occur before reentry into the intake. With any significant lake current, the recirculation will be further reduced.

Because of the low induced velocities and minimal impact on the current patterns at the site, the operation of the intakes will not alter erosion of the shoreline, localized turbidity levels, or siltation patterns in the area.

5.3.1.2 Aquatic Impacts

The estimated impacts of entrainment of ambient water into the Unit 2 intake on each of the major biotic groups are discussed in subsequent sections. Since Unit 2 utilizes a closed-cycle cooling system, only the organisms diverted by the fish collection system are expected to survive entrainment into the power plant intake. Under average operating conditions, 27 percent of the total intake flow is returned through the fish diversion system.

5.3.1.2.1 Phytoplankton

The impact of entrainment cropping on phytoplankton was evaluated based on projected water flow into Unit 2, general water circulation in Lake Ontario, and reproduction times for plankton populations in lakes[1]. The general circulation patterns in Lake Ontario have been documented and were reviewed by Lawler, Matusky & Skelly Engineers (LMS)[2]. The predominant currents are alongshore, however, onshore and offshore currents also occur[3]. Thus, no parcel of water will be subject to entrainment for any length of time and no portion of the plankton community will be continuously cropped.

If a water body segment is assumed to extend east of Nine Mile Point and west of Oswego Steam Station (OSS) as described by LMS[2], the cropping due to either Unit 2 alone or Unit 2 in conjunction with the other plants located within this segment (JAF, Unit 1, and OSS) can be examined. This segment contains approximately 9.6×10^9 cu m (3.4×10^{11} cu ft) of water. The daily water intake for Unit 2 is approximately 3.3×10^5 cu m/day (1.2×10^7 cu ft/day), or 0.0034 percent of the volume of the water body segment per day. In a year's time, Unit 2 would withdraw only 1 percent of the volume of the segment if the segment were

not being naturally flushed by lake circulation and dispersion. When the turnover time of organisms in the water body segment is considered, the effect of entrainment cropping becomes negligible.

Data collected in the Nine Mile Point vicinity (Section 2.4.2.1) have indicated no long-term changes in the abundance or species composition of the plankton community that are attributable to the operation of the existing stations. The influence of Unit 2 is projected to be minimal because of the low volume of cooling water used. Since, on an annual basis, the plant will withdraw less than 1 percent of the volume of the surrounding water body for cooling, this small withdrawal rate, coupled with the potential for regeneration, leads to the conclusion that Unit 2 will have a negligible impact on the phytoplankton community[3].

5.3.1.2.2 Microzooplankton

As indicated in Section 2.4.2.1.2, seasonal abundance and species composition have been similar for microzooplankton for the last 6 yr. No major shifts in this community have been noted. In addition, analysis of spatial trends has revealed no consistent patterns in the abundance of zooplankters[3].

Based on the same rationale developed for phytoplankton in Section 5.3.1.2.1, the impact on microzooplankton will be small and probably not distinguishable from natural variability.

5.3.1.2.3 Macrozooplankton

To assess the projected impact of macrozooplankton entrainment by Unit 2, impact on Gammarus fasciatus, an amphipod selected as a Representative Important Species in the Nine Mile Point vicinity[1,4] (Section 2.4.2.1.3) is discussed. While numerically more abundant in the benthic collections, this epibenthic organism will be subject to entrainment only when present in the water column. Therefore, for discussion purposes, Gammarus is classified as a macrozooplanktor.

To assess the impact of plant entrainment on this species, estimates were made of the total number entrained into the plant. These estimates were compared to the calculated standing stock of Gammarus in the lake in the vicinity of the plant[3]. Since Unit 2 will have closed-cycle cooling, 100 percent mortality through the plant was assumed. Data collected during 1976 JAF entrainment studies were used[5].

Table 5.3-1 gives the results of the cropping calculations for two plant flow conditions, the projected mean and maximum plant flow at Unit 2. The estimated percent cropping is the percentage of the Gammarus standing stock[3] present in the water body segment removed by entrainment mortality.

Estimated percent cropping during either projected mean or maximum plant flow conditions was less than 0.5 percent of the population throughout each sampling period, except during January-February 1976. At this time, the increase in the estimated percent cropping resulted from the high January entrainment abundance. Since similarly high abundances were not detected during either the summer period of naturally high lake abundance or the following winter period, it is probable that the January 1976 estimate was an anomaly in the data and not representative of actual entrainment cropping during the month.

The results of the Gammarus entrainment cropping analysis clearly indicate that the projected numbers removed by entrainment at Unit 2 represent an extremely small percentage of the local population and that such mortalities would have a negligible effect on the population.

5.3.1.2.4 Ichthyoplankton

To assess the projected impact of plant entrainment on the ichthyoplankton community, data collected during entrainment studies at Unit 1 and the JAF plant have been utilized in conjunction with the results of the aquatic ecology studies presented in Section 2.4.2.

Nearly all species identified from the lake collections were also found during entrainment sampling at either Unit 1 or the JAF plant, and their temporal occurrence in the entrainment collections coincided with their occurrence in the lake[1,4-8]. Peak concentrations of eggs and larvae in the lake occurred during the late spring/summer period and were dominated by alewives and rainbow smelt (Section 2.4.2.1.4). Peak entrainment also occurred during this period, with alewife and rainbow smelt dominating the collections[1,4-8]. Rainbow smelt and alewife are the only two Representative Important Species of fish[1] collected in sufficient numbers during ichthyoplankton entrainment surveys to allow impact assessment.

The projected total numbers of alewife and rainbow smelt eggs and larvae entrained at Unit 2 were computed from the day/night abundance data from the regular 1976 entrainment

sampling program at Unit 1 and the JAF plant[3]. This data set was chosen since the JAF plant was shut down for refueling during the summer of 1977 and only limited analyses were conducted on 1978 data. The Unit 2 and the JAF plant data are considered to be representative of the intake abundance that will occur at Unit 2 since all the intakes are all at approximately the same depth contour. Since 100 percent mortality is assumed for the Unit 2 closed-cycle cooling system, no adjustment has been made for the fish diversion system flow. This flow normally represents 27 percent of the total flow withdrawn and would not be expected to incur 100 percent mortality to organisms entrained in it. However, since no studies have been made, the conservative approach, assumption of 100 percent mortality, has been taken.

The estimated total number of alewife eggs entrained per week at Unit 2 under projected average flow conditions was compared with the estimated number present in the adjacent segment of the lake during the same week[3]. The area of the lake chosen for comparison was a water body segment bounded by the extent of sampling (i.e., larval tows) which extends out to the 34-m (112-ft) depth contour and 5.8 km (3.5 mi) along the Nine Mile Point shoreline[3].

Table 5.3-2 lists the estimated percent of alewife eggs cropped by Unit 2 based on Unit 1 and the JAF plant entrainment and the estimated number of alewife eggs present in the water segment. As can be seen from the table, extremely low percentages of the weekly standing crops of alewife eggs are removed by entrainment. The overall seasonal cropping rates based on the Unit 2 flow rate and either the Unit 1 or the JAF plant entrainment data is 0.01 percent.

Since rainbow smelt eggs are demersal and adhesive and spawning in the Great Lakes occurs on stream bottoms or, under adverse weather conditions, in the offshore areas on gravel shoals (Section 2.4.2.1.6), their eggs are not usually subject to entrainment. Because the eggs are attached to the bottom, plankton tows or entrainment collections are not representative of the actual numbers available.

To attain a better concept of the entrainment egg abundances, the estimated total number of alewife and rainbow smelt eggs entrained was compared with the average fecundity of these species in Lake Ontario. The estimated total number of eggs entrained for each species was divided by the mean number of total eggs per female to determine the average number of females required to produce the eggs lost

to entrainment[3]. The results of these calculations indicate that the entrainment rate for Unit 2 based on the Unit 1 or the JAF plant results is equivalent to the fecundity of 2,200 or 3,400 alewives and about 23 to 91 smelts, a very small fraction of the population estimate[3].

Plant cropping estimates for alewife and rainbow smelt larvae were based on the same water body segment described for eggs as well as on an estimate of the lakewide larval standing crops of these species. A lakewide cropping estimate was developed because alewife and rainbow smelt are distributed throughout the lake and apparently use the entire shoreline for spawning. Fishery and impingement sampling at widely spaced locations on Lake Ontario on both the United States and Canadian sides has shown the alewife and rainbow smelt to be abundant at all locations[3].

Because the larval stage lasts more than 1 week, both weekly cropping estimates and total entrainment are compared with an average standing crop during the peak of larval abundance. This approach is conservative because the actual population present in the water body segment throughout the larval period is greater than the number present during the peak abundance period. Furthermore, because larvae living in the deeper portions of the lake were not accounted for in the computation of cropping rate, an additional conservative factor was added to the estimate.

The weekly cropping estimates for alewife larvae in the water body segment of interest ranged from 0 to approximately 4 percent (Table 5.3-3). Weekly cropping estimates for rainbow smelt larvae ranged from 0 to 10 percent (Table 5.3-4).

During their period of maximum abundance in the vicinity of Nine Mile Point (August 1 to September 4), alewife larvae had a mean weekly abundance of 143×10^6. Cropping percentages based on total alewife larvae entrained in 1976 were approximately 0.3 and 1.2 percent based on Unit 1 and JAF plant data, respectively (Table 5.3-3). Rainbow smelt larvae had a mean weekly abundance of 3×10^6 during the period of peak abundance (May 30 to July 17) in the vicinity of Nine Mile Point. Annual cropping percentages of approximately 0.1 and 0.4 percent based on Unit 1 and JAF plant data, respectively, were obtained from the estimated total number entrained during 1976 (Table 5.3-4). The conservative nature of this calculation should be emphasized in that the standing stock estimates do not account for the immigration and emigration of larvae to and from the water body segment[3].

Considering the demersal nature of the eggs of both alewife and rainbow smelt, a low percentage of cropping (less than 1 percent) of eggs is indicated. The egg cropping estimate, in terms of the number of average mature females required to produce the eggs lost (2,200-3,400 alewife and 23-91 smelt), indicates that this loss represents only a small fraction of the spawning potential of these populations[3].

Water body segment cropping of larvae, based on an average entrainment during the peak abundance period and conservative estimates of the population size during the same period, produced percentages cropped ranging up to 1.2 percent. These percentages are conservative estimates since only those larvae inside the 34-m (112-ft) depth contour were included and the assumption of 100 percent plant mortality increases the estimated cropping over that actually occurring.

The projection of plant cropping on a lakewide larval population basis is only a rough estimate. It is based on an average standing crop for only a small portion of the total potential spawning area, and it does not factor in additional sources of cropping within the system. The actual larval population density would be expected to vary significantly from place to place along the shoreline. However, the lakewide cropping estimates do provide a rough estimate for the lake as a whole, which is an important perspective for impact assessment. The lakewide cropping estimates attributed to Unit 2 are very low (0.02 percent)[3].

The combined cropping of eggs and larvae of alewife and rainbow smelt by the JAF plant and Units 1 and 2 will remove an undetectable amount of the reproductive potential of these populations[1]. The impact of Unit 2 alone will be immeasurable since projected cropping is more than an order of magnitude lower than cropping by the existing plants whose effects have been undetectable (Section 2.4.2.1).

5.3.1.2.5 Benthos

The degree to which the Unit 2 intake system interacts with the adjacent invertebrate communities is a function not only of flow rate and design characteristics of the plant but also of the nature of the organisms themselves. Of significance is the life history of each taxon under consideration. Some benthic forms, for example, pass their entire lives closely associated with the bottom, moving within (infauna) or upon (epifauna) the lake bottom. Others make transient use of the water column either for breeding, feeding, active swimming, or drifting with water currents.

Benthic species that utilize the water column are susceptible to power plant entrainment. During these life stages, their degree of susceptibility depends mainly upon their pelagic movement (near the surface, bottom, or throughout the entire water column) and swimming ability.

In considering intake system impacts, both direct and indirect effects are evaluated. Direct effects include entrainment of all life stages. Indirect effects may occur via attraction of nektonic predators to the intake area. If either type of interaction occurs, it is likely to be discernible near the existing Unit 1 intake where long-term monitoring at nearfield and farfield stations has continued during a 6-yr study period.

As reported in Section 2.4.2.1, benthic organisms near the intake of Unit 1 showed a variety of natural changes since the initial sampling in 1968 and during the 6 yr of intensive study. The key factors involved in these fluctuations, however, were natural environmental changes over time, climate, substrate nature, and organic content of the sediment. The data base described in Section 2.4.2.1 indicates typical benthic patterns over time and does not suggest adverse processes that were identifiable with the operation of the Unit 1 intake system[3].

Because of the large data base showing no impact on the benthic communities by the operation of Unit 1 intake, it is reasonable to expect no impact from the withdrawal of a lesser amount of water for Unit 2.

5.3.1.2.6 Fish

The impingement sampling data for Unit 1 and the JAF plant provide a basis for estimating the total annual entrapment by species at the Unit 2 intake. Because a fish diversion and return system was incorporated into the Unit 2 intake, only a fraction of the fish entrapped in the offshore intake will be impinged. The major portion of these fish will be returned to the lake. The studies of fish protection systems for Unit 2 and ongoing studies on a similar system at the OSS Unit 6 provide estimates of survival subsequent to passage through the diversion system. This information was used to estimate the mortality expected for selected species at Unit 2. A complete description of the diversion system is provided in Section 3.4.1.3.

The impingement rate for Unit 2 was estimated by extrapolating the impingement rates of Unit 1 to Unit 2 by the

ratio of the plant flows. This method assumes that the impingement rate is directly proportional to plant flow rate.

The Unit 1 impingement data were selected as the primary bases for extrapolation because there are 9 yr of continuous sampling as compared to only 6 yr at the JAF plant. The trend in both fishery and impingement sampling indicated cyclic trends in abundance of some species. Because the Unit 1 data cover a longer time than the JAF plant data, they better reflect the changing abundances of these species in the Nine Mile Point vicinity. In addition, the Unit 2 intake design is similar to the Unit 1 design and differs substantially from the JAF plant design.

The estimated impingement rate for Unit 2 assumes that the plant will operate all days of the year, because it is impossible to predict when plant outages will occur. This method will, therefore, produce an estimated total annual mortality greater than the actual one. The difference between the estimated total and the actual total will depend on the duration and seasonal occurrences of downtime. Extended downtime in early spring would have the most pronounced effect on the annual total because the spring peaks in alewife and rainbow smelt impingement would be eliminated.

The Unit 2 intake structure will incorporate a diversion system to return entrapped fish to the lake. This system was designed by Stone and Webster Engineering Corporation (SWEC), which conducted laboratory tests of diversion efficiency and survival of alewife after passage through the system. These tests indicated a test mortality rate of 11.8 percent and a control mortality of 7.8 percent[9]. Preliminary studies conducted by LMS on the OSS Unit 6 diversion system, similar in design to the Unit 2 diversion system, have demonstrated substantially lower alewife survival following passage through the system. The results of the Oswego studies indicate alewife survivals between 2 and 34 percent, with an estimated yearly survival rate of 9.6 percent[10]. The rainbow smelt, white perch, and spottail shiner estimated yearly survival rates were 13.1, 41.1, and 85.1 percent, respectively. The major game fish (brown trout, smallmouth bass, lake trout) collected from the system all demonstrated greater than 95 percent survival.

Since the LMS studies were conducted on an operating system as compared to the SWEC studies which were conducted on a laboratory scale, the results from the LMS Oswego studies will be used for this assessment. These results are believed to be conservative (effects are overestimated)

because no adjustments were made for control or handling mortality.

Table 5.3-5 contains the estimated monthly impingement and estimated yearly total number impinged for selected species at Unit 1[3]. Table 5.3-6 provides an estimate of Unit 2 entrapment, obtained by the multiplication of the Unit 1 total by 0.20, the ratio of Unit 2 to Unit 1 plant flows, and mortality, obtained by the multiplication of the number entrapped by the mortality observed from the Oswego diversion system[3].

The estimated mortality is low for all species except alewife, and when the alewife total is compared with annual impingement rates at other Lake Ontario power plants, the mortality at Unit 2 is estimated to be a very small contribution. The effects of impingement cropping at power plants on Lake Ontario were evaluated in the 316(b) demonstration for the JAF plant[1].

The analysis of the impact of removing a number of fish from a population can be addressed in many different ways. In this analysis, the removal of fish is related to such measures of population size as 1) lake standing stock estimates, 2) commercial fishing removals, 3) stocking statistics for the species, and 4) exploitation rates based on tagging studies.

The analyses of impingement cropping are presented separately below for the Representative Important Species identified by the EPA for the Nine Mile Point vicinity: alewife, rainbow smelt, white perch, yellow perch, smallmouth bass, coho salmon, threespine stickleback, and brown trout.

<u>Alewife</u>

Alewife standing stock estimates based on New York State Department of Environmental Conservation (NYSDEC) data[1] are presented in Table 5.3-7. These estimates are only for the near bottom waters where the trawl fished and are based on the assumption of 100 percent trawl efficiency. Edsall et al[11], in an analysis of the standing stock of alewives in Lake Michigan, concluded that only 3 percent of the fish (80-139 mm [3-5.5 in] long) taken in gill nets fished from surface to bottom in 26 fathoms were in the lower 12 m (40 ft) of water. They, therefore, used a factor of 10 to expand standing stock estimates, based on the assumption that only 10 percent of the fish were in the lower 1.2-2.4 m (4-8 ft) of the water column where the trawl fishes. In the

results presented, the alewife standing stock is estimated with and without the factor of 10 to show bottom-trawled standing stocks and the full water column estimate (adjusted standing stock).

This analysis is open to two possible sources of error, in addition to fish distribution in the water column and the assumption of 100 percent gear efficiency. First, the NYSDEC estimates extended only to the 110-m (360-ft) depth contour. Since these estimates represent 18 percent of the total New York State lake area, the standing stock estimates were divided by 0.18 for extrapolation to the total New York State lake area. This may result in an error if the total population estimate of the alewife is not uniformly distributed from shore to midlake.

Second, the average weight of the alewives collected by NYSDEC was 27.2 g (0.06 lb), while the average weight of impinged fish was 18.0 g (0.04 lb), indicating that a greater percentage of younger fish were present in impingement collections than were sampled by the trawl. The trawling program conducted by NYSDEC either did not collect young fish (young-of-the-year and yearlings) or natural mortality of these ages had occurred by the time of the trawling, and the average weight reflects the true average weight/individual of the remaining stock. The NYSDEC trawling program was conducted between October 18 and November 12 1976, late enough in the year so that mortality of young fish could have occurred, whereas impingement collections were conducted throughout the year. Thus, the NYSDEC stock estimate may not be representative of the populations affected by impingement; however, no stock estimates are available for other times of the year.

The former hypothesis that NYSDEC simply did not collect young fish is supported by several observations. Smith[12] stated that young alewives reside in the water column off the bottom for at least the first year of life. NYSDEC stated that many targets were observed with hydroacoustic equipment in the upper water column at the time of the surveys in the Rochester area. Wells[13] found alewives in the water column throughout the year in Lake Michigan. It appears, therefore, that the trawling conducted by NYSDEC would result in an underestimate of the true standing stock since a large portion of the population would be above the bottom waters sampled by the trawl. This is additional evidence supporting the use of the multiplier to estimate total standing stock from bottom trawls. The evidence on alewife distribution in the water column, the weight differential between impinged and netted fish, and the assump-

tion of 100 percent gear efficiency all support the use of the stock adjustment.

The estimated yearly impingement mortality at Unit 2 was divided by the NYSDEC standing stock estimates to determine alewife impingement cropping. The cropping effect of Unit 2, 0.20 percent, is extremely small for the Oswego sector and even smaller for other designated areas of the U.S. waters of Lake Ontario (Table 5.3-7). The cropping estimates for Unit 1 based on its once-through cooling system are included in this table to contrast Unit 2 which has a fish diversion system. For the preceding reasons, these estimates of cropping are considered conservative.

Rainbow Smelt

The NYSDEC forage fish standing stock estimate included an estimate of the rainbow smelt stock. The standing stock data derived in this section were calculated in the same manner as the alewife data. The results, therefore, are subject to the same conservative approach as the alewife results. The rainbow smelt mortality at Unit 2 was estimated to represent 0.12 percent, an extremely small percentage of the estimated standing stock in the Oswego sector and other designated areas of the U.S. waters of Lake Ontario (Table 5.3-7).

White Perch

Storr[14] tagged a total of 1,421 white perch in the Nine Mile Point vicinity from 1972 to 1976, of which 488 were tagged in 1976. Only one tagged white perch was recovered in the JAF plant impingement collections (April 1977) with no tag returns observed at the Nine Mile Point plant. Since annual mortality rates for tagged white perch were not computed, it is impossible to determine the total number of tags available at the time of the recovery in 1977. But with an assumed 50 percent mortality rate and only those fish tagged during 1976 considered, an exploitation rate of 0.82 percent would result after adjustment for impingement sampling frequency. The lack of any tagged fish in the Unit 1 impingement studies, which have been ongoing since 1973, indicates that impingement cropping of white perch is negligible.

A total of 20,525 kg (45,249 lb) of white perch were harvested by commercial fishermen from New York State waters of Lake Ontario during 1976[15]. If an average weight of 32.4 g/fish (0.07 lb/fish) (from 1976 impingement at the JAF plant)[1] is assumed, a total of 633,487 fish were

harvested. The average Unit 1 impingement during the period 1973 through 1981 amounted to 6,666 fish. Thus, impingement was 1.0 percent of commercial fishing. The Unit 2 mortality rate is projected to be 0.12 percent of the commercial catch in 1976. The available data indicate that impingement cropping is minimal when compared with available fish in the area or commercial fishing pressure.

Yellow Perch

An exploitation rate was calculated based on the number of tagged fish recovered in impingement collections compared to the number of tagged fish available in the lake. Although yellow perch tagging began in 1972, no tagged yellow perch were recovered in impingement collections at either the JAF plant or Unit 1 prior to 1976. During 1976, two tagged fish were recovered at Unit 1 and one at the JAF plant. Since sampling at both plants took place on 43 percent of the days during 1976, the total estimated number of returns is calculated to be five fish and two fish at Unit 1 and the JAF plant, respectively.

An estimated 1,232 tagged yellow perch were available in 1976. The seven fish impingement estimate for Unit 1 and the JAF plant combined then represents an exploitation rate of 0.57 percent of the available tagged yellow perch. When compared to an average exploitation rate of 7.41 percent[14], based on other fishing efforts (total tag returns), the impact of impingement is negligible. Based on the total number of yellow perch impinged during 1976 (3,695) and the New York State commercial catch of 23,841 kg (52,560 lb)[15], which represents 478,000 fish based on an average weight of 49.8 g/fish (0.11 lb/fish), impingement at Unit 1 and the JAF plant during 1976 represented 0.77 percent of the commercial harvest. Compared to other sources of mortality, impingement at Unit 1 and the JAF plant is insignificant. The Unit 2 impingement based on 1976 statistics would represent less than 0.01 percent of the commercial harvest.

Smallmouth Bass

Storr[14] has tagged 126 smallmouth bass since 1972, but none have been collected from the traveling screens at Unit 1 or the JAF plant through December 1981. Since the majority of these fish were tagged and released in the immediate vicinity of the two intakes, the lack of any recoveries in impingement collections would indicate that the plants do not have a significant effect on the local smallmouth bass population.

No commercial catch statistics are available for smallmouth bass, so comparisons to commercial harvest were not possible; however, Storr has had 19 tags returned of the total of 126 smallmouth bass tagged. These tags, for the most part, were returned by commercial and sport fishermen, and an exploitation rate of 15.1 percent can thus be attributed to commercial and sport fishing combined. Therefore, based on the lack of any tag returns in impingement collections, cropping by the power plants would be at least an order of magnitude less than that by fishing mortality.

Coho Salmon

Coho salmon do not occur naturally in Lake Ontario, but are stocked by various state and federal agencies. Thus, the only population size data available are from stocking statistics. Impingement at Unit 1 and the JAF plant and estimated impingement at Unit 2 are therefore compared to stocking conducted by NYSDEC.

The estimated total impingement of coho salmon from 1976 through 1981 at Unit 1 and the JAF plant was 10 fish[3]. NYSDEC stocked approximately 1,753,000 coho from 1975 through 1980[3]. The 10 fish impinged at the two plants represent an insignificant portion of the fish stocked during this period and the fish return system on Unit 2 will return any salmon inadvertantly entrapped in its cooling water flow.

Threespine Stickleback

Since no standing stock or tagging data are available for the threespine stickleback, impingement cropping rates cannot be calculated. However, the large cycles of population abundances exhibited by this species noted in Section 2.4.2 and indicated in the impingement data demonstrate that the population is regulated by other factors (weather, predation, fecundity, or inherent behavior) which far override the localized effect of impingement cropping.

Brown Trout

The brown trout is not native to North America but was introduced into New York during the 19th century. Recently, Lake Ontario stocks have been maintained by New York and Canadian stocking programs. Therefore, cropping at Unit 1, the JAF plant, and Unit 2 is compared to New York State stocking statistics.

An estimated 256 brown trout were impinged from 1976 through 1981 at Unit 1 and the JAF plant[3]. NYSDEC stocked 1,881,000 brown trout from 1975 through 1980[3], and impingement cropping therefore represents less than 0.02 percent of the stocked fish. Unit 2 represents a small addition to this estimated cropping.

Endangered Species

Table 2.4-16 provides a list of the fish species classified by NYSDEC as endangered or threatened. Only three of the species (longjaw cisco, shortnose sturgeon, and blue pike) reported at one time in New York State or the Great Lakes were listed by the U.S. Fish and Wildlife Service (FWS) as endangered or threatened. Of the 15 species on the New York State list, eight are found in areas outside of Lake Ontario. While the remaining seven species have been reported from Lake Ontario by various researchers over the 6
years, either their behavior or low numbers have precluded all but the lake chubsucker (*Erimyzon sucetta*) from the 9-year lake sampling program or the impingement sampling at Unit 1 or the JAF plant.

A single lake chubsucker was collected during the summer of 1975 in a seine haul conducted at the mouth of the Salmon River, approximately 5 km (8 mi) east of the Nine Mile Point vicinity. This species typically prefers a shallow weedy habitat except during spawning when it will move into small streams. Thus, based on their behavior, entrapment of lake chubsucker at the proposed Unit 2 off-shore velocity cap intake is not anticipated.

The literature on the general biology of the endangered species in Lake Ontario and the fishery sampling at Nine Mile Point indicates that this area is not of unique importance to these species. A recovery of the populations now in low abundance may be possible in the future for some species. The biological requirements of these species are such that the effects of power plant operation at Nine Mile Point would not prevent the recovery of these species if other factors were favorable.

Summary of Impingement Impact

The preceding analyses indicate that the total annual mortality at Unit 2 is expected to be very low for all species. This mortality relative to various measures of abundance in the vicinity of Nine Mile Point indicates that plant effects will be insignificant at the population level. Previous analyses[1,16,17] have indicated that the impingement crop-

ping due to the operation of three major power plants at the eastern end of Lake Ontario has a minimal effect on fish populations. Because the cropping at Unit 2 is an extremely small increment of mortality, the conclusions of the previous analyses are not changed when Unit 2 mortality is added to the existing effect. This is also true for the conclusions of an analysis of the lakewide effects of cropping which included all operating power plants on Lake Ontario[1].

5.3.2 Discharge System

5.3.2.1 Thermal Description and Physical Impacts

5.3.2.1.1 Hydrothermal Description of Affected Area

The Unit 2 discharge consists of cooling tower blowdown flow, service water bypass flow, and waste treatment system and liquid radwaste discharge flow which pass through a 1.4-m (4.5-ft) diameter pipe within one of the Unit 2 intake tunnels. The pipe emerges from the lake bed at a point approximately 450 m (1,500 ft) from the existing shoreline, where the discharge flow enters a 1.4-m (4.5-ft) diameter steel riser leading to a two-port diffuser located on the lake bottom. Section 3.4 provides a complete description of

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the cooling system and its expected flow rate and associated temperature rises for different operating conditions.

The discharge consists of a two-port diffuser, each 0.5 m (1.5 ft) in diameter, off a common header with a horizontal angle of 120 deg between the ports (Figure 5.3-4). Each port is located 1.1 m (3.8 ft) above the lake bottom and angled 5 deg up to reduce jet contact with the bottom, which could result in local scour. The centerline submergence of the ports at the point of discharge is 10.7 m (35.2 ft), relative to the minimum controlled lake level (el 74.4 m [244.0 ft]).

To evaluate the performance of the discharge system, maximum surface temperatures and associated dilution factors were computed for a range of total discharge flows and associated temperature rises. The range was selected to include normal seasonal operating modes as well as low probability extreme conditions.

5.3.2.1.2 Theoretical Framework of Mathematical Model

The theory of submerged discharges indicates that effluent dilution is dependent on the exit densimetric Froude number, relative port spacing, and relative submergence of the discharge when momentum and buoyancy forces dominate the plume dynamics. The Froude number represents the ratio between the discharge inertial force and buoyancy and is given by:

$$F = \frac{V}{\sqrt{g \frac{\Delta\rho}{\rho} D}}$$

Where:

V = Exit velocity

D = Port diameter

G = Gravitational acceleration

$\frac{\Delta\rho}{\rho}$ = Density difference of the effluent relative to the ambient water

Relative port spacing is the ratio of the port centerline spacing to the port diameter; relative submergence is the ratio of the port centerline submergence to the port diameter.

A complete analysis of the trajectory, the extent (length, width, area), and the temperature distribution of the jet plume system must consider all of the following factors:

1. Hydrodynamics of the lake (velocity field and ambient turbulence).

2. Lake geometry (depth, bottom roughness, and local topography).

3. Ambient temperature distribution in the vicinity of the discharge.

4. Effluent characteristics (flow rate, density differences from ambient lake water, and discharge velocity).

5. Discharge port characteristics (location, orientation, submergence, size and shape of outlets, number and spacing of ports).

Koh and Fan applied an integral method in solving the differential equations of mass, momentum, and energy conservation under various assumptions encompassing the preceding factors[18]. The mathematical model developed by these investigators for a row of equally spaced round jets discharging at an arbitrary angle of inclination to the horizontal has subsequently been used to generate standard nomograms published by EPA[19]. The nomograms can be used to predict the surface temperature rises and nearfield temperature distributions resulting from either single or multiple submerged discharge jets. The temperature rise distribution between the discharge and the point of jet surfacing is determined by the densimetric Froude number, the relative submergence, and the relative port spacing of the discharge system.

Robideau introduced the concept of the effective depth of dilution to the theory of submerged jets[20]. Briefly, Robideau's analysis indicates that, depending on the relative submergence and the exit Froude number, dilution of the jet occurs over only some portion of the full depth of submergence since the overlying surface plume precludes dilution of the effluent in the surface layer. Thus, Robideau's effective submergence leads to more realistic predictions than those of Koh and Fan.

The main thrust of Robideau's formulation is the consideration of the finite water depth in limiting the available supply of ambient water for dilution.

"The jet is deflected upward, or toward any boundary, because the water available for jet entrainment is not unlimited. This results in the creation of vortices in the ambient fluid and an associated decrease in pressure."[20]

Therefore, Robideau's approach was to assume a surface impingement, or surface mixing region, in which there is no further dilution of the jet. In order to present a synopsis of his analysis, the two primary zones of jet flow are defined. The region in the immediate vicinity of the discharge is called the zone of flow establishment and extends from point o to point e (Figure 5.3-5). In this region, the velocity and temperature distributions undergo a transition from the profile of turbulent flow through a port to the Gaussian distribution which characterizes a free jet. In the zone of established flow, which begins at point e, the jet is unaffected by boundaries and is treated as if it were in an infinite environment until it enters the surface mixed region at point c. This mixing region constitutes a control volume over which the equations for the conservation of mass, momentum, and energy are written in integral form. These equations are combined with the description of the jet in the zone of established flow to give the maximum surface temperature resulting from a submerged jet with various discharge conditions and water depth.

One of the basic assumptions in the analysis is that no further dilution of the jet by ambient water occurs in the surface mixed region. Because the control volume is a mixing region, the surface temperature there is necessarily higher than the average temperature of the incoming plume flow, but less than the maximum temperature. To ensure conservative results in the analysis presented here, this mixing was not considered. It was assumed that the maximum surface temperature is the same as that on the jet centerline as it enters the control volume at point c. From Figure 5.3-5 it can be seen that point c is a relative distance y_C above the discharge. The jet is diluted as it rises to y_C, but the remaining distance, $h-y_C$ (where h is the dimensionless water depth), provides no further reduction in the jet temperature.

The algorithm developed by Robideau departs from the classical formulations of jet plume dilution by substituting a polynomial distribution for the assumed Gaussian velocity distribution of velocity in the plume.

Gaussian : $\bar{u} = ue^{-(r/b)^2}$

Polynomial: $\bar{u}' = u' [1-(r/r_m)^2]^2$

Where:

$\bar{u}$ and $\bar{u}'$ = Centerline velocity for Gaussian and polynomial distributions

r = Coordinate normal to the round jet centerline

r_m = Maximum radius of the round jet with polynomial distribution

b = Local round jet nominal radius Gaussian distribution

The polynomial expression is a very close approximation of the Gaussian and, in fact, agrees with the experimental data just as well, or better, than the Gaussian form. This key mathematical substitution enables a numerical solution of the velocity and temperature over depth based on the discharge characterized according to its Froude number. The plots of the ratio of the effective depth for dilution, y_c, to the actual depth, h, versus the discharge Froude number, F_o, for various dimensionless depths, h, have been verified by comparison among the dilutions 1) measured in hydraulic model studies[21] and in recent thermal surveys[2], 2) predicted according to Robideau's effective depth of dilution, and 3) predicted with the use of the total submergence rather than its effective submergence. When the depth correction is not included, predicted dilutions are greater than those actually measured.

Because these experimental data agreed with Robideau's findings and a conservative design was desired to ensure compliance with standards, the depth correction presented by Robideau was used to predict the temperature distributions resulting from the Unit 2 discharge.

5.3.2.1.3 Isotherms and Velocity Vector Data

Maximum surface temperature rises for a range of plant operating conditions and temperature distributions in the nearfield submerged plume were predicted for the most severe operating conditions. Given the low potential impact of the small volume Unit 2 discharge and the high dilution achieved by the diffuser in the nearfield region, complex modeling of temperature distributions beyond the nearfield is not necessary. This is consistent with the NRC guidelines, which state: "Where the thermally affected discharge will

be relatively small and have low ecological impacts, only simple methods of analysis using conservative assumptions need be applied."

The results of the surface temperature rise predictions are given in Table 5.3-8, along with the associated discharge conditions and plant operating conditions. The detailed description of worst-case conditions is provided in Section 3.4. Worst-case discharge conditions were based on the maximum cooling tower evaporation and the maximum cooling tower blowdown temperature differential during summer and winter conditions. An annual average condition was also modeled.

Two worst-case conditions were modeled because discharge parameters and factors affecting dilutions vary. The winter case (March) has the worst discharge conditions of highest temperature rise and lowest exit velocity; however, the cold ambient temperatures allow for a less buoyant plume. The summer case (July) has the highest temperature rise during the summer months when the ambient temperature is 21°C (70°F) or higher and near lowest flow (August worst flow was 1.635 cu m/s [25,954 gpm] vs July's 1.637 cu m/s [25,984 gpm]). The summer ambient temperatures will have a more buoyant plume which should surface quicker with less dilution.

The use of Robideau's findings to predict the surface temperature rises required a slight alteration of his procedures. Because of the Unit 2 discharge design and flow rates, the modeled conditions had Froude numbers of 68.4 (annual), 42.2 (summer), and 60.6 (winter), which were significantly higher than the maximum Froude number (30) used in his study. Since the dilution increases with an increasing Froude number, a conservative alternative procedure was selected; i.e., use a Froude number of 30 for all conditions with higher Froude numbers. The result of this alternative procedure is that the predicted dilution of the discharges with higher Froude numbers (annual and winter) are lower than may actually occur. Even with these conservative estimates, the predicted maximum difference in the surface temperature is only 1.3°C (2.3°F).

The impact of the alternative procedure on effective depth is not as clear as with dilution. According to Robideau, increasing Froude numbers (in the range of 0 to 30) will decrease the effective depth. However, it is unlikely that this relationship would continue with Froude numbers higher than 30; most likely the curve will level off at a set effective depth. The changes in effective depth have no im-

pact on the dilution calculations and may be noticeable only in the predicted temperature distributions.

As indicated in Table 5.3-8, the initial discharge temperature rise is diluted in excess of 10:1 for all discharge conditions, and surface temperature rises are thus all less than 1.3°C (2.3°F). The dilution is achieved in the nearfield and thus will not vary with meteorological conditions.

Since maximum surface temperature rises are less than 1.3°C (2.3°F) under all operating conditions, the discharge is in full compliance with New York State surface temperature criteria governing Lake Ontario as described in Sections 704.2 and 704.3 of the New York Codes, Rules, and Regulations and does not require the allowance of a surface mixing zone.

The effects of the worst-case discharge conditions on lake temperatures were further evaluated by predicting the distribution of temperature rises in a vertical section through the centerline of each discharge jet. The computational method for determining the temperature distribution in the nearfield is based on various relationships described in the literature. Previous studies[4] have indicated that the dilution of temperature along the centerline of the plume outside the zone of flow establishment is proportional to the centerline distance raised to some power, a.

$$\frac{T(S)}{T_o} = \frac{k}{S^a}$$

Where:

$T(S)$ = Surface temperature

T_o = Discharge temperature

S = Centerline distance

k = Constant

a = Constant

The solution of this equation yields the temperature rise with distance along the centerline of the plume. To determine the shape of the isotherms in the vertical plane, the nomograms developed by Shirazi and Davis[19] have been employed since the Robideau analysis does not explicitly

describe the plume shape. The Shirazi and Davis analysis is based on a normal or Gaussian distribution of temperature with perpendicular distance from the centerline. Figures 5.3-6 through 5.3-8 show the cross-sectional distribution of temperature rises in a typical jet under the three modeled conditions with no ambient lake current. The rapid dilution of the discharge in the submerged nearfield zone of the plume and the small size of the zones affected by the higher temperature rises are evident. Based on the predictions in Figure 5.3-8, the winter worst-case initial discharge temperature rise of 15.6°C (28.0°F) will be diluted by 2.8:1 to 5.5°C (10°F) within 3.7 m (12 ft) of each discharge port, and by 5.6:1 to 2.8°C (5.0°F) within 11 m (36 ft). Under other, less critical discharge conditions with higher velocities and lower discharge temperature rises, dilution in the submerged jet will be increased, reducing the zones bounded by the higher isotherms.

It should be noted that this temperature distribution plot shows dilution over the entire water column, whereas the Robideau approach does not credit any dilution in the upper mixing region. A more detailed submerged plume prediction following Robideau's type of analysis would predict broader (less elongated) isotherms with more rapid centerline dilution. The volume of water entrained by the plume in either model is comparable. Consequently, the model used does not substantially alter the cross-sectional area encompassed by the isotherms, as illustrated on Figures 5.3-6 through 5.3-8.

Abramovitch has shown that velocity in the nearfield plume must decay along the centerline at least as rapidly as temperature[22]. If velocity and temperature in the nearfield plume are assumed to decline at approximately the same rate, velocities and turbulence would both be greatest when the temperature rise is greatest in the nearfield. Table 5.3-9 lists the predicted plume velocities for selected isotherms.

In summary, the temperature distribution resulting from the Unit 2 discharge complies with applicable Lake Ontario water quality standards, and temperature rises in excess of 1.7°C (3.0°F) are predicted to be confined to a small submerged region in the immediate vicinity of the discharge structure. The submerged nearfield regions subjected to higher temperature rises are also associated with high velocity and turbulence levels. The thermal effects of the discharge beyond the immediate discharge vicinity are minimal because of the low temperature rises

(0.5°C and 1.0°C [1.0°F and 2.0°F]) and relatively low volume of discharge.

The minimal farfield surface temperature effects, combined with the offshore orientation of the discharge, serve to minimize the potential for recirculation of any measurable portion of the plume through either of the inshore submerged intake structures. The buoyancy of the plume tends to restrict it to the upper levels of the water column, whereas the intakes draw from the lower levels.

The high velocities of the initial discharge jet may cause some local benthic scouring of fine sediment where the bottom of the jet contacts the lake bottom. However, the upward orientation of the discharge ports and the relatively low discharge flow serve to minimize the extent of bottom scour. Based on the prediction of submerged plume size, the scoured area will extend, at most, approximately 45 m (150 ft) from the discharge structure with deposition occurring on the periphery. Although the benthic community in the scoured area would be disrupted, the small area involved would not have a significant adverse impact on the benthic community as a whole.

5.3.2.1.4 Interaction With Other Discharges

As described in Section 3.4, the Unit 2 discharge is located between the two existing thermal discharges of Unit 1 and the JAF plant.

While the initial discharge temperature rise for the three discharges is similar, the Unit 2 discharge flow rate is between 6 and 13 percent of the flow rate of either Unit 1 or the JAF plant.

Because of its extremely low volume of discharge (compared with that of Unit 1 and JAF plant discharges) and the submerged high velocity mode of discharge, the Unit 2 discharge will have little thermal effect beyond its immediate discharge area. The Unit 1 and JAF plant discharges, however, can exert a thermal effect at greater distances from their respective discharges, and therefore may affect temperatures at the lake surface in the vicinity of the Unit 2 discharge. Thus, the greatest effect of plume interactions would occur in the immediate vicinity of the Unit 2 discharge when natural lake conditions cause the plume from either the Unit 1 or the JAF plant discharge to be in the vicinity of the Unit 2 discharge. Since the predominant currents in the area are alongshore in either an easterly or westerly direction and the Unit 2 discharge is between the Unit 1 and the

JAF plant discharges, it is improbable that both discharges would interact simultaneously with the Unit 2 plume.

Section 2.3.1.1.6 describes the Unit 1 and JAF plant plumes. Temperature elevations associated with the Unit 1 plume have not exceeded 6.0°C (11.0°F) at the surface. The JAF plant plume is even more diluted than that of Unit 1 and has a lower temperature elevation.

When either the Unit 1 or JAF plant plume is in the vicinity of the Unit 2 discharge, it will be confined by its buoyancy to the upper half of the water column, usually the upper 2.1 m (7 ft). The method used to predict the surface temperature rises from the Unit 2 discharge alone includes dilution of the jet only in the lower half of the water column and assumes no dilution from mixing with upper layers. Therefore, the presence of a surface plume in the vicinity of the Unit 2 discharge will not alter the conservatively predicted surface temperature rises at the point of plume surfacing.

Any interaction between the Unit 2 plume and either the Unit 1 or the JAF plant plume will involve the mixing of the Unit 2 surface plume, after jet surfacing, with the surrounding surface plume. The temperature rises resulting from the mixing of the two plumes must necessarily be between the temperature rises in the separate plumes prior to mixing.

When the surface temperature rises resulting from the Unit 2 discharge are less than or equal to the temperature rises in the surrounding plume, the result of the interaction of the plumes will be to reduce the higher temperature rises in the plume of the existing station. This results from mixing with the cooler Unit 2 plume and increased mixing with underlying ambient waters caused by turbulence in the combined plume. The Unit 2 discharge will contribute to the volume of the combined plume contained within the lower temperature rise isotherms; however, the contribution based on the relative discharge flow between Unit 2 and the JAF plant or Unit 1 will be less than 10 percent.

When the portion of the Unit 1 or JAF plant plume that interacts with the Unit 2 plume has temperature rises less than the Unit 2 surface temperature rise, the result will be an area of slightly increased temperature rises within the combined plume. Even with the increase, however, the surface temperature rise will not exceed the maximum previously described for Unit 2 alone, since the required dilution will occur in the lower portion of the water column.

In general, the local effect of interactions between the Unit 2 and either the Unit 1 or JAF plant plumes will be to increase local mixing and produce temperature elevations no greater than those from the existing plumes or the predicted maximum temperature effect of Unit 2 alone, whichever is greater. Given the variations present in plume sizes that occur from naturally variable meteorological and ambient lake conditions and the relatively small contribution of the Unit 2 discharge, the overall effects of plume interaction will be negligible and most probably undetectable.

5.3.2.2 Aquatic Impacts of the Discharge

5.3.2.2.1 Benthos

Potential sources for discharge impacts on benthic communities include temperature-induced mortality of sessile organisms, plume entrainment of semiplanktonic forms, and scouring of the bottom habitat. For the most part, benthic organisms remain closely associated with the lake substrate and are not usually subjected to thermal elevations because the plume is buoyant. After initial mixing, a neutrally buoyant or sinking plume may develop during the winter. In addition, many benthic species burrow into and live in the sediments, which further protect them against plume-related thermal effects. Studies at other power plants have shown that plume-induced elevations in water temperature near the substrate are not transmitted through the sediments[23].

Local scour and subsequent deposition will be limited to the nearfield. As described in Section 5.3.2.1, the scour area is projected to be within 45 m (150 ft) of the outfall. Any impacts of scouring to benthos will be limited to this area.

Based on the analysis of 6 yr of benthic data collected near the Unit 1 discharge and at a control transect, as well as a year of collection at the JAF plant, no measurable effect was demonstrated on either species assemblages or abundances as a result of operations[2,3,5]. None would be expected at Unit 2 which, because of its smaller volume, has a lower potential for causing impact.

5.3.2.2.2 Plankton

Plankton generally exhibit limited mobility and will become entrained into the thermal plume. Entrainment can affect the organisms in several ways. Thermal effects include inhibition or stimulation of metabolic processes and mortality. Effects caused by increased turbulence can include physical damage and redistribution of planktonic or-

ganisms within the water column. Effects resulting from chemical composition include acute and sublethal toxic actions and synergistic effects of the chemicals with temperature.

Because Unit 2 has a closed-cycle cooling system, the discharge waters will be devoid (or nearly so) of live plankton. The consequences of this may be a reduction in plankton standing stocks in the immediate vicinity of the discharge; however, as a result of mixing of discharge waters with lake water and the patchy nature of planktonic communities, this localized reduction is not expected to be observable. This potential effect applies to all types of plankton; the remainder of this discussion will focus on phyto-, zoo-, and ichthyoplankton separately.

The effect on plume-entrained phytoplankton will most likely result in an alteration of metabolic processes observable as a change in primary productivity. Depending upon season or ambient temperatures, individual species may be either stimulated or inhibited, but the overall effect will be small. Studies to determine the effect of plume entrainment on phytoplankton conducted at JAF from 1976 through 1979 confirmed this[5,7,8,24]. The results of these studies are presented in a summary report prepared by LMS[3].

Studies conducted by LMS and Texas Instruments, Inc. (TI) at JAF to determine the effects of plume entrainment on zooplankton survival also indicated little or no effect[5-8,24]. In general, the survival of zooplankton collected in the intake and subjected to plume simulation studies in the laboratory and those collected at the 1.1°C and 1.6°C (2°F and 3°F) isotherms in the lake was within the range observed for intake organisms, indicating that the greatest mortality was probably a result of collection and handling procedures.

LMS reviewed the literature regarding plume entrainment of zooplankton[3]. The general conclusion was that there was no lasting or permanent effect of entrainment on resident zooplankton communities. The thermal tolerance of <u>Gammarus</u> sp. was also reviewed, and, based on the available data, their survival is expected to be high even if <u>Gammarus</u> is entrained near the discharge ports and exposed to the full effects of the discharge plume[3].

The effects of plume entrainment on ichthyoplankton were studied at the JAF plant during 1976, 1977, and 1978[5,7,8]. Live larvae were obtained and survived the simulation

process, demonstrating that fish larvae can survive the plume temperatures expected from the Unit 2 discharge.

In order to further evaluate the impact of the Unit 2 plume on ichthyoplankton, the available literature on thermal effects was reviewed[3]. In general, these studies provided conservative estimates. Eggs and larvae were exposed to temperature increases for a minimum of 30 min. At the JAF plant, an organism entrained exactly at the point of discharge is exposed to temperatures 5°C (9°F) above ambient for less than 2 sec for the worst-case condition, and the time is less at Unit 2. In general, the cited studies found that a 10°C (18°F) increase did not affect survival, while a 15°C (27°F) increase resulted in less than 50 percent mortality. Since these studies were done for exposure periods that were substantially longer than expected at Unit 2, it is anticipated that plume entrainment at Unit 2 will have a minimal effect on survival of eggs and larvae.

In summary, discharge impacts of Unit 2 on plankton communities are expected to be minimal. These conclusions are further supported by the aquatic ecology studies conducted for Unit 1 and the JAF plant from 1972 to 1978, which showed no measurable reductions in plankton numbers nor alterations in temporal patterns in the thermally influenced area as compared to the control areas. Based on this 6-yr data base and the relatively small flow rate being discharged by Unit 2 as compared to Unit 1 and the JAF plant, the thermal discharge is expected to have a minimal impact on the plankton communities.

5.3.2.2.3 Nekton

Thermal discharges can affect populations both directly, through individual contact, and indirectly. Indirect effects result from an interaction of the discharge with other potentially stressful conditions or from an ecosystem imbalance initiated through direct effects.

Fish can voluntarily swim into the plume or be entrained into it. The temperature distributions in the plume indicate a sharp temperature gradient caused by the rapid dilution produced by the high velocity discharge[3]. Therefore, the likelihood of a fish intentionally experiencing the full ΔT by swimming into the plume is very remote. Only those few fish entrained near the discharge ports will experience the highest temperatures, and the exposure period will be on the order of only a few seconds. Analysis of laboratory-derived critical thermal maxima (CTM) indicates that some mortality could occur at the highest acclimation

temperatures (20°C-25°C [68°F-77°F]) for fish that experience the full 15.6°C (28°F) ΔT[3]. However, as discussed in a summary report prepared by LMS, CTMs are determined by raising temperature until equilibrium loss occurs[3]. Fish entrained into the thermal plume experience a brief exposure to a high temperature followed by a rapid decline as the plume mixes with lake water. During the brief exposure, the fish's body temperature will not reach equilibrium with ambient, and it can be postulated that the temperature at which adverse effects will occur is higher than the laboratory CTM.

LMS analyzed the available data on swimming speeds in fish and on predicted plume velocities and determined that most species could voluntarily maintain themselves in the area of 30 cm/s (0.98 fps) water velocity during the summer months when their swimming ability is at a maximum[2]. Temperature increases of 1.5°C (2.7°F) above ambient are expected in this area. Upper incipient lethal levels for all species of concern at low to moderate ambient lake temperatures are well above temperatures in the 30 cm/s (0.98 fps) area of the plume[3]. Summer lethal thresholds for smallmouth bass, yellow perch, white perch, spottail shiner, threespine stickleback, and young-of-the-year alewife are also above the plume temperatures under consideration.

Behavioral characteristics of other selected species will tend to keep them away from the discharge area during the period of warm ambient temperatures. Brown trout, coho salmon, and rainbow smelt are cold-water species that normally reside in the cool waters of the lake depths during the summer months. Adult alewives, which are less tolerant of high temperatures than young-of-the-year alewives, also move to the cool waters[2].

Sublethal effects that could result from a thermal discharge include alterations in the reproductive cycle, changes in growth, and changes in feeding patterns. Alterations to the reproductive cycle could be manifested as delays in spawning or reduced numbers of eggs. Changes in growth and feeding could affect one another and both could precipitate changes in the reproductive cycle. No alterations attributable to operation of the existing plants have been detected in the fish community (Section 5.3.1.2).

In conclusion, the data indicate that operation of existing plants has not measurably affected the fish populations of Lake Ontario, and the relatively small addition of heat of Unit 2 is not expected to have a significant impact.

5.3.2.3 Plant Shutdown

Mortality of aquatic life due to cold shock, i.e., abrupt exposure of organisms acclimated to a warm effluent to very low ambient temperatures, has occurred at a number of power plants. The small size of the Unit 2 discharge plume limits the potential for residency. However, some fish and benthic species may become acclimated to the discharge plume outside the high velocity (and turbulent) area. In the event of a Unit 2 shutdown, the temperature at the Unit 2 outfall would return to the slightly elevated temperatures (0.5°C-1.0°C [1°F-2°F]) produced by the Unit 1 or the JAF plant plume. Fish would then seek out their preferred temperature within the existing plumes. Because of the dynamic nature of the plume (constantly moving due to changing wind and current), fish residing within the plume must regularly change position to remain at their preferred temperature. Benthic organisms experience elevated temperatures only in the near-field where the plume contacts the substrate. In this area, the organisms would either acclimate to the changing temperatures or burrow into the substrate.

Simultaneous shutdown of all three units is very unlikely. A minimum of one plant would be operating and provide a zone of elevated temperature throughout the winter months for any acclimated residents to the discharge area. Therefore, the potential for mortality due to cold shock resulting from a Unit 2 shutdown is minimal.

5.3.3 Heat Dissipation System

5.3.3.1 Heat Dissipation to the Atmosphere

The natural-draft cooling tower is the only significant source of plant effluent capable of affecting local meteorology and terrestrial ecology. The following sections present a discussion of fogging, icing, drift, humidity, and their impact on local weather and ecology. These impacts are also addressed in an NRC report on the cooling tower at Unit 2[25].

5.3.3.1.1 Predictions of the Following Impacts for the Affected Site and Vicinity Locations

5.3.3.1.1.1 Additional Amounts of Ground-Level Fogging and Icing and Transportation Impact

Ambient air becomes heated and moisture-laden when induced through the natural-draft cooling tower. This air is discharged from the tower as a plume which may be occasionally

visible. The frequency of visible plume occurrence and its extent depend on the meteorological conditions existing at the time and the design and physical parameters of the tower.

A mathematical model, using as input simultaneous observations of wind speed, wind direction, ambient dry-bulb temperature, ambient wet-bulb temperature, and relative humidity, is used to determine the configuration and extent of visible plumes from the natural-draft cooling tower at Unit 2. Onsite meteorological data for the period January 1, 1974, through December 31, 1976, are used for the visible plume predictions. The mathematical model used in this analysis is described in detail in FSAR Appendix 2C.

The results of these model predictions are illustrated on FSAR Figures 2.3-1 through 2.3-25, which depict the frequency of occurrence of various plume extents in each of the four primary wind direction quadrants for each season of the year and for the entire 3-yr period. These contours do not represent individual plume outlines but the combination of many individual plumes, to show the maximum horizontal and vertical extent of the visible plume for each given frequency of occurrence. The visible plume rarely (<0.2 percent) descends below heights of 91 m (300 ft) above ground, as can be seen on FSAR Figures 2.3-1 through 2.3-25. In addition, more than 90 percent of the time, the plumes do not extend beyond 1,370 m (4,500 ft). The plume remains aloft because it is initially injected into the atmosphere at a height of 165 m (541 ft) with an exit velocity of 3-6 m/s (10-20 fps) and is buoyant because its temperature exceeds that of the ambient air. Occurrences of visible plumes below the height of the tower are due to strong winds and the associated tower-induced turbulence in the wind field. As can be seen on FSAR Figure 2.3-25, less than 1 percent of the visible plumes fall below the tower height at a distance of 762 m (2,500 ft) or greater.

Based on the modeling results and the fact that the nearest airport is over 16 km (10 mi) from the Unit 2 site, it is expected that air traffic will be unimpeded by the cooling tower plumes. Furthermore, in a comprehensive study conducted at the Chalk Point Generating Station, it was concluded that the natural-draft cooling tower plume posed no hazard to aircraft in terms of flight visibility, turbulence, or icing to structures and engines[26].

Since the visible plume rarely descends below heights of 91 m (300 ft) above ground and does not impinge the ground surface, it will not contribute to ground fogging or icing.

In addition, ground icing due to cooling tower drift was assessed and found to be of little consequence. This conclusion was based on the results of the modeling analysis presented in Section 5.3.3.1.1.2, in which a maximum annual surface accumulation of water due to drift was estimated to be 0.08 mm (0.003 in). Assuming that this entire accumulation of water occurred during freezing conditions, it is still an insignificant amount compared with a light ice storm, which is defined as one that deposits less than 2.5 mm (0.1 in) of ice per hour[27]. Therefore, impacts to highway or lake traffic are not expected.

5.3.3.1.1.2 Annual and/or Monthly Amount of Drift Deposition in g/sq m or Drift Concentration in mg/cu m

A mathematical model is developed to determine the downwind distribution of salt, the water deposition, and the concentration of airborne salt resulting from cooling tower operation. A detailed description of the model and results are contained in FSAR Appendix 2D. The model takes the following into account:

1. Configuration and performance of the tower.
2. Drift rate.
3. Exit velocity.
4. Total dissolved solids (TDS) level.
5. Droplet size distribution.
6. Evaporation rate.
7. Plume buoyancy.
8. Wind speed.
9. Wind direction.
10. Wet-bulb temperature.
11. Relative humidity.

The amount of drift leaving the cooling tower is assumed to be 0.002 percent of the circulating water flow through the tower. This number is less than that guaranteed by the cooling tower manufacturer, and in fact even lower drift rate percentages may be achieved. Monthly average TDS

concentrations in the blowdown and 3 yr of onsite, hourly average meteorological data (January 1, 1974, through December 31, 1976) are used as input to the salt drift model.

The meteorological input data used in the model consist of wind speed, wind direction, dry-bulb temperature, wet-bulb temperature, and relative humidity at the 61-m (200-ft) level. The difference between the dry-bulb temperatures at 61 m (200 ft) and at 8 m (27 ft) (ΔT) is also used. Normally, the low level relative humidity would be used to determine tower performance, but due to the large amount of missing data for this parameter, the upper level relative humidity is chosen. A comparison of the relative humidities at these two levels shows an average difference of only 4.6 percent, which has little effect on the salt drift model results. The results of a sensitivity test of the drift model to relative humidity, using 1 month (December 1974) of meteorological data, show an 11-percent decrease in the maximum salt deposition rate and an 8.7-percent decrease in the maximum water deposition rate by using the 61-m (200-ft) relative humidity in place of the 9.1-m (30-ft) relative humidity.

There is also a substitution of the 31-m (100-ft) wind direction when the 61-m (200-ft) wind direction is missing to ensure that a high percentage of data is used. This practice does not significantly affect the salt drift results because of the very small changes in wind direction with height between these levels.

6 Salt deposition is the depositing on the ground of all solids dissolved in the cooling tower drift droplets which are larger than 50 microns in diameter. Predicted average annual salt deposition rates in lb/acre/yr are shown on FSAR Figure 2.3-26. The maximum salt deposition rate is predicted to be 0.03 g/sq m/yr (0.27 lb/acre/yr), occurring approximately 2,000 m (6,562 ft) northwest of the tower. This location is over water. The maximum salt deposition
6 rate predicted to occur over land is 0.011 g/sq m/yr (0.099 lb/acre/yr) at a distance of approximately 990 m (3,248 ft) west-southwest of the tower. FSAR Figure 2.3-27 presents annual water deposition rates in lb/acre/yr, with a maximum value of 77.4 g/sq m/yr (690.6 lb/acre/yr) occurring 2,000 m (6,562 ft) northwest of the tower. This amount corresponds to 0.08 mm (0.003 in) of water per year. Predicted average monthly salt deposition rates in lb/acre/yr are shown on FSAR Figures 2.3-28 through 2.3-39. Monthly and seasonal water deposition rates are not shown because the maximum annual amount of 0.08 mm (0.003 in) is insignificant

compared to annual precipitation at the site of over 76 cm (30 in).

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In addition to the drift deposition rates, airborne salt
concentrations at ground level are calculated. This
concentration is the sum of the suspended particle
concentration and the settleable particle concentration.
The latter is calculated by dividing the deposition rate of
a certain particle size class by the final fall velocity of 6
the median droplet size in that class. The airborne
concentration at each grid point is then the sum of the
contributions of each depositing size class to that grid
point. The maximum annual average airborne salt
concentration is predicted to be 0.83×10^{-6} mg/cu m
(5.18×10^{-14} lb/cu ft) at a distance of 2,400 m (7,874 ft)
northwest of the tower. The highest value over land is
predicted to be 5.6×10^{-7} mg/cu m (3.50×10^{-14} lb/cu ft) at 6
1,067 m (3,500 ft) south of the tower. A value of 1.22×10^{-3}
mg/cu m (7.62×10^{-11} lb/cu ft) is predicted for the maximum
hourly airborne salt concentration which occurs at a
distance of 500 m (1,640 ft) west-northwest from the tower.
The maximum hourly airborne salt concentration over land is
predicted to be 1.19×10^{-3} mg/cu m (7.43×10^{-11} lb/cu ft) at a
distance of 1,067 m (3,500 ft) west-southwest of the tower.

5.3.3.1.1.3 Cloud Development and Cloud Shadowing

The extent to which natural-draft cooling tower plumes contribute to cloud formation can be qualitatively assessed based on observational studies conducted at three operating, natural-draft cooling tower sites[28]. At each of these sites, cooling tower plumes were observed to occasionally cause broken cloud decks to become overcast and to make thin clouds thicker. Separate cloud formations were sometimes observed to result from visible plume formation from the cooling towers but usually at altitudes of several thousand feet above ground. Therefore, the potential for increased cloud development due to cooling tower operation appears to be minimal compared to the potential for development due to natural causes.

The impact of plume shadowing depends highly on the extent and duration of visible plume formation. The results of the analysis presented in Section 5.3.3.1.1.1 provide a quantitative assessment of the configuration and frequency of occurrence of visible plumes resulting from the operation of the Unit 2 tower. FSAR Figure 2.3-25 indicates that any shadowing effects of the visible plumes on the region would be very localized, since less than 10 percent of the plumes extend beyond 1.6 km (1 mi) from the tower. Likewise, the infrequent occurrence of plumes longer than 1.6 km (1 mi) would most likely be on naturally cloudy days, which would not contribute to shadowing. Therefore, it is highly

unlikely that cooling tower plume shadowing would have an adverse impact on any offsite locations.

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5.3.3.1.1.4 Weather Modification in Terms of Increased Precipitation

The natural-draft cooling tower at Nine Mile Point could create an insignificantly small increase in precipitation, primarily during the winter months. Sufficient research and field data are now available to rule out the triggering of violent storms such as thunderstorms or squalls.

Observations of precipitation falling from natural-draft plumes are very limited. Kramer and Seymour have documented one observation of light rain falling from a natural-draft cooling tower plume and several observations of light snowfall(29). Though it may be possible for a cooling tower to modify the precipitation pattern immediately downwind of the tower, it will not alter the total precipitation in the region, as the water vapor emissions from the tower are small compared to natural fluxes(30).

During the winter of 1975-1976, Kramer et al observed light snow from several different cooling tower plumes on 10 separate days(31). Furthermore, only light, fluffy snowfall has been observed in studies of natural-draft cooling tower plumes associated with power plants of a size similar to Unit 2. These events have been of short duration, and the area affected by the precipitation has been confined to the region under the visible plume. None of these occurrences took place during the agricultural season.

Though little is known about the actual precipitation mechanisms causing the snowfall, it was found to occur only during stable atmospheric conditions with temperatures below -12°C (10°F) at the height of the plume centerline. These observations have been theoretically substantiated by Koenig(32).

While studies of actual natural-draft cooling tower plumes have not documented any cases of the plumes triggering a thunderstorm or squall, the potential for a cooling tower plume to trigger such an event has been analytically considered. Hanna has compared the energy produced by natural phenomena such as thunderstorms and Great Lakes snowsqualls and found that the energy produced by these phenomena is 10 to 10,000 times the energy released by a wet cooling tower at a 1,000-MW generating station(33). Such effects require concentrated heat releases in a small area, substantially larger than those from the Unit 2 cooling tower.

Since Lake Ontario is a large source of local weather modifications along its shores, the effect of the cooling tower is minuscule in comparison. The lake creates very large variations in the amounts and frequency of precipitation so that changes associated with the tower plume should be impossible to measure.

5.3.3.1.1.5 Humidity Increase

The amounts of moisture emitted from cooling towers not only contribute to visible plume formation but also may increase ambient ground-level relative humidities, even if the plume remains aloft. In order to evaluate the potential augmentation of ambient relative humidities due to cooling tower operation, a mathematical diffusion model, which incorporates tower-specific information and onsite meteorological data, is developed. A detailed description of this model is provided in FSAR Appendix 2E.

The model described in FSAR Appendix 2E is utilized to determine relative humidity increases due to the operation of the Unit 2 natural-draft cooling tower. Using tower-specific information on evaporation rate and other performance characteristics, along with local topographic information, the model is run with a 3-yr onsite meteorological data base (1974-1976) to arrive at long- and short-term increases in relative humidity as a function of distance and direction from the tower. The results of this model run are presented in Table 5.3-10, which contains maximum hourly, daily, monthly, and annual average increases in ground-level relative humidity for each 22.5-deg sector from the tower. This table also includes the average ambient diurnal changes in relative humidity at the site as a basis for comparison. The maximum 1-hr relative humidity increase of 3.3 percent points out the insignificant impact of the cooling tower when compared with the diurnal fluctuations of relative humidity, as shown in FSAR Appendix 2B. The reason for such a small increase can be related to the large discharge height of the cooling tower (165 m [541 ft]), which allows the moisture to effectively disperse before reaching the ground. Therefore, no significant humidity changes are expected from this cooling tower.

5.3.3.1.1.6 Interaction of the Heat Dissipation System Plume With Existing Pollutants

The chemical interaction of the natural-draft cooling tower plume with any local industrial pollutant plumes in the vicinity of Nine Mile Point should have a negligible impact on the environment. Both research and literature indicate

that the merging of natural-draft cooling tower plumes with nearby fossil or industrial plant plumes produces no detrimental effects.

Quantitative field studies performed by Pennsylvania State University at Keystone and Bowen Power Plants and by the Chalk Point Cooling Tower Project support this conclusion, as do qualitative studies sponsored by American Electric Power Service Corporation at five fossil-fuel power plant sites (Amos, Gavin, Muskingum, Big Sandy, and Mitchell)[34-37]. The absence of any published reports on adverse effects in Cooling Tower Environment (1974 and 1978) indicates that as of 1978, there were no known or measured impacts from the merging of natural-draft cooling tower plumes with associated fossil or industrial plumes[38,39]. Furthermore, a summary by Argonne National Laboratory of the atmospheric impacts of evaporative cooling systems concludes that the lack of reported significant adverse impacts caused by the merging of stack and cooling tower plumes suggests that the effects of merging are of minor importance[30].

All sources of chemical plumes are located more than 2.0 km (1.3 mi) from the natural-draft cooling tower, including the nearest fossil-fuel plant, which is 11 km (7 mi) away. Merging of these plumes or entrainment of an industrial or fossil-fuel plant plume into the cooling tower plume is a remote possibility. Since plume merging requires that one source be directly downwind of the other and that the plumes be at the same altitude, and since the predicted frequency of cooling tower plumes greater than 1.6 km (1.0 mi) in length is less than 10 percent of the time annually, the merging of plumes should be extremely infrequent.

5.3.3.1.2 Unusual Heat Dissipation System Impacts

There are no anticipated heat dissipation system impacts other than those described in Sections 5.1.1, 5.1.3, 5.3.3.2, and 5.8.1. Unusual impacts of drift emissions and blowthrough, such as discoloring or corrosion of plant structures, transmission line interruption or station outage due to salt buildup on switchyards or transmission line insulators, or damage due to ice buildup on transmission lines or structures, are very unlikely. The use of freshwater (solids concentration of about 400 ppm) as makeup to the cooling tower and the significant emission height (165 m [541 ft]) of drift and water vapor result in very low solids deposition rates and water vapor concentrations at ground level (Section 5.3.3.1.1), precluding the occurrence of such impacts. In addition, operating experience with freshwater

natural-draft cooling towers has not shown any of the unusual impacts previously described.

5.3.3.1.3 Mitigating Actions

Due to the extremely minor nature of the atmospheric impacts associated with the heat dissipation system, as described in Section 5.3.3.1.1, no mitigating actions are required for this system.

5.3.3.1.4 Summary of Unavoidable Adverse Impacts

The results of the atmospheric impact analyses of the heat dissipation system, as described in Section 5.3.3.1.1, indicate that there are no significant unavoidable adverse impacts associated with this system.

5.3.3.2 Impacts to Terrestrial Ecosystems

5.3.3.2.1 Induced Icing on Vegetation

Vegetation in the Nine Mile Point region is commonly subjected to natural icing (FSAR Section 2.3.1). It is expected that the cooling tower will not induce icing (Section 5.3.3.1.1.1), and no significant damage to local vegetation is expected.

5.3.3.2.2 Effects of Chemical Discharges on Vegetation

Operation of the natural-draft cooling tower at the site will result in the release of water droplets containing dissolved solids, including concentrations of sodium (9 percent), calcium (17 percent), chloride (19 percent), and sulfate (44 percent) ions (Table 3.6-1). The emission of these droplets (i.e., salt drift) represents a source of potential impact to terrestrial ecosystems.

Salt injury of woody plants has been attributed to chloride (Cl^-) and sodium (Na^+) ions[40,41]. The exact mechanism of plant injury due to these ions has yet to be established; however, vegetative shoot content of Cl^- is considered to be a reliable index of the degree of salt injury[42]. In general, the greater the amount of Cl^- in tissue, the more rapid the onset of damage and the more severe the injury[40,43].

Data for the Cl^- levels in tissue of injured plants are often extremely variable because of species specificity, plant part sampled, time of sample collection, and analytical techniques[43]. In addition, plant survival in saline soils

does not automatically imply survival where salt is applied to the foliage[40]. Thus, any assessment of potential salt drift injury must include considerations of the effects due to the accumulation of salts in the soil and the effects due to deposition of airborne salts, either as particulates or in solution, on plant foliage.

Soil Salinization

In the presence of high concentrations of soluble salts in the rooting zone of plants, uptake of water and nutrients by the plants may be restricted. Moreover, in some plants, the absorption of saline constituents may result in a damaging or lethal accumulation of a particular ion. Sublethal accumulation of soluble salts may also inhibit growth and productivity of plants.

Factors that appear to be most important in tolerance of plants to salts in the soil are climate, soil permeability (including various soil chemical and physical parameters), plant genetics, physiology, and pathologic responses[44-52]. High surface runoff or appreciable rainfall and good soil permeability increase the rate at which most salts are carried or leached from the soil. Toxic accumulation is less likely under these conditions.

From the standpoint of soil salinization, no appreciable impact resulting from operation of the natural-draft cooling tower is anticipated either for vegetation at the Unit 2 site or for agricultural crops which may be grown offsite. This assessment is based on the following:

1. The estimated maximum annual average rate of salt deposition resulting from the natural-draft cooling tower is 30.37 kg/sq km/yr (0.27 lb/acre/yr), occurring 2,057 m (6,750 ft) northwest of the cooling tower (Section 5.3.3.1.1.2). Deposition rates over land in vegetated areas are less. The maximum annual deposition rate predicted for vegetated areas (pasture, woods, and agricultural parcels) is 11.08 kg/sq km/yr (0.099 lb/acre/yr) and occurs 991 m (3,250 ft) west-southwest of the cooling tower (in the vicinity of the Visitors Center).

2. The drift is composed primarily of calcium (17 percent) and sulfate (44 percent) ions. Bicarbonate (7 percent) and other trace ions make up another 4 percent. Na^+ and Cl^- ions constitute only 9 and 19 percent of the drift, respectively. Thus, the majority (72 percent) of the constituents

of the salt deposited at the site by operation of the cooling tower are the much less toxic ions of calcium, sulfate, bicarbonate, and others.

3. The potential for salt accumulation in the soil is greatly reduced by the relatively high rate of rainfall of 91 cm (36.41 in)[53] annually (Section 2.7.1) and the high soil permeability.

An estimate of dissolved solids in the water passing through the soil due to cooling tower drift was calculated using the maximum predicted annual drift deposition rate over land of 0.111 kg/ha/yr (0.099 lb/acre/yr) and the rainfall rate of 0.925 m/yr (36.41 in/yr). This estimate is extremely conservative because it assumes that all salt resulting from tower operation and deposited on the soil remains in the soil and is not leached. The average increase in dissolved solids for water passing through the soil 991 m (3,250 ft) west of the tower is estimated at 0.012 ppm annually. Concentrations would be less elsewhere onsite and in offsite areas. Bernstein found that even the most sensitive species were not affected at soil salinities of less than 1,280 ppm[46]. Thus, given this potential incremental increase in soil salinities, it is highly unlikely that even salt-sensitive species would be measurably affected by operation of the Unit 2 cooling tower.

Foliar Salinization

Most of the available literature addressing the effects of salt sprays on vegetation is qualitative in nature[54,55]. Salts from aerosol sprays have been shown to accumulate and cause damage to leaves of many species[50,52,56-67]. Naturally occurring levels of chloride have been shown to accumulate in flowering dogwood (Cornus florida) leaves during much of the growing season and to reach near-toxic levels (3,800 ug/g [1.6625 gr/oz] dry weight) just before leaf abscission[68]. Salts also play an important role in the zonation of beach communities and affect the productivity of many agricultural plants[45-47,51,69-74].

Generally, foliar salinization tends to be more harmful under humid conditions than dry conditions[61,62,74,75].

Other factors that appear to determine the degree of foliar damage include precipitation, wind velocity, temperature, sunlight availability, insect damage, species tolerance, age, growth form, and cumulative dose[72]. In addition, foliar injury may occur in response to extended low levels of aerosol salt concentrations (chronic) or in response to

higher levels of aerosol salt concentrations for relatively short periods of time (acute)[70]. It appears that, in the presence of a corresponding increase in leaf chloride levels, the minimal deposition of salt drift that would cause injury to sensitive species of native perennials is about 10 kg/ha/mo (11 lb/acre/mo)[68]. Based on mathematical model predictions performed, a maximum of 0.19 kg/ha/mo (0.17 lb/acre/mo) of salt would be deposited near the Nine Mile Point site, 2,210 m (7,250 ft) west-northwest of the cooling tower. Deposition rates over land in vegetated areas will be less. The degree of salt damage will also depend on the seasonal distribution and amount of rainfall and the ability of native vegetation to accumulate chloride over the growing season. Thus, little potential for injury to native perennials from salt drift exists.

No adverse impact to native perennials or agricultural crops is anticipated, since predicted deposition rates are far below those levels known to cause injury.

5.3.3.2.3 Effects of Heat Dissipation System Operation on Wildlife

The principal sources of potential impact to wildlife from the operation of the heat dissipation system are fog and salt drift from the cooling tower, tower noise, and bird collisions with the tower during inclement weather.

Any impacts to wildlife resulting from dense fog would probably be limited to a reduction in activity levels, particularly in birds. Ground fog in the area of the Nine Mile Point site occurs, on the average, about 0.02 percent of the time (FSAR Section 2.3.1). Fogging in the vicinity of the cooling tower is not expected to increase significantly due to tower operation (Section 5.3.3.1.1.1). Since wildlife in the area experiences fog under natural conditions, any slight increases of incidence which might occur due to the operation of the tower would have no adverse impact on the fauna of the area.

The major effect of salt drift on wildlife occurs through alteration of habitat (which serves as food, shelter, and breeding cover). It is unlikely that wildlife populations will be affected, because it is anticipated that there will be little or no adverse salt drift effect on vegetation, due to the nature of the constituents of the drift, the low deposition rates, and the dilution provided by rainfall.

Several factors are involved in the reaction of wildlife to the noise generated by cooling tower operation. Animals

generally exhibit an initial fright reaction to elevated noise levels, followed by a period of acclimation, depending on the intensity of the noise level and the degree to which it is monotonous or repetitive[76]. Onsite, this reaction will also be related to the noise levels present prior to the commencement of plant operation, since previous conditions may reduce the period of acclimation.

The predicted maximum noise level at the property boundary during operation of the plant (including Unit 1 and ambient) ranges from about 32 to 40 dBA (Section 5.8.1.3). During operation of the tower, the intensity and quality of the noise will remain more or less constant. In the presence of these monotonous sounds, the animals are expected to adapt to them and resume their normal patterns of behavior. Consequently, the noise produced by station operation should have no permanent adverse impact on the wildlife in the area.

The height and width of the cooling tower present a potential hazard to migratory species of birds. From the base (el 79.3 m [260 ft], 4.3 m [14 ft] above lake level), the tower extends approximately 165 m (541 ft) above grade, and 7
its width varies from 132 m (433.6 ft) at the base ring to 83 m (273.2 ft) at the top. It will also occasionally produce visible plumes that extend somewhat below the top of the tower (FSAR Figures 2.3-1 through 2.3-25). The assessment of potential impact, discussed in the following paragraphs, is based on considerations of bird migratory patterns, migratory cues, and meteorology in the Oswego area.

Hochbaum states that a bird's eyes are the basic sensory organ from which it receives its initial orientation[77]. In flight, birds must maintain true spatial orientation. On clear days with good visibility, orientation is not a problem. However, at night and/or under adverse weather conditions, such as low ceilings with precipitation and/or fog, nocturnally migrating birds may become spatially disoriented. Herbert states that for birds to maintain a visual horizon under adverse weather conditions, they are forced to migrate at lower elevations[78]. In general, most small birds migrate at elevations above 152.4 m (500 ft)[79]. Shadows and lights, such as aircraft warning lights atop tall buildings, television-radio towers, and ceilometers, may spatially disorient birds that normally utilize natural land and water shadows against the horizon as visual cues[78]. In attempting to orient themselves, birds may seek new visual references and thus orient themselves to a false horizon. Their flight may then become er-

ratic and uncontrolled with the discrepant visual and sensory cues.

Birds may also fly directly into the ground, building, tower guy wires, or other brightly illuminated structures at night because of a complete loss of visual cues[80-87]. This may occur when the light source is constant or is a continually rotating beam and completely obliterates any background, causing birds to lose their visual cues to the horizontal.

Major periods of potential bird mortality would be expected to occur during peak periods of nocturnal migration under unfavorable weather conditions, although losses may occur at any time during the year. Studies have shown that most bird losses coincide with overcast weather conditions, wind shifts due to passing cold fronts, and precipitation and/or fog. Some kills, however, have occurred on clear nights[82,86]. Guy wires associated with radio and TV towers appear to be responsible for a large percentage of bird mortalities[83,86].

Some quantitative information is available on bird kills at TV towers and large buildings. During the 1972 fall season, 561 birds were killed at four TV towers in North Dakota[88]. It also has been reported that 576 birds were killed during 1 night at the Washington Monument in Washington, DC[89].

Bird collisions with cooling towers have been observed and recorded at the Three Mile Island Nuclear Station on the Susquehanna River near Harrisburg, PA; the Davis/Besse Nuclear Power Station on the southeast shore of Lake Erie near Port Clinton, OH; and the Beaver Valley Power Station - Unit 1 on the Ohio River[90-92]. At the Three Mile Island site, 66 bird collisions were reported from July 17, 1973 through May 31, 1975 (predominantly passerines, vireos, kinglets, and warblers). At the Ohio site, 157 bird casualties were reported during the fall of 1972 and spring and fall of 1973 seasons. It was also reported that ducks and gulls readily avoided the Davis/Besse tower. At the Beaver Valley site, 27 bird casualties (only passerines) were observed during 9 seasons of monitoring.

The mortality of birds from a nuclear power plant with cooling towers appears small compared to mortality due to other hazards encountered during migration. For example, migrating game species face an additional hazard during the fall migration period. Throughout New York State, as well as other parts of the country, large numbers of migratory game birds are harvested during annual hunting seasons

(Table 2.4-7). The harvest of game birds has not been detrimental to the survival of these species.

In assessing the potential impact of the natural-draft cooling tower at the Unit 2 site, all of the preceding factors must be taken into consideration.

It is anticipated that the majority of the bird mortalities associated with the cooling tower will occur during the spring and fall migration periods, since the Nine Mile Point Station is located in a major flyway[93,94]. Mortalities will primarily occur when weather conditions are unfavorable, forcing birds to migrate below 152.4 m (500 ft) at night. The potential for mass mortalities at the site is reduced for a number of reasons:

1. The cooling tower associated with the facility is located south of the plant and is lighted in accordance with FAA regulations, using high-intensity white beacons flashing at 40 flashes/minute. The tower will occasionally produce visible plumes that extend below the 152.4-m (500-ft) level (Section 5.3.3.1.1.1). These plumes, by themselves, are not expected to affect overall ambient visibility. Also, the height of the tower (165 m [541 ft]) is well below normal migration levels. 1

2. Along Lake Ontario, the spring and fall migration periods may extend over 2 to 3 months, with peak movements expected over a 6- to 8-week period during the year. The potential for large mortalities of migratory birds within this period is further reduced by the low frequency of occurrence of unfavorable weather conditions. Data provided by the Rochester weather tapes (1949 to 1958) indicate that the total frequency in occurrence of ceilings below 152.4 m (500 ft) with visibility of zero to 1.6 km (1 mi) are 1.3 percent of the time in the spring (March, April, and May) and 0.7 percent of the time in the fall (September, October, and November). During a 17-day study conducted in 1975, only one song sparrow (<u>Melospiza melodia</u>) was killed at the Nine Mile Point meteorological tower and no bird mortalities occurred at the stacks[95].

3. Lake Ontario, in the vicinity of the site, is moderately used by migratory waterfowl and birds for resting and feeding during migration. The potential for mortality from waterfowl and hawks

(Falconiformes) the cooling tower should be reduced because these birds are most active diurnally when orientation is generally not a problem. This conclusion is supported in other studies on bird mortality at towers. These studies indicate that only a small percentage of the birds that are killed are waterfowl or hawks[82,88,96].

When the low frequency of occurrence of ceilings below 152.4 m (500 ft) is combined with the short period of time of moderate bird migrations (6 to 8 weeks/yr), the potential for mass mortalities at the site is greatly reduced. Some losses of passerine species may occur, even during the day, but these are not expected to be appreciable when compared to other sources of bird mortality occurring from natural and manmade hazards during migration.

5.3.3.3 Land Use Impacts of Heat Dissipation System

Tall buildings and other structures can cause interference with normal television signal reception. The effect of the 541-ft tall natual-draft cooling tower on television reception in the vicinity of Unit 2 has been investigated by NMPC.

The results of this investigation indicate that, while television reception at nearby residences in the Lycoming area was of marginal quality prior to construction of the cooling tower, the presence of the tower may have degraded
2 signal reception. Suboptional reception quality in the Lycoming area can be attributed to a number of factors, including the relatively long distance to local television transmitters, the installation of poor quality antennas, and the improper installation or alignment of antennas. The reflection of television signals by the cooling tower can cause reception interference (e.g., double images) thereby intensifying the problem.

NMPC is investigating alternative measures to mitgate the television reception problem in the area. Among the measures being investigated are the installation of better quality antennas and cable television service.

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TABLE 5.3-1

PROJECTED TOTAL ENTRAINED, TOTAL IN WATER BODY SEGMENT, AND PERCENT CROPPING OF GAMMARUS FASCIATUS
NINE MILE POINT UNIT 2

Sampling Period	Projected Volume[1] (m^3) Mean ($\times 10^6$)	Projected Volume[1] (m^3) Max ($\times 10^6$)	Estimated Entrainment Abundance[2] (No./m^3)	Estimated Entrainment (No.) Mean ($\times 10^6$)	Estimated Entrainment (No.) Max ($\times 10^6$)	Estimated Standing Crop[2] ($\times 10^7$)	Estimated Percent Cropping Mean	Estimated Percent Cropping Max
Jan-Feb	16.468	17.825	2.740	45.12	48.84	864.9	0.52	0.56
Mar-Apr	17.490	18.137	0.272	4.76	4.93	269.8	0.18	0.18
May-Jun	18.178	18.178	0.242	4.40	4.40	601.3	0.07	0.07
Jul-Aug	18.178	19.300	0.312	5.67	6.02	1840.5	0.03	0.03
Sep-Oct	18.147	18.147	0.217	3.94	3.94	1459.9	0.03	0.03
Nov-Dec	18.128	18.128	0.276	5.00	5.00	1459.9	0.03	0.03

(1) Section 3.3, Table 3.3-1.
(2) Reference 3.

TABLE 5.3-2

PROJECTED TOTAL ENTRAINED AND PERCENT CROPPING
OF ALEWIFE EGGS AT NINE MILE POINT UNIT 2

Sampling Period	Unit 2 Projected Flow[1] ($m^3 \times 10^6$)	1976 Entrainment[2] (No./m^3)		Projected Unit 2 Entrainment ($\times 10^6$) Based on		Estimated Total in Water Segment[3] ($\times 10^6$)	Estimated Percent Cropping Based on	
		Unit 1	JAF	Unit 1	JAF		Unit 1	JAF
Jun 6-12	2.084	0.0025	0.0	0.005	0.0	9.1	0.06	0.00
Jun 13-19	2.084	0.018	0.009	0.038	0.019	190.8	0.02	0.01
Jun 20-26	2.084	1.026	3.060	2.138	6.377	23,943.9	0.01	0.03
Jun 27-July 3	2.084	34.412	8.057	71.715	16.791	9,100.1	0.79	0.18
Jul 4-10	2.084	4.421	9.807	9.213	20.438	197,257.5	<0.01	0.01
Jul 11-17	2.084	0.791	3.786	1.648	7.890	332,552.4	<0.01	<0.01
Jul 18-24	2.084	1.393	1.435	1.999	2.991	149,800.3	<0.01	<0.01
Jul 25-31	2.084	0.481	0.080	1.002	0.167	62,646.2	<0.01	<0.01
Aug 1-7	2.083	0.270	0.867	0.562	1.806	10,317.8	<0.01	0.02
Aug 8-14	2.083	0.068	0.562	0.142	1.171	443.4	0.03	0.26
Aug 15-21	2.083	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total (Jun 6-Aug 21)				88.462	57.650			
Mean (Jun 6-Aug 21)				8.042	5.241	71,508.3	0.01	0.01

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[1]Section 3.3, Table 3.3-1.
[2]Reference 6.
[3]Reference 1.

TABLE 5.3-3

PROJECTED TOTAL ENTRAINED AND PERCENT CROPPING
OF ALEWIFE LARVAE AT NINE MILE POINT UNIT 2

Sampling Period	Unit 2 Projected Flow[1] ($m^3 \times 10^6$)	1976 Entrainment[2] (No./m^3)		Projected Unit 2 Entrainment ($\times 10^6$) Based on		Estimated Total in Water Segment[3] ($\times 10^6$)	Estimated Percent Cropping Based on	
		Unit 1	JAF	Unit 1	JAF		Unit 1	JAF
Jun 13-19	2.084	0.0	0.0	0.0	0.0	0.14	0.0	0.0
Jun 20-26	2.084	0.0	0.006	0.0	0.012	0.85	0.0	1.41
Jun 27-Jul 3	2.084	0.004	0.071	0.008	0.148	3.61	0.22	4.10
Jul 4-10	2.084	0.013	0.015	0.027	0.031	14.54	0.19	0.21
Jul 11-17	2.084	0.054	0.137	0.113	0.286	17.57	0.64	1.63
Jul 18-24	2.084	0.008	0.020	0.017	0.042	32.74	0.05	0.13
Jul 25-31	2.084	0.014	0.300	0.029	0.625	30.38	0.10	2.06
Aug 1-7	2.083	0.481	2.524	1.002	5.257	320.64	3.13	1.64
Aug 8-14	2.083	0.015	0.527	0.031	1.098	133.84	0.02	0.82
Aug 15-21	2.083	0.372	0.612	0.775	1.275	160.90	0.48	0.79
Aug 22-28	2.083	0.135	0.438	0.281	0.912	36.59	0.77	2.49
Aug 29-Sept 4	2.082	0.116	0.032	0.242	0.067	60.77	0.40	0.11
Sep 5-11	2.081	0.004	0.002	0.008	0.004	1.18	0.68	0.34
Sep 12-18	2.081	0.008	0.005	0.017	0.010	7.03	0.22	0.14
Sep 19-25	2.081	0.012	0.0009	0.025	0.019	NS		
Sep 26-Oct 2	2.081	0.006	0.0006	0.012	0.012	NS		
Oct 3-9	2.079	0.001	0.0003	0.002	0.006	NS		
Oct 10-16	2.079	0.001	0.002	0.002	0.004	NS		
Oct 17-23	2.079	0.001	0.002	0.002	0.004	NS		
Total (Jun 13-Oct 23)				2.593	9.812			
Mean (Aug 1-Sep 4)				0.466	1.722	142.55	0.33	1.21

KEY: NS = Not sampled.

[1]Section 3.3, Table 3.3-1.
[2]Reference 6.
[3]Reference 1.

TABLE 5.3-4

PROJECTED TOTAL ENTRAINED AND PERCENT CROPPING OF RAINBOW SMELT LARVAE AT NINE MILE POINT UNIT 2

Sampling Period	Unit 2 Projected Flow(1) ($m^3 \times 10^6$)	1976 Entrainment(2) (No./m^3)		Projected Unit 2 Entrainment ($\times 10^6$) Based on		Estimated Total in Water Segment(3) ($\times 10^6$)	Estimated Percent Cropping Based on	
		Unit 1	JAF	Unit 1	JAF		Unit 1	JAF
May 2-8	2.083	0.006	0	0.012	0	NS	-	-
May 9-15	2.083	0	0.001	0	0.002	NS	-	-
May 16-22	2.083	0.008	0.006	0.017	0.035	NS	-	-
May 23-29	2.083	0	0.004	0	0.008	NS	-	-
May 30-Jun 5	2.084	0.006	0.006	0.012	0.012	9.46	0.13	0.13
Jun 6-12	2.084	0.002	0.021	0.004	0.044	2.23	0.18	1.97
Jun 13-19	2.084	0.001	0.005	0.002	0.010	3.04	0.07	0.33
Jun 20-26	2.084	0	0	0	0	2.84	0	0
Jun 27-Jul 3	2.084	0	0	0	0	0.35	0	0
Jul 4-10	2.084	0.001	0.001	0.002	0.002	2.30	0.09	0.09
Jul 11-17	2.084	0.004	0.007	0.008	0.015	3.00	0.27	0.50
Jul 18-24	2.084	0	0.002	0	0.004	1.12	0	0.36
Jul 25-31	2.084	0	0	0	0	0.11	0	0
Aug 1-7	2.083	0.001	0	0.002	0	0.97	0.21	0
Aug 8-14	2.083	0.003	0.001	0.006	0.002	0.54	1.11	0.37
Aug 15-21	2.083	0.004	0.001	0.008	0.002	0.45	1.78	0.44
Aug 22-28	2.083	0.020	0.000	0.042	0	0.42	10.0	0
Aug 29-Sep 4	2.082	0	0.001	0	0.002	0.13	0	1.5
Sep 5-11	2.081	0	0	0	0	0	0	0
Sep 12-18	2.081	0	0.001	0	0.002	0.43	0	0.46
Sep 19-25	2.081	0	0.001	0	0.002	NS	-	-
Total (May 2-Sep 25)			0.115		0.142			
Mean (May 30-Jul 17)			0.004		0.012	3.32	0.12	0.36

KEY: NS = Not sampled.

(1)Section 3.3, Table 3.3-1.
(2)Reference 6.
(3)Reference 1.

TABLE 5.3-5

ESTIMATED MEAN MONTHLY* AND TOTAL YEARLY IMPINGEMENT
FOR SELECTED SPECIES
NINE MILE POINT UNIT 1

Species	Yearly Total	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Alewife	1,261,910	1,301	284	60,504	631,964	399,278	44,670	28,440	33,618	9,778	20,049	17,050	14,974
Rainbow smelt	79,939	13,988	5,377	6,957	11,981	10,798	1,571	357	536	1,435	962	3,698	22,279
White perch	6,666	1,099	628	1,613	918	221	44	37	166	377	116	583	863
Yellow perch	2,817	579	198	102	128	912	42	113	78	36	77	202	350
Smallmouth bass	223	35	26	11	5	24	30	13	15	7	13	16	28
Coho salmon	<6	<1	0	<1	<1	<1	0	<1	<1	0	0	0	0
Threespine stickleback	45,589	1,253	2,071	4,872	20,044	14,645	1,171	961	2	33	34	95	106
Brown trout	12	2	0	<1	0	<1	1	3	1	<1	0	1	1
Spottail shiner	3,298	300	112	231	260	1,252	268	185	107	84	51	136	312

*Mean estimated impingement based on monthly collection from 1973 through 1981.

TABLE 5.3-6

ESTIMATED TOTAL ENTRAPMENT AND MORTALITY
FOR SELECTED SPECIES
NINE MILE POINT UNIT 2

Species	Annual Total Unit 1	Annual Total Entrapment Unit 2[1]	Annual Total Mortality Unit 2[2]
Alewife	1,261,910	252,382	228,153
Rainbow smelt	79,939	15,988	13,590
White perch	6,666	1,333	785
Yellow perch	2,817	563	28
Smallmouth bass	223	45	2
Coho salmon	6	1	<1
Threespine stickleback	45,589	9,118	456
Brown trout	12	2	<1

(1) Obtained by multiplying Unit 1 total by 0.20, the ratio of design plant flows.

(2) Obtained by multiplying Unit 2 total by the estimated mortality rate in the fish diversion system based on the OSS Unit 6 diversion results.

TABLE 5.3-7

STANDING STOCK ESTIMATES FOR ALEWIFE AND RAINBOW SMELT IN THE NYSDEC OSWEGO SECTOR, ALL OF NEW YORK STATE'S WATER TO 110 M (360 FT), AND THE TOTAL U.S. LAKE AREA[1]

						Percent Cropped at Unit 1		Percent Cropped at Unit 2	
Species	Location	Number Impinged at Unit 1	Estimated Mortality at Unit 2	Standing Stock	Adjusted Standing Stock[2]	Standing Stock	Adjusted Standing Stock	Standing Stock	Adjusted Standing Stock
Alewife	Oswego sector	1,261,910	228,153	122,998,300	1,229,983,000	1.03	0.10	0.20	0.019
	N.Y. State waters to 100 m (360 ft)[3]			226,083,000	2,260,830,000	0.56	0.06	0.10	0.010
	Lake-wide (U.S. only)[4]			1,256,021,000	12,560,210,000	0.10	0.01	0.02	0.002
Rainbow smelt	Oswego sector	79,939	13,590	11,703,510	117,035,000	0.68	0.07	0.12	0.012
	N.Y. State waters to 110 m (360 ft)[3]			17,902,650	179,026,500	0.44	0.04	0.08	0.008
	Lake-wide (U.S. only)[4]			99,459,000	994,590,000	0.08	0.01	0.01	0.001

(1)Reference 97.
(2)Standing stock from bottom trawl collections multiplied by 10 for upper water column fish.
(3)Represents 18% of U.S. lake surface area.
(4)Extrapolated to 100% of U.S. lake surface area.

TABLE 5.3-8

PREDICTING SURFACE DILUTION AND ΔT - NINE MILE POINT NUCLEAR STATION UNIT 2

Operating Condition	Lake Elevation[1]		Ambient Temperature		Discharge Flow[2]		Discharge[2] ΔT		Dilution[3]	ΔT_s	
	ft	m	°F	°C	gpm	m³/s	°F	°C	$\Delta T_s/\Delta T_o$	°F	°C
Annual average	244.0	74.4	50	10.0	28,752	1.81	17.64	9.8	0.084	1.48	0.82
Summer worst	244.0	74.4	70	21.1	25,984	1.64	25.83	14.4	0.084	2.16	1.21
Winter worst	244.0	74.4	32	0.0	23,055	1.45	27.99	15.5	0.084	2.34	1.27

[1] Minimum controlled lake elevation.
[2] See Table 3.3-1.
[3] Includes depth corrections and correction for 5 percent upward orientation.

TABLE 5.3-9

PREDICTED PLUME VELOCITIES AT NINE MILE POINT NUCLEAR STATION UNIT 2

Operating Condition/ Season	Predicted Velocities in m/s (fps) at Isotherm Levels				
	10.0°F	5.0°F	3.0°F	2.5°F	1.5°F
Annual average	3.1 (10.3)	1.6 (5.2)	0.9 (3.1)	0.8 (2.6)	0.5 (1.6)
Summer worst	1.9 (6.3)	1.0 (3.2)	0.6 (1.9)	0.5 (1.6)	-
Winter worst	1.6 (5.2)	0.8 (2.6)	0.5 (1.6)	0.4 (1.3)	-

TABLE 5.3-10

GROUND-LEVEL INCREASES IN AMBIENT RELATIVE HUMIDITY (RH) DUE TO THE OPERATION OF THE NATURAL-DRAFT COOLING TOWER AT NINE MILE POINT

Downwind Sector	Max Annual RH Increase (%)	Distance ft	Distance m	Max Monthly RH Increase (%)	Distance ft	Distance m	Max Daily RH Increase (%)	Distance ft	Distance m	Max Hourly RH Increase (%)	Distance ft	Distance m
N	0.002	3,250	991	0.010	4,000	1,219	0.22	3,250	991	1.40	3,250	991
NNE	0.001	3,750	1,143	0.013	3,750	1,143	0.10	4,500	1,372	1.60	3,500	1,067
NE	0.001	3,000	914	0.015	3,000	914	0.44	3,000	914	2.00	3,250	991
ENE	0.002	2,750	838	0.020	2,500	762	0.58	2,500	762	1.60	4,000	1,219
E	0.005	2,500	762	0.043	2,500	762	1.70	2,750	838	2.10	2,750	838
ESE	0.012	2,750	838	0.230	2,750	838	1.80	2,750	838	2.80	2,500	762
SE	0.018	3,000	914	0.160	2,750	838	3.30	2,750	838	3.30	3,000	914
SSE	0.014	3,000	914	0.088	3,000	914	1.00	2,750	838	2.20	3,500	1,067
S	0.012	3,250	991	0.053	3,500	1,067	0.52	3,000	914	2.40	3,000	914
SSW	0.005	3,500	1,067	0.070	3,000	914	0.68	3,000	914	2.50	3,250	991
SW	0.003	3,500	1,067	0.039	3,250	991	0.85	3,250	991	2.50	3,250	991
WSW	0.0001	4,750	1,448	0.004	4,250	1,295	0.11	4,250	1,295	1.10	4,000	1,219
W	0.005	4,500	1,372	0.014	4,250	1,295	0.38	4,000	1,219	1.50	3,750	1,143
WNW	0.001	3,500	1,067	0.017	3,500	1,067	0.26	3,750	1,143	1.60	3,750	1,143
NW	0.002	3,500	1,067	0.010	3,250	991	0.29	3,250	991	1.40	4,000	1,219
NNW	0.003	3,250	991	0.013	3,000	914	0.21	3,500	1,067	1.80	3,250	991
Worst sector	0.018	3,000 (SE)	914	0.230	2,750 (ESE)	838	3.30	2,750 (SE)	838	3.30	3,000 (SE)	914

Ambient Diurnal RH Mean Value at Nine Mile Point*				
01	07	13	19	(LST)
78%	81%	71%	71%	

*Based on 3 yr (1974-1976) of onsite meteorological data.

KEY: LST = Local standard time

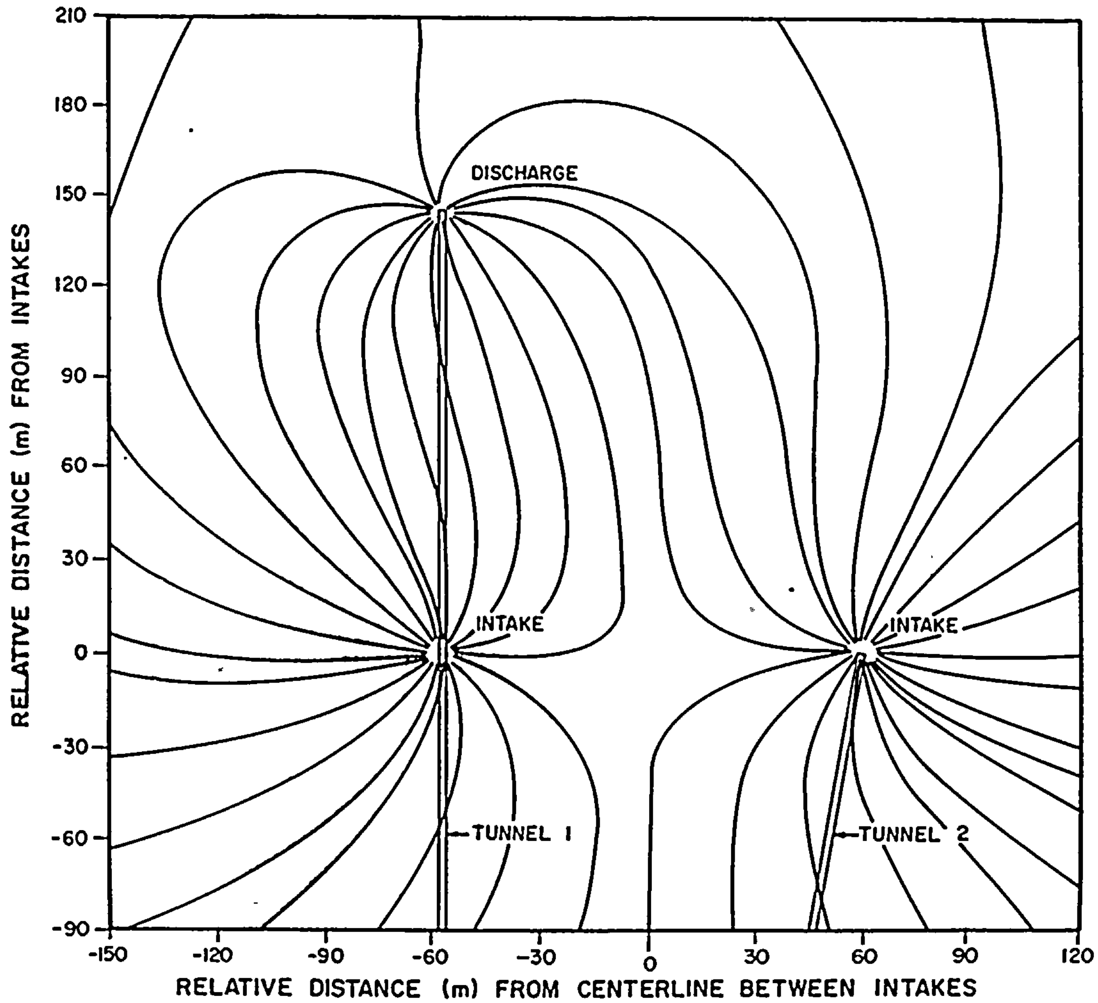


FIGURE 5.3-1

STREAM-LINE PATTERNS BASED ON YEARLY INTAKE-DISCHARGE FLOWS AT NINE MILE POINT NUCLEAR STATION UNIT 2 (NO LAKE CURRENT)

NIAGARA MOHAWK POWER CORPORATION
NINE MILE POINT-UNIT 2
ENVIRONMENTAL REPORT-OLS

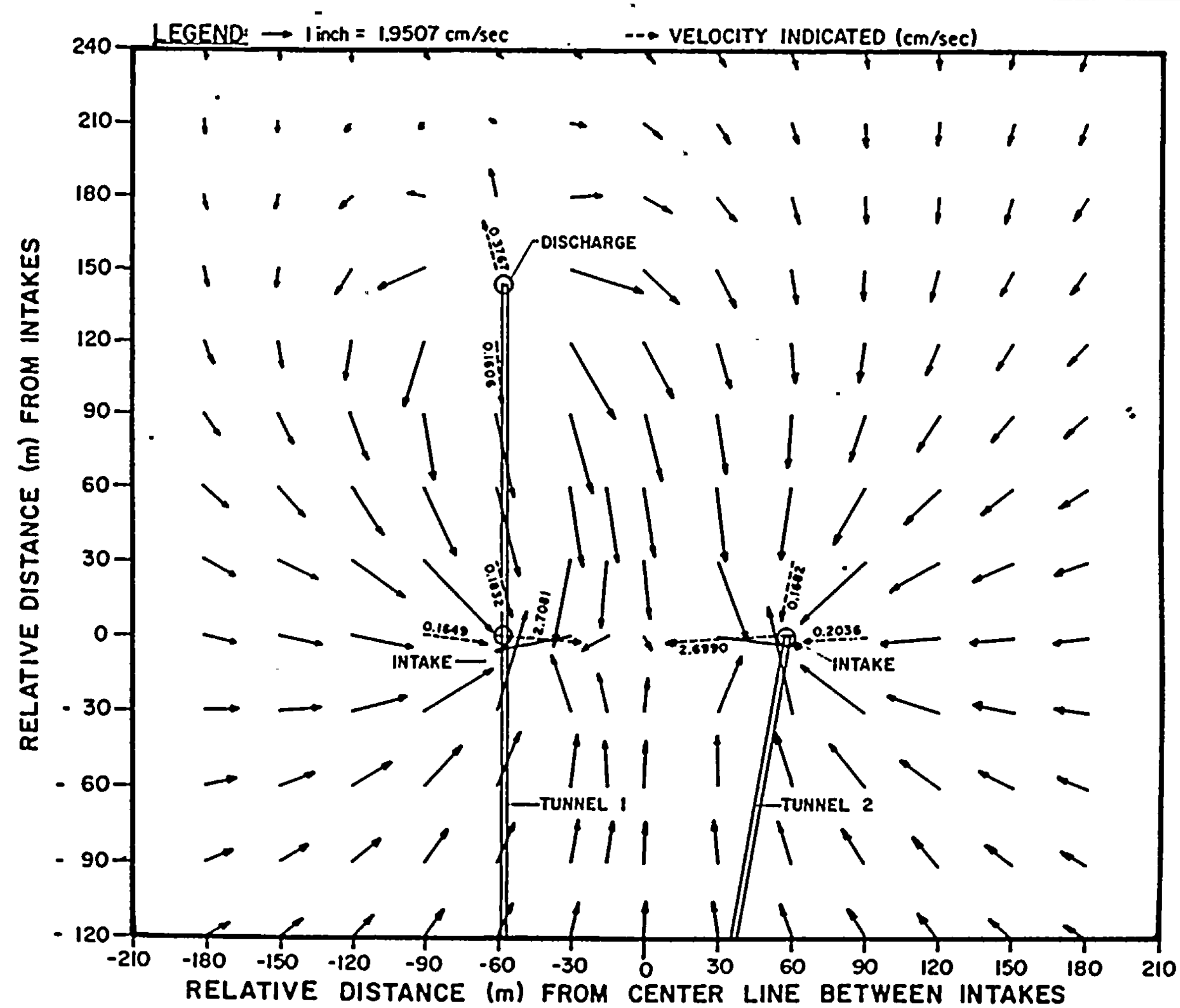


FIGURE 5.3-2

INDUCED VELOCITY PATTERNS AT NINE MILE POINT NUCLEAR STATION UNIT 2 (NO LAKE CURRENT)

NIAGARA MOHAWK POWER CORPORATION
NINE MILE POINT-UNIT 2
ENVIRONMENTAL REPORT-OLS

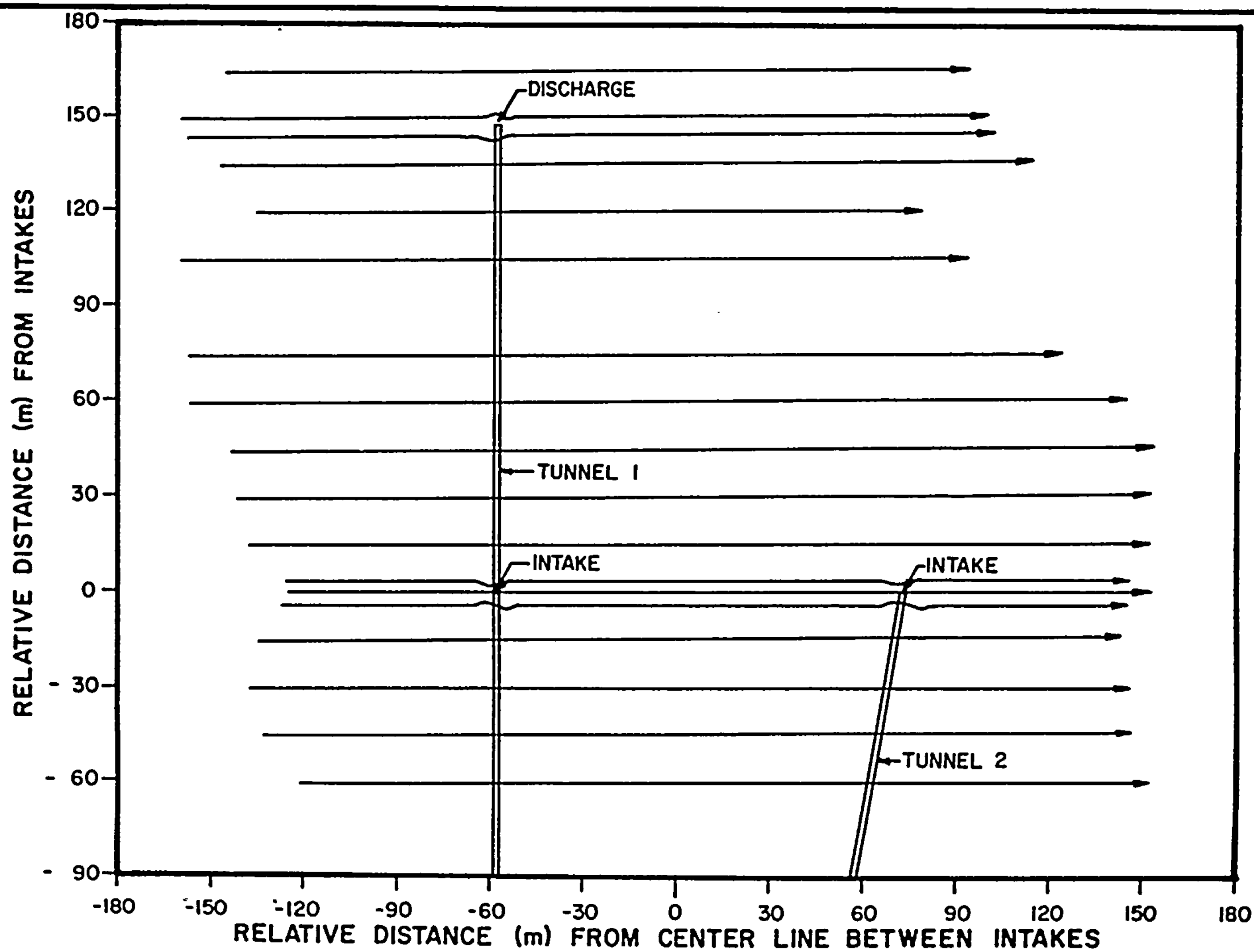


FIGURE 5.3-3

STREAM-LINE PATTERNS BASED ON YEARLY INTAKE-DISCHARGE FLOWS AT NINE MILE POINT NUCLEAR STATION UNIT 2 (WITH A 15 CM/S W-E LAKE CURRENT)

NIAGARA MOHAWK POWER CORPORATION
NINE MILE POINT-UNIT 2
ENVIRONMENTAL REPORT-OLS

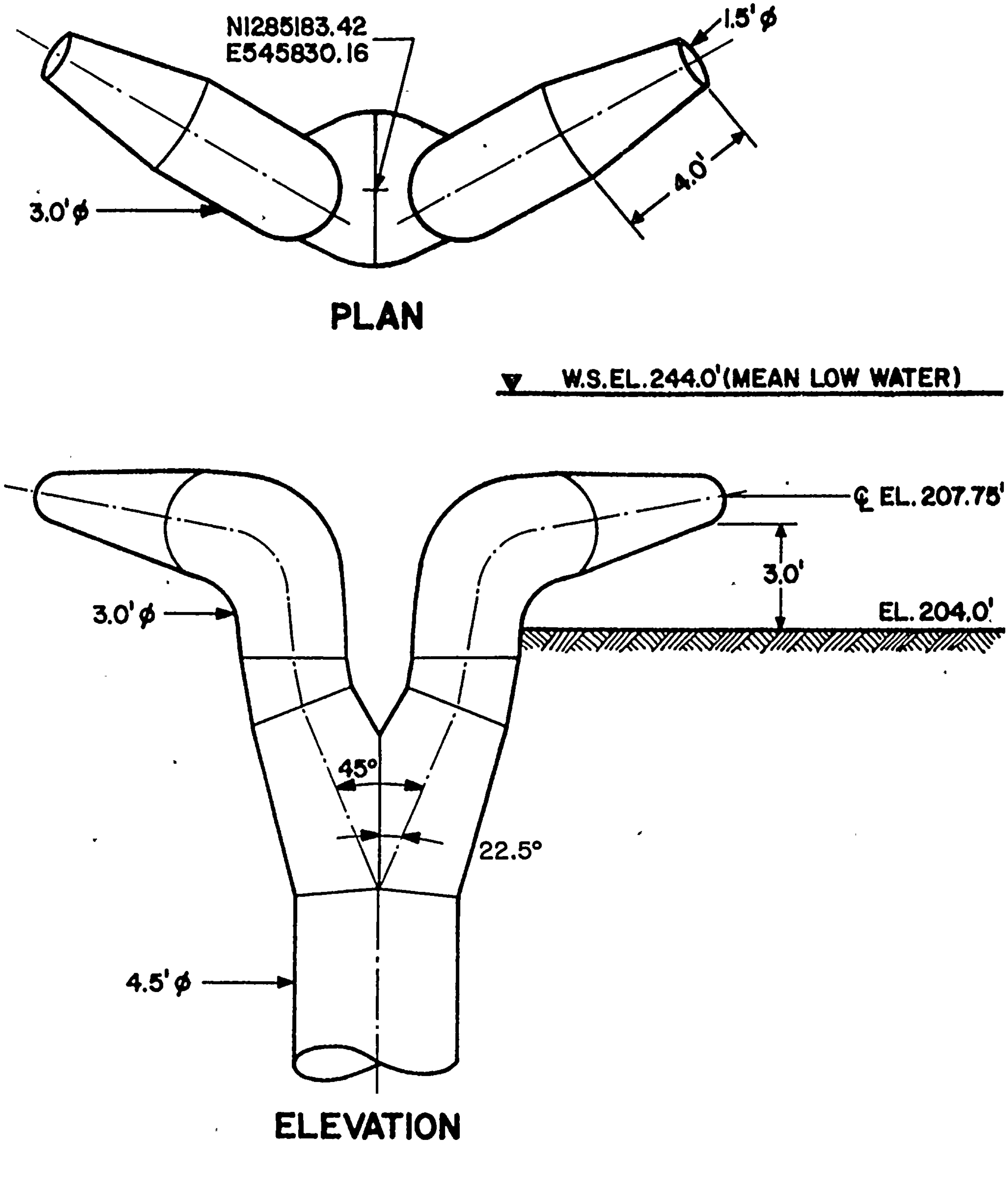


FIGURE 5.3-4

DISCHARGE DIFFUSER

NIAGARA MOHAWK POWER CORPORATION
NINE MILE POINT-UNIT 2
ENVIRONMENTAL REPORT-OLS

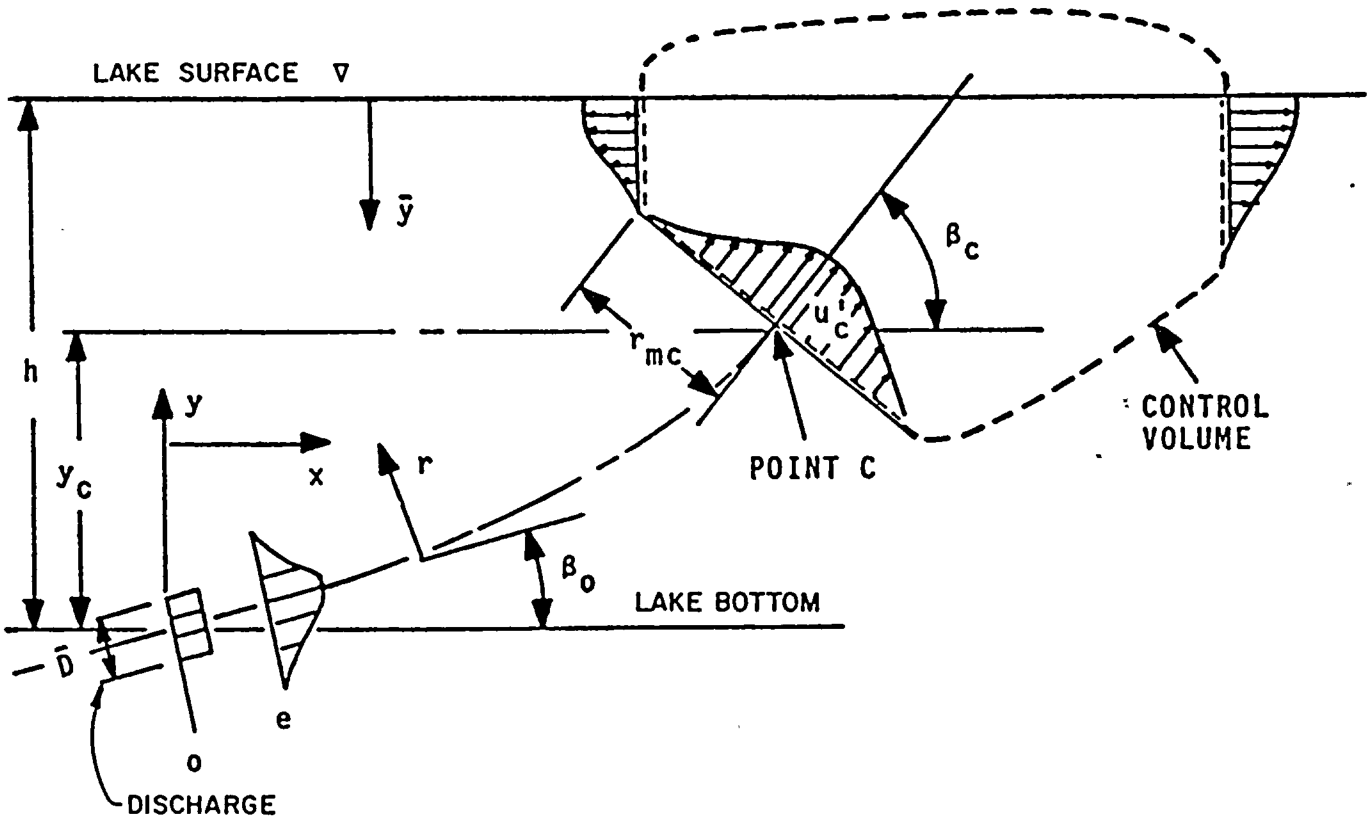
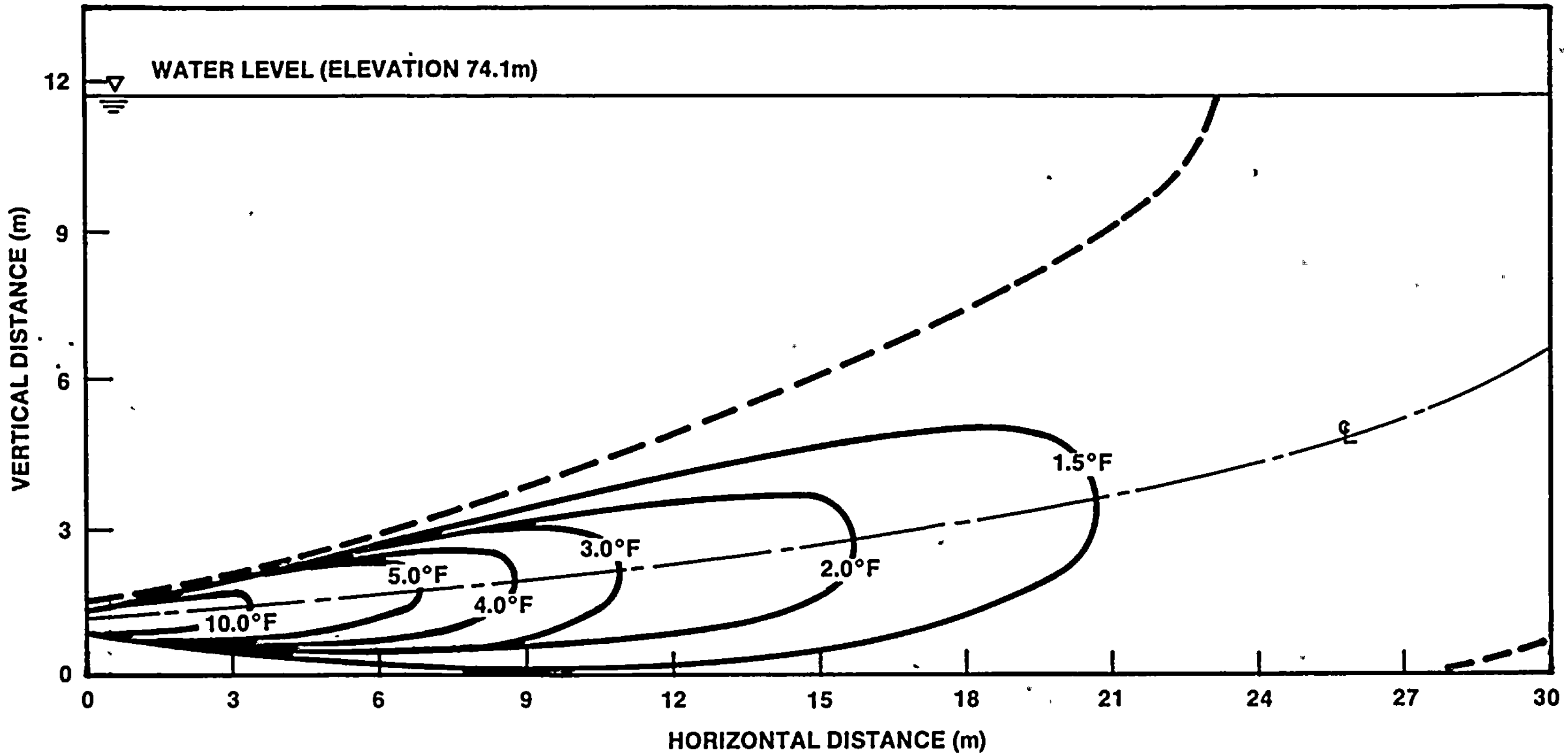


FIGURE 5.3-5

A VIEW OF THE PLANE CONTAINING THE CENTERLINE OF A ROUND BUOYANT JET DISCHARGING INTO WATER OF FINITE DEPTH (SOURCE: ROBIDEAU [31])

NIAGARA MOHAWK POWER CORPORATION
NINE MILE POINT-UNIT 2
ENVIRONMENTAL REPORT-OLS



PARAMETERS

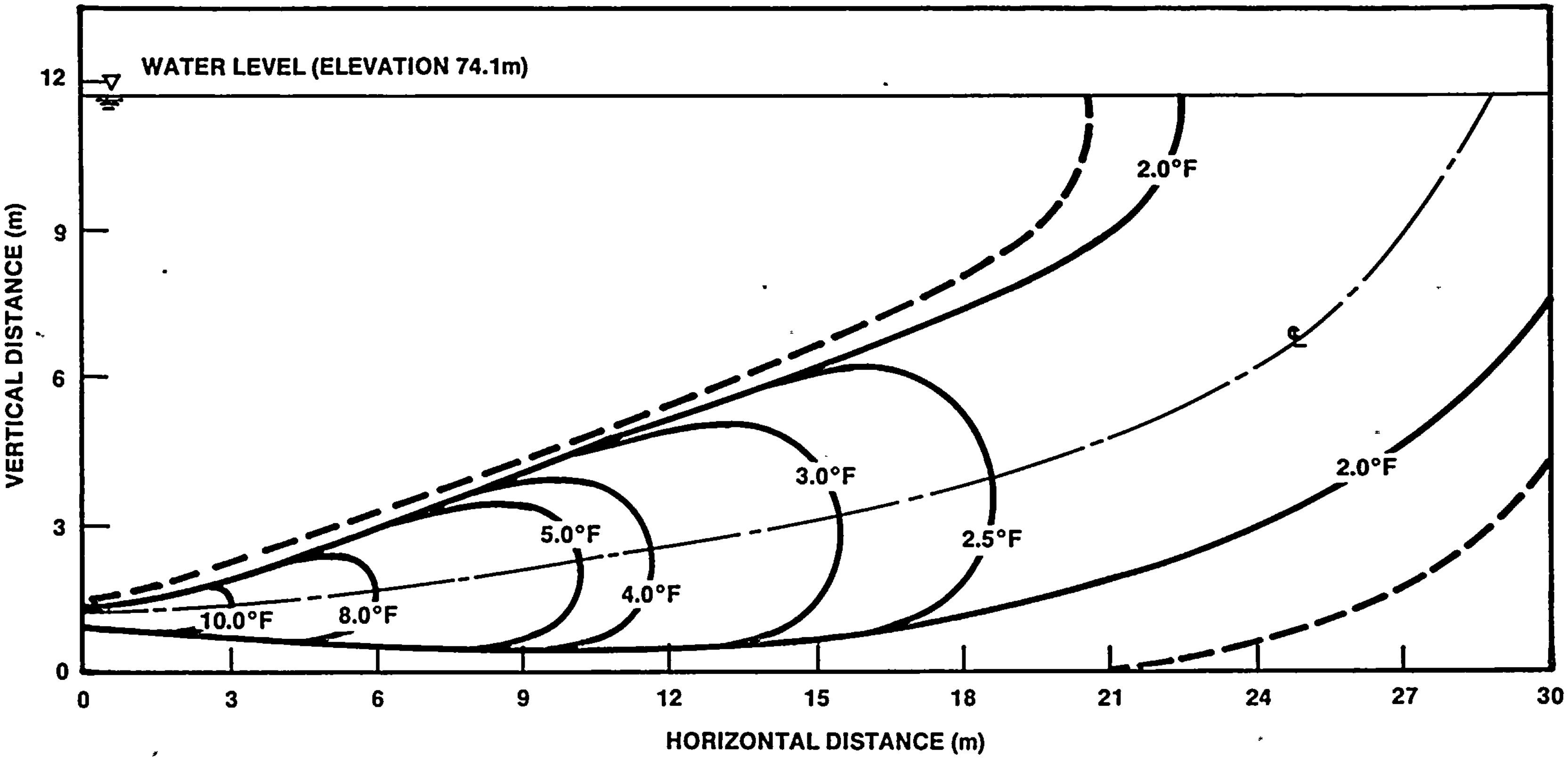
NOZZLE DIAMETER: 0.5m (1.5ft)
NOZZLE ANGLE: 5°up
NUMBER OF NOZZLES: 2

DISCHARGE FLOW: 1.81m 3/s (28,752 gpm)
DISCHARGE ΔT: 9.8°C (17.64°F)
DISCHARGE VELOCITY: 5.51m/s (18.1 fps)

FIGURE 5.3-6

PREDICTED TEMPERATURE DISTRIBUTION— VERTICAL SECTION ALONG CENTERLINE ANNUAL AVERAGE CONDITION

NIAGARA MOHAWK POWER CORPORATION
NINE MILE POINT-UNIT 2
ENVIRONMENTAL REPORT-OLS



PARAMETERS

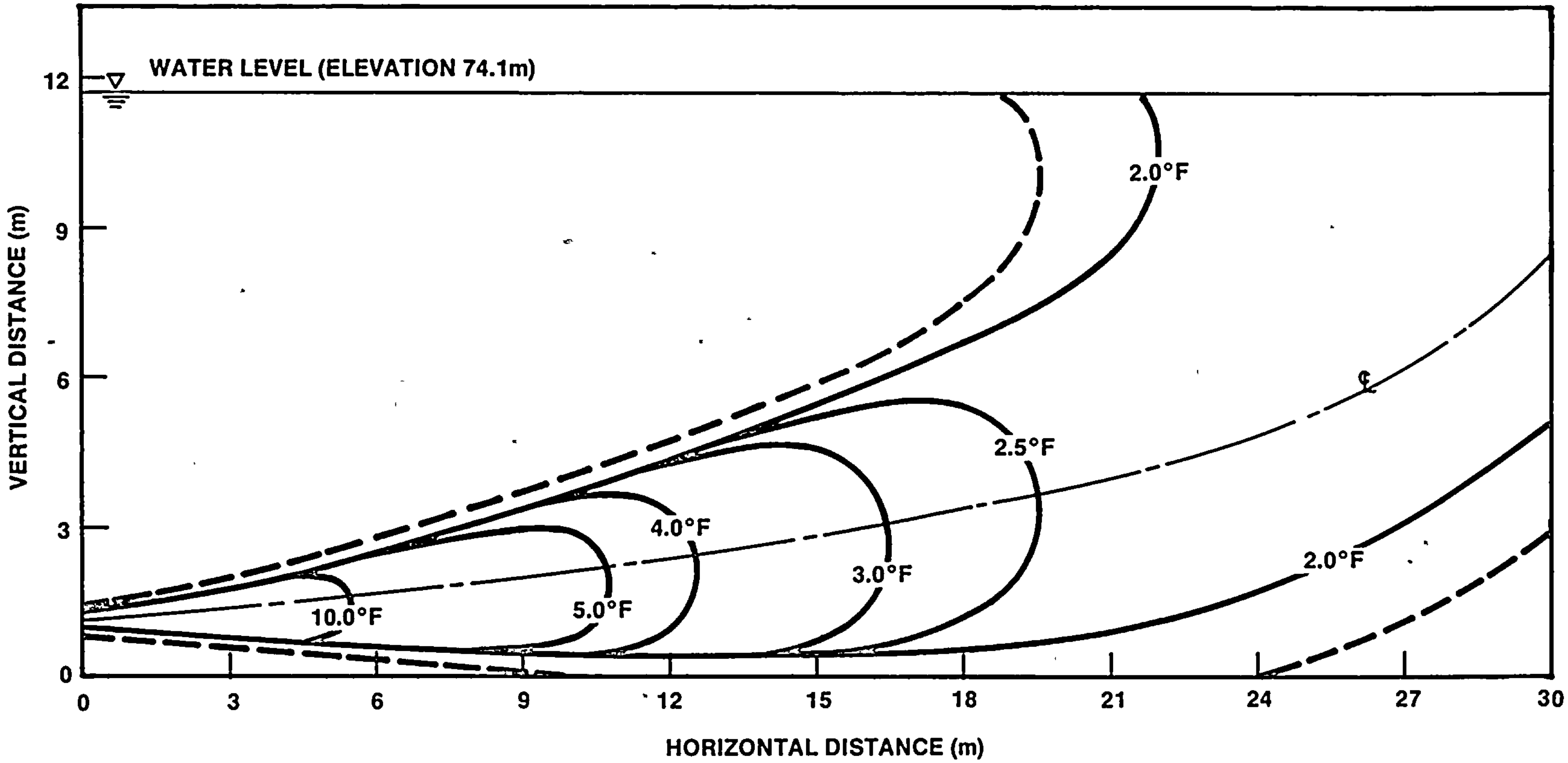
NOZZLE DIAMETER: 0.5m (1.5ft)
NOZZLE ANGLE: 5°up
NUMBER OF NOZZLES: 2

DISCHARGE FLOW: 1.64m 3/s (25,984 gpm)
DISCHARGE ΔT: 14.4°C (25.83°F)
DISCHARGE VELOCITY: 4.99m/s (16.38 fps)

FIGURE 5.3-7

PREDICTED TEMPERATURE DISTRIBUTION—
VERTICAL SECTION ALONG CENTERLINE
SUMMER WORST CONDITION

NIAGARA MOHAWK POWER CORPORATION
NINE MILE POINT-UNIT 2
ENVIRONMENTAL REPORT-OLS



PARAMETERS

NOZZLE DIAMETER: 0.5m (1.5ft)
NOZZLE ANGLE: 5°up
NUMBER OF NOZZLES: 2

DISCHARGE FLOW: 1.45m 3/s (23,055 gpm)
DISCHARGE ΔT: 15.5°C (27.99°F)
DISCHARGE VELOCITY: 4.42m/s (14.5 fps)

FIGURE 5.3-8

PREDICTED TEMPERATURE DISTRIBUTION—
VERTICAL SECTION ALONG CENTERLINE
WINTER WORST CONDITION

NIAGARA MOHAWK POWER CORPORATION
NINE MILE POINT-UNIT 2
ENVIRONMENTAL REPORT-OLS

5.4 RADIOLOGICAL IMPACT FROM ROUTINE OPERATION

During routine station operation, small quantities of radionuclides are released to the environment. The routine release of radionuclides in the gaseous and liquid effluents from Unit 2 results in doses lower than the design objectives established in Appendix I of 10CFR50, thereby meeting the as-low-as-is-reasonably-achievable philosophy (Table 5.4-1). Environmental transport and radiation dose estimates presented in this section are based on discharge rates projected for the Unit 2 waste treatment systems. These discharge rates and their bases are given in Section 3.5. The following sections discuss the possible pathways of radiation exposure, the distribution of the radioactive effluents in the environment, and the radiological impact on man and on local flora and fauna. The flora and fauna evaluated are those whose terrestrial and/or aquatic habitats provide the highest potential for radiation exposure.

5.4.1 Exposure Pathways

This section discusses the possible pathways of radiation exposure to flora and fauna and to man from routine operation of the station.

5.4.1.1 Exposure of Flora and Fauna

Figure 5.4-1 illustrates the generalized pathways leading to radiation exposure to biota other than man.

5.4.1.1.1 Gaseous Pathways

Plants and animals in the vicinity of the station receive an external exposure from the radioactive gases that are released into the atmosphere and from radioactive iodines and particulates, either released directly or formed as decay products of the effluents, deposited on the ground.

Deposition of radioiodines and particulates on vegetation (foliar deposition) and root uptake of long-lived radionuclides deposited on soil result in internal exposure of plants. These radionuclides can subsequently be consumed by grazing animals. Food chains involving animals that have the highest potential for radiation exposure have been analyzed.

Although the inhalation of radionuclides can result in internal exposure to the body and various organs of animals, some of the available information suggests that the doses

from this pathway are generally insignificant when compared to the doses from the ingestion pathway. Sufficient data are not available to warrant specific consideration of the inhalation pathway[1].

5.4.1.1.2 Liquid Pathways

Aquatic organisms are exposed to radiation emitted by radionuclides in the liquid effluent discharged to the receiving waters. This exposure is not considered significant beyond the immediate vicinity of the station discharge because of the effluent dilution in the water. Some radionuclides may be absorbed by waterborne sediment particles and deposited on the bottom. This process is complex since there are numerous physical, chemical, and biological factors involved. Such sedimentary accumulation can occur for the life of the station. Benthic organisms, which live near the bottom or in the sediment, may be exposed to the radiation emitted. Plants and animals on land can be exposed to the gamma radiation emitted from deposits on shorelines that have little water covering or are exposed during low water level conditions.

Aquatic biota accumulate radionuclides in their body tissues through ingestion or direct absorption from the water. Radionuclides in aquatic organisms are transferred to terrestrial organisms deriving all or part of their diet from the receiving water. Animals, such as ducks, feed on aquatic vegetation and, therefore, are in a position to ingest and accumulate radionuclides. Doses to terrestrial animals result from the consumption of aquatic vegetation as well as from direct ingestion of water. Transfer of nutrients, and thus radionuclides, in the terrestrial food chain is through successive trophic levels.

5.4.1.1.3 Direct Radiation

Direct radiation exposure due to the storage of radioactive materials, including radioactive wastes, and gamma radiation emitted by plant equipment may result in small doses to plants and animals in the site vicinity.

5.4.1.2 Exposure of Man

In providing guidance for implementing Section II of Appendix I to 10CFR50, the NRC staff has made use of the maximum exposed individual approach. In this approach, the numerical design objectives of Section II are compared to the calculated radiation exposures to maximum individuals in each of four age groups.

The population is considered to be made up of infants (0 to 1 yr), children (1 to 11 yr), teenagers (11 to 17 yr), and adults (17 yr and older). For the purpose of evaluating dose commitment, the maximum infant is assumed to be newborn, the maximum child is taken to be 4 yr old, the maximum teenager is taken to be 14 yr old, and the maximum adult is taken to be 17 yr old.

Maximum individuals are characterized as maximum with regard to food consumption, occupancy, and other usage of the region in the vicinity of the plant site and, as such, represent individuals with habits representing reasonable deviations from the average for the population in general. In all physiological and metabolic respects, the maximum exposed individuals are assumed to have those characteristics that represent the averages for their corresponding age group in the general population. Although specific individuals will almost certainly display dietary, recreational, and other living habits considerably different from those suggested here, and actual physiological and metabolic parameters may vary considerably, the NRC staff considers the maximum exposed individual to be a well-defined reference for implementation of Section II of Appendix I.

Figure 5.4-2 illustrates the generalized exposure pathways to man.

5.4.1.2.1 Gaseous Pathways

Radionuclides released in the plant's gaseous effluents include tritium, carbon-14, iodines, particulates, and noble gases (xenon and krypton). The inhalation of these effluents may result in an internal exposure to various body organs.

Immersion in the noble gases results in an external exposure to the whole body and skin.

Radioiodine and particulate deposits on vegetation may result in radioactivity entering food chains to man. The ingestion of vegetation grown in the vicinity of the plant and the ingestion of animals that graze on affected vegetation may result in an internal exposure to man. An example of a food chain that is important to man is the vegetation-cow-milk-infant pathway. Milk cows consuming locally grown feed may contribute to the internal dose to man. An herbivorous game animal near the site that may be a potential source of food to man is the white-tailed deer.

The following possible gaseous pathways to man have been analyzed:

1. Dose from standing on contaminated ground (contamination due to deposition of activity from routine releases of gaseous effluents).

2. Inhalation dose.

3. Ingestion of vegetation.

4. Ingestion of milk (cow) and meat (beef cattle).

5. Doses from immersion in and direct exposure to noble gaseous effluents.

6. Ingestion of deer.

5.4.1.2.2 Liquid Pathways

Radionuclides released in the liquid effluent can reach man through several potential pathways. Internal doses could be received through ingestion of these radionuclides either by direct consumption of the water or indirectly via aquatic animals that reside in the water. Consumption of secondary organisms such as ducks, which obtain all or part of their food from aquatic organisms in the receiving water, is another potential pathway to exposure of man.

In addition to the consumption of aquatic animals and their predators, another potential internal exposure pathway to man is through the consumption of agricultural crops that have been irrigated with receiving water. Although irrigation is not a major pathway for this site, it has been considered, using the assumption that water is withdrawn from the Metropolitan Water Supply of Onondaga County.

In addition to these internal exposure pathways to man, there are several potential external exposure pathways. Swimming and boating are two pathways by which individuals may receive direct exposure from the radionuclides in water. Another potential source of external exposure is from the buildup of activity in sediments along the shoreline of the receiving water.

The following possible liquid pathways to man have been analyzed:

1. Ingestion of potable water.

2. Ingestion of fish.

3. Ingestion of duck.

4. Swimming and boating.

5. Shoreline recreation.

6. Ingestion of vegetables associated with irrigation.

5.4.1.2.3 Direct Exposure

Direct radiation exposure due to normal plant operation, storage of radioactive materials and spent fuel, and gamma radiation emitted from plant equipment may result in doses in the site vicinity.

5.4.2 Radioactivity in the Environment

Section 3.5 presents the expected radionuclide release rates associated with the release of gaseous and liquid effluents from the station. Quantitative estimates of the distribution of these radionuclides in the site environs, and descriptions of the models used to obtain these estimates, are provided in the following sections.

5.4.2.1 Radioactivity in Surface Waters

Concentrations of radioactive effluents in water affected by operation of the plant were calculated according to the methods set forth in Regulatory Guide 1.113. The specific rationale is discussed in FSAR Section 2.4.12.

5.4.2.2 Radioactivity in Air

Atmospheric dispersion factors (X/Q) and deposition factors (D/Q) utilized in evaluating the releases of gaseous effluents were calculated according to the methods set forth in Regulatory Guide 1.111. The specific rationale is discussed in Section 2.7.4.

5.4.2.3 Radionuclide Concentrations

5.4.2.3.1 Liquid Effluents

The radionuclides released with the liquid effluents are rapidly diluted in the receiving water. An assumed annual average liquid effluent flow rate of 116,250 lpm (30,000 gpm) is used for the dose calculations. A dilution factor of 5.9 is used for activities taking place within the

vicinity of the nearfield dilution zone. Table 5.4-2 presents the calculated concentrations of various radionuclides in the discharge, nearfield dilution zone, nearest accessible shoreline, and public water supply with the potential for the highest radionuclide concentrations. These calculated concentrations are based on the assumed annual average discharge rates for one unit.

Table 5.4-3 lists the equilibrium bioaccumulation factors used to determine the doses to the primary organisms (fish, invertebrates, and aquatic plants) and subsequent doses to the secondary predatory animals. The equilibrium bioaccumulation factors are also used in the calculations of doses to man from the consumption of certain primary and secondary organisms.

Although Lake Ontario is not used extensively for irrigation, this pathway was considered for the maximum individual dose estimates. It is conservatively assumed that irrigation water is withdrawn from the Metropolitan Water Supply of Onondaga County and has the radionuclide concentration listed in Table 5.4-2. The maximum individual's garden was assumed to be irrigated each day for a 6-month growing season. Maximum individual consumption rates for vegetables grown in the garden were taken from Regulatory Guide 1.109 and were used to calculate the estimated doses.

5.4.2.3.2 Gaseous Effluents

Radionuclides emitted in the gaseous effluents accumulate on the ground throughout the life of the plant. Table 5.4-4 lists the ground plane concentrations of radionuclides at a point 4,106 m (13,471 ft) east of the plant. The concentrations at this point represent the maximum calculated offsite deposition occurring at an occupied residence. These concentrations were calculated using the approach outlined in Regulatory Guide 1.109, along with the assumption of a 40-yr plant life. Relative deposition rates were calculated using the methodology in Regulatory Guide 1.111.

Concentrations of radionuclides can accumulate in vegetation growing in the vicinity of the site. The model used for estimating the transfer of radionuclides from the atmosphere to vegetation considers deposition on foliage and uptake from soil for all radioiodines and particulates, except tritium and carbon-14. The concentration of carbon-14 in vegetation is estimated by assuming that its ratio to the natural carbon in the vegetation is the same as the ratio of

carbon-14 to natural carbon in the atmosphere surrounding the vegetation. The concentration of tritium in vegetation is calculated from its concentration in water vapor surrounding the vegetation. Vegetation is assumed to be exposed to contamination for 60 days and have an agricultural productivity yield of 2 kg/sq m (0.41 lb/sq ft). The soil is assumed to have a surface density of 240 kg/sq m (49 lb/sq ft), and buildup on the soil is assumed to occur over 20 yr (midpoint of plant life). Table 5.4-5 lists the concentration of radionuclides in vegetation grown at the location of the maximum individual's garden. Foliage retention factors of 0.2 for particulates and 1.0 for elemental radioiodines from airborne deposition are used as recommended in Regulatory Guide 1.109.

5.4.3 Dose Rate Estimates for Biota Other than Man

The exposure pathways and the concentrations of radionuclides in the environment are discussed in previous sections. The doses to terrestrial and aquatic organisms other than man, resulting from these radionuclides, are presented in the following sections and tables. Calculated internal and external dose rates to biota are based on the models and assumptions presented in Appendix 5A.

5.4.3.1 Doses through Gaseous Pathways

Tables 5.4-6 and 5.4-7 list the calculated doses to biota other than man from gaseous pathways. These doses are calculated for terrestrial animals residing within the vicinity of the gaseous effluent release points. The external dose rates are based on external dose rates calculated for man.

5.4.3.2 Doses through Liquid Pathways

Table 5.4-6 also lists the calculated external doses to biota other than man from submersion in water at the edge of the nearfield dilution zone and exposure to shoreline sediments. Table 5.4-7 lists the calculated internal doses to these animals due to the bioaccumulation process.

5.4.3.3 Direct Radiation Doses

This external exposure rate is independent of the biotic type and is assumed to be the same for biota as for man. Section 5.4.4.3 describes the calculational techniques used and the calculated doses.

5.4.4 Dose Rate Estimates for Man

Calculated doses to the maximum offsite individual and the 80-km (50-mi) radius 2010 population are based on the gaseous and liquid releases discussed in Section 3.5. The mathematical models and assumptions used to calculate these doses are given in Appendix 5A.

5.4.4.1 Liquid Pathways

Tables 5.4-8 through 5.4-11 present the calculated doses to the maximum individual from liquid pathways. These tables present the calculated total-body and organ doses for the four age groups: adult, teen, child, and infant.

Table 5.4-1 presents a comparison of the maximum individual calculated doses from liquid effluents to the design objectives of 10CFR50 Appendix I limits.

5.4.4.2 Gaseous Pathways

Tables 5.4-12 through 5.4-23 present the calculated doses to the maximum individual from gaseous pathways. These tables present the calculated total-body and organ doses for the four age groups: adult, teen, child, and infant.

The analysis was performed for the maximum location where a resident, milk cow, and beef animal actually exist. Each analysis case considers exposure pathways that exist at the specified location. For example, if a milk cow and a beef animal existed at the same farm, the maximum individuals residing at that farm were analyzed for immersion, inhalation, ground deposition, ingestion of vegetation, and consumption of cow milk and beef meat pathways. It was assumed that a vegetable garden could exist at each location analyzed. In addition, the consumption of deer was analyzed.

Tables 5.4-12 through 5.4-15 present the calculated doses to the maximum individuals living at the residence location. Tables 5.4-16 through 5.4-19 present the doses to the maximum individuals living at the highest milk cow location. Tables 5.4-20 through 5.4-23 present the doses to the maximum individuals living at the highest beef animal location.

Table 5.4-1 presents the comparison of the maximum individual calculated doses from gaseous effluents to the design objectives of 10CFR50 Appendix I.

Annual gamma air dose and beta air dose values were calculated and are compared to the 10CFR50 Appendix I design objective values in Table 5.4-1.

5.4.4.3 Direct Radiation from Facility

Direct radiation exposure rates at the site boundary from Unit 2 direct and air-scattered N-16, gaseous and liquid effluents, and solid waste liner loading and from all normal operations of the Unit 1 and James A. FitzPatrick power plants (as measured by thermoluminescent dosimeters) is 7 estimated to be 16 mrem/yr. This is less than the 25-mrem/yr limit specified in 40CFR190.

5.4.4.4 Annual Population Doses

5.4.4.4.1 Eighty-Kilometer (Fifty-Mile) Radius Population Doses

Population dose commitments were calculated for all individuals living within 80 km (50 mi) of the facility employing the same models used for individual doses (Regulatory Guide 1.109).

Table 5.4-24 presents the calculated annual total-body and thyroid doses from gaseous and liquid pathways to the population projected to reside within an 80-km (50-mi) radius of the site in the year 2010.

5.4.4.4.2 Contiguous U.S. Population Doses

In addition to the 80-km (50-mi) radius population doses, population doses associated with the export of food crops produced within the 80-km (50-mi) region and the atmospheric and hydrospheric transport of the more mobile effluent species, such as noble gases, tritium, and carbon-14, were calculated.

Table 5.4-25 presents the calculated annual total-body and thyroid doses to the contiguous U.S. population.

5.4.5 Summary of Annual Radiation Doses

The calculated annual radiation doses to the maximum individual from liquid and gaseous pathways are presented in Tables 5.4-8 through 5.4-23. As these tables and Table 5.4-1 indicate, the calculated annual radiation doses are below the design objectives of 10CFR50 Appendix I for

the site. The maximum calculated dose was 1.7+00 mRem/yr* to an infant thyroid. It represents an infant who resides at a location 2,350 m (7,710 ft) east-southeast of the

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*1.7+00 = 1.7×10^0

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facility and who obtains all of his or her milk from a cow located at the same location. The highest calculated external exposure rates to the whole body and skin from immersion in noble gases at an occupied location were 0.03 and 0.06 mRem/yr, respectively. These occurred at the residence location 1,693 m (5,555 ft) east of the site.

The highest calculated beta and gamma air doses at an unoccupied location from noble gas releases were 0.04 and 0.06 mrad/yr, respectively. These occurred at the exclusion area boundary 1,603 m (5,259 ft) east of the site.

For the liquid releases, it was assumed that the maximum individual obtains drinking water from the Metropolitan Water Supply of Onondaga County, located 12.87 km (8 mi) from the facility. The maximum individual was assumed to consume fish and ducks caught at the edge of the nearfield dilution zone. This assumption leads to an overestimation of accumulation of radioactive material in fish, since fish do not permanently occupy this zone. This location was also used in calculating doses from swimming and boating. Food products assumed to be irrigated were irrigated with water taken from the Metropolitan Water Supply of Onondaga County. The calculated doses from shoreline recreation also were performed at the nearest occupied beach.

The calculated dose to the maximum individual from liquid pathways is 7.9-01 mRem/yr to a child's bone. This dose is primarily a result of fish consumption.

The calculated annual doses for the population residing within an 80-km (50-mi) radius of the site are presented in Table 5.4-24. For liquid effluents, the calculated whole-body and thyroid doses are 6.5-01 man-Rem/yr and 1.3-01 man-Rem/yr, respectively. The calculated doses from gaseous pathways are 6.3-01 man-Rem/yr whole body and 2.2+00 man-Rem/yr thyroid. These doses were calculated for a projected population in the year 2010 of 1.2+06 people within 80 km (50 mi) of the site. The milk, meat, and vegetation 80-km (50-mi) radius crop yield, as well as the 80-km (50-mi) radius sport and commercial fish harvest, are presented in Appendix 5A.

The calculated doses to the contiguous U.S. population are presented in Table 5.4-25. The total annual doses were calculated to be 2.1+01 man-Rem to the whole body and 2.4+01 man-Rem to the thyroid.

5.4.6 Reference

1. Environmental Analysts, Incorporated. Standard Methodology for Calculating Radiation Dose to Lower Form of Biota. Prepared for the Atomic Industrial Forum and the National Environmental Studies Project, AIF/NESP-006, February 1975, p 33.

TABLE 5.4-1

COMPARISON OF MAXIMUM CALCULATED DOSES FROM UNIT 2 WITH APPENDIX I DESIGN OBJECTIVES

Criterion	Appendix I Design Objective[1]	Unit 2 Calculated Dose	
Gaseous effluents			
Gamma air dose[2], mRad/yr	10	5.8-02	
Beta air dose[2], mRad/yr	20	4.2-02	
Noble gas - total body[3], mRem/yr	5	2.9-02	8
Noble gas - skin[3], mRem/yr	15	6.1-02	8
Iodines and particulates[4]			
Any organ (thyroid), mRem/yr	15	1.7+00	
Liquid effluents			
Total body, mRem/yr	3	1.4-01	
Any organ[5], mRem/yr	10	7.9-01	8

NOTE: 5.8-02 = 5.8×10^{-2}

[1]Per reactor.
[2]Calculated at exclusion area boundary 1,603 m (5,259 ft) east.
[3]Calculated at 1,693 m (5,554 ft) east.
[4]Infant thyroid dose from cow milk 2,350 m (7,710 ft) east-southeast.
[5]Child bone dose is calculated to be the highest organ dose.

TABLE 5.4-2

ESTIMATED RADIONUCLIDE CONCENTRATIONS
IN EFFLUENT AND RECEIVING WATER

Final Effluent Flow Rate = 66.80 cfs

(pCi/l)

Isotope	Discharge Concentration	Edge of Nearfield Dilution Zone(1)	Nearest Accessible Shoreline(2)	Metropolitan Water Board Onondaga County(3)
H-3	8.56+02	1.45+02	2.78+00	1.85+00
Na-24	1.81-01	3.07-02	7.17-05	3.72-05
P-32	6.92-03	1.17-03	2.05-05	1.35-05
Cr-51	2.14-01	3.63-02	6.65-04	4.39-04
Mn-54	2.47-03	4.19-04	8.00-06	5.30-06
Mn-56	3.29-02	5.58-03	4.78-10	7.61-11
Fe-55	3.62-02	6.14-03	1.18-04	7.80-05
Fe-59	1.09-03	1.84-04	3.43-06	2.27-06
Co-58	7.08-03	1.20-03	2.26-05	1.50-05
Co-60	1.48-02	2.51-03	4.82-05	3.19-05
Ni-63	3.62-05	6.14-06	1.18-07	7.81-08
Ni-65	1.81-04	3.07-05	2.29-12	3.59-13
Cu-64	4.45-01	7.54-02	1.22-04	6.07-05
Zn-65	7.25-03	1.23-03	2.34-05	1.55-05
Br-83	3.46-03	5.86-04	2.01-11	2.88-12
Br-84	9.06-09	1.54-09	1.64-37	9.92-41
Sr-89	3.79-03	6.42-04	1.20-05	7.93-06
SR-90	2.47-04	4.19-05	8.03-07	5.32-07
Sr-91	4.61-02	7.81-03	5.27-06	2.37-06
Sr-92	7.90-03	1.34-03	2.08-10	3.55-11
Y-91	1.81-03	3.07-04	5.76-06	3.81-06
Y-92	4.78-02	8.09-03	1.96-08	4.60-09
Y-93	5.10-02	8.65-03	7.37-06	3.41-06
Zr-95	2.80-04	4.74-05.	8.92-07	5.90-07
Zr-97	1.10-04	1.87-05	5.39-08	2.87-08
Nb-95	2.80-04	4.74-05	8.77-07	5.79-07
Mo-99	6.09-02	1.03-02	1.23-04	7.68-05
Tc-99m	1.22-01	2.07-02	2.05-06	7.37-07
Ru-103	7.08-04	1.20-04	2.23-06	1.47-06
Ru-105	6.59-03	1.12-03	1.69-08	4.90-09
Ru-106	1.10-04	1.87-05	3.58-07	2.37-07
Ag-110m	3.62-05	6.14-06	1.17-07	7.77-08
Te-129m	1.45-03	2.46-04	4.53-06	2.99-06
Te-131m	2.47-03	4.19-04	2.79-06	1.64-06
Te-132	3.13-04	5.30-05	6.77-07	4.28-07
I-131	1.50-01	2.54-02	4.14-04	2.69-04

TABLE 5.4-2 (Cont)

Isotope	Discharge Concentration	Edge of Nearfield Dilution Zone[1]	Nearest Accessible Shoreline[2]	Metropolitan Water Board Onondaga County[3]
I-132	2.63-02	4.47-03	8.06-11	1.07-11
I-133	1.22+00	2.07-01	8.63-04	4.79-04
I-134	7.57-05	1.28-05	4.35-23	4.33-25
I-135	3.95-01	6.70-02	1.05-05	3.98-06
Cs-134	5.10-02	8.65-03	1.66-04	1.10-04
Cs-136	3.46-02	5.86-03	1.02-04	6.66-05
Cs-137	1.43-01	2.43-02	4.66-04	3.09-04
Cs-138	8.73-07	1.48-07	6.23-35	4.43-38
Ba-139	2.96-04	5.02-05	1.14-16	5.39-18
Ba-140	1.42-02	2.40-03	4.15-05	2.72-05
La-142	3.29-04	5.58-05	1.20-15	7.32-17
Ce-141	1.09-03	1.84-04	3.39-06	2.24-06
Ce-143	7.74-04	1.31-04	9.62-07	5.71-07
Ce-144	1.10-04	1.87-05	3.57-07	2.37-07
Pr-143	1.45-03	2.46-04	4.28-06	2.80-06
Nd-147	1.05-04	1.79-05	3.04-07	1.99-07
W-187	6.75-03	1.14-03	5.82-06	3.31-06
Np-239	2.31-01	3.91-02	4.29-04	2.66-04

NOTE: 8.56+02 = 8.56×10^2

[1] Dilution factor = 5.9
Travel time = 0.0 hr
[2] Dilution factor = 307.4
Travel time = 45.8 hr
[3] Dilution factor = 463.8
Travel time = 51.1 hr

TABLE 5.4-3

EQUILIBRIUM BIOACCUMULATION FACTORS
FOR AQUATIC BIOTA IN FRESHWATER

Element	Fish(1)	Crustaceans(1)	Mollusks(1)	Algae(2)
H	0.9	0.9	0.9	0.9
Cr	200.0	2,000.0	2,000.0	4,000.0
Mn	400.0	90,000.0	90,000.0	10,000.0
Fe	100.0	3,200.0	3,200.0	1,000.0
Co	50.0	200.0	200.0	200.0
Br	420.0	330.0	330.0	50.0
Rb	2,000.0	1,000.0	1,000.0	1,000.0
Sr	30.0	100.0	100.0	500.0
Y	25.0	1,000.0	1,000.0	5,000.0
Zr	3.3	6.7	6.7	1,000.0
Nb	30,000.0	100.0	100.0	800.0
Mo	10.0	10.0	10.0	1,000.0
Tc	15.0	5.0	5.0	40.0
Ru	10.0	300.0	300.0	2,000.0
Te	400.0	6,100.0	6,100.0	100.0
I	15.0	5.0	5.0	40.0
Cs	2,000.0	1,000.0	1,000.0	500.0
Ba	4.0	200.0	200.0	500.0
La	25.0	1,000.0	1,000.0	5,000.0
Ce	1.0	1,000.0	1,000.0	4,000.0
Pr	25.0	1,000.0	1,000.0	5,000.0
Np	10.0	400.0	400.0	300.0

(1) Regulatory Guide 1.109, Revision 1, October 1977.
(2) Regulatory Guide 1.109, Revision 0, March 1976. Values for algae were eliminated from Revision 1; therefore, values published in Revision 0 were utilized.

TABLE 5.4-4

DEPOSITION OF RADIONUCLIDES ON SOIL*

Isotope	Deposition (pCi/m²)
H-3	0.0
C-14	0.0
Cr-51	1.6-01
Mn-54	1.8+00
Fe-59	6.6-02
Co-58	2.5-01
Co-60	3.7+01
Zn-65	7.2+00
Sr-89	8.0-01
Sr-90	3.1-01
Zr-95	1.5-01
Nb-95	1.3+00
Mo-99	6.2-01
Ru-103	8.6-02
Ag-110m	2.3-03
Sb-124	2.0-02
I-131	3.1+00
I-132	6.3-01
I-133	4.6+00
I-134	5.6-01
I-135	1.5+00
Cs-134	1.2+01
Cs-136	2.5-02
Cs-137	9.1+01
Ba-140	9.5-01
Ce-141	9.2-01

NOTE: 1.6-01 = 1.6×10^{-1}

*Location is 4,106 m (13,471 ft) east of the main stack - annual average.
D/Q1 = 6.5-10 1/m²
D/Q2 = 2.2-09 1/m²
D/Q3 = 8.8-10 1/m²

TABLE 5.4-5

CONCENTRATION OF RADIONUCLIDES IN VEGETATION

Isotope	Stored Vegetation Concentration (pCi/kg)	Fresh Vegetation Concentration (pCi/kg)
H-3	3.1+00	3.1+00
C-14	4.0+00	4.0+00
Cr-51	1.2-03	4.9-03
Mn-54	6.5-03	7.4-03
Fe-59	5.7-04	1.4-03
Co-58	2.2-03	3.9-03
Co-60	2.6-02	2.7-02
Zn-65	4.0-02	4.7-02
Sr-89	7.3-03	1.6-02
Sr-90	1.2-04	1.2-04
Zr-95	1.3-03	2.4-03
Nb-95	1.1-02	3.4-02
Mo-99	1.3-08	3.8-02
Ru-103	7.2-04	2.0-03
Ag-110m	1.0-05	1.2-05
Sb-124	1.8-04	3.5-04
I-131	5.4-03	8.6-01
I-132	0.0	2.1-04
I-133	3.2-21	9.5-01
I-134	0.0	1.5-09
I-135	1.6-66	5.8-02
Cs-134	1.8-02	1.9-02
Cs-136	5.1-05	1.2-03
Cs-137	3.1-02	3.1-02
Ba-140	1.8-03	4.4-02
Ce-141	7.4-03	2.6-02

NOTE: 3.1+00 = 3.1×10^0

*Location is 4,106 m (13,471 ft) east of the main stack - grazing season.
X/Q1 = 1.9-08 sec/m^3
D/Q1 = 6.6-10 1/m^2
X/Q2 = 1.1-07 sec/m^3
D/Q2 = 2.2-09 1/m^2
X/Q3 = 8.3-08 sec/m^3
D/Q3 = 8.6-10 1/m^2

TABLE 5.4-6

ANNUAL CALCULATED EXTERNAL DOSE RATES TO BIOTA OTHER THAN MAN FROM ROUTINE REACTOR OPERATIONS

	External Dose Rate (mrad/yr)				
Biotic Type	Air Immersion*	Standing on Contaminated Ground*	Shoreline Exposure	Water Immersion	Water Surface
Muskrat	4.45-02	4.1-02	7.52-02	2.63-03	NA
Raccoon	4.45-02	4.1-02	5.64-02	NA	NA
Heron	4.45-02	4.1-02	7.52-02	NA	1.31-03
Duck	4.45-02	4.1-02	1.13-01	NA	1.97-03
Deer	4.45-02	4.1-02	NA	NA	NA

NOTE: 4.45-02 = 4.45x10n²

*Location of dose receiver analysis is 1,603 m (5,259 ft) east of the main stack.

TABLE 5.4-7

ANNUAL CALCULATED INTERNAL DOSE RATES TO BIOTA OTHER THAN MAN FROM ROUTINE REACTOR OPERATIONS

Biotic Type	Internal Dose Rate (mrad/yr)
Primary Organisms[1,2]	
Fish	2.1+00
Crustaceans	1.0+01
Mollusks	1.0+01
Algae	1.2+01
Secondary Organisms[2,3]	
Muskrat	1.3+01
Raccoon	0.7+00
Heron	1.3+01
Duck	1.3+01
Terrestrial Animals	
Deer[4]	2.1-01

NOTE: 2.1+00 = 2.1×10^0

[1] Primary organisms are defined as those exposed by interaction with radionuclides in the water.
[2] Location of dose receiver analysis is assumed to be at the edge of the nearfield dilution zone.
[3] Secondary organisms are defined as those which consume primary organisms.
[4] Location of dose receiver analysis is 1,603 m (5,259 ft) east of the main stack.

TABLE 5.4-8

ANNUAL DOSES TO MAXIMUM INDIVIDUAL IN THE
ADULT GROUP FROM LIQUID EFFLUENTS

(Annual Dose in mRem/yr)

Pathway	Total Body	Skin	Bone	Liver	Thyroid	Kidney	Lung	GI-Tract
Potable water	1.7-04	0.0	3.2-05	1.8-04	6.5-04	1.6-04	1.5-04	2.8-04
Fish consumption	1.4-01	0.0	5.6-01	2.0-01	2.5-02	6.0-02	1.9-02	6.5-02
Shoreline recreation	4.0-06	4.6-06	4.0-06	4.0-06	4.0-06	4.0-06	4.0-06	4.0-06
Fresh vegetation	1.9-05	0.0	7.5-06	2.2-05	4.7-05	1.6-05	1.3-05	4.0-05
Stored vegetation	1.4-04	0.0	4.9-05	1.5-04	9.0-05	1.1-04	9.6-05	1.9-04
Duck consumption	1.9-04	0.0	4.7-03	3.1-04	9.3-06	1.3-05	1.8-06	8.6-04
Swimming exposure	8.9-05	1.2-04	8.9-05	8.9-05	8.9-05	8.9-05	8.9-05	8.9-05
Boating exposure	8.9-05	1.2-04	8.9-05	8.9-05	8.9-05	8.9-05	8.9-05	8.9-05
Total dose	1.4-01	2.4-04	5.6-01	2.0-01	2.6-02	6.0-02	1.9-02	6.7-02

NOTE: 1.7-04 = 1.7×10^{-4}

TABLE 5.4-9

ANNUAL DOSES TO MAXIMUM INDIVIDUAL IN THE TEEN GROUP FROM LIQUID EFFLUENTS

(Annual Dose in mRem/yr)

Pathway	Total Body	Skin	Bone	Liver	Thyroid	Kidney	Lung	GI-Tract
Potable water	1.2-04	0.0	3.1-05	1.4-04	5.4-04	1.5-04	1.0-04	1.1-04
Fish consumption	9.0-02	0.0	6.1-01	2.1-01	2.4-02	6.1-02	2.3-02	4.7-02
Shoreline recreation	2.2-05	2.6-05	2.2-05	2.2-05	2.2-05	2.2-05	2.2-05	2.2-05
Fresh vegetation	1.2-05	0.0	6.7-06	1.7-05	3.6-05	1.7-05	9.3-06	8.9-06
Stored vegetation	1.6-04	0.0	8.6-05	2.3-04	1.2-04	2.0-04	1.3-04	1.2-04
Duck consumption	1.6-04	0.0	4.0-03	2.7-04	7.0-06	1.0-04	1.6-06	3.5-04
Swimming exposure	8.9-05	1.2-04	8.9-05	8.9-05	8.9-05	8.9-05	8.9-05	8.9-05
Boating exposure	8.9-05	1.2-04	8.9-05	8.9-05	8.9-05	8.9-05	8.9-05	8.9-05
Total dose	9.1-02	2.7-04	6.1-01	2.1-01	2.5-02	6.2-02	2.3-02	4.8-02

NOTE: 1.2-04 = 1.2×10^{-4}

TABLE 5.4-10

ANNUAL DOSES TO MAXIMUM INDIVIDUAL IN THE CHILD GROUP FROM LIQUID EFFLUENTS

(Annual Dose in mRem/yr)

Pathway	Total Body	Skin	Bone	Liver	Thyroid	Kidney	Lung	GI-Tract
Potable water	2.1-04	0.0	8.7-05	2.7-03	1.3-03	2.2-04	2.0-04	2.0-04
Fish consumption	5.4-02	0.0	7.8-01	1.9-01	2.7-02	5.2-02	1.8-02	2.0-02
Shoreline recreation	4.6-06	5.4-06	4.6-06	4.6-06	4.6-06	4.6-06	4.6-06	4.6-06
Fresh vegetation	1.2-05	0.0	1.2-05	2.1-05	5.1-05	1.4-05	1.1-05	1.0-05
Stored vegetation	2.2-04	0.0	2.0-04	3.8-04	1.9-04	2.5-04	2.1-04	1.9-04
Duck consumption	3.0-04	0.0	7.5-03	3.7-04	1.1-05	1.1-05	1.9-06	2.2-04
Swimming exposure	5.0-05	6.7-05	5.0-05	5.0-05	5.0-05	5.0-05	5.0-05	5.0-05
Boating exposure	5.1-05	6.8-05	5.1-05	5.1-05	5.1-05	5.1-05	5.1-05	5.1-05
Total dose	5.5-02	1.4-04	7.9-01	1.9-01	2.9-02	5.3-02	1.9-02	2.1-02

NOTE: 2.1-04 = 2.1×10^{-4}

TABLE 5.4-11

ANNUAL DOSES TO MAXIMUM INDIVIDUAL IN THE INFANT GROUP FROM LIQUID EFFLUENTS

(Annual Dose in mRem/yr)

Pathway	Total Body	Skin	Bone	Liver	Thyroid	Kidney	Lung	GI-Tract
Potable water	2.0-04	0.0	9.3-05	2.9-04	1.9-03	2.2-04	2.0-04	1.9-04
Total dose	2.0-04	0.0	9.3-05	2.9-04	1.9-03	2.2-04	2.0-04	1.9-04

NOTE: 2.0-04 = 2.0×10^{-4}

TABLE 5.4-12

ANNUAL DOSES TO MAXIMUM INDIVIDUAL IN THE ADULT GROUP FROM GASEOUS EFFLUENTS*

At Maximum Residence Location

(Annual Dose in mRem/yr)

Pathway	Total Body	Skin	Bone	Liver	Thyroid	Kidney	Lung	GI-Tract
Contaminated ground	7.9-03	9.2-03	7.9-03	7.9-03	7.9-03	7.9-03	7.9-03	7.9-03
Inhalation	1.6-04	0.0	1.6-04	2.4-04	1.3-02	3.0-04	2.8-04	2.1-04
Fresh vegetation	7.5-04	0.0	1.7-03	1.1-03	1.3-01	1.2-03	2.1-04	8.0-04
Stored vegetation	2.7-03	0.0	6.3-03	3.2-03	4.5-03	1.8-03	1.1-03	1.8-03
Deer 1,603 m east	1.4-04	0.0	1.7-04	1.9-04	3.2-04	9.2-05	3.1-05	3.3-04
Total dose	1.2-02	9.2-03	1.6-02	1.3-02	1.6-01	1.1-02	9.5-03	1.1-02

*Analysis performed at maximum residence location is 4,106 m (13,471 ft) east.

NOTE: 7.9-03 = 7.9×10^{-3}

TABLE 5.4-13

ANNUAL DOSES TO MAXIMUM INDIVIDUAL IN THE TEEN GROUP FROM GASEOUS EFFLUENTS*

At Maximum Residence Location

(Annual Dose in mRem/yr)

Pathway	Total Body	Skin	Bone	Liver	Thyroid	Kidney	Lung	GI-Tract
Contaminated ground	7.9-03	9.2-03	7.9-03	7.9-03	7.9-03	7.9-03	7.9-03	7.9-03
Inhalation	1.8-04	0.0	2.2-04	2.9-04	1.7-02	3.8-04	3.8-04	2.3-04
Fresh vegetation	5.4-04	0.0	1.6-03	1.0-03	1.1-01	1.1-02	1.9-04	5.8-04
Stored vegetation	3.5-03	0.0	1.1-02	5.7-03	7.3-03	6.0-02	2.0-03	2.7-03
Deer 1,603 m east	7.8-05	0.0	1.4-04	1.5-04	2.4-04	7.6-03	2.7-05	1.9-04
Total dose	1.2-02	9.2-03	2.1-02	1.5-02	1.4-01	8.7-02	1.0-02	1.2-02

*Analysis performed at maximum residence location is 4,106 m (13, 471 ft) east.

NOTE: 7.9-03 = 7.9×10^{-3}

TABLE 5.4-14

ANNUAL DOSES TO MAXIMUM INDIVIDUAL IN THE CHILD GROUP FROM GASEOUS EFFLUENTS*

At Maximum Residence Location

(Annual Dose in mRem/yr)

Pathway	Total Body	Skin	Bone	Liver	Thyroid	Kidney	Lung	GI-Tract
Contaminated ground	7.9-03	9.2-03	7.9-03	7.9-03	7.9-03	7.9-03	7.0-03	7.0-03
Inhalation	1.8-04	0.0	3.0-04	2.8-04	2.1-02	3.6-04	3.3-04	1.9-04
Fresh vegetation	7.1-04	0.0	2.9-03	1.4-03	1.6-01	1.4-03	3.2-04	5.3-04
Stored vegetation	5.7-03	0.0	2.8-02	1.1-02	1.5-02	6.2-03	4.5-03	4.6-03
Deer 1,603 m east	8.6-05	0.0	2.5-04	2.0-04	3.6-04	9.5-05	4.0-05	1.2-04
Total dose	1.5-02	9.2-03	3.9-02	2.1-02	2.0-01	1.6-02	1.3-02	1.3-02

*Analysis performed at maximum residence location is 4,106 m (13,471 ft) east.

NOTE: 7.9-03 = 7.9×10^{-3}

TABLE 5.4-15

ANNUAL DOSES TO MAXIMUM INDIVIDUAL IN THE INFANT GROUP FROM GASEOUS EFFLUENTS*

At Maximum Residence Location

(Annual Dose in mRem/yr)

Pathway	Total Body	Skin	Bone	Liver	Thyroid	Kidney	Lung	GI-Tract
Contaminated ground	7.9-03	9.2-03	7.9-03	7.9-03	7.9-03	7.9-03	7.9-03	7.9-03
Inhalation	1.2-04	0.0	2.2-04	2.2-04	1.9-02	2.3-04	2.4-04	1.1-04
Total dose	8.0-03	9.2-03	8.1-03	8.1-03	2.7-02	8.1-03	8.1-03	8.0-03

*Analysis performed at maximum residence location is 4,106 m (13,471 ft) east.

NOTE: 7.9-03 = 7.9×10^{-3}

TABLE 5.4-16

ANNUAL DOSES TO MAXIMUM INDIVIDUAL IN THE
ADULT GROUP FROM GASEOUS EFFLUENTS*

At Maximum Cow Location

(Annual Dose in mRem/yr)

Pathway	Total Body	Skin	Bone	Liver	Thyroid	Kidney	Lung	GI-Tract
Contaminated ground	1.3-02	1.6-02	1.3-02	1.3-02	1.3-02	1.3-02	1.3-02	1.3-02
Inhalation	1.4-04	0.0	1.1-04	2.0-04	9.7-03	2.5-04	2.7-04	1.9-04
Fresh vegetation	7.0-04	0.0	1.3-03	1.1-03	1.3-01	1.1-03	1.3-04	7.3-04
Stored vegetation	2.4-03	0.0	4.3-03	3.0-03	4.1-03	1.4-03	6.9-04	1.4-03
Cow milk	2.4-03	0.0	3.0-03	3.7-03	2.2-01	2.7-03	4.5-04	1.1-03
Deer 1,603 m east	1.4-04	0.0	1.7-04	1.9-04	3.2-04	9.2-05	3.1-05	3.3-04
Total dose	1.9-02	1.6-02	2.2-02	2.1-02	3.8-01	1.9-02	1.5-02	1.7-02

*Analysis performed at maximum cow location is 2,350 m (7,710 ft) east-southeast.

NOTE: 1.3-02 = 1.3×10^{-2}

TABLE 5.4-17

ANNUAL DOSES TO MAXIMUM INDIVIDUAL IN THE
TEEN GROUP FROM GASEOUS EFFLUENTS*

At Maximum Cow Location

(Annual Dose in mRem/yr)

Pathway	Total Body	Skin	Bone	Liver	Thyroid	Kidney	Lung	GI-Tract
Contaminated ground	1.3-02	1.6-02	1.3-02	1.3-02	1.3-02	1.3-02	1.3-02	1.3-02
Inhalation	1.5-04	0.0	1.5-04	2.4-04	1.3-02	3.1-04	3.6-04	2.1-04
Fresh vegetation	4.8-04	0.0	1.2-03	9.5-04	1.1-01	1.2-02	1.2-04	5.1-04
Stored vegetation	2.8-03	0.0	7.7-03	5.2-03	6.5-03	6.5-02	1.3-03	1.9-03
Cow milk	3.0-03	0.0	5.3-03	6.4-03	3.5-01	4.7-03	8.5-04	1.5-03
Deer 1,603 m east	7.8-05	0.0	1.4-04	1.5-04	2.4-04	7.6-03	2.7-05	1.9-04
Total dose	2.0-02	1.6-02	2.7-02	2.6-02	4.9-02	1.0-01	1.6-02	1.7-02

*Analysis performed at maximum cow location is 2,350 m (7,710 ft) east-southeast.

NOTE: 1.3-02 = 1.3×10^{-2}

TABLE 5.4-18

ANNUAL DOSES TO MAXIMUM INDIVIDUAL IN THE
CHILD GROUP FROM GASEOUS EFFLUENTS*

At Maximum Cow Location

(Annual Dose in mRem/yr)

Pathway	Total Body	Skin	Bone	Liver	Thyroid	Kidney	Lung	GI-Tract
Contaminated ground	1.3-02	1.6-02	1.3-02	1.3-02	1.3-02	1.3-02	1.3-02	1.3-02
Inhalation	1.5-04	0.0	2.1-04	2.3-04	1.6-02	2.9-04	3.1-04	1.7-04
Fresh vegetation	5.8-04	0.0	2.2-03	1.3-03	1.6-01	1.3-03	1.8-04	3.9-04
Stored vegetation	3.8-03	0.0	1.9-02	9.3-03	1.3-02	4.4-03	2.6-03	2.6-03
Cow milk	4.3-03	0.0	1.3-02	1.1-02	7.1-01	7.9-03	1.6-03	1.8-03
Deer 1,603 m east	8.6-05	0.0	2.5-04	2.0-04	3.6-04	9.5-05	4.0-05	1.2-04
Total dose	2.2-02	1.6-02	4.8-02	3.5-02	9.1-01	2.7-02	1.8-02	1.8-02

*Analysis performed at maximum cow location is 2,350 m (7,710 ft) east-southeast.

NOTE: $1.3\text{-}02 = 1.3 \times 10^{-2}$

TABLE 5.4-19

ANNUAL DOSES TO MAXIMUM INDIVIDUAL IN THE INFANT GROUP FROM GASEOUS EFFLUENTS*

At Maximum Cow Location

(Annual Dose in mRem/yr)

Pathway	Total Body	Skin	Bone	Liver	Thyroid	Kidney	Lung	GI-Tract
Contaminated ground	1.3-02	1.6-02	1.3-02	1.3-02	1.3-02	1.3-02	1.3-02	1.3-02
Inhalation	9.6-05	0.0	1.5-04	1.8-04	1.5-02	1.8-04	2.3-04	9.5-05
Cow milk	6.6-03	0.0	2.3-02	2.2-02	1.7+00	1.3-02	3.2-03	4.7-03
Total dose	2.0-02	1.6-02	3.6-02	3.5-02	1.7+00	2.6-02	1.6-02	1.8-02

*Analysis performed at maximum cow location is 2,350 m (7,710 ft) east-southeast.

NOTE: 1.3-02 = 1.3×10^{-2}

TABLE 5.4-20

ANNUAL DOSES TO MAXIMUM INDIVIDUAL IN THE ADULT GROUP FROM GASEOUS EFFLUENTS*

At Maximum Beef Animal Location

(Annual Dose in mRem/yr)

Pathway	Total Body	Skin	Bone	Liver	Thyroid	Kidney	Lung	GI-Tract
Contaminated ground	2.4-02	2.8-02	2.4-02	2.4-02	2.4-02	2.4-02	2.4-02	2.4-02
Inhalation	2.3-04	0.0	1.3-04	3.1-04	1.2-02	3.6-04	4.9-04	3.2-04
Fresh vegetation	1.6-03	0.0	2.7-03	2.4-03	2.6-01	2.3-03	2.4-04	1.7-03
Stored vegetation	5.7-03	0.0	8.4-03	7.4-03	7.9-03	3.1-03	1.3-03	3.0-03
Beef	9.7-04	0.0	1.7-03	1.4-03	1.5-02	8.1-04	3.2-04	4.4-03
Deer 1,603 m east	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total dose	3.2-02	2.8-02	3.7-02	3.6-02	3.2-01	3.1-02	2.6-02	3.3-02

*Analysis performed at maximum beef animal location is 1,693 m (5,555 ft) east.

NOTE: 2.4-02 = 2.4×10^{-2}

TABLE 5.4-21

ANNUAL DOSES TO MAXIMUM INDIVIDUAL IN THE
TEEN GROUP FROM GASEOUS EFFLUENTS*

At Maximum Beef Animal Location

(Annual Dose in mRem/yr)

Pathway	Total Body	Skin	Bone	Liver	Thyroid	Kidney	Lung	GI-Tract
Contaminated ground	2.4-02	2.8-02	2.4-02	2.4-02	2.4-02	2.4-02	2.4-02	2.4-02
Inhalation	2.4-04	0.0	1.8-04	3.6-04	1.6-02	4.3-04	6.6-04	3.4-04
Fresh vegetation	1.1-03	0.0	2.5-03	2.2-03	2.1-01	3.2-02	2.3-04	1.2-03
Stored vegetation	6.3-03	0.0	1.5-02	1.3-02	1.3-02	1.7-01	2.4-03	4.0-03
Beef	6.1-04	0.0	1.4-03	1.1-03	1.1-02	9.2-02	2.6-04	2.5-03
Deer 1,603 m east	1.4-04	0.0	1.7-04	1.9-04	3.2-04	9.2-05	3.1-05	3.3-04
Total dose	3.2-02	2.8-02	4.3-02	4.1-02	2.7-01	3.2-01	2.8-02	3.2-02

*Analysis performed at maximum beef animal location is 1,693 m (5,555 ft) east.

NOTE: 2.4-02 = 2.4×10^{-2}

TABLE 5.4-22

ANNUAL DOSES TO MAXIMUM INDIVIDUAL IN THE CHILD GROUP FROM GASEOUS EFFLUENTS*

At Maximum Beef Animal Location

(Annual Dose in mRem/yr)

Pathway	Total Body	Skin	Bone	Liver	Thyroid	Kidney	Lung	GI-Tract
Contaminated ground	2.4-02	2.8-02	2.4-02	2.4-02	2.4-02	2.4-02	2.4-02	2.4-02
Inhalation	2.3-04	0.0	2.4-04	3.4-04	2.0-02	4.0-04	5.6-04	2.6-04
Fresh vegetation	1.2-03	0.0	4.5-03	2.8-03	3.3-01	2.6-03	3.1-04	7.8-04
Stored vegetation	7.6-03	0.0	3.6-02	2.2-02	2.6-02	9.2-03	4.4-03	4.4-03
Beef	7.9-04	0.0	2.5-03	1.4-03	1.7-02	8.8-04	4.4-04	1.6-03
Deer 1,603 m east	7.8-05	0.0	1.4-04	1.5-04	2.4-04	7.6-03	2.7-05	1.9-04
Total dose	3.4-02	2.8-02	6.7-02	5.1-02	4.2-01	4.5-02	3.0-02	3.1-02

*Analysis performed at maximum beef animal location is 1,693 m (5,555 ft) east.

NOTE: 2.4-02 = 2.4×10^{-2}

TABLE 5.4-23

ANNUAL DOSES TO MAXIMUM INDIVIDUAL IN THE INFANT GROUP FROM GASEOUS EFFLUENTS*

At Maximum Beef Animal Location

(Annual Dose in mRem/yr)

Pathway	Total Body	Skin	Bone	Liver	Thyroid	Kidney	Lung	GI-Tract	
Contaminated ground	2.4-02	2.8-02	2.4-02	2.4-02	2.4-02	2.4-02	2.4-02	2.4-02	1.30
Inhalation	1.4-04	0.0	1.8-04	2.5-04	1.8-02	2.5-04	4.1-04	1.4-04	1.32
Total dose	2.4-02	2.8-02	2.4-02	2.4-02	4.2-02	2.4-02	2.4-02	2.4-02	1.34

*Analysis performed at maximum beef animal location is 1,693 m (5,555 ft) east.

NOTE: $2.4\text{-}02 = 2.4 \times 10^{-2}$

TABLE 5.4-24

CALCULATED ANNUAL DOSES FOR
POPULATION WITHIN 80-KM (50-MI) RADIUS

	Whole Body (man-Rem)	Thyroid (man-Rem)
Liquid Effluents		
Ingestion of potable water	2.2-02	7.0-02
Ingestion of fish	6.2-01	5.3-02
Shoreline recreation	4.2-03	4.2-03
Swimming	1.9-05	1.9-05
Boating	7.8-06	7.8-06
Total	6.5-01	1.3-01
Gaseous Effluents		
Submersion	3.3-01	3.3-01
Inhalation	1.4-02	9.6-01
Standing on contaminated ground	7.2-02	7.2-02
Ingestion of fruits, grains, and vegetation	1.6-01	1.5-01
Ingestion of cow milk	4.8-02	6.4-01
Ingestion of meat	3.8-03	6.9-03
Total	6.3-01	2.2+00

NOTES: 1. Based upon a projected 80-km (50-mi) population of 1.2+06 for the year 2010.

2. 2.2-02 = $2.2x10^{2}$

TABLE 5.4-25

CALCULATED POPULATION DOSE COMMITMENT

(Contiguous U.S. Population Dose)

	Annual Dose Per Site	
	Total Body (man-Rem)	Thyroid (man-Rem)
Liquid effluents	6.5-01	1.3-01
Noble gas effluents	1.2+00	1.4+00
Radioiodines and particulates*	1.9+01	2.2+01
Total	2.1+01	2.41+01

NOTE: 6.5-01 = 6.5×10^{-1}

*Carbon-14 and tritium have been added to this category.

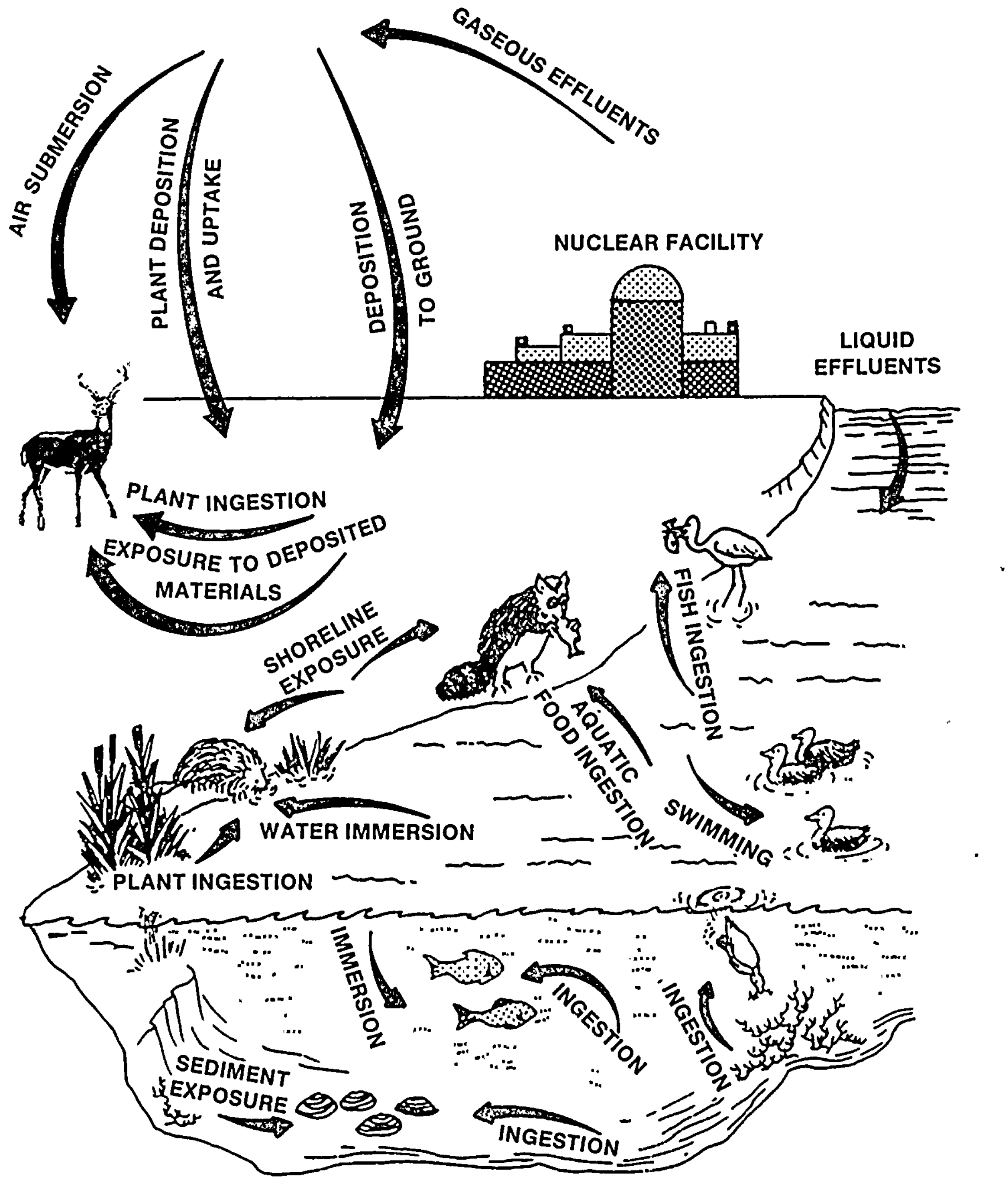

FIGURE 5.4-1

EXPOSURE PATHWAYS TO ORGANISMS OTHER THAN MAN

NIAGARA MOHAWK POWER CORPORATION
NINE MILE POINT-UNIT 2
ENVIRONMENTAL REPORT-OLS

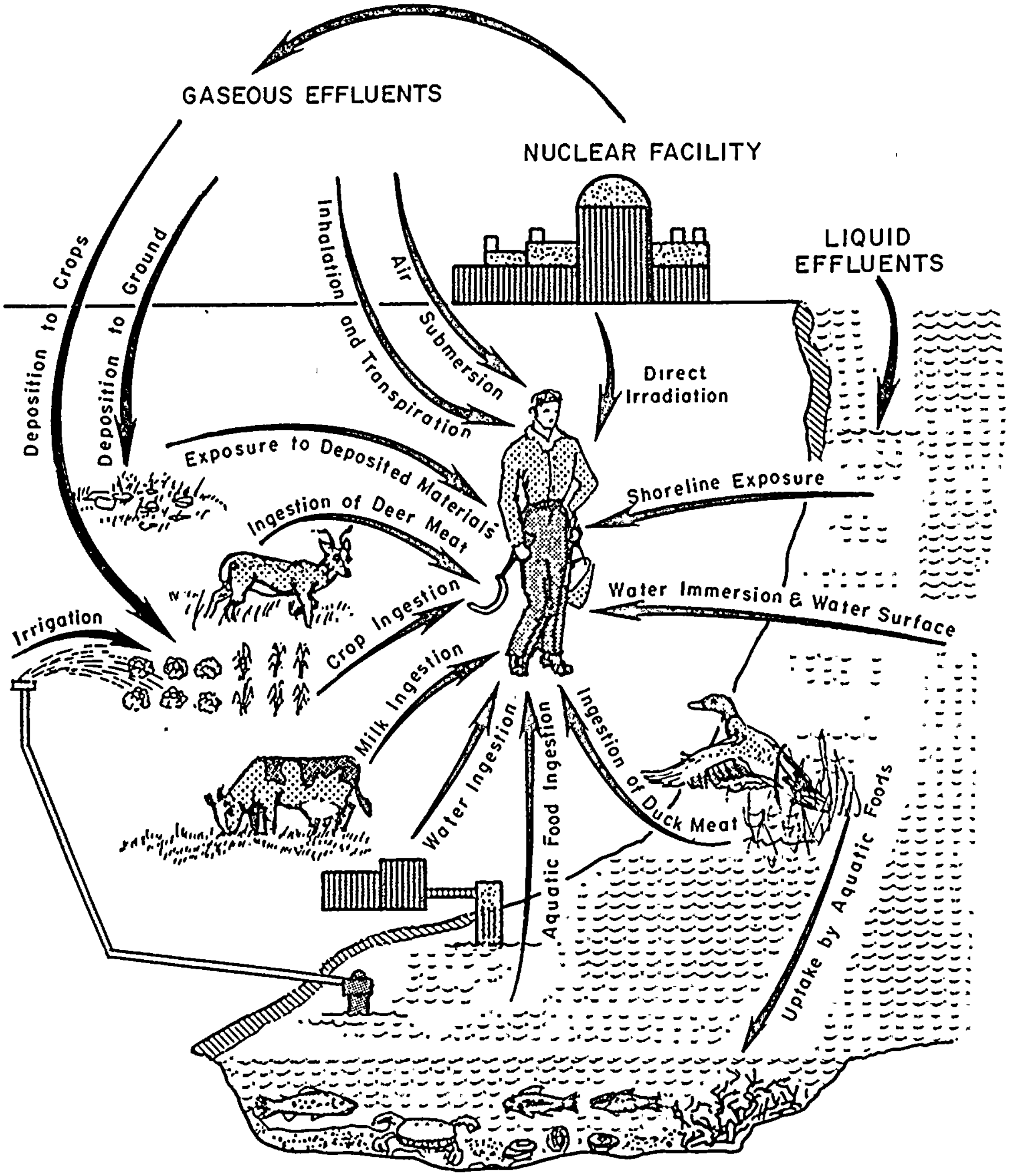

FIGURE 5.4-2

EXPOSURE PATHWAYS TO MAN

NIAGARA MOHAWK POWER CORPORATION
NINE MILE POINT-UNIT 2
ENVIRONMENTAL REPORT-OLS

5.5 NONRADIOLOGICAL WASTE SYSTEM IMPACTS

5.5.1 Identification of Nonradiological Effluent Discharges

Unit 2 operation will result in effluent releases to air and water and solid waste disposal on land. Nonradiological effluents released to water are discussed in detail in Sections 3.6.1, 3.6.2, and 3.6.3.

Solid wastes that are disposed of on land are discussed in Sections 3.6.2 and 3.6.3 and consist of cooling tower sludge and sanitary waste treatment sludge.

Sources of nonradiological effluent discharges to the atmosphere include combustion products (SO_2, NO_X, and particulates) from the operation of two standby diesel generators, one high-pressure core spray (HPCS) diesel generator, and the diesel-driven fire protection pump. Diesel generator operation, specifications, and flue gas parameters are discussed in Section 3.6.3.4.

Other nonradiological effluents discharged to the atmosphere include drift and water vapor emissions from the natural-draft cooling tower. Drift refers to droplets of circulating water entrained in the cooling tower airflow and discharged in the exhaust flow from the top of the tower. The drift contains dissolved solids that are present in the circulating water system. Water vapor is emitted from the cooling tower as a result of the evaporative cooling process in the tower and may form a visible plume upon discharge to the atmosphere. These effluents are described in detail in Section 3.6.1.3.

5.5.2 Compliance With Effluent Standards

5.5.2.1 Discharges to Water

Discharges are subject to two types of restrictions: effluent limitations and receiving water body quality standards (and criteria). The effluent limitations limit concentrations at the waste stream. Discharge water quality standards apply to the receiving waters after allowance for initial dilution, i.e., mixing zone near the outfall.

Effluents discharged to Lake Ontario must conform to the federal effluent limitations guidelines and standards for the steam electric power generating category (40CFR423)[1]. The numerical values of the applicable limitations are listed in Table 3.6-1. In addition to these regulations, New York State water pollution control laws (Article 17,

Titles 1-11)[2] include regulations for the State Pollutant Discharge Elimination System (SPDES) permit under 6NYCRR750-757, which can require more stringent effluent limits than the federal standards. A copy of the Nine Mile Point Station SPDES permit is included in Chapter 1. Water quality standards for Lake Ontario are specified in 6NYCRR702.1[3] based on the lake's classification, Class A - Special Waters, and are summarized in Table 3.6-1. In addition to the pertinent state water quality standards for pH, total dissolved solids, and iron, guidelines for selected metals have been established.

The International Joint Commission (IJC)[4] makes recommendations to regulatory agencies and sets objectives or goals, but these objectives do not constitute standards unless they become incorporated into the New York State standards.

5.5.2.1.1 Cooling System Discharge

The cooling system discharge, including various small-volume waste streams, is mixed with service water in a combined plant discharge. The predicted chemical composition of this waste stream is described in Section 3.6.1 and summarized in Table 3.6-1. The maximum and average predicted concentrations at the discharge point and the previously discussed effluent limitations are also summarized in Table 3.6-1. With the exception of the following parameters, all effluent standards and water quality criteria will be met at the point of discharge prior to mixing.

As shown in Table 3.6-1, average ambient total dissolved solids concentrations are above the lake water quality standard. As a result of solids concentration by the cooling tower, effluent concentrations are also predicted to be higher than the lake water quality standard. In general, the Unit 2 discharge will create a nearfield increase in total dissolved solids that will be indistinguishable from ambient concentrations after the 10:1 dilution which occurs within the zone of active mixing induced by the turbulence of the discharge (Table 3.6-1).

The maximum effluent zinc concentration is greater than the guideline. However, after mixing induced by the discharge, the lake concentration for zinc will be within the guideline value.

The discharge has been designed as a high-velocity submerged jet to minimize the area affected and achieve the most rapid dilution possible. The description of the mixing zone in

the vicinity of the outfall is described in quantitative terms in Section 5.3.2.1. The design of the outfall will minimize the area influenced by the discharge. The proposed discharge complies with New York State's best usage classifications for Lake Ontario.

5.5.2.1.2 Treated Sanitary Effluent

The sanitary waste effluent from Unit 2 will be combined with effluent from Unit 1 and treated prior to discharge to the lake. The combined flow (Section 3.6.2) is estimated to total 74,943 cu m/day (19,800 gpd) during normal operation and 374,715 cu m/day (99,000 gpd) during refueling/maintenance. The Unit 2 contribution to this flow under normal conditions is 37,472 cu m/day (9,900 gpd) and 187,358 cu m/day (49,500 gpd) during an outage.

Federal regulations 40CFR133[5] describe secondary treatment effluent standards. Sanitary effluent from the wastewater treatment system for Units 1 and 2 will be restricted to limits specified in the SPDES permit pursuant to the 40CFR133 regulations and receiving water quality standards. The treated effluent will meet the SPDES permit limitations for this discharge.

5.5.2.1.3 Storm Water, Roof, and Yard Drainage

Storm water and roof drains are effluent streams generated by precipitation events. It is anticipated that these discharges will be exempted from SPDES limitations under 6NYCRR751. No treatment is planned for this discharge.

Drainage or oil spills from the main and reserve station transformer area are directed through oil/water separators to remove oil prior to discharge to the storm drain system.

5.5.2.1.4 Floor Drainage

Drainage or oil spills from the diesel generator building are directed through an oil/water separator to remove oil prior to discharge. The 40CFR423 standards for low-volume wastes are applicable to the diesel generator building drainage and other nonradiological floor drainage. These standards specify maximum daily total suspended solids (TSS) concentrations of 100 mg/l and maximum daily oil and grease concentrations of 20 mg/l. The average daily concentration limits for 30 consecutive days are 30 mg/l for TSS and 15 mg/l for oil and grease. It is anticipated that nonradiological floor drainage will meet the preceding requirements through proper isolation and containment of

material spills to floors served by the nonradiological floor drains.

5.5.2.2 Discharges to Air

There are no federal new-source performance standards (NSPS) or state emission standards applicable to the standby diesel generators and diesel-driven fire pump, except for the New York State limit for a stationary combustion installation to 40 percent opacity for any time period or 20 percent opacity for a period of 3 min or more during any continuous 60-min period (Section 3.6.3.4). Through proper operation and maintenance of the standby diesel generators, compliance with these opacity limits will be achieved.

The suspended portion of the drift emissions from the natural-draft cooling tower will contribute to the ambient suspended particulate concentration levels. The magnitude of this contribution was determined based on the results of the modeling analysis presented in Section 5.3.3.1.1. Maximum annual average and maximum 24-hr average ground-level concentrations of suspended particulates due to cooling tower operation were predicted to be 0.0004 ug/cu m and 0.026 ug/cu m, respectively. The national primary air quality standards for particulates are 75 ug/cu m (annual) and 260 ug/cu m (24 hr). The secondary standards for the annual and 24-hr periods are 60 ug/cu m and 150 ug/cu m, respectively. The corresponding applicable New York State ambient air quality standards (6NYCRR257) are 45 ug/cu m (annual) and 250 ug/cu m (24 hr). The predicted particulate concentrations due to cooling tower drift emissions are several orders of magnitude below the federal and state standards. Therefore, the cooling tower emissions will neither cause nor exacerbate any violation of air quality standards.

Prevention of significant deterioration (PSD) requirements does not apply to the cooling tower since the estimated emission rate of particulates (8,980 kg/yr [9.9 ton/yr]) is well below the 226,800 kg/yr (250 ton/yr) emission criterion.

5.5.2.3 Discharges to Land

Unit 2 operation will result in the production of sludges generated from cooling tower operation and sanitary wastewater treatment (Sections 3.6.2 and 3.6.3). Prior to disposal, the quality of the cooling tower sludge will be determined, and a disposal method providing the necessary level of environmental protection in accordance with

regulations pursuant to PL94-580 (the Resource, Conservation, and Recovery Act) and New York State solid waste management laws, Article 27 (collection, treatment, and disposal of refuse and other solid waste), will be selected. The sanitary waste sludge will be disposed of by a contractor (Section 3.6.2) in accordance with NYCRR Title 6, Chapter 360 (solid waste management facilities).

5.5.3 Impacts Associated With Nonradiological Effluent Discharges

5.5.3.1 Discharges to Water

As discussed in Section 3.6, there are several sources of liquid effluent from Unit 2. The impact to biota resulting from the thermal component of these discharges is discussed in Section 5.3. The potential impact of the chemical constituents of the discharges to aquatic life is discussed in this section.

The combined plant effluent, including the circulating water blowdown stream, discharges into Lake Ontario 457 m (1,500 ft) from the shoreline in approximately 10.7 m (35 ft) of water. The chemical makeup of this stream is determined principally by the ambient lake water quality, as concentrated (average 1.67 times) and treated in the closed-cycle cooling system. Additions of other effluent streams resulting from station operation, which provide small quantities of various constituents on a variable schedule, are discussed in Section 3.6.1.

Table 5.5-1 lists the expected composition of the wastewater stream at the point of discharge, along with laboratory-determined acute toxicity levels for each of the constituents. Toxicity data for Lake Ontario species were used whenever possible. In cases where tests were conducted under a variety of conditions, the data chosen showed water quality most similar to Lake Ontario. Table 5.5-2 shows proposed EPA water quality criteria for protection of aquatic life. The 24-hr average values as well as peak levels are included. In those cases where the level must be calculated using ambient hardness, a level of 90 mg/l as $CaCO_3$ was used as representative of Lake Ontario waters in the Nine Mile Point vicinity (Section 2.3.3).

For most constituents, maximum effluent concentrations at the point of discharge are well below levels that have been reported to be acutely toxic to aquatic life (Table 5.5-1). These levels would be further diluted as the discharge rapidly mixes with lake water.

The calculated effluent concentrations for chlorine, at the point of discharge, copper, and zinc could exceed toxic levels based on continuous exposures for 48 to 96 hr. However, this is considerably longer than the exposure expected at Unit 2, even if organisms are entrained near the discharge ports (Section 5.3.2.2). Because of the rapid dilution of the plume with lake water and the high water velocities near the discharge ports, organisms will only be exposed to potentially harmful concentrations for periods of less than a few minutes. Dilution is projected to be approximately 3:1 in the first 4 m (13 ft) and 6:1 in 11 m (35 ft) (Section 5.3.2.1). For example, LC values for 30-min exposures to chlorine, which are still far in excess of anticipated exposures at Unit 2, are higher than the maximum concentrations expected at the discharge ports (Table 5.5-1). Thus, the exposure duration will be short and is not expected to have a significant impact on Lake Ontario biota.

The effluent from the sewage treatment plant will contain phosphates and nitrogen that could contribute to an increase in algal biomass near the discharge[6]. However, this small nutrient addition is expected to have no detectable effect on the biota of Lake Ontario beyond the immediate discharge area. Chlorine will be added to the sanitary waste treatment effluent as required by the SPDES permit to control pathogenic organisms.

No impact on aquatic life is anticipated from the remaining effluent sources, i.e., storm water, roof, yard, and floor drainage.

5.5.3.2 Discharges to Air

The emissions of combustion products from the diesel generators and fire pump will not adversely affect air quality. Likewise, particulate emissions from the cooling tower (Section 5.5.2.2) resulting in ambient concentrations far below federal and state air quality standards will not create an adverse impact on air quality. Other atmospheric considerations associated with cooling tower emissions are discussed in Section 5.3.3.1.1. Analytical results demonstrate that there are no significant adverse atmospheric impacts associated with cooling tower operation.

5.5.3.3 Solid Waste Land Impacts

Cooling tower sludge will be disposed of in a licensed sanitary landfill. Through proper operation and maintenance

of a licensed disposal facility, impacts from land disposal can be minimized.

Sludge generated from the combined sanitary waste treatment plant, treating wastes from Units 1 and 2, will be disposed of by a licensed contractor whose disposal practices will meet the requirements of New York State solid waste management facilities (NYCRR Title 6, Chapter 360). Compliance with these regulations will assure mitigation of impacts.

5.5.4 Unavoidable Adverse Impacts

Any impacts associated with nonradiological waste systems are addressed in Sections 5.5.2 and 5.5.3.

5.5.5 Irreversible and Irretrievable Commitment of Resources

The nonradiological waste resulting from the operation of Unit 2 will cause no irreversible and irretrievable commitment of land, water, or air resources.

5.5.6 References

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TABLE 5.5-1

COMPARISON OF UNIT 2 COMBINED PLANT EFFLUENT,
LAKE ONTARIO WATER QUALITY AT NINE MILE POINT,
AND BIOLOGICAL EFFECTS FOR SELECTED CHEMICAL CONSTITUENTS

	Lake Concentration[1]		Effluent Concentration[1]		Biological Effects[2]			
Constituent	Mean (mg/l)	Maximum (mg/l)	Mean (mg/l)	Maximum (mg/l)	Concentration (mg/l)	Hardness (mg/l as $CaCO_3$)	Criterion	Source[3]
Sodium	16	26	23	42	1,640		48-hr LC50 Daphnia magna	Becker and Thatcher[7]
Calcium	42	47	56	73	160		96-hr LC50 Gambusia affinis	Ellis et al[8]
Chloride	35	53	48	82	5,000		96-hr LC50 Morone saxatilis juveniles	Hughes[9]
					1,000		M. saxatilis larvae	Hughes[9]
Magnesium	8	9	11	14	16,500		96-hr LC50 Gambusia affinis	Mackee and Wolf[10]
Sulfate	31	40	99	147	12,500 (as Na_2SO_4)		96-hr LC50 Lepomis macrochirus	Becker and Thatcher[7]
					3,500		M. saxatilis juveniles	Hughes[9]
					250		M. saxatilis larvae	Hughes[9]
Nitrate	<0.18	0.32	<0.24	0.50	10,000 (as $NaNO_3$)		96-hr LC50 L. macrochirus	Becker and Thatcher[7]
Chromium	<0.001	0.002	<0.001	0.003			96-hr LC50	
					0.067 (as K_2CrO_4)	45	Gammarus pseudolimnaeus	EPA[11]
					6.4		Daphnia magna	Dowden and Bennett[12]
					69.0 (as		Salmo gairdneri	Benoit[13]
					59.0 $K_2Cr_3O_7$)		S. fontinalis	Benoit[13]
					110.0-213.0		L. macrochirus	EPA[11]
Copper	<0.019	<0.066	<0.027	<0.105			96-hr LC50	
					0.1 (as $CuSO_4$)	100	Limnodrilus hoffmeister	Wurtz and Bridges[14]
					0.02 (as $CuSO_4$)	35-55	Gammarus pseudolimnaeus	Arthur and Leonard[15]
					0.91	50	Gammarus sp.	Rehwoldt el al[16]
					0.007-0.027	44-245	Daphnis pulicaria	EPA[17]
					60-74 (as $CuCl_2$)	89-99	Oncorhynchus kisutch	EPA[17]
					6.2-6.4 ($CuNO_3$)	53-55	Morone americana	Rehwoldt et al[18,19]
					6.97	100	Micropteros salmoides	Birge and Black[20]
Iron	0.091	0.172	0.122	0.267	6.0		96-hr LC50 Morone saxatilis	Hughes[9]

TABLE 5.5-1 (Cont)

	Lake Concentration[1]		Effluent Concentration[1]		Biological Effects[2]			
Constituent	Mean (mg/l)	Maximum (mg/l)	Mean (mg/l)	Maximum (mg/l)	Concentration (mg/l)	Hardness (mg/l as $CaCO_3$)	Criterion	Source[3]
Manganese	0.018	0.039	0.024	0.061	16		*Salmo gairdneri* 96-hr LC50	Thurson et al[21]
					0.37-4.0 (as $MnSO_4$)		5-23% increase in mortality of *S. gairdneri* eggs during 29-day exposure	Lewis[22]
							Pimephales promelas	
					33.8		96-hr LC50	Kimball[23]
					19.7		28-day survival in embryo larval test was 48%	Kimball[23]
							D. magna	
					13.5		96-hr LC50	Kimball[23]
					8.99		28-day LC50	Kimball[23]
Nickel	<0.004	0.009	<0.005	0.014			96-hr LC50	
					13 (as $NiNO_3$)	50	*Gammarus* sp.	Rehwoldt et al[16]
					1.9-2.3 (as $NiCl_2$)	100-104	*D. magna*	EPA[24]
					35.5 (as $NiNO_3$)		*S. gairdneri*	Hale[25]
					13.6-13.7	53-55	*M. americana*	Rehwoldt et al[18,19]
					5.2-5.4	20	*L. macrochirus*	Pickering and Henderson[26]
					39.6	360	*L. macrochirus*	
							96-hr LC50	
Zinc	<0.048	0.281	<0.065	0.437	8.1	50	*Gammarus* sp.	Rehwoldt et al[16]
					0.525 (as $ZnCl_2$)	105	*D. magna*	EPA[27]
					4.6 (as $ZnCl_2$)	94	*O. kisutch*	EPA[27]
					1.76 (as $ZnCl_2$)	83	*S. gairdneri*	Chapman and Stevens[28]
					14.3-14.4 (as $ZnNO_3$)	53-55	*M. americana*	Rehwoldt et al[18,19]
					0.41	20-52	12-day LC50 *S. gairdneri*	Spehan et al[29]
Chlorine-(Total residual-TRC)	0	0	<0.092	<0.27			96-hr LC50	
					0.22 (as total chloramine)		*G. pseudolimnaeus*	Arthur and Eaton[30]
					0.017 (as TRC)		*D. magna*	Ward and DeGraeve[31]
					0.037		*S. gairdneri*	Ward and DeGraeve[32]
					0.071		*Salvelinus* sp.	Ward and DeGraeve[32]
							48-hr LC50	
					1.102		*Gammarus* sp.	Ward and DeGraeve[32]
							S. trutta	Ward and DeGraeve[32]

TABLE 5.5-1 (Cont)

Constituent	Lake Concentration[1] Mean (mg/l)	Lake Concentration[1] Maximum (mg/l)	Effluent Concentration[1] Mean (mg/l)	Effluent Concentration[1] Maximum (mg/l)	Biological Effects[2] Concentration (mg/l)	Hardness (mg/l as $CaCO_3$)	Criterion	Source[3]
Chlorine (Cont)					1.19 (17°C) 0.56 (21°C)		96-hr LC50 after 30-min exposure	Basch and Truchan[33]
							30-min LC50	Brooks and Seegert[34]
					8.0 (10°C)		*M. americana*	Brooks and Seegert[34]
					1.1 (20°C)		*M. americana*	Brooks and Seegert[34]
					0.7 (30°C)		*M. americana*	Brooks and Seegert[34]
					2.15 (10°C)		*Alosa pseudoharangus*	Brooks and Seegert[34]
					1.70 (20°C)		*Alosa pseudoharangus*	Brooks and Seegert[34]
					0.30 (30°C)		*Alosa pseudoharangus*	Brooks and Seegert[34]
					1.26 (10°C)		*O. kisutch*	Brooks and Seegert[34]
					1.38 (15°C)		*O. kisutch*	Brooks and Seegert[34]
					0.9 (20°C)		*O. kisutch*	Brooks and Seegert[34]

(1) From Table 3.6-1
(2) Based on a survey of available literature and selection of most appropriate data as an indicator of potential effects on Lake Ontario organisms.
(3) See Section 5.5.6 (References).

TABLE 5.5-2

PROPOSED WATER QUALITY CRITERIA
TO PROTECT FRESHWATER AQUATIC LIFE

Constituent[1]	24-hr Average Concentration (ug/l)	Level Never To Be Exceeded (ug/l): Criterion	Level Never To Be Exceeded (ug/l): Value at Hardness of 90 mg/l as $CaCO_3$	Source[2]
Chromium hexavalent	0.29	21	21	EPA[11]
Chromium trivalent	-	$e^{(1.08[\ln(\text{hardness})] + 3.48)}$	4,187.2	EPA[11]
Copper	5.6	$e^{(0.94[\ln(\text{hardness})] - 1.23)}$	20.1	EPA[17]
Nickel	$e^{(0.76[\ln(\text{hardness})] + 1.06)}$ (equals 88.2 ug/l at a hardness of 90 mg/l as $CaCO_3$)	$e^{(0.76[\ln(\text{hardness})] + 4.02)}$	1,701.5	EPA[24]
Zinc	47	$e^{(0.83[\ln(\text{hardness})] + 1.95)}$	294.4	EPA[27]

[1] Measured as total recoverable.
[2] See Section 5.5.6 (References).

5.6 TRANSMISSION SYSTEM IMPACTS

5.6.1 Terrestrial

Consideration has been given to the potential for ecological impacts resulting from both the presence of transmission facilities in the ecosystem and the need to maintain the right-of-way (ROW). The existence and magnitude of any impacts are a function of the transmission line design, the characteristics of the areas crossed by the ROW corridor, and the maintenance practices employed.

5.6.1.1 Impact on Flora

Operation of the Nine Mile 2-Volney 345-kV transmission line is not expected to have any significant negative impact on the flora within or adjacent to the corridor. Although herbicides will be used during maintenance of the ROW (Section 5.6.1.3), only properly licensed chemicals will be used in an approved manner. Herbicides will only be used on undesirable species that could interfere with the transmission lines. It is expected that in time low-growing vegetative communities will become established within the corridor, thereby reducing the amount of vegetative maintenance required.

No rare or threatened plant species listed by the U.S. Fish and Wildlife Service or the New York State Department of Environmental Conservation (NYSDEC) are known to be present within or adjacent to the corridor (Section 2.4.1.1.2); thus, no adverse impact to such species is possible.

5.6.1.2 Impact on Fauna

Little or no impact from operation and maintenance of the transmission lines and ROW is expected on fauna. During the initial maintenance period, any fauna reestablished after construction may be disturbed occasionally by crews clearing and/or treating undesirable tree species, but even this will occur less frequently with time.

Operation or maintenance of the Nine Mile 2-Volney 345-kV transmission line or corridor will not have a significant impact on important species of fauna. Species classified as endangered or threatened by the U.S. Fish and Wildlife Service use the vicinity only occasionally in the spring, summer, or fall. Except for the possibility of bird collisions as discussed in the following paragraph, the operation and maintenance of the transmission line and corridor are not expected to have an impact on these species.

Commercially important species have adequate habitat in the area. Therefore, operation and maintenance of the transmission line and corridor will not have a significant impact on these species (Section 2.4.1.1.3).

Some potential exists for the loss of birds that collide with transmission lines, particularly during adverse weather conditions. The extent of such losses, however, is difficult to determine. Most incidences of birds striking wires go unnoticed for the following reasons:

1. Limited human activity in areas where strikes are most frequent.

2. Dead birds lying beneath wires often are concealed by dense vegetation.

3. Injured or dead birds are removed by predators and scavengers.

4. Inclement weather conditions reduce the chance for recovery.

In general, reported bird mortalities due to collisions with transmission lines are low in comparison to those caused by other obstacles such as television transmitting towers[1]. Mortality caused by collision with power lines appears to be more prevalent among large-sized birds such as waterfowl and wading birds[2]. Collisions are more common where transmission lines are perpendicular to the flight paths along migratory corridors or in areas where birds are involved in frequent local movements. Birds flying at high speeds and at low altitudes are more susceptible in these areas. Two recent bibliographies address avian mortality at manmade structures including transmission lines[2,3].

The proposed Nine Mile 2-Volney corridor does not cross large open wetlands, where the potential for strikes by low-flying birds is high. Brushland and agriculture are the primary land uses in open areas along the ROW. Most bird flight activity there will be close to the ground and of short duration. The line also follows an existing transmission corridor and thus would provide only a slight increase in potential impact. During long-distance migration, birds will usually be flying at higher altitudes and thus will not encounter any transmission lines. However, since the lines are in the airspace, there is potential for a few bird strikes.

5.6.1.3 Right-of-Way Management

The potential for ecological impacts resulting from maintaining the transmission corridor will be minimized by following an ecologically sound management program.

As part of the Environmental Management and Construction Plan (EM&CP) that will be prepared by NMPC and submitted to the New York State Public Service Commission (PSC) prior to construction of the transmission line, surveys will be conducted to provide the information necessary to formulate a ROW management program. This information will be documented on a site-by-site basis using analysis forms (Site Analysis Survey) and aerial mosaic maps. Items of importance relating to the selection of clearing methods and ROW management techniques include the location and areal extent of woodland; the location of sensitive areas such as streams, wetlands, croplands, and highway crossings; and the proportions and densities of desirable and undesirable species[4,5]. The primary objective of the ROW management program, as part of the EM&CP, is the elimination of vegetation that could obstruct or damage the transmission lines or which could hinder access required for routine or emergency activities. This objective is accomplished through the utilization of proven, sound vegetation management and control techniques, including the Site Analysis Survey (geographic, topographic, and vegetative characterization of the ROW); selective clearing and slash disposal techniques based on the Site Analysis Survey; protective measures for stream crossings, wetlands, and agricultural lands; limitations on the construction and location of access roads; and the controlled (stump, basal, or foliar spray) application of approved herbicides. The method and pattern of vegetation management is planned to retain desirable growth to the extent practical, while effectively eradicating only undesirable species. New and improved techniques are evaluated and incorporated into the ROW management program when warranted.

Selectively retaining compatible, low-growing tree and shrub species is another objective of the ROW management program. This practice fosters the natural development of dense old field shrub (low-growing) communities, which provide competition to invading undesirable species. This community frequently differs from vegetative communities adjacent to the ROW, resulting in the creation of greater vegetative diversity and improved wildlife habitat.

The ROW will also be managed to maximize compatibility with environmentally and visually sensitive areas. Where

required, this will be accomplished through the retention of vegetative buffer zones at significant streams, other sensitive water bodies, and road crossings, and through the application of selective management techniques to eventually convert these buffers to naturally invading low-growing species that are compatible with both the transmission line facility and aesthetic or other environmental considerations.

Other objectives of the ROW program include management of the ROW for compatibility with the agricultural, recreational, and other multiple-use activities.

During preparation of the EM&CP, the ROW is divided into individual areas or sites (Section 2.4.1.2.2). Information is developed on a site-by-site basis during each survey. Forms used during the EM&CP and during each successive assessment are kept on file, serve as documentation of changes in vegetation and ROW conditions, and serve as information concerning the environmental impact of construction, restoration, and management of the transmission facility.

NMPC keeps ROW clearing to the minimum width necessary for construction, operation, and maintenance of the transmission facility. A cleared ROW width of 23 m (75 ft) on each side of the centerline has been established by NMPC as a standard for 345-kV lines. NMPC-established procedures for selective clearing and slash disposal, access route layout, structure laydown site designation, and restoration measures protect undisturbed vegetation and topsoil to the extent practical. NMPC utilizes a variety of selective clearing and slash disposal methods that are environmentally compatible with each site; consideration also is given to soil stability, protection of desirable vegetation, and protection of adjacent resources. These concerns are addressed in detail in the EM&CP.

NMPC cleanup and restoration plans include grading, seeding, and fertilizing when required on exposed mineral soil resulting from construction activities. Necessary erosion control measures such as ditching and water barriers installed during construction will not exceed 8 workdays after initial disturbance. Where initial disturbance occurs in snow or frozen soil conditions, temporary control measures will be installed such as cross ditching and mulching. Seeding will be initiated as soon as soil conditions are conducive.

NMPC-established procedures for stream protection, which include no equipment access areas, restricted activities

areas, clearing and slash disposal methods, stream-crossing devices, erosion control and restoration measures, and consultation with NYSDEC protect streams crossed by the transmission line.

NMPC utilizes herbicides in both construction and maintenance of the transmission facility. During construction, while clearing operations are progressing, it is anticipated that a stump herbicide treatment and/or basal treatment prior to cutting will be applied. It is further anticipated that a second herbicide treatment will be applied to vegetation of the ROW sometime between its second and fourth full-growing seasons. The actual time and method for this second treatment will be determined following a ROW inventory, whereby vegetative and physical conditions of the ROW will be considered in preparing the treatment plan. It is anticipated that methods for the second treatment will include stem foliar, basal, and cut and stump treatments. However, changing technology could alter application methods of both treatments. Therefore, more definite plans will be discussed in the EM&CP. Only those herbicides approved by the EPA and NYSDEC will be used. It is anticipated that picloram, triclopyr, and 2, 4-D herbicides will be utilized; however, at the time of treatment the use of other EPA- and NYSDEC-approved herbicides may be more prudent. Mixtures, rates, and volumes applied will be in accordance with label instructions.

In the maintenance phase, after construction is complete, the transmission line is included in the ROW management program for existing lines. In accordance with the PSC-approved system-wide Transmission Right-of-Way Management Program prepared by NMPC, an assessment is conducted within 4 yr after the last treatment. The purpose of this assessment is to: 1) document vegetation and ROW conditions, 2) determine whether to treat the area, and 3) specify maintenance techniques and materials. The maintenance treatment will occur the year following the ROW inventory. Assessments, ROW inventories, and treatments will continue throughout the life of the facility. Subsequently, at intervals of 5 to 8 or more years, vegetation management techniques described in the PSC-approved system-wide NMPC Transmission Right-of-Way Management Program, and/or in accordance with future PSC-approved ROW management programs, will be utilized as necessary to maintain system reliability. Only approved herbicides will be utilized at mixture rates and volumes in accordance with label instructions.

5.6.2 Aquatic

5.6.2.1 Identification of Operational and Maintenance Activities Associated With Transmission Facilities

As discussed in Section 2.4.2.2, there are few aquatic habitats crossed by the transmission route. None of these are unique environments, and no threatened or endangered fish or aquatic invertebrates are present.

The actual operation of the transmission electrical system and ROW, as described in Section 3.7 and the New York State Article VII Application filed in April 1982, has very little potential for adverse impact on aquatic ecosystems(5). Activities necessary to maintain the transmission lines and the corridor are sufficiently planned and controlled to protect aquatic communities along the route.

Care was taken during initial clearing to restrict activity in stream and wetland areas. In the year prior to conducting ROW maintenance, a site-by-site inventory will be performed to document vegetative conditions and to prescribe vegetative control measures. Stream and wetland areas will be identified, and vegetative control methods suitable to those areas will be prescribed. Where it is necessary to use herbicides, they will be applied, as appropriate, on a site-by-site basis. The most effective, approved herbicide available at the time of application will be used. The use of herbicides will be restricted in stream and wetland areas. Application (if any) in these sensitive areas will follow techniques and use amounts directed by the herbicide label, and will be in compliance with all applicable permits and regulations. Any vehicular access required during maintenance activities in these sensitive areas will be limited to existing access roads and stream crossings to avoid damage or erosion to these areas.

In summary, there is little potential for impact on aquatic habitats due to transmission line maintenance and operation.

5.6.3 Transmission System Impacts to Man

5.6.3.1 Land Use Impact

Construction of the new transmission line is discussed in detail in the Article VII application(5). Land use changes resulting from line construction will be limited because the new transmission line will be located within an existing transmission corridor. No land use changes are expected from the operation of the new transmission facility. No

areas within the ROW will be taken from designated public use. A relatively small area (approximately 6 percent) in the corridor supports active farming. Transmission structures will not preclude agricultural activities in the ROW. The transmission line corridor is shown on Figure 2.4-4.

Highway and rail transportation routes have not been affected by existing transmission lines and, therefore, are not expected to be affected by operation and maintenance of the new transmission line.

Operation of the transmission line will comply with all applicable local, state, and federal regulations and standards.

5.6.3.2 Audible Noise from Transmission Lines

Noise can be generated from transmission line corona discharges resulting from moisture on the high-voltage conductors. Corona discharge noise levels generated by a 345-kV transmission line during heavy rain conditions have been measured to be about 51 dBA at a distance of 38 m (125 ft). As the distance from the transmission line increases, the noise level decreases to approximately 43 dBA at 152 m (500 ft) and 36 dBA at 305 m (1,000 ft)(6). During light rain or dense fog conditions, these noise levels would be approximately 5-8 dBA lower. Installation of the Unit 2 transmission lines within the existing transmission line corridor can result in an intermittent noise level increase of approximately 3 dBA for a total of 54 dBA at a distance of 38 m (125 ft) from the transmission lines. Since the Unit 2 transmission line will be located within the existing transmission line corridor and since very few residences are located adjacent to the transmission line, audible noise from the 345-kV transmission lines is not expected to constitute a major new noise impact in the area.

5.6.3.3 Means to Reduce Impacts of Transmission Systems

NMPC has experienced no significant environmental problems associated with the electromagnetic and electrostatic effects of 115-kV and 345-kV transmission systems. The audible and visible effects of corona discharge are intermittent, depending on atmospheric conditions, and are substantially reduced by present-day, high-voltage equipment. In addition, these effects, when detectable, are usually of low intensity and are unnoticeable. NMPC has also experienced no significant problem with electromagnetic noise or radio interference.

Electrical field strength for the Unit 2 transmission system is discussed in Section 3.7. To date, Electric Power Research Institute (EPRI) sponsored research and research from other sources have demonstrated that the electric fields emanating from 115-kV and 345-kV transmission lines do not have adverse biological effects on humans.

Ozone production is associated almost exclusively with corona discharge. In the design of the 345-kV transmission lines, this phenomenon has been compensated for by avoiding the use of a single conductor per phase. Instead of a single conductor, critical spacing and two conductors per phase are used, breaking up the concentrated electrical field around a single conductor and thereby mitigating corona and ozone production.

NMPC has not included any new or unusual designs in any of the routes, towers, distances and dimensions, or any other engineering variables that may present new or adverse environmental impacts. Based upon the success of present designs, NMPC expects no significant effects to the environment or the public from the operation of Unit 2 transmission lines.

5.6.3.4 Maintenance Practices to Reduce Visual Impacts

Visual impact of the 345-kV line from Unit 2 to the Volney Substation is expected to be minimal, because it is located within an existing transmission line corridor and because of the remote location and limited use of lands and roads surrounding the combined ROWs. One state road and two county roads cross the 14.4-km (9-mi) line. Traffic volumes on roads in the area are low (Section 2.2.1). Views from roads crossing the line will be partially screened by vegetation and topography.

Existing roads will be utilized to a large extent for transmission line construction. New access roads will be constructed as required. Selective cutting at road crossings will reduce visual impact for persons using roads that cross the transmission line corridor. Selective clearing will be employed in woodland and brushland areas. Complete clearing will take place only at construction sites and access roads.

Land cover in the vicinity of the transmission line is primarily woodland (Section 2.4). There are actively farmed areas in the vicinity of O'Connor and Hall Roads. Significant views of structures and the ROW from most of the scattered residential properties along the ROW and from sight lines of travelers driving through the area will be

largely screened by intervening vegetation or structures. Some individual residences on County Route 1, Lily Marsh Road, County Route 29, and Hall Road will have views of the new transmission line[5]. Naturally growing shrubs and certain low-growing trees will be maintained at road crossings to provide partial screening of the facility. Private property ownership along the ROW will limit public access to the corridor.

5.6.4 References

1. Lee, J. M., Jr. Effects of Transmission Lines on Bird Flights: Studies of Bonneville Power Administration Lines. Paper presented at the Workshop on Impact of Transmission Lines on Migratory Birds, Oak Ridge, TN, 1978.

2. Weir, R.D. Annotated Bibliography of Bird Kills at Man-Made Obstacles: A Review of the State of the Art and Solutions. Department of Fisheries and the Environment, Canadian Wildlife Service, Ontario Region, Ottawa, Canada, 1976.

3. Avery, M.L.; Springer, P.F.; and Dailey, N.S. Avian Mortality at Man-Made Structures: An Annotated Bibliography. United States Fish and Wildlife Service, Office of Biological Services, 1978.

4. Niagara Mohawk Power Corporation. Article VII Application: Nine Mile 2-Volney 765-KV Transmission Facility, 1978.

5. Niagara Mohawk Power Corporation. Article VII Application: Nine Mile 2-Volney 345-KV Transmission Facility, 1982.

6. Electric Power Research Institute (EPRI). Transmission Line Reference Book for 345 KV and Above. Chapter 6, Audible Noise. 1975.