Final

environmental statement

related to the

FORKED RIVER NUCLEAR STATION UNIT 1

JERSEY CENTRAL POWER AND LIGHT COMPANY

DOCKET No. 50-363

February 1973

UNITED STATES ATOMIC ENERGY COMMISSION

DIRECTORATE OF LICENSING

SUMMARY AND CONCLUSIONS

This Final Environmental Statement was prepared by the U. S. Atomic Energy Commission, Directorate of Licensing.

1. This action is administrative.

2. The proposed action is the issuance of a construction permit to the Jersey Central Power and Light Company (hereafter the Applicant) for the construction of the Forked River Nuclear Station Unit 1 (hereafter the Station), a nuclear power reactor to be located a few miles inland from Barnegat Bay near the community of Forked River, Ocean County, New Jersey (Docket No. 50-363).

   Unit 1 will employ a pressurized water reactor to produce up to 3390 megawatts thermal (MWt). A steam turbine-generator will use this heat to provide 1093 megawatts of electrical power capacity (MWe). A "stretch power level" of 1143 MWe is anticipated at a future date and is considered in the assessments contained in this statement. The turbine-exhaust steam will be cooled with seawater obtained from a canal connected to Barnegat Bay and circulated through either a counter-flow or cross-flow, natural-draft cooling tower.

   The interaction of the Forked River Station with the nearby operating Oyster Creek Nuclear Station was considered in this statement in evaluating environmental impacts. The existing environmental conditions with the Oyster Creek Station operating were used as an evaluation baseline. The Staff analysis showed no significant compounding of potential adverse effects attributable to the addition of the Forked River Station. A separate environmental statement is being prepared for the Oyster Creek Station.

3. Summary of environmental impact and adverse effects:

   a. Several hundred acres of marginally productive agricultural land will be disturbed by construction activities and preempted for other uses. The associated loss of wildlife habitat will be minimal. Some turbidity may be

added to adjacent surface waters during the construction phase due to soil erosion and runoff: and a relatively small and temporary loss of benthic organisms will result from dredging operation in the bay and discharge canal.

b. Transmission lines right-of-way construction will result in the alteration of approximately two thousand acres of forest and agricultural land and the displacement of some wildlife presently in this area. In order to minimize impacts, the Applicant has cooperated with the State and local agencies to optimize wildlife values.

c. Aquatic organisms entrained in the plant's cooling water system will be killed due to thermal, chemical, and mechanical shock. This loss is not expected to represent a significant fraction of the bay's biomass or to affect the productivity of adjacent waters.

d. From 5,000 to 10,000 finfish and crabs will be destroyed each year by impingement and entrapment on water intake screens. This loss represents a very small fraction of Barnegat Bay ecosystem's annual production.

e. Chemicals discharged from the Station, particularly chlorine, will be readily diluted to concentrations below those which might adversely affect aquatic resources.

f. The cooling tower and issuing vapor plume may constitute a visual impact from surrounding areas and a possible distraction to traffic on the nearby Garden State Parkway. The several additional hours of fogging and/or icing expected each year should be of little consequence.

g. Use of fresh and salt water at the Station will not measurably deplete supply sources nor impair the quality of return flows for other uses.

h. The deposition of salt resulting from the operation of the cooling tower within present design criteria will have no significant adverse impact on adjacent surfaces and vegetation.

i. Normal operation of the Station will introduce a very small radiation dose to the environment which will not constitute a meaningful risk. The estimated dose to the population within 50 miles is about 10 man-rem/yr.

j. The addition of heat to the discharge canal from Forked River cooling tower blowdown is relatively small and will not adversely affect aquatic life in the canal or Barnegat Bay.

k. The risk associated with accidental radiation exposure is very low.

4. Principal alternatives considered:

   a. Abandonment of the site;
   b. The purchase of power;
   c. Use of fossil fuels;
   d. Location of the Station at other sites;
   e. An ocean outfall, once-through saltwater cooling system,
   f. Other freshwater sources (surface water and treated sewage effluent) as make-up for the cooling tower,
   g. The use of treated sewage effluent as make-up for a spray pond or evaporative cooling lake, and
   h. Transportation of radioactive materials by other than normal procedures.

5. Comments on the Draft Environmental Statement were received from the agencies and organizations listed below and have been considered in the preparation of the Final Environmental Statement. Copies of these comments are included as Appendix D and discussed in Section XII.

   Advisory Council on Historic Preservation
   Department of Agriculture
   Department of the Army, Corps of Engineers
   Department of Commerce
   Department of Health, Education and Welfare
   Department of Housing and Urban Development
   Department of the Interior
   Department of Transportation
   Environmental Protection Agency
   Federal Power Commission
   State of New Jersey
   Ocean County Commissioners.

6. This statement was made available to the public, to the Council on Environmental Quality, and to the other specified agencies in February 1973.

7. On the basis of the analysis and evaluation set forth in this statement, after weighing the environmental, economic, technical and other benefits against environmental costs and considering available alternatives, it is concluded that the action called for under the National Environmental Policy Act of 1969 (NEPA) and Appendix D to 10 CFR Part 50 is the issuance of a construction permit for the Forked River Nuclear Station Unit 1 subject to the following conditions for the protection of the environment:

   a. Measures will be undertaken to assure good practices to minimize the impacts resulting from the clearing of land, dredging operations, construction equipment oils and lubricants, and cleaning of plant equipment and piping. A separate clarification pond or other suitable means will be provided and used for presettlement of construction drainage waters to minimize the discharge of sediment to the discharge canal. (See Section IV-C.)

   b. The cooling tower drift and salt deposition investigatory program must be conducted through the prototypical testing stage to provide adequate assurance that the low salt deposition and low drift goal can be achieved and maintained throughout the life of the plant, to expand drift rate information for a wide range of meteorological conditions, and to assure the statistical reliability of the methods used. (See Section V-A.)

   c. Aquatic forms in the intake will be surveyed in detail. Those adversely affected by the intake and discharge will be monitored by number and species in order to determine the need, if any to install alternate or additional means for the preservation of such forms. (See Section V-C.2.)

   d. The environmental monitoring program will be expanded to include additional surface water sampling and increased frequency of milk sampling. (See Section V-D.4.)

   e. The objective of the station design shall be such that the release of radioiodines to the environment is controlled so that the Staff's projected annual exposure to the 2-gram thyroid organ of a child will not exceed 5 millirems. (See Section V-D.2)

   f. The Applicant shall implement a monitoring program to determine environmental effects which may occur as a result of site preparation and Station construction and operation. If harmful effects or evidence of irreversible damage are detected by the monitoring program, the Applicant will Provide to the staff an analysis of the problem and a plan of action to be taken to eliminate or significantly reduce the detrimental effects or damage.

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FOREWORD

This Final Environmental Statement on environmental considerations associated with the proposed issuance of a construction permit for the Forked River Nuclear Station Unit 1 was prepared by the U. S. Atomic Energy Commission, Directorate of Licensing (Staff) in accordance with the Commission's regulation, 10 CFR Part 50, Appendix D, implementing the requirements of the National Environmental Policy Act of 1969 (NEPA).

The National Environmental Policy Act of 1969 states, among other things, that it is the continuing responsibility of the Federal Government to use all practicable means, consistent with other essential considerations of national policy, to improve and coordinate Federal plans, functions, programs, and resources to the end that the Nation may:

- Fulfill the responsibilities of each generation as trustee of the environment for succeeding generations.
- Assure for all Americans safe, healthful, productive, and aesthetically and culturally pleasing surroundings.
- Attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences.
- Preserve important historic, cultural, and natural aspects of our national heritage, and maintain, wherever possible, an environment which supports diversity and variety of individual choice.
- Achieve a balance between population and resource use which will permit high standards of living and a wide sharing of life's amenities.
- Enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources.

Further, with respect to major Federal actions significantly affecting the quality of the human environment, Section 102(2)(C) of the NEPA calls for preparation of a detailed statement on:

(i) The environmental impact of the proposed action,

(ii) any adverse environmental effects which cannot be avoided should the proposal be implemented.

(iii) alternatives to the proposed action,

(iv) the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and

(v) any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented.

Pursuant to Appendix D of 10 CFR Part 50, the AEC Directorate of Licensing prepares a detailed statement on the foregoing considerations with respect to each application for a construction permit or full-power operating license for a nuclear power reactor.

When application is made for a construction permit or a full power operating license, the applicant submits an environmental report to the AEC. The staff evaluates this report and may seek further information from the applicant, as well as other sources, in making an independent assessment of the considerations specified in Section 102(2)(C) of NEPA and Appendix D of 10 CFR Part 50. This evaluation leads to the publication of a draft environmental statement, prepared by the Directorate of Licensing, which is then circulated to Federal, State and local governmental agencies for comment. Interested persons are also invited to comment on the draft statement.

After receipt and consideration of comments on the draft statement, the staff prepares a final environmental statement, which includes a discussion of problems and objections raised by the comments and the disposition thereof; a final cost-benefit analysis which considers and balances the environmental effects of the facility and the alternatives available for reducing or avoiding adverse environmental effects, as well as the environmental economic, technical, and other benefits of the facility; and a conclusion as to whether, after weighing the environmental, economic, technical and other benefits against environmental costs and considering available alternatives the action called for is the issuance or denial of the proposed permit or license or its appropriate conditioning to protect environmental values.

Single copies of this statement may be obtained by writing the Deputy Director for Reactor Projects, Directorate of Licensing, U. S. Atomic Energy Commission, Washington, D. C. 20545.

Mr. Leonard Galanter is the Environmental Project Manager for the AEC (Area Code 301, 973-7241) for this statement.

I. INTRODUCTION

The Jersey Central Power and Light Company applied to the U. S. Atomic Energy Commission in June 1970 for a permit to construct a nuclear power plant, Forked River Nuclear Generating Station Unit 1, several miles inland from Barnegat Bay and near the community of Forked River, New Jersey (Docket No. 50-363).

The Applicant submitted an "Environmental Report, Construction Permit Stage" for Forked River Nuclear Station, Unit 1 in July 1970 and in January 1972. The AEC forwarded copies of the 1972 report to appropriate federal and state agencies for review. Subsequently, an amendment to the environmental report was submitted by the Applicant on April 18, 1972. This Final Environmental Statement takes all of these writings into account and uses information available in the Applicant's Preliminary Safety Analysis Report and its amendments, the Staff's Safety Evaluation Report[1], and the Applicant's January 22, 1973 letter responding to agency comments. The Final Environmental Statement includes data and information obtained from a site visit in March 1972 as well as information from other sources referenced in the text. Finally, it relies heavily on professional calculations and appraisals made by the Staff.

As a part of its safety evaluation leading to the issuance of construction permits and operating licenses, the Commission staff makes a detailed evaluation of (1) the applicant's plans and facilities for minimizing and controlling the release of radioactive materials under both normal operating and potential accident conditions, (2) the adequacy of the applicant's effluent and environmental monitoring programs, and (3) the potential radiation exposure that might be received by station workers and members of the public. Inasmuch as these aspects are considered in the Staff's Safety Evaluation, only the salient features that bear directly on the anticipated dose to the public are repeated here. The comments that have been received from other Federal and State agencies in respect to overall safety evaluation are not elaborated on here.

The Applicant's Environmental Report includes an appendix that provides supplemental information pertaining to the Forked River site, plant operating characteristics, and environmental assessments. The Applicant's Environmental Report and amendment, the Preliminary Safety Analysis Report with amendments, and the Staff's Safety

Evaluation Report and the Applicant's January 22, 1973 letter responding to agency comments are on file in the AEC Public Document Room at 1717 H Street, N.W., Washington, D.C., and at the Ocean County Library, 15 Hooper Avenue, Toms River, New Jersey.

Forked River Nuclear Unit 1 will share the Site with the Applicant's operating Oyster Creek Nuclear Station. The proposed new facility will include a single pressurized-water reactor (PWR), supplied by Combustion Engineering, Inc., with an average net output of 1093 MWe and a stretch output of 1143 MWe.

In addition to the safety hearing held before the Atomic Safety and Licensing Board on December 15, 1972, hearings have been held and/or permits applied for with regard to site access, building, water use, waste discharge and related environmental considerations. These actions, involving a number of local, State and Federal agencies are enumerated in Section I.B and in the Applicant's Environmental Report.

The Applicant's planned schedule included starting site preparation work in February 1973 and completing all major construction and equipment installation in June 1977. To date, no work has been done at the Site nor has it been disturbed other than for soil boring operations, a minor disturbance.

A. SITE SELECTION

The selection of a site for construction of an electricity-generating facility depends on many interacting factors, both environmental and economical. These large power plants place unusual demands on prospective plant sites. Of paramount consideration to both nuclear and fossil fuel plants is the availability of large volumes of water for the dissipation of excess waste heat; the availability of land at a reasonable cost which is not critical to the agricultural or ecological needs of the resident wildlife and human population; compatibility of power plant with land use in the surrounding area; proximity of the plant to power users; and nearness to existing transportation and electrical transmission facilities. In selecting the site of the Forked River Nuclear Station adjacent to the Oyster Creek Nuclear Station these factors were considered and studies by the Applicant. Other alternative sites such as (1) Union Beach, New Jersey, (2) Gilbert, New Jersey, (3) Portland, Pennsylvania, (4) Scottsville, Pennsylvania, (5) Three-Mile Island, Pennsylvania, and (6) a generalized northern New Jersey site were considered and studied. A more detailed discussion of these sites is given in Section XI, as well as the reasons for the selection of the site at Forked River, New Jersey.

B. APPLICATIONS AND APPROVALS

A number of applications for permits, licenses, and approvals must be filed with appropriate private, local, State and Federal agencies in connection with construction activities, water use, waste discharge and related environmental considerations. The Applicant has identified the required applications, the approval and permit issuing agencies, and the status of filing in Table 4-38 (pg. 4-154) of the Forked River Unit 1 Environmental Report. The following applications have been filed and/or approvals received:

Construction Permit and Related Environmental Report (filed)	USAEC
Building and Sanitary Waste Disposal Permit (issued)	Lacey Township
Well Drilling Permit and Water Diversion Permit for Construction Dewatering (issued)	New Jersey Department of Environmental Protection
Construction of Sanitary Waste and Sewer System (filed)	New Jersey Department of Health
Access Roads to U.S. Highway 9 (filed)	New Jersey Department of Transportation
Right to Cross Easement (filed)	Central Railroad of New Jersey
Waste Discharge Permit and Dredging Permit for Barge Unloading Facility	U. S. Army Corps of Engineers
Certificate of Compliance, Water Quality Certification	New Jersey Department of Environmental Protection
Stream Encroachment Permit	N.J.D.E.P.

The following are among the applications yet to be filed (or refiled) by Jersey Central Power and Light:

Plant Operating License and Related Environmental Report	USAEC

Cooling Tower	Federal Aviation Agency
Water Diversion Permit for Plant Needs	New Jersey Department of Environmental Protection
Air Pollution Control Stack Construction and Operating Permits	N.J.D.E.P.
Transmission Line Rights-of-way	N.J.D.E.P.
Sanitary Waste Disposal, Permanent Facility	New Jersey Department of Health

II. THE SITE

A. LOCATION OF PLANT

Forked River Nuclear Generating Station Unit 1 will be located on a site, about 2 miles south of the community of Forked River, that is partly in Lacey and partly in Ocean Townships of Ocean County, New Jersey (Figure II-1). The 1416-acre Site, owned by Jersey Central Power and Light Company, will be shared with the Oyster Creek Nuclear Generating Station that has been in operation since December 1969 (Figure II-2). The Site is in the coastal pine barrens 60 miles south of Newark, 35 miles north of Atlantic City and 9 miles south of Toms River. Barnegat Bay, 2-3/4 miles east of the Site, is about 3-1/2 miles wide and is separated from the Atlantic Ocean by the long and narrow Island Beach which is 1/2 mile wide at this location opposite the site.

U.S. Highway 9 passes through and divides the Site nearly in half with both the Oyster Creek and Forked River Stations located in the western half. Forked River Unit 1 will be 3400 ft west of the Oyster Creek Station. The Garden State Parkway is located about 0.6 miles west of the proposed Forked River Station and abuts the Station's western property line.

B. REGIONAL DEMOGRAPHY AND LAND USE

The resident and seasonal population distributions within a 60-mile radius of the Site are shown in Figures II-3 and II-4, respectively. Population centers within 10 miles of the Site are Dover Township (1970 population: 43,751) with a nearest boundary 9 miles from the Site, the Borough of South Toms River (1970 population: 3,981) with its nearest boundary 8 miles from the Site and the town of Forked River (1970 population: 4,616) about 2 miles from the Site (Figure II-5). The major centers of population within a 60-mile radius are Philadelphia and New York City. Distribution of permanent and seasonal residents in 1978 and 2018 were interpolated from population records, and state and county population projections. Table II-1 shows the population distribution projections for 1978 and 2018 between 1 and 5 miles from the Forked River facility.

The distance from industrial areas and lack of public transportation will probably limit the population near the Site to summer and retirement home development. Also, land use predictions based on zoning and past trends indicate that future development of Ocean County will be primarily east of the Garden State Parkway.

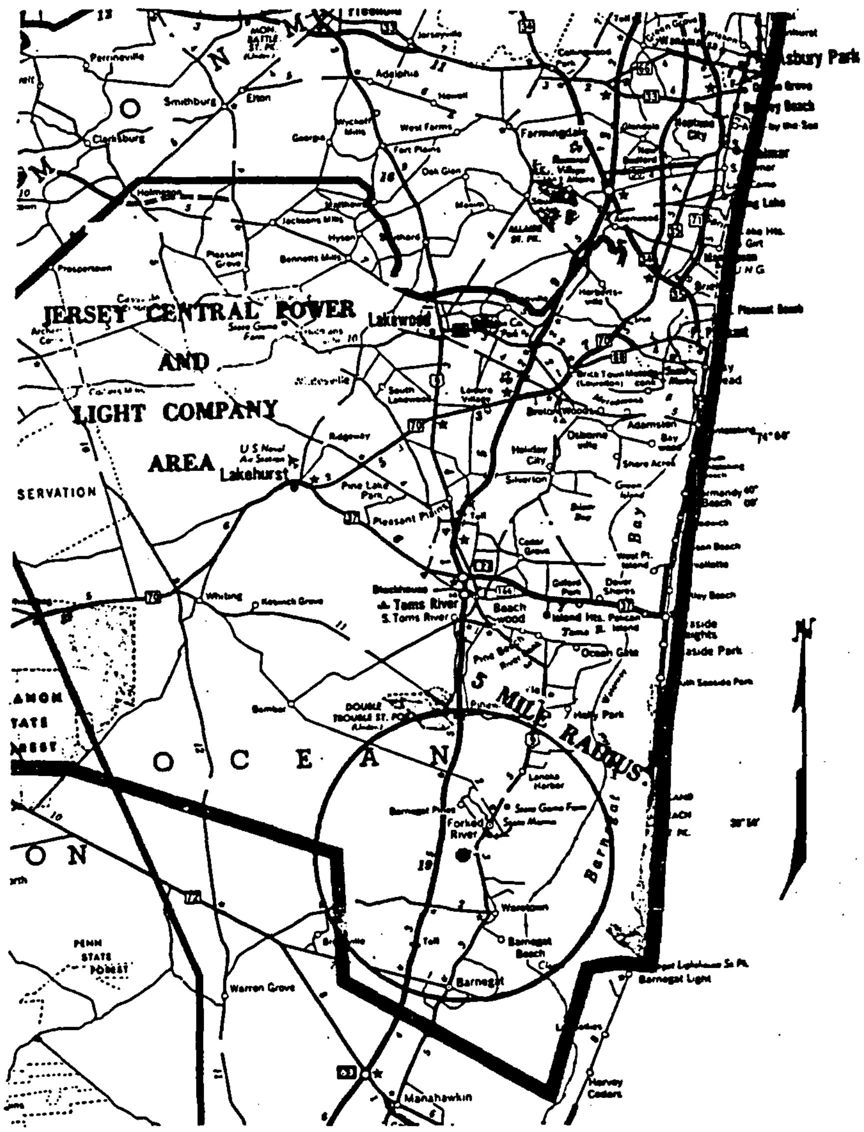
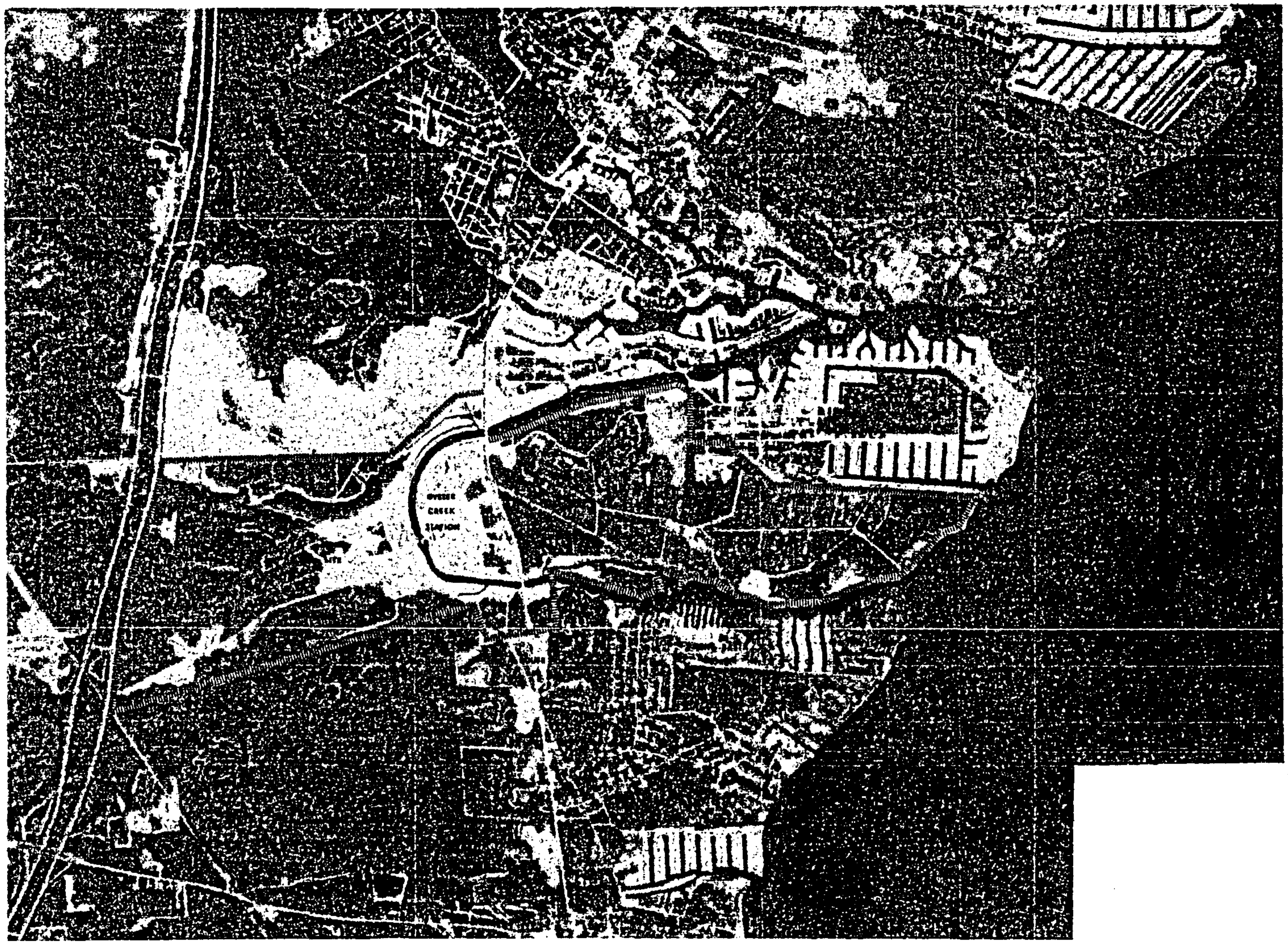
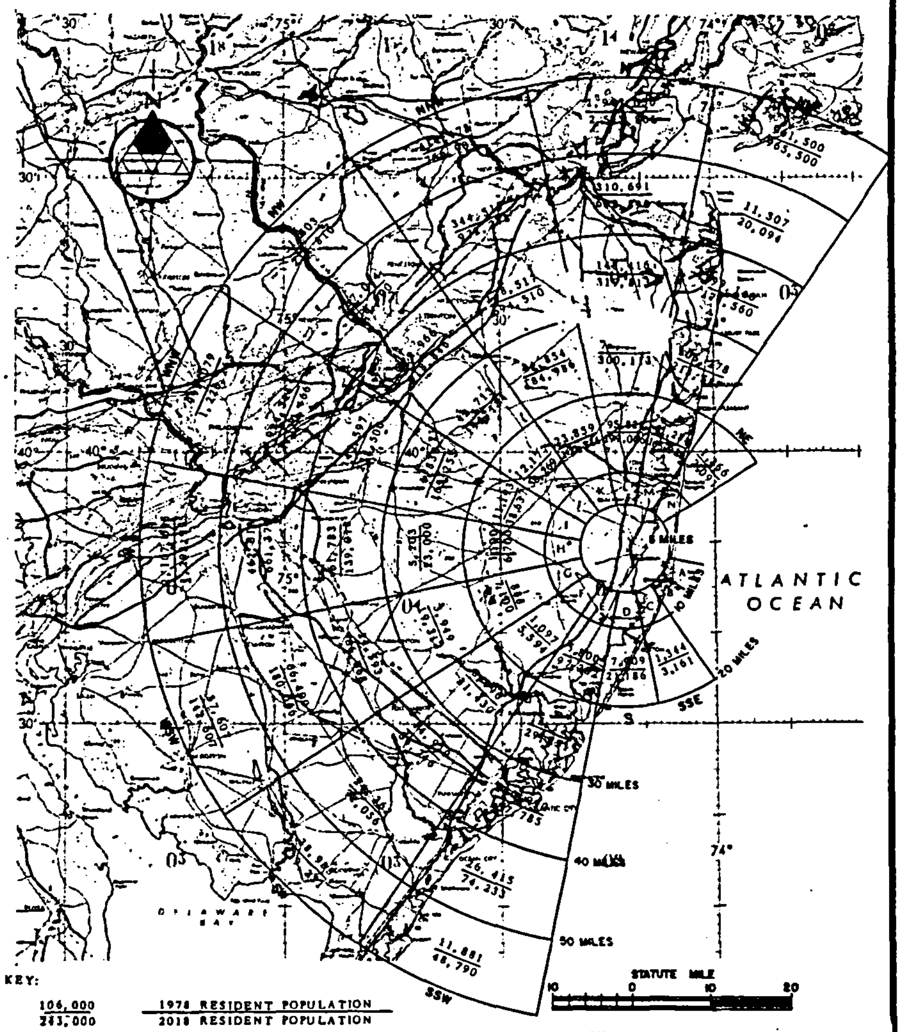


FIGURE II-1. FORKED RIVER PLANT LOCATION



<u>FIGURE II-2.</u> FORKED RIVER AND OYSTER CREEK SITES



KEY:

106,000 — 1978 RESIDENT POPULATION

243,000 — 2018 RESIDENT POPULATION

NOTE:

RADIUS IN MILES	20	30	40
ACCUMULATED POPULATION	294,841	640,563	1,598,483
	864,931	2,030,647	4,404,493

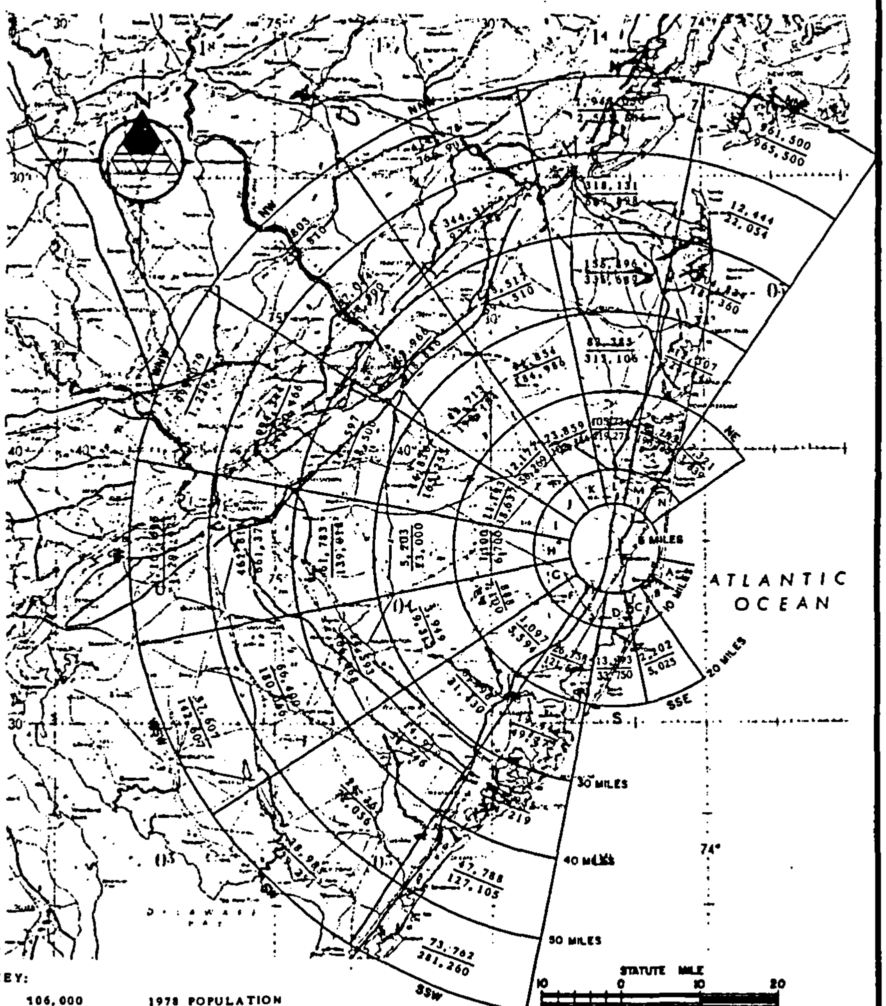
RADIUS IN MILES	50	60
ACCUMULATED POPULATION	4,106,131	9,692,227
	8,885,063	16,202,970

REFERENCE:

THIS MAP WAS PREPARED FROM PORTIONS OF SECTIONAL AERONAUTICAL CHARTS, WASHINGTON AND NEW YORK.

A = 360/688
B = 1,250/2,995
C = 550/1,204
D = 1,473/6,629
E = 1,954/9,184
F = 28/129
G = 372/1,600
H = 35/151
I = 19/82
J = 178/765
K = 39/2,617
L = 19,860/51,436
M = 12,613/30,394
N = 3,221/8,215

FIGURE II-3 REGIONAL MAP SHOWING 1978-2018 RESIDENT POPULATION



KEY:

106,000 / 243,000 = 1978 POPULATION / 2018 POPULATION

NOTE:

RADIUS IN MILES	20	30	40
ACCUMULATED POPULATION	366,429	732,110	1,714,140
	1,029,247	2,244,039	4,659,995

RADIUS IN MILES	50	60
ACCUMULATED POPULATION	4,251,758	9,899,715
	9,210,197	16,760,574

REFERENCE:

THIS MAP WAS PREPARED FROM PORTIONS OF SECTIONAL AERONAUTICAL CHARTS, WASHINGTON AND NEW YORK.

A = 224 / 1,032	H = 35 / 151
B = 1,790 / 4,494	I = 19 / 82
C = 790 / 1,860	J = 178 / 765
D = 2,062 / 9,944	K = 39 / 2,617
E = 2,736 / 13,776	L = 28,004 / 76,154
F = 28 / 129	M = 17,058 / 45,091
G = 372 / 1600	N = 4,869 / 12,323

FIGURE II-4 REGIONAL MAP SHOWING 1978–2018 SEASONAL PLUS RESIDENTIAL POPULATION

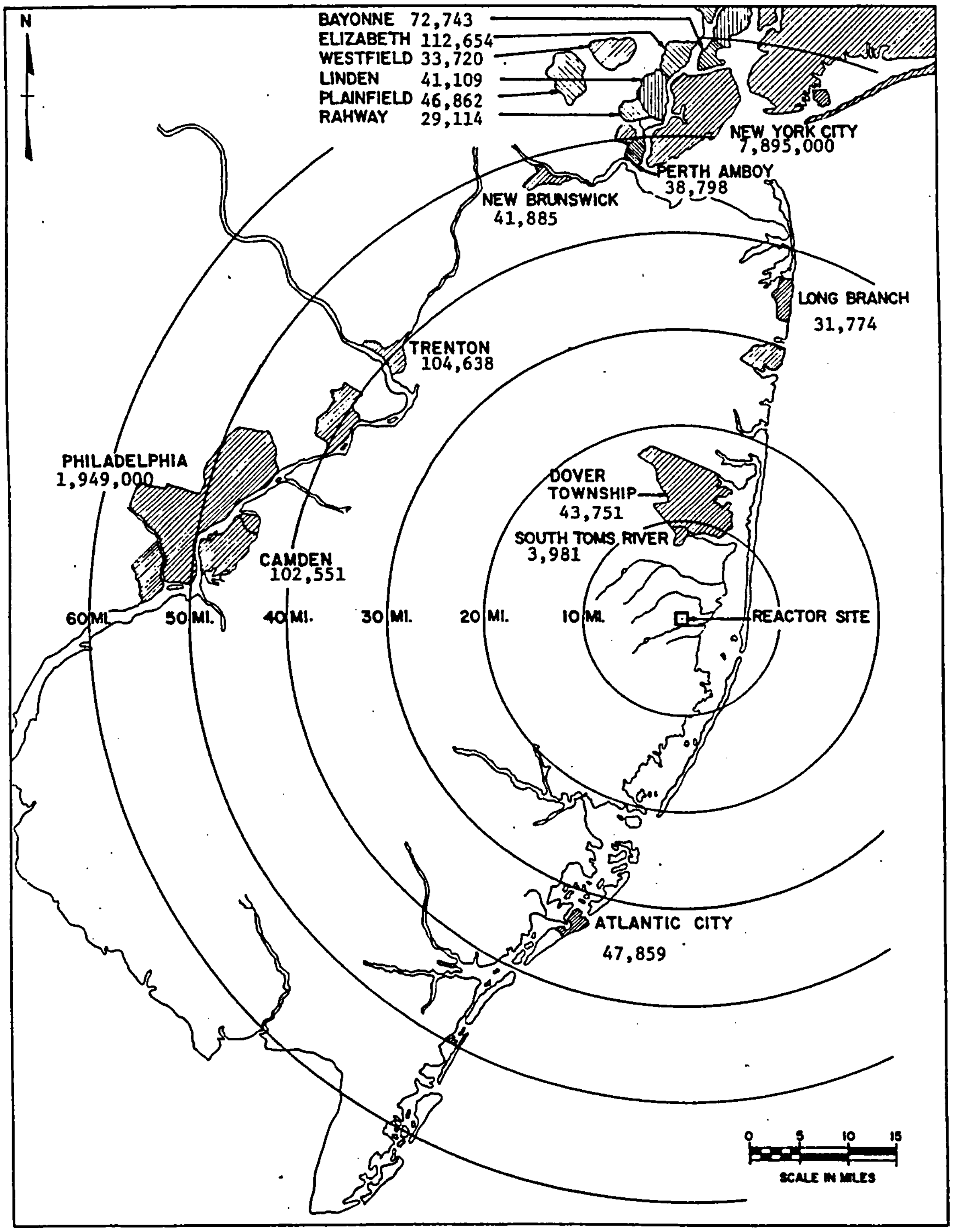


FIGURE II-5. PRINCIPAL COMMUNITIES WITHIN 60 MILES OF THE FORKED RIVER SITE

TABLE II-1

ACCUMULATED POPULATION BETWEEN 1 AND 5 MILES FROM THE FORKED RIVER FACILITY, 1978 AND 2018 PROJECTIONS

Radial Distance From Site (miles)	Accumulative Population Resident 1978	Resident 2018	Seasonal 1978	Seasonal 2018
1	31	271	43	409
2	1,447	6,172	2,020	9,256
3	4,224	18,403	5,884	27,614
4	7,257	31,826	10,050	47,503
5	9,354	40,729	12,960	60,465
10	51,106	156,818	71,124	230,484

Much of the area within 60 miles of the Site is occupied by pine barrens and approximately 70% of the land area within 40 miles is forest, vacant or farm land, with little industrial development. Heavy industrial development occurs from 40 to 60 miles from the Site near the metropolitan areas of New York and Philadelphia. Table II-2 lists the counties within a 60-mile radius of the Site and the present land uses in these counties. Ocean County, where the Site is located, has 641.0 square miles of land and 113.3 square miles of water, for a total of 754.3 square miles.

The resort industry is the major economic activity in the county with an annual gross of over $700 million. The recreational activities include auto racing, sailboat and outboard motorboat races, and a wide variety of water activities.

Land use near the Site is devoted primarily to summer, permanent, and retirement residences. Future land development is expected to continue along the same lines.

The Agricultural Census of 1969 indicates a decline in Ocean County farming since 1964. The average size of farms having more than $2500 annual sales increased from 63 to 72 acres but the number of farms dropped from 248 to 101. Total acreage dropped from 15,400 to 7,249 during the period. Still, reports showed over 368,000 laying hens and pullets on 62 farms in 1969, and 209 dairy cattle on 7 farms. Three acres distributed among four farms were assigned to watermelons.

TABLE II-2

LAND USE

COUNTY	TOTAL AREA (SQUARE MILES)	AREA WITHIN 60 MILES (SQUARE MILES)	FOREST %	FARM %	INDUSTRY %	PUBLIC LANDS %	ROADS %	RAILROADS %	RESIDENTIAL AND OTHER %
ATLANTIC CO., NJ	565.55	565.55	60.6	12.7	0.1	10.7	4.1	0.2	11.6
BURLINGTON CO., NJ	819.3	819.3	26.5	35.2	0.3	23.6	3.1	0.2	11.1
CAMDEN CO., NJ	222.16	222.16	34.1	13.2	1.9	14.3	7.9	0.8	27.3
MERCER CO., NJ	226.00	226.00	5.5	43.6	2.2	4.3	6.0	0.7	37.7
MIDDLESEX CO., NJ	308.79	308.79	24.1	21.7	6.9	6.0	7.0	1.4	32.9
MONMOUTH CO., NJ	477.01	477.01	19.1	34.6	0.4	6.4	5.1	0.4	34.0
OCEAN CO., NJ	641.00	641.00	59.0	6.9	NIL	15.2	4.6	0.2	14.1
BUCKS, PA	616.64	274.18	28.3	47.8	←———	———	23.9	———	———→
PHILADELPHIA CO., PA	129.0	129.0	NIL	NIL	←———	———	100	———	———→
RICHMOND CO., NY	57.0	57.0	9.0	15.0	2.5	10.0	6.0	0.5	57.0
SOMERSET CO., NJ	305.10	215.94	15.6	42.6	5.0	6.2	8.3	0.9	21.4
GLOUCESTER CO., NJ	328.60	300.48	29.2	36.5	0.3	9.8	7.1	0.6	16.5
UNION CO., NJ	103.39	68.96	NIL	2.2	←———	———	97.8	———	———→
CAPE MAY CO., NJ	265.34	166.23	62.0	12.5	NIL	10.8	4.5	0.2	10.0
HUDSON CO., NJ	44.10	4.97	NIL	NIL	←———	———	100	———	———→
CUMBERLAND CO., NJ	502.40	274.94	26.4	37.5	0.5	20.8	3.2	0.2	11.4
SALEM CO., NJ	343.02	83.05	31.6	50.5	←———	———	17.9	———	———→
MONTGOMERY CO., PA	491.08	112.12	19.88	37.6	←———	———	42.7	———	———→
DELAWARE CO., PA	184.43	8.13	7.95	17.3	←———	———	74.8	———	———→
HUNTERDON CO., NJ	437.00	113.30	30.3	47.3	←———	———	22.4	———	———→
NASSAU CO., NY	289.0	9.0	←———	———	100	———	———	———	———→
KINGS CO., NY	81.05	48.50	NIL	NIL	←———	———	100	———	———→
QUEENS CO., NY	118.6	9.50	NIL	NIL	←———	———	100	———	———→

Central Ocean County countryside has rich cranberry bogs. During mid-summer, cranberry bogs, often surrounded by pines and other foliage, provide attractive picnic settings. A total of 3,500 acres is devoted to cranberry production. This acreage is comparable to that set aside for blueberry raising.

The Ocean County Planning Board, which is the Economic Clearinghouse listed in Bureau of the Budget Circular A-95, has been kept informed of the progress of this project via the Ocean County Board of Freeholders. The Applicant routinely supplies the Board with pertinent information.

The Forked River Nuclear Station will increase the annual tax income of Lacey Township by at least $1 million. Further increases of the tax income of other townships in the Jersey Central Power and Light operating area will result from transmission and use of the electrical energy to be provided by the Station.

C. HISTORIC SIGNIFICANCE

The Applicant has identified 47 historical sites in Ocean County[1] including two that are recognized in the National Register of Historic Places[2]: Hangar Number 1 at the Lakehurst Naval Air Station (about 20 miles NNW of the Station Site) and Barnegat Lighthouse (6 miles southeast of the Site). These two historic sites are recognized by the Cultural Center of the State of New Jersey.

There are no historic sites on the Applicant's property nor will the Station and associated transmission lines intrude on or otherwise adversely affect the setting and significance of historic places. Also, the Curator of Cultural History of the New Jersey State Museum has found no evidence of archaeological sites within the Station property bounded by Oyster Creek, the South Branch Forked River, the Garden State Parkway, and Barnegat Bay[1].

D. ENVIRONMENTAL FEATURES

1. GEOLOGY

Considerable local and regional geological investigations were carried out in connection with the existing Oyster Creek Station well before the initiation of planning for the Forked River Station. Information from the 182 existing test borings was supplemented with that from 52 more recent borings to define in detail the soils and stratigraphy of the Station and adjacent areas.

The upper compact sand, extending from the surface to a depth of about 16 ft, is underlain by a stiff clayey-silt ranging from 10 to 17 ft in thickness. These two uppermost layers have been correlated with the Cape May Formation identified at a nearby boring. These beds are underlain by the compact coarse sands to fine gravels of the Cohansey Formation which extend from 30 to 90 ft below grade at the Site. The underlying Kirkwood Formation (varying from 9 to 54 ft in thickness, and consisting of compact, gray, fine-to-medium sands) is characterized by a thin surface layer of interbedded clay and sand. Similar interbeds of clay in dense sand were encountered predominantly at depths between 192 and 251 ft below grade. The total thickness of these clay-sand lenses in the upper 250 ft of soil profile is probably less than 10 ft.

Although the lower strata of the thick prism of Coast Plain sediments are highly consolidated, none of them are considered true bedrock. The depth to hard rock at the Site, based on seismic profiling and a deep test well drilled on Island Beach, is estimated to be between 1800 and 2000 ft.

There is no evidence of faulting in the vicinity of the Site and the nearest known fault is at Morrisville, Pennsylvania, about 40 miles to the west. Also, the Site is in a seismically quiet region of deep overburden; and although a number of small earthquakes have occurred in the general New Jersey area, the State falls into Zone I (minor damage) with respect to seismic probability.

2. CLIMATE

The climate of the Forked River area is principally continental but is moderated by land and sea breezes which produce relatively cool summers and mild winters when compared to other areas at the same latitude. Land and sea breezes occur when storms are not present in the area. During the warm season the sea breezes bring cooler ocean air inland during the late morning and afternoon.

The thermal lag of the ocean is responsible for relatively warm fall seasons and cool springs. During spring and summer, winds are predominately onshore during daylight hours and offshore at night. During winter, offshore winds dominate both day and night. The monthly distribution of temperature, precipitation, snow and sleet, relative humidity, mean wind speed and prevailing direction, and number of days of thunderstorms and heavy fog are shown for Atlantic City (31 miles south of Site) in Table II-3[3].

TABLE II-3

CLIMATOLOGY, ATLANTIC CITY, NEW JERSEY

	TEMPERATURE (°F)			PRECIPITATION (IN.)				SNOW, SLEET (IN.)	HUMIDITY[a]		WIND[a]		THUNDERSTORMS	HEAVY FOG[a]
	DAILY			MONTHLY			MAX IN. 24 HRS	MONTHLY AVG					NO. OF DAYS	NO. OF DAYS
	MAX	MIN	MONTHLY	AVG	MAX	MIN			7 AM EST	7 PM EST	MEAN SPEED	PREVAILING DIRECTION		
JAN	42.9	26.6	34.8	3.56	7.71	0.26	2.86	4.4	77	69	12.6	WNW	(a)	3
FEB	43.3	26.1	34.7	3.13	5.98	1.46	1.95	3.3	77	70	12.3	W	(a)	6
MAR	49.7	32.4	41.1	3.91	6.80	0.62	2.22	3.5	77	64	13.1	WNW	1	3
APRIL	60.3	41.7	51.0	3.41	7.95	1.24	3.37	0.3	73	59	12.9	S	2	2
MAY	71.0	51.5	61.3	3.51	11.51	0.40	4.15	0.0	77	64	11.0	S	3	3
JUNE	79.2	60.7	70.0	2.83	5.73	0.10	2.91	0.0	81	67	10.0	S	4	4
JULY	83.8	66.3	75.1	3.72	13.09	1.30	6.46	0.0	83	68	9.7	S	5	3
AUG	82.2	65.1	73.7	4.90	11.02	0.34	4.97	0.0	87	74	9.2	S	5	4
SEPT	76.0	58.4	67.2	3.31	4.92	0.46	3.98	0.0	87	76	10.1	ENE	1	2
OCT	66.5	47.8	57.2	3.20	7.50	0.15	2.95	T	85	73	10.8	W	1	6
NOV	55.5	37.9	46.7	3.66	8.60	0.72	3.93	0.3	83	71	12.2	W	(a)	3
DEC	45.1	28.1	36.6	3.22	6.57	0.62	2.75	2.8	78	70	11.9	WNW	1	5
YEAR	63.0	45.2	54.1	42.36	13.09	0.10	6.46	14.6	80	69	11.3	S	24	43

EXTREMES:

TEMPERATURE: 104°F AUGUST 1918, -9°F FEBRUARY 1934[b]

PRECIPITATION: MAX. MONTHLY 14.87 IN. AUGUST 1882, MIN. MONTHLY 0.01 IN. SEPTEMBER 1941
MAX. IN 24 HOURS 9.21 IN. OCTOBER 1903
MAX. MONTHLY SNOWFALL 27.9 IN. FEBRUARY 1899, MAX. SNOWFALL IN 24 HR 18.0 IN. FEBRUARY 1902

WIND: 91 MPH

[a] BASED ON 5 YEARS OF DATA. OTHER STATISTICS BASED UPON 19 YEARS OR MORE OF DATA.

[b] DATA FROM THE NEW JERSEY AGRICULTURAL EXPERIMENT STATION 25 MILES FROM FORKED RIVER RECORDED EXTREMES OF 106 AND -23°F DURING THE PERIOD 1926-1955.(4)

Windspeed, direction and stability data obtained by the Applicant from January 1967 through December 1968 are summarized in Table II-4. Extreme winds are associated with tornadoes and hurricanes. Between 1920 and 1967, 33 tornadoes were recorded in New Jersey with 4 of these in Ocean County. In addition, 9 hurricanes passed within 100 miles of the Station site between 1944 and 1966, with the nearest approach being 30 miles SSE of the Site. The Applicant reports that hurricane Agnes, which occurred near the end of June 1972, resulted in no flooding around the plant site and there was little effect on the tidal variation in Barnegat Bay. About 2 inches of rainfall were recorded and peak wind measured on site was 38 mph WSW on June 22, 1972.

The frequency of inversions based below 500 ft is about 20-25% throughout the year[5]. Monthly mean mixing depths vary from about 1900-3000 ft in the morning to about 5000 ft in the afternoon[6].

The temperature difference data presented by the Applicant showed unrealistic characteristics when compared with similar coastal sites. Also, a site visit by the Staff revealed that there were large errors during calibration checks. Therefore, the onsite data have not been used in our evaluation. We estimate the annual average χ/Q to be 1×10^{-5} sec/m^3 at the site boundary (646 m SE of the plant) based on wind direction frequency and stability conditions extrapolated from nearby sites.

Atlantic City Airport records indicate that dense fog (visibility less than 3/8 mile) occurs on an average of 155 hrs/yr. The potential for incremental fogging effects from cooling towers along most of the Atlantic seaboard has been evaluated to be moderate[7].

3. HYDROLOGY

a. Surface Waters

The Station site is closely involved with adjacent Barnegat Bay which is historically connected to Ocean County waterbased activity dating to colonial times. The geologic history of the New Jersey shore has produced a unique lowlands environment in which long-term rising and subsidence of the relatively low and flat topography has interacted with the shoreline interface to form a highly convoluted, extensively estuarine swamplands protected by barrier islands which form saline inlets. This is more or less typical of the entire Eastern Seaboard below New York City; and, because of the resemblance of this coast to Western European coastlines, it was a hospitable environment to the water-based industry and commerce of the colonial times.

TABLE II-4

FORKED RIVER ONSITE METEOROLOGICAL DATA SUMMARY, 1967-68

DIRECTION VERSUS STABILITY (%)[a]

	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL HR
UNSTABLE (A, B, C)[b]	4.0	3.7	5.4	6.5	4.1	3.6	5.0	6.3	8.7	9.0	6.0	5.4	6.9	10.4	9.3	6.0%	9190
NEUTRAL (D)	2.1	0.9	1.0	3.2	8.0	6.0	4.3	3.0	4.3	5.4	6.2	9.4	12.2	13.6	13.2	7.2%	4095
STABLE (E, F)	2.1	1.0	0.1	0.4	2.3	2.9	1.9	2.4	2.6	3.9	8.0	21.1	18.7	12.8	13.4	7.0%	1601

SPEED VERSUS STABILITY (%)[a]

MPH	UNSTABLE (A, B, C)	NEUTRAL (D)	STABLE (E, F)
1-3	12.5%	13.9%	19.0%
4-7	27.8	44.0	61.0
8-12	35.2	31.6	18.9
13-18	18.2	7.8	1.1
19-25	5.6	2.4	0
26-32	0.6	0.3	0
33-40	0.1	----	0
>40	----	0	0
TOTAL HR	9101	4095	1606

STABILITY DISTRIBUTION

BASED ON:	ΔT[c]	σθ[a]
A[b]	24%	6.4
B	2	13.5
C	2	41.6
D	12	27.6
E	26	9.3
F	14	1.6
G	20	----

[a] BASED ON σθ RANGE MEASUREMENTS AT 75-FT LEVEL

[b] PASQUILL STABILITY CLASSES

[c] BASED ON A TEMPERATURE DIFFERENCE BETWEEN 12 AND 75 FT LEVELS, AND THE STABILITY CLASS CORRELATION WITH ΔT RANGES RECOMMENDED BY AEC SAFETY GUIDE 23 (FEB 17, 1972)

In more recent times, the barrier islands forming Barnegat Bay have become tourist and vacation attractions of considerable public interest, and the location of the paralleling Garden State Parkway was dictated by the necessity of providing public access to this water-based recreation area. This is accented by the existence of the highest average occurrence of sunshine on the east coast area and a moderate rainfall. This, combined with the relatively low relief of the countryside, creates a great deal of swampy and poorly drained countryside which has evolved through the geologic ages as the New Jersey "pine barrens". Direct measurements of the drainage from the area are difficult and the total run-off is poorly documented except as implied from salinity gradients measured in Barnegat Bay. Computations of the net outflow into the Bay by consultants to the Applicant[8] indicate a mean drainage flow of some 360 cfs. Since the mean evaporation for Ocean County is about 32 in./yr, the data suggest a total drainage into the bay from an area of some 700 square miles from all sources combined.

In the immediate Station site, the area is drained by two small drainage basins which converge into the Forked River and Oyster Creek before entering Barnegat Bay. The flow of the Forked River is intermittent, ungaged and is estimated to average less than 5 cfs. The companion stream, Oyster Creek, averages 25 cfs and varies between a maximum of 125 cfs and a minimum of 12 cfs. Other more major sources of drainage to the bay include the Toms River Basin which averages 200 cfs with a minimum of 85 cfs, and the Cedar Creek Basin which averages 108 cfs with a minimum of 40 cfs. The integrated summary of these inflows and their associated drainage areas appear to confirm the estimate of net inflow made from salinity variations and net tidal exchange through the mouth of Barnegat Bay.

The bay itself is approximately 50 miles long and opens into the Atlantic Ocean at two points. The major inlet is about 20 miles from the north end, and at the south end Barnegat Bay connects to Manahawkin Bay. Salinities range from near brackish at the north end to seawater at the south end. Information presented by the Applicant, which was obtained in field studies by Carpenter-Pritchard Consultants, reveals that salinities average about 12 ppt in the vicinity of Toms River 9 miles north of the proposed facility and about 32 ppt at the southern end adjacent to Manahawkin Bay (normal sea water contains about 35 ppt salinity). Because the seasonal rainfall distribution is relatively uniform, these salinity gradients are similarly uniform throughout the year. The vertical profile of salinity is also relatively uniform indicating that tidal mixing is the principal factor in the distribution of salinity. Above Toms River a relatively permanent halocline develops and vertical gradients of salinity ranging from 18 to 20 ppt at the

bottom and 10 to 13 ppt at the surface are evident in the summer months when maximum rainfall occurs. The average depth of the bay is about 5 ft with a few deeper locations ranging to a maximum of 20 ft, all referenced to mean low tide. The surface area of the bay is about 60 square miles (41,300 acres) and the volume is about 195,000 acre-ft. The normal tidal range in the bay is about 3.5 ft with a time cycle of about 12.7 hrs. The effects are highly attenuated north of Barnegat Inlet and the normal tidal range decreases to as little as 0.6 ft at the mouths of Oyster Creek and Forked River adjacent to the proposed Station site.

The natural hydrology of the proposed Station site area has been extensively altered in the past by construction of the Oyster Creek reactor which is currently operating as a once-through cooled system. A semicircular canal has been dredged between the South Branch of Forked River and Oyster Creek to form a circulation loop for the circulating water system flow into and out of Barnegat Bay, the principal cooling surface. In addition, Oyster Creek has been dammed to form a small fresh-water reservoir (fire pond) just to the south of the Station complex, the outlet of which merges with the original Oyster Creek and the superimposed canal. The circulating canal system is dammed at the approximate midpoint so that the entire flow of the system is presently either through the Oyster Creek plant condensers, through dilution pumps which essentially bypass the dam, or a combination of both. In essence, the South Branch of Forked River and Oyster Creek have become physical extensions of the Oyster Creek plant with the object of using circulation water and the cooling surface area of Barnegat Bay. The general arrangement of this system as it exists today with appropriate flows superimposed is illustrated in Figure II-6.

Because Barnegat Bay is relatively shallow, the water temperature responds readily to changes in air temperature. Surveys conducted in the spring of 1968 (prior to operation of the Oyster Creek Station) showed the bay surface and bottom temperature varying between 52-55.5°F in April and 61-66.4°F in May. Little, if any, persistent vertical change in water temperature was evident. Superimposed on the normal temperature of bay waters in the vicinity of the Station is the thermal regimen attributable to the discharge of condenser cooling water from the Oyster Creek Station. Additional discussions of this consideration are presented in Section III.D.1.

The water quality of streams flowing into Barnegat Bay was determined by the Applicant in 1965 prior to operation of the Oyster Creek Station. These values are essentially typical of the region

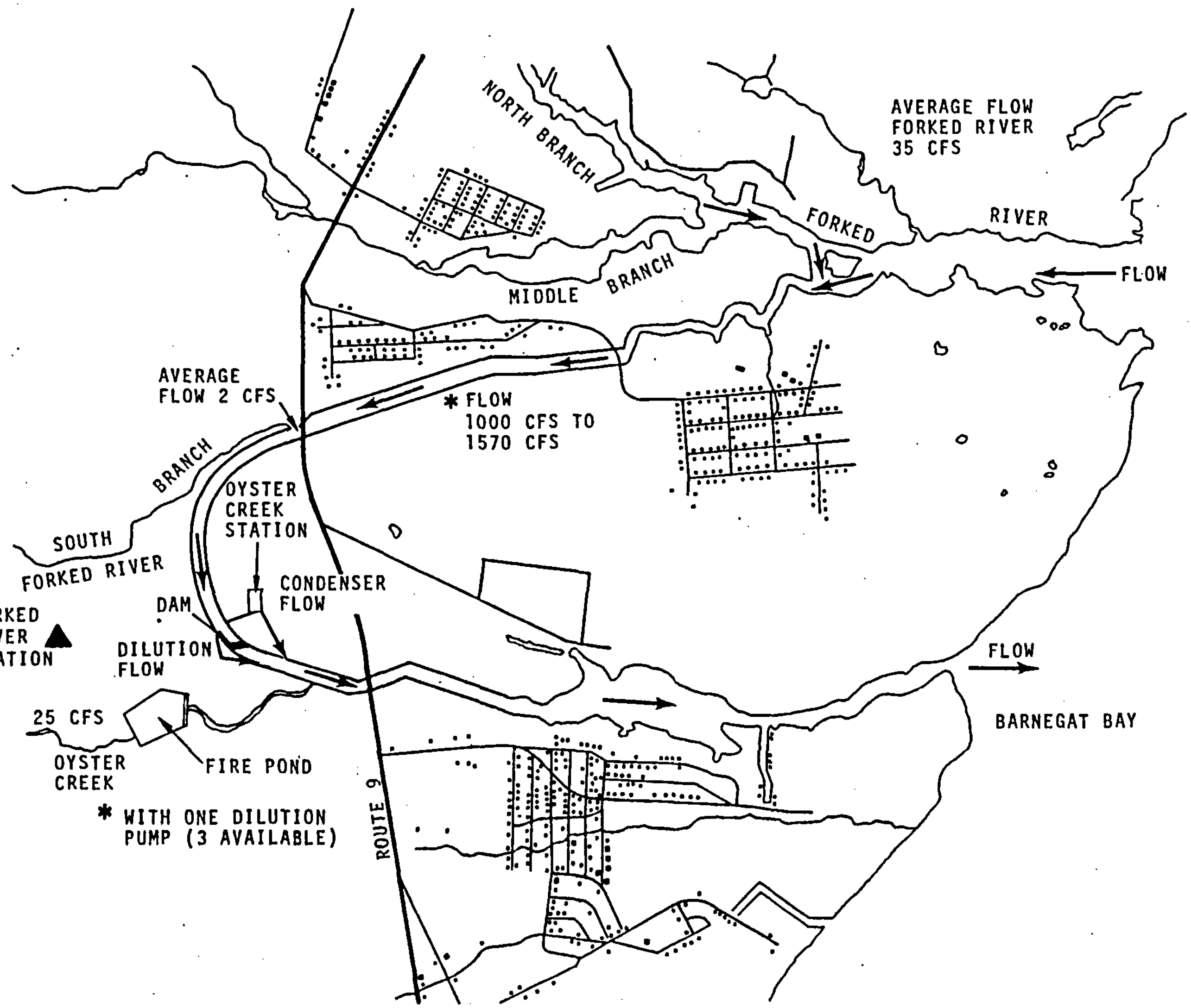


FIGURE II-6. EXISTING CIRCULATION SYSTEM FLOW CHARACTERISTICS

and are reproduced for background information (Table II-5). In addition, the Applicant summarized the thermal conditions of the bay proper and cataloged some water quality data of interest. Because of the high degree of variability of the bay, only representative values are shown (Table II-6).

b. Groundwater

The general area of the proposed Station site and contiguous lands, including Ocean County and the entire coastal plain of New Jersey, have abundant supplies of groundwater under low artesian heads throughout the entire year. The quaternary deposits of the upper 300 ft of gravels excluding the alluvium and sand of the top 50 to 75 ft have been developed to a limited extent. Flow tests have yielded high quality, low mineral content water up to 2.8 cfs (1,200 gpm). Below these surface layers (in the tertiary and cretaceous) important aquifers have been discovered and developed with flows ranging from 1 to 2 cfs (450 to 900 gpm) to as high as 5 cfs in the Raritan formation at depths of 2000 to 4000 ft.

The Oyster Creek Station obtains make-up water supplies from a well drilled in the Cohansey Sand at a depth of 350 ft.

An inventory of groundwater users in the vicinity of the proposed Station and contiguous area has been listed in Table III-9 and Figure III-12 of the Applicant's Environmental Report. The supporting investigations of the State of New Jersey and the Applicant reveal no detectable effect of the existing Oyster Creek Station on groundwater levels and quantity, nor any information which indicates that present uses of the groundwater resource by the public have diminished the aquifer potential to a measurable extent.

E. ECOLOGY OF SITE AND ENVIRONS

1. Terrestrial Ecology

The Applicant's staff and consultants have conducted environmental studies to establish baseline information and to evaluate the potential effects of the Station complex on the environment. The undisturbed vegetation of the Site and most of the transmission line rights-of-way is typical of New Jersey Pine-Barrens as originally described by Harshberger.[9] Oak-Pine Upland Forest is the most abundant vegetation type within a 5-mile radius of the Site. Oaks and pitch pine form a rather closed canopy with many herbaceous species beneath. White Cedar Swamp Forest is the least abundant vegetation type but ecologically

TABLE II-5

CHEMICAL ANALYSES OF WATER FROM OYSTER CREEK AND THE SOUTH BRANCH OF FORKED RIVER

		1(a) ppm	2(a) ppm	3(a) ppm
ANALYSIS REPORTED AS $CaCO_3$				
Calcium		5.3	4.3	0.0
Magnesium		3.2	4.8	4.3
Sodium & Potassium		17.3	11.3	47.0
Total Cations		25.8	20.4	51.3
Chloride		11.2	9.9	10.1
Sulphate		6.9	0.3	40.0
Nitrate		0.3	0.8	1.2
Bicarbonate		6.9	9.4	0.0
Total Anions		25.3	0.4	51.3
CONSTITUENT				
Free Carbon Dioxide	CO_2	8	5	-
Hydrogen Ion Concentration	p^H	4.8	4.8	4.0
Turbidity	-	Tr.	Tr.	5.0
Organic & Solids	-	13	5	15.9
Total Solids	-	35	20	37.9
Conductivity	μmhos	42	34	69.4
Methyl Orange Alkalinity	$CaCO_3$	4	5	0.0
Total Silica as	SiO_2	8	4	5.2
Soluble Silica as	SiO_2	-	-	-
Iron & Aluminum Oxide as	R_2O_3	1.4	1.6	0.07
Iron Total	-	0.2	0.2	0.31
Calcium as	Ca	2	2	-
Magnesium	Mg	.8	1	-
Hardness as	$CaCO_3$	9	10	-
Sodium & Potassium as	Na & K	8	5	-
Chloride as	Cl	8	7	-
Sulfate as	SO_4	7	.3	-
Zinc as	Zn	.02	.02	0.05
Temperature	-	21.°C	-	-
Total Sulphide	-	-	-	0.03
Langlier's Index at 70°F	-	-5.69	-5.57	-
Langlier's Index at 140°F	-	-5.03	-5.01	-

(a) Locations where samples were collected:
1. Oyster Creek Route 9 Bridge, 7-14-65, 12:55 p.m.
2. Oyster Creek Route 9 Bridge, 7-21-65, 2:00 p.m.
3. Raw Water from South Branch Forked River Route 9 Highway Bridge, 1-29-65, 3:00 p.m.

TABLE II-6

OYSTER CREEK STATION
TYPICAL INTAKE WATER ANALYSIS[a]

Constituents	ppm
Calcium	289
Magnesium	881
Sodium and Potassium	7,134
Chloride	12,680
Sulphate	1,816
Nitrate	0.0
Phosphate	0.7
Bicarbonate	100.0
Carbonate	0.0
Hydroxide	0.0
Silica	18.0
Iron	0.6
Manganese	0.01
Zinc	0.01
Total Residue	23,458.00
Suspended Matter	17.0
Volatile Residue	3,050.0
Equivalent, NaCl	20,905
Salinity	23,000
Alkalinity, $CaCO_3$	82.0
pH	6.95
Specific Gravity	1.03

(a) Majority of Water (>95%) is from Barnegat Bay

important because it represents a unique habitat and is restricted in distribution. Four other vegetation types exist within a 5-mile radius of the Site--Oak Upland Forest, Pine-Oak Upland Forest, Pine Swamp Forest, and Hardwood Swamp Forest--as well as marshland, bay water and nonforested land. The latter two categories constitute about 47% of the 5-mile radius area. About 50 species of higher plants have been identified during field surveys.

Much of the Site cleared prior to the Applicant's ownership has been reseeded with grass to enhance the slow natural revegetation process. Only limited success was achieved due to poor fertility of the sandy soil and the action of wind erosion. Parts of the transmission line easements take advantage of existing, cleared rights-of-way and thus will not require land clearing. Approximately 85 and 80% of the Forked River-New Freedom and Forked River-Deans rights-of-way, respectively, will avoid cedar swamps and traverse upland forests or agricultural land. About 60% of each right-of-way is on state-owned land. Most of the privately-owned land is used for agriculture.

Field surveys sponsored by the Applicant have noted 24 species of land vertebrates and 57 species of nesting birds and waterfowl within a 5-mile radius of the Site. Table II-7 lists representative vertebrates reported. Evidence of the Pine-Barrens Tree Frog also was noted. This species is endemic to cedar swamps of the New Jersey pine-barrens and thus is listed as rare and endangered by the International Survival Service Commission.[10] The most prominent game animal inhabiting the Site is the white-tailed deer although red squirrel and gray squirrel are fairly common. Small mammals, especially muskrat, are common in open areas near water. Mink, weasel, and beaver are considered common,[11] but only beaver is trapped in the coastal marshes of Barnegat Bay by local residents. Important game birds occurring near the Site include bobwhite quail and waterfowl. Coastal estuaries including Barnegat Bay are within the Atlantic Flyway and are attractive to migrating waterfowl.[12] Canada goose, mallard, teal, widgion, redhead, godwall, canvasback, greater scaup, and lesser scaup are some of the more abundant waterfowl reported to utilize Barnegat Bay. Osprey, an endangered species, is not known to nest in the vicinity of the Site.

2. Aquatic Ecology

a. Freshwater Ecosystems

The Station site is situated between two small freshwater systems: Oyster Creek on the south and the South Branch of Forked River on the north. Both streams flow into the circulating water canal constructed

TABLE II-7

REPRESENTATIVE VERTEBRATE ANIMALS FROM FIELD SURVEYS

Amphibians and Reptiles

Hyla cinerea	Green Frog
Terrapene carolina	Eastern Box Turtle
Coluber constrictor constrictor	Eastern Black Racer

Mammals

Sylvilagus floridanus	Eastern Cottontail
Tamiasciurus hudsonicus	Red Squirrel
Sciurus carolinensis	Gray Squirrel
Microtus pinetorum	Pine Vole
Ondatra zibethicus	Muskrat
Scalopus aquaticus	Eastern Mole

Birds and Waterfowl (Nesting within 5 miles of Site)

Bonasa umbellus	Ruffed Grouse
Colinus virginianus	Bobwhite Quail
Chordeiles minor	Common Nighthawk
Tyrannus tyrannus	Eastern Kingbird
Progne subis	Purple Martin
Mimus polyglottos	Mockingbird
Dendroica pinus	Pine Warbler
Pipilo erythrophthalmus	Rufous-sided Towhee
Spizella pusilla	Field sparrow
Branta bernicla	American brant

for the Oyster Creek Station, and the freshwater reaches of both streams are characteristic of cedar swamp and pine barren drainage of Atlantic Coastal States. The pH is low (6.5) and because of low flows, relatively high temperatures are encountered in summer months (>70°F).

Freshwater species of fish known to have existed or that still exist in Oyster Creek and the South Branch of Forked River include: chain pickerel, Esox niger; redfin pickerel, Esox americanus; yellow bullhead, Ictalurus natilis; Eastern creek chubsucker, Erimyzon oblongus; Eastern pirate perch, Aphredoderus sayanus; mud sunfish, Acantharchus pomotis; orange-spotted sunfish, Lepomis humilis; golden shiner, Notemigonus crysoleucas; fusiform darter, Etheostoma spp; and American eel, Anguilla rostrata. Brook trout, Salvelinus fontinalis, were introduced to Oyster Creek, but their final success is not known. Areas in the upper reach were found suitable for summer holdover; however, because of limited public access and the maintenance of minimal holdover conditions, stocking was not repeated.

b. Intake and Effluent Canal Ecosystem

The lower reaches of the South Branch of Forked River and Oyster Creek are now part of the canal system supplying the Oyster Creek Power Station with cooling water. As part of this system the salinities are relatively constant throughout and reflect those found in the adjacent portion of Barnegat Bay. The bank along the dredged canal portion of these streams has very little aquatic vegetation and is subjected to heavy erosion and undercutting. Currents are unidirectional and may vary from less than 1 fps to almost 2 fps depending on the number of Oyster Creek Plant dilution pumps in operation.

The benthic infauna populations in the intake and effluent canals were dominated by Mulinia lateralis (little mactia) and Pectinaria gouldi (the golden bristled or mason worm). During the September-December period in 1970 Oyster Creek has a Pectinaria density of $45/m^2$ and a Mulinia density of $47/m^2$ and Forked River had densities of $172/m^2$ and $16/m^2$ respectively.

Benthic algae, phytoplankton, zooplankton and finfish populations in the canals are similar to those found in the Bay and are discussed in the following section.

e. Barnegat Bay Ecosystems

Marshland forms a transition zone between the terrestrial and aquatic ecosystems, and at the Forked River site consists of a band of salt-marsh vegetation at the mouth of both Oyster Creek and the South Branch of Forked River. The sediment of the salt-marsh band is primarily mud with areas of shell banks. This zone is characterized by fluctuating salinities due to the influx of fresh water, and by high primary productivity attributable largely to the coastal marsh and to intermittent beds of sea grasses and attached algae.

The marshland in the vicinity of the Site is typical of areas found throughout the Mid-Atlantic Bight. The marsh habitat serves as a nursery area for numerous species of finfish including: Atlantic silversides, bay anchovy, silver perch, northern kingfish, white perch, Atlantic herring, menhaden, striped bass and bluefish. This area also supports adult finfish populations of fourspine stickleback, common killifish, striped killifish, rainwater killifish and naked goby. Eastern oyster, bay mussel, shoft-shell clam, and blue-claw crab are the principal shellfish species. Nearly all such organisms are tolerant of wide ranging temperature and saline conditions. The importance of marshland habitats as nursery grounds for finfish and shellfish is well documented. Marshland vegetation provides vast quantities of organic detritus which contributes to the food web of many commercial and sport species within the marshland and beyond.[14]

The mudbanks exposed at low tide are colonized by the salt-marsh plants, Zostera marina, and Ruppia maritima. These two plants and algae combine to form the major producer components of the marshland ecosystem.

Because of the small standing crop of producers and their rapid turnover, and the role of the physical environment in transporting and mixing nutrients, organisms and food resources, much of the energy assimilated by producers in excess of that consumed in respiration is transferred through the food web. Thus, the salt marsh at Forked River is a dynamic producing system that supports and contributes in terms of both energy and habitat to the production of finfish, shellfish, waterfowl and faunal components of the contiguous terrestrial ecosystem.

The nearshore estuarine ecosystem is that portion of Forked River, Oyster Creek and Barnegat Bay that comes under the influence of the intake and discharge of cooling water. Finfish found in the vicinity of the Forked River site which are either important as commercial and/or sport species

or are involved in the food web of important species are listed in Table II-8. This baseline listing of 58 species, compiled by the Applicant from surveys conducted between 1966 and 1968, is subject to wide seasonal and annual variations in species abundance and location. Collection was by both seine and otter trawl; Figure II-7 shows the sampling locations. The five most abundant species of finfish captured in the 1966-1968 survey were Atlantic silversides, bay anchovy, fourspine stickleback, northern puffer, and silver perch.

Spawning times of finfish occurring near the proposed Forked River Plant are given in Table II-9. Data are available for 37 species.[15-19] Of these, 24 species are known to spawn in an estuarine environment and would potentially spawn in Barnegat Bay and environs. Fifteen species are spring or summer spawners; 6 species spawn during fall or winter; and the spawning periodicity is not known for the remaining 3 species. Offshore spawning fish total 13 species of which 5 species spawn in spring or summer; 6 species spawn in fall or winter; 1 species, Brevoortia tyranus, spawns both in summer and winter; and another species, Bairdiella chyrsura, has an unknown spawning periodicity. Nearly all produce either a pelagic embryo or larvae that potentially enters the Barnegat Estuary.

The species most often sought or caught by sport fisherman are: northern puffer, winter flounder, bluefish and weakfish. The weakfish has apparently become more abundant in the past 2 years. The bluefish is considered a highly desirable sport fish although not present in large numbers.

The value of the commercial fishery from Ocean County in Barnegat Bay for 1970 was $2,995,000.[20] Estimates in pounds of finfish species commercially caught between the years 1960 to 1969 are presented in Table II-10.[20]

Applicant surveys at the Forked River site from 1965 to 1970 revealed the presence of 136 species of benthic flora.[21,22] Variations in both species composition and abundance were related to seasonal and yearly sampling. Figure II-8 is a graphic presentation of the composition of benthic algae by months as averaged over 3 years. Species diversity was greatest in May; least diversity was recorded in September with no brown algae collected. The relative abundance of green algae (chlorophyta) to red algae (rhodophyta) is nearly constant. The brown algae (phaeophyta) demonstrate considerable variation throughout the year, undoubtedly temperature mediated. Qualitatively, the benthic flora in Barnegat Bay is relatively stable from year to year with a consistently high species diversity.

TABLE II-8

FINFISH COLLECTED IN BARNEGAT BAY

SPECIES	NUMBER CAPTURED 1966-1968	HABIT
ALEWIFE	8	MIG.
AMERICAN EEL	98	CATAD.
AMERICAN SHAD	1	ANAD.
ATLANTIC HERRING	1,405	MIG.
ATLANTIC MENHADEN	7	MIG.
ATLANTIC NEEDLEFISH	242	RESID.
ATLANTIC ROUND HERRING	?	MIG.
ATLANTIC SILVERSIDES	69,594	RESID.
BANDED KILLIFISH	416	FRESH
BAY ANCHOVY	25,950	RESID.
BLACK DRUM	2	MIG.
BLUEBACK HERRING	81	MIG.
BLUEFISH	153	MIG.
BUTTERFISH	1	MIG.
CHAIN PICKERAL	1	FRESH
CREVALLE JACK	2	MAR.
CUNNER	14	RESID.
FOURSPINE STICKLEBACK	20,169	RESID.
GIZZARD SHAD	3	MIG.-ANAD.
GOLDEN SHINER	1	FRESH
GRUBBY	13	RESID.
HOGCHOKER	6	RESID.
HORSE-EYE JACK	52	MAR.
LOOKDOWN	13	MAR.
MUMMICHOG	1,940	RESID.
NAKED GOBY	64	RESID.
NORTHERN KINGFISH	247	MIG.
NORTHERN PIPEFISH	1,407	RES.
NORTHERN SEAROBIN	8	MAR.
ORANGESPOTTED SUNFISH	?	FRESH
OYSTER TOAD FISH	271	RESID.
POLLOCK	3	MIG.
RAINWATER KILLIFISH	157	RESID.
RED GROUPER	1	MIG.
ROUGHTAIL STINGRAY	1	MAR.
SHEEPSHEAD MINNOW	110	RESID.
SHORTHORN SCULPIN	?	MAR.
SILVER PERCH	3,126	MIG.
SMALLMOUTH FLOUNDER	2	MIG.
SPOT	6	MIG.
SPOTTED BURRFISH	?	MAR.
SPOTTED SEAHORSE	1	RESID.
SQUIRREL LAKE	?	MAR.
STRIPED BASS	1	MIG.
STRIPED BLENNY	4	MAR.
STRIPED BURRFISH	3	MIG.
STRIPED KILLIFISH	1,506	RESID.
STRIPED MULLET	2	MIG.
SUMMER FLOUNDER	1	MIG.
TAUTOG	118	MAR.
THREESPINE STICKLEBACK	48	MIG.
TIDEWATER SILVERSIDES	1,977	RESID.
WEAKFISH	2	RESID.
WHITE MULLET	1	MIG.
WHITE PERCH	155	ANAD.
WINDOW PANE	17	MAR.
WINTER FLOUNDER	1,296	RESID.

RESID. = RESIDENT
MIG. = MIGRANT
MAR. = LOCAL MARINE
ANAD. = ANADROMOUS } DIADROMOUS
CATAD. = CATADROMOUS } DIADROMOUS
FRESH = FRESHWATER

TABLE II-9

SPAWNING TIMES OF IMPORTANT FINFISH IN THE VICINITY OF THE FORKED RIVER SITE

SCIENTIFIC NAME	COMMON NAME	TIME OF SPAWNING	LOCALITY	HABITAT OF EMBRYO	HABITAT OF JUVENILE
Roccus americanus	WHITE PERCH	MAR-MAY	ESTUARINE FRESHWATER	DEMERSAL	BENTHIC
Roccus saxatilis	STRIPED BASS	SPRING	ESTUARINE FRESHWATER	SEMI-DEMERSAL	BENTHIC
Tautoga onitis	TAUTOG	APR-JULY	OFFSHORE-ESTUARINE	PELAGIC	BENTHIC
Tautogolabrus adspersus	CUNNER	JUNE-JULY	ESTUARINE	PELAGIC	BENTHIC
Gobiosoma basci	NAKED GOBY	MAY-SEPT.	ESTUARINE	DEMERSAL	BENTHIC
Prionotus carolinus	NORTHERN SEA ROBIN	SUMMER	OFFSHORE	PELAGIC	BENTHIC
Myoxocephalus aeneus	GRUBBY	WINTER	OFFSHORE	DEMERSAL	BENTHIC
Poronotus triacanthus	BUTTERFISH	JUNE-JULY	OFFSHORE	PELAGIC	BENTHIC
Mugil curema	WHITE MULLET	FALL-WINTER	OFFSHORE	PELAGIC	PELAGIC
Mugil cephalus	STRIPED MULLET	FALL-WINTER	OFFSHORE	PELAGIC	PELAGIC
Menidia menidia	ATLANTIC SILVERSIDES	APR-JULY	ESTUARINE	DEMERSAL	PELAGIC
Menidia beryllina	TIDEWATER SILVERSIDES	JUNE-JULY	ESTUARINE	DEMERSAL	PELAGIC
Paralichthys dentatus	SUMMER FLOUNDER	WINTER	OFFSHORE	PELAGIC	BENTHIC
Scophthalum aquosus	WINDOWPANE	MAY-JUNE	ESTUARINE OFFSHORE	PELAGIC	BENTHIC
Pseudopleuronectes americanus	WINTER FLOUNDER	WINTER	ESTUARINE	DEMERSAL	BENTHIC
Trinectes maculatus	HOGCHOKER	SPRING	ESTUARINE	PELAGIC	BENTHIC
Sphaeroides maculatus	NORTHERN PUFFER	SUMMER	ESTUARINE	DEMERSAL	BENTHIC
Opsanus tau	OYSTER TOADFISH	JUNE-JULY	ESTUARINE	DEMERSAL	BENTHIC

TABLE II-9 (Continued)

SCIENTIFIC NAME	COMMON NAME	TIME OF SPAWNING	LOCALITY	HABITAT OF EMBRYO	HABITAT OF JUVENILE
Clupea harengus	ATLANTIC HERRING	NOV-DEC	OFFSHORE	DEMERSAL	PELAGIC
Brevoortia tyranus	ATLANTIC MENHADEN	MAY-AUG OCT-FEB	OFFSHORE OFFSHORE	PELAGIC	PELAGIC
Anchoa mitchilli	BAY ANCHOVY	MAY-SEPT	ESTUARINE	PELAGIC-DEMERSAL	PELAGIC
Strongylura marina	ATLANTIC NEEDLEFISH	———	ESTUARINE	DEMERSAL	
Cyprinodon variegatus	SHEEPSHEAD MINNOW	EXTENDED	ESTUARINE	DEMERSAL	BENTHIC
Fundulus diaphanus	BANDED KILLIFISH	———	ESTUARINE	DEMERSAL	BENTHIC
Fundulus majalis	STRIPED KILLIFISH	———	ESTUARINE	DEMERSAL	BENTHIC
Fundulus heteroclitus	MUMMICHOG	———	ESTUARINE	DEMERSAL	BENTHIC
Pollachius virens	POLLOCK	SPRING	OFFSHORE	PELAGIC	BENTHIC
Lacania parva	RAINWATER KILLIFISH	SPRING	ESTUARINE	DEMERSAL	BENTHIC
Apeltes quadracus	FOURSPINE STICKLEBACK	MAY-JUNE	ESTUARINE FRESHWATER	DEMERSAL	BENTHIC
Gasterosteus aculeatus	THREESPINE STICKLEBACK	APR-MAY	ESTUARINE FRESHWATER	DEMERSAL	BENTHIC
Syngnathus fuscus	NORTHERN PIPEFISH	MAY-AUG	ESTUARINE	BROOD POUCH	BENTHIC
Hippocampus erectus	SPOTTED SEAHORSE	SUMMER	ESTUARINE	BROOD POUCH	BENTHIC
Pomatomus saltatrix	BLUEFISH	SPRING- SUMMER	OFFSHORE	PELAGIC	PELAGIC
Bairdiella chrysura	SILVER PERCH	———	OFFSHORE	PELAGIC	BENTHIC
Menticirrhus saxatilis	NORTHERN KINGFISH	JUNE-JULY	OFFSHORE	PELAGIC	BENTHIC
Leiostomus xanthurus	SPOT	FALL-WINTER	OFFSHORE	PELAGIC	BENTHIC
Cynoscion regalis	WEAKFISH	MAY-SEPT	ESTUARINE	PELAGIC	BENTHIC

TABLE II-10

COMMERCIAL CATCH OF FINFISH FROM BARNEGAT BAY, OCEAN COUNTY
(lb)

Year	Shad	Mullet	Eels	(Winter Flounder) Black Back	Alewives	(Blackfish) Tautog	White Perch	Mixed
1960	0	0	8,200	23,100	0	0	7,000	0
1961	0	0	12,600	27,300	0	0	17,000	0
1962	0	0	6,700	12,300	4,900	0	8,500	0
1963	0	18,000	6,400	18,100	0	0	4,700	400
1964	500	16,000	29,000	22,300	6,600	0	12,000	0
1965	200	9,400	35,400	12,500	7,800	100	10,900	0
1966	0	7,900	51,900	35,200	5,800	200	6,900	0
1967	100	13,600	38,100	32,800	3,000	100	10,400	0
1968	0	10,200	42,300	24,300	4,300	0	18,900	0
1969	0	0	70,000	2,100	200	0	4,100	0

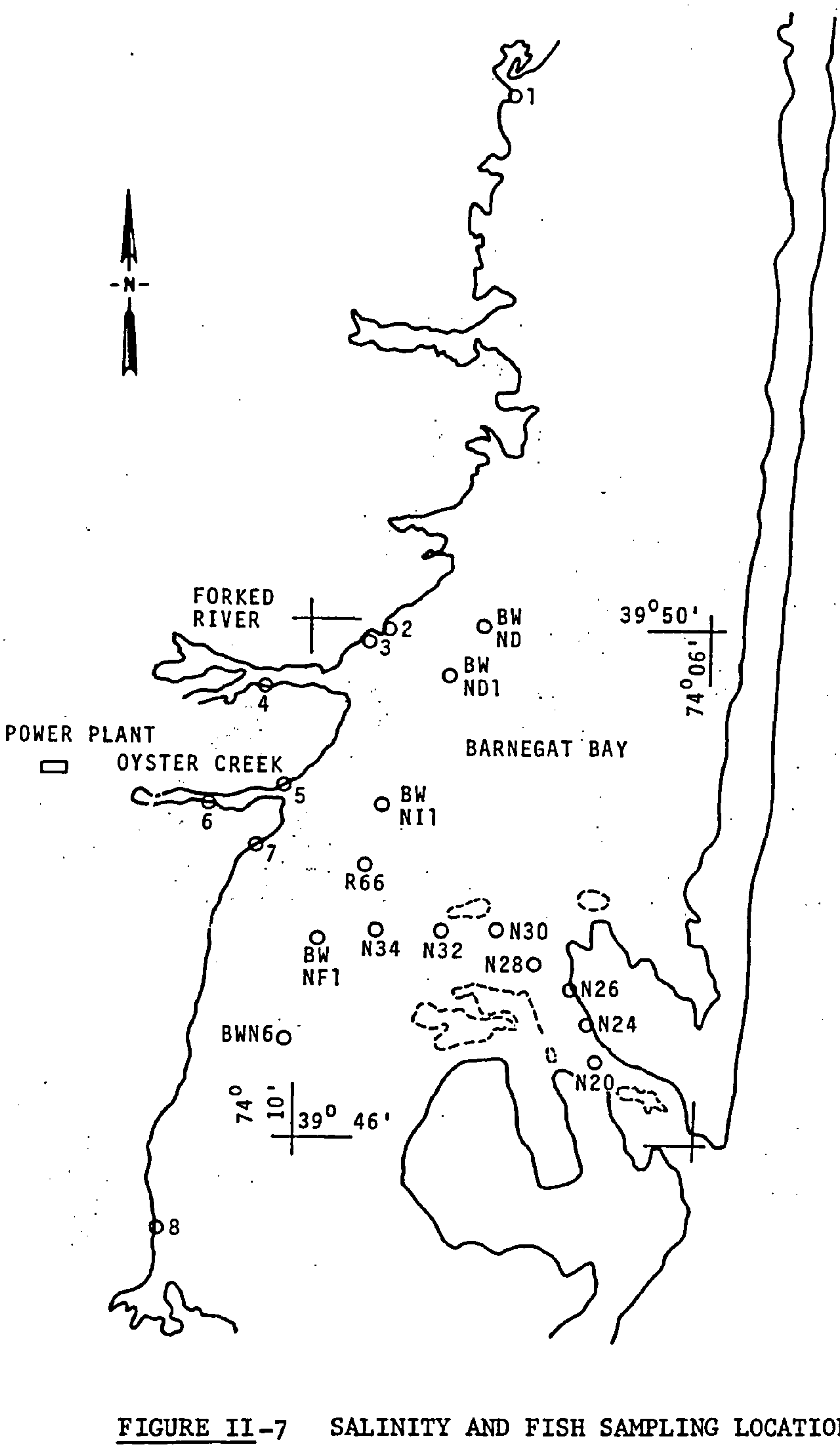


FIGURE II-7 SALINITY AND FISH SAMPLING LOCATIONS

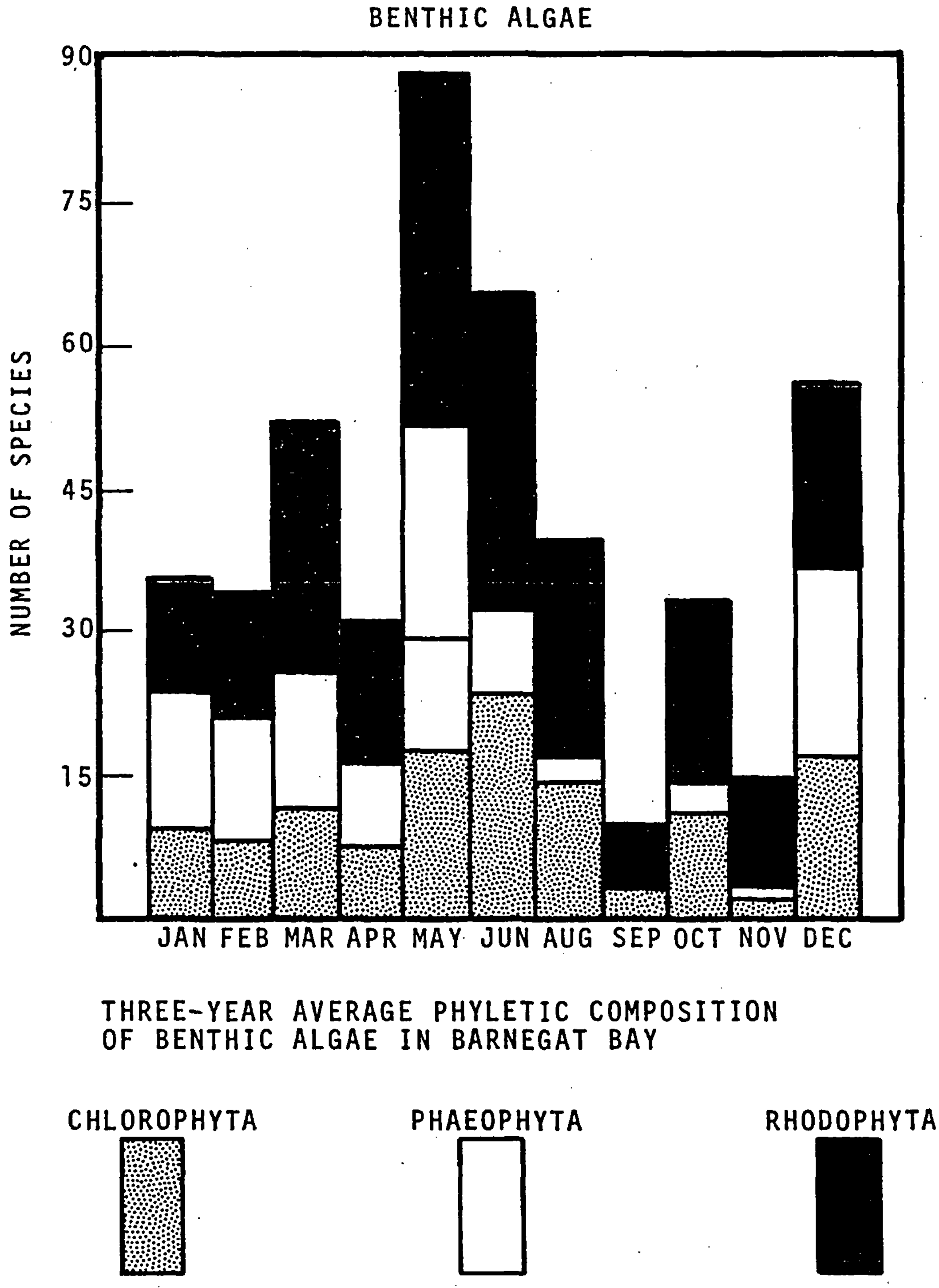


FIGURE II-8 PHYLETIC COMPOSITION OF BENTHIC ALGAE.

A listing of the ten most abundant species collected in Barnegat Bay is presented in Table II-11. Dominant forms include: Ulva lactuca, Gracilaria verrucosa, Agardhiella tenera and Ceramium fastigium. Codium fragile increased in abundance significantly from 1965 to 1970, while Champia parvula and Acrochaetium spp. decreased in abundance over the survey period. Polysiphonia nigrescens was not observed in collections during later years. The remainder, comprising 86.5% of all species, occur less than 50% of the time. Thirty-one species are considered uncommon to the study area and in excess of one-half (58%) of all species were collected less than 25% of the time. Sixteen species were collected more than 50% of the time. Additional data are available in references 21 and 22.

Applicant surveys at or near the Forked River site conducted since 1965 revealed the presence of 170 species of benthic fauna.[22] The survey areas are shown in Figure II-9. Relatively few species occured regularly throughout the sampling areas, but those found most frequently were the golden bristled worm, Pectinaria gouldi; the little mactia, Mulinia lateralis; and Tellina agilis. Pectinaria and Tellina were collected on dominantly sand substrates while Mulinia was found associated with less sandy areas. The polychaete worm, Maldanopsis elongata, was dominant in areas of good current flow having large deposits of fine sediment (silt-clay fraction), such as near the Forked River channel.

Other species identified as dominant forms include: the bloodworm, Glycera dibranchiata; channel barrel-bubble, Retusa canalicalata; alternate bittium, Bittium alternatum; lunar dove-shell, Mitrella lunata; pill bug, Idothea baltica; scud or side-swimmer, Ampelisca macrocephala; and the mud crabs, Neopanope texana, and Rithropanopus harrisii.

The relative frequency of the nine dominant forms expressed as percent of the total population found in Barnegat Bay and its tributary streams is presented in Table II-12 in a sequence of decreasing frequency.

During 1965-1966 surveys, these nine species constituted 70.8% of the total population of benthic fauna collected, based on the number of individuals present in the samples.

Species of sport or commercial value found in the bay included oyster, Crassostrea virginica; bay scallop, Argopecten irradians; hard clam, Mercenaria mercenaria; soft-shell clam, Mya arenaria; blue mussel, Mytilus edulis; and blue-claw crab, Callinectes sapidus. The few oysters that were present were not found in the immediate area of Oyster Creek or

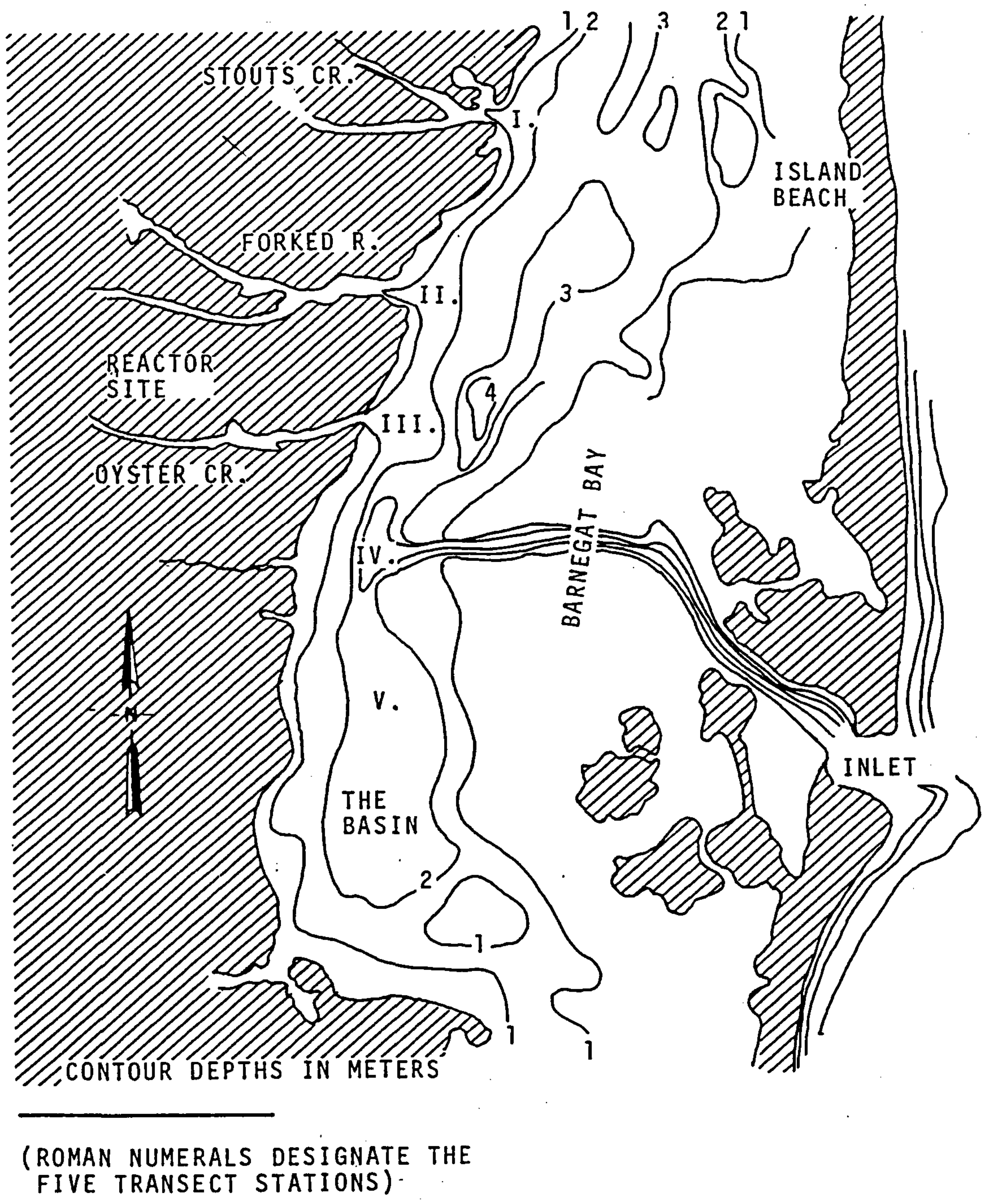


FIGURE II-9 BENTHIC FAUNA SURVEY AREAS (ROMAN NUMERALS DESIGNATE THE FIVE REGULAR TRANSECT STATIONS.)

TABLE II-11

RANKS OF THE TEN MOST ABUNDANT SPECIES OF BENTHIC FLORA IN BARNEGAT BAY DURING TWO DIFFERENT TIME PERIODS

Rank 1965-1968	Rank 1969-1970	Species
1	1	*Ulva lactuca*
2	6	*Agardhiella tenera*
3	5	*Ceramium fastigium*
4	10	*Champia parvula*
5	2	*Gracilaria verrucosa*
6	7	*Polysiphonia harveyi*
7	19	*Acrochaetium* spp.
8	(a)	*Polysiphonia nigrescens*
9	8	*Gracilaria folifera*
10	4	*Codium fragile*

(a) Not present

TABLE II-12

FREQUENCY OF OCCURRENCE OF DOMINANT BENTHOS

Tellina agilis	34.8%
Idothea baltica	7.2%
Neopanope texana	6.1%
Mulinia lateralis	4.9%
Bittium alternatum	4.1%
Mitrella lunata	3.7%
Pectinaria gouldii	3.5%
Maldanopsis elongata	3.4%
Glycera dibranchiata	3.1%

the Forked River. However, historically, before these investigations were initiated, oysters must have existed there as examination of dredgespoils from these two bodies of water revealed their remains. Scallops, which are motile, were found in clumps often associated with eelgrass communities. Clams were found near the Site and in other areas. Blue crabs were found in most areas sampled.

Estimates in pounds of shellfish commercially caught in Barnegat Bay between the years of 1960 and 1969 are presented in Table II-13.[20]

Planktonic surveys, conducted by the Applicant since 1965, show that the spring bloom of phytoplankton begins in February. Thalassiosira nordenskioldi, Detonula confervacea and Detonula cystifera are dominant species. Although Thalassiosira is the most abundant species in the bloom, the total number of microflagellates is greater, i.e., 615 of every 1119 cells are microflagellates. Microflagellates are found in the estuary in great numbers regardless of the season.

The Thalassiosira Detonula community is replaced by the diatom, Skeletonema costatum. As the water temperature nears 20°C (69°F) zooplankton grazing seems to prevent this intense phytoplankton bloom from continuing. An equilibrium apparently exists between a succession of phytoplankters and grazing zooplankton, predominantly copepods. Additional details of this relationship are shown in Figure III-18 of the Applicant's Environmental Report.

In June, predacious ctenophores grazing upon the copepods bring this equilibrium to an end. Water temperatures rising above the optimum for cold water diatoms cause a shift in the phytoplankton community to predominantly dinoflagellates, particularly Prorocentrum spp. Occasional "red-tide" blooms are observed. Dinoflagellates are distinctly dominant throughout the peak temperature season and concentrations exceeding 10^6 cells per liter are encountered.

The density of the chlorophyte Nannochloris could not be adequately determined because of its small size and extreme abundance. A few estimates made during summer blooms indicate that Nannochloris may superimpose populations of 1.1×10^6 to 10.3×10^6 cells per liter on the remaining phytoplankton community, which itself may exceed 10^6 cells per liter.

Phytoplankton abundance decreases to a minimum in early January. Dinoflagellates are replaced by the mixed diatom community of Thalassiosira and Detonula which serve as seed stock for the subsequent February bloom.

TABLE II-13

COMMERCIAL SHELLFISH CATCH IN BARNEGAT BAY
Pounds (shell weight)

	Hard Clams	Hard Crabs	Oysters	Bay Scallop	Soft Clams	Mussels	Shrimp
1960	2,616,000	175,600	152,810	0	0	0	3,800
1961	1,752,000	61,500	73,500	653,520	0	0	4,300
1962	1,576,000	4,600	86,310	3,646,980	0	0	5,800
1963	1,792,000	10,000	26,810	2,739,000	0	0	6,000
1964	2,217,600	2,200	0	3,763,020	0	0	2,000
1965	2,386,400	68,800	0	955,020	0	0	4,600
1966	3,986,400	64,800	10,500	1,746,000	27,500	108,000	0
1967	2,984,000	16,200	17,500	855,000	82,500	0	0
1968	2,794,400	13,100	21,000	168,000	60,500	0	0
1969	2,679,200	65,200	14,000	0	33,000	0	0

A listing of zooplankton collected in surveys for the Applicant between 1966 and 1968 is given in Table II-14. An extensive zooplankton community is supported by the spring bloom of phytoplankton. The calanoid copepod, Acartia spp. is the dominant species throughout the spring. As water temperatures exceed 15°C (59°F) in April, the colenterate Cyanea capitata is encountered. It forages on small fishes that include Menidia menidia, the metamorphosed juveniles of Anguilla rostrata, and small sticklebacks. Cyanea leave the Bay in late May.

The ctenophore, Mnemiopsis leidyi, becomes a dominant form in late spring and early summer. A high population develops rapidly and counts exceed $1000/m^3$. Mnemiopsis forages with particular selectivity on the calanoid copepod Acartia. Consequently the density of Acartia is reduced throughout summer months. Mnemiopsis is replaced in autumn by a second ctenophore, Beroe ovata. Both species cease to be predators of zooplankton by mid-October.

Zooplankton numbers continue to decrease as winter progresses. Consequently during the autumn, exclusive of naupliar stages, the rotifers Asplanchna spp. and Synchaeta spp. become the predominant species. The loricate tintinnid Fayella spp. is not as abundant as the rotifers but predictable swarms are recorded each autumn in Barnegat Bay.

In early February, zooplankton again begin to increase, apparently in response to an increase in phytoplankton. A lag of nearly 30 days is observed between the apparent maximum of phytoplankton and the subsequent peak of zooplankton abundance, 2×10^6 organisms per m^3.

TABLE II-14

ZOOPLANKTERS COLLECTED IN BARNEGAT BAY, 1966-1968

1. Protozoa
   - Foraminifera -
     - Pulvinulina spp.
   - Radiolaria -
     - Unidentified Radiolarian
   - Infusoria -
     - Amphileptus gutta
     - Chilodon cucullus
     - Condylostoma spp.
     - Dactylopusia brevicornis
     - Diophrys appendiculatus
     - Paramecium spp.
     - Zoothamnium spp.
     - Unidentified Hypotrich protozoans
   - Tintinnoida -
     - Favella spp.
     - Tintinnus spp.
     - Unidentified Tintinnids

2. Porifera
   - Unclassified Statoblasts

3. Coelenterata
   - Cnidarian Blepharoplasts
   - Cnidarian Planula
   - Aecuora spp.
   - Cyanea capitata
   - Obelia geniculata
   - Perigonemus

4. Ctenophora
   - Beroe ovata
   - Mnemiopsis leidyi

5. Nemathelmia
   - Unidentified Nematodes

6. Chaetognatha
   - Sagitta elegans

7. Rotifera
   - Asplanchna spp.
   - Synchaeta spp.
   - Unidentified Rotifer
   - Unidentified Rotifer Egg

8. Polychaeta
   - Undifferentiated Trochophores
   - Undifferentiated Setigers

9. Arthropoda
   - (Arachnida) - Hydrobates spp.
   - (Crustacea) -
     - Calanoid copepods, including:
       - Acartia tonsa (clausii)
       - Centropages spp.
       - Eurytemora spp.
       - Temora longicornis
       - Tortanus discaudatus
     - Harpacticoid Copepods
     - Undifferentiated Nauplii
     - Various Copepodid stages
     - Undifferentiated Copepod eggs including Evrytemora
   - Brachyuran Zoea -
     - Balanus Eburneus Nauplii
     - Cladocera
   - Unidentified Amphipods
   - Unidentified Mysids
   - Unidentified Cumacid
   - Ostracods

10. Mollusca
    - Gastropod Veligers
    - Pelecypod Veligers

11. Polyzoa
    - Bryozan Statoblasts

12. Echinodermata
    - Pluteus Larvae

13. Chordata (Tunicata)

14. Oikepleura Doicia
    - (Pisces) -
      - Anquilla rostrata (post-elver juveniles)
      - Undifferentiated Fish Larvae.

III. THE PLANT

A. EXTERNAL APPEARANCE

The two dominant features of the proposed Station will be the containment building, which will house the nuclear steam supply system and engineered safety features, and the hyperbolic cooling tower. The containment building will not be highly visible from adjacent inhabited areas or roadways, but the cooling tower will probably become a landmark. Other proposed facilities will consist of the turbine, fuel-handling, auxiliary, and services buildings; the nuclear services cooling water intake system pumps; and the electrical switchyard. An artist's rendition of the Station is shown in Figure III-1 and an aerial photograph of the Station and local area is shown in Figure III-2.

It is the intent of the Applicant[1] to design, construct and landscape the Station so that it is aesthetically unobtrusive. In this regard, a design in harmony with the surrounding area will be stressed with post-construction landscaping planned to utilize native grasses and shrubs that are visually appealing and in keeping with the natural landscape.

The presence of the large cooling tower may be objectionable to some residents, others may consider it of no concern, or possibly even attractive. The Applicant has acquainted a number of local officials with the operational and appearance aspects of this facility by providing them the opportunity to view an existing cooling tower at the Homer City, Pennsylvania plant. No significant adverse comments were received from those who made the trip.

B. TRANSMISSION LINES

The Applicant stated that the design of all structures and the routing of the transmission system has incorporated the guidelines developed by the U.S. Departments of Interior and Agriculture, and the guidelines published by the Federal Power Commission. The routes have been coordinated with State and municipal officials.

Two separate power transmission rights-of-way are being proposed to extend from the Station (Figure III-3). A 200-ft wide right-

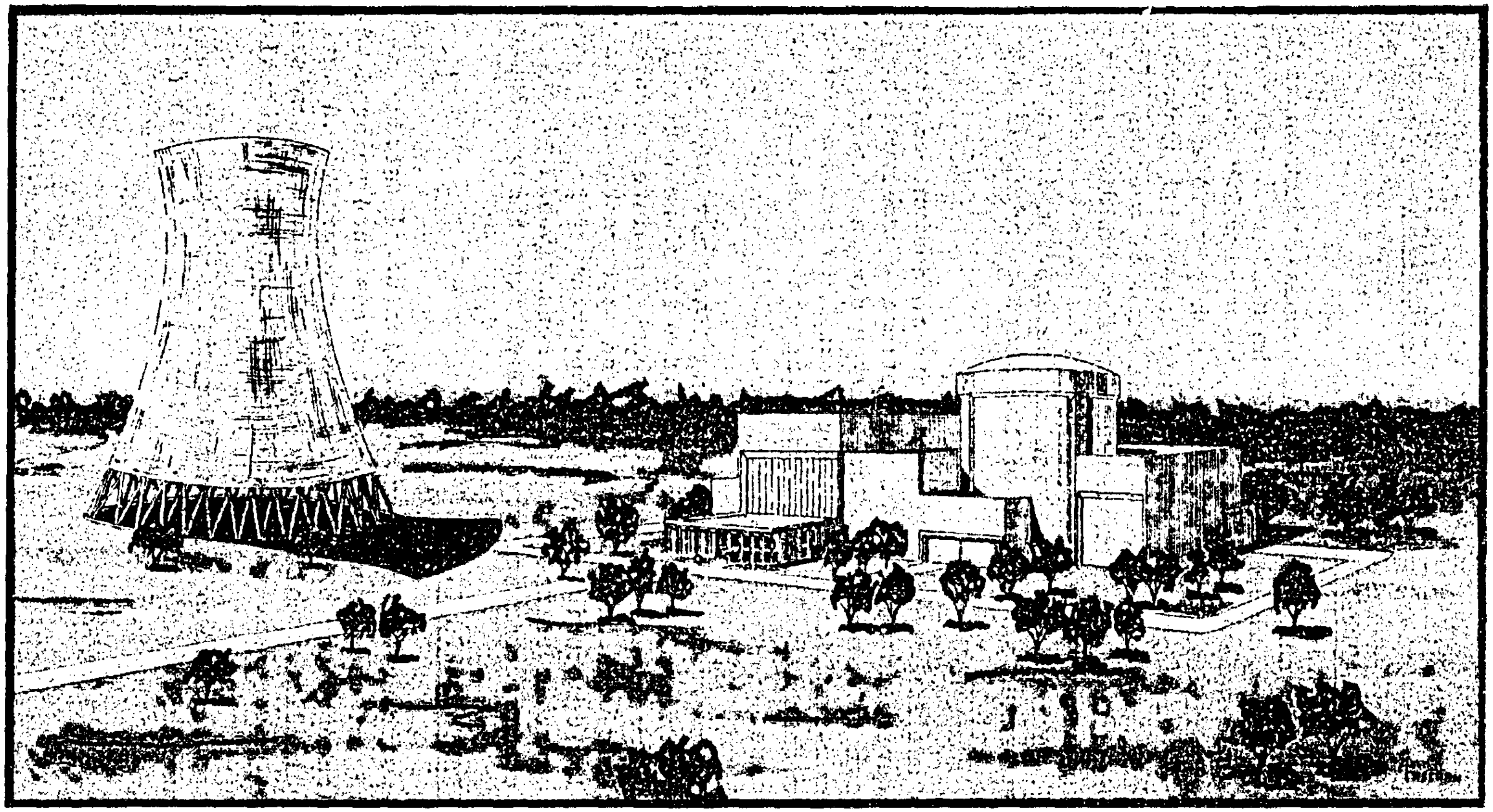


FIGURE III-1. ARTIST'S RENDITION, FORKED RIVER NUCLEAR STATION

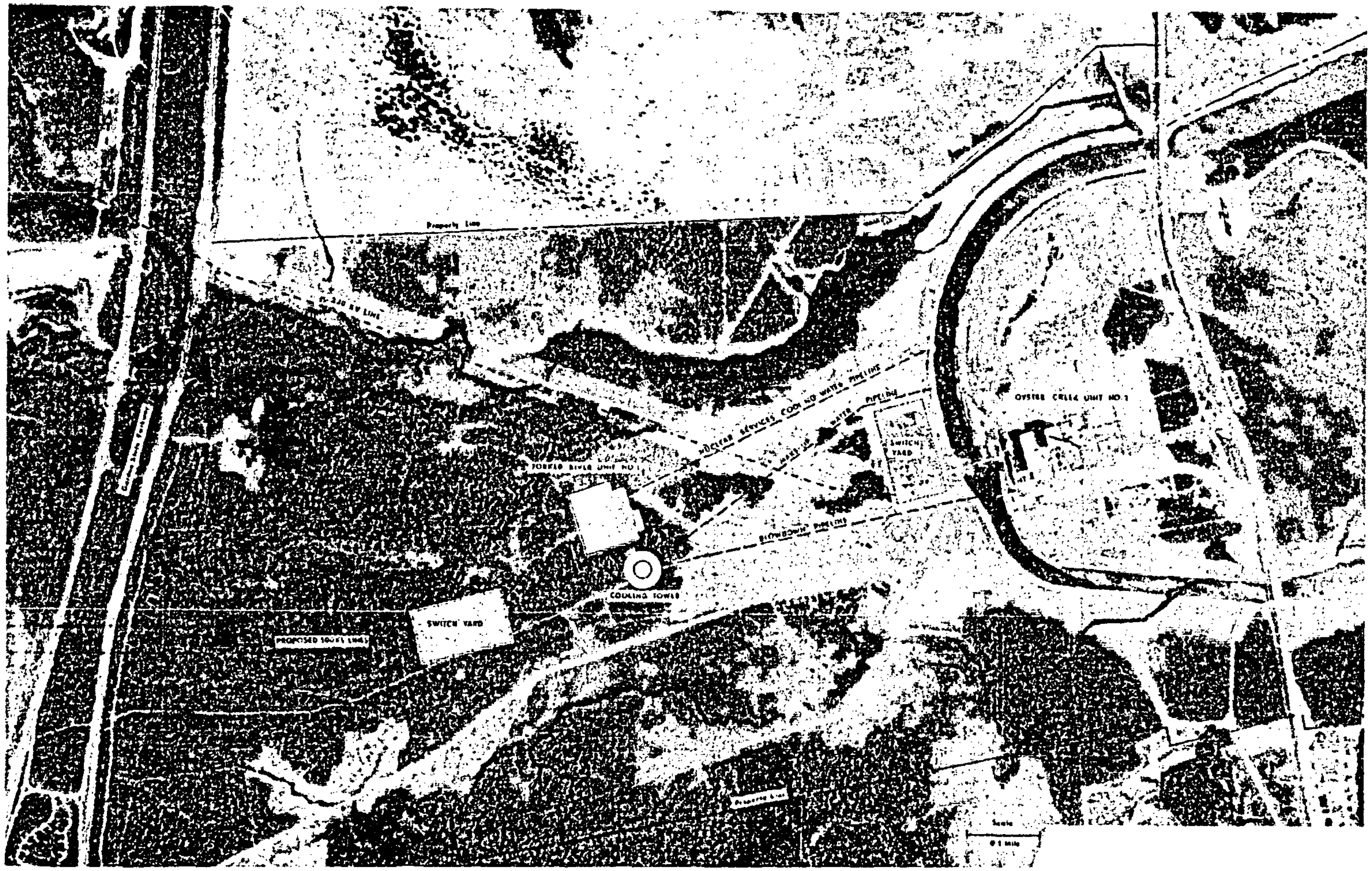


FIGURE III-2. AERIAL PHOTO OF THE FORKED RIVER STATION AND LOCAL AREA

of-way will extend about 50 miles providing one single-circuit 500 kV line to a substation under construction at New Freedom, Camden County. A 350-ft wide right-of-way will extend about 48 miles providing two single-circuit 500 kV lines, 150 ft apart, to a substation to be built at Deans, Middlesex County. The substations will be in the system of the Public Service Electric and Gas Company and will tie into the interconnected PJM 500-kV network. The New Freedom routing was determined in conjunction with the National Park Service and the State of New Jersey Department of Environmental Protection, and has been given tentative approval by the New Jersey State House Commission. The Deans routing, where involved with State lands, was treated similarly among Federal and State agencies. The 130-ft tall towers will consist of a galvanized steel base and a steel or aluminum top. Aluminum cables and standard design insulators will be used.

The Forked River Station right-of-way will cross the Garden State Parkway perpendicularly and south of the existing crossing of the Oyster Creek Station right-of-way. The use of separate right-of-way in leaving the stations is based on system reliability considerations. Subsequent sections of the routing will take advantage of existing transmission corridors, existing and abandoned railroad rights-of-way, adjoining unpaved and abandoned roads, and other areas previously cleared to minimize soil and vegetation disturbances.

C. REACTOR AND STEAM-ELECTRIC SYSTEM

The Forked River nuclear power unit will utilize a single, pressurized-water reactor (PWR) designed and fabricated by Combustion Engineering, Inc. with an expected thermal output of 3390 MW. The turbine-generator, which has an average electric power output of 1093 MW and a stretch output of 1143 MW, will be driven by steam produced in two large heat-exchangers. Brown Boveri Corporation will be the fabricator of the turbine-generator; Burns & Roe, Inc., will be the architect-engineer; and construction management will be under the Stearns-Roger Corporation.

The reactor core, fueled with uranium dioxide pellets enclosed in zircalloy tubes, is cooled with water (primary coolant) circulated through two parallel closed loops connected to the reactor vessel. The pressurized heated primary coolant transfers heat to the secondary coolant in the steam generators to produce the steam that drives the turbine-generator.

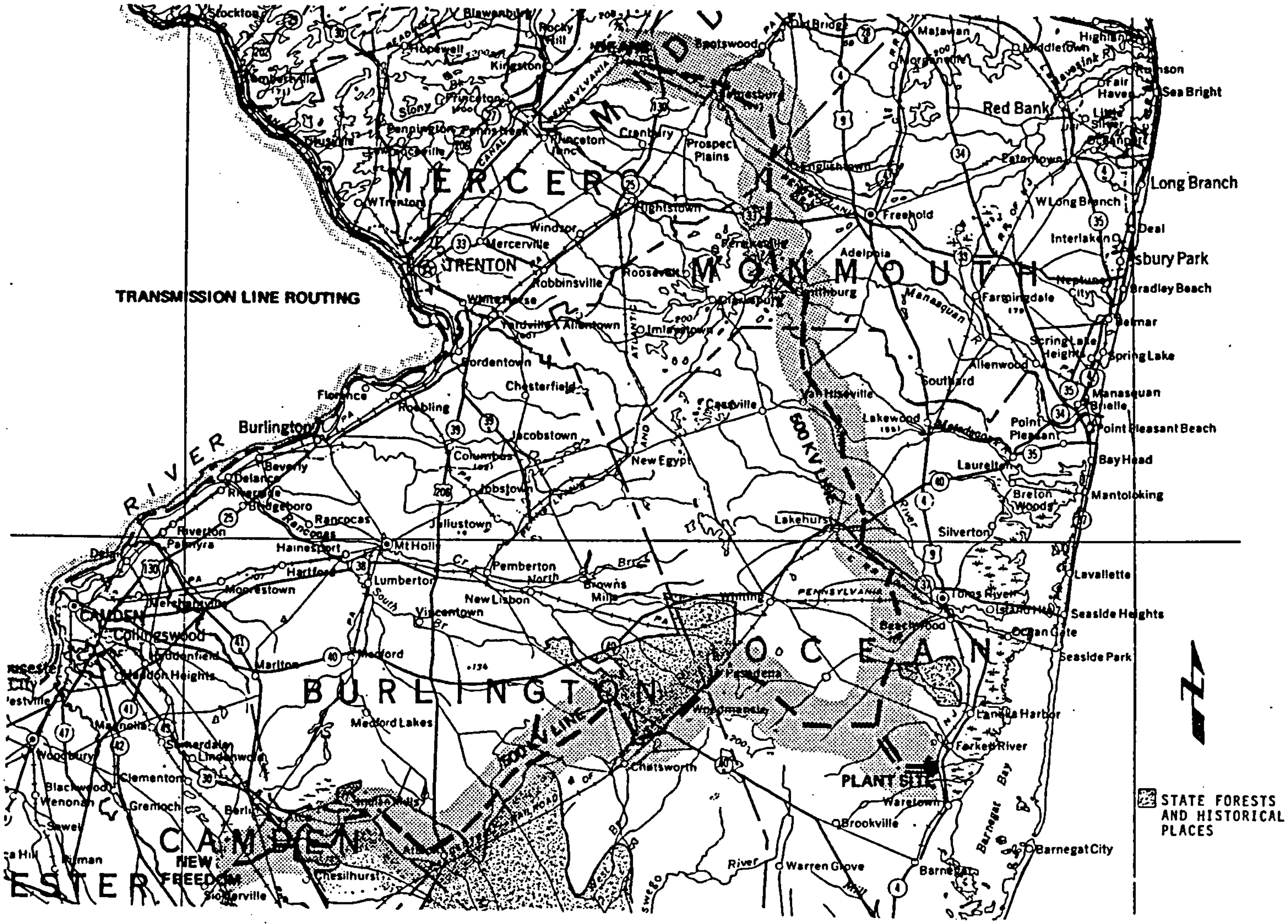


FIGURE III-3. TRANSMISSION LINE ROUTING, FORKED RIVER STATION

The secondary water coolant loop is also a closed system. Spent steam from the turbine is condensed in a heat exchanger (cooled by water recirculated through the cooling tower) and returned to the steam generators.

D. EFFLUENT SYSTEMS

1. Heat

a. Cooling Water Supply and Discharge

The proposed operational system of the Forked River Station will be integrated into the existing system of the Oyster Creek Station as depicted in the perspective view, Figure III-4. The general plan is to withdraw water at two points from the intake canal and, depending on weather and operating conditions, combine portions of the two flows in the cooling tower basin for salinity control in the circulating system. The discharge from the tower (blowdown) would be joined by the chemical and process bleed system effluents which are released after radwaste system monitoring control. The combined flow is returned through a diffuser in the discharge canal to Barnegat Bay.

The first withdrawal will be via the nuclear services water intake system at a normal rate of about 34,000 gpm (80 cfs). The intake structure is to be equipped with traveling screens to reject all suspended materials larger than 3/8 in. The approach velocity to the screens will be less than 0.7 fps. Screen cleaning will be done by hydraulic jetting, and all removed solid material will be conveyed to the discharge canal. The Staff has estimated the thermal rise of the nuclear services water system to be on the order of 10°F or an additional thermal load to the cooling tower of less than 1.8×10^8 Btu/hr. During the wwinter a portion of this water (approximately one-third) will be returned to the intake structure for the purpose of ice control; the balance would flow to the cooling tower basin. Under all other conditions, the design intent is to dissipate the thermal load in the cooling tower except when the tower is inoperative, at which time the recirculation path is through the tower basin back to the Oyster Creek Station discharge canal.

The second intake point will be the make-up water pumping station which is to be designed as a duplicate of the nuclear service water system, but with two 17,000 gpm pumps instead of three. This system will provide direct make-up to the cooling tower basin and will be operated in conjunction with the nuclear service water system to

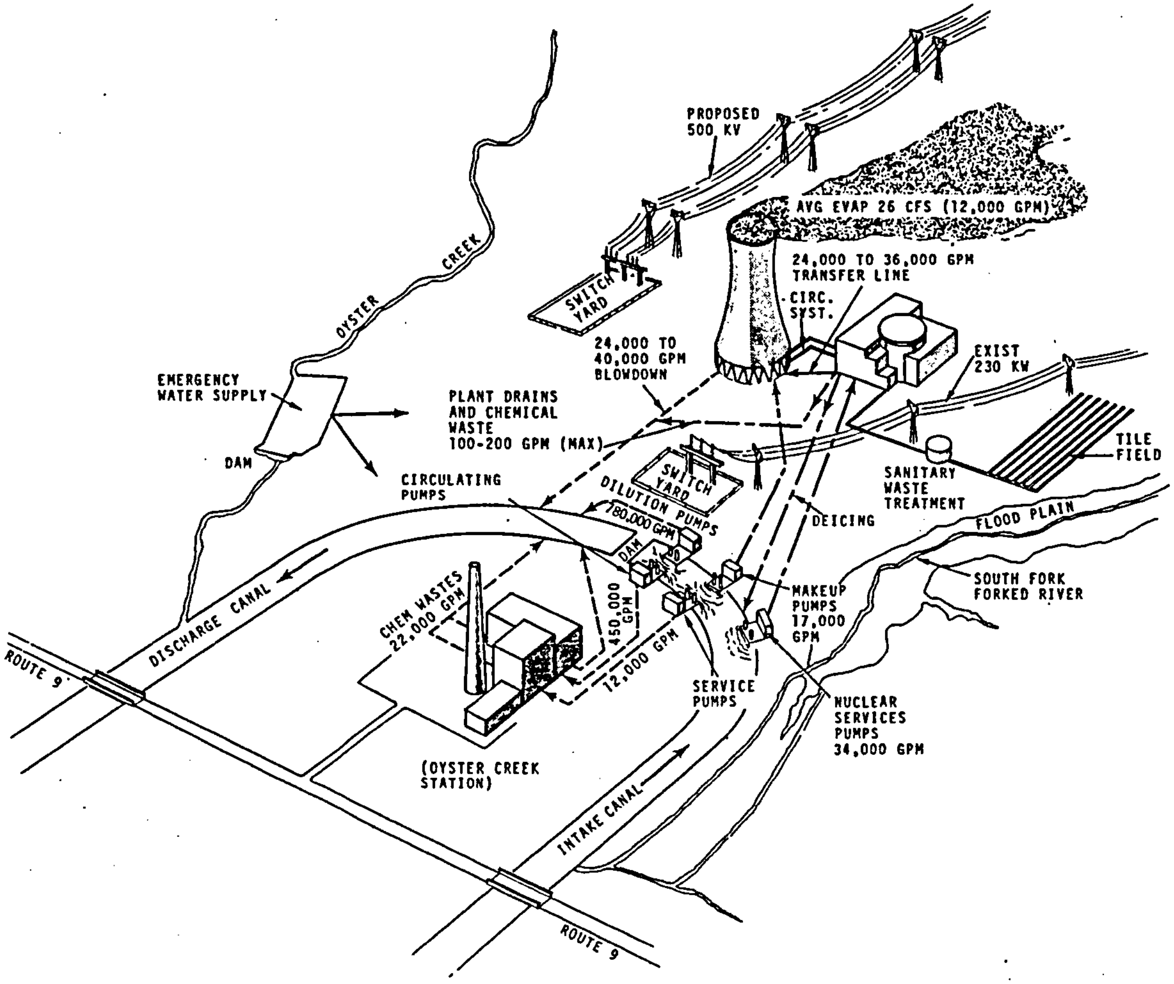


FIGURE III-4. FORKED RIVER STATION WATER SUPPLY AND DISCHARGE SYSTEMS

control the basin water level to within a fixed operation range. Flow in the tower system will be controlled to maintain tower salinity to 45 ppt maximum or a nominal concentration factor of 1.5 over maximum salt concentration at the intake. During times when the seawater salinity is abnormally high, the combined system can be operated to provide a make-up flow of 52,000 gpm (116 cfs) which would reduce the concentration factor to 1.3. During this condition a net flow of 40,000 gpm (89 cfs) would be maintained to the discharge canal. Also, because the blowdown water will be cooler than the condenser effluent from the Oyster Creek Plant, a net reduction of the temperature in the discharge canal of about 0.4°F will be realized during the hottest summer months when canal temperatures may approach 100°F without dilution flow. Similarly, since the flow ratio between the Oyster Creek once-through system and the blowdown from Forked River is on the order of 11:1, changes in the salinity of the discharge canal would be small even when maximum salinities in the tower basin approach 45 ppt.

b. The Cooling Tower

The Forked River Station will dissipate waste heat, from the electrical energy generation process, to the atmosphere through use of either a cross-flow or a counterflow, natural-draft cooling tower. Coolant from the turbine-generator condenser will be pumped to the tower where it will pass through a lattice distributor that provides the contact area necessary for efficiently transferring heat to the upward, counter-flowing air. A natural-draft cooling tower transfers heat from water to air primarily by evaporation of the water as it passes downward through the tower fill section. The air within the tower absorbs the evaporated water and heat (humidity and temperature are increased) as it moves upward to become less dense than the ambient air surrounding the base of the tower. As a result of this density difference, a partial vacuum (draft) is created within the tower which causes the outside air to flow into the base of the tower to displace the less dense air inside. Upon discharge at the top of the tower the warm moist air is carried downwind while mixing with the ambient air. This mixing process generally causes condensation to form a cloud-like plume which will vary in size dependent upon ambient meteorological parameters.

Although such large cooling towers are becoming more common in use, few have been used with high salinity (e.g. seawater) make-up; and to the best of our knowledge none in the world have yet been operated that use seawater and have a cooling capacity equivalent to that planned for Forked River. This absence of existing units is in part due to corrosion (economic) considerations and in part due to the potential effects that

salts entrained in and subsequently deposited from the air may have on the surrounding environs. The employment of such a tower at Forked River is, in effect, a pioneering effort. Although the operating conditions and, accordingly, dimensions have not been finalized, the cooling tower will have a base diameter of about 410 ft, a top diameter of about 275 ft and an overall height of about 490 ft.

Under full-power operation, about 570,000 gpm of condenser coolant at a nominal temperature of 122°F will be pumped to the tower where it will be cooled to 94°F (ΔT 28°F) prior to return to the condenser. About 12,000 gpm (2%) of the recirculation flow will be evaporated by the 750,000 cfs of air passing through the tower. Additionally, 24,000 gpm of high-salinity water (blowdown) will be bled from the tower basin to the discharge canal to maintain the salt at a concentration (<45 ppt) that will not present untenable operational problems, such as increased corrosion and reduced heat transfer efficiency. Make-up water requirement from the intake side of the canal is essentially the sum of the evaporative loss and blowdown: 36,000 gpm. Heat transfer from the water to the air will be at a rate of about 1.2×10^8 Btu/min or 96% of the heat load added by the condenser. The remaining heat will be contained in the blowdown sent to the discharge canal.

Air-entrained water droplets (drift) discharged from the top of the tower will be deposited on downwind surfaces. Although this will be an extremely small loss (on the order of 23 gpm) it is of concern with respect to potential interaction of the salt residue with biological systems and man-made structures. The Applicant has recognized the necessity for minimizing drift because of these potential interactions, and has designed the cooling tower investigatory program with high-efficiency drift elimination as a primary goal. Further, the Staff has performed an independent analysis of drift both from the technological and potential environmental impact standpoints. The results of these assessments are presented in Sections V.A. and V.C. 1.

2. Radioactive Wastes

During the operation of the Forked River Station, radioactive material will be produced by fission and by neutron activation reactions of metals and other material in the reactor coolant system. Small amounts of gaseous and liquid radioactive wastes will enter the waste streams, which will be monitored and processed within the Station to minimize the radioactive nuclides that will ultimately be released to the atmosphere and into Barnegat Bay. The radioactivity that may be

released during operation of the Station at full power will be in accordance with the Commission's regulations, as set forth in 10 CFR Part 20 and 10 CFR Part 50.

The waste handling and treatment systems for the Station are discussed in the Preliminary Safety Analysis Report, as amended July 15, 1970 and October 5, 1971; the Applicant's Enviromental Report, dated January 24, 1972, and revised April 18, 1972, and in supplementary information dated May 3, 1972.

a. Liquid Waste

The liquid waste system is shown schematically in Figure III-5. The Forked River design will have three subsystems for the collection and treatment of liquids: the chemical and volume control system, the boron management system, and the liquid waste management system.

The chemical and volume control system (CVCS) will be designed to maintain the concentration of boron in the primary coolant within prescribed limits. A letdown flow of approximately 68 gpm will be cooled in a letdown heat-exchanger and then processed through a mixed-bed purification demineralizer. A separate mixed-bed demineralizer will be used 20% of the time to remove cesium and lithium. In addition, a deborating demineralizer will be provided for boron control near the end of the fuel cycle. Our calculations take credit for only the first demineralizer. From the demineralizers the liquid will be routed to the volume control tank and returned to the primary loop. Excess liquid due to volume expansion in the volume control tank and shim bleed will be sent to the boron management system.

The boron management system will process reactor coolant letdown from the CVCS during plant startup and dilution operations. In addition the system will process primary coolant from leakoffs, drains and relief flows that will accumulate in the reactor drain tank. The liquid will first be sprayed into a flash tank where some of the dissolved gas will be released to the gas surge header. From the flash tank the liquid will be pumped to one of four holdup tanks, with a capacity of 33,000 gal/tank. The Applicant assumes an average residence time of 9 days in the system tankage and we agree with this assumption. From the holdup tanks the liquid will be routed to one of two filters and then to one of two mixed-bed demineralizers. From the demineralizer the liquid will be routed to a 20 gpm boric acid evaporator. The evaporator bottoms will be sent to the boric acid makeup tanks or disposed of as solid radioactive waste. The distillate from the evaporator will be routed to one of two anion demineralizers and then to

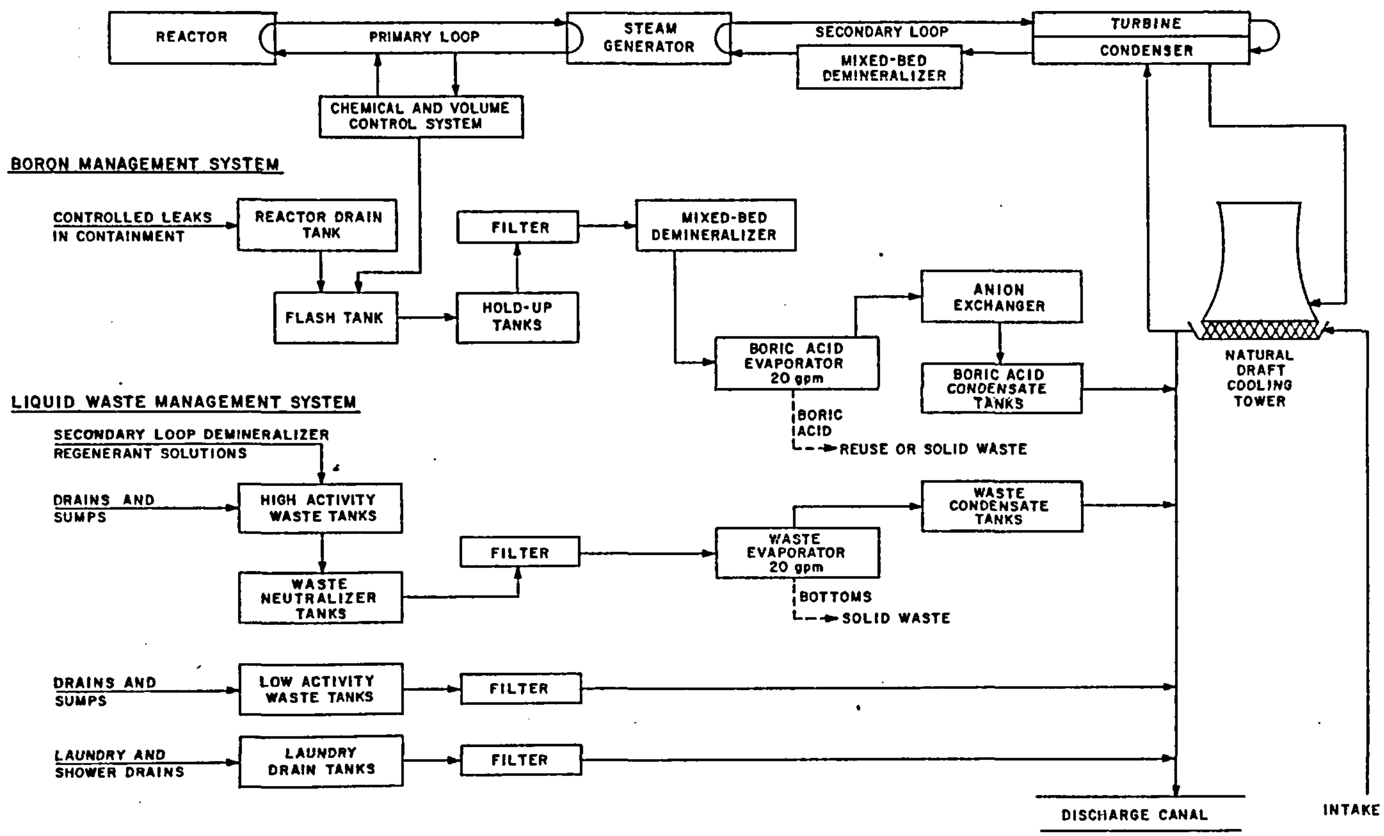


FIGURE III-5 SCHEMATIC OF FORKED RIVER LIQUID RADIOACTIVE WASTE SYSTEM

one of two boric acid condensate tanks, each having a capacity of 7,500 gal. The distillate could be reused as primary water makeup. The Applicant assumes that the total quantity of distillate, 780,000 gal/yr, will be discharged to the cooling tower blowdown and the Staff agrees with this assumption.

The liquid waste management system will process three types of waste: moderate activity waste (greater than 10^{-5} μCi/ml), low activity waste (less than 10^{-5} μCi/ml) and laundry waste. Moderate activity waste will include equipment drain fluids, laboratory and decontamination solutions, and secondary system wastes in the event of radioactivity. Low activity wastes will include equipment drain fluids which are expected to contain minimal amounts of radioactive material. The laundry waste will include detergent solutions and shower waste water.

The moderate activity waste will be collected in two high activity waste tanks (18,000 gal each). The liquid waste will then be routed to one of two neutralization tanks (18,000 gal each) where the pH will be adjusted if necessary, processed through a filter and a 20 gpm waste evaporator. The evaporator bottoms will be collected in a waste storage tank and subsequently disposed of as solid radioactive waste. The distillate from the evaporator will be collected in one of two condensate tanks (18,000 gal each) and discharged to the cooling tower blowdown.

Secondary loop cleanup will be accomplished by mixed-bed condensate demineralizers, which will be periodically regenerated. In the event of radioactivity in the secondary loop the regenerant solutions will be routed to the high activity waste tanks and processed as described above. Provision will be made for blowdown of the steam generator in the event of salt water intrusion from a condenser leak. The blowdown liquid will also be processed by the moderate activity subsystem in the event of high radioactivity. Staff evaluation assumes that the moderate activity subsystem will process the demineralizer regenerant solutions but will not process any blowdown. It is assumed that all the activity due to steam generator leakage will be reflected in the condensate demineralizer discharge activity.

Low activity waste and laundry wastes will normally be filtered and then discharged. Inter-ties will be provided between systems to provide flexibility in the use of processing equipment. In the event that the discharged liquid exceeds a preset limit, the discharge will be automatically stopped.

Based on our evaluation of the liquid waste treatment system we estimate that 2 Ci/yr excluding tritium will be discharged in the liquid effluent. The calculated annual releases of the major radioisotopes are shown in Table III-1. Tritium releases are estimated at 1000 ci/yr, based on experience with operating pressurized water reactors. The Applicant's Environmental Report estimates a liquid release of 0.08 Ci/yr excluding tritium, and 238 Ci/yr of tritium activity, based on 0.1% of the operating power fission product source. The discharged waste will be mixed with the cooling tower blowdown and discharged into the canal. The Applicant estimates that the cooling tower blowdown rate will vary from 24,000 gpm to 40,000 gpm depending on the season.

Since the liquid effluents containing radioactive materials will be discharged from both Stations (Forked River and Oyster Creek) to a common canal, a Table (III-2) of radioactive materials in the Oyster Creek Station discharge is included for the purpose of calculating radiation doses (Section V).

b. Gaseous Waste

During power operation of the facilities, radioactive materials released to the atmosphere in gaseous effluents will include low concentrations of fission product noble gases (krypton and xenon), halogens (mostly iodines), tritium contained in water vapor, and particulate material including both fission products and activated corrosion products. The gaseous waste treatment system and ventilation paths are shown schematically in Figure III-6.

Gases to be processed in the gas decay tanks will originate primarily from two operations: plant startup and bleed and feed operations, where the letdown stream will be diverted to the boron management system (the shim-bleed operation). Liquids from either of these operations will be sprayed into a flash tank wherein a portion of the dissolved hydrogen and noble gases will be transferred to the gas phase. These gases will be purged with nitrogen to the gas surge header from which they will be transferred to one of three pressurized gas-decay tanks. Other sources of radioactive noble gases and iodines to be processed in the decay tanks will include the gas removed in the boric acid and waste evaporators, cover gases displaced from the boron management system waste holdup tanks, from venting of the volume control tank of the chemical and volume control system and from various equipment vents. Gases collected in the gas

Table III-1

CALCULATED ANNUAL RELEASE

OF RADIOACTIVE MATERIALS IN LIQUID EFFLUENTS FROM

FORKED RIVER STATION (REVISED)

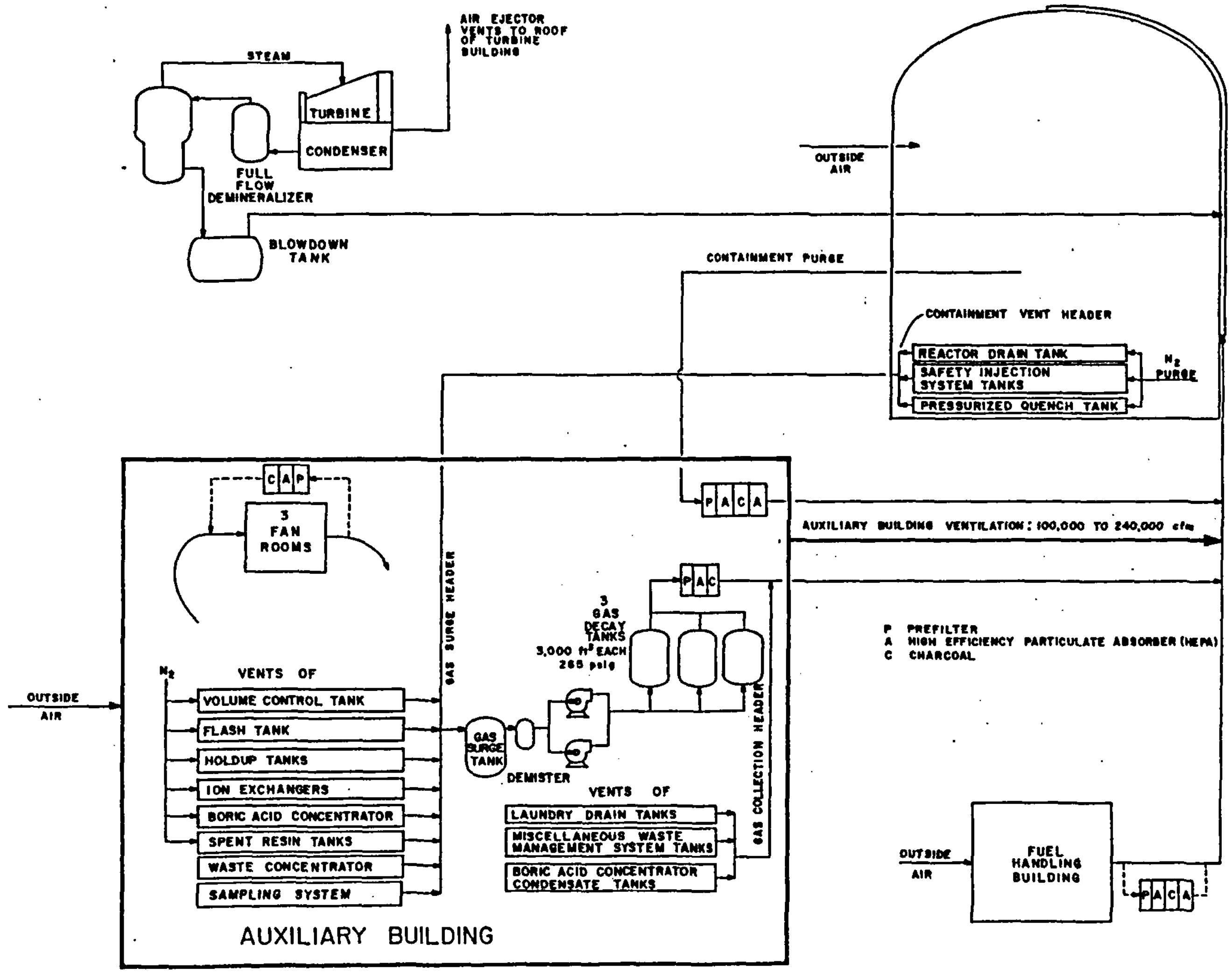
Nuclide	Curies/yr	Nuclide	Curies/yr
Rb-86	5.1(-4)	Te-131	4.0(-5)
Sr-89	1.4(-4)	Te-132	5.6(-3)
Sr-90	5.0(-6)	I-130	4.8(-4)
Sr-91	1.0(-5)	I-131	7.5(-1)
Y-90	2.7(-6)	I-132	6.0(-3)
Y-91m	6.0(-6)	I-133	2.5(-1)
Y-91	6.8(-4)	I-135	9.5(-3)
Y-93	2.1(-7)	Cs-134	3.6(-1)
Zr-95	2.3(-5)	Cs-136	5.6(-2)
Zr-97	1.8(-6)	Cs-137	2.8(-1)
Nb-95	2.4(-5)	Ba-137m	2.6(-1)
Nb-97m	1.7(-6)	Ba-140	1.4(-4)
Nb-97	1.8(-6)	La-140	1.6(-4)
Mo-99	4.4(-3)	Ce-141	2.4(-5)
Tc-99m	4.0(-3)	Ce-143	5.0(-6)
Ru-103	1.7(-5)	Ce-144	1.5(-5)
Ru-106	5.0(-6)	Pr-143	1.9(-5)
Rh-103m	1.7(-5)	Pr-144	1.5(-5)
Rh-105	4.0(-6)	Nd-147	7.0(-6)
Rh-106	5.0(-6)	Pm-147	1.6(-6)
Sn-125	1.0(-7)	Np-239	1.0(-4)
Sb-125	1.0(-7)	Cr-51	1.7(-4)
Sb-127	5.0(-7)	Mn-54	1.4(-4)
Te-125m	1.4(-5)	Mn-56	7.0(-6)
Te-127m	1.1(-4)	Fe-55	3.1(-4)
Te-127	1.2(-4)	Fe-59	1.8(-4)
Te-129m	1.1(-3)	Co-58	4.4(-3)
Te-129	6.8(-4)	Co-60	1.4(-4)
Te-131m	2.5(-4)		
		Total (excluding H-3)	2.0(0)
		H-3	1.0(+3)

The integers in parentheses indicate the power of ten by which the numbers should be multiplied, e.g., 1.3(-3) means 1.3 x 10^{-3}.

TABLE III-2

ESTIMATED ANNUAL RELEASE OF RADIOACTIVE MATERIALS IN LIQUID EFFLUENTS FROM OYSTER CREEK STATION[2]

Nuclide	Estimated Ci/yr
H-3	16.00
Xe-135	7.20
Xe-133	1.80
Mo-99	1.20
Cr-51	1.10
Ba-140	0.72
Np-239	0.54
Tc-99m	0.39
I-131	0.27
I-133	0.25
La-140	0.23
Co-60	0.23
Co-58	0.08
Sr-90	0.06
Mn-54	0.04
Cs-137	0.06
Total (excluding tritium)	14.17



GAS PATHS AND VENTILATION - FORKED RIVER NUCLEAR GENERATING STATION, UNIT 1

FIGURE III-6 SCHEMATIC OF FORKED RIVER GASEOUS RADIOACTIVE WASTE SYSTEM

surge header and containment vent header will be routed through a surge tank and demister, compressed to 265 psig by two waste gas compressors and then transferred into one of three 3000-ft^3 capacity gas decay tanks. After appropriate decay these gases will pass through a prefilter, a High Efficiency Particulate Air (HEPA) filter, and a charcoal adsorber before being discharged to the atmosphere. The Applicant assumes that the decay tanks have sufficient capacity to hold up waste gases for a minimum of 45 days and the Staff agrees with this assumption.

Other gases collected from equipment tanks, such as laundry drain tanks and miscellaneous waste management system tanks, will be discharged directly to the Station vent. These gases are not expected to be a contributing source of activity. The Station vent will be located at the top of the containment building. Redundant radiation monitors will be provided to monitor the activity of the release. Upon reaching a preset activity in the release stream, the release will be automatically terminated.

Additional sources of gaseous waste activity include ventilation air released from the auxiliary building, spent fuel building, and the turbine building, off-gases from the steam generator blowdown tanks, venting of the steam jet air ejectors and purging of the reactor containment building.

Blowdown of the steam generators is expected to occur only during periods of condenser inleakage. Staff analysis assumes a 10 gpm blowdown is required 5% of the time and that the blowdown tank is vented directly to the atmosphere via the Station vent.

Off-gases from the condenser air ejector will be discharged from a vent located on the roof of the turbine building without treatment. Turbine building ventilation exhaust will contain low concentrations of activity, primarily from steam system leakage, and will be discharged to the atmosphere without treatment.

During power operation it may be necessary to use the containment purge supply and exhaust systems for pre-access cleanup. The containment filter system will draw contaminated air across a filter assembly which will consist of a prefilter, HEPA filter, charcoal adsorber, and a final HEPA filter; the air will pass through the system fan and then be discharged into the Station vent. The auxiliary building ventilation air will be discharged to the Station vent without treatment. Under normal conditions the fuel handling building ventilation air will also be discharged without treatment; however, there will be the option of discharging

this air through a prefilter, HEPA filter, charcoal adsorber, and HEPA, as shown in Figure III-6. The system was evaluated without taking credit for these filters.

Table III-3 shows our calculated annual release of radioactive materials in the gaseous effluent, based on the assumptions in Table III-5 including 45 containment purges per year.

Due to the close proximity of the Oyster Creek Station the Staff has considered the combined releases from both Stations in calculating the radiation doses attributable to gaseous effluents. The radioactive material releases from the Oyster Creek Station used in estimating doses are those shown in Table III-4.

c. Solid Wastes

Solid wastes will consist of spent resins, concentrated evaporator bottoms, spent filter cartridges and miscellaneous low-level solid waste. The spent resin will be stored and then transferred to drums, where it will be mixed with concrete or fluorine based polymer. The waste evaporator bottoms will be pumped into shipping casks. Filter elements and miscellaneous compressible waste will be disposed of by means of a baler and packed into containers. Packaging and shipping will be in accordance with AEC and Department of Transportaion (DOT) regulations.

Based on operating plants, the Staff estimates that the equivalent of approximately 250 drums of spent resin and evaporator bottoms will be generated per year. We estimate that each drum will contain about 21 Ci after 180 days decay. In addition, it is expected that 600 drums/yr of dry waste containing less than 5 Ci/yr will be generated. The total volume of waste handled could increase significantly in the event of a seawater leak.

In its Environmental Report, the Applicant has estimated the annual accumulation of liquid concentrates to be approximately 1650 $ft,^3$ miscellaneous dry wastes to be 200 drums per year, spent resins 533 ft^3/yr and two special filter shipments annually. The shipment of solid waste may increase if the main condenser leaks. This would have the effect of more frequent resin regeneration and depletion, necessitating the shipment of more liquid concentrates and spent resins.

3. Chemical and Sanitary Wastes

Water treatment facilities at the Forked River Station will include ion-exchange demineralizers, for high purity water production, which employ sulfuric acid and sodium hydroxide for regeneration of the

TABLE III-3

ANTICIPATED ANNUAL RELEASE OF RADIOACTIVE MATERIALS IN GASEOUS EFFLUENTS FROM FORKED RIVER STATION

Ci/year

Isotope	Containment Purge [a]	Auxiliary Building	Gas Processing System [b]	Condenser Air Ejector	Steam Generator Blowdown Vent	Total
Kr-83m	-	1	-	1	-	2
Kr-85m	-	7	-	7	-	14
Kr-85	10	5	961	5	-	980
Kr-87	-	4	-	4	-	8
Kr-88	1	13	-	13	-	27
Xe-131m	9	6	45	6	-	66
Xe-133m	10	14	-	14	-	38
Xe-133	1280	1040	230	1040	-	3600
Xe-135m	-	1	-	1	-	2
Xe-135	3	21	-	21	-	45
Xe-137	-	1	-	1	-	2
Xe-138	-	3	-	3	-	6
Total	1313	1116	1236	1116		4790
I-131	0.21	0.072		0.008	0.001	0.29
I-133	0.059	0.094		0.010	0.002	0.17

(a) Based on 45 containment purges/yr
(b) Based on 45 day decay

TABLE III-4

ANNUAL RELEASE OF RADIOACTIVE MATERIALS IN GASEOUS EFFLUENTS FROM OYSTER CREEK STATION

Isotope	Release (Ci/yr)
Xe-138	76,000
Xe-135	326,000
Xe-133	198,000
Kr-88	294,500
Kr-87	218,000
Kr-85m	87,500
Total (Noble Gases)	1,200,000
I-131	4.8 Ci/yr

TABLE III-5

PRINCIPAL CONDITIONS AND ASSUMPTIONS FOR CALCULATING RELEASES OF RADIOACTIVE EFFLUENTS FROM FORKED RIVER STATION

Reactor Power, MWt	3,560
Plant Factor	0.80
Operating Power Fission Product Source Term, %	0.25
Number of steam generators	2
Leak of primary coolant into steam generator, gpd total	20
Leak of primary coolant into containment, gpd	40
Leak of primary coolant into Auxiliary Building, gpd	20
Number of containment purges/yr	45
Blowdown rate (Normal)	(a)
Cold shutdowns/yr	5
Purification letdown, gpm	68
Shim bleed, gpy	780,000
Total steam flow, lb/yr	15,800,000
Primary coolant volume, ft^3	11,400
Containment volume, ft^3	2,000,000

Decontamination Factors(b)	Cations(c)	Anions	Cs & Rb	Y, Mo, Tc
Mixed-bed (Ii-B03 form)	10	10	2	
Mixed-bed (H^+-OH^- form)	10^2/10	10^2/10	2/10	
Cation Bed (H^+ form)	10^2/10	1	10	
Anion Bed (OH^- form)	1	10^2/10	1	
Plateout: Mo & Tc-99m				10^2
Plateout: Y				10

Decontamination Factors for Radioiodine

(a)	Steam generator internal partition	100
(b)	Steam generator blowdown vent	20
(c)	Condenser air ejector	2,000
(d)	Primary coolant leak to Containment Building	10
(e)	Primary coolant leak to Auxiliary Building	200

(a) Gaseous release calculations assume a blowdown rate of 4800 lb/yr 5% of the time. Liquid release calculations assume no blowdown

(b) First/second (in series)

(c) Except Cs, Mo, Y, Rb, H-3, Tc

TABLE III-5 (Continued)

Total System Decontamination Factors (including evaporators)

	I	Cs, Rb	Y	Mo, Tc	Other Cations
Boron Management System	10^5	$4x10^2$	10^3	10^4	10^5
Liquid Waste Management System	10^2	10^3	10^4	10^5	10^3

exhausted resins. The spent chemical regenerants will be collected and neutralized to pH 6.8-7.2 prior to discharge to the canal via the cooling-tower blowdown line. During normal operation, an estimated 600 lbs/day of NaOH and 700 lbs/day of sulfuric acid will be used to regenerate the demineralizers of the polishing unit. The sodium sulfate that results from mixing the spent regenerants will add approximately 1.3×10^{-4} lbs of sodium sulfate/gal to the cooling tower blowdown over the 5-6 hour daily discharge period. During maximum usage, the sodium sulfate concentration will increase to 4.0×10^{-4} lbs/gal. Other demineralizer systems will contribute smaller quantities of regenerant waste on a 4-day frequency rather than daily. These sodium sulfate concentrations are a small fraction (about 1%) of the sodium sulfate concentration (3.0×10^{-2} lbs/gal) normally found in seawater.

Chemical treatment of the condenser cooling water will employ chlorination and, if necessary, the addition of other slimicide chemicals. The total residual free chlorine discharged to the environment should be 0.5 ppm or less. It is anticipated that the chlorine will be applied as a shock treatment three times a day for 15-20 minute periods. A minimum dilution factor of 5 will be available at the discharge point in the canal which will dilute the total chlorine residual to 0.1 ppm or less.

In addition to the chlorine required for the circulating water system, it is expected that some sulfuric acid will be injected to maintain the system pH at a maximum of approximately 7.8. The exact amount required has not yet been determined but the anticipated sulfate addition will be small compared to that naturally present in seawater.

Sanitary wastes will be treated by air activated biological degradation in a 28,500 gallon aeration tank for a minimum of 5 days. This treatment is expected to remove 95% of the biochemical oxygen demand of the waste. Effluent from the system will be clarified to remove sludge, floating debris, and scum and will be discharged to an infiltration field on site. Percolation into the soil will further aid biological degradation and provide a final separation of remaining suspended solids. Sludge will be periodically removed from the treatment unit and discharged to a drying bed adjacent to the infiltration field. Both the drying bed and infiltration field are expected to be odorless. The dried sludge will be used for landfill on Station property.

Evaporation in the cooling tower system will increase the salinity between 50 and 100%. Overall canal salinity will be limited by

mixing with circulating water from the Oyster Creek Station. The overall salinity increase will be restricted to 10% of the intake level.

Boron discharges from the Station will be insignificant relative to the boron normally found in seawater. At an estimated 2 lbs/day boron discharge, the blowdown would contain 7×10^{-3} ppm boron. Normal seawater contains 4-5 ppm boron.

4. Other Wastes

Presently, plans are that debris collected on the traveling trash rake on the cooling water inlet will be removed and flushed to the discharge canal.

IV. ENVIRONMENTAL IMPACT OF SITE PREPARATION AND PLANT CONSTRUCTION

A. SUMMARY OF PLANS AND SCHEDULES

Site preparation work on the Forked River Station was planned by the Applicant to be started in early February 1973 and to be completed (the reactor ready for fuel loading) in June 1977. To date there has been essentially no disturbance of the Site. Peak employment during construction is estimated at about 1500 men. A detailed construction schedule is presented in the Applicant's Environmental Report (Figure 2-5); major milestones are:

Task	Date
Complete Site excavation	September 1973
File Final Safety Analysis Report	January 1975
Reactor vessel installed	November 1975
Complete turbine building	January 1977
Issuance of operating license	August 1977
Start commercial operation	June 1978

B. IMPACTS ON LAND, WATER AND HUMAN RESOURCES

A total of about 210 acres will be involved in Station construction activities:

Station site - 65 acres (buildings, intake structures, switchyard, parking)

Cooling tower - 15 acres

Construction facilities - 130 acres (laydown areas, contractor buildings, access and construction roads, parking)

That area required for construction facilities will be reseeded or allowed to revert back to natural vegetation upon completion of construction activities. Disturbed Station areas will be landscaped as discussed in Section III.A.

The Applicant estimates that about 700,000 cubic yards of Site excavation will be required in constructing the facility. Some of this material will be used for backfill immediately; the remainder that is suitable for backfill will be stockpiled southwest of the

cleared area until needed. That portion unsuitable for backfill will be stored southeast of the cleared area to be later used on the Site or elsewhere and in accordance with good spoils disposal practices.

About 100 acres of relatively sparse forest land will be cleared for construction activities. As a result, some habitat will be eliminated and animals displaced that may be nesting and residing in the immediate vicinity. The opening of forested areas along the transmission rights-of-way may benefit the deer population by creating additional browse for feed.

Delivery of large equipment components to the building Site will necessitate broadening and deepening Oyster Creek Canal; however, deepening the Intercoastal Waterway in Barnegat Bay will probably not be necessary. The 40,000 cubic yards of material dredged from the canal will be used as landfill on the northshore of the canal on the Applicant's property and allowed to reseed through natural processes. The temporary barge-unloading facility will be the only shoreline structure needed for construction activities.

The Applicant has supported studies to determine the diversity and abundance of macroinvertebrate fauna in Oyster Creek since 1965. Results of these studies are presented in a series of seven semi-annual reports prepared by the Department of Zoology, Rutgers University, the highlights of which have been discussed in Section II.E.2 of this statement.

To date, 170 macroinvertebrates(benthic) species have been identified in the Rutgers' reports. The first report identified nine of these species as dominant forms while the sixth report added three further species to the list of dominants. During the 1965-1966 surveys, the nine dominant species constituted 70.8% of the total population of bottom organisms collected. With the addition of the three dominant species identified in later surveys, the twelve dominant forms will likely comprise the bulk of bottom organisms affected by dredging the Oyster Creek Canal.

The data on benthic organisms presented in the first three Rutger's reports bracket the period of the original dredging in Oyster Creek. These data do not reflect any loss of bottom organisms by the dredging operation. Although dredging is not mentioned in these reports, it is likely that recruitment and recolonization from waters outside the dredged channel proceeded rapidly and continuously without further disturbance.

Dredging of the channel in 1974-1975 is estimated to require 90 days. The dredged channel (Intracoastal Waterway to Route No. 9 Bridge over Oyster Creek) will be approximately 16,500 ft in length. Dredging will be accomplished at an average rate of 180 ft/day. Recruitment and recolonization from water unaffected, however, should restore most areas initially disturbed in 2 or 3 years.

C. CONTROLS TO REDUCE OR LIMIT CONSTRUCTION IMPACTS

Soil disturbance during Site preparation and construction will result in a potential for erosion with subsequent runoff of fine materials into adjacent watercourses. The Applicant is aware of this potential problem and will attempt to minimize erosion by preventative measures such as dikes and control contours. This same problem will exist in clearing the transmission lines rights-of-way. It is the Applicant's intent to avoid complete clearing as much as possible (e.g. around tower bases and for access roads), and to leave the natural vegetation undisturbed to lessen the impact of erosion and appearance. Screens of natural vegetation will remain at major highway and river crossings. Also, the less expansive, floristic and faunistic rich cedar swamp areas will be avoided in favor of the more expansive and tolerant hardwood and pine swamp forests. Additionally, those recommendations set forth in appropriate guidelines for transmission line routing[1,2] will be followed closely with respect to design, trimming, construction, maintenance, and cleanup and restoration.

Construction of the Station will require careful coordination of the excavation and drainage required to assure stability of the reactor and turbine-generator system. While construction plans have not been finalized, information available in the Preliminary Safety Analysis Report (PSAR) reveals the need for excavation to a level of -50 ft below surface grade. This will extend into the beach sands and gravels and could in instances extend to the upper portions of the Cape May formation. Compaction of foundation materials to suitable densities may require the extensive use of water for liquification and classification of affected foundation sands. Plans for the clarification of waste waters from foundation compaction operations and associated construction activities need to assure minimization of sediment deposits in the Oyster Creek discharge canal. A separate clarification pond or other suitable means for presettlement of construction drainage waters must be used to minimize construction impacts from this source.

The Applicant indicates that extensive use of sprinkling to minimize surface dust or "fugitive" materials will be employed. Waste materials will be disposed of in a manner approved by the State of New Jersey.

Planting of native or quick-response grasses such as red rye is under consideration for further minimization of "fugitive" materials. Water use for these purposes would be minimal and probably would be derived either from the Oyster Creek impoundment or the existing Station service water supply.

Waste chemical solutions used for cleaning piping and equipment and waste oil or lubricants resulting from the use of construction or other equipment at the site should be collected, properly treated, and disposed of by means which will not result in environmental pollution.

Resuspension of sediments during dredging operations has the potential to create greater environmental degradation than the physical removal of the substrate. Sediments rich in organics and volatile solids will, upon resuspension, significantly increase oxygen demand and result in reduced dissolved oxygen levels. Additionally, hydrogen sulfide, heavy metals, or other toxic substances may be released to the water column in concentrations toxic to marine organisms. Light penetration will be reduced resulting in reduced photosynthetic activity. Suspended dredge spoils may produce direct mechanical damage to the gill tissues of fish and the delicate filtering mechanisms of many zooplankters. Also, where the substratum or hydrological conditions are permanently altered, change in the benthic community structure, both in diversity and abundance, can be expected.

Previous studies of dredging operations involving grossly polluted sediments (11-35% volatile solids) have shown that oxygen demand remains above normal as long as sediments remain suspended in the water column.[3] However, laboratory tests indicate that the settling rate of suspended dredge spoils is highest in seawater. Concentrations of 10% seawater will appreciably accelerate redeposition. Settlement in 100% seawater is essentially complete in 3 to 4 hours.

The Applicant has stated that dredging operations will be confined to the intake and discharge canals and that all spoils will be used for landfill. Therefore, these operations will have no or little effect on Bay organisms.

V. ENVIRONMENTAL IMPACTS OF PLANT OPERATION

A. Land Use

Two primary land-use impacts associated with the operation of the Forked River Station have been identified and evaluated by the Applicant and the Staff: the removal of several hundred acres of land from other potential uses, and the possible effects of cooling tower salt drift on adjacent structures, activities and ecosystems. Assessment of the former consideration is discussed in the previous section. In summary, siting and operation of the Station at this location will not preempt the land from any other high-value or unique uses that might otherwise exist. Current and foreseeable land-use developments in the area are primarily nearer Barnegat Bay with considerable vacant land still available at similar distances (several miles) back from the bayfront. Moreover, the fact that the presently operational Oyster Creek Nuclear Station is located adjacent to the proposed site reduces considerably the impact of siting the second plant.

The operation of the transmission lines will have far less impact than the construction phase. Land suitable for agricultural use will be returned to that use with only a few restrictions such as maximum height of trees. Proper installation of erosion control devices (culverts and ditches) and proper grading should minimize long-term erosion problems such as deep channeling. Easements on federal and state-owned lands will be managed in conjunction with the government agency involved.

The Applicant has undertaken and sponsored studies on salt drift over land expected from cooling tower operation as well as from natural sources. Data from these studies show that no more than 80% of the salt from tower operation is expected to be deposited within a 75-mile radius of the tower.[1] The maximum short-term drift deposition rate from the cooling tower is estimated at 3.1 kg/minute and at no time of year is the rate of drift deposition expected to exceed 65 $kg/km^2/month$. Based on the use of available data, the long-term average natural sea salt deposition rate is 600 $kg/km^2/month$ within 1 mile of the tower. Thus, maximum tower drift could add about 11% more salt to surfaces near the tower with decreasing amounts expected at greater distances. The measured chloride content of surface soils within a 5-mile radius presently averages about 6 ppm, and about 0.5-0.6 ppm of chloride might be expected to be contributed by the operation of the salt water cooling tower. The addition of this

concentration of salt from tower drift is considered an insignificant change to the chemical and physical properties of local soils.

Considering the naturally high background salt concentrations in the Forked River region, the Applicant's consultants assessed the effects of the expected small incremental additions of salt from cooling tower drift on man-made structures. Materials and coatings evaluated were metals, wood, asphalt, concrete, and paints. Although airborne salts may have appreciable deleterious effects on such materials, the consultants and the Staff are of the opinion that the small incremental effects attributable to cooling tower drift will not be significant.

The assessment of the environmental acceptability and feasibility of operating a saltwater natural draft cooling tower at the Forked River site required consideration of the potential for economic or ecological loss due to salt deposition or climatic modifications. The potential for such impacts was assessed by a consulting group employed by the Applicant. The consulting group consisted of Pickard, Lowe and Associates and 13 technical specialists from Massachusetts Institute of Technology; State University of New York, Albany; University of Massachusetts; Rutgers; New York State University; and Environmental Systems Corporation. At present there are no saltwater cooling towers serving plants as large as the planned Forked River Station. This fact required that the study consider the technological as well as environmental feasibility of such an installation. The approach taken was to measure the drift amounts that actually occur in cooling towers, predict the diffusion and deposition of the salt, and then assess the impact of the salt by reviewing available literature and by comparing the predicted tower salt drift concentrations to measurements of the naturally occurring salt concentrations produced by onshore winds.

Drift measurements at the Homer City, Pennsylvania, counterflow natural-draft tower indicated a total drift rate of 0.0025%. The measured mass distribution with size was 0 to 60 microns, 20%; 60 to 120 microns, 46%; 120 to 180 microns, 24%; and >180 microns, 10%.

This size distribution, with a drift rate increased by 50% (to 0.00375%) to account for uncertainties and different operating conditions, was used with other tower operating characteristics and the local climatology to predict the tower produced salt concentrations. The prediction calculations took into account the rise of the droplets upon leaving the tower due to the buoyancy of the heated saturated

air, and their fallout from the buoyant plume into the ambient air when they approach the ground at a rate dependent upon their initial size and evaporation rate. The evaporation rate was predicted on the basis of the ambient vapor pressure; the vapor pressure at the droplet surface as it is affected by the curvature, temperature and salt concentration of the drop; and the fall velocity.

The diffusion of the droplets was predicted by the standard Gaussian diffusion model accounting for depletion of the plume as deposition occurs. Under light wind conditions when the plume would be predicted to attain considerable heights, a maximum plume height of 1 km was permitted to account for the presence of an inversion at that average level. Plume rise was predicted from Briggs[2] by calculating the buoyancy upon the basis of sensible plus latent heat of condensation. For very high winds, which tend to pull the plume into the turbulence wake behind a cooling tower, the results of a wind tunnel model study were used to predict ground-level air concentrations and deposition.

The results of the Applicant's analysis showed that the maximum annual average ground-level air concentration of tower-produced salt would be about 0.1 $\mu g/m^3$ (micrograms per cubic meter) and would occur in the E and ESE direction sectors between about 0.5 and 1 mile and again between 3 and 7.5 miles in the ESE sector, which is predominantly over Barnegat Bay. At all positions the annual average airborne salt concentration due to the tower is less than 10% of that occurring naturally. Short-term (several hour average) higher concentrations of about 10 $\mu g/m^3$ were predicted to occur during high winds due to the interaction of the cooling tower wake and the plume. This compares to naturally occurring short-term peak salt concentrations of about 20 $\mu g/m^3$ at 10 miles inland to 500 to 1000 $\mu g/m^3$ near the ocean shore. The maximum average monthly tower-produced salt concentration was predicted to be 0.236 $\mu g/m^3$ at 0.6 miles during January for winds blowing offshore. For onshore winds the maximum was 0.124 $\mu g/m^3$ in a distance range bounded by 6.2 and 12.4 miles.

Natural sea-salt deposition measurements ranged from 300 kg/km^2/month 10 miles inland, to 3500 kg/km^2/month near the shore. The maximum average annual deposition due to the cooling tower was estimated to be 31 kg/km^2/month. The maximum cooling tower salt deposition occurring in any month was 74 kg/km^2 between 2.5 and 6.2 miles in the ESE sector during January.

Although the Staff did not duplicate the Applicant's analysis, numerical checks and a complete review of the methods and assumptions were made. The Staff concludes that the methods and assumptions were adequate and the conclusions were valid.

Potential climatic modifications which have been discussed relative to cooling towers include fogging and icing, cloudiness, and precipitation. The Applicant concludes that ground fog will occur substantially less than 2% of the time. Other studies and operating experience indicate that ground fog from natural-draft towers occurs only a few hours per year at the point of maximum impact.[3-9] Operating experience also indicates that icing due to drift or contact of the condensed plume with the ground has not been significant.[5-7] This will also be the case at the Forked River site as estimates indicate that, even if the drift droplets are not permitted to evaporate during fall or after striking the ground, the cumulative maximum ice depostion for a month would not be perceptible (a few microns). The Applicant's consultant estimates that elevated structures, above 200 to 250 ft, might experience rime icing episodes totaling about 64 hr/yr. The Oyster Creek Station exhaust stack is the only tall structure in the near vicinity, and no adverse effects would result from minor icing on this facility.

Natural-draft towers produce persistent cloud-like plumes during most of the year, their altitudes and sizes varying with meteorological conditions. Observations and theoretical analyses indicate that plumes generally rise from a few hundred to a few thousand meters above their release points and dissipate within a few miles or less, but infrequently plumes may extend as far as 20 to 30 miles downwind before dissipating.[3-9]

It is noted that detrimental climatological influences have not been attributed to cooling towers.[6] A few qualitative observations of minor precipitation attributable to cooling tower plumes have been reported. Precipitation does not, however, appear to be a common occurrence. The effect of the added heat and moisture upon natural precipitation processes cannot be assessed at this time, although no significant effects appear to have been observed.

A potential exists for cooling tower cloud water to interact with industrial emissions to form hazardous substances such as acids. This potential hazard is appreciably reduced in the case of a cloud which rises to significant heights and which is unlikely to contact the ground as is the case for natural-draft towers. Cooling tower water vapor may interact with industrial and natural hygroscopic particles to form water droplets which increase upper level haze. Since there is no industry in the Station vicinity that produces gaseous effluents with which the tower vapors would interact, this effect is expected to be minimal.

In the Staff's judgment the impact of the cooling tower upon climatic conditions will be negligible except to the extent that individuals may find the appearance of the condensed elevated plume objectionable or distracting.

The Applicant's and Staff's assessment of environmental impacts associated with salt deposition, especially in consideration of effects on vegetation (see pages V-9, 10), has been keyed to a relatively small incremental increase over background concentrations. This incremental increase must be considered the baseline limit for present impact evaluations unless it can be demonstrated that the local terrestrial ecosystems can tolerate significantly greater salt concentrations. For this reason it is incumbent upon the Applicant to continue a formalized test program on drift losses to provide the necessary confirmation that the goal value of 0.0025% can indeed be achieved. This confirmation should be available prior to the time an operating license is requested. Such a program, carried through the necessary prototypical testing stage, will then assure that the impact is inconsequential. The program of additional drift measurements should include:

(a) Additional data on drift rate over a wide range of meteorological conditions;

(b) The determination of the precision and reproducibility of experimental methods;

(c) The determination of important parameters involving the design and use of drift eliminators.

Furthermore, plans should be formulated and presented for review, concurrent with undertaking the test program, to provide the maintenance and/or corrective actions (including alternatives) that might be required to maintain low drift losses or to otherwise operate the cooling water system in a manner that will result in no greater impact on the environment than that anticipated from the proposed mode of operation. The Applicant's monitoring program should include salt deposition measurements. The effects of salt deposition on the environment resulting from plant operation should be evaluated.

B. <u>Water Use</u>

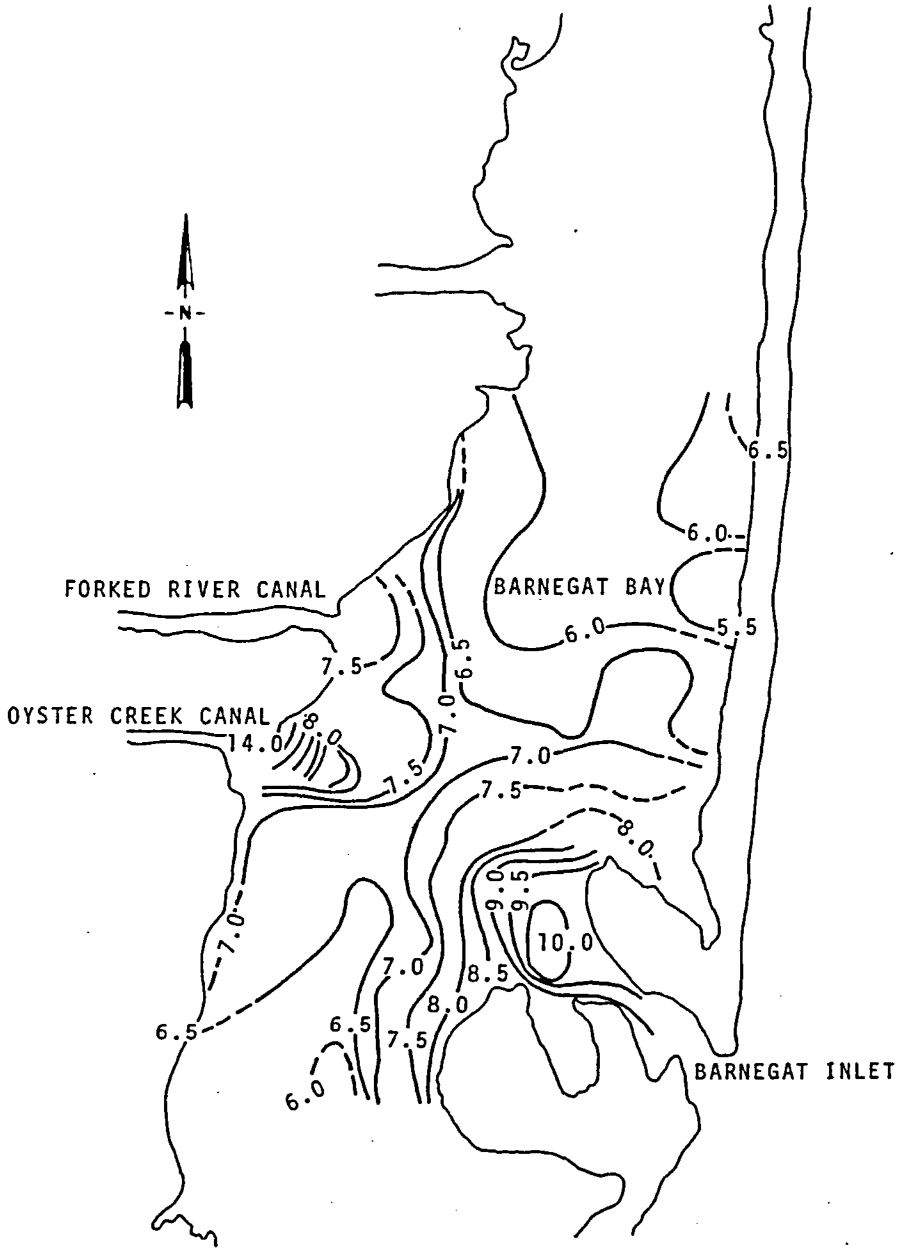
The impacts of the Forked River facility must be superimposed on the existing operational situation at Oyster Creek. For this reason, the following description of the effects of the Oyster Creek facility forms a necessary background.

The Applicant has summarized the existing status of Oyster Creek Station discharges in the Oyster Creek environmental report, and outlined the extent of the thermal effect of the Oyster Creek Station on Barnegat Bay.[10] The infrared imagery survey of November 24, 1969, is typical of the distribution of heated effluent under present conditions. The studies performed by the Applicant indicate that, of the initial 16.7°F condenser differential at Oyster Creek Station under 75% of full power, approximately 20% is dissipated to the atmosphere before the water from Oyster Creek enters Barnegat Bay (Figure V-1). Studies also show that on each succeeding tidal cycle, a significant fraction of the warmed water is moved to the open ocean via Barnegat Inlet. The infrared study suggests that 30 to 40% of the thermal energy in the effluent may be dissipated in the ocean during ebb-tide conditions. During flood tide, the principal current path is to the south and the mixed effluent is moved with the new water in that direction forming a thermal plume which impinges on the mainland for several thousand feet below the Oyster Creek outlet.

In summary, Oyster Creek Station operation has had a relatively stable and identifiable thermal effect on the normal (pre-1969) background of the Barnegat Inlet area. The detailed evaluation of potential environmental impact is presently being made and will be covered in a separate environmental statement on the Oyster Creek Station.

The impact of the use of water in the Forked River Station will consist of the effects of heat from cooling tower blowdown, and the effects of added chemical burden to the discharge canal resulting from concentration of salts in the circulating system. Some radionuclides will be released via the circulating system, but the effects of these are not directly coupled with the physical regimen of the canal ecology and are discussed elsewhere.

The discharge of thermal energy to the canal from the cooling tower blowdown is on the order of 2 to 4 x 10^8 Btu/hr, depending on the season of the year and the cooling tower basin equilibrium temperature of the Oyster Creek Station circulating system. The Forked River Nuclear Station cooling tower system is designed on the basis of cooling the water to about 23°F above the wet bulb temperature. Thus, the basin temperature (and thermal load) is a function of the air conditions rather than the bay water temperature. Evaporative losses of 12,000 gpm have been estimated by the Applicant for the summer season. These would be reduced to about 7,800 gpm in the coldest winter months as the fraction of sensible cooling duty



EBB-TIDE CONDITION

(ONE HOUR BEFORE LOW TIDE)
12:09 PM

OYSTER CREEK OPERATION

500 MW APX
ΔT = 16.7°F (9.3°C)
Q = 1000 CFS (460,000 GPM)
DATE - NOV. 24, 1969

FROM APPLICANT'S ENVIRONMENTAL REPORT

FIGURE V-1. INFRARED IMAGERY SURVEY ISOPLETHS (°C)

of the tower is increased relative to the evaporative duty by reduced vapor pressure of water. With flows of 1000 cfs in the canal, the heat in the Forked River blowdown would result in a temperature increase (or decrease, under certain conditions) of slightly less than 1.0°F at a distance of 300 yards downstream from the discharge diffuser when the Oyster Creek Station is operating at full flow.

When the Oyster Creek Station is shut down and the canal flow is restricted to 250 cfs, Forked River thermal loading on the canal would cause a maximum incremental thermal increase of 4-5°F over inlet background. It would be expected that about 20% of the temperature rise would be attenuated by the time the flow reached Barnegat Bay. Additional options, such as running two dilution pumps during critical thermal seasons, offer methods of achieving lower temperatures in the discharge canal, if necessary.

These same considerations are involved in the evaluation of the effects of the blowdown with respect to water chemistry. The Applicant has sized the tower blowdown and salt concentration to the maximum allowable buildup of salinity generally recognized as permissible during the time when Oyster Creek might be shut down and Forked River running at full power. With flow in the canal under this operating condition at 250 cfs, a blow-down flow of 40,000 gpm (89cfs) at a 1.3 concentration factor would increase the canal salinity by about 10%. Under winter or normal conditions, a lower blowdown flow of 26,000 gpm at a concentration factor of 1.5 would exceed the 10% limit unless canal flow were increased, or the blowdown rate increased to reduce the concentration factor. The Applicant appears to have a number of operational options to satisfy desired control conditions.

The chemical releases to the canal have been described in a previous section. These include water treatment chemicals involved in the circulating system itself such as biocides and inhibitors and waste neutralization chemicals, principally sodium sulfate. On occasion biocides could be expected to be used in the tower makeup water system and in the nuclear services cooling system. For purpose of evaluation, the impact of these releases are considered incremental to the Oyster Creek Station releases which are about the same order of magnitude in quantity and inventory, but differ in that the releases always take place when the circulating system is operating at full or "super" flow using the dilution pumps. Therefore, the impact of these chemical releases, including chlorine, is greatest when Forked River Station

is operating and Oyster Creek Station is shut down and the canal is being served by only one pump. Under these conditions the concentrations of chemicals in the discharge canal just below the point of full mixing would be approximately as follows:

Chlorine Residual	Less than 0.1 ppm
Na^+ and $SO_4^=$	
(from treatment)	Less than $8x10^{-5}$ lb/gal (9 ppm)
Boron	Less than $1.4x10^{-3}$ ppm

The chlorine demand of the Oyster Creek canal was not available to the Staff but on the basis of measurements of similar water bodies, a value greater than 1 ppm could be assumed. On this basis it can be estimated that the incremental chlorine residual from Forked River Station will be undetectable below the Highway 9 Bridge under the low-flow conditions assumed for the worst case.

The impact of the Forked River Station on the groundwater is expected to be minimal. The requirements for makeup water are well within the aquifer capacity of the strata to be used, and the use is monitored and regulated by the State of New Jersey. No radioactive wastes are released to the groundwater. The operation of the percolation field for the ultimate disposal of sanitary waste is expected to have no impact on the water supply aquifer which is at a depth of greater than 75 ft at the Site. Furthermore, since the Oyster Creek and Forked River watersheds intercept and feed the surface gravels, there is no possibility of landward transport of any deleterious material in the upper or unconfined aquifer under the present design. The Applicant has stated that no known effects on groundwater have resulted from the operation of the companion Oyster Creek facility.

C. BIOLOGICAL IMPACT

1. Terrestrial

The major possibility of damage to terrestrial life forms during Station operation is associated with salt drift from the cooling tower. The Applicant has sponsored relatively comprehensive onsite and laboratory studies on the effects of salt on plants and animals (results are presented in the Appendix of the Applicant's Environmental Report). A total of 77 references were reviewed during the course of these studies.

Field observations indicate that a short-term (several days) airborne salt concentration of greater than 125 μg/m^3 is required to induce injury to some native plants. Deciduous plant species extensively injured by natural airborne sea-salt concentrations of greater than 125 μg/m^3, and which grow within 2 miles of the tower are:

Vacciuium corymbosum	High bush blueberry
Rhus radicans	Poison ivy
Porthenocissus quinquefolia	Virginia creeper
Prunus serotina	Wild black cherry
Ocer rubrum	Red maple
Amelanchier canadensis	Shadblow serviceberry

No visible injury to evergreen species was observed. No damage was noted where long-term averages were about 40 μg/m^3; however, literature reports indicate long-term averages of greater than 10 μg/m^3 appear to play a role in the distribution and growth of plants. Long-term averages in excess of 10 μg/m^3 might bring about a gradual change in some communities whereby salt-sensitive plants may die out and be replaced by salt-tolerant species. The overall effect, however, would be hardly noticeable because of the present continuous change in community structure from inland areas toward the sea in response to natural airborne sea-salt concentrations. The maximum short-term drift (near-ground monthly average) from the tower is estimated at less than 0.24 μg/m^3, whereas, the measured natural summer maxima during onshore winds ranged from 9.5 to 18.8 μg/m^3 for the same vicinity (within one mile of the tower). Thus, the incremental contribution from tower drift is not expected to influence significantly the local vegetation.

Possible effects on land animals were assessed through field observations and literature review. Sodium is the primary chemical constituent of tower drift; and, unlike plants, sodium is essential to the diet of animals. It is expected that there will be no harmful direct physiological effect due to a small incremental increase in environmental salt for those species investigated and reported in the literature. However, salt tolerance of many species native to the area has not been investigated. In the opinion of the Applicant's consultant and the Staff the small incremental increase in salt will not have an appreciable influence on the physiology of those species not studied in detail. In particular, the cedar swamp habitat (pools and slow-moving acid waters) of the rare and endangered pine-barrens tree frog should not be significantly altered due to tower operation.

Operation and maintenance of the transmission lines per se is not expected to influence terrestrial life forms in or near the rights-of-way. However, because the habitat will be permanently changed, some plant growth will be restricted and some animals will be forced to relocate to adjacent sites.

2. Aquatic

a. Effects of Intake Structure

In support of development of an efficient fish-diversion system, the Applicant sponsored biological studies in 1971 in association with the existing Oyster Creek Station intake structure.[11] The proposed Forked River Station intake structure will be located on the opposite (west) side of the intake canal from the existing Oyster Creek Station intake structure and will incorporate similar design characteristics as discussed in Section III.D.1.a.

Studies conducted by the Applicant on the Oyster Creek Station intake structure emphasized a census of the numbers of fish and crabs impinged on the Station's rotary screens and transported by way of the trash flume to the head of the discharge canal. On 19 sampling dates (between April 11, 1971 and July 1, 1971), 95 samples were collected. Identification of all specimens was made as well as counts of both living and dead individuals. Thirty species of fish, 703 total individuals, were collected over the sampling period; of these, 270 were alive and 433 were dead (38% survival). Fish were impinged against the screens at an average rate of about 24/hr. The number of individuals of each species varied widely, as did the degree of mechanical damage by screen transport. One crab species was collected; a few others were found but none in significant numbers. Of 4028 crabs impinged, 198 or 5% were found dead.

Table V-1 presents information on the species found, the number of living and dead specimens as well as the total, the percent of kill for each species, and the rate of entrapment as number of fish or crabs per sampling hour.

To develop an assessment of potential damage by season, the data were arrayed in six groups representing a chronological order. Table V-2 presents the results of this ordering.

It is apparent that the number of fish trapped trends irregularly downward from mid-April to early July. At the same time, the crabs, following a low catch from April 30 to May 7, had, generally, a strongly increasing trend in numbers trapped as the season advanced. From the number of fish and crabs collected over the total sampling time of 28 hours, 46 minutes, the Oyster Creek Station intake structure can be assumed to destroy a minimum of 10,000 finfish and 5,000 crabs per month over the highly productive spring or summer months. This rate will not be sustained during winter months.

TABLE V-1

SUMMARY OF SCREEN CENSUS RESULTS

	Alive	Dead	Total	Percent Dead	Entrapment/ Sampling Hr
Spiny dogfish	1	0	1	0	0.35
Blueback herring	2	11	13	85	0.45
Alewife	2	4	6	67	0.21
Atlantic herring	0	23	23	100	0.80
Atlantic menhaden	1	0	1	0	0.35
Bay anchovy	2	208	210	99	7.30
American eel	0	2	2	100	0.69
Atlantic needlefish	1	32	33	97	1.15
Banded killifish	1	1	2	50	0.069
Mummichog	3	0	3	0	0.10
Pollock	0	2	2	100	0.069
Fourspine stickleback	3	3	6	50	0.21
Threespine stickleback	4	8	12	67	0.42
Northern pipefish	73	37	110	34	3.82
Spotted seahorse	5	3	8	38	0.28
Black sea bass	1	0	1	0	0.035
White perch	1	7	8	88	0.28
Bluefish	0	7	7	100	0.24
Crevalle jack	0	1	1	100	0.035
Silver perch	0	1	1	100	0.035
Weakfish	0	1	1	100	0.035
Longhorn sculpin	1	0	1	0	0.035
Crested cusk-eel	0	1	1	100	0.035
Atlantic silverside	3	49	52	94	1.81
Windowpane	1	0	1	0	0.035
Smallmouth flounder	0	2	2	100	0.069
Winter flounder	112	17	129	13	4.48
Hogchoker	5	0	5	0	0.17
Northern puffer	16	12	28	43	0.97
Oyster toadfish	32	1	33	3	1.15
Blue crab	4028	198	4226	5	146.89

TABLE V-2

RESULTS OF GROUPED DATA ON SCREEN CENSUS

	Dates, (1971)					
	4/12-4/26	4/30-5/7	5/10-5/24	5/28-6/7	6/11-6/21	6/25-7/1
Number of Sampling Days	4	3	3	3	3	3
Minutes of Sampling	185	271	330	341	287	312
Hours of Sampling	3.08	4.52	5.50	5.68	4.78	5.20
Number of Fish	133	57	123	157	38	195
Number of Fish/hr	43.2	12.6	22.4	27.6	7.95	37.5
Number of Crabs	154	62	469	978	612	1951
Number of Crabs/hr	50.0	13.7	85.3	172.2	128.0	375.1

Operation of the Forked River Station intake structure will probably result in the number of finfish and crabs captured and destroyed being 10% or less of the total number captured or destroyed by the Oyster Creek Station. This estimate is based on a comparison of intake volumes for the two units and assumes a similar screen efficiency in diverting marine organisms.

The biologic and economic impact of impingement resists precise assessment since natural mortality is invariably high and only a small portion of juveniles survive to become adults and reproduce. Rational assessment must be based on the relative proportion between organisms destroyed and those available in the ecosystem, the numbers expected to survive to maturity, and the importance of individuals in food chains and fisheries. Intake structure capture, however, appears to represent a very small fraction of the Barnegat Bay ecosystem's total annual production.

Any fish or other aquatic form smaller than 3/8-in. in length or width may be drawn into the circulating cooling water system and circulated a number of times through the system before discharge to the canal. Most organisms will probably be lost as a result of this recirculation.

b. Entrainment of Plankton

Those organisms small enough to pass through the 3/8 in. square-mesh, traveling screens will be subjected to a sharp increase in temperature (25°F) for a prolonged period. The transit time is relatively long since the water will be circulated a number of times through the system before discharge to the canal. Also, organisms will be subjected to a rapid salinity change and to chlorine, other biocides and corrosion inhibitors. It is highly probable that all entrained organisms will be killed as a result. This conclusion represents a "worst case," but a highly probable situation.

The Applicant has conducted thermal tolerance tests with a number of indigenous species in association with the Oyster Creek Station; however, these studies did not reflect the exposure or thermal and chemical regimes likely to be encountered in passage through the Forked River Station condenser system. Similarly, data resulting from numerous other studies in different regions and employing varying techniques are probably not applicable.

The volume of water drawn into the South Branch of Forked River (intake canal) is small relative to the daily tidal flux within the estuary. It must be emphasized, however, that the percentage of water withdrawn may not directly represent the percentage of plankton entrained. Plankton populations inclusive of phytoplankton, zooplankton, and the eggs and larvae of finfish and shellfish, have patchy distribution in both the horizontal and vertical planes. Furthermore, most planktonic forms demonstrate seasonal dependency. Hence, the impact could be more or less severe at certain times than that predictable based on a calculation of the percentage of water withdrawn from the estuary. However, as an order of magnitude estimate, the water circulated through the Forked River Station will be about 1 to 2% of the average tidal exchange in Barnegat Bay, and, therefore, the loss of entrained organisms is not expected to seriously affect the overall biological balance in the bay.

c. The Station Discharge and Mixing Zone

The relatively small addition of waste heat to the discharge canal from the Forked River Station will be for all practical purposes unnoticeable within Barnegat Bay, and will not further enhance the potential for thermal impairment of aquatic resources.

When Oyster Creek Station is shut down for fueling or other reasons, a minimum of 115,000 gpm will normally be maintained across the condensers. During this period, the 24,000 gpm of blowdown at 25°F above the intake

temperature would net, in winter, a 4.3°F maximum rise in the canal with complete mixing. After traversing the full length of the canal, the temperature of the discharge will be further reduced about 1.0°F before entering the bay. A small (~3°F) net rise above ambient will be detectable at the confluence of Oyster Creek and Barnegat Bay. Further, the Applicant has available dilution pumping capacity to reduce the temperature differential to about 1°F in the mixing zone.

The Applicant has supported studies dealing with the effect of discharge temperatures under post Oyster Creek Station operating conditions. Heated water discharged from the Oyster Creek Station in 1970 resulted in little, if any, influence on the composition of planktonic forms, but may have affected the diversity and density of macroinvertebrates at stations near the mouth of Oyster Creek.[12,13] Oyster Creek outlet temperatures over the 1970 operational period were 7.2 to 12.6°F higher than 1969 preoperational or baseline levels.

The Applicant also has sponsored studies of the potential effects of heated water on estuarine fishes known to inhabit Barnegat Bay.[14] The upper avoidance temperatures and upper avoidance breakdown temperatures of 11 species of finfish and 2 species of invertebrates were determined. The upper avoidance temperatures represent the maximum summer temperatures which, when encountered for short periods, will cause a loss of the organisms' locomotor control and thus a loss of the organisms' ability to escape from conditions which will ultimately cause death.

Summer water temperatures which are unacceptable to the several estuarine finfish species are shown in Figure V-2.[15] Notably, estuarine waters with temperatures above 87°F will be unacceptable for the majority of important Barnegat Bay fishes. It must be emphasized that most of these studies were conducted with "young-of-the-year" or older juveniles.

Summer water temperatures that will result in the death of representative estuarine finfish after short-term exposure (one hour or less) are presented in Figure V-3.[15] Brief exposure to a temperature of 94°F resulted in loss of locomotor control for most Barnegat Bay finfish. Only the cyprinodonts survived extended exposure at this temperature.

Adult grass shrimp demonstrated a mean avoidance temperature of 89.7°F and a mean avoidance breakdown temperature of 97.5°F. The blue crab indicated an avoidance temperature of 99.5°F and an avoidance breakdown temperature of 104°F. The upper avoidance temperatures and the upper avoidance breakdown temperatures presented are well above the maximum temperature likely to be attributable to the Forked River Station at full capacity; that is, when the Oyster Creek Station is shut down.

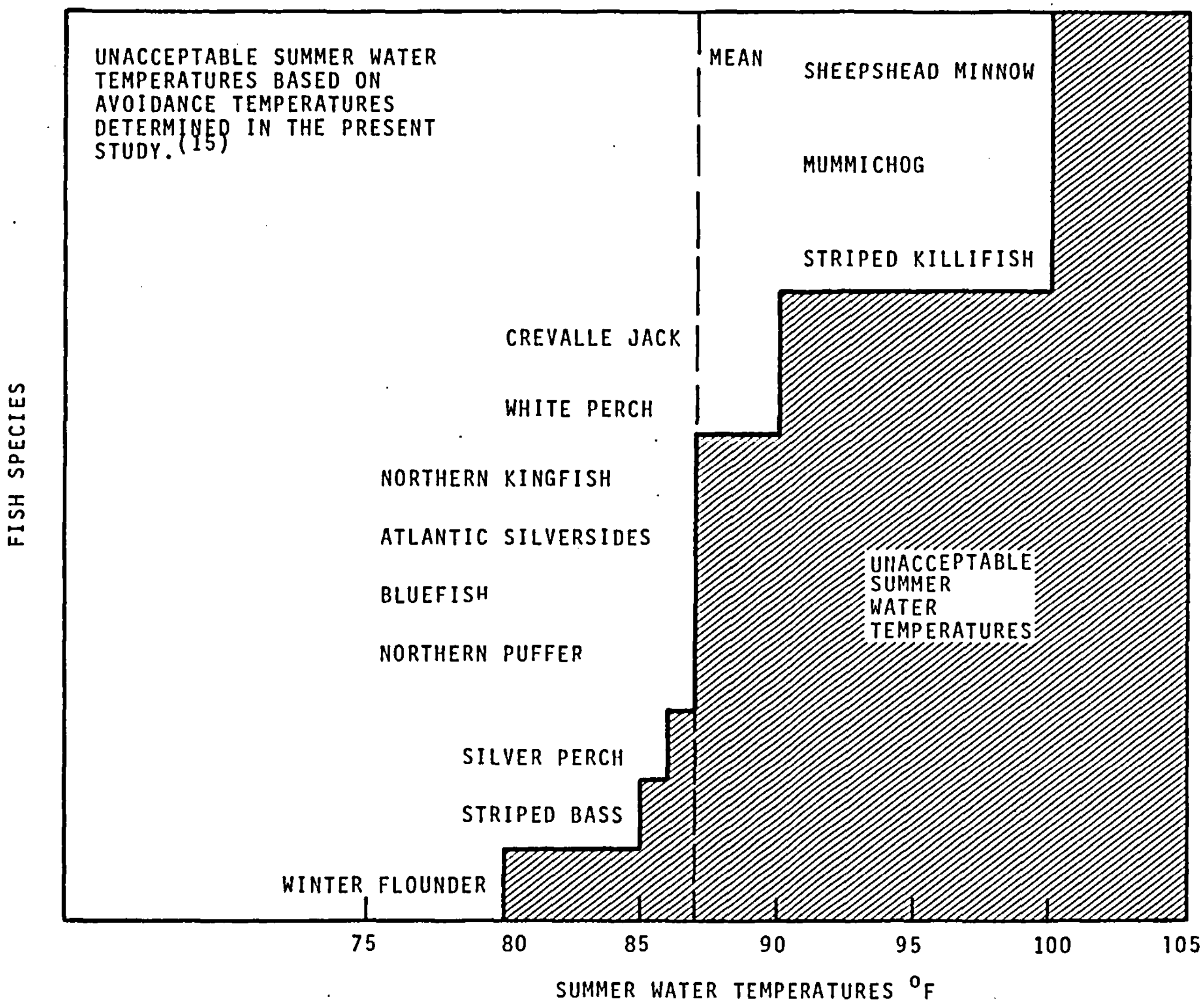


FIGURE V-2. AVOIDANCE TEMPERATURES FOR CERTAIN FISHES

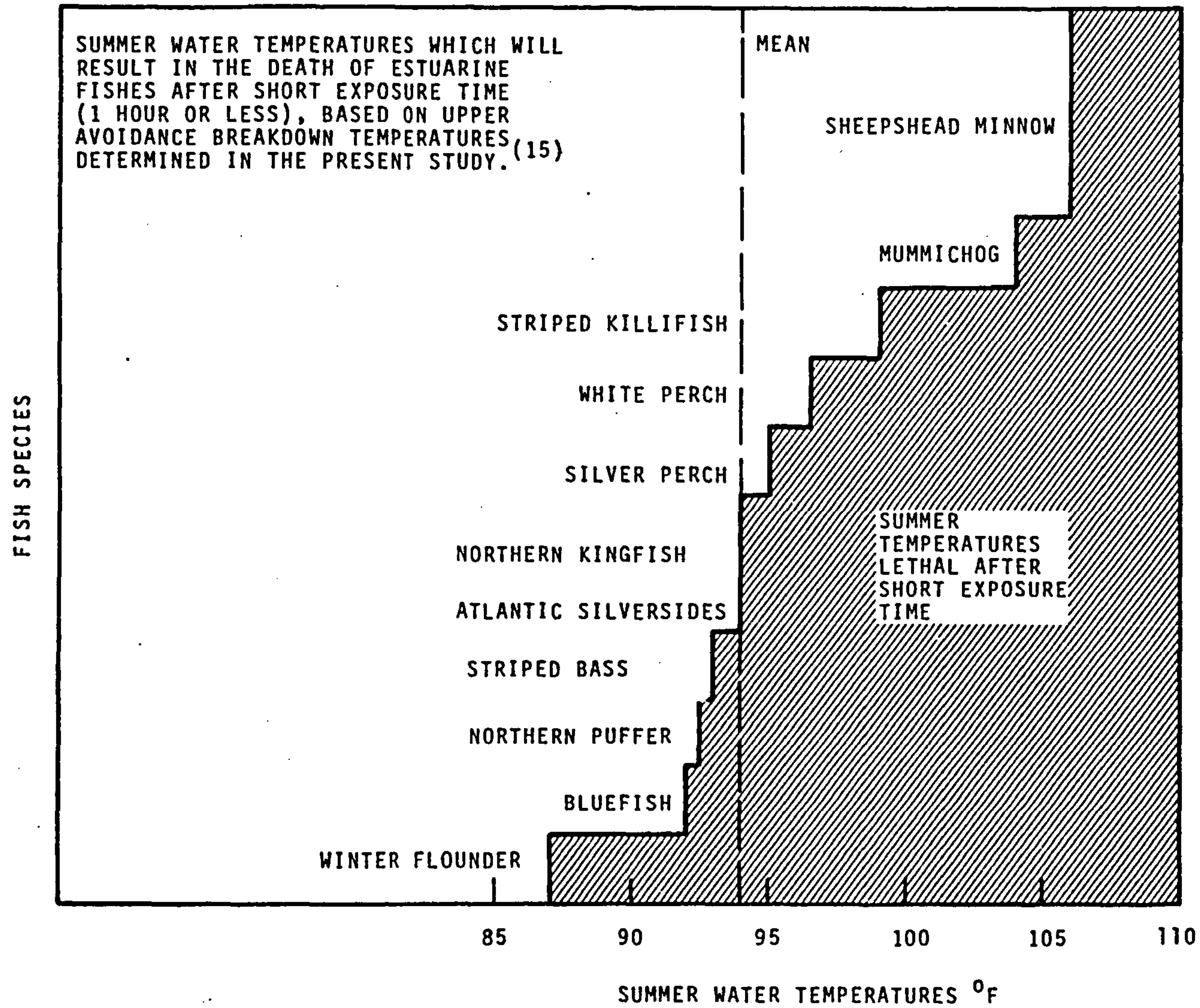


FIGURE V-3. LETHAL TEMPERATURES FOR CERTAIN FISHES

These data demonstrate that fish and invertebrates can detect small temperature changes and select favorable thermal levels according to seasons. This ability is well documented in the literature. Temperatures of the discharge at Oyster Creek, with both the Oyster Creek and Forked River units operational, are not likely to be lethal to finfish under normal conditions but will influence their local distributions as thermal conditions become more (winter) or less (summer) favorable.

Sharp declines in temperature that potentially would occur in the event of plant shutdown may result in fish mortality.[16] Following shutdown of the Oyster Creek Station in January 1972, a substantial loss of Atlantic menhaden occurred in the discharge canal. The shutdown consisted of a rapid partial (approximately one-half) load reduction followed by a normal shutdown from one-half load over a period of 6-1/2 hours. The discharge canal water temperature underwent a sharp decline of about 7°F in a short period of time followed by a gradual cooling to ambient over the next 6-1/2 hours. There also occurred a rapid natural change in ambient temperature during the 48 hours preceding this shutdown in which ambient water temperature (inlet to plant) dropped 12°F (47°F to 35°F).

The discharge water from the condensers, reflecting this lowering in ambient temperature, dropped from 72°F to 60°F. Dead fish were first reported the morning of January 29. The fish kill was limited almost exclusively to the Atlantic menhaden. The extent of the fish kill cannot be verified; however, estimates range between 100,000 to 200,000 fish lost. Menhaden normally migrate from the bay in late fall. During the period of September 17, 1971 to November 11, 1971 the Station was shut down for routine maintenance and no heated effluent was discharged. It is likely the fish entered the canal during the period of shutdown and remained there after plant startup. Furthermore, it is likely that the warmer water discharged after startup represented a preferred temperature for menhaden, hence they did not migrate to more southern latitudes.

Although the estimated loss of fish at Oyster Creek in January 1972 was insignificant in terms of the total annual catch of menhaden in New Jersey waters,[16] an intensive investigation has been initiated by the Applicant to understand the cause or causes of the incident and to develop and implement a program to minimize the possibility of such future occurrences. The major questions to be answered include:

- Why did the menhaden fail to migrate to more southern latitudes in fall?
- To what extent did the sharp drop in canal temperature or the extended immersion in lower ambient temperature water contribute to the incident?

- What modes of operation of the circulating water and dilution systems, both during operation and shutdown, will have the minimum impact on the environment?

d. Dissolved Oxygen and Toxic Chemicals

No significant reduction of dissolved oxygen (DO) between plant intake and discharge is expected. The cooling water in the intake canal (South Branch of Forked River) is well supplied with oxygen. Most studies at existing power plants indicate dissolved oxygen levels are higher in the outfall than in the intake due to turbulence in the condenser cooling water system. In this situation, dissolved oxygen levels may be reduced somewhat by recirculation but will not fall below 5.0 mg/liter.

Water passage through the cooling tower system will alter the composition of the intake water by evaporation and the addition of chemical agents. There will be evaporation of about one-third of the intake water with a resulting increase in salinity of nominally 50%. The discharge canal salinity will be limited by mixing with circulating water from the Oyster Creek Station, and the overall increase will be restricted to 10% above intake salinity. In the judgement of the Staff, 10% increase in salinity above the intake level will not cause impairment of biota in receiving waters of Barnegat Bay which is now subject to wide natural fluctuations.

Chemical treatment for the cooling tower will employ chlorination and, if necessary, other slimicide chemicals. Residual chlorine in the blowdown will be less than 0.5 ppm. Further dilution upon entry to the discharge canal will insure that the concentration of chlorine released is below that which is detrimental to aquatic life.

Minor additions of other chemicals needed in the Station will not add appreciable quantities of any deleterious substance nor measurably change the pH or composition of the intake water. Additionally, increasing the temperature of the cycled water is not expected to change the color, turbidity, alkalinity, ammonia, various toxic metals and nonmetals, aquatic plant nutrients (such as nitrogen or phosphorus) and organic compounds to an extent that there would be a measurable deterioration in water quality.

The Applicant states no other chemical releases will occur; however, trace quantities of copper and zinc are usually discharged with power plant effluent. Filter-feeding organisms such as oysters and clams concentrate these elements in their tissue at levels far exceeding concentrations in water. An increase in the concentration of copper in oyster tissue is

apparently a common occurrence at power plant sites.[17] In this case, primarily due to the relatively low volume of effluent discharged (large dilution capacity), such metals should be well below concentrations of concern in the discharge canal.

e. Eutrophication

The addition of heat and small amounts of chemicals to Oyster Creek and subsequently to Barnegat Bay from the Forked River Station is not expected to enhance the potential for eutrophic conditions. The cooling tower allows most of the waste heat from the plant to be rejected to the air, and only a small portion to be rejected to the aquatic environment.

No sewage wastewater will be discharged to local streams or to Barnegat Bay during either construction or operation of the Forked River Station. A sewage disposal plant will be installed with a capacity to treat twice the quantity of waste expected to be generated during operation.

f. Radiation Damage to Marine Organisms

Radiation dose rates that might be received by marine organisms in the vicinity of the Forked River and Oyster Creek Stations may be predicted on the basis of estimated annual release rates of radionuclides into the discharge canal (Tables III-1 and III-2) and their bioaccumulation factors (Table V-3).

At the postulated radionuclide concentrations in the discharge canal, the dose rate to organisms such as algae entrained in the effluent of the Forked River Station would be on the order of 10^{-5} mrem/hour.

The organisms most likely to accumulate the greatest dose are molluscs (oysters, clams) and crustacea (blue crabs) that reside on the bottom of the discharge canal. The annual dose to such forms might amount to about 50 mrem due to Forked River effluent and 55 mrem due to Oyster Creek effluent. Most of this would come from cesium-137 in bottom sediments. The dose to a fish would be significantly less. Table V-4 compares dose rates to marine organisms subjected to Forked River Station and Oyster Creek Station effluents.

Annual doses on the order of those predicted for aquatic organisms near the discharge canal are at least 1000 times below the chronic dose levels that might be suspected of producing demonstrable radiation damage to aquatic populations.[18]

Irradiation of salmon eggs and larvae at a rate of 500 mrem/day did not affect the number of adult fish returning from the ocean or their ability to spawn.[20] Chrionomid larvae (bloodworms) living in bottom sediments

TABLE V-3

SALT WATER BIOACCUMULATION FACTORS[19]
(pCi/kg Organism Per pCi/liter Water)

Element	Fish	Crustacea	Molluscs	Algae
H	1	1	1	1
Cr	100	1000	1000	1000
Mn	3000	10000	50000	10000
Fe	1000	4000	20000	6000
Co	100	10000	300	100
Br	3	10	10	100
Rb	30	50	10	10
Sr	1	1	1	20
Y	30	100	100	300
Zr	30	100	100	1000
Nb	100	200	200	100
Mo	10	100	100	100
Tc	10	100	100	1000
Ru	3	100	100	1000
Rh	10	100	100	100
Sn	3	3	3	10
Sb	1000	1000	1000	10000
Te	10	10	100	1000
I	20	100	100	10000
Cs	30	50	10	10
Ba	3	3	3	100
La	30	100	100	300
Ce	30	100	100	300
Pr	100	1000	1000	1000
Nd	100	1000	1000	1000
Pm	100	1000	1000	1000
Np	10	300	300	1000

TABLE V-4

COMPARISON OF DOSE RATES TO MARINE ORGANISMS
FROM LIQUID EFFLUENTS RELEASED FROM THE
FORKED RIVER AND OYSTER CREEK STATIONS

Organism		Dose Rate	
		Forked River	Oyster Creek
Algae	(mrem/hr)	$5x10^{-6}$	$2x10^{-5}$
Fish	(mrem/yr)	0.7	1.1
Crustacea	(mrem/yr)	50.	55.
Molluscs	(mrem/yr)	50.	39.

near the Oak Ridge plant that have received irradiation at the rate of about 230 to 240 rem/yr for more than 130 generations have a greater-than-normal number of chromosome aberrations but their abundance has not diminished.[21]

The numbers of salmon spawning in the vicinity of the Hanford reactors on the Columbia River have not been adversely affected by dose rates in the range of 100 to 200 mrem/week.[22]

Inasmuch as the planned release of radionuclides from the Forked River Station will be a very small fraction of the releases that have occurred in the past at any of several major nuclear facilities[23] where studies have detected no adverse effects on the aquatic population, and because the estimated dose rates to aquatic organisms will also be less than one-tenth of 1% of the dose rate expected to cause radiation damage, the populations of aquatic organisms in the discharge canal are not expected to be adversely affected by the low concentrations of radionuclides added by the Station.

g. Radiation Dose to Terrestrial Species

A small mammal such as a muskrat which makes its den near the canal and occasionally enters the discharge canal would receive a dose of about 75 mrem per year due to the Forked River Nuclear Station and about 45 mrem per year due to the Oyster Creek Nuclear Station. These doses are both internal and external and include the effects of both gaseous and liquid effluents from nuclear plants. The same animal

receives on the order of 100 mrem per year from naturally occurring radionuclides.

D. RADIOLOGICAL IMPACT TO MAN

In the design and operation of any facility utilizing or generating radioactive materials, the consideration of primary importance is the radiation dose which people in the plant environs might receive. During routine operation of the plant, small quantities of radioactive materials will be released to the environment. The releases will be as low as practicable as required by 10 CFR Part 20 and 10 CFR Part 50 and within the limits of 10 CFR Part 20.

The Staff has estimated the radiation doses that may be received by people from the concentrations of radionuclides that are anticipated in the air, the water, and on the ground as a result of the effluent releases summarized in Tables III-1 and III-3, and Tables III-2 and III-4 from the Forked River and Oyster Creek Stations, respectively.

1. Impact of Liquid Releases

The liquid effluents from both the Forked River and Oyster Creek Stations are released through a 3-mile long discharge canal into Barnegat Bay. The radionuclides are diluted in the total discharge water from both Stations (1100 cfs average flow with Oyster Creek operating at 80% load).

The individual likely to receive the highest radiation dose from the liquid effluents released from both plants would be a fisherman who spends considerable time (500 hr/yr) fishing from the bank or from a boat on the discharge canal at a location just west of the Route 9 bridge (1.2 miles east of the Forked River Station). In addition, it was assumed that this same individual swims 100 hr/yr in the canal just east of the bridge, and eats 18 kg/yr of fish, 9 kg/yr of crustacea (blue crabs), and 9 kg/yr of mollusks (clams) 24 hours after harvest from the canal. A reconcentration factor was calculated for each radionuclide to account for partial recirculation of the effluent (40% recirculated) back through the reactors. This factor which depends on half-life was estimated to be a maximum of 1.7 for cesium-137, a relatively long-lived radionuclide.

The results of the dose calculations for both Stations, based upon the above assumptions, are compared in Table V-5. For the Forked River Station the total-body dose from consumption of seafood is estimated to be 0.1 mrem/yr; an additional 1 mrem/yr is estimated to be received from exposure to the canal water and shoreline. About 79% of the latter dose results from cesium-137 accumulated in the silt.

TABLE V-5

ESTIMATED RADIATION DOSE IN mREM/YR TO AN INDIVIDUAL FROM THE EFFLUENTS RELEASED FROM THE FORKED RIVER[a] AND OYSTER CREEK STATIONS[b]

PATHWAY	EXTENT OF EXPOSURE IN 1 YEAR	SKIN		TOTAL BODY		GI TRACT		THYROID		BONE	
		F.R.	O.C.	F.R.	O.C.	F.R.	O.C.	F.R.	O.C.	F.R.	O.C.
AIR SUBMERSION[c]	8766 HR	0.19	15	0.055	8.8	(0.055)[d]	(8.8)	(0.055)	(8.8)	(0.055)	(8.8)
INHALATION[c]	7300 M^3	----	---	----	---	-----	----	0.15	0.059	-----	----
SWIMMING	100 HR	5×10^{-4}	2×10^{-3}	4×10^{-4}	1×10^{-3}	(4×10^{-4})	(1×10^{-3})	(4×10^{-4})	(1×10^{-3})	(4×10^{-4})	(1×10^{-3})
BOATING	100 HR	2×10^{-4}	1×10^{-3}	2×10^{-4}	7×10^{-4}	(2×10^{-4})	(7×10^{-4})	(2×10^{-4})	(7×10^{-4})	(2×10^{-4})	(7×10^{-4})
SHORELINE SILT	500 HR	1.6	1.0	1.4	0.89	(1.4)	(0.89)	(1.4)	(0.89)	(1.4)	(0.89)
FISH CONSUMPTION	18 KG	----	---	0.049	0.011	5×10^{-3}	0.11	0.82	0.31	0.036	6×10^{-3}
CRAB CONSUMPTION	9 KG	----	---	0.043	0.19	0.016	1.7	2.0	0.8	0.033	5×10^{-3}
CLAM CONSUMPTION	9 KG	----	---	0.013	0.036	8×10^{-3}	0.56	2.0	0.78	0.010	3×10^{-3}
MILK CONSUMPTION (CHILD)[e]	274 LITERS	----	---	----	---	-----	----	0.36	0.72	-----	----

[a] BASED ON RELEASES LISTED IN TABLES III-1 AND III-3

[b] BASED ON RELEASES LISTED IN TABLES III-2 AND III-4

[c] FOR PERSON RESIDING 1.6 MILES ESE OF THE FORKED RIVER STATION

[d] ( ) INDICATES INTERNAL DOSE FROM EXTERNAL EXPOSURE

[e] FROM COWS PASTURED 17.5 MILES NORTH OF THE FORKED RIVER STATION 9 MONTHS OF THE YEAR

2. Impact of Gaseous Releases

Release rates of radionuclides in the gaseous effluents from both plants are listed in Tables III-2 and III-4. The effluents from the Forked River Station are released from roof vents; but, to be conservative, air-submersion dose rates were calculated assuming a ground-level release. For the calculation of dose rates due to gaseous effluents released from the Oyster Creek Station via its 113-meter stack, an elevated release was used which included plume rise.

The maximum exposure rate at the Site boundary occurs 0.4 mile SE of the reactor (Forked River) where the annual average χ/Q with respect to the Forked River Station was calculated to be 1.0×10^{-5} sec/m^3. An individual residing all year at this location would receive a whole-body dose of 0.5 mrem/yr, principally from krypton-88 and xenon-133; the skin dose was somewhat higher (1.7 mrem/yr) because of the beta contribution from the radionuclides released with the gaseous effluents. The Oyster Creek Station contributes an estimated whole-body dose of 8 mrem/yr and a skin dose of 14 mrem/yr at this location ($\chi/Q = 3.6 \times 10^{-8}$ sec/m^3).

An air submersion dose was calculated for the individual fisherman, assuming he resides at the house 1.6 miles ESE of the Forked River Station. At this location the annual average χ/Q was estimated to be 1.3×10^{-6} sec/m^3 (Forked River). The total-body dose for this person was 0.07 mrem/yr, and his corresponding skin dose was 0.2 mrem/yr. Table V-5 summarizes these results. The χ/Q at this location with respect to the Oyster Creek Station is about 1/40 that of the above value for Forked River; however, since Oyster Creek gaseous releases were considerably larger, the estimated doses from Oyster Creek at this location are correspondingly larger (8 mrem/yr to the whole body and 14 mrem/yr to the skin). See Table V-5.

An estimate was also obtained for the dose to the thyroid from radioiodines released in gaseous effluents from the Station. Iodine inhalation by an individual at the house 1.6 miles ESE of Forked River Station would result in a dose of 0.2 mrem/yr to the thyroid. Cows were reported at distances of 17.5 miles N, 17 miles SSW, and 21 miles NNW from the Oyster Creek Station. The 17.5-miles N location has the highest average annual χ/Q: 1.6×10^{-8} sec/m^3 with respect to the Forked River Station and 1.9×10^{-9} sec/m^3 for the Oyster Creek Station. At this location the air concentrations (pCi/m^3) of radioiodines released by the Forked River and Oyster Creek Stations are:

	Forked River	Oyster Creek
^{131}I	1.5×10^{-4}	2.9×10^{-4} (pCi/m^3)
^{133}I	8.5×10^{-5}	---

Inhalation of these concentrations produced by the Forked River Station would result in a thyroid dose of 1.6×10^{-3} mrem/yr to an adult and 2×10^{-3} mrem/yr to a 2-year old child, principally from iodine-131. The thyroid doses from the Oyster Creek Station for the above iodine-131 concentration were estimated to be 4×10^{-3} mrem/yr to the child and 3×10^{-3} mrem/yr to the adult.

The estimated radiation dose from the Forked River Station to a child's thyroid from drinking one liter of milk per day from cows pastured 9 months out of the year at the 17.5-mile N location would be 0.36 mrem/yr; the adult dose would be about 0.04 mrem/yr. These values from the Oyster Creek Station are 0.72 mrem/yr and 0.08 mrem/yr, respectively. Table V-5 also lists the dose estimates to an individual attributable to gaseous releases from both Stations.

3. Population Doses from All Sources

In addition to the doses to the individual, an integrated annual dose (man-rem) has been estimated for the 4 million people living within a 50-mile radius of both the Forked River and Oyster Creek Stations. The seasonal population was weighted with a factor of 0.3 and the resident population was weighted with a factor of 0.7 based on the Applicant's 1978 population estimate. Table V-6 lists the cumulative population, cumulative dose, and the average annual dose to the total body from gaseous effluents (primarily noble gases) at various radial distances from the Stations. This population dose is estimated to be 1 man-rem/yr due to the Forked River Station and 310 man-rem/yr due to the Oyster Creek Station.

To arrive at an evaluation of the liquid pathway dose to the population due to seafood consumption, the Staff assumed that 2.1 kg fish, 0.75 kg crustacea, and 0.15 kg molluscs were consumed during the year[24] by each resident (seasonal and permanent) within a 50-mile radius of the Station. It was further assumed that this seafood was caught in waters of the Bay or Ocean containing 1% of the discharge canal effluent and that 24 hours elapsed between release of the radionuclides to the water and the consumption of the seafood. Based on these assumptions, the resultant total-body dose to the population from the total seafood pathway would be 1 man-rem/yr for the Forked River Station and 0.8 man-rem/yr for the Oyster Creek Station.

TABLE V-6

CUMULATIVE POPULATION, ANNUAL MAN-REM DOSE,
AND AVERAGE ANNUAL DOSE IN SELECTED CIRCULAR AREAS
AROUND THE FORKED RIVER AND OYSTER CREEK STATIONS

Cumulative Radius (Miles)	Cumulative Population (1978)	Forked River Cumulative Dose (man-rem)	Oyster Creek Cumulative Dose (man-rem)	Total Cumulative Dose (man-rem)	Average Dose (mrem)
1	35	.012	0.13	0.15	4.2
2	1,600	.098	10	10	6.2
3	4,700	0.16	25	25	5.2
4	8,100	0.19	33	33	3.9
5	10,000	0.21	39	39	3.6
10	57,000	0.31	98	98	1.7
20	320,000	0.49	170	170	.52
30	670,000	0.59	200	200	0.30
40	1,600,000	0.72	240	240	0.16
50	4,100,000	0.98	320	320	0.06

External exposure to the population from recreational activities was estimated by assuming that the predominant water-related pastimes for the people in the area were fishing from a boat; pleasure boating; water skiing; swimming; and fishing, hiking, and picnicking along the shore and beaches. It was further assumed that the average person spends 10 hr/yr boating, 5 hr/yr swimming, and 10 hr/yr near the shoreline or beach. All these activities were assumed to be in or near bay waters containing 3% canal effluent after an 8-hour decay. The total-body dose from these recreational activities is estimated to be only 3 man-rem/yr from the Forked River Station and 2 man-rem/yr from the Oyster Creek Station liquid releases.

The total population dose received from all effluent pathways by the approximately 4 million persons (1978) residing and/or recreating within 50 miles of the Site is estimated to be 10 man-rem/yr from routine operation of the Forked River Station and 312 man-rem/yr from the Oyster Creek Station. By comparison, natural background radiation at a rate of 0.125 rem/yr in New Jersey results in an integrated dose of about 500,000 man-rem/yr to the same population. Thus routine operation of the Station is expected to contribute a negligibly small incremental dose to that which area residents already receive as a result of natural background, and this dose will constitute no meaningful risk to be balanced against the benefits of the Station.

The effect of direct radiation from the Forked River Nuclear Station is estimated to be negligible. The maximum contribution of direct radiation and "skyshine radiation" from the Oyster Creek Station to the Forked River Station boundary is estimated to be less than 1 mrem per year.

4. Environmental Monitoring

The Applicant proposes that the Forked River Station pre-operational (baseline) radiological and biological surveillance results will be provided by the existing Oyster Creek Station post-operational program. The Oyster Creek program, started in 1966, will be amended as necessary to include Forked River Station effluents and appropriate changes that might be forthcoming in Commission monitoring guides.

The combined-plant monitoring program will consider potential radiation release sources, pathways of transport through the environs and modes of human exposure. The survey plan includes both background stations (locations not expected to be affected by plant releases) and indicator stations (locations where plant releases should be most evident). In addition, the program provides for monitoring within any one of three regimes (I-III), with Regime III being the most intensive surveillance program, dependent upon plant releases

and previous monitoring results. Although the background and indicator stations will be identical for the three regimes, the frequency of sampling and analysis varies between the regimes with the highest frequency being in Regime III. A listing of sample types, number of stations and monitoring frequencies is presented in Table 4-34 (page 4-94) f the Forked River Station Environmental Report. Also, maps showing the location of indicator stations and background stations are presented as Figures 4-9 and 4-10, respectively in the Applicant's Environmental Report. Measurements will be made of external radiation; and samples will be taken of airborne dust and iodine, precipitation, milk, crops, soil, surface water, clams, aquatic plants, sediment and well water. In many cases (including water, sediment, clams, aquatic plants, blue crabs, and several species of migratory and indigenous fish) initial samples will be analyzed for stable elements as well as for radioisotopes.

The Staff believes that the monitoring program as set forth by the Applicant is adequate to determine any radiological effects on the environment from operation of the Forked River Station. The Applicant should consult with the Staff and other state and federal regulatory agencies before changing any aspect of his program after startup of the Station. Also, the Applicant should increase milk sampling from monthly to fortnightly for Regime II and from every 13 weeks to monthly for Regime I. This would increase the likelihood of observing any I-131 increases in this important food. Further, the Applicant should add a surface water station in the discharge canal yacht basin.

E. TRANSPORTATION OF NUCLEAR FUEL AND SOLID RADIOACTIVE WASTE

The nuclear fuel for the reactor at the Forked River Nuclear Station in New Jersey is slightly enriched uranium in the form of sintered uranium oxide pellets encapsulated in zircaloy fuel rods. Each year in normal operation of both reactors, about 72 fuel elements are replaced.

1. Transport of New Fuel

The applicant has indicated that new fuel will be shipped by rail or truck in AEC-DOT approved containers. About 5 rail shipments of 14 elements each will be required each year for replacement fuel and about 15 rail shipments for the initial loading. If new fuel is shipped by truck about 12 shipments per year will be required for replacement fuel, assuming 6 fuel elements per cask. Although the applicant has not indicated the source of the new fuel, the Staff assumed it would come from Windsor, Connecticut, a shipping distance of about 140 miles.

2. Transport of Irradiated Fuel

Fuel elements removed from the reactor will be unchanged in appearance and will contain some of the original U-235 (which is recoverable). As a result of the irradiation and fissioning of the uranium, the fuel element will contain large amounts of fission products and some plutonium. As the radioactivity decays, it produces radiation and "decay heat." The amount of radioactivity remaining in the fuel varies according to the length of time after discharge from the reactor. After discharge from a reactor, the fuel elements are placed under water in a storage pool for cooling prior to being loaded into a cask for transport.

The applicant has indicated the irradiated fuel will be shipped either by rail or truck to a reprocessing site as yet unspecified. The Staff assumed a distance of 600 miles for shipping the irradiated fuel.

Although the specific cask design has not been identified, the applicant states that the irradiated fuel elements will be shipped in approved casks. The cask will weigh perhaps 40 tons for truck shipment to 120 tons for rail shipment. To transport the irradiated fuel from the reactor, the staff estimates 72 truckload or 12 rail carload shipments per year. An equal number of shipments will be required to return the empty casks.

3. Transport of Solid Radioactive Wastes

The applicant has indicated that spent resins and waste evaporator bottoms will be shipped in drums or truck mounted shipping containers and soft, solid wastes will be compacted in drums for shipment and disposal. The staff estimates about 37 truckloads of waste each year for the unit. The applicant has not indicated which of the approved burial sites he will use. The staff has assumed Morehead, Kentucky, a shipping distance of about 600 miles.

4. Principles of Safety in Transport

The transportation of radioactive material is regulated by the Department of Transportation and the Atomic Energy Commission. The regulations provide protection of the public and transport workers from radiation. This protection is achieved by a combination of standards and requirements applicable to packaging, limitations on the contents of packages and radiation levels from packages, and procedures to limit the exposure of persons under normal and accident conditions.

Primary reliance for safety in transport of radioactive material is placed on the packaging. The packaging must meet regulatory standards[1] established according to the type and form of material for containment, shielding, nuclear criticality safety, and heat dissipation. The standards provide that the packaging shall prevent the loss or dispersal of the radioactive contents, retain shielding efficiency, assure nuclear criticality safety, and provide adequate heat dissipation under normal conditions of transport and under specified accident damage test conditions. The contents of packages not designed to withstand accidents are limited, thereby limiting the risk from releases which could occur in an accident. The contents of the package also must be limited so that the standards for external radiation levels, temperature, pressure, and containment are met.

Procedures applicable to the shipment of packages of radioactive material require that the package be labelled with a unique radioactive materials label. In transport the carrier is required to exercise control over radioactive material packages including loading and storage in areas separated from persons and limitations on aggregations of packages to limit the exposure of persons under normal conditions. The procedures carriers must follow in case of accident include segregation of damaged and leaking packages from people and notification of the shipper and the Department of Transportation. Radiological assistance teams are available through an inter-Governmental program to provide equipment and trained personnel, if necessary, in such emergencies.

Within the regulatory standards, radioactive materials are required to be safely transported in routine commerce using conventional transportation equipment with no special restrictions on speed of vehicle, routing, or ambient transport conditions. According to the Department of Transportation (DOT), the record of safety in the transportation of radioactive materials exceeds that for any other type of hazardous commodity. DOT estimates approximately 800,000 packages of radioactive materials are currently being shipped in the United States each year. Thus far, based on the best available information, there have been no known deaths or serious injuries to the public or to transport workers due to radiation from a radioactive material shipment.

Safety in transportation is provided by the package design and limitations on the contents and external radiation levels and does not depend on controls over routing. Although the regulations require all carriers of hazardous materials to avoid congested areas[2] wherever practical to do so, in general, carriers choose the

most direct and fastest route. Routing restrictions which require use of secondary highways or other than the most direct route may increase the overall environmental impact of transportation as a result of increased accident frequency or severity. Any attempt to specify routing would involve continued analysis of routes in view of the changing local conditions as well as changing of sources of material and delivery points.

5. Exposures During Normal (No Accident) Conditions

a. New Fuel

Since the nuclear radiations and heat emitted by new fuel are small, there will be essentially no effect on the environment during transport under normal conditions. Exposure of individual transport workers is estimated to be less than 1 millirem (mrem) per shipment. For the 12 truck shipments, with two drivers for each vehicle, the total dose would be about 0.02 man-rem per year. The radiation level associated with each truckload of cold fuel will be less than 0.1 mrem/hr at 6 feet from the truck. A member of the general public who spends 3 minutes at an average distance of 3 feet from the truck might receive a dose of about 0.005 mrem per shipment. The dose to other persons along the shipping route would be extremely small. For the 5 rail shipments train brakemen would get an average exposure of 0.1 mrem per shipment. With 10 different brakemen involved along the route, the annual cumulative dose is estimated to be about 0.005 man-rem per year.

b. Irradiated Fuel

Based on actual radiation levels associated with shipments of irradiated fuel elements, we estimate the radiation level at 3 feet from the rail car will be about 25 mrem/hr.

The average exposure to the individual truck driver during a 600-mile shipment of irradiated fuel is estimated to be about 15 mrem. With 2 drivers on each vehicle, the annual cumulative dose would be about 2.2 man-rem.

Train brakemen might spend a few minutes in the vicinity of the car for an average exposure of about 0.5 millirem per shipment. With 10 different brakemen involved along the route, the annual cumulative dose is estimated to be about 0.06 man-rem.

A member of the general public who spends 3 minutes at an average distance of 3 feet from the truck or rail car, might receive a dose

of as much as 1.3 mrem. If 10 persons were so exposed per shipment, the annual cumulative dose for the 72 shipments by truck would be about 0.9 man-rem and for the 12 shipments by rail, about 0.2 man-rem. Approximately 180,000 persons who reside along the 600-mile route over which the irradiated fuel is transported might receive an annual cumulative dose of about 0.8 man-rem if transported by truck, and 0.13 if transported by rail. The regulatory radiation level limit of 10 mrem/hr at a distance of 6 feet from the vehicle was used to calculate the integrated dose to persons in an area between 100 feet and 1/2 mile on both sides of the shipping route. It was assumed that the shipment would travel 200 miles per day and the population density would average 330 persons per square mile along the route.

The amount of heat released to the air from each cask will vary from about 10 kilowatts (kW) for a truck cask to 70 kW for a rail cask. This might be compared to about 50 kW of waste heat which is released from a 100 horespower truck-engine. Although the temperature of the air which contacts the loaded cask may be increased a few degrees, because the amount of heat is small and is being released over the entire transportation route, no appreciable thermal effects on the environment will result.

c. Solid Radioactive Wastes

Under normal conditions, the average exposure to the individual truck driver during a 600-mile shipment of solid radioactive waste is estimated to be about 15 mrem. If the same driver were to drive 15 truckloads in a year, he could receive an estimated dose of about 225 mrem during the year. With 2 drivers on each vehicle, the annual cumulative dose for the 37 shipments would be about 1.2 man-rem.

A member of the general public who spends 3 minutes at an average distance of 3 feet from the truck might receive a dose of as much as 1.3 mrem. If 10 persons were so exposed per shipment, the annual cumulative dose would be about 0.5 man-rem. Approximately 180,000 persons who reside along the 600-mile route over which the solid radioactive waste is transported might receive an annual cumulative dose of about 0.4 man-rem. These doses were calculated for persons in an area between 100 feet and 1/2 mile on either side of the shipping route, assuming 330 persons per square mile, 10 mrem/hr at 6 feet from the vehicle, and the shipment traveling 200 miles per day.

VI. ENVIRONMENTAL IMPACT OF POSTULATED ACCIDENTS

A. Plant Accidents

A high degree of protection against the occurrence of postulated accidents in the Forked River Nuclear Station - Unit 1 facility is provided through correct design, manufacture, and operation, and the quality assurance program used to establish the necessary high integrity of the reactor system, as considered in the Commission's Safety Evaluation dated July 25, 1972. Deviations that may occur are handled by protective systems to place and hold the plant in a safe condition. Notwithstanding this, the conservative postulate is made that serious accidents might occur, in spite of the fact that they are extremely unlikely; and engineered safety features are installed to mitigate the consequences of these postulated events.

The probability of occurrence of accidents and the spectrum of their consequences to be considered from an environmental effects standpoint have been analyzed using best estimates of probabilities and realistic fission product release and transport assumptions. For site evaluation in the Commission's safety review, extremely conservative assumptions were used for the purpose of comparing calculated doses, resulting from a hypothetical release of fission products from the fuel, against the 10 CFR Part 100 siting guidelines. The computed doses that would be received by the population and environment from actual accidents would be significantly less than those presented in the Safety Evaluation.

The Commission issued guidance to applicants on September 1, 1971, requiring the consideration of a spectrum of accidents with assumptions as realistic as the state of knowledge permits. The applicant's response was contained in the "Environmental Report - Construction Permit Stage," dated January 24, 1972.

The Applicant's report has been evaluated, using the standard accident assumptions and guidance issued as a proposed amendment to Appendix D of 10 CFR Part 50 by the Commission on December 1, 1971. Nine classes of postulated accidents and occurrences ranging in severity from trivial to very serious were identified by the Commission. In general, accidents in the high potential consequence end of the spectrum have a low occurrence rate, and those on the low potential consequence end have a higher occurrence rate. The examples selected by the applicant for these cases are shown in

Table VI-1. The examples selected are reasonably homogeneous in terms of probability within each class. Certain assumptions made by the Applicant do not exactly agree with those in the proposed Annex to Appendix D, but the use of alternative assumptions does not significantly affect overall environmental risk.

Commission estimates of the dose which might be received by an assumed individual standing at the site boundary in the downwind direction, using the assumptions in the proposed Annex to Appendix D, are presented in Table VI-2. Estimates of the integrated exposure that might be delivered to the population within 50 miles of the site are also presented in Table VI-2. The man-rem estimate was based on the total summer population around the site for the year 2018.

To rigorously establish a realistic annual risk, the calculated doses in Table VI-2 would have to be multiplied by estimated probabilities. The events in Classes 1 and 2 represent occurrences which are anticipated during plant operation and their consequences, which are very small, are considered within the framework of routine effluents from the plant. Except for a limited amount of fuel failures and some steam generator leakage, the events in Classes 3 through 5 are not anticipated during plant operation but events of this type could occur sometime during the 40 year plant lifetime. Accidents in Classes 6 and 7 and small accidents in Class 8 are of similar or lower probability than accidents in Classes 3 through 5 but are still possible. Therefore, when the consequences indicated in Table VI-2 are weighted by probabilities, the environmental risk is very low. The postulated occurrences in Class 9 involve sequences of successive failures more severe than those required to be considered in the design bases of protection systems and engineered safety features. The consequences could be severe. However, the probability of their occurrence is so small that their environmental risk is extremely low. Defense in depth (multiple physical barriers), quality assurance for design, manufacture and operation, continued surveillance and testing, and conservative design are all applied to provide and maintain the required high degree of assurance that potential accidents in this class are, and will remain, sufficiently small in probability that the environmental risk is extremely low.

Table VI-2 indicates that the realistically estimated radiological consequences of the postulated accidents would result in exposures of an assumed individual at the site boundary to concentrations of radioactive materials with or comparable to the Maximum Permissible Concentrations (MPC) of Table II of 10 CFR Part 20. The table also shows that the estimated integrated exposures of population within

TABLE VI-1

CLASSIFICATION OF POSTULATED ACCIDENTS AND OCCURRENCES

Class	AEC Description	Applicant's Example(s)
1.0	Trivial Incidents	None
2.0	Small releases outside containment	Chemical and Volume Control System Leak and Containment Purge
3.0	Radwaste system failure	Gas decay tank leak
4.0	Fission products to primary system (BWR)	Not applicable
5.0	Fission products to primary and secondary systems (PWR)	Steam generator tube leak
6.0	Refueling accident	Refueling accident inside containment
7.0	Spent fuel handling accident	Fuel handling accident outside containment
8.0	Accident initiation events considered in design basis evaluation in the SAR	Steam generator tube rupture, main steam line rupture, control element assembly ejection, loss-of-coolant, gas decay tank rupture
9.0	Hypothetical sequence of failures more severe than Class 8	None

TABLE VI-2

SUMMARY OF RADIOLOGICAL CONSEQUENCES

OF POSTULATED ACCIDENTS[a]

Class	Event	Estimated fraction of 10 CFR Part 20 limit at site boundary[b]	Estimated dose to population in 50 mile radius, man-rem
1.0	Trivial incidents	(c)	(c)
2.0	Small releases outside containment	(c)	(c)
3.0	Radwaste system failure		
3.1	Equipment leakage or malfunction	0.073	17
3.2	Release of waste gas storage tank contents	0.29	68
3.3	Release of liquid waste storage contents	0.008	1.9
4.0	Fission products to primary system (BWR)	N.A.	N.A.
5.0	Fission products to primary and secondary systems (PWR)		
5.1	Fuel cladding defects and steam generator leaks	(c)	(c)
5.2	Off-design transients that induce fuel failure above those expected and steam generator leak	0.002	0.40
5.3	Steam generator tube rupture	0.096	23

TABLE VI-2 (cont'd)

Class	Event	Estimated fraction of 10 CFR Part 20 limit at site boundary[(b)]	Estimated dose to population in 50 mile radius, man-rem
6.0	Refueling accidents		
6.1	Fuel bundle drop	0.015	3.6
6.2	Heavy object drop onto fuel in core	0.26	62
7.0	Spent fuel handling accident		
7.1	Fuel assembly drop into fuel storage pool	0.01	2.3
7.2	Heavy object drop onto fuel rack	0.038	9.1
7.3	Fuel cask drop	N.A.	N.A.
8.0	Accident initiation events considered in design bases evaluation in the SAR		
8.1	Loss-of-Coolant Accidents		
	Small Break	0.16	68
	Large Break	1.6	2300
8.1a	Break in instrument line from primary system that penetrates the containment	N.A.	N.A.
8.2a	Rod ejection accident (PWR)	0.16	230
8.2b	Rod drop accident (BWR)	N.A.	N.A.

TABLE VI-2 (cont'd)

Class	Event	Estimated fraction of 10 CFR Part 20 limit at site boundary[b]	Estimated dose to population in 50 mile radius, man-rem
8.3a	Steam line breaks (PWR's outside containment)		
	Small Break	<0.001	0.12
	Large Break	<0.001	0.23
8.3b	Steam line breaks (BWR)	N.A.	N.A.

[a] The doses calculated as consequences of the postulated accidents are based on airborne transport of radioactive materials resulting in both a direct and an inhalation dose. The staff's evaluation of the accident doses assumes that the applicant's environmental monitoring program and appropriate additional monitoring (which could be initiated subsequent to an incident detected by in-plant monitoring) would detect the presence of radioactivity in the environment in a timely manner such that remedial action could be taken if necessary to limit exposure from other potential pathways to man.

[b] Represents the calculated fraction of a whole body dose of 500 millirem, or the equivalent dose to an organ.

[c] These releases are expected to be in accord with proposed Appendix I for routine effluents (i.e., 5 mrem per year to an individual from either gaseous or liquid effluents).

50 miles of the plant from each postulated accident would be much smaller than that from naturally occurring radioactivity. The exposure from naturally occurring radioactivity corresponds to approximately 7500 man-rem per year within 5 miles and approximately 1,100,000 man-rem per year within 50 miles of the site. These estimates are based on a natural background of 125 mrem/year. When considered with the probability of occurrence, the annual potential radiation exposure of the population from all the postulated accidents is an even smaller fraction of the exposure from natural background radiation and, in fact, is well within naturally occurring variations in the natural background. It is concluded from the results of the realistic analysis that the environmental risks due to postulated radiological accidents are exceedingly small.

B. Transportation Accidents

Based on recent accident statistics,[1] a shipment of fuel or waste may be expected to be involved in an accident about once in a total of 750,000 shipment-miles. The staff has estimated that only about 1 in 10 of those accidents which involve Type A packages or 1 in 100 of those involving Type B packages might result in any leakage of radioactive material. In case of an accident, procedures which carriers are required[2] to follow will reduce the consequences of an accident in many cases. The procedures include segregation of damaged and leaking packages from people, and notification of the shipper and the Department of Transportation. Radiological assistance teams are available through an inter-Governmental program to provide equipped and trained personnel. These teams, dispatched in response to calls for emergency assistance, can mitigate the consequences of an accident.

1. New Fuel

Under accident conditions other than accidental criticality, the pelletized form of the nuclear fuel, its encapsulation, and the low specific activity of the fuel, limit the radiological impact on the environment to negligible levels.

The packaging is designed to prevent criticality under normal and severe accident conditions. To release a number of fuel assemblies under conditions that could lead to accidental criticality would require severe damage or destruction of more than one package, which is unlikely to happen in other than an extremely severe accident.

The probability that an accident could occur under conditions that could result in accidential criticality is extremely remote. If criticality were to occur in transport, persons within a radius of about 100 ft from the accident might receive a serious exposure but beyond that distance, no detectable radiation effects would be likely. Persons within a few feet of the accident could receive fatal or near-fatal exposures unless shielded by intervening material. Although there would be no nuclear explosion, heat generated in the reaction would probably separate the fuel elements so that the reaction would stop. The reaction would not be expected to continue for more than a few seconds and normally would not recur. Residual radiation levels due to induced radioactivity in the fuel elements might reach a few roentgens per hour at 3 ft. There would be very little dispersion of radioactive material.

2. Irradiated Fuel

Effects on the environment from accidental releases of radioactive materials during shipment of irradiated fuel have been estimated for the situation where contaminated coolant is released and the situation where gases and coolant are released.

(a) Leakage of contaminated coolant resulting from improper closing of the cask is possible as a result of human error, even though the shipper is required to follow specific procedures which include tests and examination of the closed container prior to each shipment. Such an accident is highly unlikely during the 40-year life of the plant.

Leakage of liquid at a rate of 0.001 cc per second or about 80 drops/hour is about the smallest amount of leakage that can be detected by visual observation of a large container. If undetected leakage of contaminated liquid coolant were to occur, the amount would be so small that the individual exposure would not exceed a few mrem and only a very few people would receive such exposures.

(b) Release of gases and coolant is an extremely remote possibility. In the improbable event that a cask is involved in an extremely severe accident such that the cask containment is breached and the cladding of the fuel assemblies penetrated, some of the coolant and some of the noble gases might be released from the cask.

In such an accident, the amount of radioactive material released would be limited to the available fraction of the noble gases in the void spaces in the fuel pins and some fraction of the low level contamination in the coolant. Persons would not be expected to remain near the accident due to the severe conditions which would be involved, including a major fire. If releases occurred, they would be expected to take place in a short period of time. Only a limited area would be affected. Persons in the downwind region and within 100 ft or so of the accident might receive doses as high as a few hundred millirem. Under average weather conditions, a few hundred square feet might be contaminated to the extent that it would require decontamination (that is, Range I contamination levels) according to the standards[3] of the Environmental Protection Agency.

3. Solid Radioactive Wastes

It is highly unlikely that a shipment of solid radioactive waste will be involved in a severe accident during the 40-year life of the plant. If a shipment of low-level waste (in drums) becomes involved in a severe accident, some release of waste might occur but the specific activity of the waste will be so low that the exposure of personnel would not be expected to be significant. Other solid radioactive wastes will be shipped in Type B packages. The probability of release from a Type B package, in even a very severe accident, is sufficiently small that, considering the solid form of the waste and the very remote probability that a shipment of such waste would be involved in a very severe accident, the likelihood of significant exposure would be extremely small.

In either case, spread of the contamination beyond the immediate area is unlikely and, although local clean-up might be required, no significant exposure to the general public would be expected to result.

4. Severity of Postulated Transportation Accidents

The events postulated in this analysis are unlikely but possible. More severe accidents than those analyzed can be postulated and their consequences could be severe. Quality assurance for design, manufacture, and use of the packages, continued surveillance and testing of packages and transport conditions, and conservative design of packages ensure that the probability of accidents of this latter potential is sufficiently small that the environmental risk is extremely low. For those reasons, more severe accidents have not been included in the analysis.

VII. ADVERSE EFFECTS WHICH CANNOT BE AVOIDED

The Forked River Station and facilities will occupy about 80 acres of marginally productive agricultural land. In addition, about 130 acres of land at the Site will be disturbed by construction activities. This loss of wildlife habitat at the Site will be minimal, since a significant portion of the land was earlier cleared and the remainder has relatively sparse vegetation. Also, several thousand acres of land will, in part, be altered from its natural state by the construction of transmission rights-of-way. Some displacement of wildlife will result during recovery of the area. The adverse effects will be minimized by clearing only those areas necessary for tower placement (clear-cutting will be avoided), and partly offset by habitat improvements such as an increased edge effect.

Some turbidity will be added to adjacent waters due to soil erosion and run-off during the construction phase. The Applicant should minimize this potential impact on marine life by providing a clarification pond or other suitable sediment trap for the settlement of suspended solids prior to discharge into watercourses.

A relatively small and temporary loss of benthic organisms will result from dredging operations in Barnegat Bay and the discharge canal. In the interest of minimizing this impact, the Applicant should carry out dredging operations to avoid fish migration periods and tidal conditions that will distribute dredging fines over relatively large areas of Barnegat Bay.

The Applicant's present plans are to dispose of trash and debris removed from intake racks and screens by flushing to the discharge side of the canal. The Staff is of the opinion that, although such materials are inherent in bay waters and are not contributed by the Station, once they are removed from the waters they should not be returned. Even though the detritus, in this case, appears to contribute a relatively small dissolved oxygen demand, the Applicant should modify procedures so that such waste materials are collected and disposed of by land burial or other approved disposal methods.

Small aquatic organisms entering the water intake system will be recirculated through the cooling water system a number of times before discharge in the blowdown to the canal. The thermal, mechanical, and chemical stresses imposed by the system on these organisms will likely result in all of them being killed. However, the amount of loss is not expected to represent a significant fraction of the bay's biomass or to effect the productivity of Barnegat Bay and adjacent waters.

Some finfish and crabs will be destroyed by impingement and entrapment on the water intake traveling screens. Based on the Applicant's screen census taken at the adjacent Oyster Creek Station, the Staff estimates about 1000 finfish and 500 crabs may be so destroyed at the Forked River Station intake each month during the highly productive spring and summer months. This loss rate, which will be reduced during winter months, represents a very small fraction of the Barnegat Bay ecosystem's total annual production.

The discharge of chemicals from the Forked River System, particularly chlorine used in the recirculating water system, should have no adverse effects on the marine ecosystem. Chlorine in the cooling tower blowdown will be readily diluted upon discharge to the canal to concentrations below 0.1 ppm. If necessary, the Applicant should use available dilution pump capacity to assure that the 0.1 ppm chlorine concentration is not exceeded prior to the effluent reaching the Highway 9 Bridge.

No adverse effects should be associated with the small incremental addition of salt to the environs attributable to normal cooling tower drift. However, the use of salt water as a cooling fluid implies a responsibility with regard to strict cooling tower maintenance and upkeep standards to prevent accidental salt deposition damage.

The cooling tower structure will be highly visible from the level surroundings and may be regarded by some as having a negative visual impact.

The vapor plume from the cooling tower also constitutes a visual impact in this low-profile recreation area. Although ground-level fogging is expected to occur only a few hours per year at any point, a visible elevated plume will occur most of the time. Generally, the plume will dissipate within a few miles of the Station, but will extend as far as 20-30 miles during infrequent extreme conditions. Also, the visibility of the plume from the Garden State Parkway could produce hazards to traffic arising from the novelty of the vapor cloud rather than any direct loss of visibility.

There will be no appreciable impact on water availability attributable to Station construction or operation. Seawater consumptive use, at a rate of about 17 million gal/day will not measurably deplete that available from Barnegat Bay which is

recharged by the Atlantic Ocean. Also, the Station use of about one-half million gal/day of groundwater is not expected to measurably reduce the capacity of the supplying aquifer.

Operation of the Forked River Station will introduce a very small radiation dose to the environment which will not constitute a meaningful risk. The estimated dose to the population within 50 miles, resulting from operation of both the Forked River and Oyster Creek Stations, is about 320 man-rem/yr. The Forked River Station would contribute about 3% of the total.

The Staff estimates that approximately 10% of the heat discharged from the Oyster Creek Nuclear Station would be added to the discharge canal due to the operation of the Forked River Station. This small addition of heat will not significantly contribute to the thermal impairment of aquatic life in Barnegat Bay.

VIII. SHORT-TERM USES AND LONG-TERM PRODUCTIVITY

The several hundred acres of land to be occupied by the Forked River Station will be dedicated to the production of needed electrical energy for a period of 30 to 40 years. In comparison with the past history and potential future uses of the land, this period of use is considered to be short term. At best, the land would be marginally productive for agriculture, and there is no other present high-value use preempted by locating and operating the Station at this Site. Rather, the intended use is consistent with adjacent land use (the operating Oyster Creek Nuclear Plant) and the Applicant has planned the new station to take advantage of joint use of the land and existing facilities. That area on the Applicant's property not occupied by Station facilities (about 80% of the land), presently in native terrestrial flora and fauna, will have its long-term productivity protected by the restricted nature of plant operations. Further, gaseous (primarily cooling tower drift) and liquid effluents from the Station, as designed, should have no measurable effects on either the short-term or long-term productivity of Station or adjacent lands. Similarly, liquid effluents are not expected to measurably affect existing aquatic life or to restrict use of public waters in either the short or long term. Although dredging may have an effect on benthos, this disturbance will be quite small in comparison to the total productivity of Barnegat Bay and of a short-term (2-4 years) nature.

No specific plan for the decommissioning of Forked River Station has been developed. This is consistent with the Commission's current regulations which contemplate detailed consideration of decommissioning near the end of a reactor's useful life. The licensee initiates such consideration by preparing a proposed decommissioning plan which is submitted to the AEC for review. The licensee will be required to comply with Commission regulations then in effect and decommissioning of the facility may not commence without authorization from the AEC.

To date, experience with decommissioning of civilian nuclear power reactors is limited to six facilities which have been shut down or dismantled: Hallam Nuclear Power Facility, Carolina Virginia Tube Reactor (CVTR), Boiling Nuclear Superheater (BONUS) Power Station, Pathfinder Reactor, Piqua Reactor, and the Elk River Reactor.

There are several alternatives which can be and have been used in the decommissioning of reactors: (1) Remove the fuel (possibly followed by decontamination procedures); seal and cap the pipes; and establish an exclusion area around the facility. The Piqua decommissioning operation was typical of this approach. (2) In

addition to the steps outlined in (1), remove the superstructure and encase in concrete all radioactive portions which remain above ground. The Hallam decommissioning operation was of this type. (3) Remove the fuel, all superstructure, the reactor vessel and all contaminated equipment and facilities, and finally fill all cavities with clean rubble topped with earth to grade level. This last procedure is being applied in decommissioning the Elk River Reactor. Alternative decommissioning procedures (1) and (2) would require long-term surveillance of the reactor site. After a final check to assure that all reactor-produced radioactivity has been removed, alternative (3) would not require any subsequent surveillance. Possible effect of erosion or flooding will be included in these considerations.

A large plant such as the Forked River Nuclear Station may have a salvage value of about 10% of the original cost of construction. Decommissioning costs are also not known accurately, but could be on the order of 10-15% of construction cost. These two factors would obviously offset each other with either a small positive or negative effect. In any event, when one discounts this to the present (30 year single payment present worth factor at 8.75%/year is 0.0807), the net effect is relatively small and in no way would influence any of the analyses that follow in Section XI.

IX. IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

The resources to be committed in the construction and operation of the Forked River Station, with the exception of the nuclear fuel, are those used in any large industrial facility. No rare or unique materials will be used in amounts which are inordinate. It is estimated that approximately 17 tons of uranium-235 will be irretrievably used over a 30 year period of plant operation. However, in this process, plutonium will be produced as a useful by-product. The plutonium can be recovered and used as a nuclear fuel. Most other resources are either left undisturbed or committed only temporarily, as during construction or during the life of the plant, and are not irreversibly or irretrievably lost.

A relatively small amount of marginal land will be committed to the Station proper; and the consumptive use of water, principally that evaporated in the cooling tower, will result in no depletion of the replenishable supply available through tidal exchange in Barnegat Bay.

Plant construction and operation will not curtail use of the area to an extent that is greater than that incident to many other heavy industrial facilities. Recreation and other beneficial uses of the surrounding area should not be impaired.

X. THE NEED FOR POWER

The Applicant's need for power has been analyzed by the Staff to determine if the Forked River Nuclear Station Unit 1 is required. The analysis showed that without the base load generating capacity of the Forked River Station, the Jersey Central Power and Light Company and its parent company, General Public Utilities (GPU), would suffer serious system shortages by 1978.

The General Public Utilities system is made up of the Jersey Central Power and Light Company, Pennsylvania Electric Company (Penelec), Metropolitan Edison Company (Met-Ed), and New Jersey Power and Light Company (NJP&L), all of which are subsidiaries of General Public Utilities. The General Public Utilities system is planned and operated on a fully integrated basis, including generating capacity and related transmission. Therefore, the need for the Forked River Station should be measured in terms of its effects on the General Public Utilities System requirements and costs.

The General Public Utilities System lies in the region extending from Lake Erie in Pennsylvania to the Atlantic Coast of New Jersey. The region has greatly influenced the development of generating plants for the General Public Utilities System including the development of large, mine-mouth, steam-electric plants in west-central Pennsylvania which produce power for local use and for transmission to eastern Pennsylvania and New Jersey. The development of this concept began in the early 50's and was so successful that additional 230-kV and 345-kV lines were built to supplement the original lines.

The mine-mouth, steam-electric plant and the availability of low-cost coal has resulted in a concentration of power plants in western Pennsylvania. While this concept has been successful, economy and reliability requires substantial capacity in eastern load centers. This resulted in the construction of steam-electric generating plants along the Susquehanna, Schuylkill, and Delaware Rivers, and on tidewater in New Jersey. Combustion turbines, which have minimum water requirements, have been installed in the eastern area also to save transmission cost, meet local area requirements, or to take advantage of favorable fuel deliveries. The General Public Utilities System is part of the Pennsylvania-New Jersey-Maryland Interconnection

(PJM)[a] which functions as a coordinating body for planning of the generating capacity among the member companies. PJM has jointly owned generation and transmission projects, involving from two to four of the member companies. Seven PJM nuclear power stations are planned for service by 1978: Three-Mile Island, Peach Bottom, Calvert Cliffs, Salem, Limerick, Newbold Island, and Forked River. These units are linked together in such a way that delay in one or more units would affect the entire system.

Operation is carried out without reference to ownership of facilities by individual companies, and power dispatched freely among the member companies. Interchange is scheduled by PJM with four neighboring areas. A deficiency of power in any one of the PJM companies is met by purchases from others to the extent excess is available. All member companies share in the voltage reduction, load curtailment, or other measures necessary to maintain service. Therefore, a delay in the construction of the Forked River Station or any of the other planned nuclear stations will affect the entire PJM system.

The operating companies in the systems have obligations under State policy to serve their customers with both reliable and adequate power. The regulatory commissions of New Jersey and Pennsylvania have reviewed over the years the forecasted supply and demand for energy in the General Public Utilities service areas and have emphasized the necessity for providing adequate power with a minimum chance of load curtailment or voltage reduction.

(a) The PJM Pool consists of the following electric utility systems: Public Service Electric and Gas Company, Philadelphia Electric Company, Atlantic City Electric Company, Delmarva Power and Light Company, Pennsylvania Power and Light Company, UGI Corporation, Baltimore Gas and Electric Company, Jersey Central Power and Light Company, Metropolitan Edison Company, New Jersey Power and Light Company, Pennsylvania Electric Company and Potomac Electric Power Company. The pool serves a population of about 20 million in a 48,000 square mile area including three-quarters of Pennsylvania, almost all of New Jersey, more than half of Maryland, all of Delaware and the District of Columbia, and a small part of Virginia. The pool operates under a written agreement which provides for planning and operating the bulk power supply of each company as an integral part of the total PJM system and for operation as a single control area.

Table X-1 shows the actual and projected power demands for the period 1970-1981. Also included in this table is the system goal reserve which is 20% of peak demand. This reserve has been calculated on the base of a reliability index of 1 day in 10 years. This 20% reserve has been reviewed and endorsed by the New Jersey and Pennsylvania regulatory agencies. Minimum reserve margins in the General Public Utilities System will occur during the summer months. As can be seen in Table X-1, the goal reserve margin is not reached until 1975 at which time Three-Mile Island Unit 2 is expected to reach full power operation. The delay or cancellation of Forked River would cause a reserve power shortage in 1978. Under those conditions the reserve margin would be below the reliability level of 20%.

The Applicant has supplied a detailed breakdown of planned additions to the General Public Utilities System by year and type of power station. These details are shown in Table X-2.

Figure X-1 illustrates the demand and capacity of the General Public Utilities System on the basis of three service areas. The first of these is served by Pennsylvania Electric Company, the second by Metropolitan Edison Company, the third by Metropolitan Edison and the two New Jersey companies. While it is not necessary to precisely match capacity and demand in each of these geographic areas, when gross mismatches occur there is a degradation in the system reliability. In Figure X-1 area 3 is shown both with and without Forked River on line. The shortage of capacity in Area 3 is evident. Even with Forked River Station there is a small shortage of generating capacity.

As indicated by the Federal Power Commission (Appendix D, page 44), the Forked River Nuclear Station would provide the GPU system with an expected reserve margin of 18.0% of peak load during the summer of 1979. Without the station, the reserve margin would be 6.1%. The PJM system appears to have sufficient reserve margins without the Forked River Nuclear Station, but the margin is predicated on the timely completion and inservice availability of a number of large baseload generating units not yet in operation. The FPC further stated that in view of the large size of the units comprising this projected capacity, and the probability of delays in completion of construction, PJM capacity planning appears prudent. Although regional reserves may often be helpful in the event of contingencies normally experienced on interconnected power systems, these reserves are not a reliable substitute for firm power, baseload capacity within a member's system. In order to provide adequate reserves for the region, a proportionate reserve should be maintained by each system, based on its own load.

TABLE X-1

ACTUAL AND PROJECTED POWER DEMAND, GENERAL PUBLIC UTILITIES
(MW)

Year	Summer Peak Demand	With 20% Reserve	Winter Peak Demand	With 20% Reserve	Planned Capacity	Difference Between Planned & Summer Peak Plus 20% Reserve
1970	4,071	---	4,448	---	---	
1971	4,326	---	4,808	---	---	
1972	4,934	5,921	5,198	6,237	5,700	- 221
1973	5,379	6,455	5,615	6,738	5,800	- 655
1974	5,863	7,036	6,074	7,288	6,900	- 136
1975	6,377	7,652	6,571	7,885	7,800	+ 148
1976	6,954	8,345	7,107	8,528	8,700	+ 355
1977	7,583	9,100	7,692	9,230	9,200	+ 100
1978	8,269	9,923	8,320	9,984	10,250	+ 327
1979	9,022	10,826	9,003	10,804	10,850	+ 24
1980	9,851	11,821	9,740	11,688	11,550	- 271
1981	10,760	12,912	10,539	12,647	13,100	+ 188

TABLE X-2

GENERAL PUBLIC UTILITIES SYSTEM, PLANNED CAPACITY

Generating Capacity - Existing, Under Construction and Proposed
(Summer Ratings, MW)

		Nuclear	Mine-Mouth Coal Fired	Other Fossil Steam & Combined Cycle	Hydro and Pumped Storage	Diesel and Combustion Turbine	Total
Existing, 12/31/71		600	1,925	1,684	297	502	5,008
Additions, prior to Summer	1972	-	50 [a]	-	-	488	538
	1973	-	-	190	-	162	352
	1974	-	-	263	(50) [b]	-	1,005
	1975	880	-	-	-	-	880
	1976	-	320	400	-	-	720
	1977	-	140	238 [a]	175	-	553
	1978	1,070	-	-	-	-	1,070
	1979	-	-	316	-	200	516
	1980	-	640	-	280	175	1,095
	1981	1,250	-	-	-	-	1,250
	1982	-	-	-	775	200	975
Total	1982	4,592	3,075	3,091	1,477	1,727	13,962
% of Total		33	22	22	11	12	100

(a) Rerating of previously installed capacity.
(b) () Indicates transfer of ownership of capacity from General Public Utilities to Public Service Electric and Gas Company.

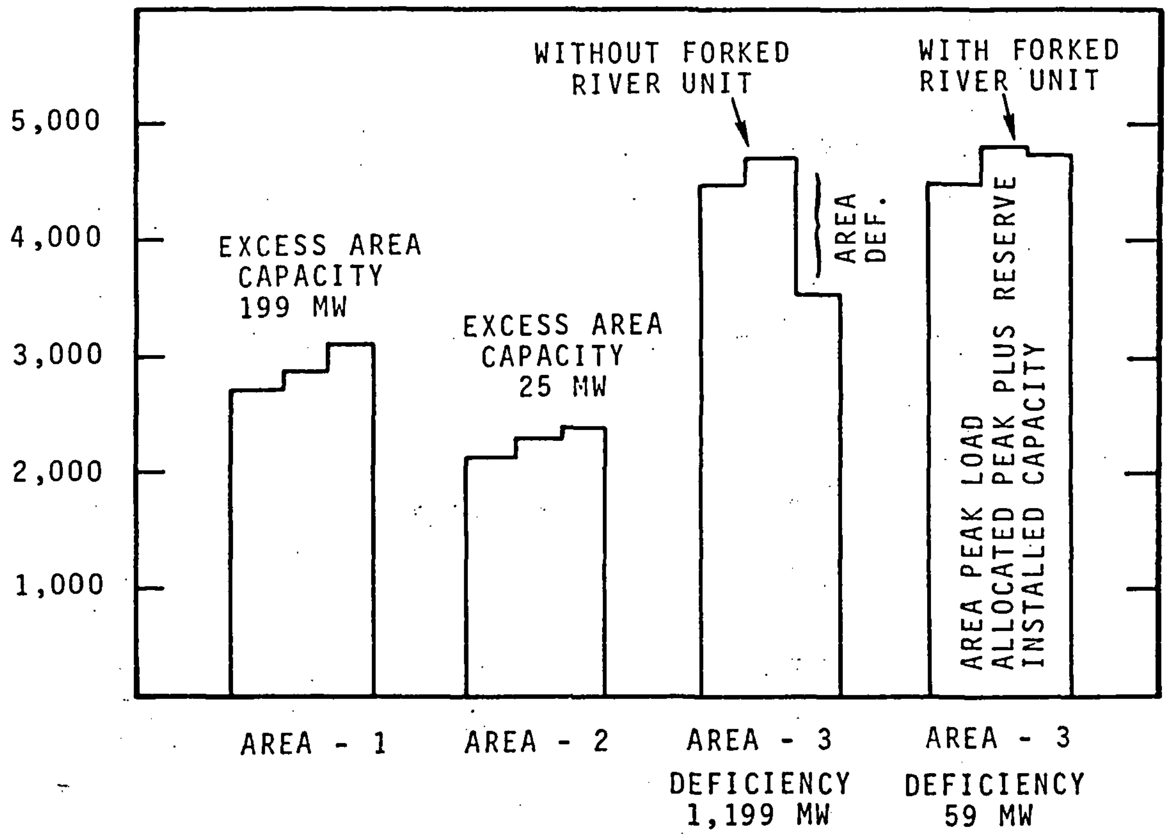


FIGURE X-1. GENERAL PUBLIC UTILITIES AREA PEAK LOAD, AREA ALLOCATED PEAK PLUS RESERVE AND AREA INSTALLED CAPACITY, 1978

XI. ALTERNATIVES TO PROPOSED ACTION AND COST-BENEFIT ANALYSIS OF THEIR ENVIRONMENTAL EFFECTS

The need for the power from the Forked River Station has been discussed in Section X. This discussion showed a power shortage developing by the latter part of 1978 under load growth conditions if Forked River's energy is not available. This shortage will also affect the General Public Utilities and PJM systems.

A. ALTERNATIVES

The following is a discussion of the various alternatives with their respective cost-benefit analysis.

1. Purchase of Power

There is no possibility of a continuing power purchase in an amount equivalent to the capacity and energy of the Forked River project. No privately-owned utility in PJM or nearby areas is in a position to finance the development and long-term sale of generating resources of such magnitude to other utilities. Arrangements have been made from time to time for temporary sales of capacity equal to about one-third the capacity of the Forked River unit. For example, the General Public Utilities system expects to purchase 400 MW for a 4-month period in the summer of 1975, and to purchase smaller amounts in the summers of 1973 and 1974. Recent efforts to purchase substantial amounts of capacity for a period of several years were unsuccessful.

There is no nearby public agency with large amounts of power for sale to utilities in Pennsylvania and New Jersey. The Power Authority of the State of New York (PASNY) is the owner of several large existing plants and of others now under construction. Except for relatively small amounts of preference power (some of which is supplied through the General Public Utilities system to Rural Electric Cooperatives in Pennsylvania), the PASNY output is dedicated to New York use.

Hydropower from Labrador and northern Quebec has at various times been considered as a potential supply for loads in the northeastern United States. The amounts available are very large and at low cost, which may justify the added transmission cost over the long distances required for use of this power in New England or New York. Because of the hydropower's location, both economic and environmental factors favor other utilities (e.g. Consolidated Edison) as potential purchasers of this power.

If power from Forked River Station is not available in 1978, the temporary purchase of equivalent power as interchanged by Jersey Central

Power and Light is estimated by the Applicant to cost about $200,000/day more than the cost of operating the Forked River Station.[1] The Staff estimates that replacement power, if available at an incremental cost of 5 mills per kW-hr, would cost the customers $40 million/yr. The economic impact of this alternative would be very severe at both the local and regional levels. The consequences of higher power costs and less reliable service would tend to discourage industry; this would mean fewer jobs and a smaller tax base for both the State and Ocean County. A direct impact on Ocean County would be the loss of 82 operating jobs at annual gross income of $1.1 million, based on 1972 dollars and about $3 million in local taxes.[2]

The importation of power from outside the system in large quantities is not feasible since no sources of such firm power could be identified. The Forked River Station is part of a complex system containing eight nuclear power plants, in various stages of planning, construction and operation. Without Forked River the reliability index of the Jersey Central Power and Light Company, and General Public Utilities would be below standard in 1978. Therefore, the feasible alternatives to be considered are:

- Building an equivalent power plant on some other site.
- Using fossil fuel rather than nuclear.
- Alternative cooling methods.

2. <u>Alternative Sites</u>

The Forked River Nuclear Station (FRNS) site was selected over several others both on the basis of the environmental and economic considerations. In selecting a site, a balance of these two prime considerations is required to make an intelligent choice. The major environmental factors evaluated included the impact of the Station on land, air, and water use. Suitability with respect to Station design and operating factors placed emphasis on population distribution, geology, seismology, meteorology, cooling water availability and site access. Economic considerations included minimizing land acquisition and development costs, and minimizing operational and power distribution costs.

The selection of the Forked River site does not necessarily indicate that the other sites were unsuitable, but rather that they were less suitable at the time the evaluation was made.

The sites given major consideration by the Applicant include:

a. Union Beach, N. J., (on Raritan Bay)
b. Gilbert, N.J., (existing plant on Delaware River)
c. Portland, Pa. (existing plant on Delaware River)
d. Scottsville, Pa. (on upper Susquehanna River)
e. Three-Mile Island (TMI), Pa. (on lower Susquehanna River)
f. A generalized northern New Jersey site, with dry cooling tower.

Although the Union Beach site (about 4 miles south of Staten Island) appeared to have a small economic advantage over Forked River, it did not meet existing AEC siting criteria with respect to population distribution in the vicinity of a nuclear power plant.

There were no significant economic advantages of the Portland, Gilbert, or Scottsville sites over Forked River, although the need for additional base-load capacity was greater in the Portland area than in the Forked River area. The use of water (either once-through or recirculating system) at the Portland and Gilbert sites, or any other new plant site on the Delaware River, is uncertain.

Portland may still constitute an acceptable future site. The existing Gilbert fossil-fueled plant is being expanded by the addition of gas turbines and a waste-heat boiler to provide some additional generating capacity at that location.

The Scottsville site, on the upper Susquehanna River, was rejected primarily on the basis of system reliability with respect to the remoteness from load centers and the potential impact of storms and other such events that might cause loss of system intergrity.

Three-Mile Island is the site of a nuclear power plant now under construction for service beginning in 1975. That plant was earlier (1968) considered for siting at Oyster Creek (Unit 2).

Although a northern New Jersey site close to load centers was considered, no such property was owned by the Applicant. Also, the dry cooling-tower contemplated for the site is questionable on a proven-technology basis.

No comparisons were made with offshore sites, since such locations for large nuclear units had not at that time reached a stage of development to appear to be feasible, either for plant construction or transmission connection.

Placing of Oyster Creek Nuclear Station and Forked River Unit 1 west of U.S. Highway 9 was based in part on the following factors: no residents presently within 1 mile of the containment building, compatibility with land-use patterns, and satisfactory soil and water factors.

Because Forked River is in the preconstruction stage of development, most of the environmental impacts from construction have yet to be experienced. However, $13 million have been spent on land costs, engineering studies, planning, and coordinating of the Forked River Project. Building a nuclear plant at a new site would result in delays and increased costs. The cost of replacement power, if it were available during the delay period, is estimated by the applicant at $200,000 per day over the cost of operating the Forked River Station.[1] If replacement power were not available during the delay period, there might be load curtailments resulting in adverse impacts on customers of the Applicant and of interconnected utilities.

3. Alternative Fuels

a. Coal

The greatest environmental advantage of coal (and other fossil fuels) over current nuclear fuels is the higher efficiency of converting thermal energy into electricity. For a station the size of Forked River, this higher efficiency would result in rejecting about 1700 MW of heat to the environs, rather than about 2400 MW in the case of the nuclear facility.

Against the thermal efficiency advantage of coal must be balanced the fuel handling and storage problems and also the atmospheric pollution problems. A nuclear station the size of Forked River operates on about 40 metric tons of fresh nuclear fuel per year, the same amount of spent fuel is transported offsite each year for reprocessing. A coal-fired plant of the same size consumes about 2.4 million metric tons of coal per year. The added impact on the environment for the construction of transportation facilities is not significant in the case of Forked River for it is near a branch line of the Central Railroad of New Jersey. Coal could also be barged from tideland in Maryland or Virginia. However, the impact of a unit train per day would be appreciable.

The quantity of gaseous and particulate material that would likely be released to the atmosphere from the burning of about 2.4 million metric tons per year of low sulfur coal are shown in Table XI-1. Also, supplies of low-sulfur coal are not readily available to this region.

TABLE XI-1

SOLID AND GASEOUS PRODUCTS FROM A 1140 MWe COAL-FIRED PLANT[a]

Product	80% Plant Factor Metric Tons/yr	2
SO_2	29,000	
NO_x	17,000	
Particulates	2,500	
Ash	341,000	

(a) 13,000 Btu/lb. coal

The aesthetic impact of a coal-fired plant is also much greater than a nuclear plant. Coal plants have high stacks which become even more noticeable from their emissions. In addition, a minimum 30-day fuel supply usually is stored on the plant site. A plant the size of Forked River would have a coal reserve of about 0.2 million tons, which would cover about 9 acres if piled 30 ft high. In addition to the storage of fuel supplies, large volumes of ash must be disposed of in the vicinity.

Also, the economics of substituting coal are unfavorable. The penalties for the cancellation of existing contracts would erode the capital cost advantage normally enjoyed by fossil-fueled plants, and the operating cost of a coal-fired plant would be significantly higher than for the nuclear alternative. Assuming new contracts could be negotiated for low-sulphur coal at a price of 65¢/million Btu, the annual fuel bill for a coal-fired plant would be about $45.2 million. Nuclear fuel-cycle costs are estimated at $14.4 million annually if levelized over the 30-year life of the plant. This annual difference of $30.8 million amounts to an incremental fuel cost of $924 million over the life of the plant. On a present worth basis this amounts to $323 million.

b. Oil

The same general comparisons may be made between the coal and oil alternatives. The thermal advantages are essentially the same.

The transportation problem with an oil-fired plant is slight because the Site is accessible by water; however, the barge channel in Barnegat Bay and the channel in Oyster Creek would have to be maintained. An equivalent capacity oil-fired plant would consume about 10.5 million

barrels per year. This would mean that one to two oil barges would have to unload every week, which would increase traffic on Barnegat Bay and substantially increase the risks of oil pollution in the area.

Oil has the same general disadvantages as coal in respect to air emissions; however, the quantities released are different. Table XI-2 shows an estimate of the combustion products released from a modern 1140 MWe oil-fired plant.

TABLE XI-2

COMBUSTION PRODUCTS FROM A 1140 MWe OIL-FIRED PLANT[a]

Product	Metric Tons/yr [3]
SO_2	25,000
NO_X	9,500
Particulates	3,200
Ash (All 1.5%)	25,000

(a)152,000 Btu/gal oil, 0.85% S., 10.5 million bbl/yr

The negative aesthetic impact of an oil-fired plant is greater than for a nuclear plant both in respect to stacks and to storage area. With the minimum 30-day storage, tanks would have to be provided with a total capacity of 46.5 million gal. Even if these tanks were buried, they would cover many acres.

Oil is an important fuel used to generate power along the Northeast coastal areas, although it is an expensive fuel for power generation. The easing of restrictions on oil imports, lowering of import taxes and encouragement of import of low-sulfur oil could permit continued use of oil in the Northeast. An adequate supply of low-sulfur oil for a large base-load power plant was available when the Forked River Station was being analyzed, but oil was ruled out because the fuel cost for base-load operation was far in excess of a nuclear facility.

The economics of converting to oil are less favorable than for coal. The same erosion of capital cost advantages normally enjoyed by oil-fired plants occurs due to the cost of abandoning the nuclear plant. The operating cost disadvantage is even greater than in the coal case. Low-sulfur oil is expected to cost 95¢/million Btu in 1976. This results in an annual fuel cost of about $66.1 million compared to the $14.4 million for nuclear fuel costs. The annual difference of $51.7 million over the life of the plant is an additional $1.55 billion, which would have to be borne by the utility customers. (On a present worth basis this amounts to $543 million.)

As in the case of coal-fired plants, the sensitivity of production costs to raw materials costs is high compared to the nuclear case. This means that total energy costs from fossil-fueled alternatives are much more sensitive to future escalation of fuel and transportation costs than is the case with the nuclear plant.

c. Gas Turbines

The substitution of gas as a fuel is not feasible because of the inadequate supply of gas available in the Northeast area for this use. It is possible to use No. 2 oil to fire gas turbines; however, this type of capacity is designed for peaking use. The Jersey Central Power and Light Company systems have a need for peaking capacity, as can be seen from their planned additions (Section X), but the Forked River Station is needed for base-load capacity. The addition of turbines for this service would have greater economic penalties than the addition of an oil-fired plant.

d. Summary

The alternative fuel sources have no clear environmental benefits over the use of nuclear power and these alternatives all have large economic penalties.

The Forked River Station is designed for nuclear fuel. A change to fossil fuel would require scrapping most of the current engineering and planning to design a completely new fossil fuel station. A large economic penalty would be the higher fuel costs for a fossil plant than for a nuclear plant. There would be a lower capital cost of a fossil plant, but this would be largely offset by the total cancellation charge for the Forked River Project estimated by the Applicant at $47 million, minus any credit for salvageable material. (This amount had increased to $69 million as of October 1, 1972.) (See page 6-28 of Applicant's Environmental Report.)

4. Alternative Cooling Methods

The Applicant has supplied a comprehensive listing of 14 potential alternatives arranged around the original ocean discharge concept as

a base case. The Staff review of the alternatives consisted of an examination of the technical factors associated with the cost estimates and included the power differentials in the production cost table presented by the Applicant (See Table 6-2, Applicant's Environmental Report). To make the evaluation of alternatives easily understandable, the Staff readjusted the cost estimates to make the reference case of the saltwater cooling tower as the base case, and further adjusted the capital cost to reflect changes in tower cost, research and development and right-of-way aquisition. These costs, derived primarily from the Applicant's sources, are presented in Table XI-3. The ocean discharge system is listed as Case 0.

The 14 alternatives were grouped by the Staff as follows:

• Technically feasible, but environmentally undesirable	Cases 5,6,7,11,13,14
• Technically and environmentally feasible, but economically infeasible	Cases 0,1,8,9,10
• Feasible on all features	Cases 2[a],3,4,12

The first grouping has some unattractive features such as excessive salt drift, undefined and perhaps excessive freshwater withdrawal from groundwater, and related institutional management problems. The second group could be justified environmentally, but suffers a weakness of high capital cost. The third group, in the opinion of the Staff, consists of viable options which are close in relative feasibility and subject to judgment as to the actual choice. In the case of the third group, the judgment would most probably be dependent on factors beyond economics and environmental feasibility, e.g., the extent to which the Applicant could assure that the Station would be completed on schedule.

On this basis the Staff selected six cases for detailed comparison including the four most feasible alternatives (2, 3, 4, and 12) and Cases 0 and 8 which are potentially feasible but contain unresolved issues or excessive costs which could delay acceptance for design purposes. Each of these six cooling alternatives has been described by the Applicant in some detail. Some excerpts from this description are quoted below.

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[a] Reference design, saltwater tower.

TABLE XI-3

FORKED RIVER UNIT 1 ALTERNATIVE COOLING SYSTEM EVALUATION SUMMARY OF RESULTS[c]

CASE NO.	CASE DESCRIPTION	MAKEUP SOURCE	PRODUCTION COSTS	INSTALLED PLANT COSTS: TOTAL DIRECT COSTS	INSTALLED PLANT COSTS: TOTAL INDIRECT COSTS	TOTAL CONSTRUCTION COSTS	TOTAL COMP. COOLING SYSTEM COSTS	DIFFERENTIAL COOLING SYSTEM COSTS
0	—	OCEAN DISCHARGE	-7.90	49.69	33.29	82.98	75.1	39.1
1	COOLING TOWER 23° APPROACH	DESALT. PLANT	18.60	42.27	28.32	70.59	89.2	53.20
2	COOLING TOWER 23° APPROACH (BASE CASE)	SALT WATER	BASE	21.6	14.40	36.0	36.0	BASE
3[a]	COOLING TOWER 23° APPROACH	TOMS RIVER	.14	18.93	12.68	31.61	31.75	-4.25
4	COOLING TOWER 23° APPROACH	EFFLUENT	6.92	14.90	9.98	24.88	31.80	-4.20
5[b]	COOLING TOWER 23° APPROACH	WELLFIELD	.20	31.36	21.01	52.37	52.57	16.57
6[b]	2 $MILE^2$ FRESH WATER RECIRC. LAKE	WELLFIELD	-5.7	47.16	31.60	78.76	73.1	37.1
7[a]	2 $MILE^2$ FRESH WATER RECIRC. LAKE	TOMS RIVER	-5.5	35.38	23.70	39.08	54.62	18.6
8	2 $MILE^2$ FRESH WATER RECIRC. LAKE	EFFLUENT	+1.1	29.60	19.80	49.40	50.5	14.50
9	2 $MILE^2$ ONCE-THROUGH SALT LAKE	NONE	-9.8	51.41	34.46	85.37	76.1	40.1

TABLE XI-3 (Continued)

10	2 MILE^2 RECIRC. SALT LAKE	SALT WATER	-3.5	42.18	28.26	70.44	66.9	30.9
11	RECIRC. SPRAY POND 23° APP.	SALT WATER	1.9	17.17	11.50	28.67	30.6	-5.40
12	RECIRC. SPRAY POND 23° APP.	EFFLUENT	10.0	15.73	10.54	26.27	36.27	.27
13	ONCE-THROUGH SPRAY POND O.C. NO.1 AND F.R. NO.1	IN SERIES	-.8	33.47	22.42	55.89	55.1	19.1
14	ONCE-THROUGH SPRAY POND O.C. NO.1 AND F.R. NO.1	PARALLEL	-11.0	27.90	18.70	46.60	35.60	-0.4

[a] COST OF MAKEUP SYSTEM AT TOMS RIVER DOES NOT INCLUDE COST OF ADDITIONAL RESERVOIR CAPACITY TO INSURE MINIMUM OUTFLOW TO THE BAY AT ALL TIMES. THIS RESERVOIR WILL NOT BE REQUIRED WHEN MAKEUP IS TO THE COOLING LAKE.

[b] COST OF PREPARING WELL FIELD SURFACE TO MINIMIZE EVAPO-TRANSPIRATION LOSSES THAT MAY BE REQUIRED IS NOT INCLUDED.

[c] ALL COSTS IN MILLIONS OF DOLLARS.

a. Ocean Discharge System (Case 0)

The Forked River Station originally was designed to include an ocean discharge system for heat dissipation. The system consisted of a 7.5-mile pipeline from the site across Barnegat Bay and Island Beach State Park and extending 2000 ft into the Atlantic Ocean. The heated circulating water from both the existing Oyster Creek Station and the proposed Forked River Station was to be discharged through the pipe to eliminate all thermal discharges to Barnegat Bay. However, the cost estimate for this heat dissipation method was quite high. The total evaluated cost (which includes capital cost, operating expenses, performance penalties or credits, etc.) was $90 million for the combined installation. The estimated cost for Forked River alone was $82.98 million; it is the latter estimate which the Staff used in its analysis and accepted as realistic, although higher than conventionally expected.

b. Hyperbolic Natural-Draft Cooling Towers (Case 2)

A hyperbolic natural-draft cooling tower is a primary vehicle for cooling water. Table XI-4 shows various combinations of two towers or one tower at various design approach temperatures. The selected version is the single tower with a design approach of 23°F. The two-tower design showed only slight gains in performance at higher costs.

The cooling performance of a tower using saltwater makeup would be nearly identical to that of a tower using fresh water, and the potential environmental effects of saltwater drift have been assessed against the technical and economic benefits of this mode of operation.

c. Cooling Lakes (Case 8)

The Applicant's estimate of the performance of a 2-square-mile cooling lake was based on Johns Hopkins University publications[5-7] covering research sponsored by the Edison Electric Institute.

A 2-square-mile lake will result in slightly better plant performance than a 23°F approach cooling tower. Vertical vinyl curtains were incorporated in the design of the vinyl-lined lake to define a long flow-channel and prevent mixing.

After clearing and shaping of the Site and compacting the soil, 10mm vinyl liner in sections of 60-80 ft width would be laid, with the edges overlapped and bonded together with adhesive. The liner would

TABLE XI-4

PRELIMINARY COOLING TOWER STUDY(5)

CASE	APPROACH (°F)	NUMBER TOWERS	SHELL HEIGHT (ft)	OVERALL DIAM. (ft)(a)	APPROX. REQD. PUMPHEAD CAPABILITY (b)	PREDICTED PERFORMANCE (APPROACH IN °F) FALL 52WB/74%RH	WINTER 32WB/71%RH	SPRING 46WB/68%RH	SUMMER 73WB/55%RH	TOTAL BUDGET PRICE (c)
1	18	2	370	410	55	23.9	32.2	26.5	16.9	$ 14,700,000
2	20	2	370	415	48	26.2	35.0	29.0	18.7	14,000,000
3	23	2	350	380	48	29.7	39.1	32.6	21.5	13,100,000
4	23	1	410	495	62	29.7	39.0	32.6	21.6	8,500,000
5	28	1	370	425	62	35.3	45.4	38.3	26.3	7,800,000

(a) OUT TO OUT OF AIR INLET LOUVERS.

(b) Ft. ABOVE COLD WATER BASIN OPERATING WATER LEVEL.

(c) BUDGET PRICES GIVEN ARE CURRENT PRICES AND DO NOT ALLOW FOR INCREASES IN LABOR AND/OR MATERIALS COSTS. PRICING IS BASED ON A REINFORCED CONCRETE HYPERBOLIC SHELL AND A PRECAST CONCRETE STRUCTURAL SUPPORT FOR THE COOLING RING, FILLED WITH ASBESTOS CEMENT BOARD FILL. PRICING INCLUDES THE USE OF SERIES 316 STAINLESS STEEL STRUCTURAL BOLTING IN THE PRECAST CONCRETE FILL SUPPORT STRUCTURE. ALSO, PRICING ALLOWS FOR WIND DESIGN AT 100 MPH AT 30 FT. IN ACCORDANCE WITH ASCE PAPER 3269.

prevent seepage and loss of water to the ground. The liner would be covered with 1 ft of sand for in-place retention and protection.

A second vinyl liner would be laid on top of the sand cover of the first liner for the saltwater lake for positive protection against seawater contamination of the underground water. However, the second liner would not receive an earth cover.

The largest lined-lake to date is about 60 acres[8], and the maintenance of a 1280-acre lined lake is expected to introduce unforeseen problems. No lake of this size has ever been lined or operated for long periods of time. The Staff review of this alternative indicated that feasibility is doubtful at this time and the potential delays and risks of plant curtailment offer little inducement to take the risk.

d. Spray Ponds (Case 12)

The powered spray units considered here are new developments by the Ceramic Cooling Tower Company, a subsidiary of First Worth Corporation, Fort Worth, Texas. A large number of floating independent modules (200 to 250) each including a 75 hp pump and motor assembly, would each pump surface water through four spray heads. The resulting spray pattern, 20 ft high and 40 ft in diameter, is made up of large drops of water over 0.25-in. in diameter. The large size of the water drops limits drift.

The performance of the spray pond is extrapolated from results based on one spray module tested at the discharge of a Texas power plant. Other existing facilties, (1) Public Service of New Hampshire, Manchester, New Hampshire and (2) Dresden Reactor of Commonwealth Edison Company, Illinois, have been operating on fresh water since 1970. A number of utilities have purchased module systems for plants required to back-fit for water quality control; these installations are not yet complete. In addition, VEPCO and Gulf States Utilities are currently testing module systems using saltwater.

The vinyl-lined reservoir, designed for 23°F approach, would be constructed similar to the large cooling lake above. A second backup liner would be necessary for saltwater makeup. The large spray pond for both Forked River and Oyster Creek Stations, located between the present intake and discharge canals, would be unlined because it is already underlaid with seawater and the problem of salt contamination of the underground water does not exist at this location.

A spray pond installation is expected to cause a fog problem on the Garden State Parkway and Route 9. Ceramic Cooling Tower Company has assured the Applicant that the fog would dissipate within a short distance. A 200-yard exclusion area on either side of the spray pond canal would probably localize drift from freshwater spray ponds under conditions of strong winds; however, no data are available to base a judgment on salt drift from spray modules, and in the absence of such data, the risk of considering this alternative is considered unacceptably large for Forked River.

e. Makeup Source (Cases 3,4,8, and 12)

Saltwater systems would obtain makeup water from the existing Oyster Creek intake canal. Freshwater systems would obtain makeup water from several possible sources. The evaporative makeup requirements are about the same for the hyperbolic cooling tower and the spray pond. They are higher for the cooling lake, although rainfall over the lake drainage area will more than compensate for differences in evaporation rates.

Makeup water from Toms River could be transported to the Forked River Station by a 9.5 mile pipeline. The availability of rights-of-way for the pipeline was not investigated but costs at $2000/acre are included in the Staff estimate. A spillway across Toms River near the Garden State Parkway was considered by the Applicant to impound about 15% of the yearly average flow for the years 1960 to 1965 (22,000 acre-ft). The makeup requirement (35 cfs) corresponds to approximately 60% of the instantaneous minimum river flow recorded in the period 1928 to 1965, and 16% of the 30-year average. State requirements for minimum downstream flow indicate that Toms River may not continuously provide the required downstream flow and plant demand without some storage. The Staff believes that a 90-day supply (6300 acre-ft) would be adequate.

A 20-square-mile well field west of the Garden State Parkway was also considered by the Applicant for makeup requirements. Thirty-seven wells, each with its own pump and motor, could supply three headers discharging into a pump basin near the Forked River Station, although only a portion of the wells would normally operate to meet the maximum makeup requirements.

For a cooling tower at the Forked River Station, an average supply of 30 cfs (13,500 gpm) would be required continuously for all purposes including essential blowdown [maximum supply, 36 cfs; 16,500 gpm]. Withdrawals of this magnitude could be met by the existing aquifers, probably the Cohansey Sands (elevation-4000 ft). However, this would commit a major portion of the known supply to loss by

evaporation, a use which has not been included in the long-range plans for aquifer development by the State of New Jersey. Thus, although technical capacity of adequate magnitude potentially exists, the use of this groundwater for makeup for the Forked River Station would require extensive institutional investigation relative to future needs for water in Ocean County. The Applicant's judgment with which the Staff concurs, was that it would not be possible to secure supplies of groundwater of sufficient magnitude to guarantee long-term continuity of the Station operation without the risk of requiring extensive back-fitting during the life of the facility. Costs of surface preparation to maximize aquifer recharge are not included in the capital cost estimates, but even without these costs this case is not economically attractive as presented. Technical details of this alternative were inadequate to make a complete judgment.

The State of New Jersey, Department of Environmental Protection, is proposing regional sewage treatment plants, including one for Ocean County. However at this date, Lacey Township has not chosen to build one. The effluent from a secondary treatment or advanced waste (tertiary) plant for Lacey Township would be approximately 34 million gal/day, more than adequate for the tower makeup requirements of the Forked River Station. Tentative State plans call for this plant to be operational late in the 1970's. The Applicant indicates he will cooperate with the State to determine the feasibility of using this effluent in the cooling tower. The Staff has found no technical or economic reasons why this source, if the proper institutional arrangements can be negotiated, is not a viable alternative.

5. Cost of Cooling Systems

The Staff summary of the cost study for the six most feasible cases, summarized in Table XI-5, shows both the total cost and the differential cost between the saltwater cooling tower (Case 2) and alternatives. It should be noted that the reference case has been changed from the ocean discharge to the saltwater cooling tower. The six alternatives in Table XI-5 were analyzed in a slightly different manner than used by the Applicant, but most of the Jersey Central Power and Light Company basic input data was incorporated.

From discussions with tower manufacturers, the Staff has concluded that saltwater towers with low drift characteristics will be approximately 50% more costly than comparable freshwater towers. Accordingly, the Applicant's direct cost estimate for a saltwater tower has been increased by $4.2 million; the indirect costs have also been adjusted.

TABLE XI-5

FORKED RIVER UNIT 1 ALTERNATE COOLING SYSTEM EVALUATION
SUMMARY OF RESULTS

CASE NO.		0	2	3	4	8	12
CASE DESCRIPTION			BASE COOLING TOWER 23^0 APPROACH	COOLING TOWER 23^0 APPROACH	COOLING TOWER 23^0 APPROACH	2 $MILE^2$ FRESH WATER RECIRC. LAKE	RECIRC. SPRAY POND 23^0 APP.
MAKEUP SOURCE		OCEAN WATER	SALT WATER	TOM'S RIVER	EFFLUENT	EFFLUENT	EFFLUENT
PRODUCTION COSTS							
DIFF. ANNUAL GROSS GEN.	KW-HR x 10^6/yr	+115	BASE	0	0	+158	-10.0
DIFF. ANNUAL AUX. POWER	KW-HR x 10^6/yr	- 46	BASE	+ 2	0	- 25	+19.0
DIFF. ANNUAL NET GEN.	KW-HR x 10^6/yr	+161	BASE	- 2	0	+183	-29
DIFF. ANNUAL FUEL CYCLE COST @ 1.8 MILLS/KW-HR	\$/YR x 10^6	- .223	BASE	+ .003	0	- .260	+ 0.042
DIFF. ANNUAL O&M COST	\$/YR x 10^6	- .020	BASE	- .01	1.0	+ .974	+ 0.964
PRESENT WORTH DIFF. ANNUAL COST - 30 YR 8.75%	\$ x 10^6	- 2.43	BASE	- .079	10.5	+ 7.50	+10.56
DIFF. CAPABILITY CHANGE	\$ x 10^6	- 8.22	BASE	+ .090	0	- 10.0	+ 1.53
SUBTOTAL	\$ x 10^6	- 10.77		+ .011	10.5	- 2.50	+12.09
INSTALLED PLANT COSTS							
TOTAL DIRECT COSTS		49.69	21.60	18.93	14.90	29.57	15.73
INDIRECTS (67% OF DIRECTS)		33.29	14.41	12.68	9.98	19.81	10.54
TOTAL COSTS OF COOLING SYSTEM		82.98	36.01[c]	31.61	24.88	49.38	26.27
TOTAL COMPARABLE COOLING SYSTEM COSTS		72.21	36.01	31.62	35.38	46.88	38.36
DIFFERENTIAL COOLING SYSTEM COSTS		36.21	BASE	- 4.38	- 0.62	10.88	2.36

[a] COST OF MAKEUP SYSTEM AT TOM'S RIVER DOES NOT INCLUDE COST OF ADDITIONAL RESERVOIR CAPACITY TO INSURE MINIMUM OUTFLOW TO THE BAY AT ALL TIMES. THIS RESERVOIR WILL NOT BE REQUIRED WHEN MAKEUP IS TO THE COOLING LAKE.

[b] COST OF PREPARING WELL FIELD SURFACE TO MINIMIZE EVAPO-TRANSPIRATION LOSSES THAT MAY BE REQUIRED IS NOT INCLUDED.

[c] INCLUDES \$1 M R&D COSTS ON SALT WATER DRIFT.

In addition $1 million of research and development was assumed by the Staff to be required to prove out the drift characteristics of the reference saltwater tower (Case 2). An alternate to such large model experiments would be a long low-power run during reactor startup. The potential delays and cost of such a procedure made it unattractive. The total system costs for the saltwater tower have thus been increased by $1 million.

Differential maintenance costs for all six cases were estimated on the following basis:

Freshwater cooling tower	$10,000/yr
Saltwater cooling tower	$20,000/yr
Lakes, Spray Modules, etc.	Annual maintenance costs of 1.5% of investment cost

The results of the Staff's analysis indicate that both of the freshwater, natural-draft cooling tower cases (Cases 3 and 4) show some potential savings over the base saltwater case. The freshwater makeup from Toms River (Case 3) requires a 9-mile pipe run. Freshwater makeup from a proposed Lacey Township municipal sewage treatment plant (Case 4) adjacent to the Site would require sewage effluent treatment which cancels the savings in the long pipeline from Toms River. At this time, however, all plans for this proposed sewage treatment plant (on Jersey Central Power and Light Company property) have been abandoned by Lacey Township. It is the Staff's opinion that either of these freshwater tower alternatives is feasible and might be used as a back-up in case technical difficulties arise in the saltwater tower design.

A vinyl-lined, 26-acre reclaimed-water pond (Case 12) with individually powered spray modules has about the same cost as the base case (saltwater cooling tower). The spray pond probably intrudes less upon the landscape than does the natural-draft cooling tower. However, the spray pond has an undefined but probably large drift and fogging problem, and is considered technically infeasible at this location with 1972 state-of-the-art knowledge.

The freshwater recirculating lake (Case 8) and the ocean discharge system (Case 0) are more expensive than the reference case by $11 million and $36 million, respectively.

6. Summary Analysis of Cooling Systems

The summary which follows is the Staff evaluation of the three alternatives (and Cases 0 and 8) which were included in the category

of "feasible in every respect." Other alternatives, although having some attractive features were not studied in detail because of unique, disabling technical or environmental considerations which did not appear capable of resolution before the critical period for choice of construction alternatives. Cases 0 and 8 were selected because they were next in order in economic feasibility.

In the Applicant's reference design, primary cooling will be supplied by a hyperbolic natural-draft cooling tower using salt water as makeup. In the proposed system, cooling water will be recirculated from the cooling tower basin to a turbine-generator condenser. Heat transfer will be by evaporation of 12,000 gpm (26.5 cfs) maximum in the summer and will require a summertime blowdown for salinity control in the discharge canal of about 40,000 gpm with a concentration factor of 1.3. This will contribute about 3.5×10^8 Btu/hr to the canal.

Makeup water to the system will come from the nuclear services cooling system and the tower makeup system. During normal operation, the entire flow of the nuclear services system will be used to supply tower makeup. In freezing conditions, for purpose of ice control on intake structures, a portion of the nuclear services cooling water will be circulated to the intake structures, which means that the tower makeup system must be operated to compensate for this diversion. Also for salinity control, both makeup systems will be used to supply needed water in response to intake canal salinity changes and the 10% increase criterion.

The blowdown will be introduced into the discharge canal just below the present dam. Changes in salinity of Barnegat Bay will be greater with the saltwater tower because the incremental evaporation is 150% greater than with once-through cooling, although local changes will occur as different cooling options affect flow patterns.

The blowdown from the freshwater tower alternatives would probably have a greater incremental effect than that of the saltwater tower, but in the opposite numerical direction; that is, the salinity would be decreased rather than increased. On balance, salinity changes from any tower system are considered minor in relation to the naturally occurring changes in salinity at the Oyster Creek location. The actual blowdown from a freshwater tower would be expected to be less than 4,000 gpm with a concentration factor of about 3.

A number of options for the supply of fresh water for tower makeup or pond were identified. These included the use of Toms River

diversion and sewage effluent after suitable secondary or tertiary treatment. The Staff considers that either source is technically and economically equivalent to the proposed use of a saltwater tower, although the New Jersey legal constraints are probably a greater potential deterrent in the case of the freshwater sources.

Feasible alternatives which were less attractive in the Staff analysis included ocean discharge (Case 0) because of cost and potential problems with salinity redistribution in Barnegat Bay; a cooling lake (Case 8) using sewage effluent for recharge because of land costs and impact and potential problems in maintenance of suitable lake levels; and a freshwater spray pond system (case 12) using sewage effluent for makeup supply because of potential low-level fogging problems and unfavorable economics relative to the reference designs.

Saltwater lakes and saltwater spray ponds appear to be technically infeasible and were not included in the detailed examination by the Staff.

In all cases other than sewage effluent, the cost of water was assumed to be nil. In the latter case, 15¢ per thousand gallons was assumed as a reasonable surcharge for study purposes.

The Staff study reveals that the lowest cost alternative is the freshwater hyperbolic tower with Toms River supply; this is followed closely by the freshwater tower with sewage effluent supply and the reference saltwater tower. Offsetting risks appear to be the institutional arrangements required to assure freshwater supplies, and alternatively the risks associated with the design and guarantee of the saltwater tower to a very low drift rate.

7. Alternatives to Normal Transportation Procedures

Alternatives, such as special routing of shipments, providing escorts in separate vehicles, adding shielding to the containers, and constructing a fuel recovery and fabrication plant on the site rather than shipping fuel to and from the station, have been examined by the Staff for the general case. The impact on the environment of transportation under normal or postulated accident conditions is not considered to be sufficient to justify the additional effort required to implement any of the alternatives.

B. COST-BENEFIT BALANCE OF ALTERNATIVES

In any analysis of alternatives only future costs should be considered. Hence, those expenses already accrued are considered as sunk costs.

The costs to be expected in the case of cancellation of existing contracts for the nuclear plant are a different matter. They are future expenses and must be reflected in the analysis of any alternative which calls for abandonment of the nuclear plant. It has been estimated by the Applicant that the cancellation of these contracts would cost an additional $34 million; hence the analysis of the oil-fired plant alternative includes this item.

Since capital and operating costs for the various alternatives vary in both magnitude and time, it is necessary to use present worth techniques to normalize them to the same base. In Table XI-6 the reference nuclear design (saltwater tower), five cooling alternatives, and an oil-fired plant are all compared on this basis. All expenses are discounted to the time of scheduled plant startup in mid-1977.

In Table XI-6 the total economic costs for completion of the reference plant are listed. Also shown is a summary of the environmental impact to be expected from this design. For alternatives, only the incremental economic costs and environmental effects are listed.

At this point in time $13 million out of a total of $530 million has been spent on design and planning of the plant. The balance of the capital expenditure is $517 million. Production costs at 2.2 mills/kW-hr, a 30-year economic life, and interest at 8.75% were used to calculate fuel and operating expenses. An average annual capacity factor of 80% was assumed. Over a 30-year period the present worth of these production costs is $185 million. The total present worth of finishing and running the plant is then $702 million.

An oil-fired plant was assumed to cost $50/installed kW less than the nuclear plant. This would result in a savings of about $44 million in capital cost. When the present worth of the cancellation costs of the nuclear contracts is considered ($52 million), these savings disappear. The present worth of the incremental fuel costs of the oil-fired plant is over $500 million. The total increase in costs is $517 million.

The incremental environmental effects of significance associated with the alternative oil-fired plant are the additional land occupied by oil storage facilities (although some exclusion area land might be released), the increased traffic on Barnegat Bay and attendant potential for an oil spill in an area of heavy recreational use. Also, the emission of combustion products associated with the fossil-fuel plant would result in a measurable impact as would the appearance

TABLE XI-6

COST-BENEFIT SUMMARY FOR FORKED RIVER NUCLEAR STATION UNIT 1 ALTERNATIVE ACTIONS

MONETARY COSTS[a]	REFERENCE CASE SALTWATER TOWER (2)	OIL-FIRED PLANT	ALTERNATIVE HEAT DISSIPATION METHODS: OCEAN DISCHARGE (0)	FRESHWATER COOLING TOWER--TOMS RIVER (3)	FRESHWATER COOLING TOWER--SEWAGE EFFLUENT (4)	FRESHWATER RECIRC. LAKE--SEWAGE EFFLUENT (8)	RECIRC. SPRAY POND SEWAGE EFFLUENT (12)
COSTS OF REFERENCE PLANT		INCREMENTAL COSTS OVER REFERENCE CASE					
CAPITAL COSTS							
CAPITAL	517	(44)	36	(4)	(12)	14	(10)
ANNUAL COSTS (PRESENT WORTH)							
CANCELLATION COST		52					
FUEL AND OPERATING COST[b]	185	509	(11)	0	11	(3)	12
TOTAL PRESENT WORTH COST	702	517	25	(4)	(1)	11	2
ENVIRONMENTAL IMPACTS		INCREMENTAL ENVIRONMENTAL IMPACTS FROM REFERENCE CASE					
LAND USE							
LAND REQUIRED	1416 ACRES	~600 ACRES OF EXCLUSION AREA COULD BE RELEASED	RIGHT-OF-WAY REQUIRED UNDER BAY AND ON ISLAND BEACH	RIGHT-OF-WAY REQUIRED FOR PIPELINE FROM IMPOUNDMENT	NO APPRECIABLE CHANGE	~1200 ADDITIONAL ACRES REQUIRED FOR LAKE	~200 ADDITIONAL ACRES REQUIRED FOR SPRAY POND
AGRICULTURE	NO APPRECIABLE FARMING IN THE IMMEDIATE AREA	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE
RECREATION	NO RECREATIONAL LAND PREEMPTED	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	POTENTIAL RECREATIONAL AREA PREEMPTED	NO CHANGE
HISTORIC AND SCIENTIFIC	TOWER VISIBLE FROM HISTORIC SITES	ADDED STACK	LESS VISUAL IMPACT	NO CHANGE	NO CHANGE	LESS VISUAL IMPACT	LESS VISUAL IMPACT
NATURAL AREA	~300 ACRES NATURAL AREA WITHDRAWN. LOSS OF WILDLIFE HABITAT	NO NECESSITY FOR EXCLUSION AREA	NO SIGNIFICANT CHANGE AFTER REVEGETATION OF RIGHT-OF-WAY	COMMITMENT OF LAND FOR IMPOUNDMENT	PIPELINE RIGHTS-OF-WAY WITHDRAWN	ADDITIONAL 1200 ACRES COMMITTED	ADDITIONAL 200 ACRES COMMITTED
SHORELINE	SHORELINE USE NOT AFFECTED	NO CHANGE	ADDITIONAL SHORELINE IMPACTS FROM DREDGING	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE
WATER USE							
COMMERCIAL	SMALL IMPACT ON CRABS, FINFISH, AND PLANKTONIC ORGANISMS	NO APPRECIABLE CHANGE	HIGHER INTAKE LOSSES	SOME LOSS OF FRESHWATER SPECIES	NO LOSS OF FISH, CRABS OR FOOD ORGANISMS	NO LOSS OF FISH, CRABS OR FOOD ORGANISMS	NO LOSS OF FISH, CRABS OR FOOD ORGANISMS
RECREATION	NO EFFECT ON WATER-BASED RECREATION. SMALL IMPACT ON SPORTS FISHERIES	INCREASED BAY TRAFFIC	PROBABLY GREATER IMPACT	SOME LOSS OF FRESH-WATER FISHERIES	NO LOSS OF FISH, CRABS OR FOOD ORGANISMS	NO LOSS OF FISH, CRABS OR FOOD ORGANISMS	NO LOSS OF FISH, CRABS OR FOOD ORGANISMS
MARINE LIFE	NO SIGNIFICANT LOSS OF PRODUCTIVITY	POTENTIAL OIL SPILLS	PROBABLY GREATER IMPACT	NO CHANGE	LESSENED IMPACT	LESSENED IMPACT	LESSENED IMPACT
AESTHETICS	TOWER AND PLUME VISIBLE FOR SEVERAL MILES. SEVERAL DAYS PER YEAR OF FOG	EXTRA STACK INCREASES IMPACT	LESS IMPACT	NO CHANGE	NO CHANGE	DECREASED VISIBILITY	DECREASED VISIBILITY ADDED FOGGING
AIR EMISSIONS	SLIGHT SALT DRIFT BUT NO IMPACT ON VEGETATION, AGRICULTURE, STRUCTURES OR ACTIVITIES	25,000 METRIC TONS/YR SO_2 9,500 METRIC TONS/YR NO_x 3,200 METRIC TONS/YR PARTICULATES	LESS IMPACT	LESS IMPACT	LESS IMPACT	LESS IMPACT	LESS IMPACT
RADIOLOGICAL	~10 MAN-REM/YR TOTAL POPULATION EXPOSURE 50-MILE RADIUS	INSIGNIFICANT	NO SIGNIFICANT CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE
FUEL TRANSPORT	~60 TONS PER YEAR FUEL	~10 MILLION BARRELS/YR	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE
WASTE PRODUCTS	40 TONS/YR IRRADIATED FUEL	25,000 TONS/YR ASH	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE

[a] ALL COSTS IN MILLIONS OF DOLLARS, PRESENT WORTH AT TIME OF PLANT STARTUP.

[b] INCLUDING AN ADJUSTMENT FOR CHANGES IN PLANT CAPABILITY.

of the stack and possible vapors and gases associated with the combustion process. Although less waste heat would be released to the atmosphere and marine waters than in the case of the nuclear plant, the proposed use of a recirculating cooling tower in both cases results in reducing what already is an insignificant impact. Similarly, a slight reduction in the amount of make-up water required for the oil-fired plant would result in a corresponding decrease in the loss of biota due to impingement on screens and entrainment; however, this again would be a reduction, on the order of 25%, of what is already a fairly minor impact. On balance, the oil-fired plant alternative appears to offer no significant environmental gains over the nuclear station as proposed; rather it presents a potential for increased impacts primarily associated with the nature of the fuel in this case.

The cooling options are analyzed in a similar manner. As has been discussed earlier, the two freshwater tower cases show some potential savings. It should be reiterated, though, that the estimate for the Toms River makeup does not include the cost of an impoundment, which would probably be required. Similarly, no contingency has been included in the sewage effluent makeup costs for the probable delay which would result from the adoption of this alternative.

A principal incremental environmental effect associated with the ocean discharge heat-dissipation option is the potential for significantly increased intake losses both from screen impingement and organism entrainment. In this case the expected losses would be on the order of 10-50 times those forecasted for the reference design. The relatively long period of exposure of biota in traversing the 6.5-mile pipeline would result in higher mortality than in the case of a plant located on the shoreline of the receiving water body. Also, the thermal loading of the receiving waters would be increased, which could significantly affect aquatic life in the discharge zone. However, this consideration is, of course, highly dependent on the populations and species exposed and on the hydrologic characteristics of the outfall regime. Furthermore, the use of once-through cooling at the Forked River Station would require a high water intake rate that potentially could significantly change the salinity, temperature, and flow patterns now inherent to Barnegat Bay. The extent and impact ramifications of such changes would be difficult to predict but major ecosystem alterations would not be unlikely.

The use of Toms River water as a supply source for a fresh water cooling tower probably comes closest to the reference case with respect to environmental effects. The substitution of fresh for salt water in the tower would eliminate salt deposition considerations;

however, this is expected to be of no significant impact with the tower as designed. On the detrimental side would be the effects on freshwater species of the impoundment, the intake structure, and of such a significant diversion of stream flow. A reliable analysis in this case would require considerably more data than the Staff was able to acquire. Also as discussed earlier, both the Toms River and treated effluent freshwater sources are beset with institutional problems which are not of a direct environmental nature but which would require considerable environmental analysis as part of their resolution.

The use of secondary (or tertiary) treated municipal sewage presents some interesting environmental concerns. Use of secondary waste in a cooling tower would result in further oxidation of organic material and thus a lower organic loading of the marine waters receiving tower blowdown than if the waste was discharged directly to the bay from the treatment plant. Thus some benefit would accrue to the Station in this regard. In addition, there would be no loss of aquatic life due to intake considerations as in the use of the Toms River or seawater supply source.

The treated sewage source appears to be a feasible and attractive alternative from the environmental effects standpoint. The institutional arrangements deterrent, however, makes it an unacceptable risk on a timeliness basis.

C. BALANCING OF COSTS AND BENEFITS

The environmental costs associated with the Forked River Nuclear Station would be the disturbance of marginally productive land which has already been excluded from use due to the adjacent Oyster Creek Nuclear Station; the alteration and reassignment of several thousand acres of natural area for about 98 miles of transmission lines; a small loss and displacement of birds and small mammals due to disturbance of their habitat; a small loss to the ecosystem of aquatic organisms in the plant's cooling water system; the yearly loss of up to 10,000 finfish and crab by impingement on water intake screens; consumption of 0.85 tons of U^{235} per year (40 tons of nuclear fuel at $\sim$ 2% enrichment); a small increase in the total dissolved solids in the bay; a small increase in occurrence of fog in the surrounding area; a small increase in salt deposition above that naturally occurring in the surrounding area; release of small quantity of radioactive materials to the air and water (total of less than 10 man-rems per year within 50 miles); and a low probability of an accident in the plant releasing radioactivity or of an accident during the transport of radioactive materials.

In the Staff's opinion, these costs are outweighed by the benefits of supplying 8 billion kW-hr electricity per year to residential, industrial, and other users, with favorable effects on both the local and regional economy. Alternatives for obtaining these benefits by burning fossil fuels would not only be much more expensive but the burning of fossil fuels would contribute to air pollution due to the exhausting of sulphur oxides, nitrogen oxides and particulate matter to the atmosphere.

XII. DISCUSSION OF COMMENTS RECEIVED ON THE DRAFT ENVIRONMENTAL STATEMENT

Pursuant to paragraph A. 6 of Appendix D to 10 CFR 50, the Draft Environmental Statement of October 1972 was transmitted, with a request for comment, to:

- Advisory Council on Historic Preservation
- Department of Agriculture
- Department of the Army, Corps of Engineers
- Department of Commerce
- Department of Health, Education, and Welfare
- Department of Housing and Urban Development
- Department of the Interior
- Department of Transportation
- Environmental Protection Agency
- Federal Power Commission
- State of New Jersey
- Ocean County Commissioners

In addition, the AEC requested comments on the Draft Environmental Statement from interested persons by a notice published in the Federal Register on October 13, 1972 (37 F.R. 21660).

Comments in response to the requests referred to above were received from:

- Advisory Council on Historic Preservation
- Department of Agriculture
- Department of Commerce
- Department of the Interior
- Department of Transportation
- Federal Power Commission
- Environmental Protection Agency
- Department of Housing and Urban Development
- State of New Jersey

Consideration of comments received and the disposition of the issues involved are reflected in part by revised text in other sections of this Final Environmental Statement and in part by the following discussion. The comments are included in this statement as Appendix D.

A. HISTORICAL, CULTURAL, ARCHAEOLOGICAL, AND ARCHITECTURAL RESOURCES (ACHP, D-1; Int. D-13)

The State of New Jersey was contacted to identify any adverse effects upon New Jersey cultural, historical and architectural resources that may be anticipated from construction and operation of the proposed Forked River Nuclear Station, Unit 1. An historian for the State informed the Staff that both the New Freedom and Deans transmission lines were completely clear of all national and state register sites.

B. SOIL EROSION (Agriculture, D-3; Interior, D-16)

There were comments with respect to reseeding of soil and erosion control practices. The Applicant will adhere to the Standards and Specifications for erosion control during construction adopted by the Ocean County Soil Conservation District.[7] Reseeding of cleared land at the construction site will take place soon after regrading or whenever seeding is required for erosion control. The material dredged from Oyster Creek, however, presents a different problem. Experience gained during construction of the Oyster Creek Station showed that immediate reseeding of dredge spoils is impractical because the dredged silt is rich in salt. Several years of natural precipitation are necessary to leach the salt from the soil before reseeding can be attempted.

C. CURTAILMENT OF SERVICE (Agriculture, D-4)

The concept of rationing power or limiting the economic growth of an area represents a change in national policy which is considered to be beyond the scope of jurisdiction of the Atomic Energy Commission by Congress and is therefore not considered in this statement.

D. TRANSMISSION LINE IMPACT AND LAND USE (Agriculture, D-5; Interior, D-16)

1. Forest Lands on Transmission Line Rights-of-Way

Land clearing along the proposed 98 miles of transmission line rights-of-way will involve approximately 1500 acres of forest land and 400 acres of non-forested land. State lands crossed are undeveloped areas of State Parks. Selective clearing procedures will be employed and only those trees which would interfere with the safe and reliable operation of the transmission line will be removed or trimmed. A minimum distance of 20 ft. between the line and tree must be maintained. Selective clearing and the avoidance of sensitive areas

such as "plains" areas and cedar swamps are expected to minimize biological impact and reduction in soil stability. Continued coordination with the State of New Jersey is planned for right-of-way management including the development of food patches for wildlife. A successful program of this type has been reported[1] and is in use along other rights-of-way of the Applicant.

As a result of land clearing, some wood inventory and animal habitat will be eliminated; however, the opening of forested areas may benefit other fauna by creating additional browse for feed.

2. Easements

The transmission line easements through state-owned land are described in the Environmental Report (Sect. 4.11). No Federal land is traversed. Basically the proposed line will run parallel and just inside part of the boundaries of Lebanon State Forest and the Wharton Tract State Forest and Park. The Staff does not expect these easements to significantly impact the use of the forest and park.

E. USE OF HERBICIDES (Agriculture, D-5)

A comment was made that the use of herbicides could cause wildlife habitat losses and the possibility of local water contamination.

The Applicant's vegetation control program[7] for transmission line rights-of-way calls for selective treatment every 4 to 5 years. Small amounts of commercial 2,4-D, 2,4,5-T, picloram or dicamba preparations in water or fuel oil are hand applied to the bases of undesirable species. Ammonium sulfamate is used instead of 2,4,5-T in wet areas that might contribute to drinking water supplies for humans or livestock. Persistence of those herbicides in soil can be as long as 12 months, but the method of application and amounts used should counteract the possibility of environmental buildup or contamination of near surface aquifers. Principal species controlled are maples, oaks, sassafras, and black cherry.

F. SHIPWORMS (Prehearing Conference, Nov. 28, 1972)

At the prehearing conference in this proceeding, an interested person raised the issue of the extent to which the operation of the proposed Forked River plant will affect the shipworm population and activity in Oyster Creek.

It has been reported that shipworms, Teredo navalis and Bankia gouldi, have been found in Oyster Creek.[15] Teredo navalis is most abundant and active at salinities between 28 and 31 ppt. Bankia gouldi is most active at intermediate salinities of 9 to 10 ppt. T. navalis is most active at temperatures around 74°F and B. gouldi is most active at higher temperatures. Since the incremental effect of the Forked River Nuclear Station blowdown results in less than 1°F change in temperature and a salinity change of less than 10% to the present concentration of about 23 ppt., it is the Staff's opinion that the Forked River Nuclear Station blowdown will not significantly enhance the activity and population of T. navalis and B. gouldi in Oyster Creek.

G. METEOROLOGY (EPA, D-29; Commerce, D-7)

The onsite data is in question since inspecting agencies have on occasion found the meteorological system to be malfunctioning. Based upon data in the area, the staff estimated the maximum average annual concentration at the site boundary for a ground source to be 1×10^{-5} sec/m^3. The Department of Commerce agrees with this estimate.

H. ACOUSTICAL NOISE LEVEL (HUD, D-9)

The Applicant states[7] that acoustical noise surveys will be performed (a) with Oyster Creek Nuclear Plant operating alone to obtain the present level, and (b) after Forked River Nuclear Station Unit 1 becomes operational to determine whether there is an increase in noise level.

I. GEOLOGY (Interior, D-13)

With regard to a comment that the description of the site geology is inadequate, it should be noted that the prime function of this statement is to assess the effects of the Forked River Nuclear Station Unit 1 on the environment. Physical properties of foundation materials and seismic considerations used for design criteria were evaluated by the Staff in the Safety Evaluation Report issued on July 25, 1972, and in Supplement 1 thereto issued on September 29, 1972. In the Staff's opinion, further discussion in this statement is not required.

J. HYDROLOGY (Interior, D-14)

The Staff review of the Applicant's program to ensure the safety of the ground water aquifer reveals thorough understanding on the part of the Applicant of the importance of this problem. The three

observation wells proposed by the Applicant will be adequate to detect incipient contamination due to the open nature of the Cohansey formation. The proposed cut-off trench to be built using slurry trench methods is a standard technique used in the construction of dams, dikes and other hydraulic control structures and has been proven in the field by a large number of applications. Major structures such as the Wanapum Dam, a part of the Priest Rapids hydroelectric project on the Columbia River depend on the integrity of slurry trenches for control of ground water flows which could compromise the safety of these structures. Therefore, it is the judgement of the staff that the Applicant intends to use appropriate means during construction to protect existing water supplies and aquifers.

K. TERRESTIAL ECOLOGY (Interior, D-15)

In addition to the rare and endangered species discussed in Sect. II-E-1, a wood turtle (Clemmys insculpta) was observed onsite in an upland forest habitat during a field survey. The red-shouldered hawk (Buteo lineatus) is also judged from field data to occur in the area. Both species are considered rare in New Jersey.[2]

The proposed plant site will cover a pine-oak upland forest. Pitch pine (Pinus regida) is the overstory tree with an understory red maple (Acer rubrum), willow oak (Querus Phellos), sassafras (Sassafras albidum), black gum (Nyssa sylvactica), black cherry (Prunnus serotina), and others. Shrubs such as serub oak (Quercus ilicifolia), bayberry (Myrica pensylvanica), and leatherleaf (Chamaedaphne calyculata) are also present.

L. BIOLOGICAL IMPACT AND UNAVOIDABLE ADVERSE EFFECTS (Interior, D-16)

An agency comment pointed out that the cooling tower and other tall structures in the area are possible obstacles to the flight paths of birds. Migrating birds especially passerine birds, have been known to be attracted to lighted structures, such as light houses, as well as unlighted tall buildings.[3]

Bright lights during foggy conditions, and the reflection of light from the windows of tall buildings are also known to sometimes attract migrating birds. These conditions do not exist for the cooling tower. While some birds may be lost as a result of the cooling tower, the number of birds killed or injured annually due to collision is expected to be small.

M. PLANT ACCIDENTS (Interior, D-17)

A comment was made that releases to water should be considered. The doses calculated as consequences of the postulated accidents are based on airborne transport of radioactive materials resulting in both a direct and an inhalation dose. In this Statement on page VI-6 it was stated that our evaluation of the accident doses assumes that the Applicant's environmental monitoring program and appropriate additional monitoring (which could be initiated subsequent to an incident detected by in-plant monitoring) would detect the presence of radioactivity in the environment in a timely manner such that remedial action could be taken if necessary to limit exposure from other potential pathways to man.

Interior states that Class 9 accidents should be described and the environmental impact discussed. Because the current AEC position is as stated in the accident assessment writeup in Section VI (that in view of the low probability of the accident the environmental risk is extremely small) no specific response to this Interior comment is included in the Final Environmental Statement.

N. ALTERNATIVE COOLING WATER (Interior, D-18)

It was suggested that consideration be given to use of fresh water make-up from the fire pond to reduce salt drift from the cooling tower. The flow from Oyster Creek to the fire pond is not sufficient to provide cooling tower make up requirements (25 CFS compared to 80 CFS required). Furthermore, the Applicant states that this water contains cedar bark leachings which make it unacceptable for use as make-up because of an extreme frothing problem.

O. TRANSMISSION LINE - RAILROAD COMMUNICATION AND SIGNAL ELECTRICAL INTERACTION (DOT, D-19)

The problem of inductive coupling, direct faulting or flashover with railroad signal and communications circuits has been considered but does not apply in this case since the proposed 500 KV transmission lines will not be using any existing railroad right-of-way.

P. DOSE ASSESSMENT AT BOUNDARY (EPA, D-29)

There was a comment that during short-term releases meteorological conditions may exist which may be confined to a few geographical sectors rather than distributed in all directions. It has been determined by the Staff that annual average releases and intermittent releases (with considerations of probability and time of

exposure) yield essentially the same dose and no special requirements for gaseous releases with regard to meteorological conditions will be necessary.

Q. DIRECT RADIATION (EPA, D-30)

A comment was made that direct radiation may contribute significantly to site boundary exposures. The direct radiation dose to an individual located at the site boundary line is estimated to be negligible. The gas-decay and liquid holdup tanks containing radioactivity from the reactor primary coolant are located deep inside the auxiliary building and thus well shielded with many feet of concrete. For example, if one of the gas-decay tanks were holding the activity from a complete degassing of the coolant, the dose rate to an individual standing at a location 0.5 mile (about minimum distance to site boundary) from a non-shielded tank holding this activity would be 0.02 mrem/hr. The shielding ($\geq$ 10' ordinary concrete) would reduce this value by a factor of 10^{-12} for an actual tank inside the auxiliary building.

R. THERMAL EFFECTS (EPA, D-34)

The EPA comments do not really relate to the impact of the Forked River Nuclear Station Unit 1, but rather stress the lack of thermal data in the Draft Environmental Statement from the operation of the Oyster Creek Nuclear Station. Further, EPA requested the Staff to review their data.

Upon review of the EPA data by the Staff and EPA in January 1973, it was mutually agreed that the data were not useful for thermal plume evaluation. Much of the data were taken before the Oyster Creek Station became operational and at intermittent time periods.

The Staff's evaluation indicates that the thermal discharge from Forked River Station will make an incremental addition of 0.3°F to the 18-23°F temperature rise resulting from the operational Oyster Creek Station. Thus, no measurable change in aquatic life is expected to result from operation of the Forked River Station. Since the major aquatic impact from thermal discharge is due to the Oyster Creek Station, this subject will be appropriately evaluated in the environmental statement for the Oyster Creek Nuclear Station.

S. CHEMICAL WASTE (EPA, D-36)

Dissolved oxygen levels reported by Loveland et al.[4] indicate that no serious depletion of oxygen is occurring because of the Oyster Creek

Plant. They found that the decrease between the intake and outfall averaged 1.19 mg for a period from June until December. At no time did their reported values fall below a minimum of 5 mg/l.

The small volume of water being added by the Forked River Station (approximately 1/20 of the Oyster Creek low flow value) will cause no significant decrease of the dissolved oxygen level by itself or in combination with the Oyster Creek Plant.

The Applicant plans to modify the method of chlorine injection into the circulating water system to reduce the amount of residual chlorine in the blowdown. Chlorine injection will be employed every eight hours for fifteen minute durations. The rate of chlorine injected will be controlled so as not to exceed suggested limits for residual chlorine in the receiving water. The suggested limits for residual chlorine on an intermittent basis are (1) 0.1 mg/l not to exceed 30 minutes per day and (2) 0.05 mg/l not to exceed 2 hours per day. The toxicities of the principal components of residual chlorine (free chlorine, monochloramine, and dichloramine) are not sufficiently different to preclude the use of residual chlorine as a control measure.[5,6]

The Applicant will monitor[15] dissolved oxygen (DO), residual chlorine, and ammonia in addition to those constituents being monitored as required by the EPA discharge permit. The Staff's opinion is that any additional monitoring to assess biological effects of thermal discharges should be related to operation of the nearby Oyster Creek plant. Thermal discharges from the Forked River Plant will be a small fraction (1/14) of those from the Oyster Creek Plant.

T. ENTRAINMENT AND IMPINGEMENT (EPA, D-38)

As indicated previously, the incremental impact from the Forked River Station will not result in a measurable change in aquatic life due to discharges to the canal. It is the opinion of the Staff that if any significant adverse effects on the aquatic biota occur, these will be due to the operation of the Oyster Creek Station. Therefore, evaluation and any necessary corrective measures will be considered in the environmental statement for the Oyster Creek Station.

U. AIR QUALITY EFFECTS (EPA, D-41)

1. Auxiliary Boilers

An auxiliary boiler (42,000 lb/hr saturated steam @ 100 psig) and two 5400 BHP, emergency diesel electric generating units will be

used intermittently. The estimated quantities of combustion products emitted from those sources are tabulated. Fuel for all three units will be No. 2 Fuel Oil having 19,550 Btu/lb and containing 0.3% sulfur, 0.6% oxygen plus nitrogen, 12.7% hydrogen, and 86.4% carbon.

ESTIMATED COMBUSTION PRODUCTS EMISSION FROM AUXILIARY BOILER AND DIESEL ELECTRIC GENERATING UNITS[7,8]

	Emissions	
Pollutant	Auxiliary Boiler* lbs/1000 gal fuel	Diesel Units** lbs/1000 gal fuel
Particulate	15	25
Sulfur Oxides (SO_x or SO_2)	43	39
Carbon Monoxide	0.2	70
Hydrocarbons	3	50
Nitrogen Oxides	40-80	75
Aldehydes	2	4

*Estimated annual fuel use rate is 500,000 gallons
**Estimated annual fuel use rate is 20,400 gallons

Annual SO_2 and NO_x boiler emissions appear to be within EPA standards which are not strictly applicable due to the small size of the auxiliary boiler. No standards have been established for diesel unit emissions. The selection of fuel oil with 0.3% sulphur complies with New Jersey limits.

2. Concrete Batching Plant

The Applicant states[7] that contracts for production and delivery of concrete, including the concrete batch plant, will require that:

> "In the execution of the work the contractor and his lower tier contractors shall comply with all prevailing and applicable laws and ordinances of the United States, and of the State, County, and Municipality wherein the project is located."

and

> "When work of any kind creates harmful dust or fumes, equipment for the complete protection of all personnel and property against dust and fumes shall be installed, maintained and effectively operated by the contractor as required by law."

The Applicant further states that the measures to control particulate emissions from the concrete plant can include:

1. Enclosed cement storage and transfer system.
2. Dust collector system on cement batcher.
3. Use of covered conveyors for fine and coarse aggregate.
4. Enclosure for weather protection of open areas of plant to control effect of wind.

The Applicant further states that prior to award of the contract for this work, the specific measures planned by the Contractor for meeting the State Emissions Standards will be discussed.

3. Ozone Production from Transmission Lines

Recent studies[9,10] have been carried out which show that no measurable amounts of ozone (less than 2 ppb) are formed due to the presence and operation of transmission lines carrying up to 765 kV. No adverse effect on vegetation or animals occurred even during foul weather when the heaviest corona loss occurs. High voltage lines for the station will carry a maximum of 500 kV; therefore, no significant adverse effects are expected as a result of ozone formation. The National Primary Air Quality Standard for photochemical oxidants, as issued by the Environmental Protection Agency, is 80 ppb (by volume) maximum arithmetic mean for a 1-hour concentration not to be exceeded more than once per year.

4. X/Q Estimates

The nearby site data for Atlantic City, New Jersey, was used to determine the average annual X/Q of 1×10^{-5} sec/m^3 at the site boundary.

V. COST BENEFIT (EPA, D-42)

A comment was made that an average annual plant load factor of 80% may not be realistic and could affect the economics of this plant. While it may be true that load factors tend to be low for the first years of plant startup and for later years near the end of the plant life, the Applicant has provided data and curves in the Environmental Report (p.6-26,27) to show that, for plant load factors as low as 52%, the comparative cost of producing electrical power by nuclear means will be less than for fossil fuel plants. Further, experience with operating plants indicate a plant load factor of as high as 78% during much of the plant life.

W. RADIOACTIVE WASTE RELEASES (EPA, D-26, D-27, D-28)

Several comments were made regarding release of radioactive discharges from steam generator blowdown system, low activity and laundry wastes, and radioactive iodine released in gaseous effluents.

Calculations were performed to determine the annual release from the turbine building drains, utilizing our standard assumptions. The release from this source was calculated to be 0.03 curie per year exclusive of tritium, and therefore considered to be negligible.

Calculations were performed to determine the annual release from the laundry and other wastes that normally have an activity lower than 10^{-5} µCi/cc. The release from this source was estimated to be 0.05 curie per year exclusive of tritium, and therefore considered to be negligible. Figure III-5 of the Draft Environmental Statement shows the regular flowpaths of the liquid radwaste system. Steam generator blowdown is done infrequently since the secondary water is purified by condensate demineralizers. The turbine building drains are not presently connected to the radwaste system. Therefore, neither of these pathways are shown in Figure III-5.

Calculations were performed regarding the iodine releases from the condenser air ejector, the blowdown flash tank, and the auxiliary building ventilation system. The calculated annual emissions of I-131 are contained in Table III-3 of this statement, and are as follows: condenser air ejector 0.008 curie, blowdown vent 0.001 curie, auxiliary building 0.072 curie. Considering the absence of potential pastures in the vicinity of the site, these emissions are not significant and further treatment does not appear to be necessary. The contents of the gas collection header are routed to the gas decay tanks where they are stored for a minimum of 45 days, at the end of

which the iodine activity in the discharged waste gas will be insignificant. The turbine building vent will result in an estimated release of less than 0.05 curie per year, which again is insignificant for this plant.

X. UNDETECTED RADIOACTIVITY RELEASES (EPA, D-43)

The main release points are equipped with automatic shutoff valves. The amounts released between the time the monitor alarms and the discharges are terminated, averaged over the 40 year life of the plant, will be negligible.

Y. DOSE FROM MATERIAL ON SPOIL BANKS AND RESUSPENSION IN BAY AREA (EPA, D-43)

The dose from material deposited on the spoil banks would be much smaller than the shoreline dose estimated in the Draft Environmental Statement, Page V-23. That is because the material will be mixed up during the dredging transfer from the canal bottom to the banks, thus greatly reducing the surface concentration of the contributing radionuclides Cs-134 and Cs-137. However, the use of this material in future construction, such as fill for housing developments or concrete for basements (walls and floors), should be prohibited unless rigorously monitored.

Resuspension of the material during dredging would add only a fraction of a percent to the water concentration and thus not appreciably increase the swimming or boating dose or the ingestion dose from fish and other seafood.

Z. VARIATION IN SHELL FISH CATCH (NJ, D-55)

The Applicant contacted Mr. Eugene A. LoVerde of the National Marine Fisheries in Toms River, New Jersey, who compiled the data presented in Table II-13 of the AEC's Draft Environmental Statement. It should be noted that the Oyster Creek Station did not start commercial operation until December 23, 1969. Mr. LoVerde indicated that the decline in hard clams catch was due to an outbreak of hepatitis in humans that was either justly or unjustly attributed to these clams. The hard crab catch declined because it was more profitable at that time for the commercial fisheries to catch the bay scallop. The latter declined because of the degradation of the water quality in Barnegat Bay. Oysters and soft clams may not be harvested in many parts of Barnegat Bay because of the sewerage pollution along the shoreline.[11]

AA. MASS SALT RATE EMISSION FROM COOLING TOWER (N.J., D-55)

A comment was made with regard to the mass salt-emission rate per unit of time from the tower, the effect of spread between wet and dry bulb temperature on the emission rate and the method used in arriving at these values.

In Appendix B, Attachment 5, to the Applicant's Environmental Report, the estimated salt emission rate for the Forked River tower of 3.1 kg/min was stated, based upon a .00375% mass drift rate and a 45,000 ppm tower basin salinity. The reported environmental evaluation by the Applicant and the Staff was based upon these values.

The Applicant recently reported that further evaluation work completed since the initial publication of the Environmental Report indicates that a more realistic, but still conservative estimate of average salt discharge is 1.02 KG/min based upon a 0.002% drift rate, 34,500 ppm basin salinity, and a plant availability factor of 0.80.

To establish the percentage drift rates used in the above calculations, the Applicant made drift measurements in operating natural draft cooling towers at GPU's Homer City Station. The principal measurement technique employed was the isokinetic heated glass bead sampler, essentially that as described in Appendix B, Attachment 5, to the Environmental Report.[12] In a sampling program which included 81 measurement runs of about two hours duration each, over a variety of meteorological conditions, the average measured drift rate was 0.0012%. The Applicant reports that on the basis of these measurements, drift measurements made by others, and information from several cooling tower manufacturers with regard to guaranteed drift elimination efficiency, a mass drift rate of 0.002% is considered a reasonable, but conservative, value for the Forked River tower. Predicted salt emission rates for this tower can be calculated by applying percentage drift rates to Forked River conditions of circulating water flow rate and salinity.

An analysis by the Applicant of the experimental results from Homer City indicates that drift eliminator performance is relatively insensitive, (i.e., variation by less than a factor of 2) to the spread between wet bulb and dry bulb temperatures. In general, there appears to be a trend toward slightly improved eliminator performance (lower mass drift rates) with higher relative humidities (decreased spread between wet and dry bulb temperatures). The Applicant reports that further work in this area is continuing.

BB. LONG-TERM EFFECTS DUE TO SALT SPRAY DEPOSITION (N.J., D-55)

The question of possible long-term salt spray effects are discussed in Appendix B, Attachment 5 of the Environmental Report. More specifically, the effects on vegetation and animals are covered in studies sponsored by the Applicant.[13,14] The principal conclusion from observations by the Staff is that there is no detectable adverse effect from natural airborne salt on the Applicant's property even though the ambient salt air concentrations were found to average 100% greater at the western edge of the property (inland) as compared to the eastern property line (seaward). A 10% incremental increase from cooling tower operation is not likely to adversely affect existing plant and animal communities. The applicant is continuing, through Rutgers University, to develop greater understanding of the effects of salt concentration in air on the vegetation indigenous to the Forked River environs.

CC. PLANT EFFICIENCY WITH COOLING TOWERS (N.J., D-56)

Compared to once through cooling with ocean discharge, the cooling tower would be 0.3% more efficient. Compared to once through cooling with bay discharge, the cooling tower would be 1.5% less efficient. Ambient air and average bay seasonal data were used in the comparison. Fuel consumption and fission product inventory would be similarly comparable.

DD. COOLING TOWER ANALYSIS (N.J., D-56)

With regard to a comment on whether the Staff conducted a complete review of the Applicant's analysis of cooling tower design and operation, it must be emphasized that since the Staff does not disagree with the basic method of analysis the Staff did not consider it necessary to duplicate the Applicant's analysis. Rather, the Staff review was directed toward verifying the basic assumptions and methods and making numerical checks rather than completely duplicating all details of the analysis. The Staff reviewed the Applicant's data including the climatology, the methods for obtaining ambient salt concentrations, and the method of drift measurements employed. With those data the Staff independently developed a computer program to determine the trajectory of the rising vapor plume axis. The fall velocities of the droplets were determined as a function droplet size which was allowed to change during fall according to the droplet evaporation rate. Evaporation was programmed as a function of humidity, salt concentration, air temperature, and fall velocity, particle radius and van't Hoff factor. The rise of the vapor plume axis was programmed according to Briggs, utilizing the total buoyancy of the condensed plume. Plume rise was limited by the mean maximum mixing height. The effects of changes in temperature, pressure, and wind speed with height were evaluated with the result that only the latter sufficiently influence the result to warrant continued inclusion in the computer program.

Calculations were performed for the month of June conditions which have the highest onshore direction persistence in one sector. The results obtained were consistent with those reported by the Applicant.

The Staff also used the method described by Hosler[14] and obtained results consistent with those obtained by the Staff's method and by the Applicant. The document by Hosler provides a simple graphical technique which can be employed by anyone wishing to make an independent analysis. The method results in a very conservative estimate, however, as it does not account for the effect of turbulent diffusion.

Since the receipt of the Applicant's proposal to erect and use a salt water cooling tower, the Staff has reviewed a number of ongoing programs which are directed toward verifying a drift projection of 0.002% now suggested by the Applicant. The original computation of drift in the ER was based on 0.00375% drift derived from incomplete analyses programs which were underway at the time of issue. All of this work is based on measurements of fresh water towers such as Homer City. Commentary by the Applicant regarding the insensitivity of eliminator performance to humidity variations is in keeping with generic knowledge of air handling systems available.

However, over the long term, a number of unanswered questions involving the integrity of eliminator systems and the extent to which maintenance will be necessary to assure continued integrity remain to be resolved. On balance, the Staff believes that before an unqualified endorsement of salt water cooling towers can be made, a prototypical testing program using salt water is needed to verify the sensitivity and reliability of eliminator systems to long-term exposure to salt environments and to establish the degree of maintenance integrity needed to assure long term achievement of drift rates lower than 0.00375%.

EE. THERMAL RISE IN DISCHARGE CANAL (N.J., D-56)

The Staff review of the average rise of temperature in the Oyster Creek discharge canal attributable to Forked River blowdown supports the estimate of the Applicant that under all conditions, the thermal increment or decrement would be less than 1°F. The Applicant's computations in response to this comment were performed using winter conditions.[7] The Staff made the same computation using worst case summer conditions. Coincident wet bulb temperatures of 72°F might be expected. Using the Applicant's design estimate of 23° approach, a 95° blowdown temperature would be expected. Therefore, using the same flow ratios, a thermal increment of less than 0.3°F

would be attributable to the Forked River blowdown. Further, under more normal conditions, the blowdown can be expected to be cooler than the Oyster Creek discharge temperature and the blowdown will serve to reduce Oyster Creek canal temperatures by as much as 0.4°F.

FF. POWER REPLACEMENT COST (N.J., D-56)

The Applicant's response to a comment by New Jersey to clarify the meaning of power replacement cost is as follows:[7]

(References are made to four places in the Applicant's Environmental Report.)

1. Table 6-3 and Figure 6-2 (pp. 6-26 and 6-27 of Alternatives Section [Revised April 18, 1972]). In this context the oil base load and the combined cycle generating units are considered as potential complete substitutes for the Forked River Plant. The cost of electrical output from each is compared with Forked River on a levelized basis over the assumed 30-year service life. It is also assumed, in the table and figure, that fuel is at the cost level projected for the first year of operation, namely 1978, and does not rise thereafter. However, in the text on page 6-25 (Revised April 18, 1972), the additional advantage of Forked River if upward fuel price trends continue is stated. This amount is likewise presented on a levelized basis over the assumed service life of the plant.

2. Page 6-31 (Revised April 18, 1972) of Alternatives Section. In this context, it is considered that replacement power during a one-year delay in starting and completing Forked River is supplied by purchasing energy from other GPU and PJM companies and meeting associated installed capacity charges. There is no assurance that such generation would be available; the assumed availability simply provides a convenient yardstick for measuring the reasonable costs of such replacement. The replacement costs are the projected out-of-pocket costs for 1978 alone and are not levelized. Since the assumed delay would affect the starting date of construction of Forked River, the net cost of $23,000,000 for replacement power reflects one full year's saving in fixed charges on the plant investment during the delay interval and has been estimated as follows:

Estimated Cost of Replacement Power less Nuclear Fuel and Maintenance Savings

8011×10^6 KWH @8.85 mils per KWH	= $71,000,000
One year savings in fixed charges	= $48,000,000
Net	$23,000,000

In this estimate, it was assumed there would be no escalation in the present PJM installed capacity charge rate. However, in the estimates referred to in the answers to Question 3 and 4 following, which were made at a somewhat later date, the probability of escalation was recognized even though there is no fixed plan to do so. Added costs amount to roughly $4,000,000 annually and would increase the $71,000,000 above to $75,000,000 per year.

3. Page 2-1 of Additional Information Section - Question 2 (April 18, 1972). In this context, which contemplates a delay in start-up of Forked River (but not its construction), it is considered that replacement power would be obtained during the delay by purchase of interchange energy and operating capacity from GPU and PJM sources. Since the delay is assumed to be of limited duration, the projected costs are at the level expected to prevail in the year specified. Costs which are given consist almost wholly of fuel cost to generate electricity replacing the Forked River output. Under the PJM agreement there would probably also be a requirement for an installed capacity payment. It is for this reason that an upward modification of replacement cost is treated at the bottom of page 2-1 and the top of page 2-2. This modified cost is on a 30-year levelized basis.

4. Page 6-6 of Alternatives Section.
   In this context also, the replacement cost of $200,000 per day contemplates a delay in start-up of Forked River of limited duration. The cost represents the purchase of equivalent energy and operating capacity again comprised almost wholly of fuel cost, in temporary substitution for Forked River output. It is given in terms of actual out-of-pocket expense during the delay interval. Charges for equivalent installed capacity were not included in this figure but may be incurred. The $200,000 per day is approximately equal to 1/365th of the annual cost of delay shown in the response to Question 2, referenced above, to be $75,000,000 per year.

APPENDIX A

REFERENCES

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References for Section IV

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APPENDIX B
ABBREVIATIONS

AEC	Atomic Energy Commission
ASLB	Atomic Safety and Licensing Board
ATP	adnosine triphosphate
Ba	Barium
Btu	British thermal units
Ce	Cerium
cfs	cubic feet per second
Ci	Curie
Co	Cobalt
Cs	Cesium
DO	dissolved oxygen
DOT	Department of Transportation
Fe	Iron
FPC	Federal Power Commission Florida Power Corporation
fps	feet per second
ft	feet
gal	gallon
gm	gram
gpm	gallons per minute
HEPA	High efficiency particulate air
hr	hour

I	Iodine
K	Potassium
kg	kilogram
kW	kilowatt
l	liter
lb	pounds
m	meters
mg	milligram
min	minute
mm	millimeter
Mn	Manganese
mph	miles per hour
mrad	millirad
mrem	millirem
MW	megawatt
MWe	megawatt electric
MWt	megawatt thermal
NEPA	National Environmental Policy Act of 1969
P	Phosphorous
pCi	picocurie
ppm	parts per million
ppt	parts per thousand
PSA	Power service area
PWR	Pressurized water reactor
Ru	Ruthenium
sec	second
spp	species
Sr	Strontium
U	Uranium
UET	Upper exclusion temperature
yr	year
Zn	Zinc
Zr	Zirconium
°C	degrees Centigrade
°F	degrees Fahrenheit
°/oo	parts per thousand
ΔT	difference in temperature

APPENDIX C
GLOSSARY OF TERMS

In discussing the environmental effects of construction and operation of nuclear power plants and fuel reprocessing facilities, it is necesary to use words and phrases that may be unfamiliar. The following glossary lists and defines a number of the more frequently used terms that appear in environmental reports and statements.

algae	chlorophyll-bearing plants, predominantly aquatic. Sizes vary from unicells (30-millionths of an inch in diameter) to seaweeds (up to a few hundred feet in length).
benthic	referring to life on the bottom of a body of water. [the noun *benthos* refers to organisms attached to or crawling on the bottom.]
biota	the plants and animals (flora and fauna) of a region
copepod	a small (about 0.05 in. long) crustacean, a common member of the *zooplankton*
crustacean	an animal having a hard but flexible exoskeleton
diatoms	unicellular greenish-brown plants with a siliceous covering (*exoskeleton*); often forming unicellular chains
dissolved oxygen (D.O.)	concentration of oxygen in water, usually expressed in milligrams per liter (mg/l) or parts per million (ppm).
eutrophication	the process whereby water bodies undergo an increase in available plant nutrients (notably phosphates and nitrates) resulting in an increase in biological productivity in the water.
larva	an embryo that becomes self-sustaining and independent before it has assumed the characteristic features of its parents
littoral	growing or living near the shore

macrophyte	large plant
phytoplankton	planktonic plants [see *diatoms, plankton*]
plankton	passively floating or weakly swimming aquatic organisms, incapable of regulating their mobility. Consists of both plants (*phytoplankton*) and animals (*zooplankton*)
residual chlorine	chlorine (in several forms) that is available to react after the chlorine demand is satisfied; free chlorine is the chlorine gas component of the residual chlorine
rheotaxis	term referring to the movement of an organism in response to a stimulus
salinity	parts per thousand by weight of the dried solid residues obtained from water when all organic matter has been oxidized, all bromides and iodides replaced by chlorides, and all carbonates converted to oxides: usually expressed in grams/kilogram or parts per thousand (ppt or °/oo)
trophic	pertaining to, or connected with, nutrition or feeding
upper avoidence break-down temperature	a temperature which when encountered for a short period will cause a loss of the organisms' locomotor control and thus a loss of the organisms' ability to escape
upper avoidance temperature	represents the maximum summer temperature at which an organism is found
zooplankton	minute planktonic animals that feed on *phytoplankton* and, in turn, form food for young fish

APPENDIX D

COMMENTS RECEIVED ON THE DRAFT ENVIRONMENTAL STATEMENT

D-1 50-363

ADVISORY COUNCIL
ON
HISTORIC PRESERVATION
WASHINGTON, D.C. 20240

November 28, 1972

Mr. Daniel R. Muller
Assistant Director for Environmental
Projects
Directorate of Licensing
Atomic Energy Commission
Washington, D. C. 20545

Dear Mr. Muller:

In response to your request of October 13, 1972 for comments on the following environmental statement for Forked River Nuclear Station Unit #1, and pursuant to its responsibilities under Section 102(2)(c) of the National Environmental Policy Act of 1969, the Advisory Council on Historic Preservation has determined that your draft environmental statement appears procedurally adequate, however to insure as comprehensive a review of historical, cultural, archeological, and architectural resources as possible, the Advisory Council suggests that the draft environmental statement contain evidence of contact with the State Historic Preservation Officer and that a copy of his comments concerning the effect of the undertaking upon these resources be included in the environmental statement. The State Liaison Officer for Historic Preservation for New Jersey is Mr. Richard J. Sullivan, Commissioner, Department of Environmental Protection, Post Office Box 1420, Trenton, New Jersey 08625.

In order to expedite our review of the draft environmental statement, please furnish the Advisory Council with the necessary information at your earliest convenience. Should you have any questions on these comments or require any additional assistance, please contact Mr. Jordan Tannenbaum of the Advisory Council staff.

Sincerely yours,

Robert R. Garvey, Jr
Executive Secretary

2/3

DEPARTMENT OF AGRICULTURE
OFFICE OF THE SECRETARY
WASHINGTON, D. C. 20250

50-363

RECEIVED
NOV 30 1972
U.S. ATOMIC ENERGY COMMISSION
Regulatory Mail Section

November 29, 1972

Mr. Daniel R. Muller
Assistant Director for
Environmental Projects
Directorate of Licensing
Atomic Energy Commission
Washington, D. C. 20545

Dear Mr. Muller:

We have had the draft environmental impact statement for the Forked River Nuclear Generating Unit 1, Jersey Central Power and Light Company, reviewed in the relevant agencies of the Department of Agriculture. Comments from the Soil Conservation Service, the Forest Service, and the Economic Research Service, all agencies of the Department, are enclosed.

Sincerely,

T. H. Bchirley

for T. C. BYERLY
Coordinator, Environmental
Quality Activities

Enclosures

SOIL CONSERVATION SERVICE - USDA

Comments on

DRAFT ENVIRONMENTAL STATEMENT

Prepared by

Jersey Central Power and Light Company

Forked River Nuclear Station Unit 1

Docket No. 50-363

Some information is presented in the statements indicating a few erosion control practices will be used during construction. Consideration should be given to making this part a little plainer and more comprehensive. For example, no mention is made concerning the length of time the soil will be left in an exposed condition and susceptible to erosion. This applies for the landfill area which will receive 40,000 cubic yards of dredged silt. Recovery by natural methods may take too long especially on the dike slopes.

The draft statement by the Directorate of Licensing AEC indicates more erosion practices will be used than in the original statement. It is difficult to access what will really happen. Perhaps a statement indicating that the Standards and Specifications for erosion control adopted by the Ocean County Soil Conservation District will be adhered to during construction. Technical assistance is available from the District to assist in planning the needed erosion control measures.

ERS Comments on Draft Environmental Statement, Forked River Nuclear Generating Station Unit No. 1, Jersey Central Power & Light Company

1. The Applicant does not accept the curtailment of service as a viable alternative to construction of the Station (p. X-2). This does not appear to be compatible with NEPA Guidelines for environmental impact statements which require consideration of alternatives to the proposed action. Recent interpretation of section 102 (2) (c) of NEPA held, in essence, that the range of alternatives required were those "reasonably available". None were to be ruled out "merely because they do not offer a complete solution to the problem". NRDC V. Morton (D.C. Cir. 1972).

   The production of electric energy, regardless of the techniques used, consumes natural resources and results in environmental change. We feel the Statement should discuss measures that the Applicant and the regional power network of which it is a member, have under consideration to encourage consumers to conserve electric energy. This might include measures such as the reduction of demands for costly peak power through special metering, implementation of rate structures designed to promote more efficient consumption, and the revision of present utility promotional efforts.

   In light of the above, we also feel that the Applicant's discussion of "The Need for Power" would be more compatible with the intent of the NEPA Guidelines if it was placed in the chapter "Alternatives to Proposed Action...".

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
WO

Re: Forked River Nuclear Station, Unit 1
Jersey Central Power & Light Co.

The statement indicates that impact to woodland as a result of plant construction would occur from the clearing of 100 acres for the plant site. Impact to forest land would also occur as a result of clearings for transmission lines. The statement indicates that proposed transmission line rights-of-way would extend over 98 miles, and although it provides information on measures to be carried out to minimize adverse effects, the statement does not indicate how much forest land would be cleared. The statement should provide an estimate of the amount of forest land that would be lost to transmission line corridors. It would also be stregthened if the impact to forest land were made more specific by indicating that the loss of forest land not only involves loss of wildlife habitat but also includes loss of a wood inventory and annual growth, a reduction in esthetic values, less soil stability, and loss of woodland related outdoor recreation areas. Also herbicide treatment used in maintaining transmission line clearings can cause wildlife habitat losses and the possibility of local water contamination.

In regards to cost-benefit analyses, we believe the studies have overlooked some of the above forest resource values. The only cost we find associated with forest land in the analyses is the real estate cost of forest land.

D-6

THE ASSISTANT SECRETARY OF COMMERCE
Washington, D.C. 20230

50-363

November 29, 1972

Mr. Daniel R. Muller
Assistant Director for Environmental
Projects
Directorate of Licensing
United States Atomic Energy Commission
Washington, D. C. 20545

Dear Mr. Muller:

The draft environmental impact statement for "Forked River Nuclear Generating Unit 1" which accompanied your letter of October 13, 1972, has been received by the Department of Commerce for review and comment.

The Department of Commerce has reviewed the draft environmental statement and has the following comments to offer for your consideration.

The discussions relating to water quality and bottom sediments in the South Branch Forked River and Oyster Creek could be clarified. On page II-22, the conditions in Oyster Creek are described as being incapable of supporting benthic organisms during the summer months. On Pages II-35 and II-38, however, the presence of freshwater and mixed fauna downstream from the head of navigation to a point near the mouth is noted. This is then followed by the observation that anaerobic conditions prevail upstream from the mouth throughout the summer, but that conditions are altered in September (apparently for the better and apparently until the following summer). A more detailed and precise explanation of water quality and benthic conditions during various seasons or segments of the year would improve this section of the statement.

We fail to note any explanation as to the reasons for poor water quality and degraded bottom sediments in the two streams being affected by the project. Inasmuch as Oyster Creek is downstream of the presently operating station and South Branch Forked River is upstream, it might be assumed that the more degraded condition of Oyster Creek has resulted from operations at that station. Perhaps this point should be explored.

The value of commercial fishing in the area of Barnegat Bay is discussed for finfish and shellfish (Pages II-30 and II-35). A comparable evaluation for sport fishing, if available, would make a substantial contribution to the statement.

Figure III-4 shows the proposed integration of the Forked River Station operational system with that of the Oyster Creek Station. The sketch excellently depicts the Forked River Station water supply and discharge systems but totally neglects the Oyster Creek Station systems. It would seem desirable to include some details of the existing unit in the figure.

The first paragraph on Page V-21 appears to be in part rationalization. Although the greatest amount of organic matter entering Barnegat Bay may indeed come from sources other than the existing or proposed units, and although there may be evidence that the bay is already eutrophic, this is not germane to the question of what additional damage, if any, will accrue to the environment as a result of the proposed construction and operation of Forked River Nuclear Station Unit 1.

A condensed account of the radioactive wastes and environmental monitoring program is given (Page V-28). Reference is made to the Forked River Station Environmental Report which contains the detailed program. In our opinion, it would be desirable to include more of these details in the Environmental Impact Statement itself, rather than depending on the reader having access to the Environmental Report.

As stated in our letter of July 14, 1972, to the Deputy Director for Technical Review of the AEC Directorate of Licensing, we have serious doubts as to the validity of the onsite temperature and wind data measured at the 75-ft height. We are concerned that there may be instrumental problems which go back as far as 1967-68 and would affect the data in table II-4 of the AEC statement. Two recent site visits by NOAA meteorologists under contract to EPA pointed out that the temperature sensor at the 75-ft level evidently reads 3 degrees F. high, the anemoneter at the 30-ft level required about a 10 mph wind to start the cups to turn, and the orientation of the wind direction sensor at the 75-ft level was consistently 30 to 40 degrees counterclockwise of the wind systems at the levels above and below the 75-ft level. Although the data in table II-4 present a frequency distribution

of the standard deviation of the horizontal wind direction as a function of wind speed, we do not believe these data can be used to categorize vertical diffusion during inversion conditions and horizontal diffusion during calm or very low wind speed conditions when the direction vane is not responding to wind direction fluctuations.

In summary we are unable to evaluate the relative concentrations computed by the staff and listed on page V-24 by using the onsite meteorological data for 1967 and 1968. However, judging from the general location of the site on the mid-Atlantic coastal plain, we feel that there should be no unusual aspects to the diffusion climatology of the area and that the maximum average annual concentration at the site boundary for a ground source is about 1×10^{-5} sec/m^3 as stated.

We hope these comments will be of assistance to you in the preparation of the final statement.

Sincerely,

Sidney R. Galler

Sidney R. Galler
Deputy Assistant Secretary
for Environmental Affairs

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
CAMDEN AREA OFFICE
THE PARKADE BUILDING, 519 FEDERAL STREET, CAMDEN, NEW JERSEY 08103

REGION II
26 Federal Plaza
New York, New York 10007

December 6, 1972

DEC 1 1972

IN REPLY REFER TO:
2.3PM(Perlstein)

RE: Docket No. 50-363

Mr. Daniel R. Muller
Assistant Director
for Environmental Projects
United States Atomic Energy Commission
Washington, D.C. 20545

Dear Mr. Muller:

This is in response to your letter requesting our review and comment on the draft environmental impact documentation submitted for the Forked River Nuclear Station, Unit I, proposed in Forked River, New Jersey.

We have examined the Environmental Report and our comments are as follows:

1. The subject report states that there will be no increase in acoustical noise levels outside the plant above those in the present environment. It further states that when the plant becomes operational, acoustical noise surveys will be performed to assure that employee exposure and off-site levels are within State and Federal guidelines. Since the report does not indicate the standards that were applied to assess the present acoustical noise levels outside the plant we recommend that a survey be made of the acoustical noise levels in the present environment, for comparison with the survey proposed in the future when the plant becomes operational.

2. It is not clear from the report whether or not the subject proposal has been or is being coordinated with the appropriate A-95 Clearinghouses or with the local planning agencies. If this has not been done, the report should be submitted to the State and Regional Clearinghouses and the local planning agencies for review and comment.

Please feel free to contact us if you have further questions.

Sincerely yours,

Philip G. Sadler
Area Director

Attachment
Memo of Comment

HUD-96 (4-72) PREVIOUS EDITION MAY B ED

Memorandum

D-11

U.S. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT

TO : Philip G. Sadler
Area Director

THROUGH: Richard N. Fishbough

DATE: December 6, 1972

IN REPLY REFER TO:
2.3PM(Perlstein)

FROM : Michael Perlstein
Operations Division

SUBJECT: Environmental Report
U. S. Atomic Energy Commission
Forked River Nuclear Station, Unit I
Forked River, New Jersey

1. Brief Summary of the Proposal

The proposed Forked River Nuclear Generating Station, Unit I, will share the site currently occupied by the Oyster Creek Nuclear Generating Station. Total site acreage of 1,416 acres is owned by Jersey Central Power and Light Company. More than 95% of the site is in Lacey Township, with the remainder in Ocean Township, all in Ocean County.

The proposed Generating Station, Unit I, will include a single pressurized water reactor with an expected thermal output of 3,410 megawatts. The reactor will transfer its heat to the completely enclosed reactor coolant system which will employ this heat to produce steam in two large heat exchangers (the steam generators). A conventional turbine generator will be driven by this steam to produce approximately 1,140 megawatts of electric power.

2. HUD Comment

The subject Environmental Report submitted by the U. S. Atomic Energy Commission has been reviewed by various members of our Area Office staff. A general assessment of the adequacy of the Report in treating issues important to HUD has been made and our comments are as follows:

a. The subject Report states that there will be no increase in acoustical noise levels outside the plant above those in the present environment. It further states that when the plant becomes operational, acoustical noise surveys will be performed to assure that employee exposure and off-site levels are within State and Federal guidelines. Since the Report does not indicate the standards that were applied to assess the present acoustical noise levels outside the plant we recommend that a survey be made of the acoustical noise levels in the present environment, for comparison with the survey proposed in the future when the plant becomes operational.

b. It is not clear from the Report whether or not the subject proposal has been or is being coordinated with the appropriate A-95 Clearinghouses or with the local planning agencies. If this has not been done, the Report should be submitted to the State and Regional Clearinghouses and the local planning agencies for review and comment.

3. HUD Reservations About The Proposal

None

4. Observation

A review of the RAMIS, dated October 31, 1972, indicates that except for the Robert J. Miller Air Park Open Space Project (NJ-OSA-214) there are no other assisted HUD projects in the vicinity of the proposed nuclear station.

I have reviewed Miss Jennings' memorandum and concur in her finding that the nuclear site should not have an adverse environmental impact on the HUD assisted Open Space Project.

Michael Perlstein
Program Manager

Attachments:
- Planning and Relocation Branch Review
- Operations Division Review
- Economic and Market Analysis Review
- Equal Opportunity Division Review
- Architectural and Engineering Section Review
- Single Family Operations Review

United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

ER-72/1200

DEC 15 1972

50-363

Dear Mr. Muller:

This is in response to your letter of October 13, 1972, requesting our comments on the Atomic Energy Commission's draft environmental statement, dated October 1972, on environmental considerations for Forked River Nuclear Station, Unit 1, Ocean County, New Jersey.

Our comments are presented according to the format of the statement or according to specific subjects.

Regional Demography and Land Use

We suggest that data from the 1969 Agricultural Census be used in the last paragraph on page II-7. These data are now available.

Historic Significance

We suggest that the State Liaison Officer for Historic Preservation be consulted concerning properties in the project area which may be under consideration for nomination to the National Register of Historic Places. He is the Commissioner, Department of Environmental Protection, P. O. Box 1420, Trenton, New Jersey 08625. His telephone number is A/C 609 - 292-2885.

Geology

The brief description of the geology of the site is inadequate for an independent assessment of the geologic environment relevant to the proposed construction of the plant. The data presented are inadequate concerning the physical properties of the geologic materials on which the plant and its appurtenant structures will be founded. There is also no indication of how a knowledge of the physical properties has been used in

the design of the facility. The seismic design criteria and the methods of the derivation are not mentioned. Comprehensive discussions of these factors are required for an adequate assessment.

The environmental statement does not reference the applicant's Preliminary Safety Analysis Report to AEC. This report and its supplements treat the details of geologic and seismologic investigations and analyses that have been performed for the Forked River Nuclear Station. We suggest that, as a minimum, a summary of the geologic and seismologic analysis sections of the Preliminary Safety Analysis Report be included in the final environmental statement with adequate cross-references to appropriate parts of the environmental statement to indicate how the data and analyses have been utilized for purposes of design and construction of the facility.

As a result of procedures previously established between the Geological Survey of this Department and the AEC, a comprehensive review of the geologic aspects of the site as presented in the Preliminary Safety Analysis Report was performed. This review was conducted in terms of the AEC "Seismic and Geologic Siting Criteria for Nuclear Power Plants" (10CFR100, proposed Appendix A). Comments were transmitted by the Geological Survey to the Director of Regulation on July 13, 1972; and the comments were made part of the public record in the AEC licensing procedures.

Hydrology

Two aquifers underlie the site, a shallow aquifer in the Cohansey Sand above a 10-foot thick clay and silt layer which confines a lower artesian aquifer in sands in the Kirkwood Formation. Page 3-37 of the applicant's report indicates that numerous privately owned wells are located in close proximity of the site. It does not appear that the ground water contamination potential due to leakage or inadvertent releases of radioactive liquids has adequately been considered. Safeguard or barrier wells which can be routinely monitored and pumped if emergency action is necessary should be considered.

The applicant's report states that no salt water intrusion will result from dewatering operations. We think that this conclusion and the expected lack of adverse effects on privately

owned wells should be verified by using well-test data. The results of this verification should be contained in the final environmental statement.

Terrestrial Ecology

This section, beginning on page II-17, should be expanded to include the effects on the terrestrial wildlife directly affected by plant construction and operation at the site. This section should also indicate that the wood turtle (status - rare) and the red-shouldered hawk (status - undetermined) should be included in the discussion on rare and endangered species. The red-shouldered hawk is listed in the Department of the Interior's Resource Publication 34. The red-shouldered hawk and the wood turtle are listed in the New Jersey State Museum Science Notes No. 4, "Rare or Endangered Fish and Wildlife of New Jersey."

The American brant should be added to the list of waterfowl on page II-21 reported to use the coastal marshes of Barnegat Bay.

The final statement should describe the vegetation of the area affected by the proposal. Since much of the area is wooded, some idea of the site quality should be given. The economic and ecological values of the areas could be indicated with the use of site indexes. We also suggest that the Northeast Forest Experiment Station of the Department of Agriculture at 6816 Market Street, Upper Darby, Pennsylvania, be contacted for more recent information on the New Jersey Pine-Barren area.

Freshwater Ecosystems

Eelgrass is mentioned in the fourth paragraph on page II-22. This paragraph should also indicate that this grass is abundant in the project vicinity and is an important component of the high-value waterfowl habitat in this area. Eelgrass is especially attractive to the American brant.

Impacts on Land, Water, and Human Resources

According to page IV-1, the area required for construction facilities will be reseeded or allowed to revert back to natural vegetation upon completion of construction activities. Since the resort industry is the major economic activity in the County, aesthetics is an important attribute of the area. Therefore, we suggest that the landfill area resulting from dredging 40,000 cubic yards from the canal will be reseeded immediately and not allowed to reseed through natural processes as indicated on page IV-2.

Controls to Reduce or Limit Construction Impacts

The use of a separate clarification pond for presettlement of construction drainage waters would appear to provide needed mitigation. We concur with the AEC that it should be used.

Land Use

The statement should indicate the existing land uses of the State-owned lands and sufficient data to assess the impacts of the change in use of the plant site area and the associated transmission lines.

We suggest that the restriction to agricultural use such as the maximum height of trees be given in this section on page V-1.

Federal and State easements should be described in the final environmental statement.

Biological Impact

The second paragraph on page V-10 should discuss the cooling tower and its plume as a possible source of harm to migrating birds. The large tower and plume will contribute to reduced visibility, not only near the cooling tower itself but also near other high structures in the vicinity of the project.

Dissolved Oxygen Demand and Toxic Chemicals

This section should include a discussion of the possibility of chloramine formation through the reaction of residual

chlorine and nitrogenous materials in the discharge water. Although this reaction is more apt to occur in fresh waters, the range of salinities resulting from the mixture of blow-down from the cooling tower and the waters of the discharge canal may permit formation of this toxic material. If toxic materials are formed, procedures to control or eliminate them should be discussed in the final statement.

Environmental Monitoring

The discussion on page V-29 of the types of samples which will be taken and analyzed does not show the types of fish involved. Several species of migratory and indigenous fish should be included in the proposed monitoring program if the results of the program are to adequately reflect the radio-logical impacts of the plant on the fishery of Barnegat Bay.

Plant Accidents

This section contains an adequate evaluation of impacts resulting from plant accidents through Class 8 for airborne emissions. However, the environmental effects of releases to water is lacking. Many of these postulated accidents listed in table VI-2 could result in releases to Barnegat Bay and should be evaluated in detail.

We also think that Class 9 accidents resulting in both air and water releases should be described and the impacts on human life and the remaining environment discussed as long as there is any possibility of occurrence. The consequences of an accident of this severity could have far-reaching effects on land and in the Bay which could persist for centuries affecting millions of people.

Adverse Effects Which Cannot be Avoided

The AEC staff suggestion in regard to the handling of trash and debris removed from intake racks and screens appears to be advisable. We encourage the applicant to modify its plans so that such waste materials are collected and disposed of by land burial or other approved disposal methods.

We suggest that the reduction in visibility at or near the cooling tower and other high structures will have an unavoidable adverse effect on waterfowl and other birds migrating through the project area. This effect should be recognized in this section.

Alternative Fuels

We suggest that tables XI-1 and XI-2 be expanded to include Btu value; sulfur and ash content of fuel and boiler, burner, and ash collector design. This data would allow the reviewer to have the basis for the data presented in these tables.

Alternative Cooling Methods

The AEC staff concludes on page XI-17 that a freshwater natural-draft cooling tower with makeup from Toms River or a proposed Lacey Township municipal sewage treatment plant should be considered as alternative sources of makeup water if technical difficulties, including environmental effects, emerge from the use of the proposed salt water cooling tower. This conclusion appears to be reasonable.

Oyster Creek is ponded just south of the site. The storage will serve in the interest of fire protection for both the Forked River Plant and the Oyster Creek Plant. It appears that some use of this water as makeup for the tower would reduce the cooling tower maintenance and lessen salt drift. We suggest that the Alternative Cooling Systems section of the final environmental statement include consideration for this partial source of cooling water makeup.

We hope these comments will be helpful to you in the preparation of the final environmental statement.

Sincerely yours,

Deputy Assistant Secretary of the Interior

Mr. Daniel R. Muller
Assistant Director for
Environmental Projects
Directorate of Licensing
Atomic Energy Commission
Washington, D. C. 20545

D-19

DEPARTMENT OF TRANSPORTATION

UNITED STATES COAST GUARD

MAILING ADDRESS:
U.S. COAST GUARD (GWS/83)
400 SEVENTH STREET SW.
WASHINGTON, D.C. 20590
PHONE: 426-2262

RECEIVED DEC 1 1972 U.S. ATOMIC ENERGY COMMISSION Regulatory Mail Section

50-363

Mr. Daniel R. Muller
Assistant Director for
Environmental Projects
Directorate of Licensing
U. S. Atomic Energy Commission
Washington, D. C. 20545

Dear Mr. Muller:

This is in response to your letter of 13 October 1972 addressed to Mr. John E. Hirten, Assistant Secretary for Environment and Urban Systems, concerning the draft environmental impact statement, environmental report and amendment on the Forked River Nuclear Station No. 1, Jersey Central Power and Light Company, Forked River, Ocean County, New Jersey.

The concerned operating administrations and staff of the Department of Transportation have reviewed the material presented.

Noted in the review by the Federal Railroad Administration is the following:

> "In review of the draft environmental statement, we note that the proposed 500 KV transmission lines will be using abandoned and existing railroad rights-of-way. While we are in favor of the increased utilization gained by joint rights-of-way, we wish to draw attention to the possible technological problems. The problem of inductive coupling, direct faulting or flashover with railroad signal and communication circuits is one which should be addressed. Destruction of the integrity of railroad signal and communication facilities is more than an inconvenience as the potential of series accidents exists."

The Department of Transportation has no further comments to offer. We have no objection to this project. We do feel, however, that the concern of the Federal Railroad Administration should be addressed in the final statement.

The opportunity for the Department of Transportation to review and comment on the Forked River Nuclear Station is appreciated.

Sincerely,

[signature]

50-363

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

DEC 12 1972

Mr. L. Manning Muntzing
Director of Regulation
U.S. Atomic Energy Commission
Washington, D.C. 20545

Dear Mr. Muntzing:

The Environmental Protection Agency has reviewed the draft environmental impact statement for the Forked River Nuclear Station Unit No. 1. Our detailed comments are enclosed.

Our analysis indicates that a full assessment of the cumulative effects of the proposed Forked River plant and the operating Oyster Creek plant will require additional thermal, chemical and biological data. We recommend that further studies in these three areas be initiated as soon as possible and that available information be included in the final statement.

Our concern is that the impact of the operation of the Forked River Station, when combined with the existing impact of the Oyster Creek Station, may result in a violation of water quality standards and have a significant impact on the Barnegat Bay ecosystem. Therefore, in order to facilitate changes in the plant systems, should analysis of the requested data indicate that a significant impact will occur, we recommend that two alternate cooling systems be analyzed in the final statement. These two alternatives are a closed cycle cooling system for the Oyster Creek Station and a once through ocean intake and discharge system for both units.

In relation to the thermal studies, we have collected temperature data for the past five years in the vicinity of the Oyster Creek plant. We were not able, in the time allowed, to review this data in detail. Therefore, we recommend that personnel from both the AEC and the applicant meet with EPA staff members to discuss the applicability of the data.

We believe that the liquid waste management equipment provided in the Forked River Nuclear Station should have the capacity and capability to provide effluents which may be considered "as low as practicable." However, the potentially contaminated leakage from the secondary coolant system has not been adequately evaluated and discussed. It is not clear that samples of the liquids associated with this source will be collected and analyzed prior to discharge to Oyster Creek. The plant design should include provisions to route this liquid to the waste treatment equipment if the sample analysis indicates that such treatment is necessary.

The gaseous effluent controls provided do not include a means to control the gaseous radioiodine discharges from two potentially significant sources - the blowdown tank and auxiliary building. We recommend that, during the design and construction phase, provisions be included to facilitate the addition of these systems should operating experience demonstrate the need.

We will be pleased to discuss our comments with you or members of your staff.

Sincerely yours,

Sheldon Meyers

Sheldon Meyers
Director
Office of Federal Activities

Enclosure

ENVIRONMENTAL PROTECTION AGENCY

Washington, D.C. 20460

November 1972

ENVIRONMENTAL IMPACT STATEMENT COMMENTS

Forked River Nuclear Station Unit 1

EPA-AEC-06065-08

TABLE OF CONTENTS

INTRODUCTION AND CONCLUSIONS

The Environmental Protection Agency (EPA) has reviewed the draft environmental impact statement for the Forked River Nuclear Station Unit 1 prepared by the U.S. Atomic Energy Commission (AEC) and issued on October 12, 1972. The following are our major conclusions:

1. The statement attempts to consider the cumulative effects of both the proposed Forked River plant and the operating Oyster Creek plant. However, we find that there is an inadequate thermal, chemical and biological data base from which to make such a determination. Therefore, we recommend that additional:

   a. Temperature studies be initiated to supply additional data on the operation of the Oyster Creek plant,

   b. Chemical analyses be conducted for BOD, DO, chlorine and ammonia levels,

   c. Biological monitoring be instituted to account for seasonal variations in the areas of impingement and entrainment.

In our opinion, all of these programs should operate on a continuous or periodic basis so that future effects of plant operations on Barnegat Bay can be assessed.

2. In order to facilitate changes in the plant systems, should analysis of the requested data indicate that either water quality standards will be violated or a significant adverse effect on the biota will result from operation of the two units as proposed, we recommend that two alternate cooling systems be evaluated in the final statement. They are as follows:

    a. Installation of a closed-cycle cooling system on the Oyster Creek unit in addition to that proposed for Forked River,

    b. An ocean intake and discharge once-through cooling system for both units.

3. We recommend that staff personnel from both the applicant and the AEC meet with representatives from EPA to review five years of temperature data that have been collected in the vicinity of the Oyster Creek station. The purpose of the meeting would be to discuss the adequacy of the data for an assessment of compliance with water quality standards.

4. The potentially contaminated liquid wastes from secondary system leakage should be collected and analyzed and provisions should be included in the final statement to treat these liquid wastes, if the concentrations of radionuclides are significant.

5. It is possible that future operational experience may indicate the need to provide additional iodine control systems. Provisions should be made for such additions during the design and construction phases of the station, in order to prevent such changes from becoming prohibitively expensive.

6. An on-site meteorological program consistent with AEC Safety guide 23 should be instituted, as soon as possible, in order to provide data on which meaningful dose estimates can be made.

RADIOLOGICAL ASPECTS

Radioactive Waste Management Systems

We have evaluated the Forked River Nuclear Station effluent control systems to determine if the radioactive effluents expected from the facility will be consistent with "as low as practicable" criteria. In general the systems proposed are representative of present waste system technology and it appears that the releases will be consistent with the philosophy of "as low as practicable" provided the equipment is used to design capacity. The final statement should provide the criteria for the use of the waste management equipment, which will implement the provisions of 10 CFR Part 50.36a.

Although the design of the proposed liquid waste treatment system is consistent with present technology and appears to have sufficient storage and equipment capacities to enable liquid waste discharges to be maintained at a level "as low as practicable," we note that several potential sources of radioactive wastes are not to be processed by this system. Neither the draft statement nor the PSAR evaluated potential radioactive discharges to the environment associated with probable leakage from the secondary coolant system. Based on limited data from operating PWRs, this leakage may constitute a considerably greater volume than that from the steam generator blowdown system. The final statement should provide an evaluation of the potential discharge from this source and should indicate that it will be collected, analyzed, and treated if necessary, prior to discharge to Oyster Creek. In addition, we recommend that during the design and construction period, provisions be included to allow for treatment of these liquids if required, since once the plant is built, such modifications may be impracticable.

It appears that low activity (less than 10^{-5}uCi/cc) wastes and laundry wastes, which may contain significant amounts of radioactivity, will only be filtered before discharge. The final statement should include a detailed breakdown of all sources of liquid radioactive wastes, their expected volumes, and their radionuclide compositions; so that an evaluation of the significance of these various sources can be made. Also, Figure III-5 of the draft statement should be revised to include the pathways for steam generator blowdown and secondary system leakage. We encourage the applicant to utilize the waste treatment equipment in a manner to minimize radionuclide discharges to Oyster Creek (in particular long-lived radionuclides known to accumulate in the environment) and to follow the monitoring guidance of Safety Guide 21 for each potential source of radioactive liquid release.

We note that provisions have not been made for the treatment or control of radioactive iodine from the various probable sources of gaseous radioactive effluents. These include the condenser steam jet air ejector vent, the blowdown flash tank vent, the auxiliary building ventilation system, the turbine building ventilation system, and the gas collection header.

Steam generator blowdown may result in a significant gaseous radioiodine discharge via the blowdown flash tank vent. The relative importance of this source will largely depend on the integrity of the condenser tubes which are exposed to salt water since the steam generator will only be "blowndown" when there is condenser tube leakage. In addition, a potentially significant quantity of radioiodine might be

released from the auxiliary building, if pressurized reactor coolant should leak from the chemical and volume control system, or other pressurized components connected to the reactor coolant system. We recommend that during the design stages of the plant, provisions be incorporated to allow iodine control equipment and/or process modifications on the steam generator blowdown system and the auxiliary building ventilation system to be backfitted after the plant is operational should such action be necessary. If these considerations are taken into account during the plant design and construction phase, implementation, if found to be necessary during operation, should not present prohibitive costs to the applicant.

Dose Assessment

In calculating the maximum annual individual dose at the site boundary apparently it was assumed that the radioactive gaseous effluent would be distributed in all directions around the Forked River site according to annual average meteorological conditions. However, important sources of gaseous effluent, such as containment purging and waste gas decay tank releases, will be made over short time periods. Also, gaseous discharges resulting from steam generator leakage may be released over time periods much shorter than one year. For short release periods, only a few geographical sectors around the plant may receive the bulk of those radioactive gases originating from such releases. Therefore, the maximum annual individual dose at the site boundary should be reevaluated, taking into account the appro-piate meteorological conditions, including those which may exist during short-term releases.

According to the draft statement, the on-site meteorological data cannot be considered valid due to instrumentation problems. Based on our observations and our evaluations of this data during joint AEC-EPA studies at Oyster Creek, we agree. It is also questionable whether the data available from other locations would be valid for this particular site, since local topographical features, such as Barnegat Bay, may have a significant effect on the atmospheric dispersion of gaseous effluents. The data from Atlantic City, which was used for the dose assessments in the draft statement, may not be applicable since the meteorological tower there is comparatively short and, thus, does not provide information at the altitudes of interest. Therefore, an appropriate on-site

meteorological program (applying the provisions of Safety Guide 23) should be initiated as soon as possible, so that valid data will be available before the Forked River station begins operation.

A limited number of measurements taken at operating PWR plants have shown that direct external radiation exposure from large outdoor water and waste storage tanks may contribute significantly to site boundary exposures. The draft statement indicated that such exposures will be negligible. The estimated dose from such exposures and those assumptions utilized in determining the dose (e.g., the location of sources, source geometry, source strength, and mechanisms that would be used to control source strength) should be presented in the final statement.

<u>Transportation and Reactor Accidents</u>

In its review of nuclear power plants, EPA has identified a need for additional information on two types of accidents which could result in radiation exposure to the public: (1) those involving transportation of spent fuel and radioactive wastes and (2) in-plant accidents. Since these accidents are common to all nuclear power plants, the environmental risk for each type of accident is amenable to a general analysis. Although the AEC has done considerable work for a number of years on the safety aspects of such accidents, we believe that a thorough analysis of the probabilities of occurrence and the expected consequences of such accidents would result in a better understanding of the environmental risks than a less-detailed examination of the questions on a case-by-case basis. For this reason we have reached an understanding with the AEC that they will conduct such analyses with EPA participation concurrent with review of impact statements for individual facilities and will make the results available in the near future. We are taking this approach primarily because we believe that any changes in equipment or operating procedures for individual plants required as a result of the investigations could be included without appreciable change in the overall plant design. If major redesign of the plants to include engineering changes were expected or if an immediate public or environmental risk were being taken while these two issues were being resolved, we would, of course, make our concerns known.

The statement concludes "... that the environmental risks due to postulated radiological accidents are exceedingly small." This conclusion is based on the standard accident assumptions and guidance issued by the AEC for light-water-cooled reactors as a proposed amendment to Appendix D of 10 CFR Part 50 on December 1, 1971. EPA commented on this proposed amendment in a letter to the Commission on January 13, 1972. These comments essentially raised the necessity for a detailed discussion of the technical bases of the assumptions involved in determining the various classes of accidents and expected consequences. We believe that the general analysis mentioned above will be adequate to resolve these points and that the AEC will apply the results to all licensed facilities.

NON-RADIOLOGICAL ASPECTS

General

The cooling system for the proposed Forked River Unit No. 1 consists of a salt water natural draft cooling tower. The Oyster Creek unit utilizes a once through cooling system. Both units draw water from and discharge water to a canal dredged between Forked River and Oyster Creek. These two streams drain into Barnegat Bay.

Therefore, in assessing the water quality impact of the Forked River unit, it is essential to quantify the effect of the existing Oyster Creek unit on the available water resources. Only after the effect of the Oyster Creek unit has been fully determined can an estimate of the combined impact of the two power plants be made.

It can be stated that the salt water cooling tower proposed for the Forked River unit will tend to minimize the unit's impact on water quality. The question that must be answered is: will the additional water quality impact of the Forked River unit, when combined with the existing impact of the Oyster Creek unit result in a violation of water quality standards or have a significant adverse effect on the biota. It is our opinion that there is insufficient thermal, chemical, and biological data supplied in the draft statement on the operation of the Oyster Creek unit to make such a determination.

Thermal Effects

The draft statement indicates that the existing status of the thermal discharge is described solely on the basis of one infra-red imagery study conducted on November 24, 1969. The following points are noted regarding this study:

1. Thermal impact cannot be assessed without consideration of seasonal effects. The November 24 study, does not characterize thermal impact on the Barnegat Bay ecosystem in the summer months under maximum ambient and water temperature conditions or in winter months with minimum ambient temperature conditions.

2. The November study was conducted with the Oyster Creek reactor operating at only 75% of full power.

It is stated on page V-6 that, "... Oyster Creek Station operation has had a relatively stable and identifiable effect on the normal background of the Barnegat Inlet area." We can not find any basis for this statement and feel that a real potential exists for adverse changes in the biota. The following is a quote from the Environmental Report on Forked River which supports our concern:

> "Such cooling has maintained Bay temperatures at JCP & L's marked buoy J at less than 95°F during periods of peak summer conditions."

It is pointed out that most important estuarine fish species show avoidance to 87°F and die when exposed to greater than 94°F.

New Jersey's revised 1971 Water Quality Standards for Class TW-1 Waters are cited below:

Nontrout Waters - No heat may be added except in designated mixing zones, which would cause temperatures to exceed 85°F, or 82°F in yellow perch waters, or which will cause the monthly mean of the maximum daily temperature at any site, prior to the addition of any heat, to be exceeded by more than 4°F during September through May, or more than 1.5°F during June through August. The rate of temperature change in designated mixing zones shall not cause mortality of the biota.

The applicant should use these standards in assessing the water quality impact of the plant.

Regarding the lack of temperature data, EPA has had a temperature monitoring program in effect in Oyster Creek, Forked River and Barnegat Bay from June 1967, to the spring of 1972. We have not had the time in the course of this review to look at this data in the detail required to determine if a violation of thermal standards exists. However, the data are available and we recommend that personnel from both the applicant and the AEC meet with EPA staff members to review the data and discuss its applicability. We further recommend that additional temperature studies be conducted, if necessary, to supplement this temperature data and that a thermal monitoring program be established to assess, on a continual basis, the impact of the plants on Barnegat Bay.

Chemical Considerations

1. Dissolved Oxygen (DO) - The statement contains no data on the dissolved oxygen levels in the proximate area of Oyster Creek. There is the possibility of reducing DO levels by thermal enhancement of BOD and by temperature induced changes in solubility, but due to the lack of data, we cannot estimate the magnitude of this change.

It should be noted that Table 11-6 of the EIS characterized Barnegat Bay water but leaves out those parameters most relevant to an assessment of biological effects of operations (BOD, DO, NH3, etc.)

The EIS notes that in a study done in 1965 very low DO levels were found in the mouth of Oyster Creek but no data were given. This data should be reported since it represents a period of time prior to the operation of the Oyster Creek plant.

2. Chlorine concentrations - It is stated that the chlorine concentration in Forked River #1's blowdown will be 0.5 ppm and that this will lead to a concentration of 0.1 ppm maximum in the discharge canal. These are rather high levels with potentiality for formation of chloramines. However, the EIS gives no data for ammonia levels in the intake water.

Residual chlorine levels in the receiving water should be limited to:

a) for continuous chlorination - 0.002 mg/liter

b) for intermittent chlorination

1) 0.1 mg/liter not to exceed 30 min/day

2) 0.05 mg/liter not to exceed 2 hrs/day

The 0.1 ppm concentration in the discharge canal may lead to concentrations in the receiving water which are greater than those above and therefore, could have an adverse effect on the biota.

We recommend that a chemical monitoring program be established for BOD, DO, Chlorine and ammonia so that an assessment of the direct and cumulative chemical effects can be made. If data indicate that recommended levels will be exceeded then either reduced levels of chlorination or a form of mechanical cleaning should be considered.

Biological Effects

1. Entrainment: It is estimated in the draft statement that entrainment will not lead to any harmful effects on the biota of Barnegat Bay but little supporting data are presented based upon the three years of operation of the Oyster Creek plant. While this may be true of the Forked River plant alone with its proposed closed cycle cooling system, the entrainment problem it presents when coupled with that inherent in the Oyster Creek plant's once through cooling system may prove to be significant.

2. Impingement: One study was done with regard to impingement at Oyster Creek and it is concluded that there will be no significant effect on the ecosystem of the Bay. It is suggested here that this study was much too brief to justify the conclusions drawn. The study was done during the spring and early summer months (April, May, and June), and did not show a very great loss of biota by impingement. It is assumed that "This rate will not be sustained during winter months." Firstly, this is only an assumption, since apparently no such studies have been done at Oyster Creek during the winter time. Secondly, actual operating experience at other generating stations, noteably Indian Point #1, has shown the exact opposite to be true; that is, much higher mortalities in winter than in summer due to reduced swimming ability. Again, with an estimated intake velocity of 0.7 ft/sec for the Forked River unit, we would not expect impingement to be a significant problem at this plant alone. However, when coupled with the existing impingement problem at Oyster Creek, the combined effect may prove to be significant.

We recommend that a biological monitoring program be instituted that would take into account seasonal variations, and would supply information on a continual or periodic basis so that a more accurate assessment of the entrainment and impingement problems can be made.

Alternate Cooling Systems

If further analyses indicate that there will be a violation of water quality standards or a significant adverse effect on the biota from the operation of the two units as presented in the draft statement, then there are two alternate cooling strategies that we recommend be analyzed in detail in the final statement. These are:

1. Installation of a closed cycle cooling system on the Oyster Creek unit in addition to that proposed for Forked River

2. An ocean intake and discharge once through cooling system for both units.

It is recognized that the second alternate cooling strategy would have the advantage of not requiring major alterations of the once through cooling system on the existing Oyster Creek unit while achieving the same end of minimizing the water quality impact of both plants.

<u>Air Quality Effects</u>

The following information on the impact of the facility on air quality should be included in the final statement:

1. A discussion of the air quality aspects of any auxiliary boilers or emergency generating equipment to be used at this facility should be provided. This discussion should include the following:

   a. Size and type of unit

   b. Fuel type

   c. Fuel analysis including percent sulfur

   d. Annual fuel use rate

   e. Estimated annual emissions.

2. One possible source of particulate emissions during the construction of this facility is the use of an on-site concrete batch plant. The presence of such a facility and the particulate control methods to be utilized should be discussed as well as its ability to comply with applicable State emission standards.

3. Any information available, related to the quantities of ozone produced by high voltage transmission lines and some estimates of its environmental consequences should be provided.

4. Page II-12 indicates that the applicant's meterological data did not appear to be valid, therefore, it was not used in the evaluation. What nearby sites provided the data base for the AEC X/Q used in this evaluation?

COST BENEFIT

In the Cost/Benefit Balance of Alternatives (p. XI-19, 20) an assumption is made that the power plant will have an average annual load factor of 80%. This assumption is vital to the economics of this plant as well as other light water reactors. Recently the Atomic Energy Commission has suggested that these plants may be derated by 20% from their designed limits. If this occurs with Forked River, the net output will decrease accordingly - even if an 80% average load factor is attained. Regarding this latter point, perhaps a more realistic load assumption might be a load factor gradually rising to 80% after a few years of commercial service and finally, during the latter years of the plant life, declining again as newer and more efficient nuclear units come on line. Utilizing these assumptions may significantly change the economics of operations. The final statement should discuss the load factor assumption and present modifications to the cost/benefit analysis, if required.

ADDITIONAL COMMENTS

During the review we noted in certain instances that the draft statement does not present sufficient information to substantiate the conclusions presented. We recognize that much of this information is not of major importance in evaluating the environmental impact of the Forked River Nuclear Station Unit 1. The cumulative effects, however, could be significant. Therefore, it would be helpful in determining the impact of the plant if the following information were included in the final statement:

1. An evaluation of the amounts of liquid and gaseous radioactivity that could be released undetected, and estimates of the amount of radioactivity that may be discharged before monitoring alarms are activated and the discharges terminated.
2. Population estimates for the area 5 to 10 miles from the plant. (Figures II-3 and II-4 and Table II-1 of the draft statement omit this demographic data.)
3. An evaluation of the environmental dose consequences resulting from radionuclides (1) deposited on the spoil banks of dredged material, and (2) resuspended during dredging operations for the new barge canal.
4. Further information on the January 1972 fish kill at Oyster Creek (extent, causes, etc.). A review of the thermal data cited previously may help in understanding the causes and the tolerance limits of the fish species in the area.

FEDERAL POWER COMMISSION
WASHINGTON, D.C. 20426

IN REPLY REFER TO:
50-363

JAN 4 1973

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JAN 5 1973
U.S. ATOMIC ENERGY COMMISSION
Regulatory
Mail Section

Mr. Daniel R. Muller
Assistant Director for
Environmental Projects
Directorate of Licensing
U. S. Atomic Energy Commission
Washington, D. C. 20545

Dear Mr. Muller:

This is in response to your letter of October 13, 1972, requesting comments on the AEC Draft Environmental Statement related to the issuance of a construction permit to the Jersey Central Power & Light Company (JCP&L) for the Forked River Nuclear Station (Docket No. 50-363).

Pursuant to the National Environmental Policy Act of 1969, and the April 23, 1971, Guidelines of the Council on Environmental Quality, these comments review the need for the facilities as concerns the adequacy and reliability of the affected bulk power systems and matters related thereto.

In preparing these comments, the Federal Power Commission's Bureau of Power staff has considered the AEC Draft Environmental Statement; the Applicant's Environmental Report and amendment thereto; related reports made in response to the Commission's Statement of Policy on Reliability and Adequacy of Electric Service (Order No. 383-2); and the FPC staff's analysis of these documents together with related information from other sources. The staff bases its evaluation of the need for a specific bulk power facility upon long term considerations as well as the load supply situation for the next peak load period following the scheduled availability of the facility.

<u>Need for the Facility</u>

The Jersey Central Power & Light Company's Forked River Nuclear Generating Station is to be located approximately 3,400 feet west of the existing Oyster Creek Nuclear Generating Station and will share the site currently occupied by that Station.

LB

The Forked River Nuclear Generating Station, Unit No. 1, is a 1,070-megawatt pressurized-water reactor generating unit. The unit, originally scheduled for commercial service in May 1976, has been delayed and is presently scheduled for commercial operation in September 1978. Due to the 28-month delay, its 1,070 megawatts of baseload capacity will be unavailable for the 1976, 1977 and 1978 summer peak load periods. It is expected to be available in time to assist in meeting the 1979 summer peak loads.

The Applicant and the Pennsylvania Electric Company (Penelec), Metropolitan Edison Company (Met-Ed), and New Jersey Power & Light Company (NJP&L), are subsidiaries of General Public Utilities Corporation; together they comprise the GPU System. The Applicant states that the GPU System is planned and operated on a fully integrated basis, including generating capacity and related transmission. This system, in turn, is part of the Pennsylvania-New Jersey-Maryland Interconnection (PJM) which, with additional systems, comprises the entity known as the Mid-Atlantic Area Council (MAAC), one of the nine regional electric reliability coordination councils. PJM is a pool, operating under a written agreement which provides for planning and operating the bulk power supply of each company as an integral part of the total PJM system and for operation as a single control area.

The Applicant's system peak load forecast shows succeedingly greater summer and winter peaks such that there is only negligible seasonal diversity. Since exposure to the summer peaks is generally of greater duration than that of the winter peaks, and since PJM experiences its annual peak during the summer season, the summer load periods are considered the more hazardous peak periods. In determining the need for power from Forked River Unit No. 1, we have reviewed the 1979 summer peak load-supply situation for the GPU system as well as the PJM Interconnection.

The base-load generation expansion program of the GPU system to the summer of 1979 is outlined below:

Generation Expansion Program - GPU System

Estimated Commercial In-Service Date	Station	Type	Capability (MW)
May 1974	Three Mile Island No. 1	Nuclear	792
May 1976	Three Mile Island No. 2	Nuclear	880
December 1976	Homer City No. 3	Fossil	320 1/
November 1977	Union Beach No. 1	Fossil	400
May 1978	Union Beach No. 2	Fossil	400
September 1978	Forked River No. 1	Nuclear	1070
February 1979	Thuerk No. 1	Fossil 2/	316

1/ GPU share of jointly-owned unit.
2/ Combined cycle.

The following tabulation shows the electric system loads to be served by the GPU and the PJM systems, and the relationship of the electrical output of the Forked River Unit No. 1 to the available reserve capacities on the GPU and PJM systems at the time of the 1979 summer peak load period. This is the anticipated initial service period of the unit, but the life of the unit is expected to be some 30 years or more, and it is expected to constitute a significant part of the Applicant's total generating capacity throughout that period. Therefore, the unit will be depended upon to supply power to meet future demands over a period of many years beyond the initial service needs discussed in this report.

Forecast 1979 Summer Peak Load-Supply Situation

	GPU System	PJM System
Conditions With Forked River Unit No. 1 (1,070 Megawatts)		
Net Dependable Capacity - Megawatts	10,642	65,805
Net Peak Load - Megawatts	9,022	50,905
Reserve Margin - Megawatts	1,620	14,900
Reserve Margin - Percent of Peak Load	18.0	29.3
Applicant's Stated Reserve Margin Needs Based on 20 Percent Criterion - Megawatts	1,804	10,181
Reserve Margin Deficiency - Based on Applicant's Stated 20 Percent Criterion - Megawatts	184	1/
Conditions Without Forked River Unit No. 1		
Net Dependable Capacity - Megawatts	9,572	64,735
Net Peak Load - Megawatts	9,022	50,905
Reserve Margin - Megawatts	550	13,830
Reserve Margin - Percent of Peak Load	6.1	27.2
Applicant's Stated Reserve Margin Needs Based on 20 Percent Criterion - Megawatts	1,804	10,181
Reserve Margin Deficiency - Based on Applicant's Stated 20 Percent Criterion - Megawatts	1,254	1/

1/ The PJM Interconnection has not specified a reserve margin criterion, but attempts to maintain a reliability standard such that load will not exceed capability more than one day in a ten-year period.

The availability of Forked River Unit No. 1 for the summer of 1979 would provide the GPU system with an expected system reserve margin of 1,620 megawatts or 18.0 percent of peak load. Any delay which results in the unavailability of the unit for the 1979 summer peak period would reduce the system reserves to 550 megawatts or 6.1 percent of peak load, and forecasts based on this condition indicate a reserve margin deficiency of 1,254 megawatts based on the Applicant's stated 20 percent criterion. Systems of the PJM Pool presently estimate that for adequate system reliability a reserve margin of approximately 20 percent of peak load should be maintained. Any delay or outage, resulting in the unavailability of any of the system's scheduled generating units would increase the severity of the effect on system reserves.

With respect to the PJM system, the availability of Forked River Unit No. 1 for the 1979 summer peak load period would provide a reserve margin of 14,900 megawatts or 29.3 percent of peak load. If the capacity of this unit is not available as scheduled, the PJM system will enter the 1979 summer with a reserve margin of 13,830 megawatts or 27.2 percent of peak load.

FPC staff has observed that power systems generally attempt to maintain generating reserves in the range of 15 percent to 25 percent of peak load. System and load characteristics, combined with the characteristics of neighboring interconnected systems exert a determining effect on the needed reserve for reliable power supply. The PJM System reserves in the table above appear to be sufficient, even without the Forked River Unit. The reserve margin, however, is predicated on the timely completion and in-service availability of a number of large baseload generating units not yet in operation. The PJM systems, including GPU, currently have scheduled for commercial operation over 31,000 megawatts of new capacity in the years 1972-1979, more than twice the reserve margin capacity forecasted for summer 1979. In view of the large size of the units comprising this projected capacity, and the probability of delays in completion of construction, PJM capacity planning appears prudent. Although regional reserves may often be helpful in the event of contingencies normally experienced on interconnected power systems, these reserves are not a reliable substitute for firm power, baseload capacity within a member's system. In order to provide adequate reserves for the region, a proportionate reserve should be maintained by each system, based on its own load.

The reserve margins indicated in the foregoing tabulation and text are gross in that they include all of the capacity available not only for meeting expected loads but that which may be out of service due to scheduled maintenance or forced outage and any that might be needed to meet unforeseen demands due to errors in load forecasting and exceptional weather.

As noted above, the adequacy and reliability of the GPU and PJM systems in 1979 are not only dependent upon the timely commercial operation of Forked River Unit No. 1 but also on the timely operation of all the units in the systems' respective current construction programs. Current information indicates that delays are being experienced in bringing many large units into commercial operation and this trend may continue for some time.

In a recent study of delays in new capacity additions in the eastern PJM area, an area served by five utilities which serve about 50 percent of the PJM demand and operate about 52 percent of the generating capacity, all of the currently planned new generating units of 300 megawatts or larger have been delayed by Federal, state or regional licensing or permit granting agencies. The tabulation below indicates the causes of delay, the numbers and types of units and the total capacity of the units delayed.

Causes of Delays of New Capacity Additions

Cause of Delay	No. of Units 1/	Type of Unit	Total Capacity (MW)
Operating License	6	N	6,007
Construction Permit	5	N	5,430
Water Usage	6	N	6,710
" "	9	F	2,968
" "	2	PS	1,300
Const. & Dredging	9	F	3,360
Discharge Permits	5	F	1,726

N - Nuclear F - Fossil Steam PS - Pumped Storage
1/ Some units may be delayed for two or more reasons.

The tabulation covers 24 units totaling 18,939 megawatts of capacity including 13 nuclear units totaling 13,837 megawatts, 11 fossil units totaling 3,802 megawatts and two pumped storage projects totaling 1,300 megawatts. The delays indicated in the table are in addition to the construction delays caused by strikes, late equipment deliveries, low productivity, labor shortages and other problems arising during the construction of the projects.

Transmission Facilities

The transmission line additions necessary as a result of the construction of Forked River Unit No. 1 are two 500-kilovolt lines 48 and 50 miles long emanating from the Forked River Nuclear Generating Station and terminating at the Deans Substation and the New Freedom Substation of the Public Service Electric and Gas Company, respectively. Both substations tie into the PJM interconnected 500-kilovolt system.

The Applicant states the routes selected for the transmission lines associated with the Forked River Unit No. 1 were chosen with the assistance of municipal, county and State agencies, and with consideration of Federal guidelines. 1/

Alternatives to the Proposed Facilities

The Applicant, in determining the need for additional generation to meet its projected demands, considered a number of alternatives including location, type (base-load and peaking), fuel (nuclear, coal, oil or gas) purchase of power, environmental effects and economics. The final decision rested between a baseload nuclear-fueled plant and a baseload oil-fired plant. In making the economic comparison the Applicant estimated, that based on 1978 cost projections, a nuclear plant (1,143 megawatts including stretch capacity) would cost (including fuel for the first core) $560,554,000 or $491 per kilowatt of capacity. A similar sized oil-fired plant was estimated to cost $297,180,000 or $260 per kilowatt of capacity. Fuel costs of 1.3 mills per kilowatt-hour or $9.10 per kilowatt-year were calculated for the nuclear unit and 8.7 mills per kilowatt-hour or $60.90 per kilowatt-year for the oil-fired unit.

1/ Environmental Criteria for Electric Transmission Systems, U.S. Department of the Interior and U.S. Department of Agriculture, 1971.

Electric Power Transmission and the Environment, Federal Power Commission, 1971

Mr. Daniel R. Muller

The Applicant estimates the cost for operation and maintenance (including insurance) at $4.45 per kilowatt-year for nuclear and $3.55 per kilowatt-year for an oil-fired unit. Using the above costs and plant factor of 80 percent, the nuclear plant shows an annual savings of $22,517,100. The data shows also that the Forked River Nuclear Plant has a significant economic advantage over an oil-fired unit for operating times which exceed 4,800 hours per year or a plant factor of approximately 55 percent. Operation of the plant at 4,000 hours per year or a plant factor of 46 percent, however, has an economic disadvantage for the nuclear plant of $3,714,750 annually.

The Applicant estimates the cost of a one-year delay in the commercial operation of the Forked River Nuclear unit including the additional cost of plant and fuel, escalation of delayed costs, added interest during construction, and provision of adequate generating capacity and replacement energy at $83,300,000.

The staff of the Bureau of Power finds the cost estimates, except for that of nuclear fuel, within the range of similar costs reported by the industry. The estimated cost of nuclear fuel is below the low end of the range of recent nuclear costs reported to the Federal Power Commission.

Conclusions

The staff of the Bureau of Power concludes that the Forked River Unit No. 1 is one of several generating units needed to provide capacity adequate for reliable service on the GPU system in the summer of 1979. In addition, the unit will constitute nearly 9 percent of the PJM generating reserves for the same period.

Very truly yours,

T. A. Phillips
Chief, Bureau of Power

State of New Jersey
DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF ENVIRONMENTAL QUALITY
JOHN FITCH PLAZA, P. O. BOX 1390, TRENTON, N. J. 08625

December 22, 1972

Mr. L. Manning Muntzing
Director of Regulation
U. S. Atomic Energy Commission
Washington, D. C. 20545

Refer to USAEC Docket No. 50-363

Dear Mr. Muntzing:

The State of New Jersey is an intervener in the above referenced proceeding; New Jersey's concern primarily is environmental. The State of New Jersey received a copy of the Atomic Energy Commission Regulatory Staff's Draft Environmental Statement for the Forked River Nuclear Station No. 1. New Jersey's review of the Draft Statement has been completed. I regret I must advise you that in our judgment and expectation the Draft is unacceptable in that it does not adequately convey an impression of in-depth, independent review of the essential issue. The essential issue is identified as the environmental impact of a natural-draft, salt-water cooling tower--the first proposed for this country of this size and for a power reactor. In view of the precedent-setting nature environmentally, we had anticipated a much more comprehensive report of the Regulatory Staff's effort.

I specifically call your attention to the last paragraph on page V-3 of the Draft which is quoted below in its entirety:

> "Although the Staff could not duplicate the Applicant's analysis, numerical checks and a complete review of the methods and assumptions were made. The Staff concludes that the methods and assumptions were adequate and the conclusions were valid."

This paragraph does indicate a reasonably comprehensive effort; other information sources indicate Battelle Northwest Laboratory has been active in this review. We believe it is in the public interest and an obligation of the Commission to clearly elaborate and critique numerical checks and review of the Applicant's methods and assumptions in the Staff's finalized environmental impact statement.

DR- 5177

New Jersey's opinion is based in part upon a statement appearing on page one, left-hand column, first paragraph of "Guide to Preparation of Environmental Reports for Nuclear Power Plants, USAEC, August 1972," which reads in part,..."The AEC is required to assess the potential environmental effects of that plant..." New Jersey's opinion was further strengthened by our understanding of PL 91-190, Executive Order of the President, No. 11514 and the AEC's acceptance of the Calvert Cliff's Court Decision.

Specific comments relating to the environmental aspects of this Application are contained in a list of interrogatories already served. One additional comment bearing on this issue is the need for a discussion of options available if the facility as proposed is licensed and the environmental consequences of the tower are found unacceptable at some future date.

Our position has been made known to the Regulatory Staff members concerned, to the Applicant, and also the Atomic Safety and Licensing Board hearing this case. It is not our intent to delay the proceedings. New Jersey will work with the Staff and the Applicant to expedite the matter as efficaciously as possible. However, New Jersey cannot make its decision until we are sure that the requirement for a thorough review has been satisfied.

With best wishes for the Holiday Season, I remain,

Very truly yours,

Grant F. Walton
Director

GFW:CGA:dg

cc Richard J. Sullivan, Commissioner and
Chairman, N. J. Nuclear Energy Council
Joseph W. Ferraro, Esq., DAG
Charles G. Amato, Nuclear Engineer

State of New Jersey

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December 19, 1972

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In the Matter of Jersey Central Power & Light Company
(Forked River Nuclear Generating Station, Unit 1)
Docket No. 50-363

To the Parties in the Above-captioned Matter:

Transmitted herewith are questions propounded by the Nuclear Energy Council of the State of New Jersey relating to the environmental phase of the above hearings as well as a statement regarding the Staff's draft environmental report submitted herewith in the interest of efficiency.

Very truly yours,

Joseph W. Ferraro, Jr.
Deputy Attorney General
Counsel for Nuclear Energy Council

JWFJr mhb
Enclosure

Under separate transmittal the Chairman of the New Jersey Nuclear Energy Council will transmit New Jersey's comments regarding the Staff's Draft Environmental Report. In the interest of expediency and as a courtesy to all parties in this proceeding, the State of New Jersey takes this opportunity to note that the State Government has serious reservations with respect to the Draft Environmental Statement and has determined that it is inadequate for the intended purpose.

The following interrogatories are submitted to the Staff and/or Applicant as indicated. These interrogatories refer to environmental concerns.

1. Does either the Applicant or the Staff attach any significance to the variation shown for shell fish catch reported in Table II - Arabic numeral 13, Page II - Arabic numeral 37, of the Staff's Draft Report?

2. The Applicant is kindly asked to state the mass salt-emission rate per unit of time from the tower, the effect of spread between wet and dry bulb temperature on the emission rate and the method used in arriving at these values.

3. The Applicant and Staff are requested to comment upon any possible chronic long-term effects due to salt-spray deposition.

4. The Applicant is kindly asked to demonstrate compliance with Chapter 7 of the New Jersey Air Pollution Code (reproduced in full in the Applicant's Environmental Statement).

5. The Applicant is kindly asked to state the effect on plant efficiency of the cooling tower and to estimate the magnitudes of: (a) increased fuel consumption; and (b) fission product inventory.

6. The Staff is asked to kindly refer to Page V - Arabic numeral 3, of their Draft Environmental Statement and to state why no complete review of the methods and assumptions of the Applicant were made in view of the fact that the proposed cooling tower is the first of this size proposed for the United States. The Staff is further asked to clearly state in detail the basis for its conclusion that the methods and assumptions employed by the Applicant are valid.

7. The Applicant is asked to kindly clarify the rationale behind the conclusion that an additional heat rejection of 200 to 400 MBTU/hr to Oyster Creek, with 1,000 cfs flow in the canal, will produce a temperature rise not exceeding 1°F.

8. The Applicant is asked to kindly clarify the meaning of the power replacement cost cited in their Environmental Report. Specifically, is this number a first-year cost estimate or is it a levelized 30 or 40-year cost applied to the first year?

9. The Applicant is kindly asked to discuss the desirability of relating dilution flow to a temperature value sensed in the Bay as opposed to consideration of either/or intake temperature and temperature sensed at the Central Railroad of New Jersey bridge.

Dated: December 19, 1972