Final

environmental statement

related to the proposed

CRYSTAL RIVER UNIT 3

FLORIDA POWER CORPORATION

DOCKET NO. 50-302

May 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 (staff).

1. This action is administrative.

2. The proposed actions are the continuation of construction permit CPPR-51 and the issuance of an operating license to the Florida Power Corporation for the startup and operation of Crystal River Unit No. 3, a nuclear power reactor located on a site already occupied by two operating oil-fueled electrical generating plants (Units 1 and 2). The site is on the Gulf of Mexico in the State of Florida and near the town of Crystal River, Citrus County, (Docket No. 50-302).

   Unit No. 3 will employ a pressurized water reactor to produce initially 2452 megawatts thermal (MWt) and a gross electrical output of 855 megawatts electric (MWe). A design power level of 2544 MWt (885 MWe) is anticipated at a future date and is considered in the assessments contained in this statement. The exhaust steam will be cooled by once-through flow of water obtained from and discharged to the Gulf of Mexico.

3. Summary of the cumulative environmental impact and adverse effects of Units 1, 2 and 3:

   - Land areas disturbed during construction of the station, but not to be occupied by buildings or facilities, are to be allowed to revert to a natural condition.

   - The annual loss of juvenile and small finfish and shellfish on the intake screens (now estimated at 36,000 lb for Units 1 and 2) will increase due to the increased volume flow and velocity.

   - Entrainment of passing drift organisms will increase and 100% mortality of these organisms during their passage through the condenser cooling system is assumed. Total plankton populations in the area are not expected to be appreciably affected.

   - At full power, condenser cooling water heated to 14.5°F (8.1°C) above inlet temperature will be discharged at the rate of 2940 cubic feet per second at the shoreline of the Gulf of Mexico.

- The heated water will be mixed with the Gulf water such that the zone within which temperatures may exceed 6°F above ambient, while of greater extent than that for Units 1 and 2 alone, is expected to be restricted to a volume having a surface extent of about 930 acres; the corresponding area within the 10°F isotherm would be about 325 acres.

- Studies of the environment with Units 1 and 2 operating at historical load factors, indicate a minor impact upon the benthic system due to thermal discharge. If Units 1 and 2 operated at full power, a major localized impact on the biota, including grasses and benthic organisms, could be expected in an area of about 280 acres due to the thermal plume. With Unit 3, also in operation at full power, and with the discharge system proposed by the applicant, the area of major localized impact would be expected to increase to about 930 acres. These estimates are based on zones in which temperatures could exceed 95°F in most years.

- At times of high exit temperature, fish will probably find the discharge area unacceptable and avoid it.

- The impact of small amounts of chemicals upon living forms in the ecosystem should be negligible, either alone or in synergistic combination with thermal increases.

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

- No significant environmental impacts are anticipated from normal operational releases of radioactive materials within 50 miles. The estimated dose to the population within 50 miles from operation of the plant is 0.16 man-rem per year, less than normal flucuations in the 25,000 man-rem/yr background dose this population would receive.

4. Principal alternatives considered:

   - Abandonment of the facility, including consideration of the use of an alternative fuel as a power source rather than nuclear fuel.

   - Extension of the discharge canal as a means for directing the plume away from the nearshore area.

- Dilution as an alternative heat dissipation scheme.
- Supplementary cooling as a heat dissipation method.
- Closed-cycle cooling systems as a heat dissipation method.

5. The following Federal, State and local agencies were asked to comment on the Draft Environmental Statement:

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
Florida Department of Pollution Control
Florida Department of Natural Resources
Florida Office of the Governor
Florida Public Service Commission
Board of County Commissioners, Citrus County, Florida
Mayor, Crystal River, Florida

Comments on the Draft Environmental Statement, issued in September 1972 were received from the following Federal, State and local agencies:

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 the Interior
Department of Transportation
Environmental Protection Agency
Federal Power Commission
Florida Department of Natural Resources
Florida Department of State
Florida State Agencies

In addition, comments on the Draft Statement were received from Mr. Chauncey C. Hale.

The text of these comments are appended to this Final Environmental Statement.

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

7. On the basis of the analysis and evaluation set forth in this statement, after weighing the environmental, economic, technical, and other benefits of Crystal River Unit 3 against environmental and other costs and considering available alternatives, it is concluded that the actions called for under the National Environmental Policy Act of 1969 and Appendix D to 10 CFR Part 50 are:

   a. The continuation of construction permit CPPR-51, and

   b. The issuance of an operating license for the facility subject to the following conditions for protection of the environment:

      (1) Initiate action to carry out the necessary environmental assessment of alternatives to establish the most acceptable alternative or alternatives to eliminate or reduce the environmental impact associated with entrainment and discharge of heated water to the Gulf of Mexico. This effort should be carried out concurrently with the study program specified in Condition (2) below. The applicant should be prepared to immediately proceed with detailed engineering and implementation of the alternative system should the need for such a modification be indicated by the results of studies in Condition (2). (Section 12.2.4.2)

      (2) Institute the study program, developed in conjunction with the Atomic Energy Commission, the Department of Interior and the Environmental Protection Agency to collect the necessary data by November 1974 to determine the need for an alternative cooling system. (Sections 3.4.1, 5.3.2, 5.3.3, 12.2.4.2 and 12.2.5.2)

      (3) Define environmental monitoring programs required for inclusion in the Technical Specifications (for the plant operation), which are acceptable to the staff for determining environmental effects which may occur as a result of the operation of the plant.

      (4) If other harmful effects or evidence of irreversible damage are detected, the applicant will provide an analysis of the problem and a proposed course of action to alleviate the problem.

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FOREWORD

This final statement on environmental considerations associated with the proposed issuance of an operating license for the Crystal River Unit 3 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 NEPA 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 esthetically 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 the 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 questions 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, with 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.

In addition, in a proceeding such as this which is subject to Section C of Appendix D of 10 CFR Part 50, the final detailed statement includes 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 as regards the previously issued construction permit is the continuation, modification or termination of the permit 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. Donald E. Sells is the AEC Environmental Project Manager (Area Code 301, 973-7242) for this statement.

1. INTRODUCTION

The Government of the State of Florida, under which the Florida Power Corporation (FPC) operates as a public utility, requires the Corporation to supply adequate electric power to fill the residential, industrial and commercial demands of customers within its service area (see Figures 1.1 and 1.2). Toward this end Florida Power Corporation applied to the AEC for licenses to construct and operate a nuclear power plant on a site near Crystal River in Citrus County, Florida. The plant, to be known as the Crystal River Unit 3, will occupy part of an established site where fossil-fueled, oil-burning Units 1 and 2, of 387 and 510 MWe, respectively, are already located.

The application was reviewed by the Regulatory Staff of the AEC's Division of Reactor Licensing and by the Commission's independent Advisory Committee on Reactor Safeguards, both of which concluded that the proposed reactor could be constructed at the Crystal River site with reasonable assurance that it could be operated without undue risk to the health and safety of the public. Afteraa public hearing had been conducted by the Atomic Safety and Licensing Board at Crystal River, Florida, the AEC authorized construction of the plant by permit No. CPPR-51 on September 25, 1968 in Docket 50-302.

The applicant submitted an Environmental Report on February 8, 1971 in response to the request of the AEC Division of Reactor Licensing in its letter dated July 15, 1970 and in compliance with the applicant's responsibilities under the NEPA. The report provided a summary description of the plant's environmental impact. As requested by the AEC, the report discussed the environmental aspects of Crystal River Unit No. 3, as set forth in Section 102(C) of the NEPA and presented other pertinent information requested by the AEC in its letter.

On September 9, 1971, the AEC published in the Federal Register a revised Appendix D to 10 CFR Part 50 setting forth AEC's implementation of the NEPA. Paragraph E(3) of revised Appendix D generally requires a holder of a construction permit issued prior to January 1, 1970, for which an operating license has not been issued, to furnish to the AEC within 40 days of September 9, 1971, a written statement of any reasons, with supporting factual submission, why with reference to the criteria in Paragraph E(2) of revised Appendix D the permit should

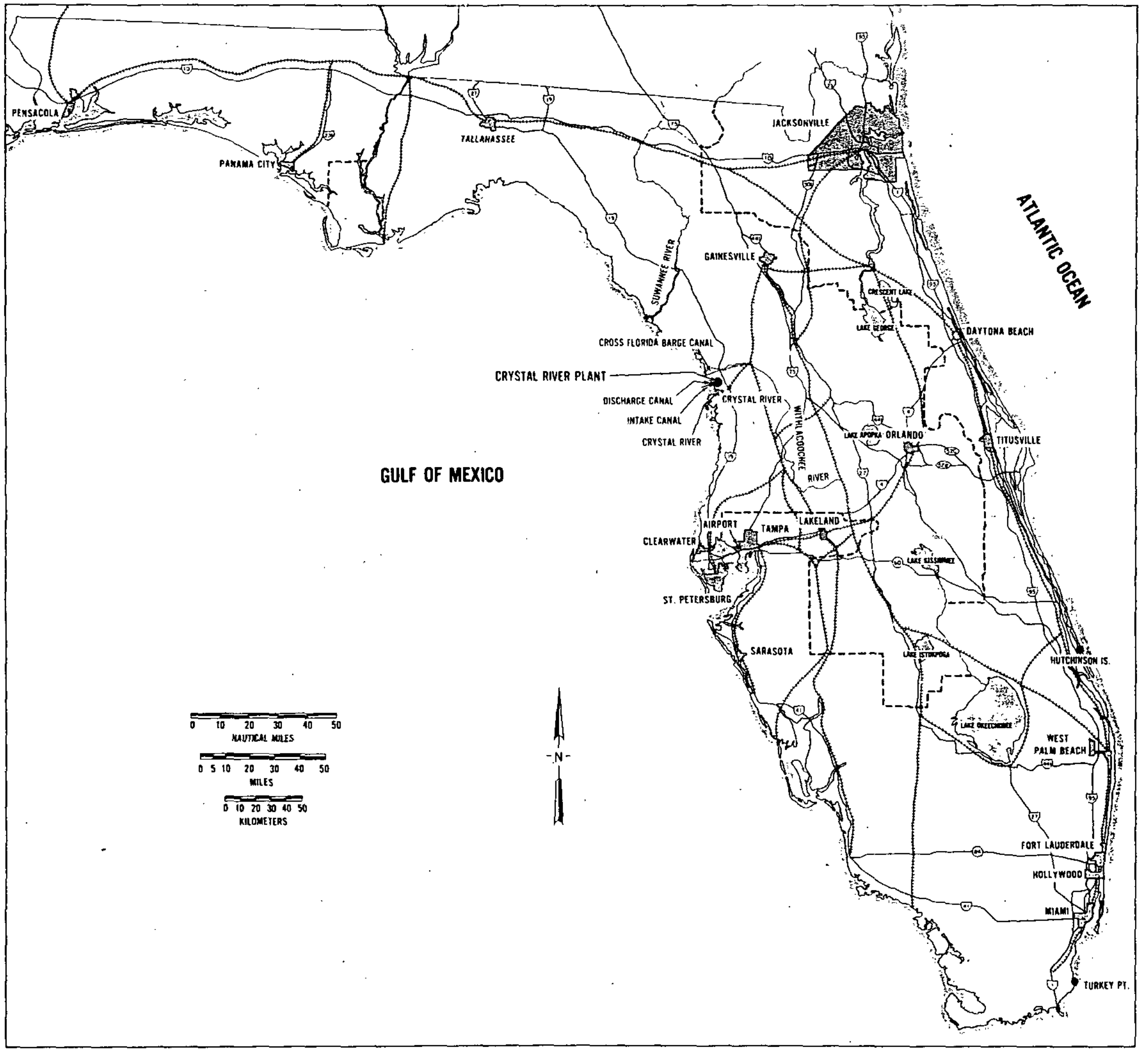

FIGURE 1.1 MAP OF FLORIDA SHOWING THE PLANT SITE

not be suspended, in whole or in part, pending completion of the NEPA environmental review specified in Appendix D.

On October 15, 1971, the applicant filed with the AEC the statement required by Paragraph E(3) of Appendix D and, in response to subsequent AEC questions, the applicant also supplied additional supporting information on November 9, 1971 as Amendment No. 15 to its Application for Licenses for Crystal River Unit 3.

In accordance with the requirements of Section E of Appendix D, the Division of Reactor Licensing, USAEC announced on November 23, 1971 that the construction permit for the Crystal River Unit 3 Nuclear Plant should not be suspended pending completion of the NEPA environmental review specified in Appendix D.

On October 15, 1971, the applicant notified the AEC that it intended to submit a new and revised environmental report to replace entirely the report submitted on February 8, 1971. The new report would contain the information called for under Section A, Paragraphs 1-5, of the revised Appendix D, and would incorporate the substance of the original Environmental Report as well as additions responding to the new requirements. The report referred to was issued in three volumes, Crystal River Unit 3, Environmental Report, Operating License Stage on January 4, 1972.

This Statement takes all of these writings into account; it uses information available in the applicant's Final Safety Analysis Report; it includes data and information obtained from a site visit in March 1972, as well as from other sources referenced in the text; finally, it relies heavily on professional calculations and appraisals made by the staff.

The applicant's reports and applications, the Safety Analysis Reports, and the AEC's Safety Evaluation are filed in the AEC Public Document Room, 1717 H Street, N.W., Washington, D. C. 20006 and in the Crystal River Public Library, Crystal River, Florida 32629.

This statement treats the projected environmental effects of Crystal River Unit 3, and the alternatives available for this unit, together with the cumulative potential effects with the two fossil Units 1 and 2.

Crystal River Unit 3 will employ a pressurized water reactor supplied by the Babcock & Wilcox Company and will have an initial gross electrical capacity of 855 MW. Gilbert Associates, Inc., has been retained as the Architect-Engineer.

The Nuclear Utilities Services (NUS) Corporation has been assisting the Florida Power Corporation engineering staff in environmental matters. The State of Florida Department of Natural Resources and the Department of Health and Rehabilitative Services were supported by Florida Power Corporation in the performance of special environmental studies at Crystal River. The Universities of Florida and South Florida were also retained under contract to perform other environmental studies related to the site. No studies of the Crystal River site area were conducted by the applicant prior to the initiation of construction and operation of Units 1 and 2. For this reason the results of completed and proposed studies may not truly reflect the original natural conditions of the site and its environs.

A number of approvals have been obtained as required by local, State and Federal agencies with regard to such activities as water use, waste discharge, dredging and environmental considerations. In addition to the operating license from the AEC, the applicant must also obtain a discharge permit under Sec. 401 of the FWPCA and an operating license from the State of Florida. A public hearing was held in connection with the application for a construction permit and is discussed in Section 1.2. The status of construction of the plant is described in Section 3.1.

1.1 SITE SELECTION

The applicant states that investigations were made for possible sites suitable for the construction of power plants both inland and along the coast within the Florida Power Corporation's service area. Various factors were considered during site selection, such as air pollution, location of power generation with respect to load, effect of the development of the area and addition of new customer loads, effects of heavy shipping, residential and recreational uses of the land, effect of transmission of bulk power and suitability of the site for future equipment installations.

Siting studies made in 1966 specifically to determine a site for nuclear development focused on three existing power plant sites within the Florida Power Corporation system. These three locations were the A.W. Higgins site, the Bartow site and the Crystal River site. The Higgins site is located at Booth Point on the upper reaches of old Tampa Bay approximately 16 miles north of the city of St. Petersburg and 8 miles east of Clearwater (see Figure 1.2). Factors leading to the rejection of this site were necessary land reclamation operations, the closeness of the site to airports and harbors, and the need for extensive facilities to minimize thermal discharge recirculation effects in the marine environment.

The Bartow site is located on Weedon Island along the shore of Tampa Bay approximately 8 miles northeast of the city center of St. Petersburg. Unfavorable factors making this site unattractive were the proximity of a large military airbase, the limitations of the property with regard to plant layout, intake and discharge locations, the required transmission of power from station transformers to substation, and the need for extensive facilities to minimize thermal discharge and recirculation effects in the marine environment. Both the A.W. Higgins and the Bartow sites were visited and inspected by the staff.

Investigations of the Crystal River site indicated that it was the best of the three mentioned for the location of the nuclear unit from the standpoint of cooling water sources, meteorology, and availability of land. At the time this conclusion was reached, the Crystal River Unit 1, a 387 MWe fossil-fired unit, was nearing completion and an additional 510 MWe unit, Crystal River Unit 2, was scheduled for construction. The Crystal River site also presented an economic advantage to the Florida Power Corporation. At the Higgins and the Bartow sites, additional costs, primarily for piling to bedrock, double containment and augmented gaseous waste holdup facilities made these two sites less attractive. The transportation of heavy components by barge to Crystal River or to Bartow appeared to present no difficult problems since existing navigation channels and the intake canal could be utilized; however, at the Higgins site a barge navigation channel would have to be dredged due to shallow waters.

In 1966 a small site at the mouth of the Anclote River just west of Tarpon Springs and about 20 miles north of St. Petersburg was considered but also rejected. In this consideration, Crystal River was chosen due to availability of a larger parcel of land.

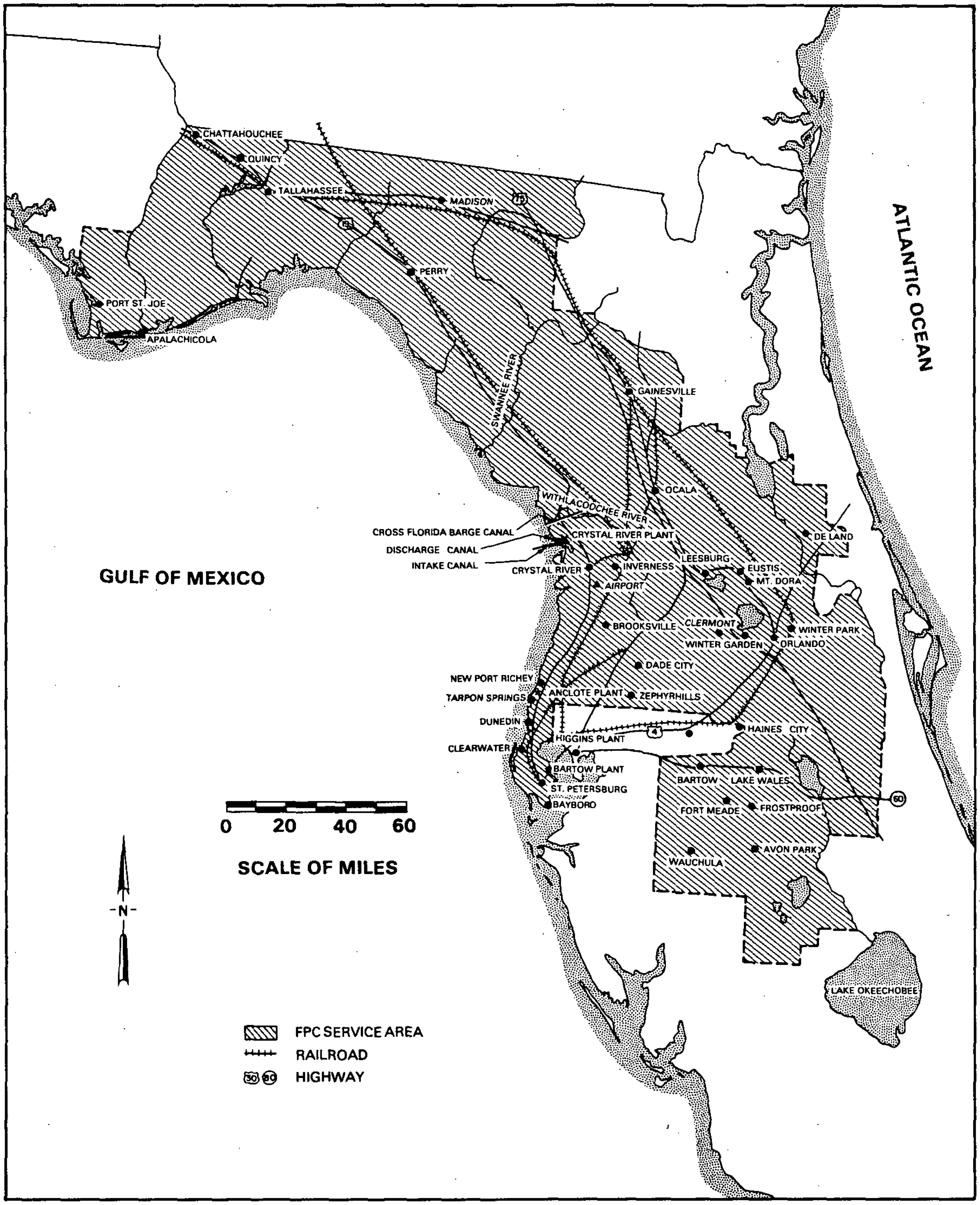

FIGURE 1.2 SERVICE AREA OF THE FLORIDA POWER CORPORATION

1.2 APPLICATIONS AND APPROVALS

A public hearing was held at Crystal River on July 16, 1968. The hearing lasted two days.

The permits, licenses or other approvals for construction, operation or environmental effects required for Crystal River Unit No. 3 are listed below. The list includes the applicable statutory or regulatory reference and the dates of issuance.

- A Provisional Construction Permit No. CPPR-51 was issued by the Director, Division of Reactor Licensing, USAEC, on September 25, 1968 for Crystal River Unit 3 (Docket No. 50-302).

- A permit to operate the Oceanographic Data Acquisition monitoring system was granted by the Federal Communications Commission for the Mobile Transmitting units on December 3, 1970 and for the fixed station transmitter on February 3, 1971.

- A permit No. CG 2554 to install 15 buoys and 25 station markers was granted by the United States Coast Guard on February 5, 1971.

- A permit No. SAJSP (70-489) to install 15 buoys and 25 station markers in the Gulf of Mexico was granted by the United States Corps of Engineers on February 4, 1971.

- Unit 3 Construction Permit No. IW-1113 was obtained from the Florida State Board of Health (now the Florida Department of Health and Rehabilitative Services) on September 26, 1968.

- The regulatory code for the Southwest Florida Water Management District agency went into effect on October 1, 1969 and is applicable to the plant with respect to wells. Well No. 3 was drilled during the period of August-September, 1966. During that time, no regulations were in effect to govern the drilling of wells. Thus, Well No. 3 does not and will not have a permit issued by the agency named.

- Necessary construction and building permits were obtained from Citrus County Board of Commissioners.

- The installation of temporary septic tanks during the period of construction was approved by the Citrus County Health Department.
- A dredging application to enlarge oil barge receiving dock facilities and to make a minor inland extension of the existing intake canal was approved by the Board of County Commissioners on June 1, 1971.

In addition to the agencies from which formal permits were required, as designated in the preceding section, a number of additional agencies and individuals have been contacted. A list of these agencies and organizations are as follows:

- Florida Department of Natural Resources
- University of Florida, Department of Environmental Engineering
- University of South Florida, Marine Science Institute
- United States Environmental Protection Agency
- United States Department of Interior
- Federal Aviation Agency
- Florida Trustees of the Internal Improvement Fund
- United States Coast Guard
- United States Public Health Service
- United States Department of Agriculture
- President's Water Pollution Control Advisory Board
- University of Miami, Rosentiel School of Marine and Atmospheric Science
- Florida State University, Office of Environmental Affairs
- Florida State Marine Research Laboratory
- Parks and Recreation, Marine Resources, State Department Of Natural Resources

. Florida Department of Transportation, State Road Department

. Florida State Museum, Gainesville, Florida

. Florida State Museum, Crystal River

. Florida State Department of Family Services, Inverness, Florida

. Inverness Hospital

. Hiller Medical Center, University of Florida, Gainesville, Florida

. City Manager, Crystal River

. Board of County Commissioners of Citrus County, Florida

. Coast Guard Auxiliary, Crystal River

2.0 THE SITE

2.1 GENERAL

The site for the plant to be known as Crystal River Unit 3 is in Citrus County, Florida, facing the Gulf of Mexico and situated about midway between the mouths of the Withlacoochee and Crystal Rivers. The general location is shown in Figure 1.1, a map of Florida, and in Figure 1.2, a map of the service area of Florida Power Corporation. The property is wholly-owned and controlled by Florida Power Corporation. It is in the northwestern portion of Citrus County approximately 7 1/2 miles northwest of the town of Crystal River and about 70 miles north of Tampa at latitude 28° 57' 24" N and longitude 82° 42' 2.4" W. It lies in the northwest corner of Section 33, Township 17S, Range 16E.

The region of the site is characterized by gradually rising terrain from mangrove swamp and marshland at the coast to gently rolling hills about 16 miles inland to the east. The plant site itself was primarily hardwood hammock forest and marshland, see figure 2.1 with a variety of vegetation ranging from swamp grass to large trees. The entire area is one of very low relief (2 to 5 ft above mean sea level) within the Terraced Coastal Lowlands of the coastal plain of west Florida.

Pine land constitutes the most significant part of the site area acreage, representing almost 60% of the total. Pasture and range constitute slightly less than 20% of the total surface but a major part of the woodland is also used for grazing.

2.2 LOCATION OF THE PLANT

The site consists of 4,738 acres including the 1/4-mile access strip provided for railroad, road, and transmission line right-of-way extending from the Plant to U.S. Highway 19. This strip is crossed by old U.S. Highway 19, 951 ft west of U.S. 19 and 2,224 ft east of the plant guard house and entrance. The general location of the site is shown in Figure 1.2. The major part of the property, superimposed on the previously existing shoreline, is shown in Figure 2.1.

The only major road within the 5-mile radius is U.S. 19, a major link in the St. Petersburg to Tallahassee system. A railroad spur off the Seaboard Coast Line Railroad serves the site. There

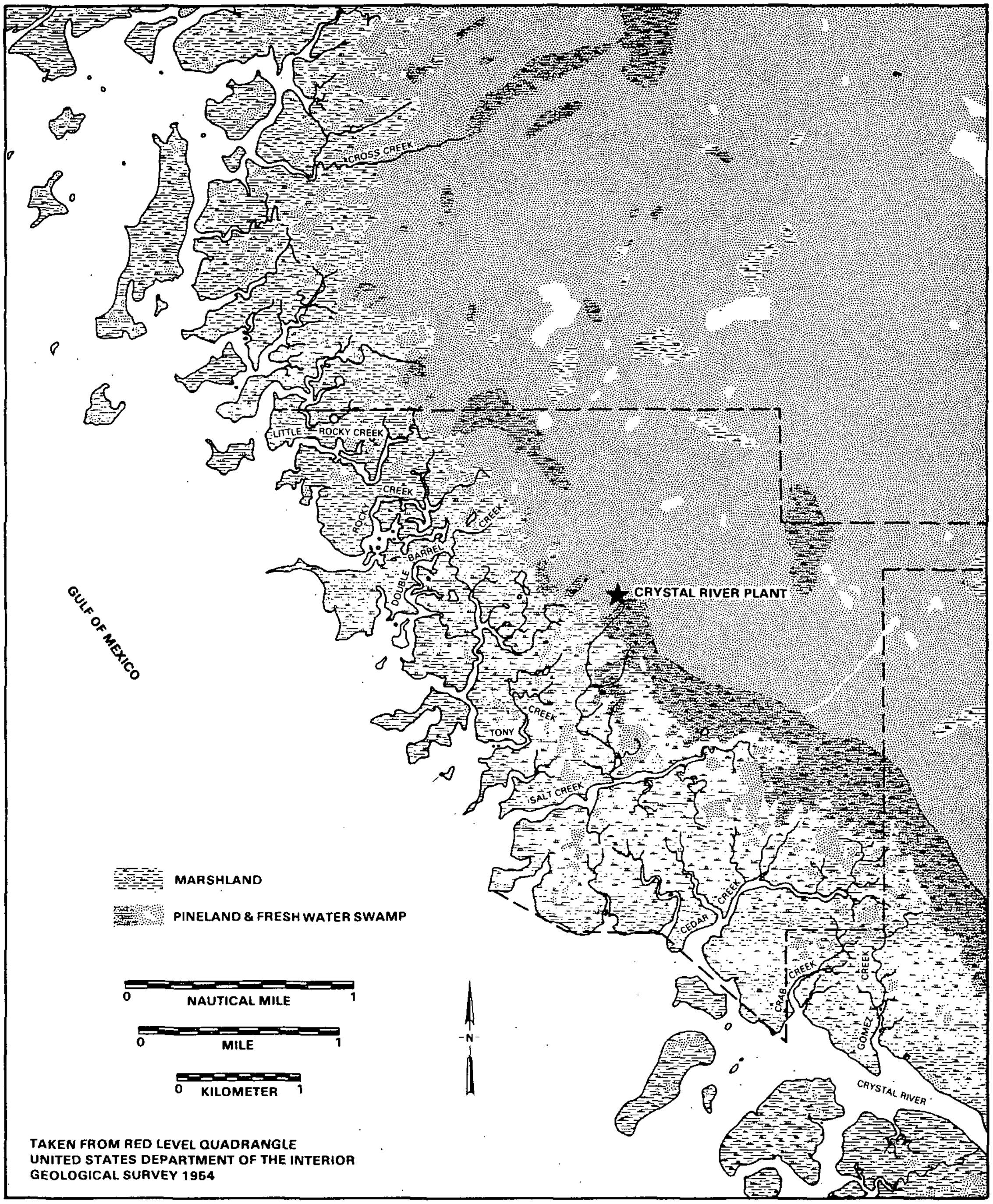

FIGURE 2.1 MAP OF THE SHORELINE WITH THE PLANT SITE SUPERIMPOSED

are no airports within the 5-mile radius. Boat landings are few, small and scattered. The proposed Intercoastal Waterway passes within 10 miles of the site in the Gulf of Mexico.

2.3 REGIONAL DEMOGRAPHY AND LAND USE

2.3.1 Farming

Scattered farms are located within the 5-mile radius area. Most of the land is not suitable for agriculture because of its marshy condition or high water table and pressure for land development is expected to reduce the number of farms in the future.

Agriculture is a major industry within 50 miles in the area east of Route 41. An agricultural belt extends south from Gainesville to Dade City in which the activities include the growing of citrus fruits, general farming and the raising of pigs, chickens, horses and cattle.

2.3.2 Human and Cultural Features

The year-round population within the 5-mile radius area is presently less than 100 persons but is expected[1] to be about 1,550 by the year 2020 as the area becomes less rural.

The area within a 50-mile radius is largely open with very low population densities, except for rural concentrations. The present population of the 50-mile radius area is estimated to be 155,900 persons. The largest city is Ocala with a population of 22,583. Gainesville, located 55 miles from the site, has a population of 63,818, while Tampa, about 70 miles south, has a population of 277,767 persons.

The projected year 2020 population of the 50-mile radius area is approximately 381,000 persons. This increase in population can be expected as a result of northerly expansion of the Tampa-St. Petersburg metropolitan area; growth of the Gainesville area, the influence of Disney World (about 80 miles to the East, near Orlando), and the improved employment conditions associated with this population growth.

Within 50 miles, urbanization occurs in two patterns. The first is the strip of residential, business and tourist development north along Route 19 from Clearwater to New Port Richey and the second is the urban concentration of small resort and residential communities such as Crystal River, Inverness, Brooksville, Ocala, and Homosassa Springs. The population distribution around the Plant site is shown in Figure 2.2.

Continued development of the Route 19 strip is anticipated. Both Citrus and Pasco Counties' master plans show expansion of Route 19 uses. Inland communities are expected to increase but not as quickly as Gulf-oriented areas.

2.3.3 Housing and Schools

The renter-occupied housing units in Citrus County represented about 11% of the total housing units in 1970. The average household size was 2.9 people in 1960 and 2.6 in 1970.

The school enrollment figures for Citrus County (Table 2.1) indicate an increase of 100% during the years 1960-1970.

2.3.4 Economic Conditions

The employment in Citrus County is shown in Table 2.2 where major employment categories are listed, giving the number of employees for March 1960 and for March 1969, with percentages and the percent change from 1960 to 1969. The last-mentioned year saw a 220% increase in the number employed in manufacturing, 140% increase in transportation and communication, 116% increase in government and 73% increase in construction. The only industry group to remain at the same level was that of finance, insurance, and real estate. Total agricultural employment decreased 6.7% of which the self-employed included in agriculture decreased 52% but hired labor increased 220%.

Of the 4,060 workers employed in Citrus County in 1969, 1,100 or 27% were directly employed at the Florida Power Corporation plants. A slow increase in residential construction is taking place and there are large landholdings where the land is being held for development. Effective buying income per household in the county was $6,104 in 1969, an increase of over 13% in the income per household in 1967.

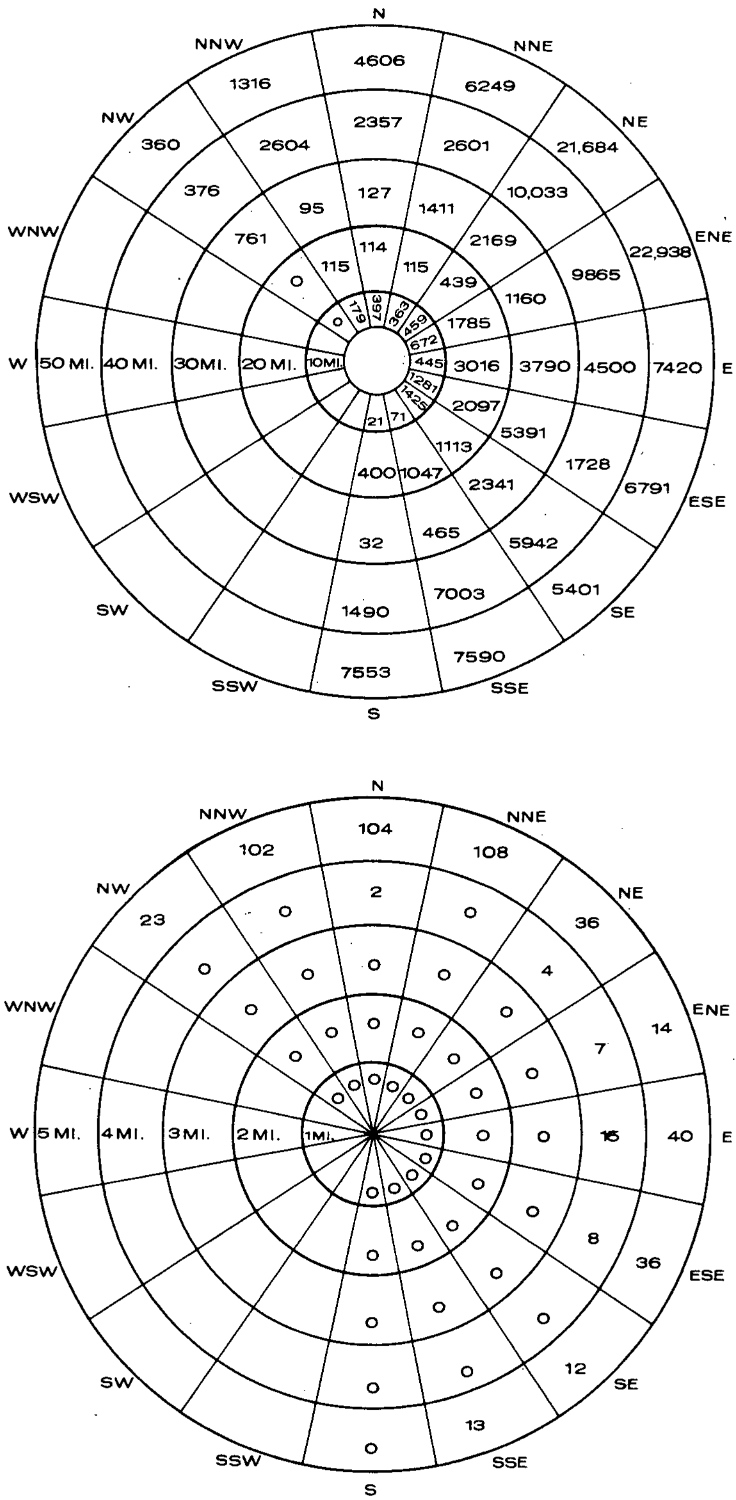

FIGURE 2.2 DISTRIBUTION OF POPULATION AROUND THE PLANT SITE, 1971

TABLE 2.1

SCHOOL ENROLLMENT, CITRUS COUNTY, FLORIDA

School Year	Enrollment
1960-1961	2293
1961-1962	2438
1962-1963	2650
1963-1964	2878
1964-1965	3010
1965-1966	3219
1966-1967	3174
1967-1968	3454
1968-1969	3541
1969-1970	3999
1970-1971	4382
1971-	4291*

* Enrollment as of September 27, 1971

TABLE 2.2

EMPLOYMENT BY INDUSTRY, BY PLACE OF WORK
CITRUS COUNTY, FLORIDA
1960-1969[2]

	1960 (March)	% of Total 1960 Employment	1969 (March)	% of Total 1969 Employment	Percent Change 1960-1969
Manufacturing	50	1.9	160	3.9	+220.0
Wholesale and Retail Trade	350	13.0	540	13.3	+ 54.3
Construction	150	5.6	260	6.4	+ 73.3
Transportation and Communication	0	0.0	140	3.4	+140.0
Government	250	9.2	540	13.3	+116.0
Finance, Insurance, Real Estate	100	3.7	100	2.5	0.0
Service and Other Wage and Salary	400	14.8	660	16.3	55.0
Total Wage and Salary Workers	1,300	48.2	2,400	59.1	+ 84.6
All Other Non-agricultural	1,000	37.0	1,220	30.0	+ 22.0
Total Non-agricultural Employment	2,300	85.2	3,620	89.1	+ 57.4
Self-employed and Domestic*	250	9.2	120	3.1	- 52.0
Wage and Salary Workers (Hired Labor)*	50	1.9	160	3.9	+220.0
Total Agricultural Employment	300	11.1	280	7.0	- 6.7
Total Unemployment	100	3.7	160	3.9	+ 50.0
Total Civilian Employment	2,700	100.0	4.060	100.0	- 50.4

* Agricultural Workers

2.3.5 Industry

The only major industrial operation within the 5-mile radius of the power plant is the Florida Power Corporation's Units 1 and 2 of the Crystal River installation. There is a small sand and gravel operation and a cement plant within and adjacent to the site.

The area is oriented toward tourism, recreation and agriculture. However, the preliminary plan for Citrus County defines a large area north of the Crystal River site, including a portion of Yankeetown, as suitable for industrial development.

Despite the constructed portion of the now terminated Cross Florida Barge Canal passing through the industrial area, major industrial development is not anticipated unless the canal project is reopened.

There are few industrial establishments in the 50-mile radius area and they are generally small and scattered. The only concentration of industry is around Ocala, approximately 45 miles from the site, and around Gainesville, somewhat more than 50 miles from the site. Sand and gravel operations are scattered throughout the area.

The basic rural character of the area is not expected to change in the coming 40 years due to the large amount of wetland, lakes and swamps, and the existence of major existing and contemplated State preservation areas. In the foreseeable future, new industry will probably be oriented north to Gainesville and south toward Clearwater at the perimeter of the 50-mile radius rather than within it.

2.3.6 Mariculture Laboratory

After a study of the practicability and benefits of mariculture at marine sites related to power plants, Florida Power Corporation and the Ralston Purina Company in February 1971 signed a 5-year joint research agreement to determine the commercial feasibility of culturing marine animals in the heated discharge water of the Crystal River power plants.

The facility for this project is located on filled land between the intake and discharge water canals at the Crystal River site. The facility presently occupies 10 acres and consists of a 75 ft by 160 ft laboratory and hatchery building and 9 raceways each 50 ft by 400 ft. Over a 5-yr period it is envisioned that the facility will occupy as many as 50 acres. The project is focusing initially on culturing shrimp.

2.3.7 Land Transportation

The present daily traffic volume generated by Unit 3 construction is estimated to total 1,000 cars and 100 to 200 trucks. This also includes short distance transportation of concrete, sand and fill. The rail traffic is approximately 12 railroad cars per week. The Florida Department of Transportation District Office indicated that there have been no problems created by the traffic to and from the plant site. The plant officials have indicated slight congestion at the intersection with Route 19 during peak hours.

2.3.8 Air Transportation

Tampa International Airport is located about 10 miles outside the 50-mile radius. Airports within the 50-mile area are located at Crystal River, Masaryktown, Ocala and Williston.

2.3.9 Recreational Features

The immediate 5-mile radius area has little land recreational activity. A minor undeveloped State park is located along the north bank of the Crystal River. On the other hand, water-based recreation is extensive.

Water recreational activity centers largely upon sport-fishing from small boats near or within a few miles of the shore. The marshy terrain of the shoreline severely limits sport-fishing from the banks, and the relatively shallow water and numerous reefs restrict near-shore commercial fishing. Beach recreational activities are restricted by the lack of sandy beaches, although there is some skin diving and water skiing from small craft. Sport-fishing catches include over 25 species of finfish, including redfish (Sciaenops oscellata), spotted seatrout

(Cynoscion nebulosus), silver perch (Bairdiella chrysura), spot or jimmy (Leiostomus xanthurus), black drum (Pogonias cromis), Atlantic croaker (Micropon undulatus), and sheepshead (Archosargus probatocephalus). Desired shellfish include American oysters (Crassostrea virginica), blue crab (Calinectes sapidus), and stone crab (Menippe mercenaria). During the cooler winter months, extensive fishing now occurs in the discharge canal of the existing Crystal River plants where the warmed water attracts sport-fish. The recreational potential for sport-fishing in the area should increase over the coming 40 years.

The most important commercialized recreation centers in the area are Homosassa Springs, Rainbow Springs and Weekiwachee. Other tourist attractions include: Yulee Sugar Mill, Cedar Keys, Manatee Springs, and Silver Springs. Several golf courses are scattered throughout the area and although they have a significant local impact, they are minor users of land. Disney World is located 30 miles beyond the 50-mile radius near Orlando.

2.3.10 Unique Natural Environments and Scenic Values

A small area of salt marsh and swamp combined with the opening of the Crystal River to the Gulf of Mexico is the ecologically sensitive area within the 5-mile radius area. A portion of this area off Route 19 and along the Crystal River is subject to real estate development, threatening the immediate surrounding environment.

The 50-mile radius area includes a number of important natural environments including salt marsh and swamps, fresh water swamps and hammocks, a lake complex, the major river systems, and grass flats.

2.3.11 Wildlife Preserves

Original acquisition of a plant area substantially in excess of that required for structures or construction has resulted in the preservation of a substantial buffer zone containing lands, salt marshes and small tidal creeks which are protected against encroachment from any other coastal development. Hunting is prohibited, thus providing a preserve for the wildlife existing in the area.

2.3.12 Public Recreation Facilities

Due to its remote location, the character of the shoreline, and the low population density, the site itself originally had only marginal recreational value. Since the Crystal River Plant Units 1 and 2 have commenced operation, sport-fishing in the plant canal waters, open to the public by sea, has been substantially enhanced. The applicant anticipates that the addition of the nuclear Unit 3 will not change this present accessibility to the public for sport-fishing or other recreational uses of the area, unless a supplemental cooling water alternative installation requires restriction.

2.4 HISTORICAL SIGNIFICANCE

The area between the north bank of the Crystal River and the south bank of the Withlacoochee has a well authenticated history.

There are numerous areas and sites of archeological and paleontological importance in the 50-mile radius area (see Figure 2.3). These include fossils in the larger rivers, indications of earliest man in association with remains of the last extinct animals, and Indian mounds and artifacts.

The Crystal River Historical Memorial is located along the north bank of the Crystal River. This area existed as a ceremonial center for the local Indian population up to about 1400 A.D. More than 450 burials have been found at that site since study and excavations began in 1903. Unique features of the site are the two stone stelae found there. These are the only two known to be in the United States.[3]

There are no historical landmarks immediately adjacent to the plant site listed in the National Register of Historic Places. The only listed[4] historical landmarks in the vicinity of Crystal River are the Crystal River Indian Mounds and the Yulee Sugar Mill ruins at Homosassa Springs. Other sites of historical and scientific significance in this part of the State are also shown in Figure 2.3.

Figure withheld per Section 304
of the National Historic Preservation Act
of 16 U.S.C. 470, et. seq.

FIGURE 2.3 SITES OF SCIENTIFIC INTEREST IN THE GENERAL AREA

After the purchase of Florida from Spain in 1821, the fertile area between the Withlacoochee and Crystal Rivers became settled. Fruit groves were started and cattle ranches flourished after the land was cleared. At Port Inglis there was considerable business and commerce. Captain Inglis' home is the only remaining structure still to be found there.

The construction and operation of the nuclear plant should not result in alteration of any site of historical or scientific value.

2.5 ENVIRONMENTAL FEATURES

2.5.1 Geology

The most significant rocks at the site are biogenic carbonates (limestones and dolomites) of Tertiary age dipping gently in a southwesterly direction. Two distinct Eocene formations were identified during the test borings. The upper is the Inglis member of the Moody's Branch Formation that overlies dense silts, sands, and organic clays of variable thickness. The lower sequence of carbonates is the Avon Park Formation, a highly variable sequence that had developed an irregular surface when exposed and that served as the structural framework for the younger sediments deposited upon it.

A seismic study indicated that the State of Florida is seismically inactive and no earthquake is known to have occurred within 50 miles of the site. The two strongest earthquakes to have affected the area were the Northern Florida earthquake (1879) listed as Modified Mercalli VI (see Table 2.3) and the Charleston, South Carolina earthquake of 1885 which had an intensity X, Modified Mercalli. Based upon the relationship between earthquake intensity and ground acceleration, the Charleston earthquake would have resulted in a ground acceleration of approximately 0.025g at the site. The nearest faulting occurs at a distance of 3 miles to the east of the site. Stratigraphic and seismic refraction evidence indicates the nonexistence of subsurface faults at the site.

TABLE 2.3

MODIFIED MERCALLI INTENSITY SCALE OF 1931
(Abridged)

I. Not felt except by a very few under especially favorable circumstances.

II. Felt by only a few persons at rest, especially on upper floors of buildings. Delicately suspended objects may swing.

III. Felt quite noticeably indoors, especially on upper floors of buildings, but many people do not recognize it as an earthquake. Standing motorcars may rock slightly. Vibration like passing of truck.

IV. During the day felt indoors by many, outdoors by few. At night some awakened. Dishes, windows, doors disturbed; walls make creaking sound. Sensation like heavy truck striking building. Standing motorcars rocked noticeably.

V. Felt by nearly everyone, many awakened. Some dishes, windows, etc., broken; a few instances of cracked plaster; unstable objects overturned. Disturbances of trees, poles, and other tall objects sometimes noticed. Pendulum clocks may stop.

VI. Felt by all, many frightened and run outdoors. Some heavy furniture moved; a few instances of fallen plaster or damaged chimneys. Damage slight.

VII. Everybody runs outdoors. Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable in poorly built or badly designed structures; some chimneys broken. Noticed by persons driving motorcars.

VIII. Damage slight in specially designed structures; considerable in ordinary substantial buildings with partial collapse; great in poorly built structures. Panel walls thrown out of frame structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned. Sand and mud ejected in small amounts. Changes in well water. Persons driving motorcars disturbed.

IX. Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb; great in substantial buildings, with partial collapse. Buildings shifted off foundations. Ground cracked conspicuously. Underground pipes broken.

X. Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations; ground badly cracked. Rails bent. Landslides considerable from river banks and steep slopes. Shifted sand and mud. Water splashed (slopped) over banks.

XI. Few, if any, (masonry) structures remain standing. Bridges destroyed. Broad fissures in ground. Underground pipelines completely out of service. Earth slumps and land slips in soft ground. Rails bent greatly.

XII. Damage total. Waves seen on ground surface. Lines of sight and level distorted. Objects thrown upward into the air.

As part of the investigation of the site, geology bedrock dissolution studies were carried out to determine the rate at which the carbonates dissolved and to establish the effect that such a process would have on the foundations of the plant. The study indicated that the volumes potentially dissolved from the bedrock beneath the plant would not represent a significant amount of deleterious action. Further, a grouting process used beneath Units 2 and 3 reduced the permeability of the carbonate rocks by a factor of more than 30 times, thus reducing the exposure of the limestone to potential solvent groundwater by the same factor. On the basis of these considerations, dissolution of limestone beneath the plant is not considered to be a significant problem.

Bedrock at the site is approximately 20 ft beneath present ground surface which is largely fill material. The surface fill is of variable thickness and density and is comprised of coarse silty sand and limestone fragments. The natural soil cover of the remainder of the site consists of recent deposits of thinly laminated organic sandy silts and clays, interspersed with a Pleistocene marine deposit. These deposits blanket the site and have a variable thickness averaging approximately 4 ft. Beneath these soils is the residual limey soil unit derived from the decomposition of the underlying bedrock. The groundwater occurs at a depth of approximately 10 ft below ground surface.

The mineral resources in the area include limestone, dolomite and phosphate. Several quarries in the Citrus-Levy County area have intermittently produced crushed limestone, mainly for road construction. The closest to the site lies 4 miles southeast of the town of Crystal River, 12 miles southeast of the power plant site. The quarry is presently idle but still contains mineable rock. Two active open-pit dolomite mines exist near the plant site. One adjoins the power plant property on the east, and the other is 12 miles northeast. The dolomite is mined mainly as a fertilizer additive.

Most of the open pit phosphate mines in this area have been abandoned; however, a small segment of the industry is presently remining old spoil sites to recover "soft" rock phosphate. A north-northwest trending bank of "hard" rock phosphate passes through the eastern parts of Citrus and Levy Counties.

It is significant to the radioactivity background of the area that the Florida phosphate deposits, certain of the terrace "black sands," and the limestone which has produced a large fraction of the usual soil, all contain greater amounts of naturally-occurring radionuclides, contributing to a higher than expected background radiation dose. These radioactive materials give rise to a small radiation dose from the particulate and gaseous materials released by natural decay and weathering.

Other presently undeveloped mineral resources of the general region include: construction sands, glass sands, and heavy mineral concentrates from the "black sands." Aside from local use in construction, the sands and associated minerals are not being exploited in the counties adjoining the plant.

Three petroleum exploration holes have been drilled in Citrus County, eight in Levy County, and two in the offshore area within 10 miles of the coast. None has yielded commercial quantities of oil or gas.

2.5.2 Climatology and Meteorology

The climate of the region is subtropical, characterized by dry winters and rainy summers, a high annual percentage of sunshine, and high humidity. Rainfall averages about 55 in/yr., with more than 50% of the total occurring during the months of June through September. Temperatures seldom exceed 90°F nor fall below 32°F. Prevailing winds are easterly but the coastal region at the site experiences local circulations caused by land-sea interactions.

Since 1871, 56 tropical storms or hurricane centers have passed within 50 miles of the Crystal River site. After 1885, weather records differentiated between tropical storms (winds <73 mph) and hurricanes (winds >73 mph). Since 1886, there have been 44 passages of tropical storms, with a maximum of 13 hurricanes experienced within 50 miles of the site. Relatively few storms have moved inland on Florida's west coast between Cedar Keys and Fort Meyer in the past 80 years.

Of the 723 reported occurrences of waterspouts in Florida from 1948 through 1969, 355 were observed on Florida's west coast. Waterspouts have occasionally caused considerable damage to shipping, and have also become destructive tornadoes when crossing from water to land.

In the period 1916-1969, 590 tornadoes were reported in the State of Florida. About 66 of these were associated with the passage of tropical storms.

The meteorology in the region of the site has been evaluated to provide a basis for determination of annual average radioactive waste gas release limits, estimates of exposure from normal operations and potential accidents, and design criteria for storm protection. The information is based on an observation period of September 1968 through July 1970.

The on-site meteorological facility at the Crystal River site initially consisted of a Bendix Aerovane wind transmitter mounted on top of a 150-ft tower; this places the sensor at approximately the same elevation as the top of the containment structure. The tower is located approximately 1440 ft south and 170 ft west of the Unit 3 reactor building. The transmitted data are recorded on a Bendix chart recorder system and are independently reduced to 15-minute averages of wind speed, wind direction, and directional variance. In July 1970 an additional wind sensor was installed at an elevation of approximately 30 ft.

Analysis of site meteorological data for the period from September 1968 through July 1970 indicated that the average wind speed is 11.4 mph and that calm conditions occur less than 1% of the time annually. Winds blow offshore about 49% of the time and thus would then transport any possible radioactive release toward the Gulf of Mexico. Although stable conditions occur about 60% of the time, average wind speeds associated with these conditions exceed 12 mph and result in favorable diffusion. The conditions referred to are based on observations at the 150-foot level and may not be representative of conditions closer to the ground.

2.5.3 Hydrology

Of the rainfall at the site, the total evaporation is estimated to amount to 38 in/yr, leaving an average of 17 in. for surface runoff and aquifer recharge. Very high rainfall rates may accompany tropical storms in the area. The maximum 24-hr rainfall accumulation measured near the site was 38.7 in. and occurred as Hurricane Easy passed near the coast in 1950. In addition the site is subject to hurricane surges.

The plant site is centered between the mouths of two rivers; the Withlacoochee, 3.8 miles to the north, drains 1700 square miles and is the larger of the two. The Crystal River is located 3.8 miles to the south, and is fed primarily by artesian springs. The Withlacoochee River has an annual average flow of 1170 cfs, with historical extreme flows ranging from 8640 to 113 cfs. The Crystal River flow has been 600 cfs on an annual average basis.

The Floridan aquifer is an artesian aquifer which underlies most of the State and parts of Georgia, South Carolina, and Alabama. This aquifer consists of limestone formations several thousand feet thick, and is generally covered by more impermeable formations. In the vicinity of the plant, the Inglis limestone and the Avon Park limestone occur near the surface and contain water under water table conditions. The top of the water table lies 8 to 10 ft beneath grade surface and slopes (2 ft/mile) in a westerly direction toward the Gulf of Mexico. The aquifer recharge rate is estimated from rainfall and evaporation data to be approximately 12 million acre-ft/yr or 10.5 billion gal/day. The limestone aquifer is highly porous, with a permeability of 10^{-3} cm/sec or greater. Thus, surface waters located above the water table will filter into the groundwater table very rapidly.

Salt water from the Gulf intrudes into the fresh water table to an extent depending on the tidal fluctuations and groundwater recharge rates. At the plant site, groundwater level varies 1.5 ft in response to tidal changes in sea level of 3.5 ft. During periods of low aquifer recharge rates, slight lowering of the water table may cause salt water intrusions as far as one mile east of the plant. Ten miles inland, a salt water-fresh water interface occurs in groundwater at a depth of 300 ft. At the plant site this interface occurs near the surface.

The Crystal River site is characterized by a low topographic relief averaging less than 5 ft in elevation. The flat topography, combined with the low energy coastline and tidal range, has led to development of salt marsh along the coast some 3/4 miles wide. The dominant physical forcing function is the tide which creates dendritic tide channels dissecting the land masses in the salt marsh.

2.5.4 Oceanography

The oceanography of the site and immediate area, particularly the mixing zone for the heated effluent, is described in detail in Appendix D. Principal influences have been superimposed on this area of the Gulf by the activities of man, specifically the construction of the Cross Florida Barge Canal and the intake and the discharge canals.

Acreages covered by the thermal plume with Units 1 and 2 operating at 100% power were estimated from the information previously reported by the applicant. These acreages will be used in Section 5 when establishing the impact of Unit 3 operation. The specific area with which the staff is most concerned is the area covered by the 6°F ΔT and greater isotherm. This is 200 acres, 360 acres and 510 acres for flood tide, ebb tide and full tidal cycle, respectively (see Section 5.3.2.4.2 and 12.2.6.2).

Salinity in the area varies widely throughout the year. Fresh water flowing into the estuary plays a major role in this flucuation. The range in the vicinity of the plant discharge is 22 to 29 ppt compared to 35 ppt 8-10 miles offshore. This fresh water intrusion is also a principal factor in causing the thermal plume to dive instead of float on the Gulf waters.

Winds play a minor role compared to tidal fluctuations in determining flow platterns near the site, except during hurricanes. The "Maximum Probable Hurricane" is projected to be one which approaches the coast from the south, with onshore winds having a maximum speed of 138.5 mph.

2.6 ECOLOGY OF SITE AND ENVIRONS

2.6.1 Terrestrial Ecology

The physiognomy of the site can be characterized by five vegetative units consisting of four natural community types (swamp, pinelands, hammocks, marshes) and ruderal areas.[5,6]

The existing intake and outlet canals traverse salt marsh land. Salt marshes are constantly influenced by tidal action and thus dissected by scour channels. They are usually referred to as semi-aquatic marine habitats.

The characteristic terrestrial habitat next immediately inland is termed hardwood hammock forest. The construction site and existing facilities occupy such an area (see Figure 2.1). Hammocks are somewhat raised and drier (mesic) than the surrounding territory and often have an island-like appearance. Further subdivision of hammock forest based on the vegetation and moisture relations is possible. Hammocks have a varied and complicated makeup with many kinds of trees, shrubs, vines, birds, mammals, amphibians, reptiles, and invertebrates.

Farther inland, e.g., at the eastern end of the applicant's transmission line corridor and along rights-of-way, the predominant community type is pineland. Pinelands often are savannah-like in appearance, due to occasional fire which maintains the openness, or they have a definite layered appearance with palmetto palms forming a dense understory. The number of species of plants and animals is considerably less than that of the hammocks. About 19% (425 acres) of the pineland along the transmission line rights-of-way is used for agriculture (beef and dairy production, citrus orchards, and forestry).

Wherever wet depressions occur, a swamp-type community exists. There are some swampy areas at the construction site which are very complicated in their makeup because of the occasional influence of saltwater. Discontinuous flooding is the main feature of the swamps.

Typical ruderal communities exist wherever construction disturbance has somewhat stabilized, such as roadway barrow pits and drainage ditches, or where the vegetation is managed as beneath transmission lines. These communities vary and depend in part upon the original type, the degree of disturbance, and the kind of maintenance. They are obviously attractive to some wildlife as food sources. Deer browse beneath transmission lines and egrets feed along the discharge canal and roadside drainage ditches, for examples.

The applicant has not supplied a detailed analysis of the biotic makeup of the main community types found at the site, but has provided a general description. Table 2.4 lists some of the plants and animals most likely to occur at the site. The range of 17 rare or endangered species[7] overlaps the site, but only two, the American Osprey and the Southern Bald Eagle, are considered to be potentially influenced by construction or operation

TABLE 2.4

PLANTS, MAMMALS AND BIRDS CHARACTERISTIC OF THE COMMUNITY-TYPES FOUND AT THE CRYSTAL RIVER SITE

Saltwater Marsh

Plants: Smooth cordgrass (*Spartina alternifolia*)
Black rush (*Juncus roemerianus*)

Mammals: Central Florida rice rat (*Oryzomys palustris*)
Florida water rat (*Neofiber alleni*)
Florida mink (*Mustela vison*)

Birds: Great blue heron (*Ardea herodias*)
White ibis (*Guara alba*)
Mallard (*Anas platyrhynchos*)
Redwinged blackbird (*Agelaius phoenicus*)

Swamps

Plants: Pond cypress (*Taxodium ascenduns*)
Swamptupelo (*Nyssa biflora*)
Swamp ash (*Fraxinus pauciflora*)

Mammals: Florida short-tailed shrew (*Cryptotis parva*)
Seminole bat (*Lasiurus seminola*)
Florida long-tailed weasel (*Musela frenata*)

Birds: White throated sparrow (*Zonotrichia albicollis*)

Hardwood Hammocks

Plants: Magnolia (*Magnolia grandiflora*)
Laurel oak (*Quercus laurifolia*)
Blue beech (*Caprinus caroliniana*)

Mammals: Florida marsh rabbit (*Sylvilagus palustrus*)
Eastern gray squirrel (*Scuirus carolinensis*)
Bobcat (*Lynx rufus*)

Birds: Turkey vulture (*Cathartes aura*)
Cardinal (*Richmondena cardinalis*)

TABLE 2.4 (Cont'd)

Pinelands

Plants:	Slash pine (Pinus elliottii)
	Loblolly pine (Pinus taeda)
	Palmetto (Serenoa repens)
Mammals:	Oppossum (Didelphis marsupialis)
	Florida deermouse (Peromyscus floridanus)
	Florida striped skunk (Mephitis mephitis)
Birds:	Florida bob-white (Colinus virginianus)
	Prairie warbler (Dendroica discolor)

Ruderal Areas (including artificial canals)

Plants:	Wiregrass (Aristida stricta)
	Cattail (Typha latifolia)
	Duckweed (Lemna spp.)
Mammals:	Florida cottontail (Sylvilagus floridanus)
	Cotton rat (Sigmoden hispidus)
	White tail deer (Odocolleus virginianus)
Birds:	American coot (Fulica americana)
	Common egret (Casmerodius albus)

of the facility.[8] The applicant has sponsored a literature study in conjunction with the radiological survey[9] which produced a checklist (and dietary) of possible animals and plants which may occur in the vicinity of the site. The report cites: 254 species of woody plants, 47 species of mammals, 233 species and subspecies of birds, 68 species of snakes and other reptiles, 28 species of amphibians and 48 species of insects and invertebrates.

2.6.2 Aquatic Ecology

2.6.2.1 Shoreline Marshland Ecosystem

The marshland forms the transition zone between the terrestrial and marine ecosystems and, at the site, consists of an extensive development of salt marsh vegetation in a coastal band some 3/4 mile wide. This band is dissected by dendritic tide channels where the deepest channels of maximum flow velocity and scouring action occur seaward. The sediment of the salt marsh band is primarily mud with small areas of exposed limestone and oyster shell banks. This zone is characterized by fluctuating salinity due to the influx of freshwater and by a high primary productivity attributable largely to the coastal marsh and to intermittent beds of sea grasses and attached algae.[10-12] The salt marsh is the most important energy source in the inshore system.

The marshland habitat at the site is typical of areas found along the northwest Gulf coast of Florida. Marsh grasses, especially Juncus and Spartina and other salt-tolerant plants, border an array of shallow creeks and bayous (Figure 2.4). The marsh habitat here and elsewhere along western Florida serves as a nursery area for numerous species of finfishes, including mullet, spot, black drum, redfish, croaker, mojarra, and silversides.

This habitat also supports considerable numbers of small oysters and blue crabs. Although sensitive to temperature and salinity changes at certain stages of development, in general these species are tolerant of wide ranging temperature and salinity conditions during their life-cycle. Marshland vegetation provides immense quantities of organic detritus, which contributes to the food chains of many commercial and sport species both within the marshland and beyond.[11,13,14]

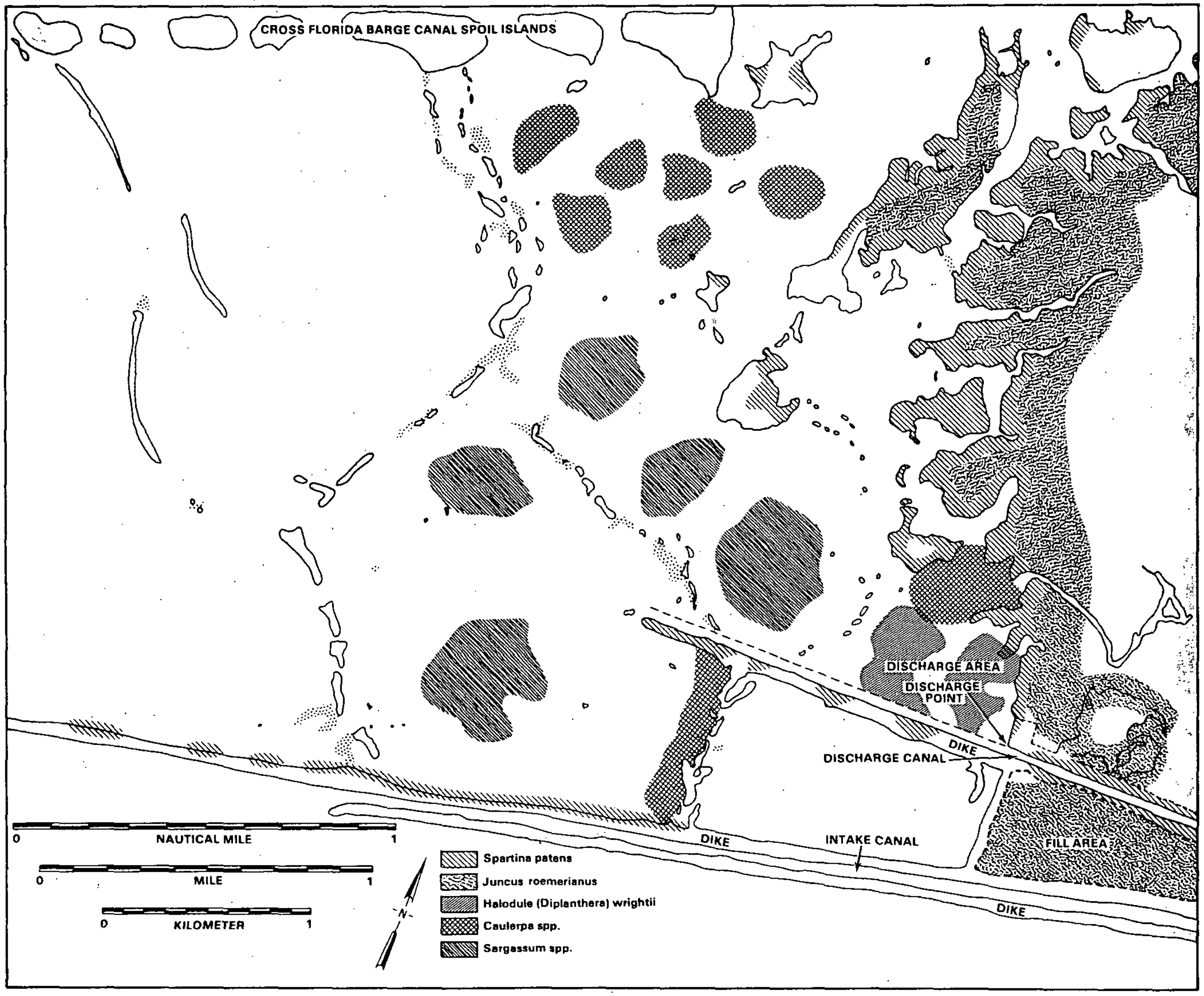

FIGURE 2.4 DISTRIBUTION OF CERTAIN MARINE GRASSES IN THE DISCHARGE AREA (In this and subsequent maps, many of the islands shown emerge only at low tide)

The scouring action of water movement and the normally turbid and dark coloration within the tide channels preclude colonization by submerged aquatic macrophytes. The dominant organisms in the channels are sessile and burrowing invertebrates, accompanied by fluctuating populations of small finfish. The mud banks delineated by the channels and exposed at low tide are colonized by salt marsh plants, predominantly smooth cordgrass (Spartina alterniflora) and black rush (Juncus roemerianus). These two plants and the algae combine to form the major producer components of the marshland trophic system (Figure 2.5). Small areas of mangroves and Salicornia scattered throughout the salt marsh contribute to primary productivity and nutrient cycling, as do algae in the surface layers of the sediment.[15,16]

Because of the large standing crop of producers, the 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 along food chains. Thus, the salt marsh at Crystal River is a dynamic producing system that supports an in-site fauna and contributes, in terms of both energy and habitat, to the production of fish, shellfish, waterfowl and some faunal components of the contiguous terrestrial system.

2.6.2.2 Nearshore Marine Ecosystem

The nearshore marine ecosystem is the portion of the Gulf of Mexico that comes under the influence of the intake and discharge of cooling water used at the present Crystal River Units 1 and 2. It includes such habitats as beds of submerged sea grasses, oyster reefs, outcroppings of limestone rock, mud-flats adjacent to the shoreline and coastal islands, and areas favorable to the production of fishes, shellfishes and a variety of marine invertebrates. This ecosystem is bordered to the south by the intake canal spoil bank, to the west by oyster reefs, and to the north by the Cross Florida Barge Canal spoil bank islands. Trophic pathways in the nearshore marine ecosystem are illustrated in Figure 2.6.

2.6.2.3 Finfish and Shellfish Populations

Finfish and shellfish near Crystal River which are either important as sport and/or commercial species or involved in the food chain of the important species are listed in Table 2.5. On-site studies

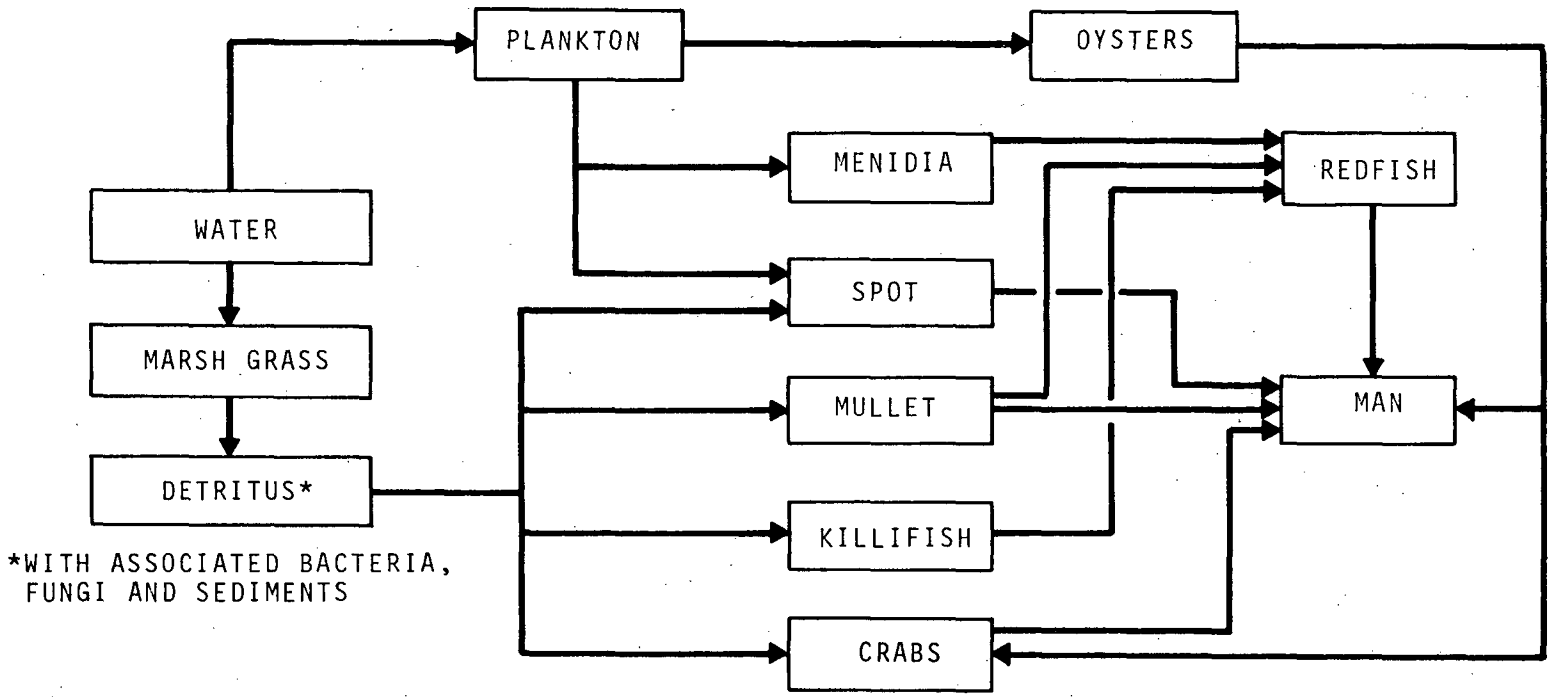

FIGURE 2.5 TROPHIC PATHWAYS IN THE MARSHLAND ECOSYSTEM

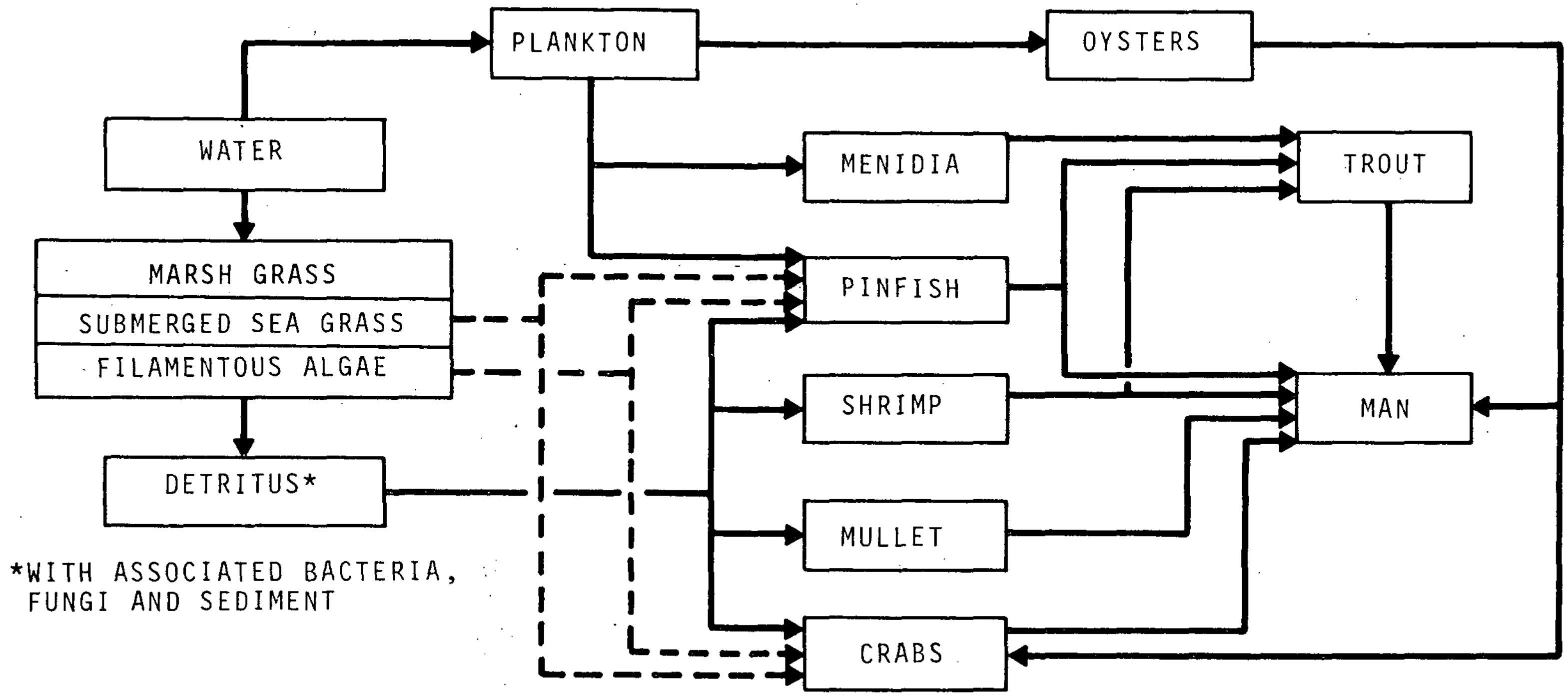

FIGURE 2.6 TROPHIC PATHWAYS IN THE NEARSHORE ECOSYSTEM

TABLE 2.5

SPECIES OF MARINE FISH AND SHELLFISH IN THE CRYSTAL RIVER AREA

Species	Common Name	Sport and/or Commercial Species	Food Chain Species
Megalops atlantica	tarpon	X	
Elops saurus	ladyfish	X	
Brevoortia patronus	Gulf menhaden	X	X
Harengula pensacolae	scaled sardine	X	X
Opisthonema oglinum	thread herring	X	X
Anchoa hepsetus	striped anchovy		X
Anchoa mitchilli	bay anchovy		X
Bagre marinus	gafftopsail catfish	X	
Hyporhamphus unifasciatus	half beak		X
Centropristes striata	black sea bass	X	
Diplectrum formosum	sand perch	X	
Epinephelus itajara	jewfish	X	
Epinephelus morio	red grouper	X	
Mycteroperca bonaci	black grouper	X	
Mycteroperca microlepis	gag	X	
Pomatomus saltatrix	bluefish	X	
Rachycentron canadum	cobia	X	

TABLE 2.5 (Cont'd)

Species	Common Name	Sport and/or Commercial Species	Food Chain Species
Caranx hippos	crevalle jack	X	
Caranx chrysos	blue runner	X	
Caranx ruber	bar jack	X	
Chloroscrombrus chrysurus	bumper	X	
Selene vomer	lookdown	X	
Seriola dumerili	greater amberjack	X	
Trachinotus carolinus	Florida pompano	X	
Trachinotus falcatus	permit	X	
Lutjanus apodus	schoolmaster	X	
Lutjanus campechanus	red snapper	X	
Lutjanus griseus	gray snapper	X	
Lutjanus synagris	lane snapper	X	
Lobotes surinamensis	tripletail	X	
Eucinostomous argenteus	spotfin mojarra		X
Eucinostomous gula	silver jenny		X
Eucinostomous lefroyi	mottled mojarra		X
Haemulon aurolineatum	tomtate	X	
Haemulon plumeri	white grunt	X	
Haemulon sciurus	blue striped grunt	X	

TABLE 2.5 (Cont'd)

Species	Common Name	Sport and/or Commercial Species	Food Chain Species
Orthopristes chrysopterus	pigfish	X	X
Archosargus probatocephalus	sheepshead	X	
Calamus arctifrons	grass porgy	X	
Diplodus holbrooki	spottail pinfish	X	
Lagodon rhomboides	pinfish	X	X
Bairdiella chrysura	silver perch	X	
Cynoscion arenarius	sand seatrout	X	
Cynoscion nebulosus	spotted seatrout	X	
Larimus fasciatus	banded drum	X	
Leiostomous xanthurus	spot or jimmy	X	
Menticirrhus americanus	southern kingfish	X	
Micropogon undulatus	Atlantic croaker	X	
Pogonias cromis	black drum	X	
Sciaenops ocellata	red drum, redfish	X	
Chaetodipterus faber	spadefish	X	
Lachnolaimus maximus	hogfish	X	
Mugil cephalus	striped mullet	X	X
Mugil curema	white mullet	X	X
Sphyraena barracuda	barracuda	X	

TABLE 2.5 (Cont'd)

Species	Common Name	Sport and/or Commercial Species	Food Chain Species
Trichiurus lepturus	Atlantic cutlassfish	X	
Scomberomorus cavalla	king mackerel	X	
Scomberomorus maculatus	Spanish mackerel	X	
Peprilus alepidotus	harvest fish	X	
Ancylopsetts quadrocellata	ocellated flounder	X	
Citharichthys macrops	spotted whiff	X	
Etropus crossotus	fringed flounder	X	
Etropus rimosus	gray flounder	X	
Paralichthys albigutta	gulf flounder	X	
Crassostrea virginica	American oyster	X	X
Aequipecten irradians	bay scallop	X	
Calinectes sapidus	blue crab	X	X
Menippe mercenaria	stone crab	X	
Penaeus duorarum	pink shrimp	X	X
Penaeus setiferus	white shrimp	X	X

supported by the applicant reveal an additional 41 fish species of lesser abundance.[17,18] The four most abundant species of finfish captured during surveys in 1969 and 1970 were silver perch (Bairdiella chrysura), spot or jimmy (Leiostomus xanthurus), pigfish (Orthopristes chrysura), and pinfish (Lagodon rhomboides). Important shellfish are American oyster (Crassostrea virginica), blue crabs (Callinectes sapidus), stone crabs (Menippe mercenaria), and pink shrimp (Penaeus duorarum). No finfish or shellfish on the endangered species list[19] are known to inhabit the area.

Spawning times of fishes occurring near the Crystal River plant, on the basis of data assembled from the west coast of Florida, are given in Table 2.6.[20] Data are available for 28 species. Of these, 11 spawn exclusively in the spring (ladyfish, gafftopsail catfish, permit, pigfish, sheepshead, grass porgy, spottail pinfish, silver perch, sand seatrout, black drum and spadefish). Six species initiate spawning in the spring and continue intermittent spawning activity through the summer or fall (southern kingfish, spotted seatrout, oyster, blue crab, stone crab, and pink shrimp). Two species begin spawning in the winter and continue until spring (black seabass and spot). Two species spawn in the winter (Gulf menhaden and striped mullet). Three species initiate spawning in the fall and continue into winter (pinfish, Atlantic croaker and Gulf flounder). Redfish spawn through the summer until fall. Spawning data are not available for tarpon, crevalle jack and grey snapper. With the exception of spotted seatrout, redfish and oyster, the remainder of the listed species spawn offshore.

Juvenile fish arrive in inshore estuarine waters within one or two months following the spawning of adults. For the juveniles of species spawning during the winter, spring, or summer, the residence span in the nearshore marine ecosystem normally continues until the following winter when lower temperatures induce the juveniles to migrate into deeper and warmer water offshore. There are three noteable exceptions. The oyster is sessile and undergoes no migration. Juvenile mullet enter inshore waters during the colder winter months and reside there throughout the year. Juvenile redfish appear inshore in the fall and overwinter there. The relation between the natural temperature cycle and migration is pronounced. Studies by the applicant showed that the abundance of fishes at inshore stations is greatest during the spring and early summer, but decreases as summer proceeds, and that the stations are nearly barren during the winter.[17]

TABLE 2.6

SPAWNING PERIOD OF IMPORTANT FINFISH AND SHELLFISH IN THE CRYSTAL RIVER AREA

(Compiled From Studies Conducted Along The Entire Coast of Florida)[28]

Scientific Name	Common Name	Spawning Periods
	FINFISH	
Megalops atlantica	tarpon	April-May,
Elops saurus	ladyfish	March-April, April-July
Brevoortia patronus	Gulf menhaden	February-March, Winter
Bagre marinus	gafftopsail catfish	April-May, February
Centropristes striata	black sea bass	Late winter-early spring May, February
Caranx hippos	crevalle jack	March-April, November
Lutjanus griseus	grey snapper	August, October, June-November, October
Trachinotus falcatus	permit	Spring, October, June, August, Summer
Orthopristis chrysoptera	pigfish	March, May, April, June, April-June
Archosargus probatocephalus	sheepshead	Spring, July, June
Calamus arctifrons	grass porgy	Early spring, June-July, March
Diplodus holbrooki	spottail pinfish	Spring, December-February, April, March, June

TABLE 2.6 (Cont'd)

Scientific Name	Common Name	Spawning Periods
Lagodon rhomboides	pinfish	Fall, late fall, November-January, late December, December, February, April, June
Bairdiella chrysura	silver perch	Spring, April, May, August, January
Cynoscion arenarius	sand seatrout	April, early spring, September, June, May
Cynoscion nebulosus	spotted seatrout	Summer-fall, April, March-October, June, May, Summer
Leiostomus xanthurus	spot	Winter, January-March, December-March, January, February
Menticirrhus americanus	southern kingfish	April-August, May-June, September, July, July-November
Micropogon undulatus	Atlantic croaker	Fall-winter, April, December-February
Pogonias cromis	black drum	Spring, May
Sciaenops ocellata	redfish	Late summer, September-October
Chaetodipterus faber	spadefish	Spring, Spring-Summer, June, October
Mugil cephalus	striped mullet	November-February, October-May, October-December, January-March, January
Paralichthys albigutta	Gulf flounder	Late fall-early winter, early winter

TABLE 2.6 (Cont'd)

Scientific Name	Common Name	Spawning Periods
	SHELLFISH	
Crassostrea virginica	American oyster	May, late May-early June, June-July
Callinectes sapidus	blue crab	May-November
Menippe mercenaria	stone crab	March-October, May-September
Penaeus duorarum	pink shrimp	April-November, May-September

Data on feeding habits and growth rates of juvenile finfish and shellfish at the site, where available,[21] are given in Table 2.7. Feeding habits are diverse, depending on age and inherent requirements of individual species. Growth rates of juveniles is generally rapid due to the warm water and abundant food supply in the nearshore habitat.

2.6.2.4 Benthic Invertebrates

Applicant surveys at the Crystal River site in 1969 revealed the presence of 286 species of marine invertebrates.[22] The common and abundant invertebrates in the collections are listed in Table 2.8. Location and environmental parameters at Crystal River suggest a typical Carolinian fauna, but few of the species have distributional patterns that conform to the classical Carolinian province, nor are many typically West Indian species found. Most invertebrates are those which have a wide geographical range. Only 16% of the decapod crustaceans and 10% of the molluscs can be considered endemic Carolinian species at the site. Conversely, 10% of the decapods and 16% of the molluscs occur only from Florida and the Gulf of Mexico southward to the Caribbean Sea. Most of the local species are widely distributed forms capable of withstanding much variation in environmental conditions. Water temperatures do not appear to affect local distribution, except in the occurrence of certain opisthobranchs and as an impetus to spawning in molluscs and crustaceans.[22]

Five species of seagrass occur in the nearshore marine ecosystem at the site.[23] Intermittent beds of submerged shoal grass (Halodule=Diplanthera wrightii) and widgeon grass (Ruppia maritima) are the most dominant. Turtle grass (Thalassia testudinum) is also abundant. Syringodium filiforme and Halophila englemanni are also present. The seagrass beds frequently contain dense assemblages of rooted green algae, primarily Caulerpa species (spp.), and limestone outcroppings provide sites for attachment of rockweeds, e.g. Sargassum spp. The local distribution of Thalassia, Halodule, Caulerpa and Sargassum is illustrated in Figures 2.4 and 2.7.

Surveys conducted in 1969 and 1970 reveal the species and diversity of benthic marine algae at the site.[23] Some 106 taxa were identified, including 19 green algae (Chlorophyta), 24 brown algae (Phaeophyta) and 63 red algae (Rhodophyta). Green algae represent about 10-20% of the total benthic flora, while brown algae account for 10-30%

TABLE 2.7

GROWTH RATES AND FEEDING HABITS OF JUVENILE FINFISH AND SHELLFISH IN THE VICINITY OF CRYSTAL RIVER PLANT

Species	Size After X yr (g or cm)	Major Dietary Items	% Composition of Diet	Amt (g) of Each Item Consumed/yr*	
				Year 1	Year 2
Callinectes sapidus (blue crab)	1 yr,45 g 2 yr,300 g	Detritus	26	117	665
		Micro-invertebrates	52	234	1330
		Macro-invertebrates	14	63	358
Crassostrea virginica (American oyster)	1 yr,8.9 cm	Phytoplankton	100		
Penaeus duorarum (pink shrimp)	1 yr,24 g	Vascular plants	20	48	
		Detritus	58	139	
		Micro-invertebrates	17	41	
Bairdiella chrysura (silver perch)	1 yr,12 cm 2 yr,21 cm	Zooplankton	24		
		Macro-invertebrates	29		
		Fish	24		
Cynoscion nebulosus (spotted sea-trout)	1 yr,185 g	Macro-invertebrates	13	240	364
	2 yr,465 g	Fish	79	1460	2210

*Assuming a conversion efficiency of 10%.

TABLE 2.7 (Cont'd)

Species	Size After X yr (g or cm)	Major Dietary Items	% Composition of Diet	Amt (g) of Each Item Consumed/yr	
				Year 1	Year 2
Fundulus similus (killfish)		Detritus	80		
		Micro-invertebrates	20		
Lagodon rhomboides (pinfish)	1 yr,12.3 g	Vascular plants	41	50	172
	2 yr,54.4 g	Detritus	20	25	84
		Crustaceans	27	33	114
Leiostomus xanthurus (spot)	1 yr,10 cm	Detritus	34		
	2 yr,22 cm	Crustaceans	36		
		Molluscs	18		
Lutjanus griseus (gray snapper)	6.2 cm/yr	Shrimp	63		
		Crabs	13		
		Fish	23		
Menidia beryllina (silversides)	1 yr,8.5 cm	Detritus	14		
		Zooplankton	7		
		Micro-invertebrates	69		
Micropogon undulatus (croaker)	13.1 cm/yr	Annelids	62		
		Macro-invertebrates	14		
		Fish	16		

TABLE 2.7 (Cont'd)

Species	Size After X yr (g or cm)	Major Dietary Items	% Composition of Diet	Amt (g) of Each Item Consumed/yr	
				Year 1	Year 2
Mugil cephalus (mullet)	1 yr, 17.5 cm	Detritus	100		
	2 yr, 25.8 cm	Periphyton	100[b]		
Pogonias cromis	1 yr,18 cm	Macro-invertebrates	99		
(black drum)	2 yr,33 cm				
Sciaenops ocellata	1 yr,334 g	Macro-invertebrates	63	2100	7460
(redfish)	2 yr,1519 g	Fish	17	570	2100
Menticirrhus americanus	1 yr,11 cm	Juveniles (2.8-5.8cm)			
(southern kingfish)	2 yr,17 cm	Mysids	85		
		Fish	6		
		Sub-adults (7-13cm)			
		Shrimp and other crustaceans	60		
		Polychaetes	20		
		Fish	20		

TABLE 2.7 (Cont'd)

Species	Size After X yr (g or cm)	Major Dietary Items	% Composition of Diet	Amt (g) of Each Item Consumed/yr Year 1	Year 2
Cynoscion arenarius	Not				
	Available	Juveniles (40-99mm)			
(sand seatrout)	Have	Zooplankton	32	NOT CALCULATED	
	Assumed	Fish	54	FOR JUVENILES	
	That Growth	Detritus	9		
	Rate Simi-	Adults (100-225 mm)			
	lar to *C.*	Fish	87	1610	2440
	nebulosus	Detritus	8	148	224
	for 1st	Crustaceans	5	98	140
	2 years				
	1 yr,185 g				
	2 yr,465 g				

TABLE 2.8

COMMON AND ABUNDANT SPECIES OF BENTHIC INVERTEBRATES
IN THE VICINITY OF THE CRYSTAL RIVER PLANT

(A = abundant, C = common)

Cnidaria	
Anthozoa	
Lophogorgia hebes	C
Leptogorgia virgulata	A
Pseudopterogorgia acerosa	C
Mollusca	
Gastropoda	
Rissoina catesbyana	C
Caecum pulchellum	C
Meioceras nitidium	C
Cerithium muscarum	C
Bittium varium	A
Cerithiopsis greeni	C
Triphora nigrocincta	C
Crepidula plana	C
Urosalpinx tampaensis	C
Polinices duplicatus	C
Anachis iontha	C
Anachis ostreicola	C
Anachis semiplicata	A
Anachis similis	C
Mitrella lunta	A
Cantharus cancellarius	C
Melogena corona	C
Nassarius vibex	A
Fasciolaria hunteria	C
Plunum apicinum	C
Haminoea succinea	C
Ocostomia impressa	C
Pelecypoda	
Glycymeris pectinata	
Brachiodontes exustus	A
Musculus lateralis	A
Argopecten irradians concentricus	C
Crassostrea virginica	A
Cardita floridana	C

TABLE 2.8 (Cont'd)

Tagelus divisus	C
Chione cancellata	C
Cephalopoda	
Lollinguncula brevis	C
Annelida	
Chaetopoda	
Polychaeta (families)	
Syllidae	A
Nereidae	A
Terebellidae	C
Eunicidae	C
Serpulidae	C
Polynoidae	C
Arthropoda	
Pycnogonida	
Anoplodactylus insignis	C
Crustacea	
Isopoda	
Cymodoce faxoni	C
Paracerceis caudata	A
Erichsonella attenuata	C
Erichsonella filiformis isabelensis	C
Decapoda	
Natantia	
Penaeus duorarum	A
Trachypenaeus constrictus	C
Palaemonetes intermedius	A
Palaemonetes vulgaris	C
Periclimenes americanus	C
Periclimenes longicaudatus	C
Hippolyte pleuracantha	A
Lysmata wurdemanni	C

TABLE 2.8 (Cont'd)

Thor floridanus	C
Tozeuma carolinense	C
Alpheus heterochaelis	C
Alpheus normanni	C
Synalpheus apioceros	C
Synalpheus brooksi	A
Synalpheus fritzmulleri elongatus	C
Palaemon floridanus	C
Synalpheus longicarpus	C
Reptantia	
Upogebia affinis	C
Pagurus bonairensis	A
Petrolisthes armatus	A
Petrolisthes galathinus	C
Libinae dubia	A
Metoporhaphis calcarata	C
Podochela riisei	C
Menippe mercenaria	C
Neopanope packardii	A
Neopanope texana texana	A
Pilamnus dasypodus	C
Callinectes sapidus	A
Portunus gibbesii	C
Ectoprota	
Gymnolaemata	
Amathia convoluta	C
Bugula neritina	A
Echinodermata	
Echinoidea	
Lytechinus variegatus	C
Mellita quinquiesperforata	C
Asteroidea	
Echinaster spinulolsus	A
Ophiuroidea	
Ophiothrix angulata	A
Ophioderma brevispinum	C

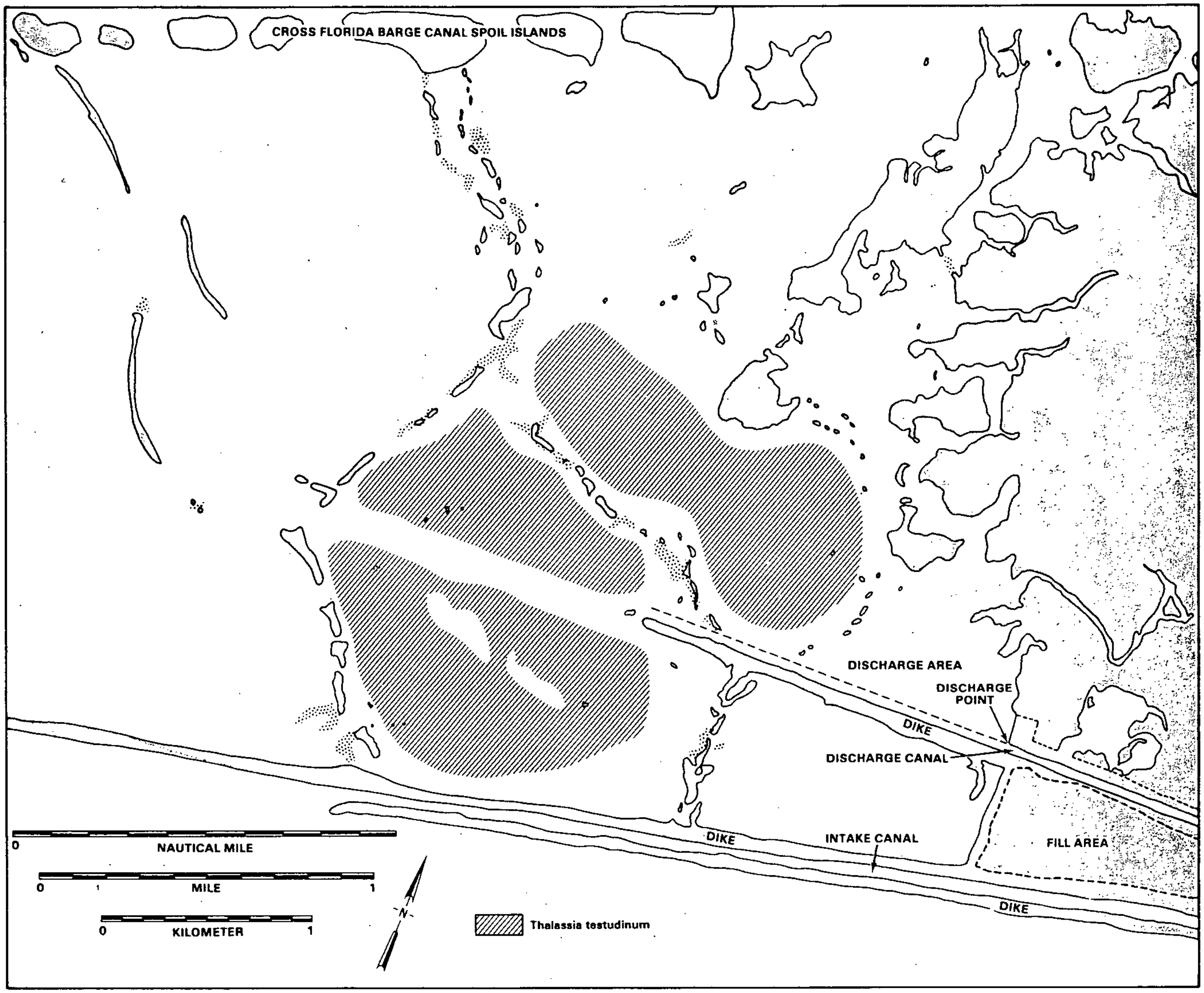

FIGURE 2.7 DISTRIBUTION OF *THALASSIA TESTUDINUM* IN THE DISCHARGE AREA

and red algae about 50-80% (Table 2.9). Brown algae reveal the greatest annual fluctuations except for Sargassum filipeudula and S. filipeudula var. montagnei, which are well established throughout the year. Winter supports the least number of species, possibly because of reduced water temperatures as indicated in other studies.[24] Algae species of wide distribution and yearly occurrence are generally eurythermal and euryhaline, whereas species of restricted seasonal occurrence show lower ranges, some being stenothermal and/or stenohaline.[23]

The most common epiphytes on benthic algae are bryozoans, hydroids, and chain-forming diatoms, e.g. Grammetophora marina, Melosira moniliformis, Biddulphia aurita, Licmorpha marina and Synedro-like species.[23]

2.6.2.5 Planktonic Organisms

Planktonic organisms present in the nearshore marine ecosystem at the plant site are imperfectly known. However, samples have been taken from the intake and discharge canals of the existing plant in April, June and July.[25] The general composition of nannoplankton in seawater from the canals is indicated in Table 2.10. Numbers of species increased with warming temperatures during late spring. Quantities in numbers per milliliter indicate a reasonable amount of nannoplankton. Protozoa are few in species and, from the paucity of ciliates and zooflagellates, bacterial populations are low. Most of the organisms consist of algae cells with diatoms predominating. Species accumulating on glass slides suspended in the intake and discharge canals are given in Table 2.11.

Plankton net catches in the intake and discharge canals in April 1971[25] reveal a substantial zooplankton population, Table 2.12. For 5 groups (unidentified ciliates, chaetognaths, large Peridinium, fish eggs and rotifers), the average occurrence was 1 in 8 liters of seawater; for other major groups (lobsters, coelenterate medusae, the ciliate Codonella, nematodes, chaetognaths, shrimp larvae and harpactecoid copepods), the average occurrence was 1 in 4 liters.

TABLE 2.9

LIST OF COMMON BENTHIC MARINE ALGAE OCCURRING IN THE VICINITY OF THE CRYSTAL RIVER PLANT

(Percent abundance in 1969 and 1970, respectively)

CHLOROPHYTA	
ULVALES	
Ulvaceae	
Enteromorpha (5 spp.)	Rare
SIPHONALES	
Caulerpaceae	
Caulerpa ashmeadii	(13%)
Caulerpa mexicana	(12%)
Caulerpa paspaloides	(34%)
Caulerpa prolifera	(33-18%)
Codiacea	
Codium isthmocladium subsp. Clavatum	(25-10%)
Codium (1 sp.)	Rare
Halimeda (2 spp.)	Rare
Udotea (1 sp.)	Rare
PHAEOPHYTA	
ECTOCARPALES	
Ectocarplaceae	
Bachelotia (1 sp.)	
Ectocarpus (3 spp.)	
Giffordia (4 spp.)	Rare

TABLE 2.9 (Cont'd)

DICTYOTALES	
Dictyotacea	
Padina vickersiae	(7%)
CHORDARIALES	
Stilophoraceae	
Stilophora rhizodes	(10%)
SPOROCHNALES	
Sporochnus pedunculatus	(11%)
FUCALES	
Sargassaceae	
Sargassum filipendula	(16%)
Sargassum filipendula var. *montagnei*	(16-20%)
Sargassum (8 spp.)	Rare
RHODOPHYTA	
NEMALIONALES	
Acrochaetium (1 sp.)	
Galaxaura (1 sp.)	
Liagora "A" (1 sp.)	Rare
CRYPTOMENIALES	
Corallinaceae	
Fosliella (2 spp.)	
Halymenia (2 spp.)	Rare

TABLE 2.9 (Cont'd)

GIGARTINALES	
Gracilariaceae	
Gracilaria (6 spp.)	Rare
Gracilaria cervicornis	(6%)
Gracilaria compressa	(7-27%)
Gracilaria debilis	(8%)
Gracilaria foliifera	(9%)
Gracilaria foliifera var. *angustissima*	(25-19%)
Gracilaria sjoestedtii	(6%)
Gracilaria verrucosa	(29-21%)
Gracilaria "A"	(7%)
Gracilaria "B"	(12%)
Hypneaceae	
Hypnea cervicornis	(11%)
Hypnea spinella	(21%)
Hypnea (2 spp.)	Rare
Solieraceae	
Agardhiella ramosissima	(7%)
Agardhiella tenera	(30%)
RHODYMENIALES	
Champiaceae	
Champia parvula	(20%)

TABLE 2.9 (Cont'd)

Crysymenia (3 spp.)	Rare
CERAMIALES	
Ceramiaceae	
Ceramium (5 spp.)	Rare
Spyridia filamentosa	(17%)
Dasyaceae	
Dasya (2 spp.),	Rare
Heterosiphonia (1 sp.)	Rare
Dasya pedicellata	(8%)
Rhodemelaceae	
Chondria (6 spp.)	Rare
Laurencia corallopsis	(12-14%)
Laurencia intricata	(24-31%)
Laurencia obtusa	(10-21%)
Laurencia poitei	(24%)
Polysiphonia (2 spp.)	Rare
Polysiphonia ramentacea	(17%)

TABLE 2.10

COMPOSITION OF NANNOPLANKTON IN INTAKE AND DISCHARGE CANALS AT CRYSTAL RIVER SITE, APRIL - JULY, 1971

Organism Groups	Number of Species April	June	July
Sulfur bacteria	1	1	-
Blue-green algae	-	4	-
Green algae	2	1	1
Volvocida	1	3	4
Euglenida	-	1	1
Cryptophsida	3	1	2
Dinoflagellida	2	9	8
Bacillarieae	20	23	24
Rhizopdea	1	-	1
Mastigophora	3	3	3
Ciliphorea	4	4	7
Chrysophsida	1	-	-
Total Species	38	50	51

TABLE 2.11

ORGANISMS ACCUMULATING ON SUSPENDED GLASS SLIDES
AT TWO CRYSTAL RIVER LOCATIONS

(I=Intake, II=Discharge)

Organism	Stations I 4-28-71	Stations II 4-28-71	Stations I 6-04-71	Stations II 6-04-71
Blue Green Algae				
Anabaenopsis sp.	1			
Borzia trilocularis		4		
Lynagbya limnetica	2			
Oscillatoriae	4	1	2	
Schizothrix	12	7		12
Green Algae				
Unidentified	32	124		
Volvocida				
Chamydomonas sp.	6	24		
Pyramidomonas sp.	4			
Euglenida				
Anisonema lineata	2	48		
Diatoms				
Coscinodiscus sp.		1	1	
Cyclotella sp.		48	4	
Diploneis sp.		4		
Frustulia sp.	7	204	46	
Gyrosigma sp.		4		
Licmophora sp. 1	1	26	28	
Licmophora sp. 2				

Organism	Stations I 4-30-71	Stations II 4-30-71	Stations I 6-10-71	Stations II 6-10-71
Melosira monilata		39		12
Melosira sp.	4	2		
Navicula sp.	16	40	10	38
Nitzchia sp.				
Nitzschia sp.			6	
Rhizosolenia sp.	1	1		
Synedra ulna	1			
Unidentified Zoomastigophorea	4	79		54
Zoomastigophorea				
Monosiga ovata	2			
Ciliophorea				
Acineta sp.	2		1	48
Cyclidium sp.	2			
Dysteria monostya				6
Folliculina sp.		1		
Pleurotricha sp.			1	
Podophyra fixa			33	
Vorticella sp.	6	59		28
Zoothamnium sp.				36
Unidentified	1			2
TOTALS	109	721	134	236

TABLE 2.12

ZOOPLANKTON POPULATION IN THE INTAKE AND DISCHARGE CANALS

Numbers per liter, April 28, 1972

ORGANISM	STATION SERIES A[a]						STATION SERIES B						STATION SERIES C					
	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
CALANOID COPEPODS	37.3	30.2	20.7	27.0	54.7	8.7	113.0	70.0	62.0	32.0	100.0	32.0	110.0	63.4	45.0	63.8	50.0	35.9
HARPACTICOIDS	0.12	0.25	0.18		0.06	0.06												
GASTROPODS	9.3	3.2	2.4	2.2	3.8	0.12	2.3	8.8	2.3	0.25	2.0	1.8	12.5	6.6	3.0	2.5	2.5	2.0
BIVALVES	4.6	3.2	0.12	0.06	0.12		0.25	2.0	0.75	0.25		0.5	1.5	1.0	0.12	0.38	0.12	0.63
BARNACLE LARVAE	5.6	3.60	3.7	5.7	7.0	3.5	10.0	3.8	5.4	3.3	18.0	1.5	5.6	2.8	2.9	4.4	4.5	2.4
SHRIMP	0.25																	
POLYCHAETES	0.75	0.9	0.24		0.7	0.9	3.8	1.0	1.3	0.25		1.8	4.5	1.9	1.9	1.9		
CHAETOGNATHS	0.12																	
TUNICATES						0.25	0.25						0.25	0.25				0.12
EGGS	2.1	2.9	0.6	1.2	1.6	0.9	3.0	1.5	1.3	1.5	1.5	0.75	3.7	6.6	1.9	0.88	0.76	2.9
UNID. LARVAE	0.62	0.9	0.18	0.5	0.6	0.5	1.5	0.25	0.25				3.7	3.0	0.12	0.75	0.63	2.7
NEMATODES					0.06	0.06						0.25						0.12
CILIATA					0.06													
CODONELLA	0.12							0.25										
ROTIFERA			0.06	0.12									0.12		0.12			
CRAB LARVAE							0.5	4.0	1.5	2.8	3.5	1.5	2.5	6.6	4.4	7.3	2.5	0.88
TORNARIA							1.0	1.0	1.0		0.5	0.5	0.37	0.62	0.38	0.12	3.8	1.0
PERIDINIA													0.12					
FISH EGG													0.12					
GAMMARID								0.5		0.5					0.12	0.12		
MEDUSAE																	0.25	0.12
LOBSTER (?)									0.25									

[a] STATION AT INTAKE, 2-6 AT THE OUTFALL AND 1/2 MILE INTERVALS THEREFROM.

2.6.2.6 Commercial and Sport Fishing

No commercial fishery exists inshore near the site due to the shallow waters and numerous reefs. Because of its location, marshy shoreline and low human density, the site has only limited value for shoreline sport fishing. Sport fishing from small boats, however, is popular and the applicant has noted that fishing has increased in the existing intake and discharge canal during the winter. Most of the popular Florida sport fish are found in the area and, consequently, sport catches encompass numerous species (Table 2.5). Three species of shellfish - oysters, blue crab and stone crab - are commonly taken. The entire area directly off the plant site and to the north is designated an approved shellfish area by the Florida State Board of Health (1970).

Juvenile fish and shellfish at the Crystal River site contribute to the offshore commercial fishery of Citrus County, Florida. Recent commercial catches for Citrus County, in pounds, are as follows:

Year	Fish	Shellfish
1965	1,226,711	3,819,529
1966	1,894,145	3,048,407
1967	1,311,742	2,320,802
1968	2,500,000*	1,613,806
1969	1,607,693	2,893,346
1970	1,487,000*	3,757,200

The species composition of landings from Citrus County in 1969 (excluding Pasco County) is as follows (U.S. Fisheries and Wildlife Service, 1970):

*Includes Pasco County, Florida

Finfish

Species	Pounds	Species	Pounds
angelfish	22	pigfish	200
barracuda	19	pompano	357
bluefish	3,107	sea bass	64,542
jack crevalle	20,681	spotted sea trout	82,322
black drum	493	sheepshead	3,494
red drum	20,624	snapper	7,913
flounders	459	Spanish mackerel	2,319
groupers	10,911	spot	723
grunts	2,400	ladyfish	1,429
king mackerel	1,384	unclassified, food	8,029
black mullet	1,339,929	unclassified, misc.	39,830
		Total	1,607,693

Shellfish

Species	Pounds
blue crabs	2,845,000
stone crabs	37,665
oysters	3,900
bay scallops	2,133
green turtles	3,748
Total	2,893,346

For comparison, commercial catches off the west coast of Florida in 1968 (latest comprehensive data available) consisted of 72 million pounds of finfish valued at $8 million and 47 million pounds of shellfish valued at $19 million.[26]

Observation by guides and fishing boat captains in the Crystal River area[27] indicates that mullet, catfish, sharks, blue crabs, and occasionally tarpon are abundant in the discharge canal. Juvenile fish such as silver perch, spottail pinfish, permit, pigfish and anchovies were absent from a grass bed at the mouth of the discharge canal during the summer; whereas, they were common at that time on grass beds outside of the zone of thermal influence. Except for sharks, all fish seem more abundant in the intake than in the discharge canal during the hottest summer months. Moreover, game fish such as redfish, spotted weakfish, sheepshead, drum, jack crevalle, and golden croaker are commonly caught in the discharge canal at Crystal River during the cool winter months, October through February. Increases in the sports catch of redfish, in particular, have been spectacular.

3. THE PLANT

3.1 EXTERNAL APPEARANCE AND CURRENT STATUS

Prior to construction of the plants, the site was composed of marsh and low-lying land covered with swamp grass and wooded patches, as shown in Figure 2.1. Clearing, grading and filling with soil from the excavations raised the general land level some 5 ft to an elevation of about 8 ft above sea level.

The plant has four principal structures: the reactor containment building, the primary auxiliary building, the control complex building, and the turbine building. The containment building is the most prominent of these structures and will consist of a cylindrical steel vessel that houses the reactor vessel and the equipment directly related to cooling and ventilating.

The other buildings, also of structural concrete, will be of more conventional design. All will be harmoniously arranged and should present a clean architectural ensemble, giving little interference with the natural surroundings.

The status of construction at the site was as follows on January 1, 1972:

- The reinforced concrete foundation and floor of the reactor containment building were complete, as was the steel liner plate cylindrical portion. Erection of the dome liner was underway. Reinforced concrete outer walls and interior shield walls were about 30% complete. Major vessels were in place.

- The reinforced concrete foundation, walls and intermediate floors of the auxiliary building were about 85% complete, and the structural steel was 70% complete.

- The foundation, walls, and the intermediate floors of the control complex building were complete.

- The reinforced concrete foundation of the turbine building, the berm-retaining walls, and the turbine-generator pedestal were complete; structural steel erection was about 90% complete. Work was underway on floors and roof.

Construction will continue on all buildings during the period of NEPA review.

The extension inland by 600 ft of the intake and discharge canals now servicing Units 1 and 2 will involve the excavation and stockpiling of 175,000 cubic yards of material and leave two large unfilled trenches. The disposition of this material is discussed in Section 4.1.

3.2 TRANSMISSION LINES

The plant will be built at an established power plant site already occupied by two fossil-fuel generating plants and located on the transmission system of the State of Florida as illustrated in Figure 3.1. Some additional transmission lines will, however, be required as a result of the construction of Unit 3.

The new lines will extend from the Crystal River site about 53 miles to the Central Florida Substation near Leesburg and about 72 miles to the Lake Tarpon Substation near Tarpon Springs.

Both transmission lines (500 kV) will be built within the existing power line easement already partly occupied by the 230 kV line. The power lines leave the plant along the access road and railroad spur on Florida Power Corporation property. The transmission line corridors, somewhat less than 150 ft wide, run through mixed terrain including forest, farm land, commercial, rural residential and uninhabited areas. Use of transmission corridors by the local residents in the past has been encouraged by the applicant. Since each case is handled on an individual basis, no overall commitment has been made by the applicant. The staff expects no change in past company actions in this area.

3.3 REACTOR AND STEAM-ELECTRIC SYSTEM

The Crystal River nuclear plant is the third unit of a three-unit power generating complex; a plan of the site is shown in Figure 3.2. Units 1 and 2, 387 and 510 MWe, respectively, are oil fired plants. Unit 3 is a pressurized water reactor built by the Babcock and Wilcox Company. Westinghouse is the manufacturer of the steam turbines. Initial power level is targeted at 855 MWe, with the ultimate design power level being 885 MWe. Gilbert Associates, Inc. is the Architect-Engineer for the nuclear plant.

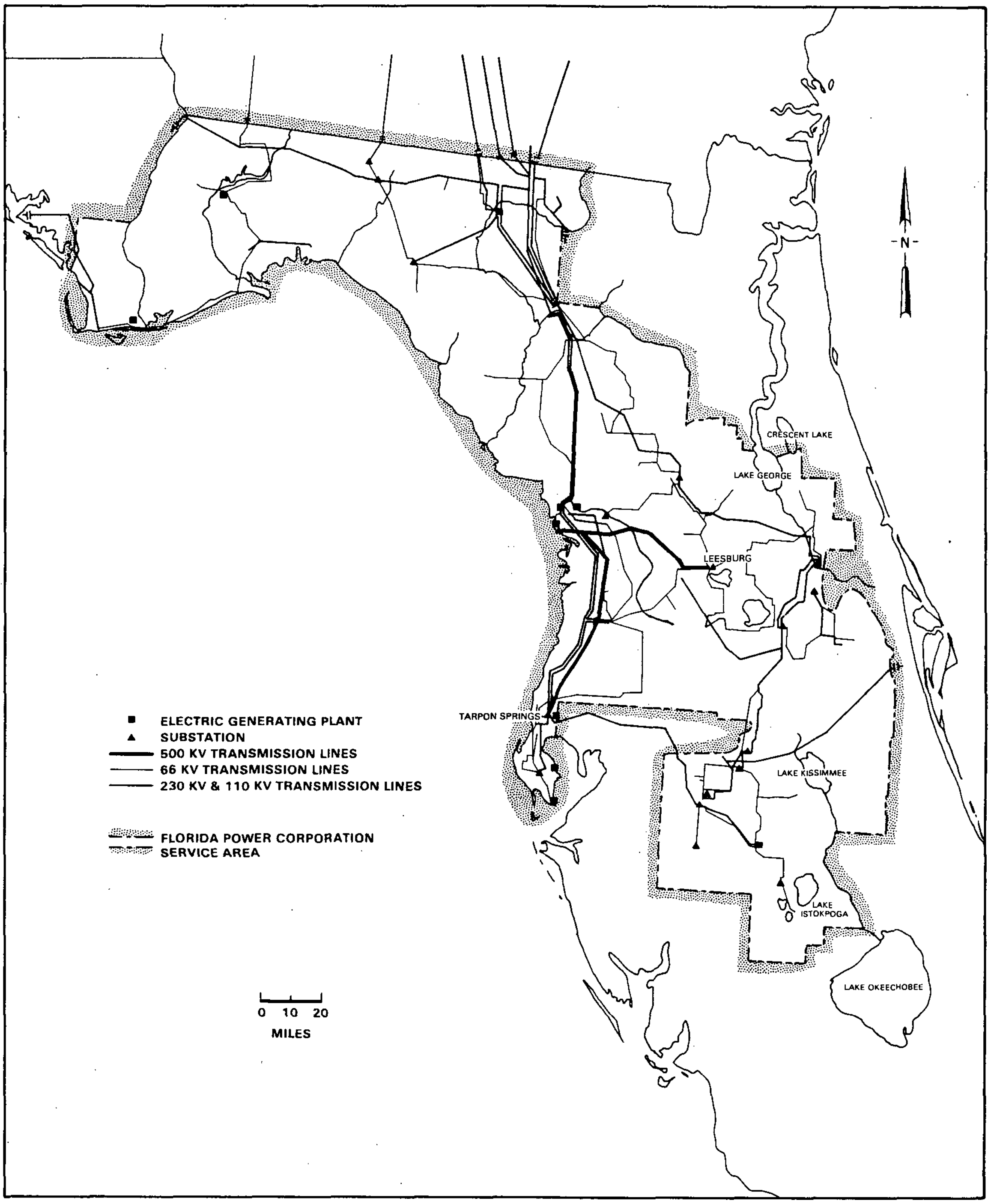

FIGURE 3.1 TRANSMISSION LINES AND SUBSTATIONS

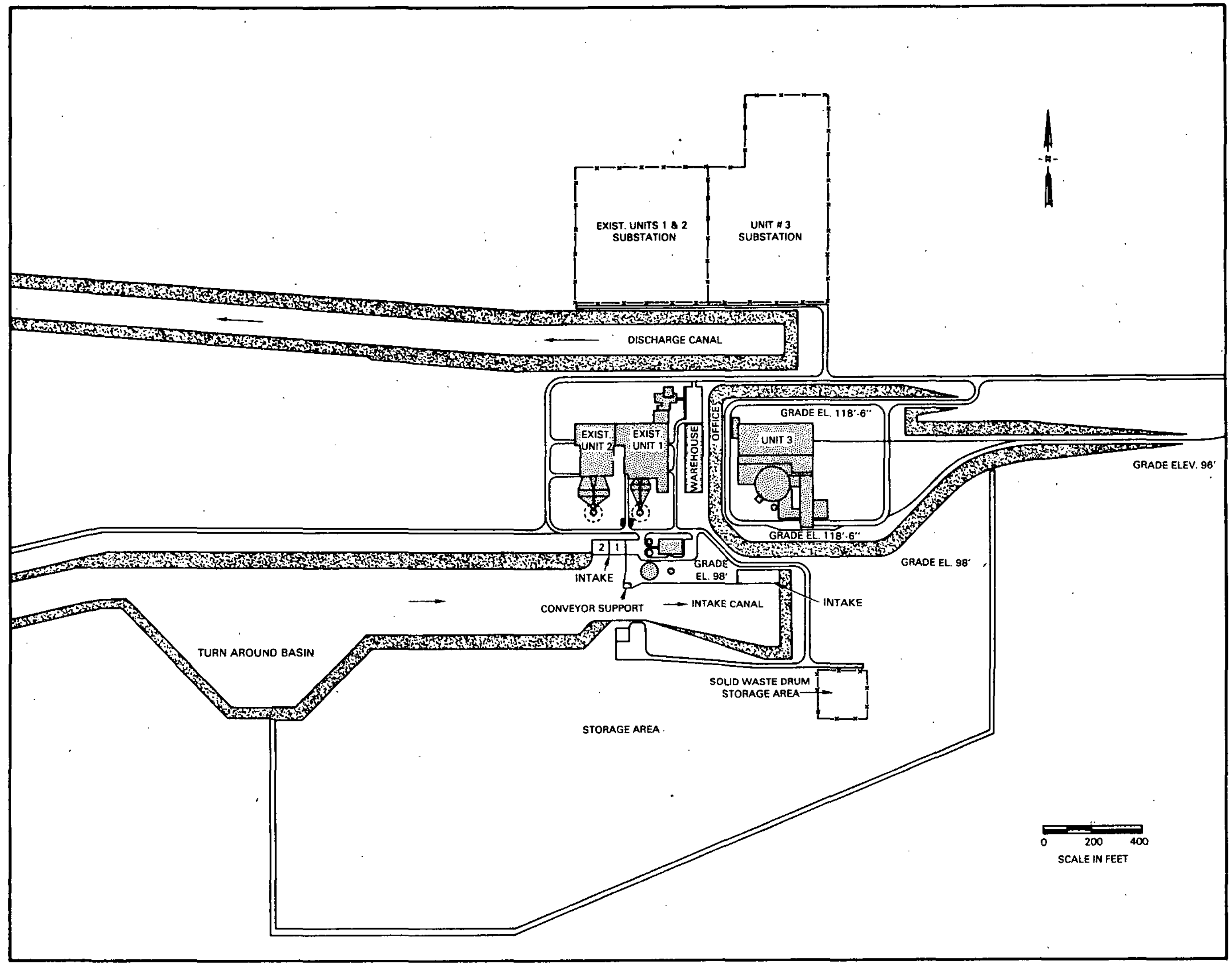

FIGURE 3.2 **SITE PLAN**

The reactor plant incorporates use of three separate loops to convert nuclear heat energy to electrical power. Water in the primary loop moderates the nuclear reaction in the core and transfers heat from the nuclear fuel elements. The heated primary loop water is pumped to a heat exchanger where steam is generated in the secondary water loop. Steam generated in the secondary loop passes through turbines where power is extracted and then to a surface condenser where the spent steam is condensed to liquid. The secondary loop condensate is pumped back to the primary heat exchanger again to form steam to drive the turbines. Both the primary and secondary cooling loops are separate, sealed, water loops, and as such do not release heat or material to the environment. In the third loop, water from the Gulf of Mexico is passed through the condenser heat exchanger. Waste heat from the spent steam is transferred to the sea water. This third loop is once-through, with warmed effluent being discharged back to the Gulf of Mexico via the discharge canal.

Conversion of heat energy to electrical energy is accomplished with an efficiency of 35%. At the design power level of 885 MWe, the plant will reject 1660 MWt into the water of the Gulf of Mexico.

3.4 EFFLUENT SYSTEM

3.4.1 Heat Dissipation System

Cooling water used on a once-through basis, will be withdrawn from the Gulf of Mexico. For Unit 3, 680,000 gpm (1520 cfs) will be heated to 17.1°F (9.5°C) above the inlet temperature when the plant is operated at design capacity. Discharge water will mix in the discharge canal (see Figure 3.3) with once-through cooling water being discharged by Units 1 and 2. Units 1 and 2 discharge 310,000 gpm (690 cfs) and 328,000 gpm (730 cfs), respectively, and operate with temperature increases of 10.3°F (5.7°C) and 12.7°F (7.1°C) respectively. The combined discharge volume for the three plants will be 1,318,000 gpm (2940 cfs) with a net temperature rise above inlet water of 14.5°F (8.1°C).

Intake water is delivered through an intake canal which is 150 ft wide, has a depth of 15 ft below mean low water, and extends into the Gulf about 3 miles but is dredged for an additional 3.5 miles into the Gulf. A spoil bank extends into the Gulf for a distance of 6.5 miles and is continuous for the first 4.5 miles except for a gap 3 miles offshore. This spoil bank prevents recycling of heated effluent. The layout of the intake and discharge canals is shown in Figure 3.3.

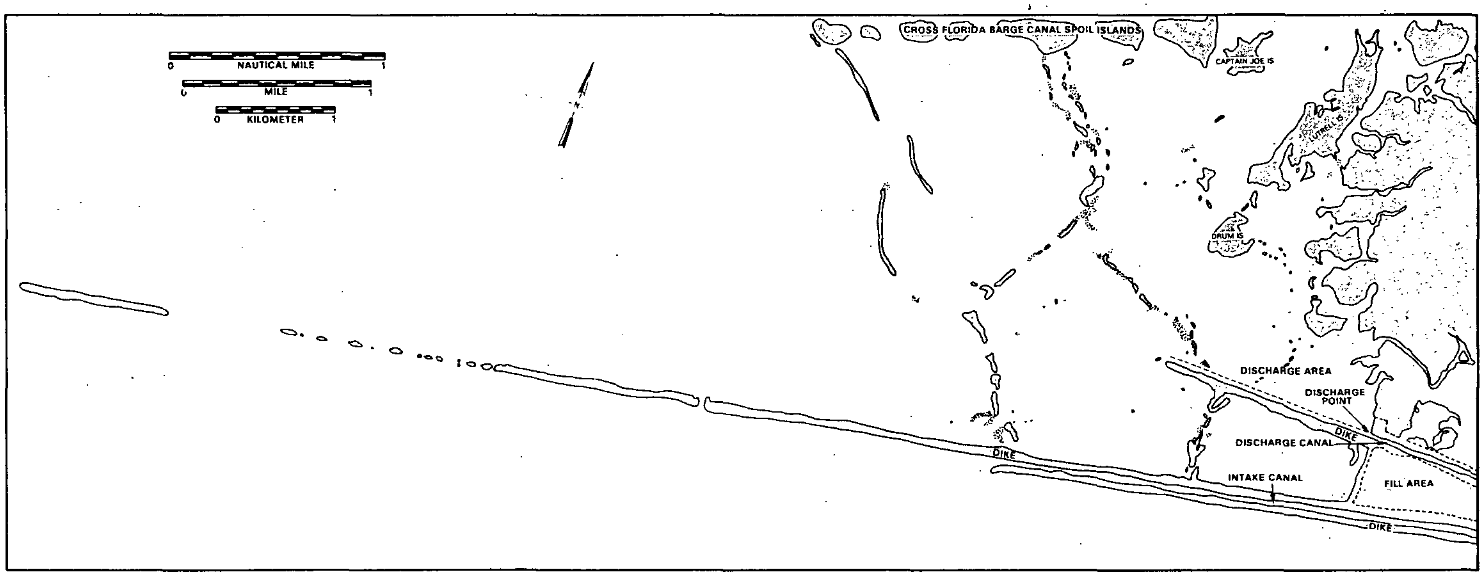

FIGURE 3.3 INTAKE AND DISCHARGE CANALS

With Unit 3 on line, the velocity in the intake canal will be 1.3 ft/sec at ebb tide. Although this velocity may be sufficiently low to prevent serious entrapment of fish,[29] the applicant will be required to monitor the fish, by number and species, caught in the plant intake.

At the plant intake, cooling water passes through a coarse trash rack (4-in. wide vertical spacing) and then through a traveling screen with openings of 3/8 in. The screens are automatically cleaned by high pressure water sprays, with accumulated debris being sluiced into a retention basket by means of a water jet. The design of the intake structure is shown in Figure 3.4.

Following the screens, the water enters four pumps (170,000 gpm each). Four 90-in. (inside diameter) concrete pipes transport the water to rectangular flumes which are 6 ft 6 in. x 7 ft 6 in. The rectangular flumes deliver the water to two, twin-shell surface steam condensers. Transit time from the intake screen to the condenser inlet will be about one minute. In the condenser, cooling water passes through horizontal Cu - Ni tubes having an outside diameter of 0.75 in. and a length of 55 ft. Transit time through the condenser is 5 seconds. From the condenser the cooling water passes through ducting similar to that described for the inlet, and then into a 600-ft long canal which leads to the discharge canal, where the water from Unit 3 will mix with that from Units 1 and 2. Transit time of the heated water from the condenser outlet to the point of mixing with discharged water from Units 1 and 2 is approximately 6 minutes. Mixing of water from Unit 3 with that from the oil-fired units results in a temperature drop of 2.5°F (1.4°C).

The combined flow from the three generating plants is transported to the Gulf via the discharge canal which is about one and one-half miles long, 125 ft wide and dredged to 10 ft below mean low water. A spoil bank or dike extends a further mile from the shore into the Gulf. Water velocity in the discharge canal will be 2.4 ft/sec. Transit time from the generating plants to the discharge point will be approximately 1 hr. At the discharge point, the heated cooling water mixes with water from the Gulf.

Through diffusers located between the intake screens and the circulating water pumps, hypochlorite concentrate will be added periodically to control growth of organisms within the cooling water piping system.

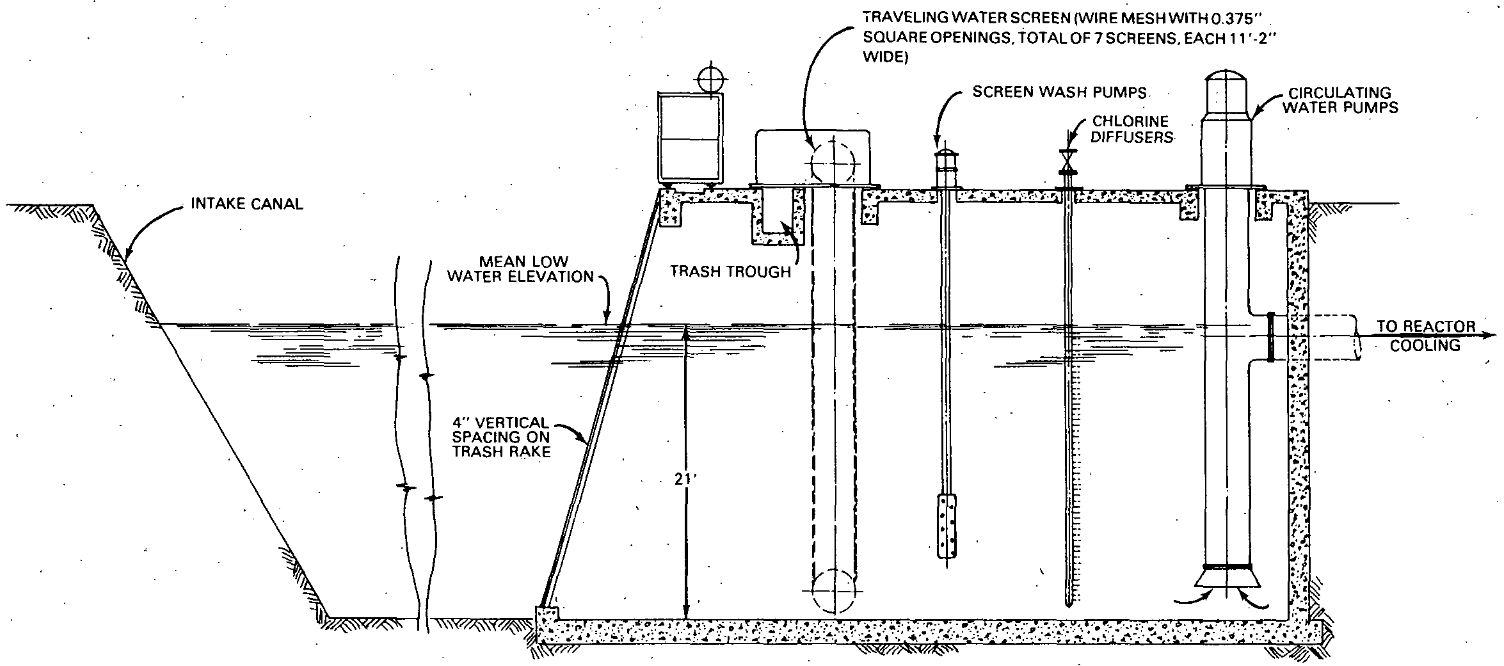

FIGURE 3.4 DETAIL OF THE INTAKE STRUCTURE

3.4.2 Radioactive Waste

During the operation of a nuclear reactor, radioactive material will be produced by fission and by neutron activation of metals and material in the reactor coolant system. Small amounts of gaseous and liquid radioactive wastes will enter the reactor effluent streams and then be processed within the plant to minimize the radioactive nuclides prior to release to the atmosphere and into the Gulf of Mexico under controlled and monitored conditions. The levels of radioactivity that may be released during operation of the plant will be in accordance with the Commission's regulations set forth in 10 CFR Part 20 and 10 CFR Part 50.

The waste treatment systems described in the following paragraphs are designed to collect and process the gaseous, liquid, and solid waste which may contain radioactive materials.

The waste handling and treatment systems for the plant are discussed in detail in the Final Safety Analysis Report, Amendments 17 and 18 to the application, and the applicant's Environmental Report.

3.4.2.1 Liquid Waste

The liquid waste system is shown schematically in Figure 3.5. The system has been designed such that the collection and processing of liquid wastes is divided into two separate processing chains, the makeup and purification chain and the miscellaneous waste processing chain. The wastes in these two chains will be collected and processed through separate evaporators; the condensates from both evaporators then will be passed through common demineralizers, and discharged batchwise to the circulating water discharge canal, from the evaporator condensate storage tanks.

The makeup and purification chain will maintain the quality and boron concentration of the primary coolant. A stream will be continuously "let down," cooled, passed through a mixed-bed demineralizer, filtered and fed to the makeup tank from which it will be returned to the reactor. The boron concentration will be maintained by diversion of a side stream of the "letdown" flow to the bleed tanks. Equipment drains and miscellaneous high purity liquid wastes will also be collected in the bleed tanks. In the staff's evaluation, it was assumed that an average of 14 days will be required to accumulate wastes in each of the three bleed tanks. From these tanks the stream will be processed through cation demineralizers into the reactor coolant evaporator.

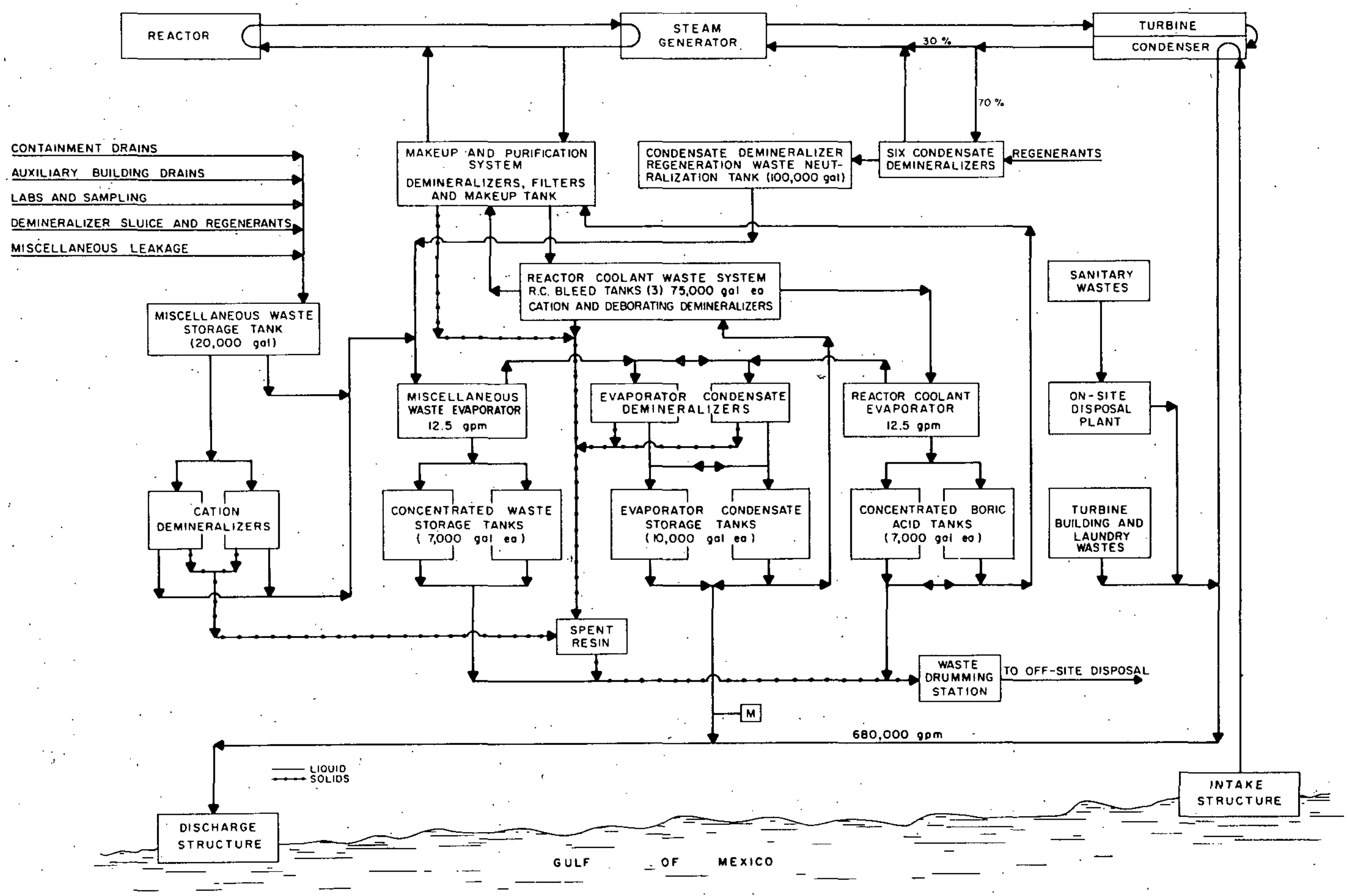

FIGURE 3.5 LIQUID RADWASTE SYSTEM

The condensate from the evaporator will be processed through a mixed-bed demineralizer, collected in storage tanks and either recycled or discharged. The staff used the applicant's assumption that 85% of the bleed stream will be discharged. In addition, it was assumed that 100% of the equipment drains and miscellaneous wastes will be discharged to the circulating water discharge canal.

The miscellaneous waste processing chain will process demineralizer regenerated solutions and sluices, liquids from containment and auxiliary building floor drains, laboratory and sampling wastes, and miscellaneous leakage. These wastes will be accumulated in the miscellaneous waste storage tank, processed through a cation demineralizer (when appropriate) and then through the miscellaneous waste evaporator. The staff assumed that an average of 14 days will be required to accumulate wastes in the miscellaneous waste storage tank. Condensate will be processed through a mixed-bed demineralizer and collected in the condensate storage tanks. After sampling and analysis, the batch will either be recycled or discharged. It was assumed that 100% of this waste will be discharged. The applicant assumed 85% would be discharged. Regenerant solutions from the turbine condensate demineralizers are calculated to constitute over 95% of the volume to be processed through the miscellaneous waste evaporator.

The laundry and hot shower decontamination and washdown wastes will be collected in the laundry waste tank. After sampling and analysis, the waste will be discharged without processing if activity in the discharge canal is less than 1×10^{-9} μCi/cc. If the analysis indicates that this concentration limit cannot be met, the contents of the laundry waste tank will be pumped to the miscellaneous waste storage tank for processing by evaporation and demineralization. The staff analysis assumes that 100% of the laundry wastes will be discharged without treatment.

The applicant estimated that about 0.0025 Ci/year of mixed isotopes and 346 Ci/year of tritium will be released to the environment based on 0.1% of the operating power fission product source term with about 85% fuel burnup. Based on the assumptions shown in Table 3.1, the releases from the liquid waste system in our evaluation were calculated to be less than 1 Ci/year. To compensate for treatment equipment downtime and expected operational occurrences, the values shown in Table 3.2 have been normalized to 5 curies per year. Based on experience at operating PWR reactors, the staff estimates that about 1,000 Ci/year of tritium will be released to the environment in liquid effluent.

TABLE 3.1

Principal Assumptions Used in Evaluating Crystal River Unit 3

1.	Reactor Power	2544 MWt
2.	Failed Fuel	0.25%*
3.	Steam Generator Leak Rate	20 gallons/day
4.	Rate of "Let Down"	45 gallons/min
5.	Rate of Shim Bleed	0.21 gallons/min
6.	Primary Coolant Degassed	2 times/year
7.	Containment purge	12 times/year
8.	Containment Leak Rate	40 gallons/day
9.	Auxiliary Building Leak Rate	20 gallons/day
10.	Plant Capacity factor	80%

11. Iodine partition and removal coefficients:

Steam generator internal	1
Condenser air-ejector	2000
Primary coolant leakage to containment + charcoal adsorber	100
Primary coolant leakage to auxiliary building + charcoal adsorber	2000

12. Decontamination factors:

	Anion	Cs, Rb	Other Cations
Cation-bed demineralizer	1	10	10^2
Horizontal evaporator	10^2	10^3	10^3
Mixed-bed demineralizer (before evap.)	10^2	2	10^2
Mixed-bed demineralizer (after evap.)	10	2	10
Mixed-bed demineralizer (condensate)	10^3	10	10^3

13. Removal factors:

Mo & Tc	100
Y	10

*This value is constant and corresponds to 0.25% of the operating power fission product source term.

Table 3.2

Calculated Annual Release of Radioactive Material in Liquid Effluent from Crystal River Unit 3

Nuclide	Release (Ci/yr)
Rb-86	0.0020
Rb-88	0.044
Sr-89	0.000053
Y-90	0.00031
Y-91M	0.00016
Y-91	0.081
Y-92	0.000025
Y-93	0.000043
Zr-95	0.000009
Nb-95	0.000010
Mo-99	0.14
Tc-99M	0.0081
Te-127M	0.000045
Te-127	0.000045
Te-129M	0.00039
Te-129	0.00025
Te-131M	0.000023
Te-132	0.00076
I-130	0.00069
I-131	2.0
I-132	0.097
I-133	0.30
I-134	0.0010
I-135	0.042
Cs-134	1.1
Cs-136	0.29
Cs-137	0.91
Cs-138	0.0015
Ba-137M	0.0038
Ba-140	0.000040
Cr-51	0.00012
Mn-54	0.000049
Fe-55	0.00016
Fe-59	0.000033
Co-58	0.0016
Co-60	0.00016
	∿ 5

Tritium ∿ 1,000 Ci/yr.

3.4.2.2 Gaseous Waste

During operation of the plant, 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 systems for the processing of radioactive gaseous waste, and ventilation paths are shown schematically in Fig. 3.6.

The primary source of gaseous radioactive waste will be from the degassing of the primary coolant during letdown of the cooling water into the various holding tanks. This is principally from the exhaust of cover gas from waste holdup tanks, venting of the makeup and purification system, and from equipment vents. Additional sources of gaseous waste activity include ventilation air released from the auxiliary building and the turbine building, venting of the condenser air-ejector pump, and purging of the reactor containment building.

As indicated, most of the gas received by the gas processing system will be from the degassing of the primary coolant during letdown of the cooling water into the various holdup tanks. Gases collected in the vent header will flow to one of two waste gas compressors and from there will be pumped to one of three gas storage tanks. The control arrangement is such that one tank will be filled at a time. Gas held in the decay tanks will be sampled shortly after completion of filling of a waste tank. If the analysis of this sample indicates the gas may be reused, recycle may be initiated at any convenient time. If it is to be released to the environment, a minimum of 90 days holdup time will be provided prior to release to the atmosphere. The gas released from the decay tanks will be combined with ventilation air exhausted from the auxiliary building, filtered through HEPA filters and charcoal adsorbers, and discharged to the atmosphere through the plant vent located 157 feet above ground level.

The ventilation system for the auxiliary building has been designed to provide air flow from areas of low potential to areas having a greater potential for release of airborne radioactivity. The auxiliary building exhaust system will draw air from the equipment rooms and open areas of the building through high efficiency particulate filters and charcoal adsorbers and discharge to the atmosphere through the plant vent.

Off-gas from the condenser air ejectors will be vented directly to the atmosphere without treatment. There is no blowdown from the once-through type steam generators of this nuclear plant. Steam which may

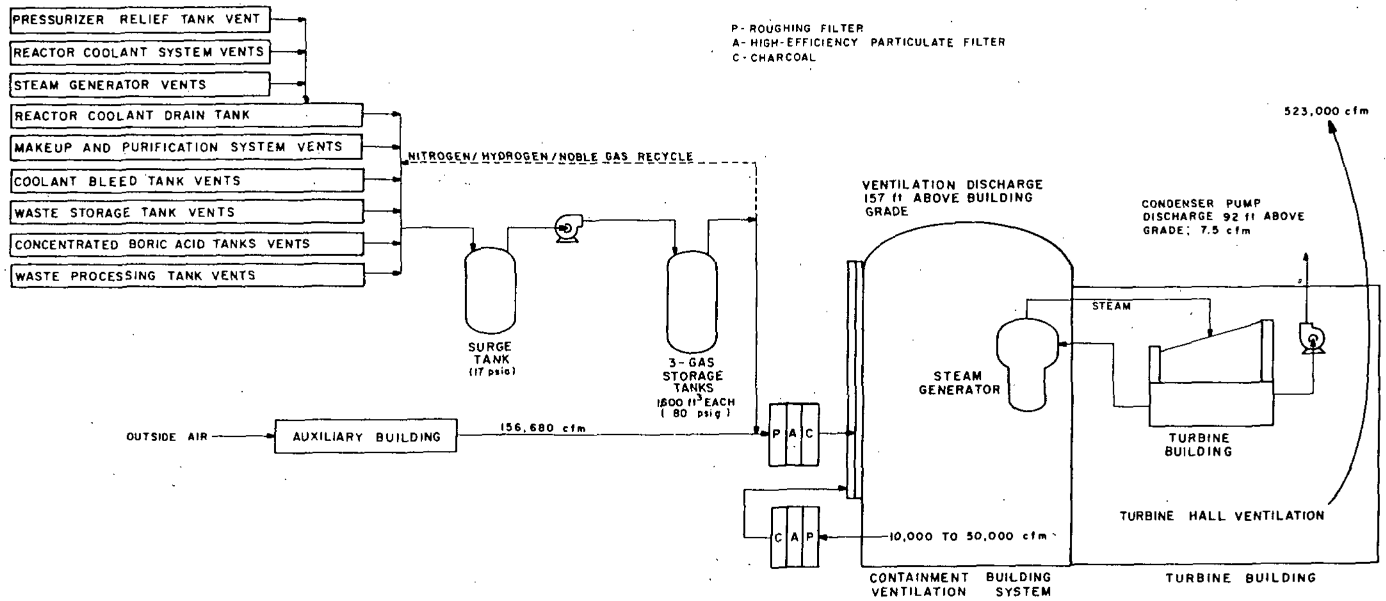

FIGURE 3.6 GASEOUS WASTE DISPOSAL SYSTEM

leak from the turbines and/or ancillary equipment will be released directly to the atmosphere without treatment 92 feet above ground level.

Radioactive gases may be released inside the reactor containment building when components of the primary system are opened to the building atmosphere for operational reasons or when minor leaks occur in the primary system. To permit personnel access, the reactor containment atmosphere will be purged through roughing filters, HEPA filters, charcoal adsorbers, and discharged to the plant vent. The staff assumed that the reactor building will be purged once per month. The full flow rate is 50,000 cfm which is equivalent to 1.5 air changes per hour.

The applicant estimated that about 340 curies of noble gases and essentially no iodines will be released to the environment based on gases liberated from 0.1% of the operating power fission product source term collected continuously for 45 days and decayed for 90 additional days prior to release.

Table 3.3 shows the calculated annual release of radioactive materials in gaseous effluent from Unit 3 in the staff evaluation. The evaluation of the system considered operation of the reactor with 0.25% of the operating power fission product source term and a 20 gallon per day primary to secondary system leak rate. Calculated noble gas releases from the waste gas processing system were based on a holdup time of 90 days.

3.4.2.3 Solid Waste

Four types of solid wastes will be packaged for offsite disposal. Dry wastes will be compacted in 55-gallon drums. Spent filter cartridges will be packaged in shielded drums. Evaporator wastes will be pumped directly from the concentrated waste storage or concentrated boric acid tanks into the solidification mixture contained in drums. A disposable liquid inlet flow pipe in the drum distributes the concentrate throughout the solidification mixture. Resins from the spent resin tank will be discharged from the spent resin storage tank directly into a truck-mounted cask.

All solid waste will be packaged and shipped to a licensed burial site in accordance with AEC and DOT regulations. Based on plants presently in operation, it is expected that approximately 470 drums of spent resin filters, flotation wastes and evaporator bottoms will be stored per year. The staff estimates that each drum will contain about 21 curies after 180 days decay. In addition, it is expected that 1,200 drums/yr of dry waste containing less than 5 Ci/yr will also be transported offsite.

Table 3.3

Calculated Annual Release of Radioactive Nuclides in Gaseous Effluent from Crystal River Unit 3

Isotope	Containment Purge	Auxiliary Building	Gas Processing System[a]	Condenser Air Ejector	Total
	(Curies/year)				
Kr-83m	-	1	-	1	2
Kr-85m	-	5	-	5	10
Kr-85	24	12	650	12	700
Kr-87	-	3	-	3	6
Kr-88	-	9	-	9	18
Xe-131m	6	6	1	6	19
Xe-133m	2	10	-	10	22
Xe-133	440	900	-	900	2240
Xe-135m	-	1	-	1	2
Xe-135	1	15	-	15	31
Xe-137	-	-	-	-	-
Xe-138	-	2	-	2	4
					3,050
I-131	0.11	0.008	-	0.009	0.123
I-133	0.014	0.008	-	0.01	0.033

[a]90 day holdup

3.4.3 Chemical and Sanitary Wastes

3.4.3.1 Reactor Coolant Chemicals

Small quantities of borate are discharged from the radioactive liquid waste processing system via the circulating water discharge canal. The average daily discharge with the condensate demineralizer operating is estimated to be 1.14 x 10^{-2} lb/day which results in a concentration of 0.022 microgram/liter when diluted in the circulating water. The maximum daily discharge with the condensate demineralizer not operating is estimated to be 0.686 lb/day which results in a concentration of 0.22 microgram/liter. These average and maximum concentrations of boron are insignificant compared to the concentration of boron normally present in seawater (4-6 mg/1).

Steam generator water will be transferred to a holding tank so that it can be recycled through a demineralizer for reuse. Therefore, no discharge of water conditioning chemicals, such as phosphate and hydrazine, will result from this source (see Figure 3.7).

Chemical wastes from acid cleaning of the secondary system will be pumped to a tank where they can be neutralized prior to processing by evaporation. Rinse water, used after acid cleaning, will be diverted to settling basins where it will be recycled for boiler and air heater washings.

3.4.3.2 Water Treatment Wastes

Chemical wastes will consist primarily of material generated by water treatment facilities which produce finished water for the plant from raw water supplied by local wells. The water treatment facilities include processes for cold lime softening, filtration, and ion exchange demineralization. The bulk of the waste produced is composed of spent demineralizer regenerant and precipitated solids. The former consists largely of sodium sulfate dissolved in water and the latter is mainly calcium carbonate and magnesium hydroxide.

The applicant is planning to install a closed-cycle system to eliminate liquid chemical waste discharges from the water treatment facilities and other sources including floor and equipment drains, acid cleaning of boiler internal and secondary system, and boiler blowdown. The conceptual design of this system is illustrated in Figure 3.7. The system features a storage basin for recycle and reuse of dilute waste solutions, such as backwashes and rinses,

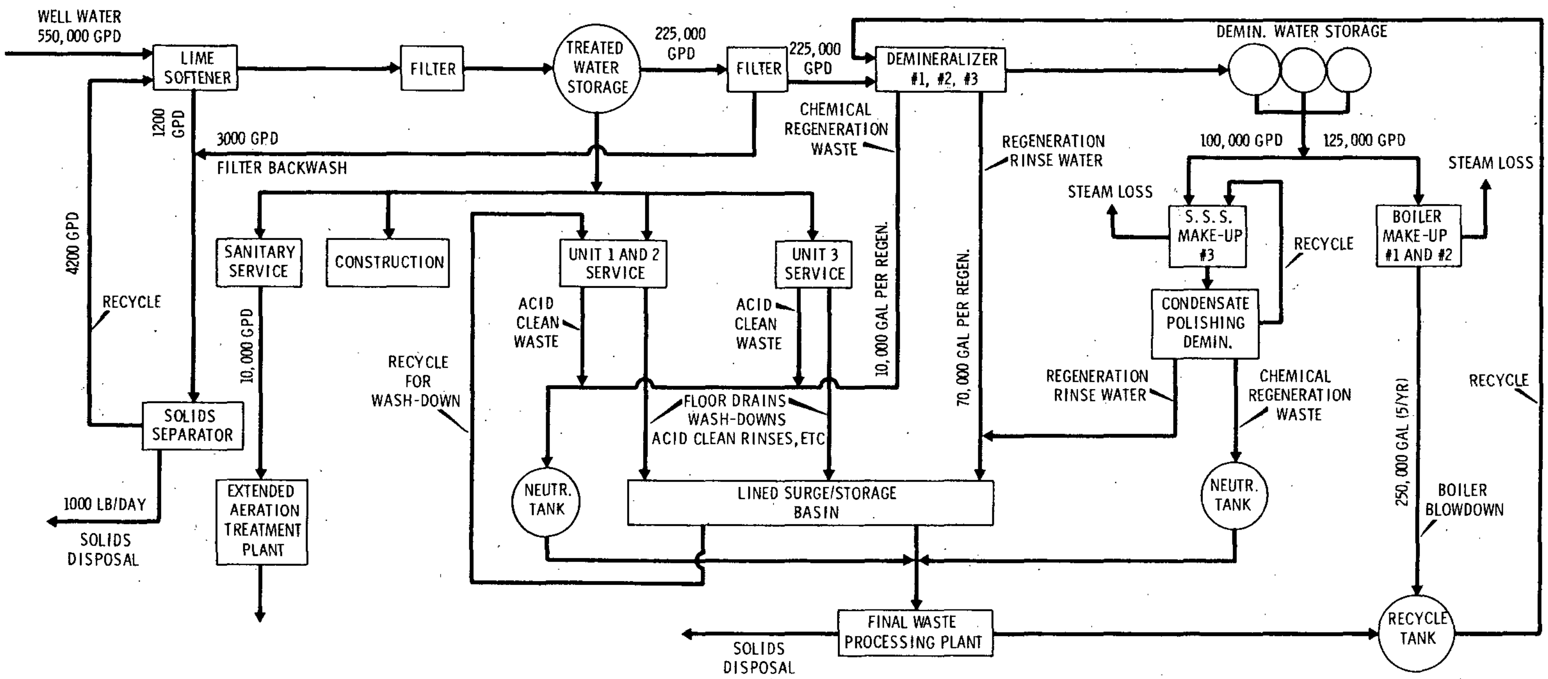

FIGURE 3.7 THE CLOSED CYCLE CHEMICAL SYSTEM

and an evaporator for treating concentrated waste solutions, such as spent demineralizer regenerant. Condensate for the evaporator is recycled to the demineralizers and solid wastes from the evaporator are collected for disposal. Final disposition of solid wastes is currently under investigation. The applicant is expected to utilize two percolating ponds, each about 100 by 200 feet. These will be similar to ponds used in the local area and will require State approvals for operation.

The maximum chemical concentrations in effluent water as limited by Florida water quality standards[30] are shown in Table 3.4. The applicant will operate within these water quality standards.

3.4.3.3 Closed Cooling Water Loops

The staff recognizes that wastes such as those from closed cooling water loops will contain corrosion inhibitors, e.g., dichromate. These should be processed, where volume allows, in the closed-cycle system in order to minimize discharge of corrosion inhibitors into the environment.

3.4.3.4 Condenser Cooling System Output

The control of marine growth in the condenser tubes will involve the controlled intermittent addition of sodium hypochlorite solution to the cooling water. The sodium hypochlorite will be supplied as a 0.05 - 0.1% solution from two electrolytic cells each rated at a 500 lb Cl_2/day capacity. The cell output is regulated automatically from a residual chlorine analyzer-controller. It is anticipated that hypochlorination will be accomplished in a manner similar to that used in the fossil-fueled Units 1 and 2. In the latter cases, hypochlorite is added to one of eight intake flumes for a 15-min period to give a chlorine residual of 0.5 ppm in the effluent from a single condenser unit. The discharge from the treated condenser unit is mixed at the outfall with the discharges from the remaining seven, with a resulting undetectable chlorine residual in the total flow. The chlorine residual in the effluent from the treated condenser unit is largely consumed in meeting the chlorine demand (0.6 - 1.8 ppm) of the untreated water from the other units.

This system is designed such that no onsite storage of large amounts of chlorine would be required and the potential for accidental massive injection of chlorine is minimized through the use of small diameter piping and low flows.

3.4.3.5 Laboratory and Decontamination Solutions

Solutions from the chemistry laboratory and from the plant decontamination area will be collected in the miscellaneous waste storage tank.

TABLE 3.4

CHEMICAL DISCHARGE LIMITS FROM
STATE WATER QUALITY STANDARDS

Fluorides (non-public water supplies)	$\leq$1.0 mg/l F
Chlorides (saline waters)	$\leq$10% increase above background
Dissolved solids	$\leq$1000 mg/l at any time $\leq$500 mg/liter, monthly average
Specific conductance	$\leq$100% increase above background
Cyanide or cyanate	none detectable
Copper	$\leq$0.5 mg/l
Zinc	$\leq$1.0 mg/l
Chromium	$\leq$0.5 mg/l Cr^{+6} or 1.0 mg/l total $\leq$0.05 mg/l after mixing
Phenolics	$\leq$0.001 mg/l phenol
Lead	$\leq$0.05 mg/l
Iron	$\leq$0.30 mg/l
Arsenic	$\leq$0.05 mg/l
Oils and greases	$\leq$15 mg/l, no visible oil
pH	normal $\pm$ 1.0, $\geq$6.0, $\leq$8.5
Detergents	$\leq$0.5 mg/l
Mercury	none detectable

Treatment includes evaporation in the miscellaneous waste evaporator and may include treatment by a cation exchange unit. The effluent from this system is essentially a pure water distillate which may contain traces of radioactive materials. The effluent may be recycled for reuse or discharged via the circulating water system if radioactivity limits are not exceeded.

3.4.3.6 Sanitary Wastes

Sanitary waste is to be processed through an extended aeration activated sludge sewage treatment plant. Retention in the aeration basin will be not less than 24 hr and not less than 2 hr in the clarifier. Biochemical Oxygen Demand (BOD) satisfaction is expected to be greater than 90% and suspended solids reduction 98%; BOD concentration in the effluent is estimated to be 20 ppm. The effluent will be chlorinated for disinfection utilizing a chlorine contact chamber having not less than one hour detention time.

3.4.4 Other Wastes

Pollution from storm drainage will be minimized by landscaping, grading, and "plant keeping" to assure that the runoff will be kept as natural as possible. Yard drains from the area of the transformers are routed through specially-designed sumps to trap oil that may leak from the transformers. Storm drainage is routed to the discharge canal.

4. ENVIRONMENTAL IMPACT OF SITE PREPARATION AND PLANT CONSTRUCTION

4.1 SUMMARY OF PLANS AND SCHEDULES

The plant is being constructed on a site already occupied by two oil-fired plants. Construction of access roads and fencing and other site preparation activities are largely completed. The same barge and water-intake and discharge canals will serve all of the facilities, although each canal will require about 600 ft of additional length. This excavation was postponed until the NEPA review was completed. When this activity is completed, some 175,000 cubic yards of soil will have to be removed. This will be placed in two already cleared areas. One of the areas, approximately 25 acres in size, is located north of the discharge canal. The other area, approximately 15 acres in size, is located east of the plant. Landscaping of these spoil areas should be planned and carried out by the applicant.

The major work items remaining in the construction of the plant are as follows:

Installation of the underground circulating water and nuclear services seawater piping system.

Construction of the plant berm began in April 1972.

Construction of the circulating water outfall structure began in May 1972.

Construction of the machine shop and administrative office buildings.

Excavation of the circulating water inlet canal extension.

Excavation of the circulating water outfall canal extension.

Other remaining construction activities do not involve a modification of the environment. These require the construction of and assembly of plant units in the interior of already-built structures. They are as follows:

Installation of reactor vessel
Containment leak rate test
Hot functional test
Fuel loading
Commercial operation of the plant

4.2 IMPACTS ON LAND, WATER AND HUMAN RESOURCES

At the time when Units 1 and 2 were constructed land clearing at the site destroyed a portion of the existing ecosystem (see Figure 2.1). No new cleared acreage was required for the construction of Unit 3.

The original dredging of the intake and discharge canals and the establishment of an enclosed fly ash dumping area (not required now) between the two canals has altered approximately 330 acres of marshland and nearshore bottom land. These areas were originally important in contributing to the primary productivity, in the production of organic detritus, and as a nursery area for fish.

Construction of the dikes along the intake and discharge canals, however, provided a new habitat. Carr, of the University of Florida,3] states that the large aggregations of juveniles of the spottail pinfish and permit are found along the edges of the dikes of the intake canal, while the submerged rocks support growths of algae and encrusting organisms which may be utilized as a food source by higher life forms.

The marshland between the intake and discharge canals was originally established to receive fly ash from coal-fired generating units. With the conversion of Units 1 and 2 to fuel oil, the area is now utilized by Ralston-Purina in its mariculture project.

The proposed inland extension of the discharge canal will be a carefully controlled dredging operation so that it should avoid any adverse effect on the benthos north of the discharge canal.

4.3 CONTROLS TO REDUCE OR LIMIT IMPACTS

Controls are planned to limit turbidity produced during the intake and discharge canal extensions and its discharge to the Gulf of Mexico. These will take the form of excavating the inland portion of the canal first and isolating the excavation from the present canal by a berm, thus preventing loose sediment from being swept out to the present discharge area. The berm will be removed behind turbidity restraining structures after the eastern portion of the canal has been constructed. The impact of these operations should be minimal.

5. ENVIRONMENTAL IMPACT OF PLANT OPERATION

5.1 LAND USE

The largest permanent alteration of the land due to the presence of Crystal River Unit 3 is the removal from the natural habitat of about 30 additional acres, over and above those needed for Crystal River Units 1 and 2. An additional 40 acres of land will be disturbed as spoil areas for the material excavated for the intake and discharge canal extensions.

Existing transmission line rights-of-way will be used and no new land will be required for that purpose. There will be some additional disturbance of these lands due to erection of towers and the stringing of lines. This involves 2,140 acres of land.

5.2 WATER USE

Groundwater supplies about 70% of the water used for municipal, industrial, agricultural, and domestic applications in the State of Florida. Present usage of groundwater at the plants amounts to approximately 500,000 gal/day. This water is withdrawn from two shallow wells drilled into the Floridan aquifer. Unit 3 will require an additional 100,000 gal/day for cooling system makeup, and this will be supplied from a third well to be drilled. Total withdrawal rate of water is thus anticipated to be approximately 600,000 gal/day. The total aquifer recharge rate is predicted to be about 10,500 million gal/day on a yearly basis; withdrawal of 0.6 million gal/day will be a small part of the available supply and will not have a deleterious impact.

How much larger a volume of fresh water could be withdrawn at the site without detrimental effect on its use (stemming from salt water intrusion) is not known at the present time. Detailed engineering studies would be required before such use of the Floridan aquifer could be planned.

5.3 BIOLOGICAL IMPACT

5.3.1 Terrestrial Ecology

Permanent impact due to plant operation will be of minor consequence compared to that from construction activity already completed. The small number of acres (about 30) permanently removed from natural habitats should have little or no effect on the area as a whole, because of large natural areas adjacent to it. Moreover, the applicant has title to a large area at the site (4,738 acres) and plans to preserve as much as possible of the land in its natural state, thus minimizing impact. The property has been set aside as an Eagle Sanctuary in a cooperative agreement with the Florida Audubon Society.[32]

Due to the moist tropical climate, ruderal areas appear to recover quite rapidly; or, when desirable, they are easily maintained. The flat land and permeable soils minimize the importance of soil erosion as an impact. Nonagricultural areas of the transmission line rights-of-way may be beneficial to wildlife such as by producing additional deer browse.

5.3.2 Aquatic Ecology

A major localized impact covering an area of about 1500 acres is expected to occur in the vicinity of the end of the discharge canal as a result of the operation of all Units. This presupposes operation of all Units at 100% power, and, therefore, is felt to be a conservative estimate. The incremental impact associated with Unit 3 is about 1000 acres of this total (see Section 12.2.6.2).

Applicant studies at Crystal River site (since opening up the site for Units 1 and 2) provide some basis for predicting the subsequent impact of Unit 3. These studies, in some cases preliminary or partial, include:

- Fish and invertebrate population analysis
- Plant screenwash sampling
- Discharge canal monitoring
- Analysis of trace metals in oysters
- Laboratory experiments with oysters
- Thermal plume dispersal studies
- Analysis of seawater composition
- Determination of diffusion and flushing rates in the discharge basin and
- Effects on entrainment.

The impact factors requiring evaluation for Unit 3 operation on the aquatic environs are:

- The intake structure and impingement
- Discharge and entrainment of organisms
- Discharge canal scouring
- Inshore mixing zone
- Thermal rheotaxis and effects on sport fishing
- Dissolved oxygen and toxic chemicals
- Eutrophication and
- Radiation damage to marine organisms.

5.3.2.1 Effects of the Intake Structure

The effects of the intake structures on the biota arise from the combined stress of the intake velocities, the impingement itself, and the force of the high pressure jets. The affected finfish and shellfish are those of sufficiently small size to pass through the trash rake and sufficiently large to be blocked by the screens.

The applicant supported studies through 1969 to determine the species and number of individuals of finfish and invertebrates affected by the intake of Units 1 and 2. The data on the basis of 24-hr samples taken monthly, are given in Table 5.1. Greatest numbers of species and individuals occur during the early spring and late fall, when low temperatures presumably cause lethargism and make organisms more susceptible. Since numbers and individuals captured in the screenwash are biased toward small or weak swimmers, disproportionate numbers of juveniles and small species are captured by the screenwash mechanisms. On the basis of 30 days/month the staff calculates that about 200,000 finfish and 50,000 shellfish are now destroyed at the intakes annually; a doubling is to be expected when Unit 3 goes on line. The applicant calculates that 32,000 lbs of fin-fish and 4,000 lbs of shellfish, with values of $4,800 and $1,560, respectively, were killed in 1969 on the intake screens of Units 1 and 2.

Operation of Unit 3 will require an additional 680,000 gal/min of seawater at an increased flow rate and four additional traveling

TABLE 5.1

SEASONAL ABUNDANCE OF FINFISH AND INVERTEBRATES IN SCREENWASH SAMPLES AT CRYSTAL RIVER PLANT, UNITS 1 AND 2, 1969

FISHES	JAN.	FEB.	MAR.	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
Dasyatis sabina			3		2							1
Gymnura micrura				1	9							
Elops saurus			1									
Brevoortia patronus		5	1	4					1			1
Opisthonema oglinum									3		2	
Anchoa hepsetus		6	78	15					3			
Anchoa mitchilli			260	2					9			
Synodus foetens									2			
Bagre marinus												9
Galeichthys felis [(a)]											4	1574
Gymnothorax nigromarginatus		1										2
Ophichthus gomesi		1		8						3		
Strongylura marina			2			5			5			
Hemiramphus saltator		1										3
Hyporhamphus unifasciatus			3									
Hippocampus sp.			7	2			1				1	2
Syngnathus sp.			3									
Centropristis stricta			2								PRESENT	
Mycteroperca bonaci			1									
Pomatomus saltatrix			1									
Caranx hippos												14
Chloroscombrus chrysurus											2	
Oligoplites saurus									1			
Selene vomer							5		3		9	
Vomer setapinnis											PRESENT	
Eucinostomus argenteus									11		PRESENT	22
Eucinostomus gula											1	107
Haemulon plumieri									2			
Haemulon sciurus									2			
Orthopristis chrysopterus		1	7	18			5		4			3
TOTAL FISHES		15	369	50	11	5	11		46	3	19	1738
TOTAL SPECIES		6	13	7	2	1	3		12	1	9	11

(a) THESE SPECIES ACCOUNT FOR 69% OF THE ORGANISMS IMPINGED ON THE SCREENS

TABLE 5.1 (Continued)

INVERTEBRATES	JAN.	FEB.	MAR.	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
Lolliguncula brevis[a]		371	139		81		12	5	53	7	24	20
Squilla empusa		12	115	1	2				1	2		
Penaeus duorarum			2	1	119	2	5	11	115	20	PRESENT	4
Palaemonetes sp.	1		4	3								
Alpheus sp.			15		6							
Synalpheus sp.							1					
Petrolisthes armatus				1	2		6		3	1		
Pagurus pollicaris						1						
Callinectes sapidus	1	23	39	15	33	14	8		41		PRESENT	7
Portunus gibbesii		1	3	1	1	4	3			60	PRESENT	10
Menippe mercenaria		2	1	5	11	11	1	6	6			
Neopanope texana			1	1	3	2	3	3				
Panopeus herbstii		1	1	4	1			2	2			
Uca sp.				1			1		1			
Metoporhaphis calcarata	3				1	3	23	2	12			
TOTAL INVERTEBRATES	5	410	320	33	260	37	63	29	234	90		41
TOTAL SPECIES	3	6	10	10	11	7	10	6	9	5	4	4

[a] THESE SPECIES ACCOUNT FOR 69% OF THE ORGANISMS IMPINGED ON THE SCREENS

TABLE 5.1 (Continued)

FISHES	JAN.	FEB.	MAR.	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
Bairdiella chrysura [a][b]		9	84	1		1			1	8	107+	377
Cynoscion arenarius									1			
Cynoscion nebulosus				4	17				3	1	1	1
Sciaenops ocellata		1		1								
Archosargus probatocephalus		1	1									
Calamus arctifrons						1					PRESENT	
Lagodon rhomboides		8	111		2	3			2	2		50
Chaetodipterus faber		3	6								1	6
Scomberomorus maculatus				1								
Prionotus scitulus			1		8							
Prionotus tribulus		14	36	4								
Chasmodes saburrae		1										
Hypsoblennius hentzi		8	19	4		3		1			PRESENT	
Mugil cephalus			3								PRESENT	1
Menidia beryllina		1	2	1					4		3	6
Ancylopsetta quadrocellata		2	43	1								
Etropus crossotus			4									
Etropus rimosus		1										
Paralichthys albigutts				3								
Trinectes maculatus									3			3
Symphurus plagiusa		1		3								
Alutera schoepfi		4	4				2					
Monacanthus sp.			2	3			2	1		1	3	1
Lactophrys quadricornis		5	17					1			PRESENT	14
Sphoeroides nephelus		4	8	1					1		PRESENT	4
Chilomycterus schoepfi		10	11				5	2			5	
Opsanus beta		1	1	4						2	11	
Porichthys porosissimus				2								
Ogcocephalus nasutus [a]		138	620	21	83	29	5	9	58	56	472	277
TOTAL FISHES		204	973	54	110	37	14	14	73	70	603+	740
TOTAL SPECIES		18	18	15	4	5	4	5	8	6	13	11

(a) THESE SPECIES ACCOUNT FOR 69% OF THE ORGANISMS IMPINGED ON THE SCREENS

(b) OF SPORT FISHING VALUE. ABOUT 9% OF THE IMPINGED SPECIES BY COUNT screens. The velocity in the intake canal will increase to about 1.3 fps; the velocity at the screen will be about 1.0 fps. The number of finfish and shellfish captured in the screenwash may increase twofold. The biological and economic impact of impingement resists accurate assessment since natural mortality is invariably high and only a small proportion of juveniles usually survive to become adults and reproduce. Rational assessment must be based on the division between organisms destroyed and those available in the ecosystem, the numbers expected to survive to maturity and the importance of individual species in food chains and fisheries. These types of data are not amenable to analysis using existing techniques. It is the staff's opinion, however, that screenwash capture will represent a small fraction of the total annual production of the inshore ecosystem.

Since the intake canal serves as a waterway for the delivery of fuel oil and supplies for Units 1 and 2, its use will probably result in occasional minor pollution and localized oil spills. The synergistic effects of these with the warm water are not expected to cause a noticeable impact resulting from the nuclear plant.

5.3.2.2 Discharge and Entrainment of Organisms

Entrainment of organisms in the cooling water and their passage through the plant and discharge canal will affect both micro- and macroplankton. Resultant effects will be site-specific and dependent upon ambient temperatures, thermal increment, duration of exposure, mechanical action and the presence of toxic materials such as chlorine.

Limited data[25] indicate that there is "a reasonable amount" of nannoplankton and "substantial zooplankton" present at the Crystal River site. The zooplankton is dominated by calanoid copepods. Quantities of eggs and larvae of valued finfish and shellfish are very low since most species spawn offshore beyond the predicted mixing zone, with the exception of seatrout, redfish and oysters.

The applicant supports continuing studies on the effects of heat and chlorine on entrained organisms at Crystal River Units 1 and 2.[33-43] Methods have involved bacterial counts as well as analyses of chlorophyll a, primary productivity, and adenosine triphosphate (ATP) from samples taken at the intake, outfall and progressive stations down the discharge canal. Preliminary results indicate that heat and chlorination both affect entrained organisms. In terms of productivity, the amount of change in photosynthetic activity due to thermal increments is correlated with intake water temperatures. Measurement of productivity across the condenser showed a decrease when the intake temperature was 81°F (27°C) or greater. Productivity increased 8.2% in one test when the intake temperature was 76°F (24.3°C). Temperature had a variable effect on chlorophyll a; in 4 out of 5 tests, ATP values increased across the condenser. The exception revealed a slight decrease in ATP when the intake temperature was 27.5°C. During chlorination, primary productivity values decrease an average of 55% across the condenser, and this is accompanied by an average drop of 40% in ATP values.[34]

The extent of entrainment will be greater after Unit 3 begins operation because of the doubled flow. The effect of the chlorination (essentially 100% kill) will remain as it is now in the operation of Units 1 and 2 but will, therefore, extend to a greater number of organisms. The thermal increment is not expected to lower significantly the dissolved oxygen (DO) or to affect total or suspended solids, or permit chlorine build-up in organisms and sediments. The total time through the condensers and the discharge canal will be approximately 1 hr under full load operation of all units. Since the flow velocity in the discharge canal will be about 2.4 fps, compared to the existing 1.1 fps, the total period of exposure to elevated temperatures during entrainment will be substantially reduced. A kill of 100% of the entrained organisms is nevertheless assumed.

Thermal shock imparted to entrained organisms across the condenser is dependent upon intake temperatures. Under full load conditions of all three units at Crystal River, intake temperatures above 80°F (27°C) can be considered to be critical to entrained organisms. At an ambient 27°C, the estimated 14.5°F (8.1°C) ΔT will bring the discharge temperature to 95°F (35°C). This condition will exist about 35% of the time annually, compared to about 18% at the present (see Figure D.4).

The applicant has evaluated the problem of plankton entrainment in terms of the total estuary involved. The Marine Science Institute, University of South Florida, designated[44] the size of the influenced area as a "total grid" for computer modeling program. The available body of water was then compared with the water used by the plant. If the extreme case of total planktonic kill is assumed, about 18% of the organisms within a volume of water equivalent to the total grid area will be influenced at maximum flood tidal state under stress of Units 1, 2 and 3. Under normal low-high tidal extremes, this figure may average about 14% (based on an ebb tide percentage of 9.7 and a flood tide percentage of 18.3) over a period of 28 hr. Thus, if the plant were drawing on an enclosed reservoir the size of the total grid area, it would use 14.3% of the available water in 28 hr. The open Gulf coastal ecosystem adjacent to the Crystal River site communicates directly with the deeper offshore water and allows free exchange of inshore planktonic populations with those offshore. There is no evidence that the total plankton population is significantly depleted by present Plant operations or will be with the addition of Unit 3.

Organic remains of planktonic organisms killed provide a source of nutrition for pelagic and benthic organisms inhabiting adjacent estuarine waters. The shallow nature of the estuarine area at the Crystal River site provides favorable conditions for recycling of nutrients in the inshore marine ecosystem. However, if the thermal increment proves to be detrimental to desirable organisms, the increased availability of organic nutrients may be selective for nuisance species, thereby causing an undesirable shift of flora and fauna.

5.3.2.3 Discharge Canal Scouring

Some bottom scouring is now associated with the discharge canal, although there is no evidence of delta building due to dropping of the sediment during operation.[37] Increasing the discharge volume and flow with addition of Unit 3 will increase the scouring effect until solid substrate is reached.

If canal turbidities should be doubled, they will approach turbidities of the Withlacoochee River-Barge Canal water moving into the discharge area from the north. Since grain size of the scoured canal sediment may be larger than that of the sediments suspended in the slower Withlacoochee water, regions near the discharge canal outlet may be affected. Much of the suspended sediment will be deposited in the area 1-1/2 miles to the west where canal and ocean currents converge. The impact upon benthic marine invertebrates is not expected to be ecologically significant, however, due to the relatively small amounts of suspended particles (comparable to Withlacoochee River water) and low deposition rates.

5.3.2.4 The Mixing Zone

5.3.2.4.1 Physical Phenomena

Water flow patterns within the mixing zone are governed primarily by tide-induced flow and by water influx from the Withlacoochee River-Cross Florida Barge Canal source. Mixing in the discharge basin has been studied by Carder and his associates[106-109,38] from the University of South Florida, and by Cornell Aeronautical Laboratory, Inc.[39] A number of experimentally-derived temperature contours (isotherms) have been obtained for thermal discharge from Units 1 and 2. This information is provided in Appendix D.

Carder and co-workers[106] are developing a computerized mathematical model of flow and diffusion in the mixing basin. This model will aid in accurately predicting the temperature profiles for the discharge conditions that will accompany operation of all three generating plants. The applicant[111] has made an initial estimate of the area included in the 5°F (2.8°C) isotherm, and concluded that 900 acres would, on the average, be covered by water heated to a ΔT of 5°F (2.8°C) or more.

As noted earlier in this report (Heat Dissipation System) the present flow rate of cooling water is 638,000 gpm (1420 cfs) and at maximum power production, this water is heated 11.5°F (6.4°C). When Unit 3 starts operating, an additional flow of 680,000 gpm (1515 cfs), at a maximum temperature rise of 17.1°F (9.5°C) will be added. The resulting total flow of 1,318,000 gpm (2940 cfs) will experience a maximum temperature rise of approximately 14.5°F (8.1°C). Based on these flow rates and temperatures, it would be possible to operate the generating complex in such a way that the maximum temperature rise were 17.1°F (9.5°C). For instance, if Units 1 and 2 were shut down (including the cooling water flow) and the nuclear plant operated at full power, the discharge water would be heated 17.1°F (9.5°C) above ambient. In the assessment made in this statement, it has been assumed that the plants will be operated to prevent the occurrence of a temperature rise of more than 14.5°F (8.1°C) from intake to discharge canal. The applicant states that circumstances which would lead to higher temperature rises would be classified as emergencies.[40]

Ambient water temperatures attain maximum values during the summer months. Seasonal temperature patterns were described in detail earlier in this statement. The monthly means and percent frequency with which various temperatures are reached during summer months[41] in the condenser intake are shown in Figures D.3 and D.4. According to these data, 92°F (33.3°C) was the maximum temperature reached during 1971. This maximum temperature agrees with the maximum measured at Cedar Keys over a many-year period (Figure D.2). Temperatures in the mixing zone may be estimated from the seasonal ambient temperatures by adding the temperature increment caused by plant operation.

The staff has made estimates of the mixing zone temperatures. This was done by an application of existing data (see preceding description, Section 2.5.4, and Appendix D Oceanography) to the larger, warmer plume which will result from the startup of Unit 3.

The temperature rise predicted for flood tide conditions is shown in Figure 5.1. During the incoming tide phase, water is forced to flow north along the coast line. The shallow areas along the shore line will be exposed to temperatures from 6°F (3.3°C) to 10°F (5.6°C) higher than ambient. For the flood-tide portion of the cycle, acreages covered by specific isotherms are listed in Table 5.2.

TABLE 5.2

ACREAGES COVERED BY HEATED WATER
DURING FLOOD TIDE

Temperature Increase Above Ambient	Acreage Covered
1°F (0.5°C)	2860
2°F (1.1°C)	2100
4°F (2.2°C)	1350
6°F (3.3°C)	730
8°F (4.4°C)	400
10°F (5.5°C)	220

For the ebb-tide portion of the tidal cycle, effluent water flows westward along the discharge canal spoil bank causing a heated tongue as shown in Figure 5.2. On the outgoing tide, the warmest water follows the bank of the discharge canal dike, and extends along a westerly line. The acreages covered by specific isotherms for this condition are listed in Table 5.3.

During a complete tidal cycle, the heated water will alternate in position between that shown for ebb-tide and that for flood-tide. As a result, the area located between the two positions would likely experience periods of heating and cooling. The entire area exposed to heated water was delineated by connecting isotherms for ebb-tide and flood-tide flow regimes. The resulting temperature distribution is shown in Figure 5.3. The isotherms obviously encompass larger areas because they enclose the entire areas exposed to the stated temperatures. The total acreages covered by specific isotherms are listed in Table 5.4.

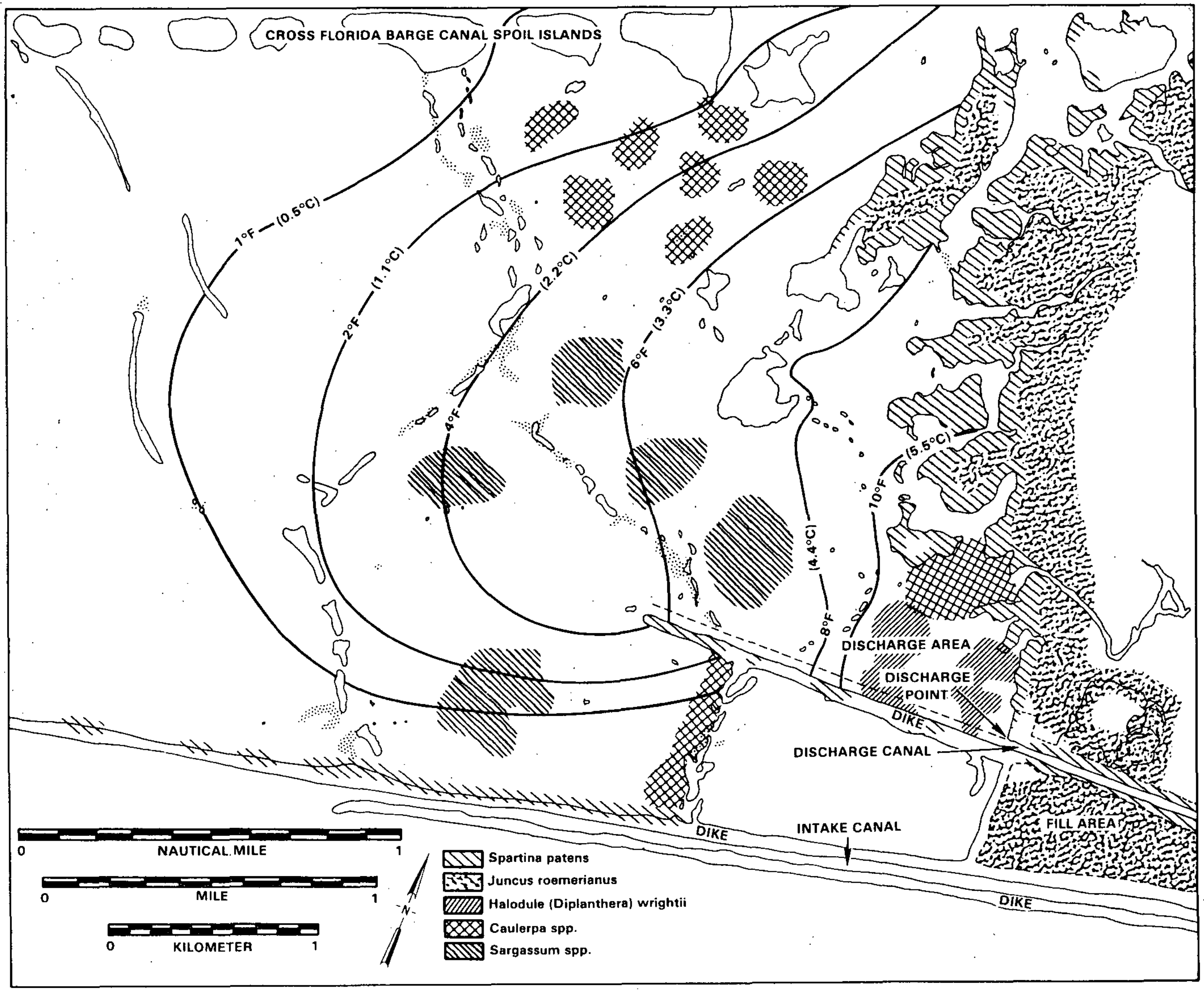

FIGURE 5.1 PREDICTED TEMPERATURE INCREMENTS ABOVE AMBIENT IN THE DISCHARGE AREA, FLOOD TIDE, ALL UNITS AT 100% POWER

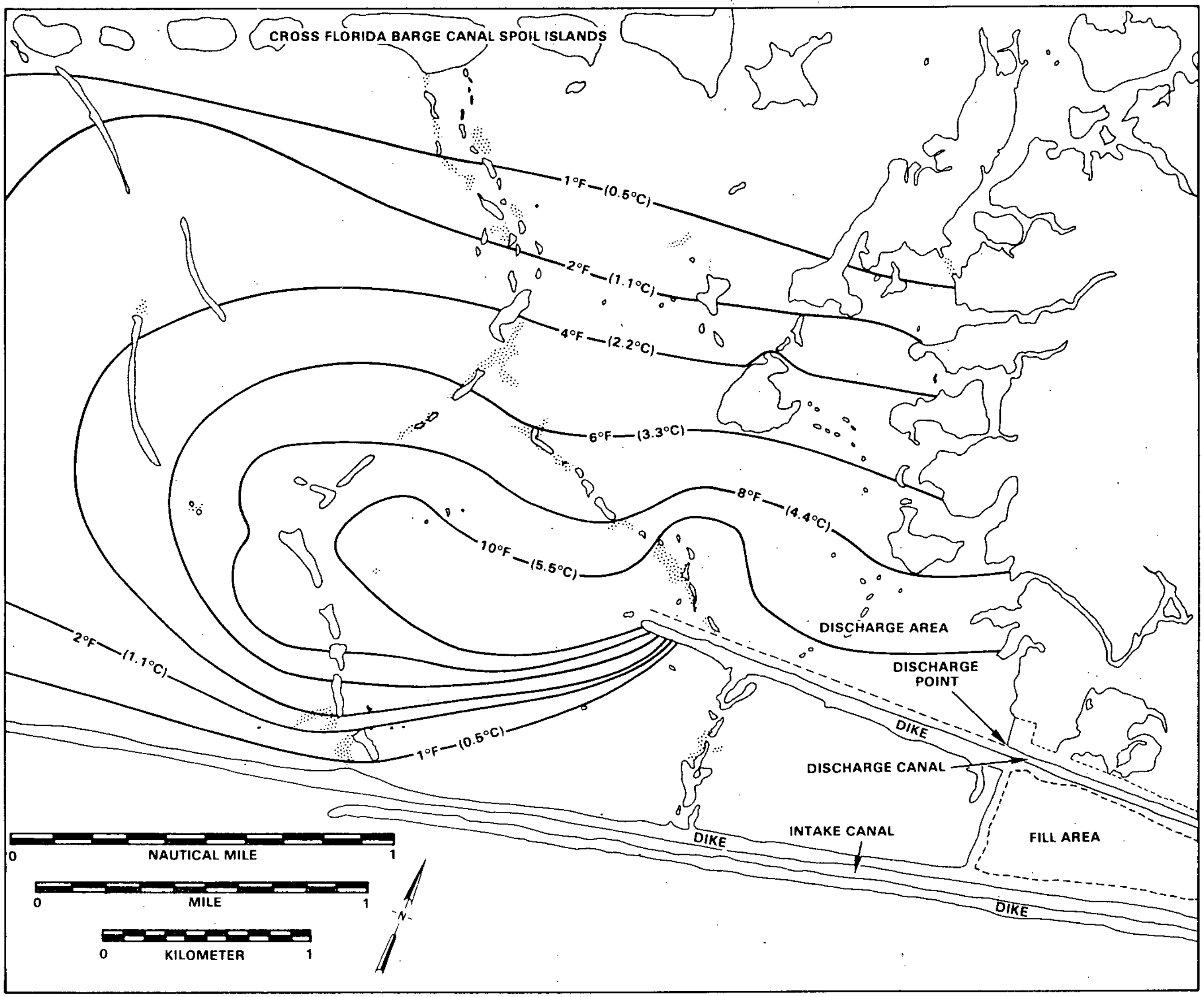

FIGURE 5.2 PREDICTED TEMPERATURE INCREMENTS ABOVE AMBIENT IN THE DISCHARGE AREA, EBB TIDE, ALL UNITS AT 100% POWER

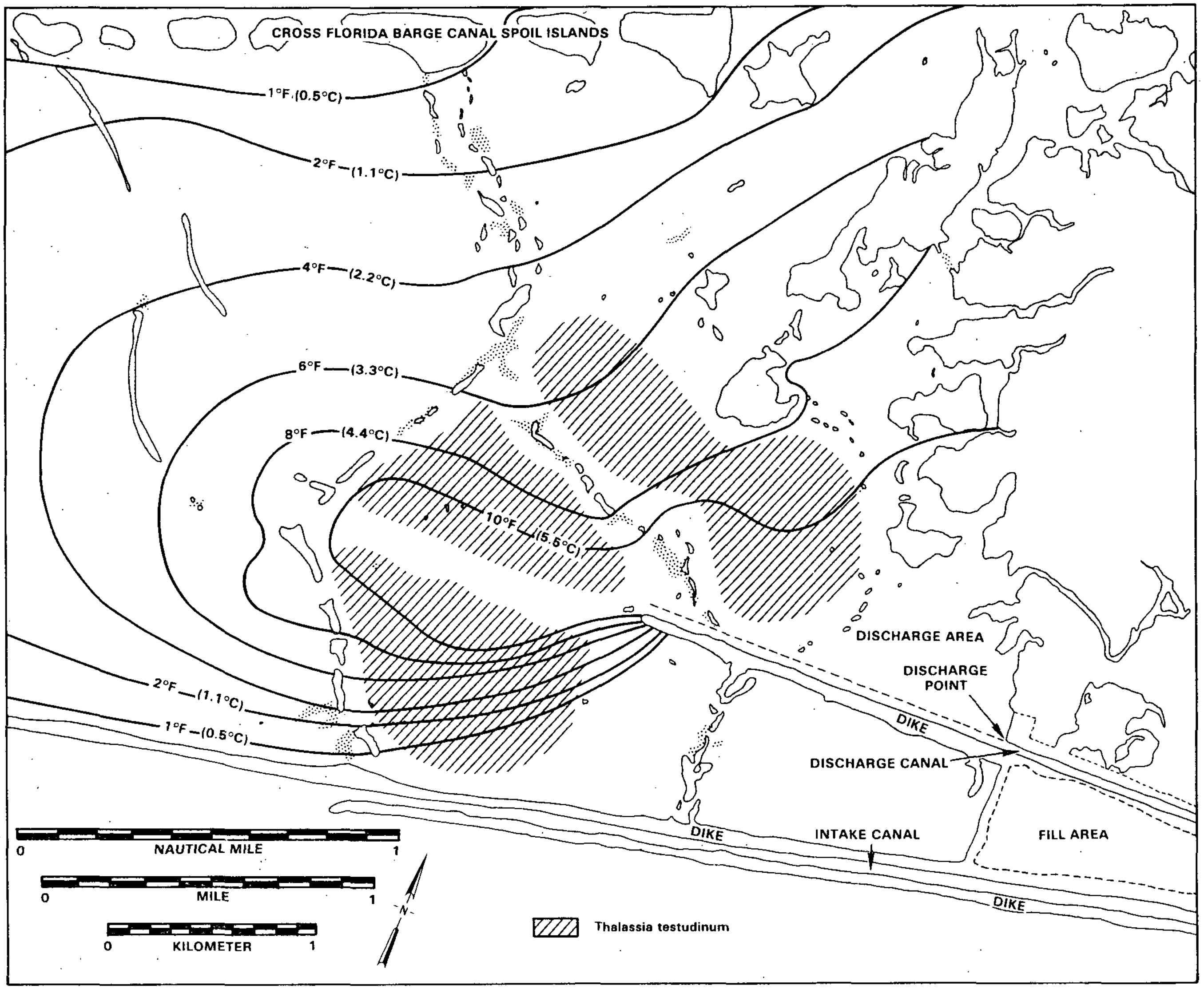

FIGURE 5.3 PREDICTED TEMPERATURE INCREMENTS ABOVE AMBIENT IN THE DISCHARGE AREA, FULL TIDAL CYCLE, ALL UNITS AT 100% POWER

TABLE 5.3

ACREAGES COVERED BY HEATED WATER
DURING EBB TIDE

Temperature Increase Above Ambient	Acreage Covered
1°F (0.5°C)	3770
2°F (1.1°C)	2760
4°F (2.2°C)	1750
6°F (3.3°C)	1130
8°F (4.4°C)	740
10°F (5.5°C)	430

The maximum water temperatures do not occur at the surface, but rather at 3 ft or more below the surface, as discussed in Appendix D, Oceanography. The isotherms as shown in Figures 5.1-5.3 were based on data determined for the 3-ft depth level and therefore represent the highest temperatures which would occur. Below 3 ft, the temperature gradient is small, therefore the bottom would be exposed to water having a temperature close to that experienced at the 3 ft depth level. It should be remembered that the mixing zone is shallow, varying from 5 to 10 ft in depth. This shallowness precludes significant temperature stratifications below the 3-ft depth.

TABLE 5.4

ACREAGES COVERED BY HEATED WATER
DURING COMPLETE TIDAL CYCLE

Temperature Increase Above Ambient	Acreage Covered
1°F (0.5°C)	4600
2°F (1.1°C)	3500
4°F (2.2°C)	2300
6°F (3.3°C)	1500
8°F (4.4°C)	950
10°F (5.5°C)	500

The impact of the operation of the nuclear plant can best be measured by comparing the mixing zone temperature profiles with those for the present operation of Units 1 and 2 (Figures D.9, D.10 and D.11). An estimate of the impacted acreage may be made on the basis of areas predicted for a full tidal cycle. The added impacted areas due to operation of Unit 3 alone were estimated by subtracting the area covered by the present plume (Figures D.9, D.10, and D.11) from that projected for the appropriate case (see Figures 5.1-5.3). Results are shown in Table 5.5 where the added areas are shown for specific isotherms.

TABLE 5.5

INCREMENTAL AREAS COVERED BY THERMAL PLUME
CAUSED BY OPERATION OF UNIT 3 FOR FULL TIDAL CYCLE

Temperature Increment	Acreage Covered		
	Units 1 & 2	Units 1, 2 & 3	Unit 3 Incremental Acreage*
1°F (0.5°C)	2350	4600	2250
2°F (1.1°C)	1700	3500	1800
4°F (2.2°C)	1050	2300	1250
6°F (3.3°C)	510	1500	990
8°F (4.4°C)	220	950	730
10°F (5.5°C)	-	500	500

* Incremental Acreage= Area covered in addition to that predicted for operation of Units 1 and 2 at full power.

As noted earlier, the tidal sinusoid is the dominant forcing function which determines flow and mixing in the heated water mixing zone. Ebb tide and flood tide profiles represent limits. The precise time interval over which a particular temperature profile persists was not evaluated. Instead, the analysis was based on the assumption that the area at risk is that covered by heated water for a complete tidal cycle.

Minor variations in temperature patterns may be expected as a result of wind stress and variations in fresh water influx from the Withlacoochee River-Cross Florida Barge Canal complex. Little information is available concerning these minor influences. It is unlikely that changes in mixing zone temperatures which might occur as a result of these influences would appreciably influence the predicted temperature profiles.

Finally, it should be noted that any increased jetting effect due to the increased velocity of the new plume has not been accounted for in the predictions made by the staff. This will err on the side to over-estimate any damage since the doubling in velocity, which will occur with startup of Unit 3, will tend to carry the warmest water away from the nearshore marshlands.

Acreages covered by specific isotherms have also been predicted by the applicant, using his numerical computer model.[42] For full power operation of Units 1, 2 and 3, predicted acreages covered are shown in Table 5.6.

Table 5.6. Applicant's Estimate of Thermal Plume Size

Temperature Increase Above Ambient	Acres	
	High Water (Flood Tide)	Low Water (Ebb Tide)
1.0 - 2.0°F	150.5	265.5
2.0 - 3.0	140.5	196.2
3.0 - 4.0	136.9	417.9
4.0 - 5.0	87.6	149.6
5.0 - 6.0	15.5	98.5
6.0 - 7.0	12.8	58.4
> 7.0	34.6	9.1
Total > 4.0	150.5	315.6

The acreages shown in Table 5.6 are smaller than those estimated by the staff. For example, the staff estimated the acreage covered by temperature increments greater than 4°F to be 1750 acres at ebb tide and 1350 acres at flood tide. These estimates are about 5 times those of the applicant shown in Table 5.6. The applicant's initial estimate of 900 acres for the 5°F isotherm is in agreement with the estimates made by the staff and is also larger than the more recent predictions of the applicant.

A small part of the discrepancy between the applicant's recent estimates of plume size[42] and those made by the staff may be explained by noting that the predictions made by the staff are believed to be conservative and may, therefore, overestimate the areas covered by specific isotherms. The major part of the discrepancy, however, is believed to result from inaccuracies in the applicant's predictions. It is the opinion of the staff that the applicant's predictions are inconsistent with experimental measurements of plume size. For example, based on operation of Units 1 and 2 at approximately 75% power, Carder's[106] measurements of plume size (Figures D.5-D.8) indicate that the 4°F isotherm above ambient would cover approximately 500 acres for the ebb tide conditions. It is doubtful that the area covered by the 4°F isotherm would decrease to 316 acres with the start-up of Unit No. 3, which would double the flow rate and increase the discharge temperature. The calculational procedure used by the applicant is considerably more sophisticated than that used by the staff and would be expected to be capable of more accurate prediction of plume size. However, it is the opinion of the staff that the numerical model used by the applicant is still in a developmental stage, and cannot be relied on at this time to give reliable predictions. Very careful observation of the distribution of the thermal plume must be planned and carried out to determine exactly the extent of the plume and initiate corrective action should the staff deem it necessary.

5.3.2.4.2 <u>Effects on Aquatic Life</u>

Thermal rheotaxis is either positive or negative (attracting or repelling) and is characteristic of fish, which can detect small temperature changes in their medium.[48,49,50] The natural effects of ambient temperatures on seasonal movements of fish at the Crystal River site have been noted.[27] Numbers of most fish in the discharge canal of the Turkey Point plant on Biscayne Bay, Florida decrease[51] during the summer; grey snapper and tarpon showed no avoidance, lemon sharks were more abundant, and blue crabs were more abundant except in July and August.[44]

These observations indicate that positive and negative thermal rheotaxis would be exhibited by marine finfish at Crystal River. The response is expected to be more noticeable with the addition of Unit 3. Seasonal changes of temperature in the discharge area will occur gradually. Fish living in the discharge canal are expected to leave as temperature levels approach their upper zone of thermal tolerance. Avoidance is also likely for the more mobile fish residing in the affected discharge area.

It is possible that some juvenile fish living in the marshy inshore area, or habitual benthic dwellers, will be subject to detrimental temperatures arising from changing discharge patterns at various tidal stages. Ecologically, sudden declines in water temperature are more detrimental than increases to Florida fish.[45,46] Past outage rates, resulting in lowering of discharge canal temperatures at Crystal River, are given in Table 5.7. For Unit 3, the applicant estimates[47] that there will be a six-week outage the first year and one four-week outage per year thereafter. A forced outage rate of 12% is estimated to occur to the extent of 968 hr/yr the first three years and of 484 hr/yr thereafter.

TABLE 5.7

PAST OUTAGE RATES FOR CRYSTAL RIVER UNITS 1 AND 2

	FORCED RATE		SCHEDULED RATE		TOTAL	
YEAR	UNIT 1	UNIT 2	UNIT 1	UNIT 2	UNIT 1	UNIT 2
1971	15%	2.3%	9.0%	24.4%	24%	26.5%
1970	17.1%	5.7%	23.6%	5.6%	40.7%	11.3%
1969	7.1%	0.04%	7.2%	18.2%	14.3%	18.24%
1968	2.2%		20.6%		22.8%	
1967	1.1%		10.9%		12%	
1966	7.7%		6.5%		14.2%	

If all units were operating at peak power output, outage of Unit 3 would cause a temperature decrease of 8.8°F at the discharge point while outage of Units 1 and 2, separately, would cause temperature decreases of 2.4°F (1.3°C) and 3.2°F, (1.7°C), respectively, at that point. As before, this assumes that cooling water flow is maintained in the downed plant.

Despite the occurrence of forced and scheduled outages at Crystal River, the possibility that all three units will be shut down simultaneously is remote. Should simultaneous unscheduled outage occur during the winter, resulting in a temperature drop of 14.5°F (8.1°C), cold shock would cause mortalities of fish attracted to the discharge canal.

The applicant has supported studies dealing with the effect of discharge temperatures on marine biota under past operating conditions. Heated water discharged from the Crystal River Unit 1 in 1969 revealed little, if any, influence on the composition of invertebrate fauna but apparently stimulated spawning of molluscs and crustaceans.[22]

Investigations of fish fauna by trawling were conducted in 1969 and 1970 (Units 1 and 2 operating) in areas affected and unaffected by thermal discharge.[17,18] In 1969, only shallow inshore areas near the discharge were thermally influenced. Abundance of fish at all shallow areas was greatest during the spring and fall, but decreased during the summer as temperatures peaked. All areas were nearly barren in winter when temperatures were minimal. Abundance was greatest at affected areas during late fall and early winter, but there were no large differences during other seasons. No significant differences were detected in annual growth increments of juvenile silver perch, pigfish, and pinfish collected at affected and nonaffected areas.

In 1970, higher temperatures existed than in 1969 due to a natural increase in ambient Gulf temperature and increased discharge levels from the added Unit 2. The influence of the discharge plume extended into previously unaffected depths. Species abundance was higher in 1970 than in 1969 at intermediate areas, except during August, and higher also at unaffected than at affected areas, except in December. Species diversity was higher in shallow affected areas during the winter of 1970, but higher in unaffected areas during that summer suggesting thermal stress on the community. However, occurrence of the four most abundant species (pinfish, pigfish, silver perch and spot) did not differ greatly between affected and unaffected areas.

The above observations demonstrate that fish can detect small temperature changes and select favorable thermal levels according to seasons.[48-50] Temperatures of the discharge at the site, for this reason, are not likely to be lethal to finfish but will influence their local distribution as thermal conditions become more (winter) or less (summer) favorable. Effects on spawning or on eggs and larvae will be minimal since most fish species, except seatrout and redfish, spawn offshore. Juveniles of some species can be expected to migrate to shallow areas near the shore for protection and food, thus making them susceptible to entrainment and habitat changes. Thermal effects and tolerance limits of some finfish and shellfish occurring at the Crystal River site, where known, are given in Table 5.8.

With the increases in discharge temperature and discharge velocity, projected for Unit 3, sport fishing in the discharge canal will be adversely affected. In particular, the summer period of undesirably high temperature will be lengthened and the canal avoided by the fish.

TABLE 5.8

SOME THERMAL EFFECTS AND UPPER TOLERANCE LIMITS OF SOME CRYSTAL RIVER FINFISH AND SHELLFISH

References 59-74

Species	Life Stage	°C (°F)	Remarks
Pomatomus saltatrix	adult	29.8 (85.6)	Swimming speeds increased
(bluefish)	adult	30.4 (86.7)	Feeding decreased after 6 days
	juvenile	31.1 (89)	avoidance; acclimation 72°F, salinity 4 parts per thousand
Bairdiella chrysura (silver perch)	eggs	27.2-27.8 (81-82)	Maximum hatching temperature
Brevoortia patronus (Gulf menhaden)	adult	40.0 (104.0)	Upper level of reported occurrence
Cynoscion nebulosus (spotted seatrout)	adult	25.6-28.3 (78-83)	Normal spawning temperatures, Florida
Leiostomus xanthurus	juvenile	29.9-31.8 (85.8-89.3)	Critical thermal maximum at:
(spot or jimmy)	juvenile	33.4-35.6 (92.2-96.1)	10°C acclimation, 5-25% salinity
	juvenile	37.4-39.5 (99.4-103.1)	20°C acclimation, 5-25% salinity
	adult	1.2-35.5 (34.2-95.9)	30°C acclimation, 5-25% salinity
	adult	25.6 (78)	Range of occurrence avoidance; acclimation 68°F, salinity 4-5 parts per thousand

TABLE 5.8 (Continued)

Species	Life State	°C (°F)	Remarks
Micropogon undulatus (Atlantic crooker)	adult	0.4-35.5 (32.8-95.9)	Range of occurrence
Pogonias cromis (black drum)	adult	29.4 (85)	Avoidance; acclimation 77°F, salinity 4 parts per thousand
	adult	26.1 (79)	Avoidance, acclimation 65°F, salinity 4.5 parts per thousand
Lagodon rhomboides (pinfish)	?	40 (104)	Avoidance
Lutjanus apodus (schoolmaster)	?	"35-40" (95-104)	Upper tolerance limit
Mugil cephalus (striped mullet)	pr larvae and postlarvae	32 (89.6)	Upper tolerance limit
Anchoa hepsetus (striped anchovy)	eggs	19-21 (66.2-69.8)	Maximum hatching temperature
Callinectes sapidus (Blue crab)	juvenile	34.4 (94)	Avoidance; acclimation 79°F, salinity 4 parts per thousand
	adult and juvenile	31.4-39.0 (88.5-102)	48-hr TLM; less tolerant at low salinities

TABLE 5.8 (Continued)

Species	Life State	°C (°F)	Remarks
Callinectes sapidus (Blue crab) (continued)			1000 min TLM
	juveniles	37.1 (98.7)	20°C acclimation
		38.6 (101.4)	25°C acclimation
		39.4 (103.0)	30°C acclimation
	immature and mature	10-30 (50-86)	No effect on osmoregulation
Crassostrea americana (American oyster)	adult	42 (107.6)	---
	adult	32 (89.6)	Feeding rate depressed
	adult	35 (95.0)	lethal, 35% salinity
	adult	35 (95.0)	induced spawning and various pathological effects
Penaeus duorarum (pink shrimp)	adult	30 (86)	Occurrence in Tampa Bay, Florida
	?	33-34 (91.4-93.2)	lethal, prolonged exposure
Menippe mercenaria (stone crab)	?	33-34 (91.4-93.2)	Lethal, prolonged exposure

Sport fishing near the discharge canal dike may be affected but not necessarily adversely; concentrations of fish will shift according to individual preference.

Sessile marine organisms are unable to avoid unfavorable temperature conditions. The increased area of the mixing zone (see preceding Figures) will encompass more of the inner oyster reefs, as well as beds of seagrasses (Halodule-Diplanthera wrightii, Thalassia testudinum and Ruppia martima), marsh grasses (Juncus roemeriamus and Spartina patens), and marine algae (Sargassum spp., Caulperia and others).

Studies conducted[67] to evaluate the effects of thermal discharges at the Turkey Point plant, Biscayne Bay, southeast Florida, are pertinent to predicting the effects of Crystal River Unit 3 because ecological features in the discharge area are similar. Exclusion and optimum temperatures for broad categories of animals in Biscayne Bay are as follows:

Taxa	LET_{75}	LET_{50}	Max c/e	Max Div.	UET_{50}	UET_{75}
Fish	15.6[(a)]	21.1	25.9	26.6	31.8	37.8
Molluscs	15.3	19.7	25.5	26.0	32.7	37.4
Crustaceans	14.8	19.6	25.8	26.0	33.3	38.7
Porifera	0.2	9.1	24.9	24.3	31.4	35.5
Coelenterates	13.0	18.2	17.2	26.0	29.9	32.5
Echinoderms	15.4	20.5	26.2	27.3	31.8	35.2
All species	14.3	19.3	25.7	26.3	33.4	38.6

(a) All temperatures in °C

In the preceding table, LET_{75} and LET_{50} are the lower exclusion temperatures (due to low temperature) of 75% and 50% of the organisms, respectively; Max. c/e is the optimum temperature for numbers of individuals; Max. Div. is the optimum temperature for diversity of species; and UET_{50} and UET_{75} are the upper exclusion temperatures (due to high temperature) of 50% and 75% of the organisms, respectively.

These data show that the optimal temperature for diversity of species and maximum number of individuals was 26-28°C (78.8-80.4°F). The upper exclusion temperature for all organisms combined was between 30 and 34°C (86.0 and 93.2°F) for 50% and between 35 and 39°C (95.0 and 102.2°F) for 75%. In general, average temperature elevation 3 to 4°C above ambient summer temperatures at Biscayne Bay caused severe depletion of biota.[67] It was also noted that areas with fluctuating temperatures were not as severely damaged as areas constantly exposed to elevated temperatures.

The optimum temperature for growth of larval oysters is between 86 and 90°F (30 and 32.2°C) at salinities above 10 parts per thousand[68] The optimum temperature for external embryonic development is 27.5°C at salinites above 16°/oo. Although oysters live in water reaching 36°C (96.8°F) in Florida, little is known about prolonged exposures above 32 to 34°C (89.6 to 93.2°F).[69] Experimental evidence indicates that oysters exposed to temperatures of 35°C (95°F) in western Florida undergo various physiological stresses which may cause mortality.[70]

The blue crab is generally tolerant of high temperatures and the upper lethal level for both juveniles and adults ranges from 31.4 and 39.0°C (88.5 and 102°F), depending on acclimation level and salinity.[71] In another study, the 1000 min. TL_m values for juvenile blue crabs acclimated to 20, 25 and 30°C were 37.1, 38.6 and 39.4°C, respectively, while salinities of 2-21% had little effect on growth and mortality.[72] Stone crabs were killed in the effluent canal at Biscayne Bay by temperatures above 37°C.[73] The critical temperatures for juvenile <u>Penaeus</u> shrimp appear[61] to be 36.3-38°C (97.3-100.4°F).

At Biscayne Bay, thermal increments increasing the water temperature an average 5°C (2.8°F) at the point of discharge severely reduced the abundance of <u>Thalassia</u> and <u>Diplanthera</u> (=<u>Halodule</u>), and the normal fauna of green, red and brown algae were replaced by a blue-green algae mat.[74]

On the basis of the above, a localized impact can be expected to occur among sessile marine invertebrates, attached algae and plants, some planktonic organisms, and possibly some fishes in the discharge area at the Crystal River site. This is due to the increase of temperatures in the discharge effluent from the present 6.4°C (11.5°F) to about 8.1°C (14.5°F) but primarily to the more than doubling of the size of the mixing zone. Ecological impact will occur during the season when any combination of ambient and incremental temperatures exceeds 35°C (95°F), a condition which will exist about 53% of the time annually.

Biological and ecological effects will be most severe near the outlet of the discharge canal and will probably extend outward to near the predicted 3.3°C (6°F) isotherm. This isotherm is expected to cover 1500 acres over a complete tidal cycle when all three units are operating at full power. About 1000 acres of this area would result from Unit 3. Within this isotherm, the affected area may not cover the entire 1500 acres since, at Biscayne Bay, areas with fluctuating temperatures were not as severely damaged as those areas constantly exposed to elevated temperatures.[67] Nevertheless, the affected area will include major portions of the inshore marsh ecosystem north of the discharge canal and of the sensitive beds of seagrass within the discharge basin. In view of this potential major localized effect, it is the staff's conclusion that the applicant must initiate action to alleviate this problem by extension of the discharge canal to deeper water and away from the near shore area or other means which might result in lesser environmental impact. The applicant should undertake immediately the necessary engineering design and studies to determine the environmental impact associated with such a modification. The results of this effort must be available so that appropriate reviews and implementation can be accomplished prior to full power operation of Unit 3.

No significant reduction of dissolved oxygen (DO) between plant intake and discharge is expected. The cooling water in the intake at Crystal River is well supplied with oxygen.[75] Monitoring at Units 1 and 2 shows that dissolved oxygen values may be reduced somewhat by condenser passage, but are not expected to fall to dangerously low levels (4 ppm).

Chemicals from the plant operation will also be released into the condenser cooling water. The expected concentration of chemicals in the discharge canal is expected to be held below levels causing detrimental effects on aquatic life. This is due both to the large amounts of cooling water required (1,318,000 gpm, Units 1, 2 and 3) and the applicant's intent to essentially eliminate pollutant discharges to the Gulf to assure compliance with State water quality standards. The direct impact of chemicals, or related synergistic effects with temperature elevations, upon living organisms in the discharge area should be negligible.

Under present operation of Units 1 and 2, chlorine is applied in the form of sodium hypochlorite to destroy fouling organisms in the condenser tubing. Chlorination is applied to only one condenser unit at a time. Since the discharge from the treated unit mixes at the outfall with that from the other seven units, the resulting chlorine residual occurs at low levels. Due to the chlorine demand of untreated seawater,[76] the residual is largely consumed by the time the effluent enters the sea. A much greater volume of cooling water will be used with the addition of Unit 3. No deleterious effect should result to marine organisms from the chlorination. Experimental studies elsewhere[77] suggest that, if ambient temperatures are 28°C (82.4°F) and the increment is 8-10°C (4.4-5.5°F), resulting temperatures and 0.1 ppm of residual chlorine entering the sea do not cause great damage to sensitive marine phytoplankton.

Applicant-supported studies show that oysters from the discharge canal under operation of Units 1 and 2 reveal substantial increases in copper and zinc.[17] These increases are believed to be related to increased ionic concentrations in the discharge waters as well as to increased temperatures that stimulate metabolism. This phenomenon is apparently common at power plant sites,[78] but is not necessarily lethal. Research to date has not indicated the point at which such concentrations become detrimental to the oyster.

5.3.2.5 Eutrophication

Eutrophication occurs when organic material in surplus of that utilized by living organisms accumulates in water; if excess oxygen is consumed, an oxygen deficiency can result. The addition of heat and small amounts of chemicals to the Crystal River environment is not expected to create eutrophic conditions, even though some entrained planktonic organisms will be destroyed during the warmer part of the year. This is due, largely, to the volumes of water to be pumped through all Units under full load conditions, the limited nutrient content of the water, the mixing and flushing characteristics of the discharge basin and the ability of the environment to assimilate and recycle biological and chemical resources.

The greatest amount of organic matter contributing to eutrophication will issue from natural resources, the flow of freshwater from the Withlacoochee River-Cross Florida Barge Canal to the north and the nearshore marsh ecosystem. Since the Crystal River plant is situated on a 4,738-acre preserve owned by the Florida Power Corporation, no future housing or commercial development will arise nearby to create organic pollution problems. The possibility is extremely remote that eutrophic conditions in the warmed discharge area will ever instigate the development and bloom of "red tide" organisms so detrimental to marine fishes.

5.3.2.6 Radiological Effects on Marine Organisms

As described in an earlier section, processed liquid waste will be released from the plant on a batch basis via the nuclear services seawater system and discharge canal into the Gulf of Mexico. Contents of each batch will be sampled before its release to determine activity levels. Based on activity analysis, the wastes will either be released under strictly controlled and monitored conditions or recycled for further processing. For liquid releases, the dilution available before discharge to the Gulf includes 10,800 gpm of nuclear services seawater and 680,000 gpm from Unit 3 condenser cooling flow. In addition, the release will mix with 638,000 gpm of condenser cooling water from Units 1 and 2. The maximum discharge rate from the evaporator condensate storage tanks is 30 gpm. Consequently, the resulting dilution is 38,000 to 1 before discharging into the Gulf and further mixing. Radionuclides added to the sea are diluted by the corresponding stable elements normally present in seawater.[79]

Radiation dose rates that may be received by marine organisms in the near vicinity of the Crystal River plant can be predicted on the basis of the estimated release rates of radionuclides into the discharge canal, their subsequent dilution in the receiving water and the bioaccumulation factors tabulated in Table 5.9.

At the postulated concentrations in the discharge canal, the planktonic forms entrained in the cooling water would receive dose rates of the order of 3×10^{-6} mrem/hr but this rate would diminish rapidly as the effluent is diluted in the mixing zone and is transported away from the point of discharge.

The organisms most likely to accumulate the greatest doses are shellfish (crabs, shrimp, oysters, mussels, barnacles) or marine plants (algae, seagrasses) that reside near the discharge canal point for extended periods of time. The annual dose to a crab or oyster might amount to about 30 mrem. Much of this would come from cesium from bottom sediments near the outfall.

Annual doses on the order of those predicted for marine organisms near the discharge canal (30 mrem/yr) are at least 1000 times below the chronic dose levels that might produce demonstrable radiation damage to aquatic populations. Field and laboratory studies concerned with relevant dose versus effect relationships

TABLE 5.9

SALT WATER BIOACCUMULATION FACTORS

(pCi/kg Organism per pCi/liter Water)

Isotope	Fish	Crustacea	Molluscs	Algae
H-3	1	1	1	1
Cr-51	100	1,000	1,000	1,000
Mn-54	3,000	10,000	50,000	10,000
Fe-55	1,000	4,000	20,000	6,000
Fe-59	1,000	4,000	20,000	6,000
Co-58	100	10,000	300	100
Co-60	100	10,000	300	100
Rb-86	30	50	10	10
Rb-88	30	50	10	10
Sr-89	1	1	1	20
Y-90	30	100	100	300
Y-91m	30	100	100	300
Y-91	30	100	100	300
Y-92	30	100	100	300
Y-93	30	100	100	300
Zr-95	30	100	100	1,000
Zr-95D	30	100	100	1,000
Nb-95	100	200	200	100
Mo-99	10	100	100	100
Mo-99D	10	100	100	100
Tc-99m	10	100	100	1,000
Te-127m	10	10	100	1,000
Te-127	10	10	100	1,000
Te-129m	10	10	100	1,000
Te-129	10	10	100	1,000
Te-131m	10	10	100	1,000
Te-132	10	10	100	1,000
Te-132D	10	10	100	1,000
I-130	20	100	100	10,000
I-131	20	100	100	10,000
I-132	20	100	100	10,000
I-133	20	100	100	10,000
I-134	20	100	100	10,000
I-135	20	100	100	10,000
Cs-134	30	50	10	10
Cs-136	30	50	10	10
Cs-137	30	50	10	10
Cs-138	30	50	10	10
Ba-140	3	3	3	100
Ba-140D	3	3	3	100

are summarized in "Radioactivity in the Marine Environment"[80] in the Templeton chapter.[81] The irradiation of salmon eggs and larvae at a rate of 500 mrem/day did not affect the numbers of adult fish returning from the ocean or their ability to spawn.[82]

Blue crabs irradiated at the rate of 3.2 or 7.3 rads/hr[(a)] for over 70 days survived as well as the controls.[83] Stocks of plaice living in the vicinity of the outfall of the British nuclear facility at Windscale have received chronic radiation at the rate of about 10 rem/yr without a discernible adverse effect.[84] Chironomid larvae (bloodworms) living in bottom sediments near the Oak Ridge plant, Tennessee have received irradiation at the rate of about 230 to 240 rem/yr for more than 130 generations and, while they have a slightly greater than normal number of chromosome aberrations, their abundance has not diminished.[85]

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 mrads/week.[86] The fecundity of a freshwater fish (Gambusia affinis) exposed to chronic radiation of 10.9 rads/day at Oak Ridge was increased brood size, although more dead embryos and abnormalities were observed in irradiated populations than in controls. Increased fecundity is the means by which natural populations with a short life cycle and producing large numbers of progeny can adjust to increased stress caused by radiation.[87]

The planned release of radionuclides from the Crystal River plant will be a very small fraction of one percent of the releases that have occurred in the past at several major nuclear facilities[88] where studies have detected no adverse effects on the aquatic population. Moreover, the estimated dose rates to marine organisms will be several orders of magnitude less than those expected to cause radiation damage.[89] Consequently, populations of marine organisms near the discharge point are not expected to be adversely affected by the low concentrations of radionuclides added by the plant.

5.3.3 Environmental Monitoring

In addition to the radiological monitoring system (to be described in Section 5.4.6), a system of biological monitoring, including its supporting chemical aspects, should be activated before start-up and continued thereafter.

(a) For purposes of this discussion, 1 rad (or 1 mrad) may be assumed equivalent to 1 rem (or 1 mrem).

The objectives of the monitoring are to continue the surveillance of the area with respect to certain physical, chemical and biological parameters and establish a biota baseline so that any off-standard or gradually worsening condition may be promptly detected.

Among the parameters which should be given continuous attention throughout the discharge area are:

Water temperature	Productivity
Salinity	Plankton populations
pH	Benthic organisms
Dissolved solids	Coliform bacteria
Turbidity	Fish eggs
BOD	Fish
Total organic	Insects
Heavy metals	Vegetation

Records should be kept of dead organisms on the intake screens and on the numbers and condition of dead organisms after passage through the condensers.

Inventories and measurements of the various animal species in the terrestrial as well as the aquatic sectors should be made.

To determine the ecological significance of the data, any observed changes must be related to previous population data, to the population dynamics and to the regeneration times of the organisms concerned.

This separate treatment of the non-radiological from the radiological monitoring is not meant to imply an absence of relationship between the two phases. On the contrary, the physical, chemical and biological work must be continuously integrated with the meteorological and the radiological and each must be responsive to the others in such a manner that a truly ecological analysis can be made at all times.

5.4 RADIOLOGICAL IMPACT ON 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. The release rates of radionuclides to the environment must be in conformance with Federal regulations set forth in 10 CFR Part 20. In addition, the releases must meet the requirements specified in 10 CFR Part 50 as finalized.

The estimated 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 are summarized in Tables 3.2 and 3.3.

5.4.1 Impact of Liquid Releases

The liquid effluents from all three Crystal River plants are released through a 1-1/2 mile long discharge canal into the Gulf of Mexico. The radionuclides released from the nuclear plant are diluted in the total cooling water from all 3 plants (2950 cfs). The staff has estimated the radiation doses from pathways associated with the liquid effluent (Table 3.2) and the bioaccumulation factor previously given in Table 5.9.

The individual likely to receive the highest radiation dose from the effluents released from the Crystal River Plant would be a fishing "guide" who spends considerable time (1000 hrs/yr) in a boat in the effluent canal as close to the reactor as possible (0.1 mile) and who eats seafood harvested from the canal. In addition, it is assumed that this same individual swims 100 hr/yr in the Gulf when the plant effluent had been diluted to 1/10 of the concentration in the canal and that he is exposed for 100 hr/yr to the radionuclides accumulated in the sediment along the shoreline of the canal.

This individual is assumed to eat 18 kg/yr of fish and 18 kg/yr of crustacea (crabs) caught in the canal. No consumption of molluscs is assumed since, according to the applicant, very few molluscs (local oysters) are eaten in this region.

The results of the dose calculations based upon the above assumptions are summarized in Table 5.10. The total-body dose from consumption of seafood was estimated to be 0.09 mrem/yr, while an additional 0.02 mrem/yr was estimated to be received from exposure to the canal water and shoreline. The latter dose results from ^{137}Cs (80%) and ^{134}Cs (20%) accumulated in the silt.

5.4.2 Impact of Gaseous Releases

Release rates of radionuclides in the gaseous effluents were listed in Table 3.3. These effluents are released from roof vents, and, to be conservative, air submersion dose rates were calculated assuming ground-level release, applicant's meteorological data with wind speed adjusted to 10 meter height, and no building wake correction.

TABLE 5.10

RADIATION DOSE IN MREM/YR TO AN INDIVIDUAL FROM THE EFFLUENTS RELEASED AT THE CRYSTAL RIVER PLANT[(a)]

Pathway	Extent of Exposure in One Year	Skin	Total Body	GI Tract	Thyroid	Bone
Air Submersion[(b)]	1000 hr	0.84	0.25	(0.25)[(d)]	(0.25)	(0.25)
Inhalation[(b)]	200 hr	--	--	--	0.40	--
Milk Consumption[(c)]	365 liters	--	--	--	0.29	--
Swimming	100 hr	2×10^{-4}	2×10^{-4}	(2×10^{-4})	(2×10^{-4})	(2×10^{-4})
Boating	1000 hr	2×10^{-3}	1×10^{-3}	(1×10^{-3})	(1×10^{-3})	(1×10^{-3})
Shoreline silt	100 hr	0.023	0.019	(0.019)	(0.019)	(0.019)
Fish Consumption	18 kg	--	0.032	3×10^{-3}	0.51	0.025
Crab Consumption	18 kg	--	0.057	0.012	2.5	0.045
Total Dose (Adult)		0.86	0.36	0.28	4.0	0.34
Milk Consumption (child)[(c)]	365 liters	--	--	--	2.4	--

(a) Based on releases listed in Tables14a and 14b.
(b) For fisherman fishing at entrance to discharge canal 0.1 mile north of reactor.
(c) From cows pastured 4 miles ENE of Plant.
(d) ( ) indicate internal dose from external exposure.

The maximum exposure rate at the site boundary occurs 0.9 mile ENE of the reactor where the annual average atmospheric dilution factor was calculated to be 1.7 x 10^{-6} sec/m^3. At this location the total-body dose was 0.05 mrem/yr, principally from ^{88}Kr and ^{133}Xe. The skin dose is somewhat higher (0.20 mrem/yr) because of the beta contribution from the radionuclides released with the gaseous effluents.

The total-body dose from air submersion to the fishing guide was 0.2 mrem/yr (based on an atmospheric dilution factor of 7.7 x 10^{-5} sec/m^3 and 1000 hr/yr exposure). The corresponding skin dose was 0.8 mrem/yr. The thyroid dose to this individual from the inhalation of ^{131}I and ^{133}I released from the plant would be 0.4 mrem/yr.

According to the applicant there are two milk cows approximately 4 miles ENE of the plant. The annual average atmospheric dilution factor at this location is 1.6 x 10^{-7} sec/m^3 and the air concentrations of ^{131}I and ^{133}I are 6.5 x 10^{-4} pCi/m^3 and 1.5 x 10^{-4} pCi/m^3, respectively. Inhalation of such concentrations of radioiodine would result in thyroid doses of 7 x 10^{-3} mrem/yr to an adult and 9 x 10^{-3} for a 2 yr-old child, principally from ^{131}I.

The estimated radiation dose to the child's thyroid from consumption of one liter of milk per day from cows pastured all year at this location would be 2 mrem/yr. The adult thyroid dose would be about 0.3 mrem/yr.

The closest dairy herd to the plant is pastured near Inverness, approximately 20 miles ESE of the Plant where the atmospheric dilution factor is 1.9 x 10^{-8} sec/m^3. For the same assumptions as above, a child's thyroid dose from milk produced by a cow in this herd would be 0.3 mrem/yr.

5.4.3 Impact of Solid Waste

The level of radiation from the solid waste storage area is expected to be negligible at the site boundary.

5.4.4 Population Doses from All Sources

In addition to the doses to the individual, an integrated annual dose (man-rem) has been estimated for the 210,000 people estimated (by linear interpolation between 1971 and 2020 estimates) to be living within a 50-mile radius of the plant in 1980. Table 5.11 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 plant. This population dose was estimated to be 0.041 man-rem/yr.

TABLE 5.11

CUMULATIVE POPULATION, ANNUAL MAN-REM DOSE, AND AVERAGE ANNUAL DOSE IN SELECTED CIRCULAR AREAS AROUND THE CRYSTAL RIVER PLANT

Cumulative Radius (miles)	Cumulative Population (1980)	Cumulative Dose (man-rem)	Average Dose (mrem)
1	0	0	0
2	0	0	0
3	0	0	0
4	48	2.5×10^{-4}	5×10^{-3}
5	710	1.8×10^{-3}	3×10^{-3}
10	7,500	1.1×10^{-2}	1×10^{-3}
20	21,000	1.8×10^{-2}	9×10^{-4}
30	42,000	2.3×10^{-2}	5×10^{-4}
40	100,000	3.1×10^{-2}	3×10^{-4}
50	210,000	4.1×10^{-2}	2×10^{-4}

The population doses received from pathways associated with the liquid effluents were also estimated by the staff. The applicant has estimated that 1,400,000 lb of fish and 3,000,000 lb of shellfish (mostly crabs) are harvested from the Gulf by Citrus County fishermen. Radiation doses to the population from seafood consumption were estimated by the staff, assuming that all the seafood was consumed by persons residing within 50 miles of the plant; that the edible weights of the fish and crabs were 50% and 13% of the live weight, respectively, that 24 hr elapsed between release of the radionuclides and the consumption of the fish, and that the seafood was caught in waters of the Gulf containing effluent radionuclides at a dilution of 10%. Based on these assumptions, the resultant total-body dose to the population from seafood consumption would be 0.11 man-rem/yr.

External exposure to the population from recreational activities was estimated by assuming that the predominant water-related pasttime for the people in the area was fishing from a boat. Shoreline activities such as hiking and picnicking are hindered by the physical nature of the shore (swampy). Swimming and skin diving are negligible sports in the area. Therefore, it is assumed that the average person spends 2 hr/yr boating, 0.1 hr/yr swimming, and 0.1 hr/yr near the shoreline (primarily fishing near spoil banks from a boat). All these activities are assumed to be in Gulf waters of 1:10 dilution after 3 hr decay. The total dose from these recreational activities was estimated to be only 8×10^{-4} man-rem/yr.

5.4.5 Evaluation of Radiological Impact

The total population dose received from all effluent pathways by the approximately 210,000 persons (1980) residing within 50 miles of the site was calculated to be 0.16 man-rem/yr, from routine operation of the Crystal River Plant. By comparison, natural background radiation at a rate of 0.12 rem/yr results in an integrated dose of about 25,000 man-rem/yr to the same population.

Thus, routine operation of the plant 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 benefits of the plant.

5.4.6 Environmental Radiological Monitoring

There are two environmental surveillance programs which have been operating in and near the plant site. The State of Florida, Department of Health and Rehabilitative Services, Division of Health, funded by the applicant initiated a preoperational survey in May 1969. The actual work within the Division of Health is being done by the Radiological and Occupational Health Section and by the Radiological Laboratory of the Bureau of Laboratories. This survey will be referred to here as the "Off-Site Radiological Surveillance Program."[90] A second program was begun in August 1970 by the University of Florida under a research contract with Florida Power Corporation.[91]

The latter program involves on-site stations and other research activities; it is defined here as the "On-Site Radiological Surveillance Program." The study is coordinated by the Department of Environmental Engineering, College of Engineering, but includes personnel from the Departments of Zoology and of Botany, the Aquatic Sciences Center and the Departments of Radiology and of Nuclear Engineering.

5.4.6.1 Off-Site Radiological Surveillance Program

The Florida Division of Health conducts radiological surveillance in the vicinity of the sites of all announced nuclear facilities in the state. The Florida Division of Health uses the data to evaluate the public health impact of the facility and as part of their statewide evaluation. The off-site program concentrates on the terrestrial area from the plant boundary to about 30 miles from the plant. In the marine environment, samples are taken at several shoreline stations both north and south of the plant. The location[90] of sampling stations is shown in Figure 5.4.

At the shoreline stations, oysters, crabs, food fish, marine algae, seawater, and silt are collected quarterly. Soil is collected quarterly at the terrestrial stations and palmetto and/or cabbage palm is collected monthly. Row crops are not grown commercially in the area. Public water supplies, one private well water and four surface waters are sampled quarterly. The closest dairy herd, located at Inverness, is sampled on a quarterly basis. A citrus grove about 8 miles northeast of the plant is sampled.

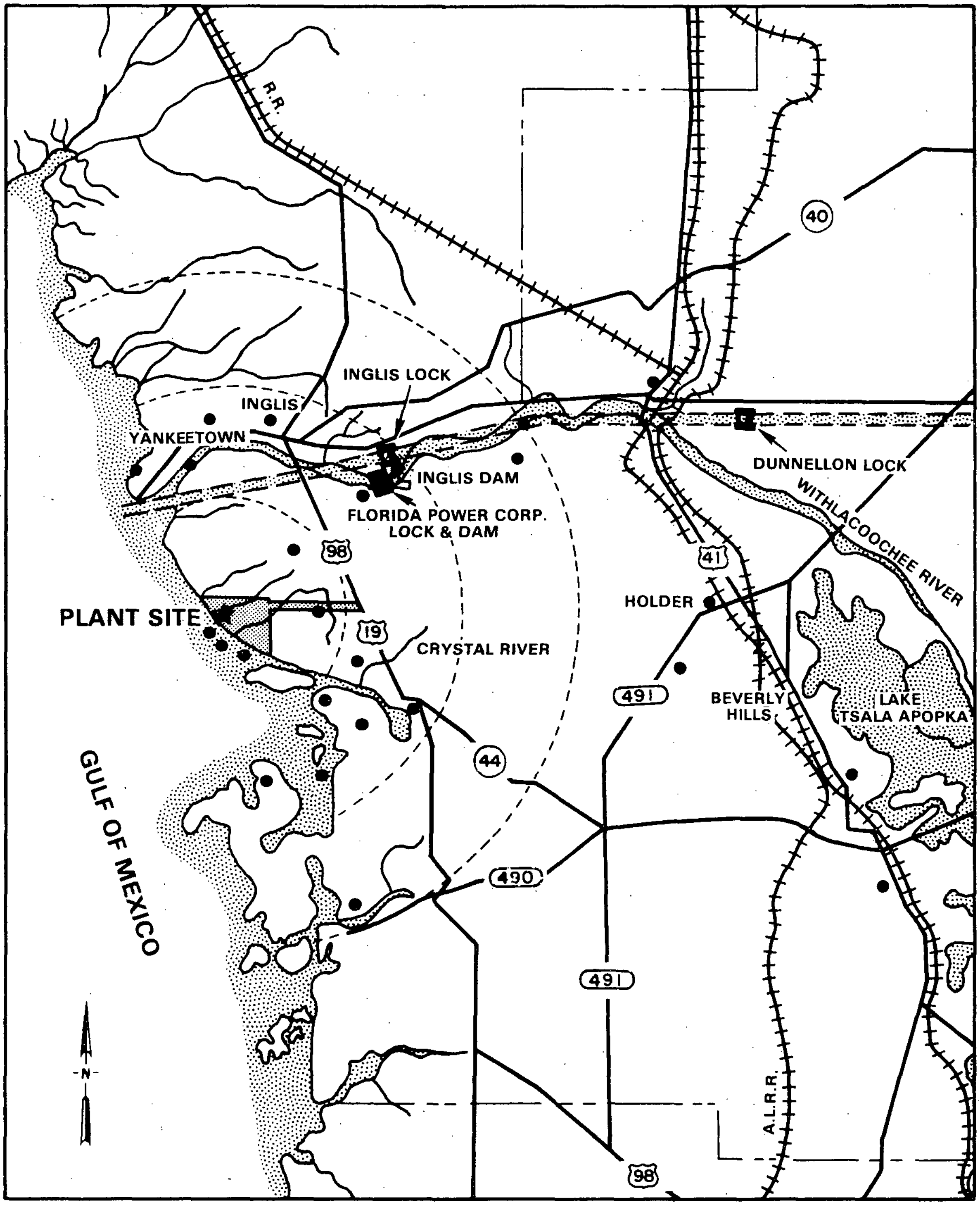

FIGURE 5.4 THE OFF-SITE RADIOLOGICAL SURVEILLANCE PROGRAM

All water samples are analyzed for tritium utilizing liquid scintillation techniques. Gross alpha and beta determinations are made on dissolved and undissolved solids in water. Milk samples are gamma scanned for ^{137}Cs, ^{131}I, ^{140}Ba and ^{40}K; radiochemical differentiation of ^{89}Sr and ^{90}Sr is made. Selected seafood samples are analyzed for ^{90}Sr and ^{32}P by liquid scintillation techniques. Certain samples will receive radiochemical separation for determination of levels of ^{58}Co and ^{55}Fe.

All media are measured by gamma spectroscopy for ^{144}Ce, ^{131}I, ^{106}Ru, ^{134}Cs, ^{137}Cs, ^{95}Sr, ^{54}Mn, ^{58}Co, ^{60}Co, ^{65}Zn, ^{140}Ba and ^{40}K.

Occasional samples enter the laboratory as blind duplicates; this is done for quality control and statistical comparison. The laboratory also periodically participates in inter laboratory quality control programs.

The accumulated monthly ambient external gamma radiation exposure is monitored at five of the stations and five are operated for airborne particulates. The micro membrane filters are analyzed for gross beta activity and are submitted to gamma spectrometry. Two off-site stations collect precipitation. A one-liter representative sample is submitted to gross alpha, gross beta and gamma spectrometry on a monthly schedule. Activated charcoal canisters and caustic scrubbers are currently being evaluated for monitoring airborne radioiodine.

5.4.6.2 On-Site Radiological Surveillance Program

The nature and scope of the contract with the University of Florida is considerably broader than the objective of measuring the baseline levels of radioactivity and the theme of the program is the application of principles of ecology to the selection of samples.

The objectives of the University of Florida on-site surveillance study are:

- To gather information on the preoperational levels of radioactive materials in the environment.

- To obtain information on the critical nuclides, pathways and biological groups associated with the introduction of radioactive materials into the human food chain.

- To estimate exposure levels from edible species.
- To test and exercise the procedures to be used in later radiological surveys.
- To gather baseline data to provide a comparison with future levels of radioactivity in the environment.
- To provide Florida Power Corporation with experience and training in environmental monitoring.

A wide variety of materials is collected and some samples that are collected for specific ecology research may receive radioassay. All data are transmitted to Florida Power Corporation for incorporation in the computer stored records. Some stations in the on-site program are more intimately associated with the plant, by distance and direct transport pathways. The corresponding data may give early warning and evaluation of the behavior of any radioactivity released to the environment. Sampling in some cases overlaps the off-site surveillance program.

The ecological study areas are the nearshore marine ecosystem, the marshland ecosystem, the terrestrial ecosystem and the freshwater ecosystem. The stations are shown in Figure 5.5.

5.4.6.3 Sample Analysis

The primary method of analysis in the case of these various samples is low-level gamma spectroscopy except for gross alpha and gross beta determinations on air particulate filters and tritium, and gross alpha and beta measurements on water samples. The accumulated monthly ambient external gamma radiation exposure is monitored at nine stations inside and at six stations outside the plant boundary. Thermoluminescent dosimeter ribbons located at each station are read and changed monthly.

The on-site monitoring system operates one airborne particulate sampler inside and one station outside the plant boundary, both northeast of the plant to provide maximum exposure to any airborne effluents from the site. The filters are submitted to gamma spectroscopy and gross alpha and beta analysis. Fourteen water sample stations are used in the on-site tritium network. Ten are

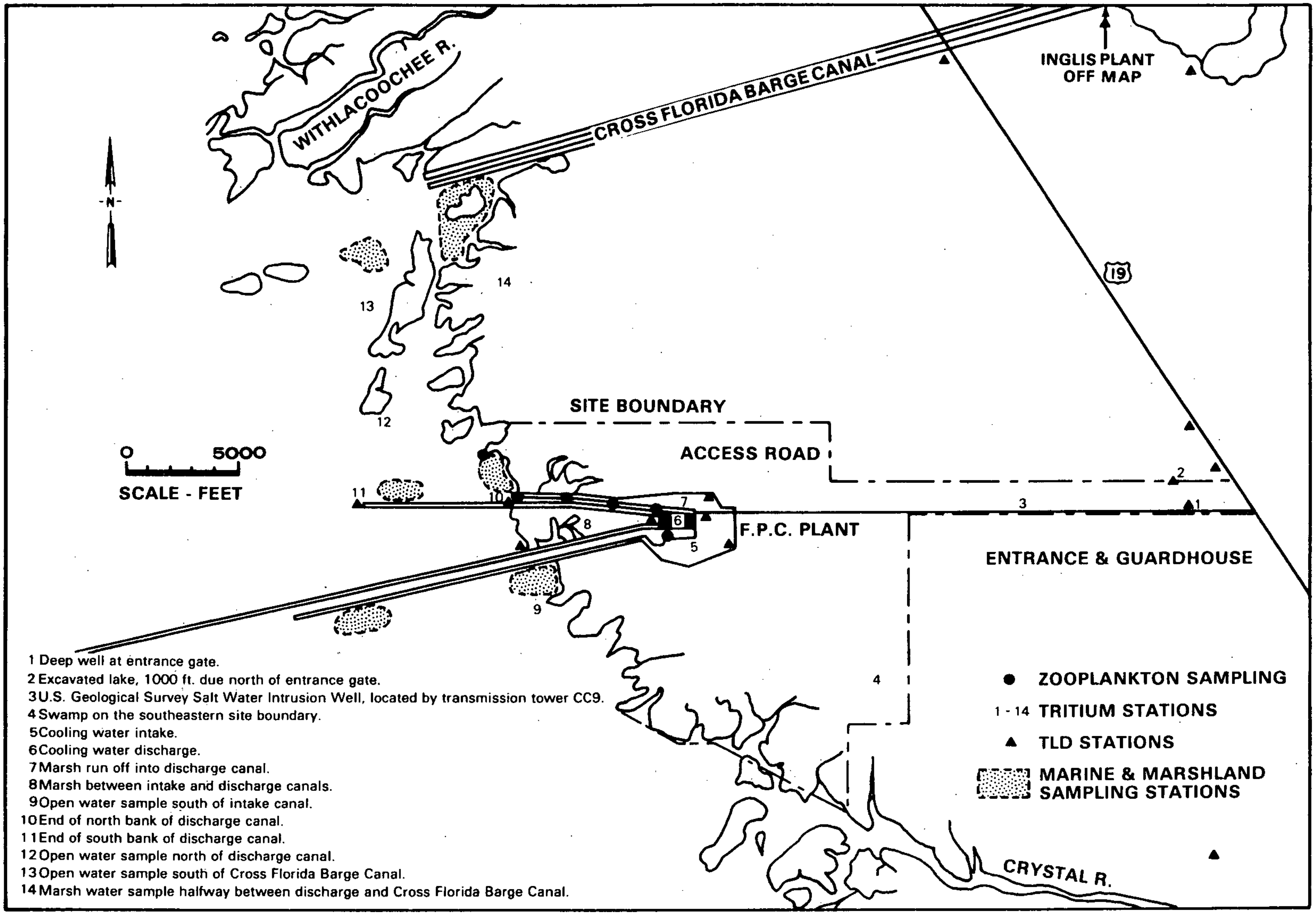

FIGURE 5.5 THE ON-SITE RADIOLOGICAL SURVEILLANCE PROGRAM

within the plant boundaries and others are off-site. A deep well, a salt water intrusion well, excavated lake, cooling water intake and discharge, nearshore marine seawater, and marshland waters are represented. Samples are counted in a liquid scintillation spectrometer after electrolytic enrichment.

The University of Florida contract is expected to continue for at least two years after the plant goes into operation during which Florida Power Corporation will have established in-house capability.

The staff considers that the preoperational environmental monitoring program as sponsored by the applicant and described earlier is adequate in the extent of its coverage. Desirably it would have commenced at least one year earlier.

The operational phase of the environmental radiological surveillance program will be an adaptation and extension and modification of the two existing pre-operational programs developed in consultation with the staff. Sampling locations and frequencies, particularly in relation to the milk sampling program, will be changed as necessary. Details will be given in the Technical Specifications. The applicant will be required to take a cow census semi-annually to determine if additional cows have been introduced at locations that may be affected by emissions from the Crystal River Plant. If such is the case, milk from these cows will also be sampled and analyzed.

5.5 TRANSPORTATION OF NUCLEAR FUEL AND SOLID RADIOACTIVE WASTE

The nuclear fuel for Crystal River Unit 3 is slightly enriched uranium in the form of sintered uranium oxide pellets encapsulated in zircaloy cladded fuel rods. Each year in normal operation, about 60 fuel element assemblies will be replaced.

5.5.1 Transport of New Fuel

The applicant has indicated that new fuel will be shipped in AEC-DOT approved containers which hold two fuel elements per container. About 5 truckloads of 6 containers each will be required each year for replacement fuel and about 15 truckloads for the initial loading. New fuel will be shipped initially from Lynchburg, Virginia by truck and then from New Haven, Connecticut.

5.5.2 Transport of Irradiated Fuel

Irradiated fuel elements 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, all fuel elements will contain large amounts of fission products and some plutonium. As the radioactivity decays, all fuel elements produce radiation and "decay heat." The amount of radioactivity remaining in the fuel varies according to the length of time after discharge from a 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.

Although the specific cask design has not been identified, the applicant states that the irradiated fuel elements will be shipped in approved casks designed for transport by rail after a 120-150 day cooling period: the cask will weigh perhaps 70 to 100 tons. To transport the irradiated fuel, the staff estimates 10 shipments per year with 6 fuel elements per cask and 1 cask per carload. An equal number of shipments will be required to return the empty casks. The irradiated fuel shipments will be made by rail to Barnwell, South Carolina, a distance estimated to be 350 miles.

5.5.3 Transport of Solid Radioactive Wastes

The applicant estimates that about 705 drums of solid radioactive wastes will be generated by normal operation of Unit 3 per year. Spent resins and waste evaporator bottoms will be solidified and soft, solid wastes compacted in drums for shipment and disposal. The staff, assuming 40 drums per shipment, estimates about 18 truckloads of waste each year. The applicant has not decided which of the approved burial sites it will use. The staff has assumed Moorehead, Kentucky, a shipping distance of about 850 miles.

5.5.4 Principles of Safety in Transport

The transportation of radioactive material is regulated by the Department of Transportation and the Atomic Energy Comission. 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[92] 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 might 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 an accident include segregation of damaged and leaking packages from people and notification to 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[93] 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.

5.5.5 Exposures During Normal (No Accident) Conditions

5.5.5.1 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 5 shipments, with two drivers for each vehicle, the total dose would be about 0.01 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.

5.5.5.2 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.

Train brakemen might spend a few minutes in the vicinity of the car at an average distance of 3 feet, for an average exposure of about 0.5 millirem per shipment. With 10 different brakemen involved along the route, the annual cumulative dose for 10 shipments during the year is estimated to be about 0.05 man-rem.

A member of the general public who spends 3 minutes at an average distance of 3 feet from the 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 would be about 0.1 man-rem. Approximately 105,000 persons who reside along the 350-mile route over which the irradiated fuel is transported might receive an annual cumulative dose of about 0.06 man-rem. 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 300 persons per square mile along the route.

The amount of heat released to the air from each cask will be about 250,000 Btu/hr. For comparison, 115,000 Btu/hr is about equal to the heat output from the furnace in an average size home. Although the temperature of the air which contacts the loaded cask may be increased a few degrees, no appreciable thermal effects on the environment will result, because the amount of heat is small and is being released over the entire transportation route.

5.5.5.3 Solid Radioactive Wastes

Under normal conditions, the individual truck driver might receive as much as 15 mrem per shipment. If the same driver were to drive 18 truckloads in a year, he could receive an estimated dose of about 270 mrem during the year. The cumulative dose to all drivers for the year, assuming 2 drivers per vehicle, might be about 0.5 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 0.2 man-rem. Approximately 255,000 persons who reside along the assumed 850-mile route over which the solid radioactive waste is transported might receive an annual cumulative dose of about 0.3 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 300 persons per square mile, 10 mrem/hr at 6 feet from the vehicle, and the shipment traveling 200 miles per day.

6. ENVIRONMENTAL IMPACT OF POSTULATED ACCIDENTS

6.1 PLANT ACCIDENTS

A high degree of protection against the occurrence of postulated accidents at the Crystal River Plant Unit 3 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 June 6, 1968. 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 postulated 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 "Applicant's Environmental Report," dated January 4, 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 6.1. The examples selected are reasonably homogeneous in terms of probability within each class, although (1) a loss of electrical load is more appropriately in Class 2, (2) the release of the waste gas decay tank contents is more appropriately in Class 3, and (3) the steam generator tube rupture is more appropriately in Class 5. 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.

Staff 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 6.2. Staff estimates of the integrated exposure that might be delivered to the population within 50 miles of the site are also presented in Table 6.2. The man-rem estimate was based on the projected population around the site for the year 2015, extrapolating the 1967 population data.

To rigorously establish a realistic annual risk, the calculated doses in Table 6.2 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. The probability of occurrence of large Class 8 accidents is very small. Therefore, when the consequences indicated in Table 6.2 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 protective 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

TABLE 6-1

CLASSIFICATION OF POSTULATED ACCIDENTS AND OCCURRENCES

Class	AEC Description	Applicant's Example(s)
1.0	Trivial Incidents	Not considered
2.0	Small releases outside containment	Small reactor coolant spill
3.0	Radwaste system failures	Release of 15% of the activity in a waste gas decay tank
4.0	Fission products to primary system (BWR)	Primary system leakage to containment
5.0	Fission products to primary and secondary systems (PWR)	Normal operation with fuel failures and steam generator leakage
6.0	Refueling accident	Mechanical damage to fuel element during refueling inside containment
7.0	Spent fuel handling accident	Mechanical damage to fuel element outside containment
8.0	Accident initiation events considered in design basis evaluation in the SAR	Uncompensated operating reactivity charges, startup accidents, rod withdrawal accidents, moderator dilution, cold water addition, loss of electrical load, steam line failure, steam line leakage, steam generator tube failure, rod ejection accident, waste gas decay tank rupture, loss-of-coolant
9.0	Hypothetical sequence of failures more severe than Class 8	Not considered

TABLE 6-2

SUMMARY OF RADIOLOGICAL CONSEQUENCES OF POSTULATED ACCIDENTS

Class	Event	Estimated Fraction of 10 CFR Part 20 limit at site boundary 1/	Estimated Dose to population in 50 mile radius, man-rem
1.0	Trivial Incidents	2/	2/
2.0	Small releases outside containment	2/	2/
3.0	Radwaste System failures		
3.1	Equipment leakage or malfunction	0.020	0.7
3.2	Release of waste gas storage tank contents	0.078	2.9
3.3	Release of liquid waste storage contents	0.022	0.1
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	2/	2/
5.2	Off-design transients that induce fuel failure above those expected and steam generator leak	<0.001	<0.1
5.3	Steam generator tube rupture	0.026	1.0
6.0	Refueling accidents		
6.1	Fuel bundle drop	0.004	0.2
6.2	Heavy object drop onto fuel in core	0.072	2.6

TABLE 6-2 (cont'd)

Class	Event	Estimated Fraction of 10 CFR Part 20 limit at site boundary[1]	Estimated Dose to population in 50 mile radius, man-rem
7.0	Spent fuel handling accident		
7.1	Fuel assembly drop in fuel rack	0.003	0.1
7.2	Heavy object drop onto fuel rack	0.010	0.4
7.3	Fuel cask drop	N.A.	N.A.
8.0	Accident initiation events considered in design basis evaluation in the SAR		
8.1	Loss-of-Coolant Accidents		
	Small Break	0.044	2.9
	Large Break	0.308	69
8.1(a)	Break in instrument line from primary system that penetrates the containment	N.A.	N.A.
8.2(a)	Rod ejection accident (PWR)	0.030	6.9
8.2(b)	Rod drop accident (BWR)	N.A.	N.A.
8.3(a)	Steamline breaks (PWR's outside containment)		
	Small Break	<0.001	<0.1
	Large Break	<0.001	<0.1
8.3(b)	Steamline break (BWR)	N.A.	N.A.

1/ Represents the calculated fraction of a whole body dose of 500 mrem, or the equivalent dose to an organ.

2/ 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).

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 6.2 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 within the Maximum Permissible Concentrations (MPC) of Appendix B, Table II, 10 CFR Part 20. Table 6.2 also shows that the estimated integrated exposure of the population within 50 miles of the plant from each postulated accident would be orders of magnitude smaller than that from naturally occurring radioactivity. The exposure from naturally occurring radioactivity corresponds to approximately 110 man-rem per year within a 5 mile radius and approximately 45,000 man-rem per year within a 50 mile radius (based on a natural background of 120 mrem/yr.) 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.

Radioactive liquid wastes in the Crystal River plant are contained within Class I structures. Failure of equipment within these structures would not lead to a release of radioactive liquid to the environment. The quantity of low-level liquid radioactive materials outside Class I structures is very small and release of this material would not affect substantially the environmental impact determined for routine operation of the plant.

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.

6.2 EXPOSURES RESULTING FROM TRANSPORTATION ACCIDENTS

Based on recent accident statistics,[94] 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[95] 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.

6.2.1 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 would occur under conditions that could result in accidental criticality is extremely remote. If criticality were to occur in transport, persons within a radius of about 100 feet 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 feet. There would be very little dispersion of radioactive material.

6.2.2 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.

6.2.2.1 Leakage of Contaminated Coolant

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.

6.2.2.2 Release of Gases and Coolant

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 feet 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[96] of the Environmental Protection Agency.

6.2.3 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

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.

6.2.4 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 later potential is sufficiently small that the environmental risk is extremely low. For those reasons, more severe accidents have not been included in the analysis.

7. ADVERSE EFFECTS WHICH CANNOT BE AVOIDED

The Crystal River Unit 3 occupies about 30 acres of the 4,738-acre site. This area, the corresponding area occupied by the fossil-fueled plants, the switchyard areas and other smaller areas are already cleared and are no longer in the natural state. The impact of altering the marshland has already been made.

Soils excavated from the reactor and associated locations were used elsewhere on the site as fill and cover and this may be expected to add materially to the aesthetics of the area.

The plant will require about 100,000 gal/day of fresh water; this will be drawn from shallow wells about 4 miles east of the buildings. Considering the magnitude of the recharge of the aquifer, this is a minor withdrawal of water and the impact on the groundwater resource is negligible.

The temperature increase in the cooling water and that, of lesser degree, in the discharge area due to the mixing that occurs there will increase the evaporative losses both in the canal and in the Gulf. This will amount to less than 50 acre-ft/day; this is a small loss and should have a negligible effect on the long-range climate in the area.

Water temperatures of more than 4°F above ambient in the discharge zone are expected to occur in about 2300 acres. If the sessile flora and fauna are contacted by such waters, there is a potential for damage. Forms passing through such zones are expected to avoid exposures of duration sufficient to result in harm.

Chemicals and radioactive materials added to the effluent water should be of such small concentrations and activities that no toxic or long-term accumulative effects are to be expected.

Phytoplankton, zooplankton and larval forms drawn into the intakes will be killed in passing through the condensers and canal. This loss will have negligible effect on the overall productivity of the inshore marine ecosystem.

Releases of radioactive materials in the gaseous effluents will conform to requirements that they be as low-as-practicable so that the resulting dose to people in the environs will be within an acceptable range and the overall effect on the environment will be insignificant.

There will be some visual impact of the plant but the high point (the 190 ft high reactor containment building) is lower than the boiler houses of the fossil plants and particularly their 499 ft stacks. The overall effect of the plant should be aesthetically pleasing; the architect's concept is shown in Figure 7.1

The transmission corridors and the steel towers were planned, by choice of route and materials, to be as unobtrusive as possible. The former avoided points of interest and scenic locations. The towers are to be constructed of stronger materials so as to have fewer and less massive members and hence a less noticeable silhouette than existing towers. The aluminum conductors use an inverse structure with harder strands on the surface to reduce damage during mounting and resulting in decreased radio and TV interference from high voltage corona. Phase spacing and hardware design contribute to the same end.

Routine traffic volume will increase on nearby highways but this would be to about the same extent elsewhere, regardless of the location of the new power source.

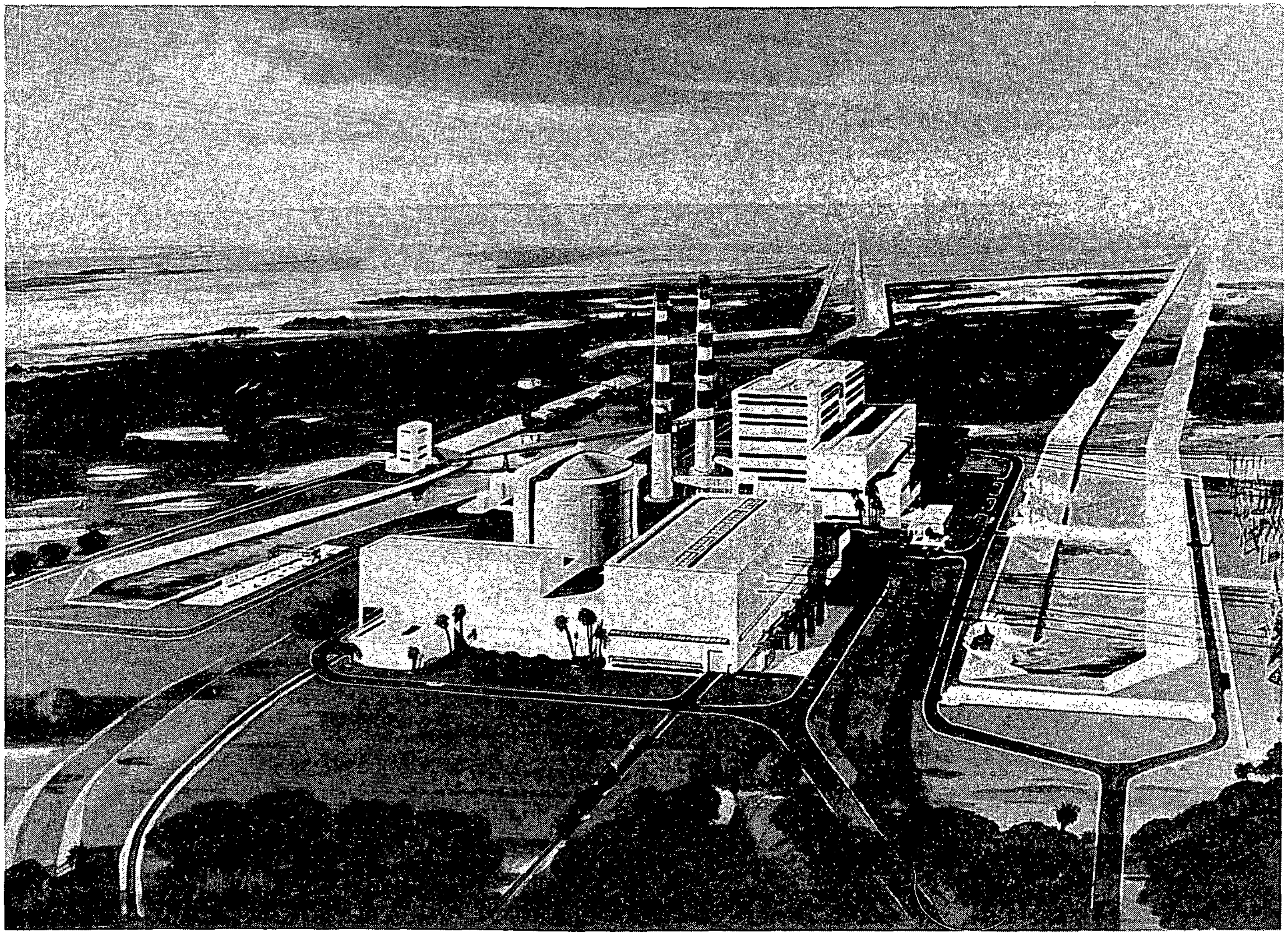

FIGURE 7.1 **ARCHITECT'S CONCEPT OF THE CRYSTAL RIVER PLANT COMPLEX**

8. SHORT-TERM USES VERSUS LONG-TERM PRODUCTIVITY

8.1 SHORT-TERM USES

During the approximately 40-year life of Crystal River Unit 3, the environment will be used in various ways. The Gulf of Mexico will be used to supply water for cooling and to receive it again and disperse it as heated condenser cooling water. The Gulf of Mexico will also be used to receive and disperse small quantities of radioactive liquid wastes mixed into the condenser cooling water. The atmosphere will be used to receive and disperse small quantities of radioactive gaseous wastes. The plant itself will use a part of a site already cleared and occupied by two producing power plants. The plant will use various materials of construction, such as steel and concrete and approximately 70,300 lb of uranium-235 (1.2×10^6 lb U_3O_8) over its lifetime as fissionable material in the fuel.

Some of the site land is being used for parking for the labor force and for storage of equipment and materials during the construction of Unit 3 plant facilities. Most of this land will not be required for such purposes after startup and will be allowed to revert to natural vegetation at that time. This will decrease the impact otherwise inflicted on the environment by becoming a recovered habitat, though of a modified nature, to the local fauna.

8.2 LONG-TERM PRODUCTIVITY

8.2.1 Electric Power

The applicant states that its decision to include Crystal River Unit 3 in its expansion program was based upon economics, power supply reliability, and a desire to minimize the impact upon air pollution in Florida. From the economic view, equivalent energy produced by fossil-fueled plants would result in fuel costs from two to three times greater than those required for the nuclear fuel in Crystal River Unit 3.

8.2.2 Mariculture

The applicant and Ralston Purina Company in February 1971 signed a 5-year joint research agreement to determine the commercial feasibility of culturing marine animals, beginning with shrimp, in the heated discharge water of the power plants. The facility for the project is located on the applicant's property between the intake and discharge canals. The facility now occupies 10 acres and consists of a laboratory and hatchery building and raceways. Over a 5-year period it is envisioned that the facility will occupy up to 50 acres. Investigations on the feasibility of culturing other fish and crustacea will begin later.

Utilization of heated, condenser discharge waters for mariculture, if widely practiced, could provide a continuing source of high quality protein. In the meantime, plans are to develop methods for the propagation of bait shrimp.

8.2.3 Fishing

The canals in the immediate area of the plant are open to sports fishermen only and are stated to be very productive in certain seasons. The discharge canal is a highly favored fishing area in the winter months. The exposure of rock along the intake canal and the constant flow of water through it have enhanced oyster growth there.

8.2.4 Socio-Economic Benefits to the Community

At the present time, there are approximately 1,300 persons employed at Crystal River Unit No. 3. The work force is expected to remain at about this level for the next year. The associated payroll would be about $15 million. Commercial operation of the plant is scheduled for December 1974. Between 80 and 85 employees will be needed to operate the plant. Over the long-term, the annual payroll of these employees will be about $1 million.

Additional information concerning socio-economic benefits to the community is contained in Section 11.2.1.

Plankton and immature forms of commercially valuable species are killed on passing through the condenser and by the chlorine when it is used. This is not a complete loss, however, since such organic material still provides food for consumer and decomposer organisms in the food chain.

8.3 DECOMMISSIONING STATION AFTER OPERATING LIFE

No specific plan for the decommissioning of Crystal River Unit 3 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.

The cost of permanently shutting down the facility - including reactor core removal, decontamination of remaining components, and building isolation -- has been estimated by the staff at several millions of dollars on a current cost basis, plus annual maintenance costs to maintain the shutdown facility in safe condition.

These estimates do not include removing all equipment, razing the buildings, and returning the site to its original condition. The value of the 20 acres or so thus made available for other uses would probably not justify the added expense. Analysis of dismantling original construction would be required to accomplish such restoration.

In cost-benefit considerations, future decommissioning costs should be discounted to obtain their present worth. At a discount rate of 8.75% per year for 30 years of operation, costs incurred at the end of that operating period would be divided by 12.4 to determine their present worth. Thus, even if the plant area were to be restored to its original condition, the present worth of the future costs involved would be roughly 1% of the original construction cost. This indicates that including decommissioning costs would not alter any of the conclusions of the cost-benefit analysis in this statement.

9. IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

The materials and the land used by the plant, together with the uranium-235 used as fuel and any living forms killed, are the only resources irreversibly and irretrievably committed by the construction and operation of the Crystal River Nuclear Plant.

The materials committed in construction and operation of the Crystal River Nuclear Plant are those common to any large industrial plant e.g., wood, iron and steel, aluminum and concrete. One and one-half million board feet of lumber, about 190,000 cubic yards of concrete, about 2,500 tons of iron and steel, and about 80 tons of aluminum have been used in the construction of the reactor installation. While these are not strictly irretrievable, it is hardly conceivable that any one of them would be completely recovered except under conditions of dire stress.

The construction of the three Crystal River Units will involve consumption of approximately 330 acres of marshland. Approximately 87 acres were destroyed for the intake canal and barge turning basin, 68 acres for the discharge canal and 175 acres for miscellaneous purposes. It would probably be impossible to restore the marshlands to their original condition; however, upon completion of the useful life of the generating units, the land conceivably could be converted to other productive purposes.

10. THE NEED FOR POWER

Florida is supplied by seven major electrical utilities, one of which is the Florida Power Corporation, and a number of smaller municipal generating systems. The Florida Power Corporation provides electrical service to 472,743[97] customers over an area of about 20,600 square miles in North Central and Northern Florida. The service area includes parts or all of 32 counties (see Figure 1.1). St. Petersburg is the major population center in the Florida Power Corporation service area. In total, the FPC service area has a resident population of approximately 1,139,000.[98] This is an increase of 47% over the 1960 service area population. The Bureau of Economic and Business Research at the University of Florida indicates that the population growth in the 32-county area will increase at an average annual rate of 2.8% per year through 1978,[99] which is about twice the national average.

Population growth of the service area, coupled with increased unit consumption of electricity (kilowatt sales per residential customer increased from 4,480[100] in 1960 to 9,415[100] in 1970, a 110% increase) has caused a rapid increase in the demand for system electrical energy. During the same 10-year period, energy sales increased 205%, producing an annual average growth rate of 11.8%.[100] System peak load during the same period grew at an annual rate of 10.2%.[100]

The public service laws of the State of Florida, under which Florida Power Corporation operates as a public utility, require that Florida Power Corporation supply quality electric service in the quantity required by its customers. Because of lead times necessary in planning and construction of major power facilities, Florida Power Corporation's generation expansion program must be based on long-range electrical load demand forecasts. The basis for projecting demand is tied to estimates of service area population levels, commercial activities, industrial growth, and an increasing use of electricity per customer. For the 11-year period, 1960 through 1971, the annual average increase in electrical sales per customer class was: residential, 12.7%; commercial, 13.0%; industrial, 8.7%; and other, 13.3%. By 1971, residential consumers were by far the largest consumer class, accounting for 40% of total sales. Commercial, industrial, and other customer classes were closely bunched at 21.1, 20.3, and 17.7%, respectively.

The applicant sees the consumer class growth rates decreasing only slightly during the 1972-1980 period. During this period, total system sales of electrical power are expected to grow at an annual rate of 10.9%. Thus, the forecasted values for 1972 through 1980 assume a continuation of historical growth patterns. The basis for the forecast appears reasonable in light of the population projections in the service area. Also, the growth rate is in agreement with the Federal Power Commission's projections for Power Service Area (PSA) 24, which includes most of the State of Florida. Federal Power Commission data[101] for PSA 24 forecasts an increase in power demand of 11% annually for the period 1970 through 1980.

Peninsular Florida is served by five principal suppliers: Florida Power Corporation, Florida Power and Light Company, Tampa Electric Company, and the municipal systems of Jacksonville and Orlando. These suppliers, surrounded on three sides by water, are subject to hurricanes and the highest incidence of lightning in the nation, yet undertake to stand on their own feet and provide their own reserves. They are strongly interconnected and comprise what has come to be known as the Florida Group. In emergencies, each supplier aids the Florida system in trouble to the maximum extent of its resources. Each Florida supplier operates its own system in the most economical manner consistent with its individual requirements and policies. Reserves are based on a statistical analysis of past equipment failure rates and a goal of a minimum reasonable power interruption rate. For the Florida subregion, the Federal Power Commission estimates the appropriate reserve level to be about 28% of peak load.

Summarized electrical statistics of the applicant for the years 1960, 1965, 1970 and 1971, plus the applicant's forecast for 1972 through 1980, are presented in Table 10.1. It is apparent that without Crystal River Unit No. 3, the applicant's system will fall considerably short of the system capability required to maintain a peak load reserve of 28% (see Figure 10.1). Table 10.1 also summarizes the forecast electrical statistics for the entire Florida subregion.[102]

TABLE 10.1

ELECTRICAL STATISTICS
(MW)

	FLORIDA POWER CORPORATION								FLORIDA SUBREGION*				
							"Net Capacity"					"Net Capacity"	
Year	Generation Capability	Firm Purchases	Firm Sales	System Capacity	Peak Load	28% Reserves	With No.3	Without No.3	Generation Capability	Peak Load	28% Reserves	With No.3	Without No.3
1960	808.4	---	---	808.4	730	204	---	-126					
1965	1154.6	300	---	1454.6	968	271	---	216					
1970	2225	275	75	2425	1920	538	---	-33					
1971	2292	200	---	2492	2077	582	---	-167					
1972	2492	200	---	2692	2410	675	---	-675	13066	11371	3184	---	-1489
1973	2692	250	---	2942	2640	739	---	-437	15008	12574	3521	---	-1087
1974	4032	---	---	4032	2880	806	346	-479	17477	13913	3896	332	-493
1975	4492	---	---	4492	3130	876	486	-339	20258	15337	4294	627	-198
1976	4533	---	---	4533	3390	949	194	-631	21418	16896	4731	-209	-1034
1977	4674	---	---	4674	3700	1036	-62	-887	23078	18597	5207	-726	-1551
1978	5484	---	---	5684	4000	1120	564	-261	25785	20447	5725	-387	-1212
1979	5646	---	---	5646	4320	1210	116	-709	28408	22474	6293	-359	-1184
1980	5846	---	---	5846	4640	1299	-93	-918	31627	24743	6928	-44	-869

* Includes Florida Power and Light Company, Florida Power Corporation, Tampa Electric Company, Jacksonville Electric Authority, Orlando Utilities Commission, City of Tallahassee, and City of Lakeland.

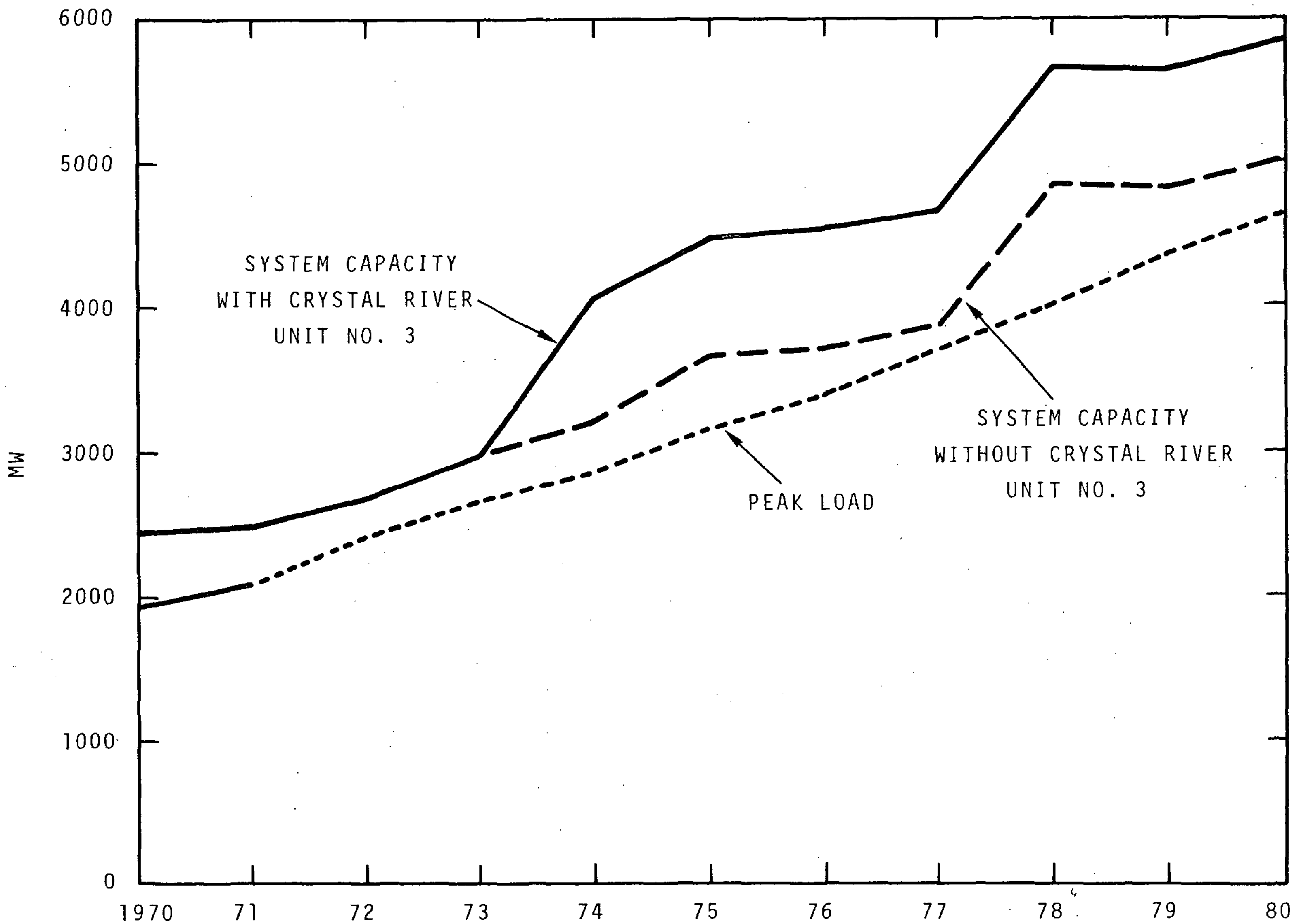

FIGURE 10.1 FLORIDA POWER CORPORATION ELECTRICITY LOADS

11. ALTERNATIVES TO THE PROPOSED ACTION AND BENEFIT-COST ANALYSIS OF ENVIRONMENTAL EFFECTS

The applicant considered six general alternatives when planning for and implementing the Crystal River Unit 3 program for the Florida Power Corporation service area during the period 1967 to 1980. These were:

Not providing the forecast power requirements
Purchase of power
Alternative power sources
Selection of a site other than Crystal River
Alternative land uses of the site
Alternative heat dissipation systems

11.1 SUMMARY OF ALTERNATIVES

11.1.1 Not Providing the Power

The alternative of not providing the North and Central Florida area with an additional block of power represented by Crystal River Unit 3 would have the following principal costs and social impacts: (1) reduction in system reserves with attendant risks of power shortages associated with equipment failure; (2) a loss of capital investment to date in Unit 3 of approximately $186 million, depending on salvage values, dismantling costs, and contract cancellations; and (3) the economic effects associated with a power shortage in the region.

The need for power was demonstrated in the preceding section, (Section 10). The applicant is required by law to provide the electrical needs in its service area. Not providing the additional power represented by Crystal River Unit 3 is, therefore, an infeasible alternative.

11.1.2 Purchase of Power

A review of generating capabilities of Florida Interconnected Utilities indicates that large amounts of power will not be available from other utilities over the long run. In addition purchased power is generally priced at the supplier's top cost estimate and physical transmission limitations affect availability. Thus, the purchase of power is considered to be an infeasible alternative. The reserve margin for the five peninsular Florida utilities of 21% is below the 28% reserve recommended by the Federal Power Commission, see Table 11.1.

TABLE 11.1

ESTIMATED AUGUST 1972 LOADS AND GENERATING CAPABILITIES
OF FLORIDA INTERCONNECTED UTILITIES[103]

Utility	Generating Capability, MW	Peak Load, MW[(a)]	Reserve[(a)] MW	Reserve[(a)] %
Florida Power Corporation	2,593	2,370	223	9.4
Florida Power & Light Company	7,431[(b)]	6,110	1,321	21.6[(b)]
Jacksonville Electric Authority	1,222	1,071	65	14.0
Orlando Utilities	430	365	65	17.8
Tampa Electric Company	2,025	1,400	625	44.6
Total	13,701[(b)]	11,316	2,385	21.0[(b)]

[(a)] Not simultaneous values.

[(b)] Includes first Turkey Point nuclear unit. If it is not available, Florida Power and Light Company capacity becomes 6,857 MW, State total becomes 13,127 MW, Florida Power and Light Company reserve margin becomes 12.2% and State reserve margin becomes 16%.

11.1.3 Alternative Power Sources

Generation of power by means of fossil-fired plants is the only alternative for generating power that is available to Florida Power Corporation, as there are no hydroelectric sites in Florida. Two types of fossil facilities can be considered. As a short-term measure, gas turbine-peaking units could be installed to supply power in place of Unit 3. For the longer time period, coal or oil-fired plants must be considered.

Use of gas turbine-peaking units as a substitute for a base load unit such as Unit 3 is uneconomical, and at the same time does not eliminate environmental considerations. Increased fuel costs for operation of peaking units in place of Unit 3 would amount to $51 million during the 1973-1974 period alone. Although the gas turbine units would not use cooling water from the Gulf, heat would be rejected directly to the atmosphere with the exhaust gas. The exhaust gas would also carry pollutant loads of sulfur oxides, nitrogen oxides, and particulates. Although natural gas is used extensively in the applicant's system, firm sources of supplies are not available for new base-load plants.

The applicant has undertaken an expensive program to convert several large coal-fired plants to oil operation because of the availability of oil and the economics of low sulfur coal. Thus, oil is the most viable alternative power source to nuclear fuel. Oil, like natural gas, is not readily available in the quantities required and its use releases combustion products to the atmosphere. The use of oil increases the burden on available transportation systems.

The applicant considered an oil-fired power plant as an alternative at the time the decision was made to build Crystal River Unit No. 3. At that time, analyses of the economics, financing, and environmental impact of the two plants favored nuclear power. The nuclear plant had a higher capital cost component and lower fuel cost component than the fossil equivalent.

The primary environmental effects of the nuclear unit are release of up to about 1700 MW of heat, depending on power level, and the addition of about 0.16 man-rem of radiation exposure. In contrast, an oil-fired plant releases at full power about 1100 MW of heat to the sea, but it also releases about 23,000 tons/year of chemicals and particulates to the atmosphere.

11.1.4 Selection of a Site Other than Crystal River

As discussed in Section 1.1, the applicant considered two other sites in addition to the Crystal River site for the construction of a nuclear power plant. Both the A. W. Higgins and Bartow sites are located on Tampa Bay. Proximity to large airports, land reclamation or property limitations and a need for extensive facilities to minimize thermal discharge and recirculation effects in the marine environment were major considerations in rejecting these two sites by the applicant. The Crystal River site, on the other hand, did not appear to have any of these limitations and hence it was selected by the applicant as the best of the alternatives considered.

11.1.5 Alternative Land Uses of the Chosen Site

Crystal River Unit 3 is located adjacent to fossil-fired Units 1 and 2. Land to be occupied by Crystal River Unit 3 was cleared during construction of the two fossil-fired units. The only reasonable alternatives for the cleared land would have been to maintain it as open space around the fossil plants, to allow it to develop a low profile natural environment, or to develop it for grazing. Crystal River Unit 3 land has no unique characteristics that would demand a higher price since there are many square miles of similar land along the Gulf of Mexico.

11.1.6 Alternative Heat Disposal Systems

There are three possible methods for the disposal of waste heat from the Crystal River site.

- Adding heat to the Gulf of Mexico in the effluent discharge, as planned
- Evaporating heated water into the atmosphere
- Directly heating the atmosphere

The applicant has considered the first method as the base for design of Crystal River Unit 3. Various designs can be used to lower the temperature of discharged water and reduce the heat load to the Gulf, thus decreasing the size of the mixing zone at a given temperature increment. An alternative design could be used to disperse hot water away from the shore line. Possible alternatives based on these designs for disposing waste heat include:

Closed-Cycle (Unit 3)

- Cooling Pond
- Cooling Towers

Supplemental Cooling (all units)

- Dilution
- Hold-Up Pond
- Spray Module Systems
- Cooling Tower

Other Design (all units)

- Extension of Discharge Canal

11.1.6.1 Closed-Cycle Cooling (Unit 3)

Closed-cycle heat dissipation alternatives are designed to restrict essentially all waste heat from Crystal River Unit 3 from entering the nearshore ecosystem.

11.1.6.1.1 Cooling Pond

A proposed design for a closed-cycle cooling pond to dissipate the total waste heat discharge from Unit 3 is shown in Figure 11.1. This pond would handle a total flow of 680,000 gpm with an in-plant temperature rise of 17°F. The pond would cover about 700 acres.

The size of the cooling pond was selected so that the maximum condenser pressure would not exceed about 4 in. of mercury absolute under peak summer conditions. Due to the condenser inlet temperatures at levels above those associated with the once-through scheme, the exhaust pressure is higher and results in a loss of capability of about 24,000 kW for Unit 3. The applicant estimates loss of capacity at $226/kW. Construction of the 700 acres cooling pond is expected to take about 21 months and cost about $20 million. Operation, maintenance and fuel costs are expected to be $230,000 annually.

Advantages of a closed-cycle cooling pond include 1) removal of heat stress from marine life in the discharge area, and 2) reduction of intake screen kill by about 32,000 lb of finfish and about 4,000 lb of shellfish per year.

Disadvantages include 1) alteration of upland and marsh ecosystems, 2) possible intrusion of salt water into the water table as a result of seepage 3) potential fogging or condensation in the atmosphere, and 4) relatively low heat transfer rate, 5) reduction of aesthetic appeal at the site, and 6) possible eventual filling with sediment and accumulation of minor chemical and radwastes within the pond.

11.1.6.1.2 Cooling Towers

Case 1. A dry cooling tower, in which the waste heat is transferred to air by surface heat exchangers, evaporates no water and hence eliminates the need for special fresh or salt water sources. Dry tower technology is still being developed. It is unlikely that a reliable dry tower could be obtained in time for Unit 3, even if a premium cost factor was accepted. Moreover, dry towers are at a disadvantage compared to wet towers because of the restricted level to which water can be cooled. For these reasons, a dry cooling tower does not appear to represent a viable alternative for Unit 3.

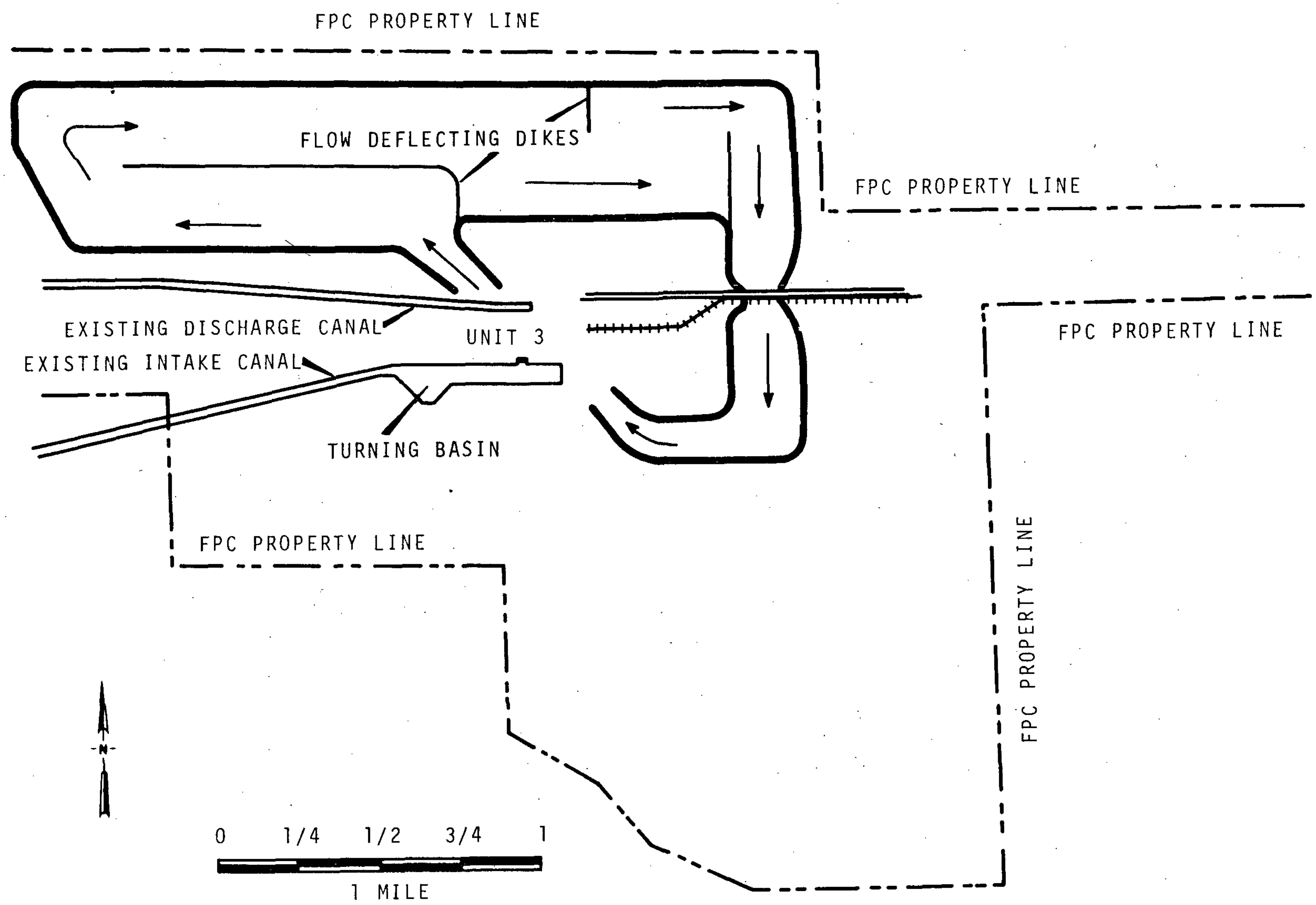

FIGURE 11.1 CLOSED CYCLE COOLING POND FOR UNIT NO. 3

Case 2. A mechanical draft cooling tower using fresh water was considered for Crystal River because costs are somewhat lower and environmental impact due to salt drift is nil compared with the alternate towers discussed. The main disadvantage is the lack of a reliable fresh water source. Preliminary study of possible fresh water sources for Crystal River Unit 3 showed that water could be piped from either the Crystal River or the Withlacoochee River. The five-mile long pipeline would cost about $1 million to install, and would represent a cost added to the standard installation of the tower. During drought periods, the potential river sources attain very low flow rates (60 cfs for the larger Withlacoochee River). The cooling tower fresh water requirements could be about 30 cfs. Therefore, use of rivers alone to supply fresh water in adequate quantities cannot be considered reliable.

Groundwater is available at the site from the Florida aquifer. The staff has concluded that adequate fresh water for a cooling tower could be obtained only through a double supply system using both river and groundwater. River water could be used most of the time with the local aquifer being called on during emergency periods to supplement river sources. The mechanical draft tower and pipeline would involve a capital cost of about $19 million with operating costs of about $1.5 million annually.

Disadvantages of a mechanical draft cooling tower include: 1) an efficiency related to atmospheric conditions, 2) potential fogging or condensation of evaporated water, 3) some discharge of chemically contaminated blowdown, 4) potential of hot air recirculation, 5) increase the annual operating and maintenance costs of the plant, 6) internal consumption of power, and 7) some terrestrial impact due to pipeline construction. In addition, water in the Withlacoochee and Crystal Rivers does not exist in biological surplus. Thus, stress would be imparted to two distinct fresh water ecosystems by withdrawal of the water required for tower operation, particularly during periods of low river flows.

Case 3. A natural draft salt water cooling tower was considered because of the availability of Gulf water. Lower salt drift losses can be achieved with natural draft towers, as compared with mechanical draft towers using salt water. Make-up and bleed water for a salt water tower with a closed-cycle for Unit 3 would amount to 25,000 gpm (56 cfs). Such a cooling tower, operating with a condenser temperature of 93°F, would involve a capital cost above the proposed method estimated at about $16.8 million. Operation costs are estimated to be about $1.1 million per year.

Advantages for closed-cycle cooling towers (Cases 2 and 3) are primarily reduced stress in Gulf waters in terms of near zero additional heat load and, in addition, a reduction of screen kill of finfish and shellfish that is roughly equivalent to the reduction reported for a cooling pond. Minimizing environmental impact in the nearshore marine environment is important. However, operation of cooling towers requires the use of certain chemicals to prevent corrosion of metal parts, to inhibit slime-forming bacteria and algae, to restrict deterioration of wood construction, and to prevent scale deposition. These chemicals are discharged via tower blowdown and, unless well diluted, present a potential hazard to aquatic life.

Disadvantages of a natural draft salt water cooling tower include: 1) salt drift (0.0035% of recirculating flow), 2) potential atmospheric fogging or condensation of water, 3) reduced plant capacity due to higher condenser water temperatures, 4) some discharge of chemically contaminated blowdown, 5) relatively high shell height to produce a draft, and 6) increased construction and maintenance costs. In addition, some risk exists since technology for salt water cooling towers is still developing. A large scale installation, however, is planned for a nuclear facility at Forked River, New Jersey.

A natural draft tower of standard design at Crystal River would be vulnerable to hurricanes along the coast.

11.1.6.2 Supplemental Cooling (All Units)

Total cooling water flow for Units 1, 2 and 3 will be 1,318,000 gpm (2937 cfs) with an approximate maximum temperature rise of 14.5°F (8.1°C) above the inlet temperature. Present design calls for dispersing this water into the nearshore Gulf environment using the existing discharge canal. Units 1 and 2 discharge 638,000 gpm (1422 cfs), effecting 11.5°F (6.4°C) maximum temperature rise.

The supplemental cooling alternatives are intended to reduce the temperature of the water discharged into the Gulf below a ΔT of 14.5°F, and thus reduce the impact on aquatic life. The alternatives function in conjunction with the discharge canal and do not require redesign of the condenser and piping for Unit 3. The alternatives can effect a prescribed temperature rise for the discharge entering the mixing zone. For this analysis, two temperature cases have been chosen: limiting the Unit 3 temperature rise to 7°F (3.9°C) above inlet temperature for the six-month period, May to November (Case 1) and limiting the Unit 3 temperature rise to 11.5°F (6.4°C) above inlet temperature for the six-month period, May to November (Case 2). It is assumed that Units 1, 2 and 3 will be operating at maximum capacity during the prescribed six-month period.

11.1.6.2.1 Dilution

The temperature of the discharge canal may be reduced by mixing the cooler intake water with the heated water leaving the discharge canal. This approach requires the construction of a short canal connecting the intake and discharge canals and the addition of pumping facilities. Existing intake and discharge canals can be used if the volume of dilution water does not exceed the practical limit for the canals.

Case 1. To reduce the discharge maximum temperature rise to 7°F (3.9°C) above inlet temperature, about 1,400,000 gpm (3110 cfs) of dilution pumping is required. A dilution scheme to achieve a 7°F (3.9°C) temperature rise is shown schematically in Figure 11.2. Engineering, construction and facility costs are estimated to be about $11 million, with operation costs averaging $60,000/yr.

Although the scheme does not reduce the total heat units discharged to the Gulf, it does lower thermal stress on the nearshore marine system by reducing the size of the area exposed to a ΔT of 5°F (2.8°C) or more by about 650 acres over the applicant's reference design using once-through cooling.

Adverse factors include 1) the temporary effect of dredging the dilution canal, 2) mechanical stress on planktonic organisms in passing through dilution pumps, 3) entrapment of fishes on the dilution pump screens of about 32,000 lb of finfish and 4,000 lb of shellfish annually, 4) abrupt exposure of planktonic organisms entrained in the dilution canal to thermal shock of the heated discharge water, 5) a small decrease in efficiency of plant as a result of pumping, and 6) the approximate doubling of the total amount of sea water required for plant operation.

Case 2. About 333,000 gpm (743 cfs) of dilution pumping is required to reduce the discharge canal temperature from a maximum 14.5°F (8.1°C) temperature rise to 11.5°F (6.4°C). Engineering, construction and facility costs would be about $4 million.

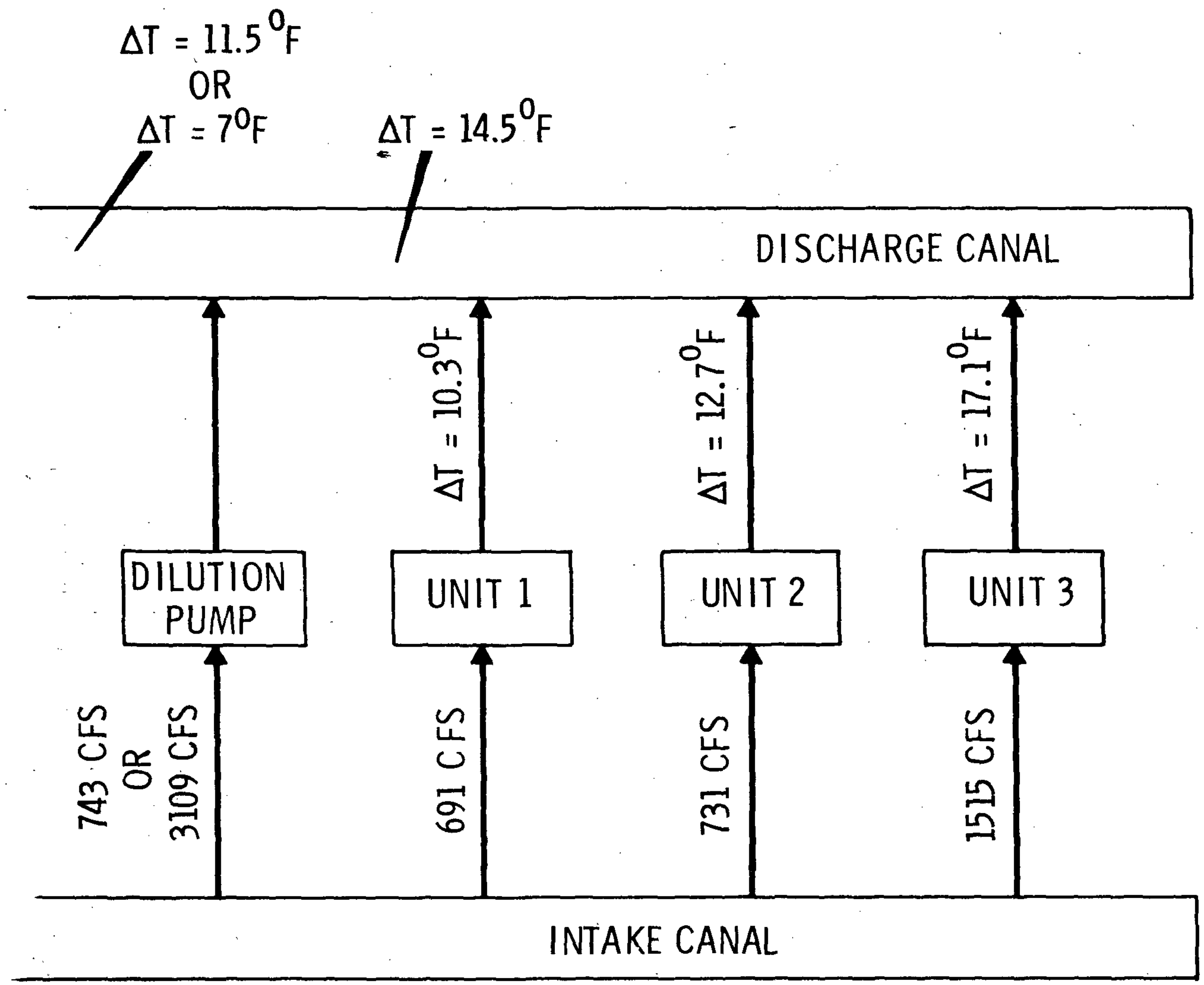

FIGURE 11.2 DILUTION IN THE DISCHARGE CANAL

The benefits for this scheme appear to be slight, i.e., in the case of the 7°F isotherm the area covered is about 100 acres less than the reference case; however, the area within the 4°F isotherm is about 80 acres larger than that for the reference case.

Adverse factors are essentially the same as for Case 1, above, except that entrapment of finfish and shellfish as well as entrainment of planktonic organisms would be reduced because of the lower volume of dilution water required.

11.1.6.2.2 Hold-Up Pond

A hold-up pond, in contrast to a closed-cycle cooling pond, could be used to effect a partial cooling of the effluent.

Case 1. A hold-up pond complex of about 750 acres would lower the discharge canal incremental temperature from 14.5°F (8.1°C) to 7°F (3.9°C).

Based on data supplied by the applicant, the pond surface would be at sea level and the pond bottom would be dredged to a depth of seven feet (see Figure 11.3). The hold-up pond complex would utilize the area between the spoil banks of the existing intake and discharge canals. Excavation, dikes and earthwork is expected to cost about $15 million.

The primary advantages of a hold-up pond of the considered type include: 1) No reduction of plant efficiency, 2) relatively low construction and maintenance costs compared to towers, 3) dispersal of the heated discharge away from the productive marshland ecosystem to the north, 4) potential of fogging or condensation from evaporation over land areas is decreased, 5) no increase in numbers of impinged or entrained organisms as required for dilution by pumping, 6) no major increase in volume of sea water as required by pumping, and 7) probable enhancement of sport fishing in the outer basins during cold seasons.

The primary limitations include: 1) alteration of 750 acres of inshore marine habitat and associated destruction of existing beds of seagrasses, 2) effects on marine organisms associated with dredging and construction activities, 3) the relatively large acreage required to effect a reduction to 7°F (3.9°C) ΔT due to low heat transfer rates, 4) potential entrapment and exposure

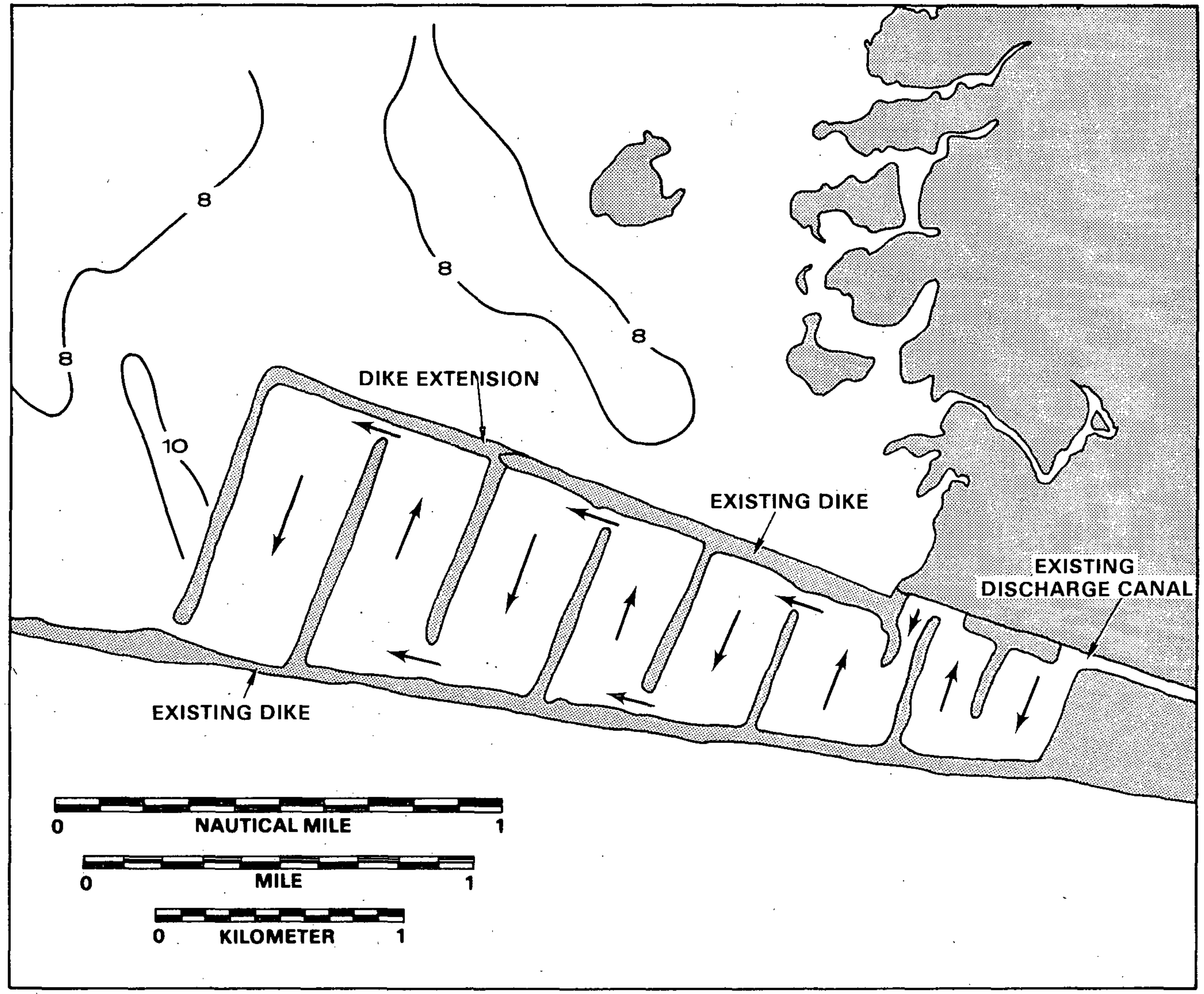

FIGURE 11.3 HOLD UP POND TO ACHIEVE ΔT 7°F, UNITS 1, 2, AND 3,

of finfish and shellfish entering the basins to sudden changes of water temperature, and 5) possible eventual sedimentation and concentration of minor chemical and radwastes within the basins.

Case 2. To effect a discharge canal temperature drop from 14.5°F (8.1°C) to 11.5°F (6.4°C) above inlet temperatures, a hold-up pond complex of about 200 acres is required. This scheme is shown schematically in Figure 11.4, again utilizing the area between the spoil banks of the existing intake and discharge canals. Engineering and construction costs are estimated to be about $4 million.

The benefits of this hold-up pond scheme are essentially the same as those for Case 1, above, except that construction and maintenance costs would be lower.

Adverse factors are also essentially the same as those in Case 1, above. The potential environmental impact would be less because only 200 acres of inshore marine habitat are required to affect a reduction to 11.5°F (6.4°C). However, this temperature increase holds greater biological significance in the dispersal area.

In both examples of hold-up ponds, circulation of heated water to the south is restricted by the north dike of the intake canal so the possibility of recycling heated water through the plant remains very low.

11.1.6.2.3 Spray Module Systems

An alternative method of reducing discharge temperatures would be the installation of spray modules within the discharge canal. The amount of cooling that can be achieved is limited unless the discharge canal is enlarged.

Case 1. To limit the maximum temperature rise in the discharge canal to 7°F (3.9°C) above inlet temperatures, 220 spray modules would be necessary. This would require widening the discharge canal from 125 to 200 ft. Total cost for a 220 unit installed spray module system and discharge canal expansion is about $8 million. Annual operation expenses are about $1.3 million.

The main advantage of this system over the hold-up pond complex is that it does not require 750 acres of marine habitat to effect a decrease to 7°F (3.9°C) maximum temperature rise for the combined discharges from Units 1, 2 and 3.

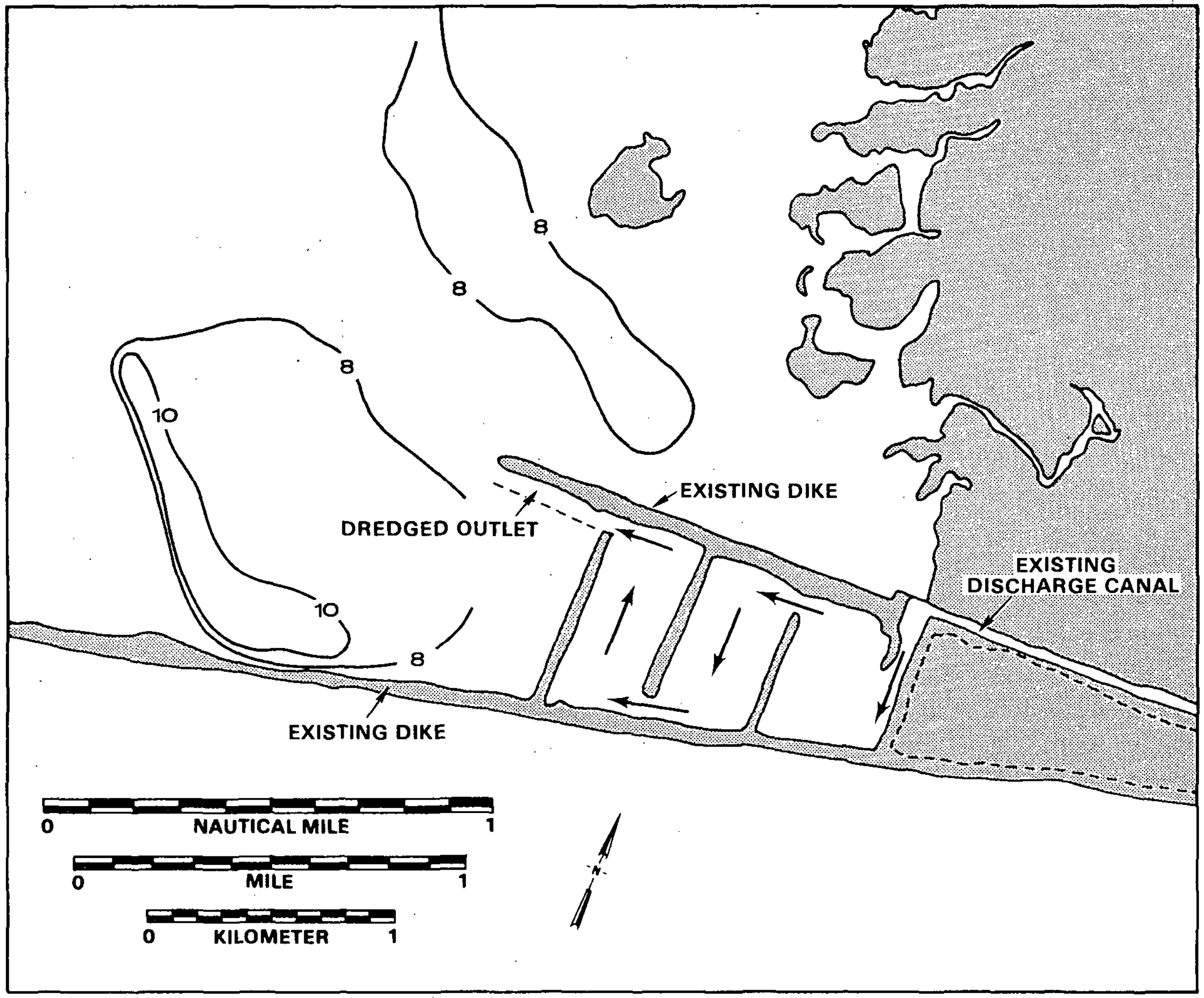

FIGURE 11.4 HOLD UP POND TO ACHIEVE ΔT 11.5°F, UNITS 1, 2, AND 3,

The primary disadvantages include: 1) elimination of sports fishing in the discharge canal, 2) potential salt drift to the surrounding terrain, 3) increased construction and maintenance costs, 4) limited reduction in plant output, 5) a cooling efficiency dependent upon atmospheric conditions, and 6) the mixing zone still encompasses a significant portion of the marsh and nearshore marine ecosystems.

Case 2. The 80-unit spray module to effect an 11.5°F (6.4°C) maximum temperature rise above inlet can be placed within the existing canal. Cost of such a system is about $3 million with operating expenses of about $0.5 million per year. The main advantage of the smaller spray module system is lower construction, operation and maintenance costs. The main disadvantage is a limited reduction of discharge temperatures over Case 1, above, with increased biological impact in the mixing zone.

11.1.6.2.4 Supplemental Cooling Towers

Another method for extracting heat from the discharge canal would be the operation of a natural draft cooling tower designed to utilize nearly 50% discharge canal flow. The open-cycle cooling tower could be located between the existing canals and would utilize less than 5 acres of the land fill.

Case 1. To reduce the discharge canal temperature rise from 14.5°F (8.1°C) to 7°F (3.9°C) about 1460 MW of heat needs to be withdrawn. Estimates of the capital costs for a salt water natural draft cooling tower capable of dissipating that heat are about $17 million with annual operating costs in the range of $0.5 million.

The main benefit of an open-cycle cooling tower is the reduction of temperature in the discharge water and its lowered biological impact on the mixing zone.

Disadvantages include: 1) construction, operation and maintenance costs, 2) some salt drift, 3) discharge of additional chemicals used to maintain the tower, 4) an efficiency dependent upon atmospheric conditions, and 5) relatively large shell height to produce the draft.

Case 2. About 590 MW of heat needs to be withdrawn from the discharge canal to lower the maximum temperature from 14.5°F (8.1°C) to 11.5°F (6.4°C) above inlet. Capital cost for a salt water natural draft cooling tower to dissipate 590 MW is about $10 million with annual operating cost about $0.2 million.

The main advantage of such a smaller supplemental cooling tower is lower construction, operation and maintenance cost. The main disadvantage is the limited reduction of discharge temperature over Case 1, above.

11.1.6.3 Modification of the Discharge Canal

An alternative for direct disposal of discharge from combined Units 1, 2 and 3 to the Gulf involves modification of the discharge outfall to minimize exposure of the shoreline marine environment to heated water. One means to accomplish this is to extend the discharge canal, 6000 ft outward as shown in Figure 11.5. The expense of this extension is estimated at about $2.7 million.

The applicant has also considered a canal extension[104] scheme which involves adding a north dike to the existing discharge canal. Surface areas covered by the 3°F isotherm have been predicted by the applicant for various tidal stages. The staff has scaled these areas from the diagrams and found them to vary from 10 acres to 140 acres depending on tidal stage. The staff believes that the thermal plume acreage predicted by the applicant is an underestimate for this alternative. The staff has not attempted to make a detailed prediction of temperature patterns for this alternative, but it is the opinion of the staff that the acreages covered by the plume would be comparable to those covered by the plume for the base case. (See Tables 5.2 and 2.3.) Therefore, in evaluating this canal extension, the advantages have been weighed in terms of exposure of offshore bottom land versus exposure of nearshore marshland. In addition, the staff estimates that 30 to 35 acres of bottom land would be affected for each linear mile of extension.

Advantages of extending the discharge canal include: 1) relatively low construction and maintenance costs, 2) a minor cooling of the water before discharge, 3) removal of the mixing zone from the marsh and nearshore marine ecosystems, 4) avoidance of the salt wedge effect resulting from inshore freshwater intrusion from the north, 5) more efficient mixing due to the deeper water as well as exposure to ocean currents and wave action.

Disadvantages include: 1) A temporary effect on aquatic life by dredging and extension, 2) exposure of offshore marine organisms to the thermal plume including outer oyster reefs, and 3) prolonged exposure of entrained organisms to elevated temperatures in the canal.

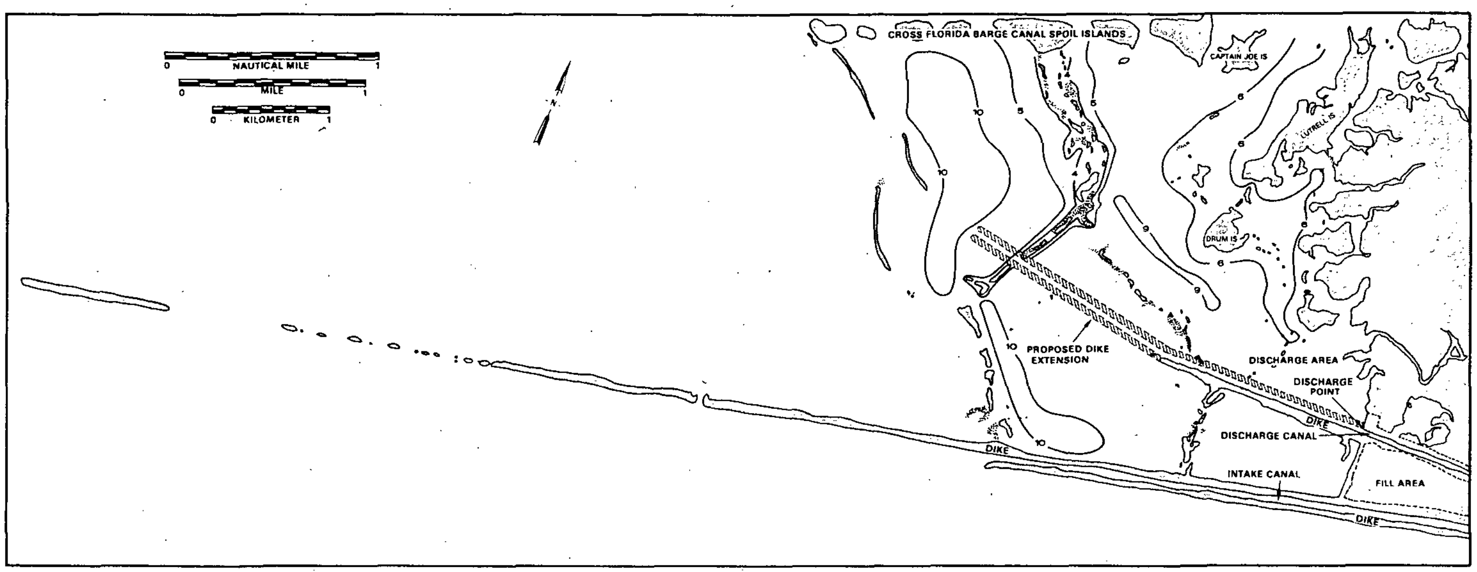

FIGURE 11.5 DISCHARGE CANAL EXTENSION

11.1.7 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.

11.2 BENEFIT-COST ANALYSIS OF PROPOSED ACTION WITH RESPECT TO VIABLE ALTERNATIVES

Previous sections described characteristics of Crystal River Unit 3 and identified several possible alternative heat disposal systems. This section reviews beneficial and detrimental effects of Crystal River Unit 3 and the viable heat disposal systems as a basis for a benefit-cost comparison.

11.2.1 Plant and Environmental Benefits

11.2.1.1 Power Generation

Crystal River Unit 3 is designed to operate at an 825 MWe net (885 MWe gross) electricity generation rate. The plant is estimated to generate power at an average annual rate of 5.78×10^9 kW-hr over the first 30 years.

11.2.1.2 Employment

The permanent work force for the plant is 80 to 85 persons, with an estimated annual payroll of about $1 million. On the basis of one service or support job created for every industrial job in the county, plant operation represents a total of about 160 jobs.

Construction of the plant will take place over a five-year period. Currently, the construction work force is at a high of approximately 1,300, with an estimated weekly payroll of $295,000. This level of work force is scheduled to be employed during the next 12 months, representing an annual wage rate of over $15 million.

Construction of Crystal River Unit 3 eliminates about 30 acres of land which would otherwise be used for grazing. Elimination of this land has negligible impact on employment opportunity.

11.2.1.3 Tax Generation

The applicant states that one of the socio-economic benefits occurring to the community as a result of the construction and operation of the $242 million Crystal River Unit 3 is taxes, estimated to be approximately $8,435,000 annually, paid by the Florida Power Corporation. The ad valorem property tax based on 1971 tax rates for Citrus County is $1,826,000.

11.2.1.4 Scientific Benefits

Basic scientific research is being conducted in site meteorology, marine ecology, marine thermal plumes and pre- and post-operational radiological surveillance. Several of the research programs have been in existence for over two years. These programs are of a continuous nature with current findings reported in quarterly environmental status reports. Distribution of the reports is extensive, with copies going to Federal, State, and local governmental agencies, as well as to universities within the State and a number of concerned individuals.

11.2.1.5 Educational Benefits

Crystal River Unit 3 is the first nuclear generating plant scheduled for operation in the Florida Power Corporation service area. Construction and operation of the plant are being followed closely by many local residents and are of general interest to many of Florida Power Corporation's customers. Thus, Crystal River Unit 3 is contributing to education through increased public knowledge of nuclear power plants and their effects.

In addition, the applicant's investments in the development of environmental expertise are contributing long-term benefits to the State of Florida. Investment by Florida Power Corporation in the research programs mentioned above has expanded the training of scientists and researchers in environmental problem solving and has added materially to the development of university and State research centers.

11.2.1.6 Other Benefits

The mariculture research program in conjunction with Crystal River Unit 3, under development by Ralston Purina, has potential benefits of producing commercially marketable shrimp in an environment supported by controlled amounts of warmed discharge water. The project is still in an early stage of development and no attempt has been made to quantify annual benefits.

The primary recreational benefit from the operation of Crystal River Units 1 and 2 has been a significant increase in the sports fishing in the discharge canal. This benefit is not expected to be appreciably affected either positively or negatively by the addition of Crystal River Unit 3.

11.2.2 Plant and Environmental Costs

11.2.2.1 Capital Cost and Related Resource Commitments

Construction of the plant is estimated to cost approximately $242 million. Assuming the normal distribution between labor and materials for nuclear plants, expenditures are about $54 million for labor, $91 million for site materials, and $47 million for factory equipment.

Resources committed to the construction of Crystal River Unit 3 include 1,500,000 board-ft of lumber, 190,000 cu yds of concrete, 2,500 tons of iron, 80 tons of aluminum, and the destruction of approximately 70 acres of marshland from construction and spoil areas for excavated materials.

Permanent resource commitments include much of the materials mentioned above, especially materials in the reactor, plus adjacent shields and equipment. These probably will be committed for decades because of activation within them of long half-life isotopes by the reactor neutrons. The few acres occupied by the reactor building and allied facilities, although restorable to its natural state, are more likely to be irretrievably committed to industrial use.

The applicant states that the natural uranium requirement for fuel for Crystal River Unit 3 is 483 tons of natural uranium (as U_3O_8) for the initial core loading, and about 210 tons/yr, thereafter. The applicant also notes that the energy required for construction is a major irretrievable commitment of the project.

As discussed previously in Section 5.3, larval fishes will be exposed to the thermal discharge and some will pass through pumps and condensers and be killed.

11.2.2.2 Operating Cost and Related Resource Commitments

The localized operating, maintenance and fuel costs for Crystal River Unit 3 is estimated to be about $14.3 million/yr.

11.2.2.3 Aesthetics

Crystal River Unit 3 facilities provide a clean architectural design and do not require a tall stack such as associated with fossil-fueled Units 1 and 2. Also, because of the lack of both fuel storage and handling facilities, Crystal River Unit 3 presents an improved appearance compared to the already existing units.

The transmission lines utilize an already existing transmission corridor. In some areas, trees were removed along the right-of-way. The power lines have the normal aesthetic impact of power lines across forested and agricultural land. There are no unique scenic views along the transmission corridor.

11.2.2.4 Water Pollution

The primary chemical added to the once-through cooling system is hypochlorite. This chemical is greatly diluted so that the net effect on the water quality of the discharge area in the Gulf is minor if not negligible. Radionuclides released to the Gulf with the proposed radwaste facilities are estimated to create an integrated radiation dose of 0.11 man-rem/yr.

Thermal discharges associated with doubled discharge volumes into the Gulf from the proposed once-through cooling system for Crystal River Unit 3 will increase any present deleterious thermal effect on the aquatic resources. This major localized effect is expected to amount to an area of about 1500 acres of which 1000 acres are directly attributable to the operation of Unit 3 at full power with Units 1 and 2 simultaneously operating at full power. Cooling ponds, spray modules, cooling towers or canal extension would decrease any such effect.

11.2.2.5 Air Pollution

There is no significant release of particles or noxious chemical compounds to the atmosphere from the proposed system. The alternative heat dissipation schemes utilizing evaporative systems, such as cooling towers and spray modules, would contribute significant quantities of salt to the local atmosphere.

Radionuclides released to the air with the present radwaste facilities would lead to a radiation dose of 0.041 man-rem/yr distributed among approximately 210,000 persons expected to be living within 50 miles of the plant in 1980. The increased dose received by any person would be negligible in comparison to the normal background dose of 0.12 rem/yr per person.

11.3 SUMMARIZED COMPARISON OF PLANT AND ALTERNATIVES

Table 11.2 summarizes the primary factors that must be evaluated when balancing the economic costs against the environmental impacts of constructing and operating Crystal River Unit 3. Items receiving consideration are listed in the first column. The second column identifies the cost or impact of the plant as it is presently designed. The remaining columns provide comparative information for twelve alternative heat dissipation schemes.

The first three rows of Table 11.2 list costs in millions of dollars. The remaining rows identify levels of environmental impact through numerical description or qualitative terms. Each of the 12 alternative schemes is compared to a reference physical characteristic such as the temperature of water discharged to the Gulf, the amount of heat discharged into the Gulf, or the thermal plume contact with the nearshore ecosystem. In projecting possible modifications to the character of the thermal discharge, certain environmental impacts may be decreased, while at the same time other environmental impacts are increased, e.g., reducing marine environmental impact at the expense of increasing terrestrial environmental impact.

Differential economic costs and environmental impacts of the 12 alternatives compared to the applicant's design are summarized in Table 11.3. Because the various capital and annual costs for the alternatives differ, a present worth calculation has been used to reduce cost factors to an equivalent present capital expenditure. The applicant's figure of 10.8% was used for the discount rate. The differential cost associated with each alternative scheme is shown in Row 3. The differential costs are those expenses required in addition to the reference case to implement and operate the alternative over the 30-year life of the plant. Thus, the $22 million differential cost of the first alternative, a closed cycle cooling pond heat dissipation, represents a total cost of $395 million ($22 million over the $373 million cost of the reference case). The 12 heat dissipation schemes vary in differential costs from $1 million to $29 million. Each of the 12 alternatives has advantages and disadvantages, which have been discussed in detail in the preceding material.

The three closed-cycle cooling options evaluated are 1) saltwater cooling pond, 2) freshwater mechanical draft cooling tower and 3)

TABLE 11.2

SUMMARIZED COMPARISON OF EXISTING PLANT AND ALTERNATIVES

COSTS OR ENVIRONMENTAL IMPACT	CRYSTAL RIVER UNIT 3 (APPLICANTS DESIGN)	CLOSED CYCLE			SUPPLEMENTAL COOLING $7^{o}F$ ΔT			
		COOLING POND	MECHANICAL COOLING TOWER (FRESHWATER)	NATURAL DRAFT COOLING TOWER (SALT WATER)	DILUTION	HOLD-UP POND	SPRAY MODULES	NATURAL DRAFT COOLING TOWER (SALT WATER)
CAPITAL COST ($\$10^6$)	242	262	251	259	253	257	250	256
ANNUAL CHARGE ON CAPITAL @ 17.73% ($\$10^6$)	42.9	46.5	44.5	45.9	44.9	45.6	44.3	45.4
ANNUAL OPERATING AND FUEL COSTS ($\$10^6$)	14.8	15.0	16.3	15.9	14.9	14.8	16.1	15.3
LAND PURCHASES REQUIRED (ACRES)	0	0	0	0	0	0	0	0
LAND DIVERTED TO FACILITY USE (ACRES)	30	730	35	35	50	780	30	35
HEAT ADDED TO GULF FROM UNIT 3 (MWt)	1718	10	0	0	1718	256	256	256
EFFECT ON AQUATIC LIFE ACRES EXPOSED TO >4°F ΔT OVER FULL TIDAL CYCLE	1250 ACRES NEAR SHORE WATERS	0	0	0	1000 ACRES NEAR SHORE WATERS	-50 ACRES OFF[a] SHORE WATERS	-50 ACRES[a] NEAR SHORE	-50 ACRES[a] NEAR SHORE
INTAKE SCREEN FISH KILL	36,000 LBS VALUED AT APPROX. $6500/YR	NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE	72,000 LBS VALUED AT APPROX. $13,000/YR.	36,000 LBS VALUED AT APPROX. $6500/YR	36,000 LBS VALUED AT APPROX. $6500/YR	36,000 LBS VALUED AT APPROX. $6500/YR
OTHER		REMOVAL OF 700 ACRES OF MARSH AND TERRESTRIAL LAND.	REMOVAL OF 30 CFS OF FRESH WATER FROM RIVER AND/OR AQUIFER			REMOVAL OF 750 ACRES OF NEAR SHORE WATER IN HOLDING POND		
EFFECT ON BIRD LIFE	NEGLIGIBLE	INCREASED USE BY WATER FOWL	NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE
EFFECT ON TERRESTRIAL ANIMAL LIFE	NEGLIGIBLE	REMOVAL OF 700 ACRES OF MARSH AND TERRESTRIAL LAND	NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE
EFFECT ON AQUATIC ANIMAL LIFE	MAJOR LOCALIZED	NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE	MINOR	NOT SIGNIFICANT	NOT SIGNIFICANT	NOT SIGNIFICANT
EFFECT ON AQUATIC PLANT LIFE	MAJOR LOCALIZED	NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE	MINOR	MINOR	NOT SIGNIFICANT	NOT SIGNIFICANT
RAD WASTES	NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE
CHEMICALS: RELEASE TO WATER	NEGLIGIBLE	NEGLIGIBLE	SOME CHEMICALS (BLOWDOWN)	SOME CHEMICALS (BLOWDOWN)	NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE	SOME CHEMICALS (BLOWDOWN)
RELEASE TO AIR	NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE	APPROX. 10 TONS OF SALT PER DAY	NEGLIGIBLE	NEGLIGIBLE	APPROX. 9 TONS OF SALT PER DAY	APPROX. 9 TONS OF SALT PER DAY
FOGGING	NONE	LOW FOG RIME DURING COLD WEATHER	FOGGING	HIGH LEVEL FOGGING	NONE	LOW FOG RIME DURING COLD WEATHER	LOW FOG RIME DURING COLD WEATHER	HIGH LEVEL FOGGING
AESTHETICS	MINOR IMPACT	MINOR IMPACT	MINOR IMPACT	MEDIUM IMPACT	MINOR IMPACT	MINOR IMPACT	MINOR IMPACT	MEDIUM IMPACT

(a) 50 ACRES LESS THAN THE PRESENT (UNITS 1 AND 2) CASE

TABLE 11.2 (Continued)

COSTS OR ENVIRONMENTAL IMPACT	SUPPLEMENTAL COOLING 11.5°F ΔT				
	DILUTION	HOLD-UP POND	SPRAY MODULES	NATURAL DRAFT COOLING TOWER (SALT WATER)	EXTENDED DISCHARGE CANAL
CAPITAL COST ($10⁶)	246	246	245	251	246
ANNUAL CHARGE ON CAPITAL @ 17.73% ($10⁶)	43.6	43.6	43.4	44.5	43.6
ANNUAL OPERATING AND FUEL COSTS ($10⁶)	14.8	14.8	15.3	15.0	14.8
LAND PURCHASES REQUIRED (ACRES)	0	0	0	0	0
LAND DIVERTED TO FACILITY USE (ACRES)	45	230	45	35	30
HEAT ADDED TO GULF FROM UNIT 3 (MWt)	1718	1133	1133	1133	1718
EFFECT ON AQUATIC LIFE ACRES EXPOSED TO >4°F ΔT OVER FULL TIDAL CYCLE	1330 ACRES NEAR SHORE	780 ACRES NEAR SHORE	780 ACRES NEAR SHORE	780 ACRES NEAR SHORE	1250 ACRES OFF SHORE WATERS
INTAKE SCREEN FISH KILL	45,000 LBS VALUED AT APPROX. $10,000/YR	36,000 LBS VALUED AT APPROX. $6500/YR	36,000 LBS VALUED AT APPROX. $6500/YR	36,000 LBS VALUED AT APPROX. $6500/YR	36,000 LBS VALUED AT APPROX. $6500/YR
OTHER		200 ACRES OF NEAR SHORE WATER USED IN HOLDING POND			TEMPORARY SILTATION
EFFECT ON BIRD LIFE	NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE
EFFECT ON TERRESTRIAL ANIMAL LIFE	NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE
EFFECT ON AQUATIC ANIMAL LIFE	MINOR	NOT SIGNIFICANT	NOT SIGNIFICANT	NOT SIGNIFICANT	NOT SIGNIFICANT
EFFECT ON AQUATIC PLANT LIFE	NOT SIGNIFICANT	MINOR	NOT SIGNIFICANT	NOT SIGNIFICANT	NOT SIGNIFICANT
RAD WASTES	NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE
CHEMICALS: RELEASE TO WATER	NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE	SOME CHEMICALS (BLOWDOWN)	NEGLIGIBLE
RELEASE TO AIR	NEGLIGIBLE	NEGLIGIBLE	APPROX. 3 TONS OF SALT PER DAY	APPROX. 3 TONS OF SALT PER DAY	NEGLIGIBLE
FOGGING	NONE	LOW FOG RIME DURING COLD WEATHER	LOW FOG RIME DURING COLD WEATHER	HIGH LEVEL FOGGING	NONE
AESTHETICS	MINOR IMPACT	MINOR IMPACT	MINOR IMPACT	MEDIUM IMPACT	MINOR IMPACT

TABLE 11.3

DIFFERENTIAL COST-BENEFIT EVALUATIONS: CRYSTAL RIVER UNIT NO.3

		DIFFERENTIAL COST OF ALTERNATIVES (FROM REFERENCE CASE)											
		CLOSED CYCLE COOLING (UNIT 3 ONLY)			SUPPLEMENTAL COOLING FOR 7^oF ΔT ALL UNITS				SUPPLEMENTAL COOLING FOR 11.5^oF ΔT ALL UNITS				
			COOLING TOWER										
MONETARY COSTS	REFERENCE CASE (APPLICANT'S DESIGN)	COOLING POND	MECHANICAL DRAFT (FRESHWATER)	NATURAL DRAFT (SALT WATER)	DILUTION	HOLD-UP POND	SPRAY MODULES	NATURAL DRAFT COOLING TOWER	DILUTION	HOLD-UP POND	SPRAY MODULES	NATURAL DRAFT COOLING TOWER	EXTENSION OF DISCHARGE CANAL
CAPITAL COST ($\$10^6$)	242	20	9	17	11	15	8	14	4	4	3	9	3
ANNUAL COSTS, CAPITALIZED ($\$10^6$) REPLACEMENT POWER FUELS OPER. EXP.	131	2	14	10	1	-	11	4	-	-	4	2	-
TOTAL PRESENT WORTH	373	22	23	27	12	15	19	18	4	4	7	11	3

ENVIRONMENTAL CONSIDERATIONS	REFERENCE CASE IMPACT	DIFFERENTIAL ENVIRONMENTAL IMPACT (FROM REFERENCE CASE)											
AREA DIVERTED TO FACILITY USE (ACRES)	30	700	5	5	20	750	0	5	15	20	15	5	0
HEAT ADDED TO GULF MW_t[a]	1718	-1718	-1718	-1718	0	-1462	-1462	-1462	0	-585	-585	-585	0
AQUATIC AREA EXPOSED TO >4^oF ΔT (OVER FULL TIDAL CYCLE, ACRES)	1250	-1250	-1250	-1250	-250	-1300[b]	-1300[b]	-1300[b]	80	-470	-470	-470	0
FISH KILL INTAKE SCREENS (POUNDS)	36,000	-36,000	-36,000	-36,000	NOT SIGNIFICANT	NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE	NOT SIGNIFICANT	NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE
CHEMICALS RELEASED TO WATER	NEGLIGIBLE		SOME CHEMICALS IN BLOWDOWN	SOME CHEMICALS IN BLOWDOWN				SOME CHEMICALS IN BLOWDOWN				SOME CHEMICALS IN BLOWDOWN	
RELEASED TO AIR	NEGLIGIBLE			APPROXIMATELY 10 TONS OF SALT PER DAY			APPROXIMATELY 9 TONS OF SALT PER DAY	APPROXIMATELY 9 TONS OF SALT PER DAY			APPROXIMATELY 3 TONS OF SALT PER DAY	APPROXIMATELY 3 TONS OF SALT PER DAY	
RAD WASTES	NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE
EFFECT ON TERRESTRIAL ANIMAL LIFE	NEGLIGIBLE	REMOVAL OF 700 ACRES OF HABITAT	REMOVAL OF 5 ACRES OF HABITAT	REMOVAL OF 5 ACRES OF HABITAT				REMOVAL OF 5 ACRES OF HABITAT				REMOVAL OF 5 ACRES OF HABITAT	
EFFECT ON AQUATIC ANIMAL LIFE	MAJOR LOCALIZED	IMPROVED	IMPROVED	IMPROVED	IMPROVED	IMPROVED	IMPROVED	IMPROVED	IMPROVED	IMPROVED	IMPROVED	IMPROVED	IMPROVED
EFFECT ON AQUATIC PLANT LIFE	MAJOR LOCALIZED	IMPROVED	IMPROVED	IMPROVED	IMPROVED	IMPROVED	IMPROVED	IMPROVED	IMPROVED	IMPROVED	IMPROVED	IMPROVED	IMPROVED

(a) ABOVE THAT USED BY CRYSTAL RIVER UNITS 1 AND 2 AT FULL POWER

(b) THESE CASES WOULD REDUCE THE AFFECTED ACREAGE OF THE REFERENCE CASE BY 1250 ACRES AND WOULD REDUCE THE PRESENT (UNITS 1 AND 2) CASE BY AN ADDITIONAL 50 ACRES.

saltwater natural draft cooling tower. Each reduces the intake screen fishkill by approximately 36,000 lb annually. The value of this kill is estimated to be about $6,500 annually, less than one percent of the annual commercial landings for Citrus County. The closed-cycle cooling alternatives also reduce the impact of the reference design on aquatic animal and plant life in the effluent discharge area. However, the cooling pond alternative requires permanent alteration of about 700 acres of terrestrial habitat. Thus, the cooling pond substitutes increased terrestrial impact for a reduced marine impact. All cooling towers will release some blow-down chemicals to the Gulf. Differential cost of these three alternatives is high, ranging from $22 to $27 million. Because of the relatively high cost of these alternatives with transfer of environmental impact from the Gulf to the terrestrial and marshland areas, the reference case is preferred to these closed-cycle cooling alternatives.

The supplemental cooling alternatives will not reduce the fishkill on the intake screen since the supplemental cooling options do not alter the intake design. The supplemental cooling alternatives will, however, reduce the thermal impact imposed by the reference case on aquatic life. The saltwater natural draft cooling tower and spray module alternatives release considerable amounts of salt to the atmosphere. The environmental impact of the supplemental cooling schemes has not been investigated in the same detail as the reference case. Such an investigation is required before implementing any of these schemes. It appears that some overall environmental benefits are possible with the supplemental cooling options but these must be balanced against construction and maintenance costs. For some designs it appears that the overall environmental impact may present a stand-off with the reference design. The differential cost of the supplemental cooling alternatives ($4 to $19 million) over the reference case does not appear warranted in view of small or possibly no overall environmental benefits.

Extending the discharge canal allows the heated discharge water to be released at some distance from the shoreline. This design substitutes an offshore mixing zone and offshore marine life impact for nearshore impacts. This alternative does not necessarily reduce the total size of the area exposed to the thermal plume. Uncertainties of the ecological impact of dredging on the local marine environment coupled with the uncertainty of benefits to be derived from substituting offshore for nearshore marine impacts does not permit a solid conclusion that this alternative is environmentally superior to the reference design. The monetary cost of this alternative is approximately $3 million above the reference design. This option warrants additional study as a possible alternative.

11.4 BENEFIT-COST SUMMARY

The staff concludes that the primary benefit of increased availability and reliability of electrical energy outweighs the environmental and economic costs of the station. The applicant must initiate the necessary programs outlined in Section 12.3 to resolve the outstanding concerns of the staff and commenting Federal agencies and implement such changes as necessary to correct any identified, unacceptable impacts.

12. DISCUSSION OF COMMENTS RECEIVED ON THE DRAFT ENVIRONMENTAL STATEMENT

Pursuant to Appendix D to 10 CFR Part 50, the Draft Environmental Statement was transmitted in September 1972 with a request for comment to the Federal, State, and local agencies listed in the Summary at the beginning of this final statement. In addition, the AEC requested comments on the Draft Environmental Statement from interested persons by a notice published in the Federal Register on September 12, 1972.

Comments in response to these requests were received from the Environmental Protection Agency; the Federal Power Commission, the Department of Commerce; the Department of Agriculture; the Department of Transportation; the Department of the Army, Corps of Engineers, the Department of Interior; the Advisory Council on Historic Preservation; the State of Florida Department of Administration (for the Department of Agriculture and Consumer Services, Board of Trustees of the Internal Improvement Trust Fund, Department of Commerce, Department of Community Affairs, Department of Natural Resources, Department of Pollution Control, Public Service Commission and Department of State).

Private citizen responding was Chauncey C. Hale (Dunedin).

Our consideration of the comments is reflected in part by text changes in other sections of the statement, which are listed by subject at the end of this section, and in part by the following discussion.

12.1 RADIOLOGICAL TOPICS

12.1.1 Gaseous Waste Management (EPA pp E-18 and E-23)

Table 3.11 is a listing of the principal assumptions used in developing the source terms and contains those used for developing the estimated releases from the condenser air ejector.

According to the staff's evaluation, the expected release of radioiodine in a single event of load loss or other reasons for a steam dump is a small number of millicuries of I-131, which is an insignificant contribution to the gaseous source term.

12.1.2 Liquid Waste Management (EPA pp E-18, E-22 and E-24; DA p E-46)

Decontamination factors for the condensate mixed-bed demineralizers are now shown under item 12 of Table 3.1 on page 3-12.

In the staff's evaluation it was assumed that a 5 gpm condensate leakage will not be treated prior to discharge. Since the liquid releases are within the proposed Appendix I limits for this assumption, no criteria for routing condensate leakage to the waste treatment system was considered.

The staff expects that releases of radioactive material in liquid effluents will be a fraction of the values shown in Table 3.2. However, to compensate for equipment downtime and expected operational occurrences, including maintenance, the expected values have been normalized to 5.0 curies per year.

As operating data becomes available from the plant and other operating PWR's, the staff intends to evaluate the potential effect of abnormal occurrences and nonroutine maintenance on radwaste treatment systems and recommend changes as may be necessary.

Table 3.2 includes 1,000 curies per year of tritium releases to the environment. This release rate is based on the discharge of 1.44×10^4 gallons per year of primary coolant and 2.15×10^6 gallons per year of secondary coolant. The tritiated secondary coolant will be disposed of by controlled release to the environment and has been considered in the source term.

The radioactive liquid waste processing system has been designed to collect, store, and process all radioactive wastes for reuse or disposal.

The system is designed such that both high purity waste such as reactor coolant and miscellaneous waste such as radioactive laboratory drains, building and equipment drains and sumps, etc., are processed by the primary and the secondary process streams, respectively.

The concentrated boric acid from the primary stream can be either recycled for reuse or further processing.

The concentrates from the secondary stream can be recycled for further concentration or storage with subsequent transferral to the waste solidification system. The waste solidification system provides the capability to solidify and package plant radioactive waste in containers for the transportation to an AEC approved burial (disposal) facility.

The evaporator condensate polishing demineralizers and storage tanks are common to both process streams. Each process stream up to the polishing demineralizer is normally isolated from the other; however, if required, valving and piping can be aligned such that cross-connection of various equipment in each stream is possible. The effluent from the primary and secondary process streams, after processing, may be transferred to the reactor coolant bleed tanks and used for makeup to the primary system or may be discharged via the Nuclear Services Seawater System and discharge canal.

The radioactive liquid waste processing system eliminates the possibility of external radioactive spills from infiltrating to the groundwater due to the fact that all radioactive liquid wastes are solidified before removal from the plant and that only carefully monitored processed effluent is emitted from the plant via the Nuclear Services Seawater System and discharge canal.

12.1.3 Reactor and Transportation Accidents (DOC p E-17; EPA p E-26; DOI p E-57)

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. 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.

A comment was made on the meteorological assumptions used for the accident analysis. The meteorological conditions indicated in the Annex to Appendix D of 10 CFR Part 50 approximate the dispersion conditions which would prevail at least 50% of the time.

As pointed out in Section 5.5.4 the transportation and ultimate disposal of radioactive wastes will be accomplished in AEC-DOT approved containers. Compliance with shipping regulations will ensure that these wastes will be properly handled by the applicant when shipment occurs.

12.1.4 Radiological Impacts (EPA p E-38)

Doses to shrimp in the discharge canal are estimated to be less than 30 mrem/yr. This dose is primarily external and arises mainly from the radiocesiums in the sediments. It does not take into account the water shielding and any mixing and decay of the plant effluents. The impact to any shrimp organisms in the areas concerned are considered to be infinitesimal. However, periodic sampling by the applicant within the shrimp-farm is recommended.

12.1.5 Radiological Monitoring (DOC p E-13; DA p E-46)

Activity data regarding the seawater around the plant are given in the applicant's Environmental Status Reports. K-40 was the only radionuclide measurable. Its activity concentration[1,2] was 200-400 pCi/ℓ. The following table lists the radionuclides monitored and the respective analytical limits.[3]

Radionuclide	Analytical Limit, pCi/ℓ
H-3	72
Ce-144	98.6
I-131	18.5
Ru-106	75.5
Cs-137	17.4
Zr-95	14.6
Mn-54	15.2
Zn-65	32.0
K-40	19.4
Ba-140	18.8

The gamma background around the plant as measured by the applicant with thermoluminescent dosimeters was approximately 0.025 mrem/hr,[1,2] which is equivalent to 220 mrem/yr. This is approximately twice that reported in an EPA survey[4] which gave 120 mrem/yr for the background dose rate to an individual living in Florida.

The applicant states that he intends to sample many species of biota both on the site and offsite from the various ecological systems in the vicinity. The offsite sampling program will include the quarterly radiological analysis of oysters, crabs, food fish, and marine algae.[4] A quarterly sampling of a citrus grove eight miles from the plant will also be made.

Sampling of onsite life forms for radioactivity will be from four ecological systems: nearshore marine, marshland, terrestrial, and freshwater to a lesser degree. The biota selected to be sampled from the marine environment on a quarterly basis include plankton, algae (Sargassum sp.) grass, oysters, shrimp, blue crabs, finfish, mullet, silversides, and several gamefish which have not been selected as yet. One of the locations for taking marine samples will be at the site of the plant discharge. Quarterly samples from the marshland include oysters, blue crabs, mullet, killfish, silversides, and spot. Terrestrial sampling will include pokeberries, crayfish, snails, armadillos, saltwater mussels, cabbage palms, raccoons, red-breasted mergansers, Spartina, prickly pear cactus, and mushrooms.[5]

The applicant is now preparing a more detailed description of the monitoring program, including species sampled. It will be fully described in the Technical Specifications.

"Concentration per hour" is not a legitimate unit. Quantities per unit time are release rates, but hour is not a normal unit of time used in these statements. Concentrations in microcuries per second may be derived from the given release rates of curies per year divided by 3.15×10^7, the number of seconds per year.

12.1.6 Technical Specifications (EPA p E-25)

The Technical Specifications will contain criteria for utilization of waste treatment equipment and limits for discharge of waste to the environment; e.g., dilution rates, and concentrations. The Technical Specifications will be developed and made a part of the license.

12.1.7 Decommissioning (Section 8.3)

The applicant estimated the cost for shutting down Crystal River Unit 3 and holding it in a safe-shutdown condition, if and when it may become necessary, at $750,000. This estimate is based upon leaving the reactor and its associated nuclear systems in place and salvaging the secondary side of the plant. All nuclear fuel, of course, would be removed from the plant and sent offsite for final reprocessing. Thus prepared, the area would probably be isolated by suitable fencing and monitored periodically by guards. The estimated annual cost to maintain the facility in this condition is about $50,000. The staff considers these estimates to be somewhat low (see Section 8.3).

In considering the above cost estimates, it must be remembered that items such as inflation, Florida Public Service Commission regulations, future AEC regulations, etc. may greatly alter these costs.

12.2 NON-RADIOLOGICAL TOPICS

12.2.1 Recreational Value and Potential (DA p E-44)

Because of the factors cited in 2.3.12, the plant site has not been developed recreationally and is essentially unused for recreational purposes. In common with all sea frontage land, however, the potential recreational value is considerable.

12.2.2 Historical Significance (ACHP p E-7; Fla DOS p E-48; DOI p E-52; Fla DOA pp E-97, E-98 and E-101)

A complete archaeological and historical inventory of the Crystal River Plant Site and adjacent areas was conducted in the summer of 1972. The State of Florida Division of Archives, History, and Records Management has certified complete satisfaction with the procedures instituted by the applicant in assessing the potential adverse effects resulting from this project, relative to historic preservation (Appendix E).

12.2.3 Geology and Hydrology (DOC pp E-15, E-16 and E-34; DOI p E-53; Fla DOA p E-102)

The hurricane design bases required by the staff for the subject plant are predicated on preventing accidental releases for hurricanes as severe as a probable maximum hurricane. This postulated event is considered to produce the upper limit of surge and wave effects reasonably possible at the site, and is significantly more severe than has been recorded. Since the facility is to be designed to withstand such an event, a postulated accident due to hurricanes is not considered credible.

While it is recognized that the widely extending and important aquifer lying beneath the plant is located in porous limestones in which the water is relatively quite mobile, there are several circumstances which are in favor of decreasing hazard from a ground surface spill. The first of these is that the soils overlying the aquifer are much less fissured and cavitied than the limestone itself and are frequently of compacted fill material of different characteristics. In particular, this is significant at the ground surface. In some places artificial grouting has been used to increase load bearing characteristics and to decrease soil porosity and permeability; this will decrease the rate and extent of infiltration into the aquifer. Secondly, the water table lies at lower elevations in the direction of the Gulf and its natural drainage is in that direction and not landward toward habitation where wells and other withdrawal points may be located. Waters reaching the Gulf by means of this aquifer become rapidly diffused and diluted. Most importantly, it must be recognized that spills of radioactive solutions, if they did occur, would generally do so within buildings and in the neighborhood of chemical equipment where the problems of confinement and decontamination are understood and relatively easily managed.

12.2.4 The Ecosystems

12.2.4.1 The Terrestrial Ecosystem (DOA p E-44; DOI p E-53)

In addition to Table 2.4, a total of 9 species may be added to provide a more complete list of terrestrial fauna.

Swamps

Birds: Pintail Duck (*Anas acuta tzitzihoa*)
Green-winged Teal (*Anas carolinensis*)
Ward's Great Blue Heron (*Ardea herodias wardi*)

Hardwood Hammocks

Birds: Tufted Titmouse (*Parus bicolor*)
Chuck-will's Widow (*Antrostomus carolinensis*)

Pinelands

Birds: Yellow-shafted Flicker (*Colaptes auratus auratus*)
Florida Black Crow (*Corvus brachyrhynochos pascuus*)

Ruderal Areas

Birds: Black Duck (*Anas rubripes*)
Boat-tailed Grackle (*Cassidix mexicannus major*)

12.2.4.2 The Aquatic Ecosystem (DOC p E-12, E-13; EPA pp E-31 to E-34; DA p E-45; DOI p E-52)

It is well recognized that the nursery area of the marsh habitat plays a vital role in sustaining the productivity of finfish and shellfish along the western Florida coast.

The trophic pathways illustrated in Figures 2.5 and 2.6 are based on a generalized energy flow. Food habits of finfish and shellfish vary with season, age of the species, geographical location, availability of food organisms, or food material, chemical and physical features of the water, tidal stages, and many other factors. In addition, certain intermediate stages such as the "insect link" between detritus and killfish and the "scavenger link" preceding crabs are omitted to attain simplicity.

Data given in Table 2.7 are those provided by the reference source. Although independent recalculation of the amount of food of each item consumed per year may show slight differences, these are within the range of normal variation. One would not expect, in nature, that each individual finfish or shellfish would consume precisely the estimated quantity of food. The staff accepts the data provided in the referenced source as a rational estimate.

Early life stages of finfish and shrimp arrive in inshore waters within one or two months following the offshore spawning of adults.

Fish and shellfish originating in coastal waters of Citrus County may move up and down the coast and contribute in varying degrees to catches of other coastal counties. Conversely, fish and shellfish originating in other coastal waters of western Florida may enter and contribute to sport and commercial fisheries off Citrus County.

Although shrimp are not taken commercially in waters of Citrus County for human consumption, a significant bait fishery exists where shrimp are sold individually rather than by the pound. Surveys of the bait-shrimp fishery began in 1963. Citrus County statistics from 1963 through 1970 are as follows:[6]

Year	Number of Shrimp	Value ($)
1963	3,113,030	39,241
1964	3,826,615	43,055
1965	944,347	12,407
1966	549,550	9,192
1967	8,079,000	88,746
1968	10,413,450	124,297
1969	7,824,500	89,078
1970	12,123,000	187,266

A comment has been made that irretrievable damage has already occurred in the Crystal River area due to the operation of Units 1 and 2 and that Unit 3 will cause a greater adverse impact. The staff has no information to indicate that an adverse impact has definitely occurred in the area. It is the conclusion of the staff that adverse impacts may occur from the increased volumes of water being pumped through the canals and due to the added heat load in the discharge area. The applicant must provide a means for measuring these effects and be prepared to modify the cooling water design to reduce the impact.

12.2.5 Construction and Operating Effects

12.2.5.1 Effects on Air Quality and Land (EPA pp E-37 and E-38; DOI p E-55)

The 3,000 kW diesel electric generators are employed at Crystal River Unit 3 for secondary emergency power. Frequency of operation for testing of the diesels will be one generator each week for approximately two hours running time. Type of fuel used in the diesels is No. 2-D containing a maximum sulfur content of 0.7 percent by weight and a maximum ash content of 0.02 percent by weight.

During periods of testing, the exhaust emissions will be comparable to the passage of a large single-unit railroad locomotive. Alternatively, if an emergency occurs, their operation will be in the absence of the relatively larger emissions from fossil Units 1 and 2 which would be presumed shutdown since they are the primary source of emergency power for the nuclear unit. Other minor venting of miscellaneous equipment would be expected to be undetectable either by sight or measurement outside of the immediate exclusion area.

Control of dust during construction of Unit 3 has been accomplished by using water spraying of the area. Also, due to the nature of the hard limerock fill at the site, dust is not a major concern. Parking lots for construction workers are compacted with boiler ash from Units 1 and 2 and do not present a dust nuisance.

There is no concrete batch plant on site at Crystal River.

Disposal of non-radiological combustible construction debris and solid wastes generated at Crystal River Unit 3 during construction is accomplished in a number of ways. Non-reusable form material and scrap metal are given away for charitable purposes or home use. Also, when practicable, scrap materials are sold. Other combustible wastes are burned when permit conditions allow such disposal method. During operation, disposal methods will be similar to the above. Also, some land burial in fill areas will be used.

All significant land clearing, excavation, and filling was completed during the construction of the original fossil-fueled unit.

Material excavated for building foundations for Crystal River Unit 3 was used for upland fill. Excavation for the circulating water intake structure is complete. This excavation, roughly 200' x 100' x 40' deep, was de-watered by open sump pumping. Effluent was discharged into an upland settling basin of a size and configuration such that the overflow was within the established water quality standards before release into the marshlands. Excavation for the circulating water outfall structure is complete. This excavation, roughly 150' x 100' x 25' deep, was de-watered and the effluent was treated in the same manner as the intake structure.

Excavations of the circulating water inlet canal extension and outfall canal extension are scheduled to begin in late spring of 1973. The inlet canal extension is an upland extension of 600' x 125' x 17' deep to an existing canal from the Gulf of Mexico. Total material to be removed is approximately 125,000 cubic yards. This material will be deposited on uplands, which are presently filled to an elevation of eight feet above mean low water. The outfall canal extension is also an upland extension of an existing canal to the Gulf. This extension is 600' x 125' x 10' deep with approximately 50,000 cubic yards of material to be removed. Excavation and disposal of material will be accomplished in the same manner as the intake canal extension. Essentially all excavation will be accomplished behind an earthen plug, which will be left at the terminus of the existing canal, thereby eliminating any disturbance to the open water of the Gulf. The final removal of the earthen plug will be accomplished behind an encircling silt curtain and all precautions will be taken to maintain the open water turbidity well below the established standards. No de-watering will be required in connection with this excavation.

The construction of an additional transmission line on 2140 acres stretched over 125 miles of existing rights-of-way should have a minimal impact. The land is generally flat and the soil is porous so that erosion should not be a problem. Equipment tracks and cuts into the vegetation are expected to revegetate quickly.

Sound levels within and around nuclear plants are generally low. Within the plant, acoustical insulation can be used if problem areas are discovered to exist. Sound reducing barriers can be placed around transformers, if necessary, to reduce levels to acceptable ranges; the isolation of this plant is expected to prevent any need for such structures in the near future.

12.2.5.2 Effects of the Intake Structure and Cooling Water (DOC p E-14; EPA pp E-18, E-29 and E-39; DOI pp E-50 to E-57)

The additional discharge of heated water as a result of the operation of the nuclear unit at Crystal River will roughly double the volume of pumped water through the intake and discharge canals and increase the ΔT across the intake/discharge canals by about 3°F. The results of the plankton sampling were given in the referenced source, but tha actual methods were not detailed. The data available are limited. The staff recognizes that certain inadequacies in sampling may have existed because of the preliminary nature of the survey and its limited scope.

The staff believes that the present estimated losses may increase at least twofold when Unit 3 becomes operational based on the doubled amount of cooling water required. Impingement impact is a complex relationship between swimming ability of individual species and intake velocity, as well as such factors as the seasonal presence and abundance of susceptible forms, the onset of cold water causing lethargy, and other factors. A few species may appear on the screens that were not previously impinged due to the increase in intake canal velocity, but the existing impingement data include most species common to the area.

Entrainment of planktonic eggs and larvae of finfish and shellfish has little relationship to intake velocity because these organisms have little or no swimming ability. They can no more resist velocities of 0.5 fps than 5.0 fps. The impact of entrainment thus becomes a function of the volume of water used in the plant, the quantities of different finfish and shellfish eggs and larvae per given volume of water, and the physical and chemical stress imposed during passage.

Data on the relationship of size (age) to swimming ability for the numerous species of Crystal River fish are not available, which would permit assessment of potential impact. Impingement of certain juvenile finfish and shellfish occurs at the existing intake of Units 1 and 2, but adequate data on entrainment of eggs and larvae are not available. As noted in Section 2.6.2.3, most species of fish spawn offshore and the juveniles move to inshore waters one or two months later with at least some swimming ability.

The staff has required that studies be conducted to provide quantitative data on entrainment of eggs and larvae of finfish and shellfish at Crystal River (see Section 12.3).

A somewhat more straightforward assessment of the economic loss from impingement on intake screens of Units 1 and 2 can now be made on the basis of monetary values applied to individual marine species in recent court applications in the State of Florida.[7] Assuming an average value of $2.00 per individual of each species and 75,000 total number of valued finfish and shellfish (25% of total estimated kill), the economic loss might amount to about $150,000 annually and twice this amount for the three units.

The U. S. Department of Commerce[6] has quoted studies recently made by the St. Petersburg Beach Laboratory which show that the average volume of zooplankton present in Crystal Bay area waters to be 0.25 ml per m^3. On the assumption that the total water flow will be approximately 1,250,000 gpm after the addition of Unit 3, that the cooling water is drawn from the Crystal Bay area and that a total kill of zooplankton is obtained, the Department calculates that the accumulation of dead organisms will be at a rate of about 2 cubic yards or 1.4 tons of zooplankton per day.

The staff does not have sufficient data to show that the cooling water is indeed drawn from Crystal Bay nor that the dead plankton would not be consumed as readily as the live plankton which would normally be resident in the discharge area--whatever that amount of plankton might be. Even assuming the amounts described above, it is yet to be demonstrated that such a turnover of such nutrients would be deleterious.

The improved location of sampling stations in both intake and discharge areas and the use of improved sampling methods are planned in the more thorough study of these problems.

Data on salinity in the intake and discharge canal in 1970 are provided by Grimes and Mountain.[8]] Comparison of these data with those figured in Appendix D indicates that differences in salinity between the intake and discharge zone will generally be less than 8 parts per thousand. Since the inshore estuarine zone is characterized by widely fluctuating salinities that are always less than full strength seawater, no significant ecological impact is expected.

It has been shown that the heated saline effluent leaving the discharge canal tends to wedge under a layer of less saline water which issues from the Withlacoochee River and Cross Florida Barge Canal to the north (Appendix D). Since the less saline water stratifies at the surface, intertidal flats in the mixing area are apt to be affected by water of relatively low salinity as well as by heated water of relatively high salinity. Observations by the EPA in April 1972 indicated some damage to oyster reefs southeast of Drum Island, in the freshwater influx area, as well as abnormal quantities of blue-green algae and a lack of nudibranchs and brittle stars. These phenomena may have been caused by the freshwater influx, the heated discharge, or a combination of both. According to Galtsoff,[9] oysters inhabiting parts of estuaries in which salinity is below 10 parts per thousand are seriously affected by freshwater and can be destroyed by floods lasting several weeks.

Little is known about the various effects of thermal increments on fish and shellfish in the mixing zone that are indirect consequences of the added heat in environments such as coastal Florida. These effects theoretically could include such aspects as increased predation, increased disease of parasite infestation, or failure of sex products to develop.

Increased predation would occur only if prey organisms are thermally stunned and rendered more susceptible to predators. If the prey is a required food organism of a more valued species, the impact could be advantageous. There is usually an optimum temperature for feeding of all cold-blooded aquatic organisms. At Crystal River, the increased temperatures of the mixing zone may improve feeding of valued species during the winter minima, or decrease feeding during the summer maxima.

The principal disease known to be influenced by increased temperature in the Crystal River area is the fungus Labyrinthomyxa marina of oysters. Oysters exposed continuously to 35°C (95°F) showed an often slow but distinct rise in L. marina infection incidence and intensity during the first 1 to 2 weeks exposure regardless of time of year.[10] However experiments longer than two weeks showed an inhibition of L. marina infection at 35°C (95°F) and possibly at 30°C (88°F).

Warm temperatures generally increase the maturation rate of sex products in fishes at sublethal levels and can advance their spawning times. Since fish are mobile, they can leave the mixing area when temperatures become unfavorable. High temperatures also increase the development of sex products in attached shellfish such as oysters and these sessile organisms can become exhausted at continuous exposure to a high temperature level.

If the discharge area at Crystal River were an enclosed body of water, significant eutrophication could occur as a result of warmer temperature and the increased nutrient supply from entrained organisms. Some evidence of eutrophication may appear in the discharge area even though it is open to the sea. Significant eutrophication, or the excess consumption of oxygen resulting in an oxygen deficiency, is not expected by the staff.

12.2.5.3 Effects of the Discharge System (DOT p E-9)

As pointed out in the Draft Environmental Statement (p. 4-2), the lengthening of the discharge canal would be carried out under carefully controlled conditions according to the plans of the applicant so that deleterious effects due to silting in the discharge area should be minimized. Some scouring of the channel appears to be inevitable although the magnitude of the resulting turbidity should, in the opinion of the staff, be less than that currently resulting from the Withlacoochee River-Cross Florida Barge Canal. The consequence of scouring on the overall productivity of the estuarine region of the Crystal River power station is difficult to assess. At most the movement of sediment at the discharge would cause a temporary disorder until the scouring action exposed sufficient limestone bed rock to curtail this action, thus allowing the aquatic organisms to rehabilitate in the new environment.

The Environmental Protection Agency has commented that the addition of Unit 3 to the Crystal River complex may not permit operation at full capacity at all times in compliance with existing Federally-approved state water quality standards and suggests that closed cycle cooling may be required as an ultimate consequence. In other portions of this section, the staff has developed a number of alternatives, in addition to those presented in the DES, including the use of a supplementary cooling channel system. All of these would meet either exisiting or proposed standards as understood by the staff. These alternatives have been added to complete the potential means by which a full range of considerations related to the question of standards could be evaluated.

These new alternatives share a common difficulty of requiring the dedication of relatively large acreages of upland area. Further in the case of the closed cycle spray pond, the uncertainties raised by the drift of salt fog are beyond the existing state of the art to evaluate. All of the closed cycle alternatives involve the commitment of large capital expenditures and, in the case of cooling towers, additional losses of capacity because of increases in back pressure on the turbine generator system. In summary, the staff believes that all of the potential closed cycle alternatives open to the applicant would involve financial losses of relatively large magnitude. Further, the alternatives using ponds and canals could, within the limits of existing known technological feasibility while offering a technical means of meeting gulf water quality standards, do so at significant environmental cost. This cost is very high in comparison to the expected impacts on the aquatic environment which the staff has been able to identify. It is concluded, therefore, that none of the alternatives studies has produced a wholly staisfactory means of satisfying all of the objections which might be raised, and, in fact, all appear to result in a greater net degradation of the local combined air-water-aesthetic environment. Therefore, pending resolution of effluent standards questions raised by the Water Pollution Control Act Amendments of 1972, the staff believes that the previous recommendation to extend the discharge canal and license the operation of Crystal River Unit 3 under the restrictions listed in the DES is in the public interest.

12.2.5.4 Relationship of Present Design to State Standards (EPA pp E-18 and E-20; DA p E-46; Fla DOA p E-69)

Florida water quality standards in effect July 1, 1972 required consideration of temperature such that the temperature of effluents should not be increased so as to cause any damage or harm to the aquatic life or vegetation of the receiving water or interfere with any beneficial use assigned to such waters (Amendment of January 16, 1969). The staff review of the combined effects of Crystal River Units 1, 2 and 3 has been carried out under criteria of NEPA which places overriding emphasis on the benefit-cost aspects of the proposed installation with due consideration to the quantifiable factors of environmental interaction. It was concluded by the staff that if measures were taken to improve the mixing of the discharged effluent and reduce the potential for the release of warmed waters to the in-shore areas by means of a canal extension, it was in the public interest to license the Crystal River installation using the once-through configuration. Further, it is required that extensive studies of the operating system be carried out to determine if, in the judgment of the staff, this course of action was sufficiently conservative to protect the general aquatic environment of the Gulf in the Crystal River region. If, as a result of these studies, definitive damage of serious scope is established, and considering the favorable recuperative characteristics of the shoreline, the staff would recommend actions which would improve the situation. These actions could include either supplementary cooling or closed cycle cooling.

The new requirements under the Water Pollution Control Act Amendments of 1972 are being applied to the water discharge permits of Crystal River Units 1, 2 and 3. Additional alternatives, responsive to proposed thermal standards have been developed and evaluated. None of these, under the interpretation of NEPA, under which this review is being carried out, appears to have a net benefit greater than for the original system when considered over the 30-year life of the facility. On this basis, the staff sees no reason to alter the recommendations for licensing in the Draft Environmental Statement.

12.2.6 <u>Proposed Modifications</u> (EPA pp E-18, E-20 and E-31 to E-34; DOI pp E-50, E-54, E-55, E-58, E-59 and E-60; Fla DOA p E-85)

12.2.6.1 <u>Modifications in the Intake System</u>

Concern has been expressed regarding entrainment losses of finfish and shellfish resulting from the increased flow in the intake canal when Unit 3 is operated. As noted in the Draft Statement (p. 5-7) the staff expects entrainment losses to increase at least twofold as a result of the increased flow. EPA has suggested that the entrainment losses will more than double because increased velocity will greatly reduce the chances of escape for juvenile species which cannot swim faster than 1.3 ft/sec for prolonged periods. While the staff does not believe that available information points to a major detrimental influence as a result of the present intake configuration, we have considered several modifications of the intake structure designed to reduce entrainment losses.

First, widening of the intake canal to the extent that no increase in velocity would be experienced upon startup of Unit 3 was considered as a means for preventing increased entrainment due to higher velocity. The modified canal would be 325 ft wide compared to the present width of 150 ft. Depth would remain at 15 ft. Cost for the dredging required is estimated to be $4 million. Adverse effects from the canal widening include the cost, the disruption of ocean bottom, and the temporary generation of turbidity as a result of the dredging operation. The benefit from this modification is not easily quantified on the basis of existing information. Thus in the opinion of the staff, this modification should be seriously considered only if experience with Unit 3 demonstrates that the increased velocity in the intake canal greatly increases entrainment losses compared to the twofold increase expected.

A second modification considered was the installation of vertical travelling screens and air bubble curtains at the entrance to the canal. These installations were considered at two alternate locations. In the first, the screens would be installed at the end of the south dike of the existing canal, or about two miles offshore. Sufficient screens would be used to limit screen velocity to 1 ft/sec for a water depth of 5 ft. Air bubble curtains would be installed at the approach to the screen as a fish deterrent. Barge gates, 125 ft wide, would be installed to permit barge traffic. The alternative location for this modification would be at the end of the existing north dike, or about 8 miles offshore. Installation at this site would require extensive dike building as the south dike presently ends 2 miles out and the north dike is incomplete after 4 miles. Cost for the close-in installation is estimated at about $2 million and for the more offshore installation, the cost is estimated to be $10 million.

Benefit from such an installation would be to prevent larger fin-fish from entering the canal. Hopefully, the air bubble curtain would frighten juvenile fish away from the area and prevent their passage through the screens. The installation 8 miles into the Gulf would be the more effective because fewer juvenile fish would be present as compared to installation closer to shore. Adverse effects include those associated with the extensive dredging required, the cost, and for the far offshore installation, the imposition of dike barriers to littoral flow in the Gulf. It is the opinion of the staff that this modification should be seriously considered only if experience with Unit 3 demonstrates that the increased velocity in the intake canal greatly increases entrainment losses compared to the twofold increase expected.

A third alternate means for reducing biota entrainment losses considered by the staff involves use of a submerged pipe in place of the intake canal. All cooling water for the three plants at Crystal River would be delivered from 7 miles offshore by means of a buried 16' dia. conduit. The outer half mile of the pipe would be perforated, and covered with large aggregate. Entrainment losses are expected to be minimal for the pipe intake because the inlet is relatively far offshore where the juvenile fin fish population is low and because low infiltration velocities would be used. The buried pipe is superior to an intake canal extension because it offers no obstruction to natural circulation of near-shore Gulf water. Adverse effects of this alternative water intake include the cost of at least $36 million and could approach $50 million depending on conditions imposed on construction activities and the temporary disruptions caused by the installation work. The high cost of this alternative suggests that it be considered seriously only if experience demonstrates that entrainment losses increase sharply when Unit 3 begins operation, and that neither of the other two less costly alternatives can satisfactorily resolve the problem.

12.2.6.2 Modifications of the Discharge System (DOA p E-11; EPA pp E-28 and E-39; DOI pp E-58 and E-59; Fla DOA p E-87)

Extension of the discharge canal was discussed as a means for minimizing exposure of the shoreline marine environment to heated water (p. 11-16 of Draft Statement). It is recognized by the staff that the primary benefit of a canal extension is a trade-off between highly productive near-shore areas versus less productive areas offshore. The staff agrees that the specific canal extension indicated in the Draft Statement may not be optimum in length or location. However, it is the opinion of the staff that the objective of minimizing exposure of the shoreline marine environment to heated water can be met by an extension of optimum design.

It appears certain that the extended canal would be appreciably shorter than the existing north dike of the intake canal. Thus, the added dikes would pose only a minor additional obstacle to natural along-shore flow.

Dikes formed from natural aggregate should not be considered as unalterable. If, at some future date, it were determined that the dikes should be removed, they could either be leveled in place, or excavated and hauled away. In this sense, the addition of canal extension dikes does not foreclose future alterations in the heat dissipation system at Crystal River.

As noted in the Draft Statement (p. 5-9), some additional canal scouring is expected upon startup of Unit 3 when the velocity in the discharge canal will increase from 1.1 ft/sec to 2.4 ft/sec. Scouring of loose sediments on the bottom of the canal can be expected to increase when the velocity is increased. On the basis of geologic cross-sectional data obtained during construction of the intake canal,[11] most sediments prone to scour should have been removed when the intake canal was dredged. However, existing data do not permit precise evaluation of the extent of scouring which will occur with the higher water velocity. The staff recommends that the applicant be required to monitor scouring in the discharge canal, and take corrective action if significant damage to biota is threatened.

The staff concurs with USDA, Soil Conservation Service that scouring is the one of the factors which should be considered in the design of any new discharge canals.

Effluent temperatures have been described in the Draft Statement primarily in terms of ambient water temperature and incremental temperatures due to plant operation. The actual temperature of the effluent cannot be simply stated because it depends on the ambient temperature and the power level of the plant. Both of these factors vary seasonally and hourly, making it impossible to state the discharge temperature as a fixed quantity. A plot showing maximum temperatures at the end of the discharge canal was prepared by the staff assuming that all three plants operate at 100% power level, that 6% of the heat load is lost to the atmosphere from the surface of the water in the discharge canal, and that the ambient intake temperature is equal to the mean maximum temperature of surface water as measured over a many year period at Cedar Keys, Florida. The result is shown in Figure 12.1. Highest temperatures are reached in July-August and peak near 102°F. It should be understood that these temperatures are usually lower than the mean maximum, and that it is unlikely that all three power plants will operate at 100% power simultaneously.

A cooling alternate in which cooling water from Unit 3 is discharged through a submerged pipe at a point south of the intake canal has been considered involving a 12 ft. diameter pipe, approximately 8 miles long and laid out in a southwest direction. Water would be discharged through perforations located in the outer 0.5 mile of pipe. The pipe would be buried beneath the Gulf bottom for all but the last 0.5 mile. Cost of installing such a pipe was estimated to be in excess of $25 million and could approach $40 million, depending on conditions imposed on construction activities.

The advantage of using a separate discharge point for Unit 3 is to limit the impact of the heated water in the present mixing zone. Although the total area covered by specific isotherms would not be substantially altered, the discharge into deeper water 8 miles offshore allows substitution of an offshore acreage for a biologically productive nearshore area.

Disadvantages include the cost, the detrimental effects of construction and the use of a second thermal mixing zone. This alternative would not reduce the impact of intake losses, would not change the effects of existing dikes, and would not eliminate whatever damage is now occurring in the present discharge basin. It is the opinion of the staff that it would be inconsistent to adopt this alternative because it represents a costly but only partial solution to the potential cooling problem.

The thermal plume is described in the Applicant's Environmental Report as being an area of 900 acres at a temperature higher than 5°F above ambient. The applicant has recently submitted an opinion that the temperature level of 5°F should have been listed as 0.5°C. The 5°F temperature increment is cited with the 900 acre area consistently in the applicant's Environmental Report. For example, in Section V,[12] it is stated that "...the 5°F incremental temperature contours will be approximately two and one-half times that of the 5°F contour for the existing two plants." Also "...the average area encompassed by the 5°F contour will be approximately 900 acres for Units 1, 2, and 3." In Section XIII,[13] four separate statements associate the 5°F isotherm with 900 acres for the three units.

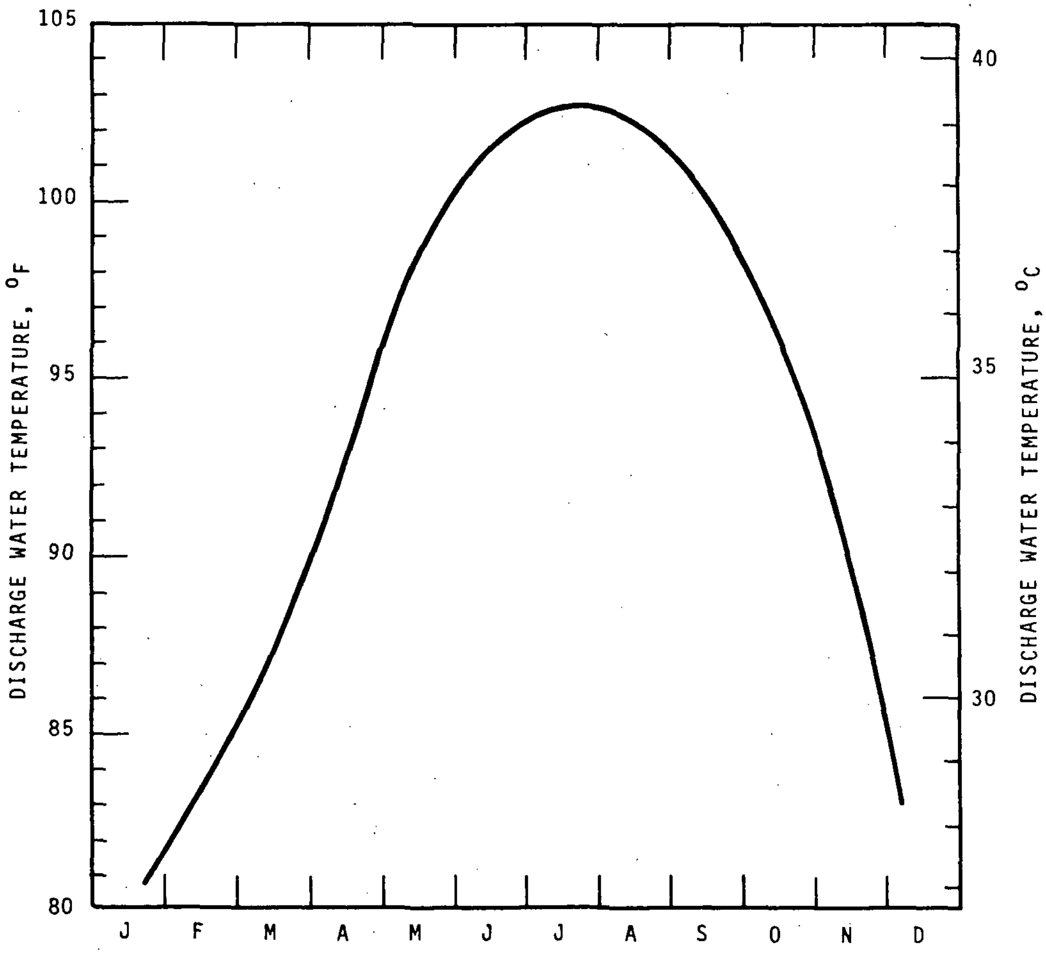

FIGURE 12.1 **MEAN MAXIMUM DISCHARGE WATER TEMPERATURE FOR UNITS 1, 2, AND 3 AT 100% POWER**

Although the staff has not used either the 5°F isotherm or the 900 acres figure in evaluating the impact of Crystal River Unit 3, we have attempted to verify the correctness of either the 5°F or 0.5°C figure. It is the opinion of the staff that the 5°F originally given is consistent with plume measurements made by the applicant and the 0.5°C figure recently supplied is in error. This consistency with 5°F is shown in two ways. First is a tabulation of plume acreage for Units 1 and 2 published by Florida Power.[14] According to this tabulation, 1399 acres were involved in the plume at temperatures more than 0.5°C above ambient. It is inconceivable that this acreage would be reduced to 900 acres with added operation of Unit 3, thus verifying the 5°F figure. The second means of verifying the 5°F temperature is to calculate the acreage involved in the plume for Units 1 and 2. From the Applicant's Environmental Report,[13] the acreage for Units 1 and 2 would be 900 divided by 2.5, or 360 acres. From data plots for Units 1 and 2 published by the applicant,[15] the staff finds the average area covered by the 5°F temperature increment to be 380 acres, which agrees well with the 360 acres derived from the 900 acres figure for the three units. Thus it is concluded that the 5°F temperature associated with an area of 900 acres for the three units must be correctly stated.

The applicant has suggested that condenser inlet cooling water is lower in temperature than the ambient temperature in the mixing zone. The reason given for this difference is that the inlet water is conducted from several miles offshore where water temperatures are lower than those in shallower near-shore water. If such a difference actually occurs, then the temperature increments above ambient in the mixing zone would be reduced. The staff has made a parametric study of this effect to evaluate its quantitative significance.

The temperature of the cooling water discharged into the Gulf at Crystal River may be represented by

$$T_o + T_i + \Delta T_{plant} + \Delta T_{canal} \qquad (1)$$

where T_o = temperature at discharge point,

T_i = condenser inlet temperature,

ΔT_{plant} = temperature rise across condensers,

ΔT_{canal} = temperature gain in discharge canal.

The temperature increment above ambient is

$$\Delta T = T - T_{amb} \tag{2}$$

where ΔT = temperature increment above ambient in mixing zone,

T = temperature of water in mixing zone,

T_{amb} = ambient temperature in mixing zone.

The degree of cooling within the mixing zone may be characterized by a dimensionless temperature ratio, $\Delta T/\Delta T_o$, where ΔT_o is the temperature increment above ambient at the discharge point. In terms of the nomenclature given in equations (1) and (2), this may be written as

$$\frac{\Delta T}{\Delta T_o} = \frac{T - T_{amb}}{\Delta T_{plant} + \Delta T_{canal} + T_i - T_{amb}} \tag{3}$$

The numerical value of $\frac{\Delta T}{\Delta T_o}$ was obtained as a function of the ratio of surface area to flowrate from experimental data as described in section 5.3.2.4 and Appendix D.

Results of the analysis are shown in Table 12.1, where the acreage covered by the 6°F isotherm is shown as a function of the difference between inlet and ambient temperature.

TABLE 12.1 Calculated Reduction in Acreage Covered by 6°F Temperature Increment When Inlet Water is Colder Than Ambient

	Average Acreage Covered by Plume		
$(T_{amb}-T_i)$°F	Units 1,2,3 At 100% Power	Units 1, 2 At 100% Power	Increment For Unit 3
0	930	280	650
1	830	240	590
2	740	160	580
3	620	100	520
4	510	0	510

Cooler inlet temperatures can have an appreciable influence in reducing the total area covered by the plume, but do not greatly reduce the calculated contribution due to Unit 3. For example, if inlet water is 4°F (2.2°C) cooler than ambient water, the total plume acreage is reduced by about 50%. The acreage attributed to Unit 3 would be reduced by only 20%. The lower intake temperatures have a relatively minor effect on the acreage increment for Unit 3 because the ΔT_{plant} for Unit 3 is higher than for Units 1 and 2. The staff is unaware of any data which demonstrate that inlet temperatures are indeed lower than ambient, hence does not believe a reduction in plume acreage due to this effect is warranted.

As described in the Draft Statement (page D-3) the condenser inlet temperature apparently reached a maximum of 92°F during 1971. This is 4°F higher than was measured during 1969 and 1970, but is in agreement with maximum values reached over a many year period at Cedar Keys, Florida, which is located some 25 miles to the northeast.

The applicant has reevaluated the data for September, 1971, and has concluded that the temperatures above 89°F, recorded on September 9, 10, 11, and September 22 are in error. The applicant feels that a best estimate for the highest temperature is 89°F.

The staff has independently evaluated the water temperatures for the days in question using a mathematical model which relates water temperature to atmospheric conditions by means of the energy balance computer program COLHEAT. The model has been checked against data obtained from Crystal River and shows excellent agreement. Measured and predicted data are compared in Table 12.2.

The maximum temperature predicted by the model on the basis of weather observations is 90°F and this occurs on the days when the 92°F readings were recorded. It is the opinion of the staff that the measured temperatures, as initially reported by the applicant, were in error and that the maximum temperature for 1971 was 90±1°F. However, this discrepancy has little impact on the biological assessment made in this report. In describing the plume area where major impact would be observed, it was assumed that 95°F was the critical temperature, and that the inlet water temperature was 89°F, the mean maximum observed at Cedar Keys. Thus the portion of the plume considered most important was that for which the temperature increment was 6°F or greater. It is recognized that temperatures as high as 92°F can be encountered at the Crystal River Site but these peaks occur infrequently and persist only for short periods of time.

TABLE 12.2 Comparison of Measured[16] and Predicted Condenser Inlet Temperatures at Crystal River

	Daily Average Temperature - °F			
	August - 1971		September - 1971	
Day	Measured	Predicted	Measured	Predicted
1	85	85	86	85
2	85	85	86	85
3	85	85	84	85
4	86	86	84	84
5	86	86	84	84
6	85	85	84	83
7	86	86	89	86
8	87	87	88	88
9	87	87	90	89
10	86	86	91	90
11	86	86	92	90
12	85	85	-	89
13	85	84	-	86
14	85	84	82	83
15	84	84	81	81
16	81	83	82	83
17	80	81	82	82
18	81	81	-	83
19	83	83	-	83
20	84	84	-	83
21	85	84	-	84
22	86	86	-	85
23	86	86	-	85
24	86	86	-	87
25	86	86	-	87
26	86	86	-	88
27	86	86	-	88
28	86	86	-	89
29	86	86	92	90
30	87	86	-	88
31	86	86		

The acreage covered by the thermal plume was described in the Draft Statement in terms of areas for two tidal phases, and an overall area for a full tidal cycle. In evaluating the size of the plume it was assumed that the affected area was that covered by a specific isotherm for the full tidal cycle. It appears that a more realistic assessment may be based on an average area covered by the plume, use of a time average area is consistent with the fact that damage to benthic organisms is less severe when exposure is periodic as compared to continuous exposure. Acreages which may be used to evaluate marine impact are listed in Table 12.3.

TABLE 12.3 Average Acreage Covered by Thermal Plume

Excess Temperature	Acreage for Units 1,2,3 at 100% Power	Acreage for Units 1,2 at 100% Power
1°F (0.5°C)	3320	1430
2°F (1.1°C)	2430	1000
4°F (2.2°C)	1550	540
6°F (3.3°C)	930	280
8°F (4.4°C)	570	130
10°F (5.5°C)	325	negligible

The areas listed in Table 12.3 are considered to represent a conservative estimate of the plume size, and thus assessment of adverse marine impact based on these areas will tend to be conservative. The applicant has made independent estimates of plume acreage using the Asbury-Frigo method which was used by the staff to arrive at the estimates shown in Table 12.3. The applicant's results are compared with those of the staff in Table 12.4.

The discrepancy in the estimated acreage is generally less than a factor of 2, which is considered by the staff to fall within the error limits of the predictive method. Thus the applicant's estimates should be considered as valid as those made by the staff. The continuing assessment of the plume by professionals from the University of South Florida should provide better understanding of mixing in the discharge basin at Crystal River and thereby provide a basis for more precise estimates of plume acreage.

TABLE 12.4 COMPARISON OF PLUME ACREAGE* ESTIMATED BY THE STAFF WITH ESTIMATES MADE BY THE APPLICANT

Excess Temperature	Staff Estimate of Plume Acreage	Applicant's Estimate of Plume Acreage
1°F	3320	1740
2°F	2430	1350
4°F	1550	780
6°F	930	440
8°F	570	195
10°F	325	63

* Units 1,2,3 at 100% Power

12.2.6.2.1 Closed-Cycle Cooling Channel System

The staff has considered a conceptual adaptation of the Turkey Point[16] channel system to the Crystal River plant. This choice was dictated by the desire to minimize the problem of spoil disposal and the availability of simulation models. A pond of equivalent acreage would impose severe problems of spoil disposal and, if elevated to minimize such disposal, would probably be excessively costly because of elevated head differentials and considerations of nuclear safety. However, should a pond be considered desirable, the equivalent surface acreage would produce a somewhat less efficient result because of the formation of humid boundary layers which decrease somewhat the surface exchange effectiveness.

With this as the basis, the staff developed a conceptual alternative consisting of a series of parallel canals, each 200 feet wide, separated by a spoil berm of 90 feet in width. Three different channel lengths were considered, 12,000, 15,000 and 18,500 feet, in order to determine the effect on plant thermodynamic performance. The inlet or cooled portion is connected to the existing inlet canal to serve as a means for periodic flushing by means of tidal action; this is controlled by a sector gate which can be adjusted for height.

The thermal computations were made with a transient computer code based on the COLHEAT thermal simulation model previously mentioned. Inputs included hourly weather parameters, synthesized hourly ambient Gulf water temperatures generated using the same computer code, and a thermal input from the plant which used a constant recirculation flow of 2940 cfs, full power operation of Unit No. 3, and transient levels of Units 1 and 2 ranging from 100% to 60% load factor to match the system demand curve for the Florida inter-connected network. The inlet temperatures synthesized by the code were verified against the 1972 Unit 1 inlet temperatures. The weather data for 1972 and 1954 used for the study of the supplementary channel system described earlier herein were also used in the study of this system.

Other factors involved include the effects of the saltwater recharge of the existing groundwater system. The recirculation system will occupy a considerably larger total area with a larger potential for saltwater intrusion. However, based on available data, the actual intrusion flows are expected to be relatively low. A system of intercepting ditches would be adequate to control the less than 10 cfs (4,500 gpm) groundwater flow estimated by the staff to be the high side flow for the channel system.

The results of the simulation for three channel length options are summarized in Table 12.5. The plant heat rate increases rather sharply as total area is reduced to 1775 acres. The staff has not attempted a detailed optimization but, using generic information available, it appears that a design with a water surface area of about 2,000 acres will produce satisfactory steam conditions for the majority of the normal weather periods exemplified by 1972. The terrestrial and aquatic evaluation is therefore based on a nominal channel length of 15,000 feet. Twenty-seven parallel channels are used. On this basis, the net water surface is 2,120 acres and the total land requirement of the system is about 3,200 acres, including land for interceptor ditches and the connecting canals. The mean water surface of the system would oscillate between 0.2 and 0.5 feet above MSL in response to tidal action and the maximum flow limits of the inlet control gate which were set at 600 cfs. Lower flows would prevail under most time periods.

The relatively long exit canal (existing intake canal) permits a long travel time for the system blowdown resulting in discharge temperatures essentially at equilibrium. Therefore, using a recirculating channel system, it can be stated that essentially all of the effluent heat is discharged to the atmosphere.

12.2.6.2.2 Other Closed-Cycle Systems (DOT p E-9; EPA pp E-30; DOI p E-59)

Spray Ponds

A preliminary design of a recirculation spray pond system was considered as an alternative cooling method. In such a case, the degree of effect of the salt spray created by the operation is not known and an in-depth study would be needed for full evaluation. On the basis of information from operating systems in New Hampshire[17] and Illinois[18] and the resulting environmental effects, the staff retains serious reservation about the applicability of this alternative. The operating data reveal that under wind conditions, the resulting salt fog would extend some 300 to 500 feet laterally from the outer edge of the system.

An additional aspect of this proposal is the effect of saltwater recharge of the existing groundwater system. The freshwater aquifer zone in the ground above tidal effect now grades to higher concentrations of salt, both with depth and toward the Gulf. In the opinion of the staff, the existence of a pond of the size needed would create a saltwater intrusion below the pond and between the pond and the estuary and the water would approach the mean salinity now expected

TABLE 12.5 CLOSED CYCLE COOLING CHANNEL SYSTEM EVALUATION

	1954 WEATHER CANAL LENGTHS, FT			1972 WEATHER CANAL LENGTHS, FT		
	12,000	15,000	18,500	12,000	15,000	18,500
Average Monthly* Gulf Ambient, °F	87.5	87.5	87.5	85.2	85.2	85.2
Maximum Hourly Gulf Ambient, °F	89.4	89.4	89.4	88.7	88.7	88.7
Maximum Hourly Blow-Down to Gulf, °F	89.3	89.3	89.5	88.6	88.6	88.6
Average Monthly* Condenser Intake, °F	95.0	93.0	91.0	92.6	90.6	88.6
Highest Hourly Condenser Intake, °F	98.2	96.1	94.5	94.8	92.7	91.1
Average Monthly* Condenser Temp., °F	109.0	107	105	106.6	104.6	102.6
Highest Hourly Condenser Temp., °F	112.4	110.3	107.8	109.0	106.9	104.4
Heat Rate Penalty % (AV)**	1.6%	1.3%	1%	1%	0.3%	-0-
Water Surface Area, Acres (including outlet canal)	1,775	2,120	2,500	1,775	2,120	2,500
Maximum Salinity Increase, ppT	+1.3	+1.1	+1.0	+1.1	+0.9	+0.8
System Flow, 2940 cfs						

* August

** Incremental penalty over existing operation at same seasonal conditions.

at about 30 foot depth; no deleterious effects of this phenomenon would be expected. Increased spread of saltwater to the uplands area would be expected but could be controlled by interceptor ditching or pond lining, if necessary.

Accordingly, as diagrammed in Figure 12.2, a recirculating spray pond was designed using standard cooling spray modules available to the industry. Two sizes of system are indicated, a basic size for Unit 3 alone and a larger system for Units 1, 2, and 3, in combination.

Because of effects noted in existing plants, the system was oriented normally to the prevailing wind in the summer in order to minimize the creation of humid boundary layers which limit the effectiveness of dense arrays of modules. Table 12.6 summarizes the information for the suggested spray pond design.

TABLE 12.6

Spray Modules: 10.6 MWT dissipation per module of four sprays and a 75 HP circulation pump. Area requirement is 40' x 160' per unit.

Units	Number of Modules and HP		Pond Length, ft.	Pond Width, ft.	Area, acres
1 & 2	100	7,500	2,000	1,500	69
3	170	12,750	3,400	1,500	117
1,2,&3	270	20,000	5,400	1,500	186

A buffer zone of 300 feet around the periphery and between the channel array is used to minimize boundary layer development and to catch salt drift from the active portion.

In order to control salinity, the pond would be connected to the existing intake canal. A movable drum gate would be installed to control water flow in and out of the system in response to the needs and using the tide as a driving force. Pond depth would be 4 feet below MSL and an equilibrium level of about 1 foot above MSL would be maintained. The existing discharge canal would be closed at a point near the present point of discharge to the canal.

Terrestrial and aquatic impacts of the spray pond system would be essentially the same for the system serving all three units or Unit 3 alone except for the actual areal differences.

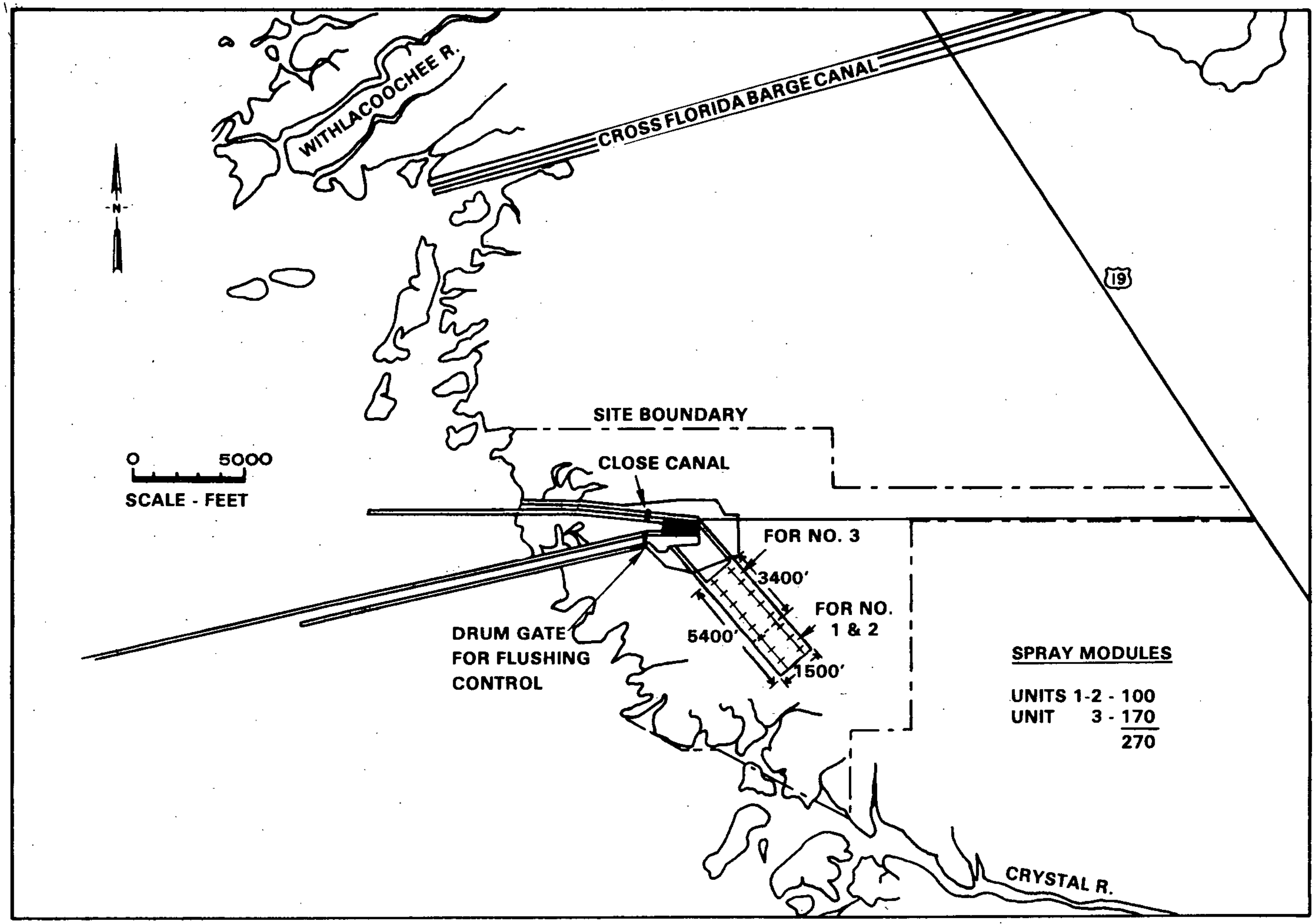

FIGURE 12.2 RECIRCULATING SPRAY POND

Supplementary Cooling with Spray Modules in Existing Discharge Canal

Another means of reducing the total thermal effluent loading on the Gulf in order to meet temperature standards of the State of Florida is the use of supplementary spray modules in the existing discharge canal. Recognizing that the standards impose a 90°F limitation on effluent temperature, a 2°F maximum differential during the months of June, July, August and September, and a 4°F maximum differential during the balance of the year, the staff considered the feasibility of installation of spray modules in the existing canal which has a usable length of about 5,000 feet. The canal is about 150 feet wide and would accommodate 125 modules with an average dissipative effect of about 10.6 MWt per module for a total of 1,300 MWt. The potential extension of the canal, one of the alternatives suggested by the staff, is in excess of the additional length required to reduce the temperature to within 2°F of ambient. This required length is 8,700 feet and would contain 216 modules. The installation of 125 modules would reduce differentials to about 7°F, a temperature which would essentially eliminate the potentially unfavorable thermal effects indicated in the staff review. The resulting isotherms for a system using 125 modules would resemble those in Figure 5.1 and 5.2 of this Statement, but the differential values would be reduced to one-half. The installation of the 216 module system with a 2°F maximum discharge differential would reduce the temperature of the isotherms to about one sixth of those illustrated in the figures.

An important consideration in a spray module system is the matter of salt drift. About 300 to 500 feet on either side of the system can be expected to be materially affected by salt drift. There is no known operating experience with spray modules using saltwater, but the freshwater experience is unfavorable from the standpoint of maintenance and the creation of spray downwind during periods of wind exceeding 10 - 15 knots, a considerable part of the year.

Supplementary Cooling Channels

Thermal standards of the State of Florida limit effluent discharges to a 2°F increment in June, July, August and September and 4°F for the remainder of the year, as well as imposing a 90°F maximum temperature to waters discharged with increased temperature. With these standards as a basis, the staff developed a conceptual alternative cooling system consisting of 12 cooling channels each 12,000 feet long with collector canals and a main canal to return the cooled effluent to the present discharge canal. The system would occupy an upland area about 3,600 feet wide by 12,000 feet long oriented in the east-west direction. Other orientations might be considered in the final design, however. An orientation was used to provide input parameters to a transient computer analysis based on the COLHEAT thermal simulation model available to the staff.[17,18] Inputs included hourly weather parameters, synthesized hourly input water temperatures generated, using the same computer code and a thermal input which assumed constant flow of 2,940 cfs, full power operation of Unit 3, and transient operation of Units 1 and 2 ranging from 100% to 60% load factor to match the system demand curve for the Florida interconnected network. The synthesized input temperatures were verified against the 1972 Unit 1 inlet temperatures supplied by the applicant. Weather for July and August 1972 was used representing an average year and for July and August 1954, which was the hottest July and August on record for the region. This latter temperature peak condition is considered a once-in-50-year-maximum by the National Weather Records Center.

The results of the analysis are summarized in Tables 12.7 and 12.8. The data generated indicated that under normal weather conditions, a system of 12 channels, each 12,000 feet long, would satisfy the proposed Florida standards. Under 1954 extreme conditions, the system would satisfy the standards if extended to a length of 15,000 feet for all but fractional day periods for five or less days during the four-month period. No further optimization was attempted, the simulation being limited to the support of the development of a conceptual alternative. In order to control water levels, the channel system would discharge through a drum gate via the existing discharge canal.

A smaller system for Unit 3 alone was not considered for computer study, but would have about 70% of the area requirements for the combination of three units. Because of the relatively large terrestrial commitment involved in a channel system for Unit 3 alone, the reduction of space for the fossil units was not considered an incremental reduction which would modify essential conclusions arising from consideration of the full system.

Environmental Impact of Spray Pond and Cooling Channels

Construction of these two alternative cooling systems will constitute a major environmental impact on existing terrestrial plants and animals. The amount of land committed to power production will increase by more than a factor of 2 for the proposed spray pond to as much as a factor of 30 for cooling channels. Construction can be expected to virtually destroy all vegetation and most terrestrial animals of the pineland

TABLE 12.7

CONCEPTUAL SUPPLEMENTARY CHANNEL SYSTEM

12,000 Foot Length

12 channels - 200' wide x 4' deep (MSL) x 12000' long

Total area = 1700 acres

Water area = 1100 acres exposed surface

Plant flow = 2940 cfs

Thermal loading: #3 - 100% L.F. #1,2 100% 9 a. m. - 11 p. m.
50% 2 a. m. - 6 a. m.

For August Conditions	°F 1954	°F 1972
Average Δt @ discharge	1.7	0.60
Highest Hourly Δt @ discharge*	5.0	4.3
Maximum hourly discharge temp	92.6	89.2
Average monthly discharge temp	89.2	86.6
Gulf intake temp (monthly average) °F	87.5	85.1
Highest hourly intake temp*	92.0	88.7

*Highest values do not coincide

Δt = discharge less ambient intake

Area of plume 1° isotherm (acres)	600	520

TABLE 12.8

CONCEPTUAL SUPPLEMENTARY CHANNEL SYSTEM

15,000 Foot Length

12 channels - 200' wide x 4' deep (MSL) x 15,000 ft long

Total area	2130 acres
Water surface area	1370 acres
Plant flow	2940 cfs
Thermal loading	#3-100% L.F. #1, 2 100% 9 a. m. - 11 p. m. 50% 2 a. m. - 6 a. m.

For August Conditions	°F 1954	°F 1972
Average Δt @ discharge	1.5	0.60
Highest hourly discharge temp * Δt	4.6	3.73
Maximum hourly discharge temp	91.0	88.7
Average monthly discharge temp	89.0	85.8
Gulf intake temp (monthly average)	87.5	85.2
Highest hourly intake temp*	92.0	88.7

*Highest values do not coincide

Δt = discharge temp - ambient intake

Area of plume (acres) (to 1° isotherm)	550	490

and freshwater swamp to be perturbed. The destruction of 2,000 acres of pineland will force many large mobile vertebrate animals to relocate and thus increase habitat pressures on adjacent areas. Revegetation along the channels is difficult to predict because of the unknown nature and layering of the spoil. The prediction is further complicated by plant operation variables.

It is reasonable to assume that salt crusts will build up on soil surfaces, either from spray drift or continued evaporation from wet soil surfaces. The latter is a well recognized phenomenon in irrigated agriculture. The buildup of salt will effectively preclude the growth of most vegetation. Without vegetation the habitat will not support most animals. Birds, however, might find some areas useful for resting.

Both alternatives will reduce the potential impact in the marine ecosystem by significantly lowering the temperature of the plant effluent.

High temperatures in the spray pond and cooling channels create a potential for blooms of obnoxious aquatic algae. Considerable reduction of power plant chemicals such as chlorine will occur in the retention areas so that small quantities of chemicals present at the actual point of discharge will be lowered further. Marine organisms surviving passage through the plant may find the pond and channel systems favorable for development, particularly during the winter when temperatures in the near-shore marine ecosystem are low.

The supplementary alternatives would not modify the potential impact of impingement and entrainment. The recirculating systems would reduce entrainment to very low values, about 2% of the average of once-through and supplementary systems.

12.2.7 St. Martin's Marsh Aquatic Preserve (Fla DOA p E-67)

The northernmost point of the St. Martin's Marsh Aquatic Preserve is the northwestern tip of Fort Island, a point approximately 3.3 miles from the intake canal. It is not likely that the Crystal River Plant can significantly affect this area because of the distance involved, the localized effects of heating and the presence of the canals themselves which greatly reduces the mixing of water to the south of the site.

12.2.8 Construction of Unit No. 4 (CCH p E-4; Fla DOA pp E-104 to E-109)

Mention was made in a comment that the applicant recently decided not to proceed further on the construction of a nuclear reactor. In actual fact, the applicant at one time proposed to build two nuclear units at the Crystal River site. As planning progressed, the decision was made to actively pursue the construction and then operation of only one nuclear unit and defer the decision on the second unit pending further analysis. Subsequent analysis of costs, siting, environmental considerations and timing of construction led the applicant to cancel its plans for this second nuclear unit at Crystal River. Construction is proceeding on a nuclear unit, Crystal River Unit 3 and is the subject of this environmental statement.

12.2.9 Storage of Chemical Solutions Before Processing (EPA pp E-34, E-35 and E-39)

Waste effluents from the sanitary service treatment plant and from the demineralizers in the water treatment plant (common to Crystal River Units 1, 2 and 3) are routed to a 75,000 gallon neutralization tank to achieve a degree of dilution and neutralization prior to discharge to the percolation ponding system. The waste effluents from Crystal River Unit 3 condensate polishing demineralizers are routed to a 100,000 gallon neutralization tank prior to discharge to the percolation ponding system. Demineralizer waste solutions are both acidic and basic; hence, a neutralization tank provides a suitable storage place to collect and mix these wastes in order to achieve relatively neutral solutions.

All other wastes from floor drains, etc. are discharged directly to the percolation ponding system. One exception to this is the waste effluent from the lime softener system. This lime sludge is processed in a solids separator to extract its water content and the resultant solid will be disposed of properly.

The Crystal River site will employ a percolation ponding system for disposal of chemical wastes generated at the site. Piping from the plants will route the wastes to the pond location west of the plant site between the intake and discharge canals. Test wells are located around the ponds for testing of water to assure compliance with applicable State of Florida water quality standards. The exact nature of the wastes is unknown at this time and will be provided to the Florida Department of Pollution Control after operational testing. Chemicals used in the plants which will ultimately go to the percolation pond after their intended uses are:

Phosphate (PO_4)	895 lbs/yr
Caustic Soda (NAOH)	47,301 lbs/yr
Hydrazine (N_2H_4)	237 lbs/yr
Lime	400,000 lbs/yr
Chlorine (NaOCl)	264,694 lbs/yr
$NaZnPO_4$	3,338 lbs/yr
Cyclohexamine	220 gallons/yr
Sulfuric Acid (H_2SO_4)	120,120 lbs/yr
Ammonia	105 gallons/yr

Due to the location of the ponds and the westward direction of groundwater flow into the Gulf of Mexico, fresh groundwater in the area will not be affected.

Application for permit to construct the chemical-industrial waste system is currently being processed by the Florida Department of Pollution Control.

Final disposition of solid waste from the chemical-industrial waste system will depend on the rate of buildup of the solids and the composition method will depend upon the above factors which are unknown until the system is operationally tested and the results are analyzed.

12.2.10 <u>Effects of High Voltage in Transmission Lines on RR Signal Circuits</u> (DOT p E-8)

Prior to crossing railroad facilities with transmission lines of any voltage, the applicant must make application to the railroad companies involved in the crossings. The application includes location of transmission structures, information indicating transmission line voltage, conductor size, and detailed information concerning clearances, which are in accordance with the National Electric Safety Code, latest revision, and other specifications concerning requirements by the railroad company.

In the case of the 500 KV transmission lines, application was made to the Seaboard Coast Line Railroad for nine crossings. Each of these applications was approved after consideration by various departments of the railroad company; therefore, the staff feels that no hazardous conditions will be created.

12.2.11 Hazard to Low Flying Aircraft (DOT p E-8)

The Crystal River site contains in addition to Unit 3, two oil-fired units which have two stacks approximately 500 feet in height. These stacks are lighted and marked in accordance with FAA regulations. The stacks are indicated on current FAA aeronautical charts. The highest portion of Unit 3 is the top of the containment dome which is an elevation of 200 feet above mean sea level. Thus, for air clearance purposes, the stacks of Units 1 and 2 are the limiting factor and these are indicated on aeronautical charts.

12.2.12 Area of Groundwater Recharge Basin (DOA p E-11)

Within a radius of 20 miles from the Crystal River site there are approximately 40 public wells with a pumping capacity of 4,000 gpm. From the period of 1964 to 1969 the piezometric surface in the Crystal River area rose approximately 5 feet and is not in a state of decline at the present. Also, within a distance of 30 miles from the site, there are the Crystal River Springs, the Homosassa Springs, the Chassahowitzka and the Weekiwachee Springs, the combined flow of which averages about 1 billion gallons per day. The groundwater flow in this area is westward which would result in the Crystal River site wells having no effect on other water usage in the area.

12.2.13 Disposition of Materials Collected on Racks and Screens (DOI p E-54)

Marine organisms entrapped on the intake screens at Crystal River are removed from the screen wash baskets at irregular intervals, depending on biomass collected, and placed in trucks. The material is then carried to an onsite dump and buried.

12.2.14 Need for Power (Fla DOA p E-80)

There are approximately 2,000 people moving to Florida each week. These people require electric service. Under the laws of the State, public utilities must provide electrical service to any person who requests such service. The growth rate in the applicant's service area is estimated at about 9 percent and includes about one-half of the new residents of the State.

12.3 ENVIRONMENTAL MONITORING AND STUDY PROGRAM

12.3.1 Introduction

As a result of comments received from a number of government agencies, principally the Environmental Protection Agency and the Department of the Interior, a series of meetings were held to develop a program aimed at determining the need for an alternative cooling system for Crystal River Unit 3.

In discharging its responsibilities under the FWPCA, the EPA is concerned with the discharges from all three Crystal River Units. The program given in section 12.3.2 attempts to incorporate as much as possible the elements that will allow the EPA to exercise its regulatory responsibilities.

12.3.2 AEC Related Environmental Research Programs at the Crystal River Power Plant Site

Problem

To determine the need for modification of the proposed cooling system for Crystal River Unit 3.

Purpose

1. To obtain necessary data of the Crystal River Site area from a coordinated and comprehensive hydrological investigation.

2. To identify and quantify those factors that have impacted the Crystal River environment and to obtain necessary information on aquatic organisms and water chemistry in the Crystal River Site area in order to be able to assess the potential impact on the aquatic biota from the operation of Unit 3.

Objective

To provide a basis for a decision with regard to the need for an alternative cooling system for Unit 3 no later than November 1974.

General Discussion

The AEC staff, in conjunction with other interested federal agencies, requires additional information in order to predict the incremental impact on the aquatic biota from the operation of Crystal River Unit 3. Of necessity this assessment must be based on data collected in conjunction with the operation of the oil-fired Units 1 and 2. The specific areas of concern are hydrology in the immediate plant environs; entrainment of organisms through the condensers; impingement of organisms on the intake structure; entrapment of aquatic organisms in the intake system; thermal, chemical and physical impact in the discharge area; and biota surveys in areas which may be affected by candidate alternatives to the proposed once-through cooling system.

In conjunction with the study program required in each of these areas, the applicant will concurrently initiate and complete detailed hydrological-environmental assessments of alternative cooling systems to identify those systems which would impose the minimum environmental impact, taking into account the areas of concern expressed above, including terrestrial impacts which are not involved in the proposed once-through cooling system.

The applicant should develop a study program in accordance with the recommendations and guidance developed in this document and will submit this program to the AEC for evaluation. Such evaluation will include a review and consultations with the interested federal agencies.

Within 90 days, the applicant will submit a progress report on this study. Following this submittal, a meeting will be held with the interested federal agencies to assess progress, results, and evaluate the need to modify the program.

Specific Programs

I. Entrainment

A. Objectives

1. To determine the source(s) of cooling water under normal hydrological and meteorological conditions and variations during high fresh water runoff periods and during unusual tide, wind and other conditions.

2. To determine the source, fate, quantities and conditions of species of plankton, fish eggs, larvae and juveniles passed through the condenser cooling water system.

3. To determine the relation between the species composition of the cooling water sources as established in item 1, and the planktonic species of the intake canal.

B. Procedures for Zooplankton and Ichthyoplankton

1. Length of program: A minimum of 12 consecutive months of data will be collected and analyzed prior to November 1974.

2. Sampling stations: 3 stations will be established in each of the three areas shown in Figure 1 (p. 54 Environmental Research Programs at the Crystal River Power Plant - A Technical Discussion); two stations shall be established in the intake canal, one directly in front of the intake pipe and another within the canal near the mouth of the double-diked section.

3. Frequency of sampling: Samples shall be taken every 3 hours over a 24-hour period, weekly at the two stations in the intake canal. Samples in intake areas 1, 2 and 3 shall be taken every 3 hours over a 24 hour period every two weeks. All samples shall be taken to determine species, abundance, distribution and condition according to tidal stage, day-night variations or other pertinent environmental factors.

4. Techniques: Replicate samples will be taken at all stations. Samples taken in the mouth of the intake canal shall be at surface, mid and bottom depths. Ichthyoplankton techniques will be the standard NMFS (MARMAP) methods and approved by the AEC staff.

C. Procedures for Source of Intake Water

During the first 3 months, the source(s) of water that are drawn in by operation of the plant under normal hydrological conditions will be determined. This program should consider, but is not necessarily limited to: dye and drogue studies; flow and direction studies; and salinity, temperature and water chemistry measurements. This program is to be continued as necessary to determine source(s) under abnormal hydrological conditions.

D. Other

Phytoplankton studies should be carried out concurrently with the above programs to allow quantification of species abundance, distribution, condition and total biomass of phytoplankton species being entrained.

II. Impingement/Entrapment

A. Objective

To quantify in terms of number, size/age class, weight and condition the species which become impinged on the travelling screens. The study will determine the variation due to season, time of day, tide, general climatic conditions or other factors. In anticipation of higher velocities caused by Unit 3 and the possibility of a change in the species composition of impinged species, studies will be performed to relate the proposed flow characteristics to impingement of species.

B. Procedure to Assess Impingement

1. Length of program: A minimum of 12 consecutive months of data will be collected and analyzed prior to November 1974.

2. Sampling stations: Collections will be made at both ends of the screen-wash sluice until it is determined statistically that there are no differences in the species composition and quantities collected at either end, after which collections may be made at one end.

3. Frequency of sampling: Samples will be taken every 3 hours over a 24-hour period, twice a week. General monitoring of the collections in the trash baskets will be conducted during the remainder of the week in terms of large numbers or biomass of individual species or large total numbers or biomass of many species. Sampling and screen operations will be modified during peak impingement periods.

4. Technique: Screen washing will be performed manually during the sample period and not on the basis of a pressure differential (clogging).

C. Organisms in Intake Canal

Once every two weeks sampling will be conducted to determine abundance, size (expressed as length/frequency), distribution and condition of fish species with a frequency to establish variations due to weather, tide, day/night, or other factors.

D. Diversion Techniques

Studies of means for returning impinged species to the Gulf, or diverting organisms before reaching the intake structure, shall be conducted in conjunction with the impingement program.

E. Other

1. The number of pumps in operation and volume of water pumped shall be recorded at all times when sampling is conducted.

2. Flow and velocity at the travelling screens, under varying operational conditions to be encountered during times of sampling shall be determined.

3. Vertical and laterial velocity profile data will be collected at selected sections located longitudinally along the intake canal during an entire tidal cycle to establish flow and velocity characteristics in the intake canal.

4. Condition of living impinged organisms shall be determined to establish the potential for returning organisms to the ambient waters of the Gulf.

III. Thermal/Chemical Impacts in Discharge Area

A. Objective

1. To define the existing three-dimensional thermal plume.

2. To develop, verify and/or modify the thermal plume mathematical model to simulate the plume described in A.1. above.

3. To utilize this mathematical model to predict the thermal plume under all modes of operation.

4. To establish baseline data for estimating thermal effects.

5. To determine how large an area of the receiving water will be affected by modifications resulting from condenser passage.

B. Thermal Plume Pattern in the Discharge Area

1. Thermal imagery overflight information should be provided to establish the extent of the thermal plume from Units 1 and 2 and should cover varying conditions of tide and weather.

2. Temperature and salinity measurements should be performed vertically and laterally throughout the thermal plume and should include continuous measurements at the canal terminus, near shore areas and other selected points.

C. Water chemistry measurements should be conducted in the mixing zone to establish present characteristics and composition.

D. The mathematical model of the thermal plume will be verified and/or modified in accordance with the above information and utilized to predict future plant configurations and temperature characteristics to allow biological impact assessments.

E. Thermal/Chemical Effects on Biota

The laboratory and field research program as outlined in Table 1, p. 89 of the applicant's program will quantify the abundance and distribution of macrophytes, macroinvertebrates and vertebrates. The exact number and location of these stations must be carefully coordinated in order to obtain the maximum usable data.

1. Consolidate existing data, and supplement as necessary to develop baseline benthic survey of community structure in the projected discharge area defined by the 2F° isotherm in Fig. 5.3, DES.

a. Substrate

Develop maps based on particle size, organic content (ashfree dry weight) and depth of deposits.

b. Vascular Plants and Macroalgae

Quantitative and qualitative characterization including maps delimiting the dominant plant communities.

c. Benthic Macroinvertebrates

Quantitative and qualitative evaluation. Suggest stratified sampling design based on substrate and plant communities defined above as well as temperature increments defined by thermal plume predictions.

2. Pelagic Surveys

a. A program similar to that for the intake side to characterize predominant species of phytoplankton, zooplankton, eggs, fry, and juveniles.

b. Document species composition and relative abundance of finfish and shellfish.

3. Intensive sampling in the plume area defined by the 8F° isotherm shown in Fig. 5.3, DES is required to identify species, seasonal abundance, in relation to thermal intensity, nutrients, of:

a. Zooplankton

b. Phytoplankton

c. Eggs

d. Fry and Juveniles

e. Adults

IV. Other General Surveys and Surveys in Areas Potentially Affected By Alternative Cooling Systems

A. Objective

1. To survey areas potentially subjected to impact from alternative cooling systems.

2. To survey areas of interest in assessing impact.

B. Intake Area

An inventory of resident organisms, especially the benthos, to allow for assessment of impacts of possible changes to the intake canal.

C. Discharge Area

Studies in III.E.1. should be extended to include expected area impacted by any anticipated extension or other modification of the discharge canal.

D. Thermal Effects on Marshland to Include Productivity Studies

E. General Surveys

1. Identify spawning and nursery areas which may come under the influence of plant operation.

2. Inventory of terrestrial flora and fauna to identify species and estimated populations.

3. Conduct marshland surveys to establish location of nursery areas and determine the species composition and estimated populations. This should identify any cyclic or seasonal pattern which may be present.

4. Obtain background levels of atmospheric salt content.

Reports and Program Changes

Quarterly reports will be required. These reports will be utilized by the staff to judge the adequacy of the program and to determine what changes may be appropriate or necessary to improve the data collection. These changes will be coordinated with other agencies prior to implementation.

Changes to the program may be submitted by the applicant at any time for consideration by the staff.

12.4 LOCATION OF PRINCIPAL CHANGES IN THIS STATEMENT IN RESPONSE TO COMMENTS

Decontamination Factors for Condensate Demineralizers	EPA	Table 3-1
Standing Crop of Producers	DOA	Section 2.6.2.1
Feeding Habits	DOA	Table 2.7
Fish UET_{50}	DOA	Section 5.3.2.4.2

Appendix A

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Appendix B
Abbreviations

ACHP	Advisory Council on Historic Preservation
AEC	Atomic Energy Commission
ASLB	Atomic Safety and Licensing Board
ATP	adnosine triphosphate
Ba	barium
Btu	British thermal units
CCH	Chauncey C. Hale
Ce	cerium
cfs	cubic feet per second
Ci	Curie
Co	cobalt
Cs	cesium
DA	Department of the Army
DO	dissolved oxygen
DOA	Department of Agriculture
DOC	Department of Commerce
DOI	Department of Interior
DOT	Department of Transportation
EPA	Environmental Protection Agency
Fe	iron
Fla DOA	Florida, Department of Administration
Fla DOS	Florida, Department of State

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
LET	lower exclusion temperature
m	meters
Max c/e	optimum temperature for numbers of individuals
Max Div	optimum temperature for diversity of species
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
NUS	Nuclear Utilities Services
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

In discussing the environmental effects of construction and operation of nuclear power plants and fuel reprocessing facilities, it is necessary 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.
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.
zooplankton	minute planktonic animals that feed on *phytoplankton* and, in turn, form food for young fish.

APPENDIX D

Oceanography

The marine area near the plant is a portion of the coastal estuarine zone that borders directly on the Gulf of Mexico. In place of surf and sandy beaches, the shore receives almost no wave action and the marshy shoreline grades almost imperceptibly into the sea in most areas. This 200-mile segment of beachless coast stretches from Anclote Key in the south to Lighthouse Point south of Tallahassee in the north. The coast is characterized by an offshore net resultant wind, so that wind-induced surf and removal of sediment is minimized, a wide and shallow shelf to the seaward, so that ocean swell is attenuated before reaching the coast, a dearth of durable sand-sized particles, and a climate favorable for prolific growth of marsh grasses and other coastal vegetation.

The Gulf of Mexico, immediately offshore, is extremely shallow and the bottom slopes very gradually to the west. At the cooling water discharge point, the mean depth is 4 to 6 ft and increases in a seaward direction by 1.5 to 2.5 ft per nautical mile. The continental shelf extends more than 100 miles to the west. The inshore bottom is covered with a layer of fine sediment broken by oyster reefs which form a nearly continuous series paralleling the shoreline. Moderately strong tidal currents pass through gaps in the reefs, thus interchanging Gulf water with the shoreward water mass.

Linear sediment traps form in the lee of the reefs and the traps accumulate a dark, organic-rich silty sand composed of mollusc fragments, small quartz grains, animal fecal pellets, carbonaceous fragments, and an undifferentiated dark silt and clay matrix.

The crests of many of the reefs are exposed at low tide thus decreasing coastal wave action. The shallowness of the Gulf and the lack of onshore wind contribute to the low level of wave action. As a result, no beaches are formed and the coast line grades almost imperceptibly from salt marshes into the Gulf. Local bathymetry and physical features in the area near the site are illustrated in Figure D.1.

The activities of man have modified the aquatic environs near the Crystal River site. The Cross Florida Barge Canal enters the Gulf less than one mile south of the mouth of the Withlacoochee River. Dredging for the Cross Florida Barge Canal

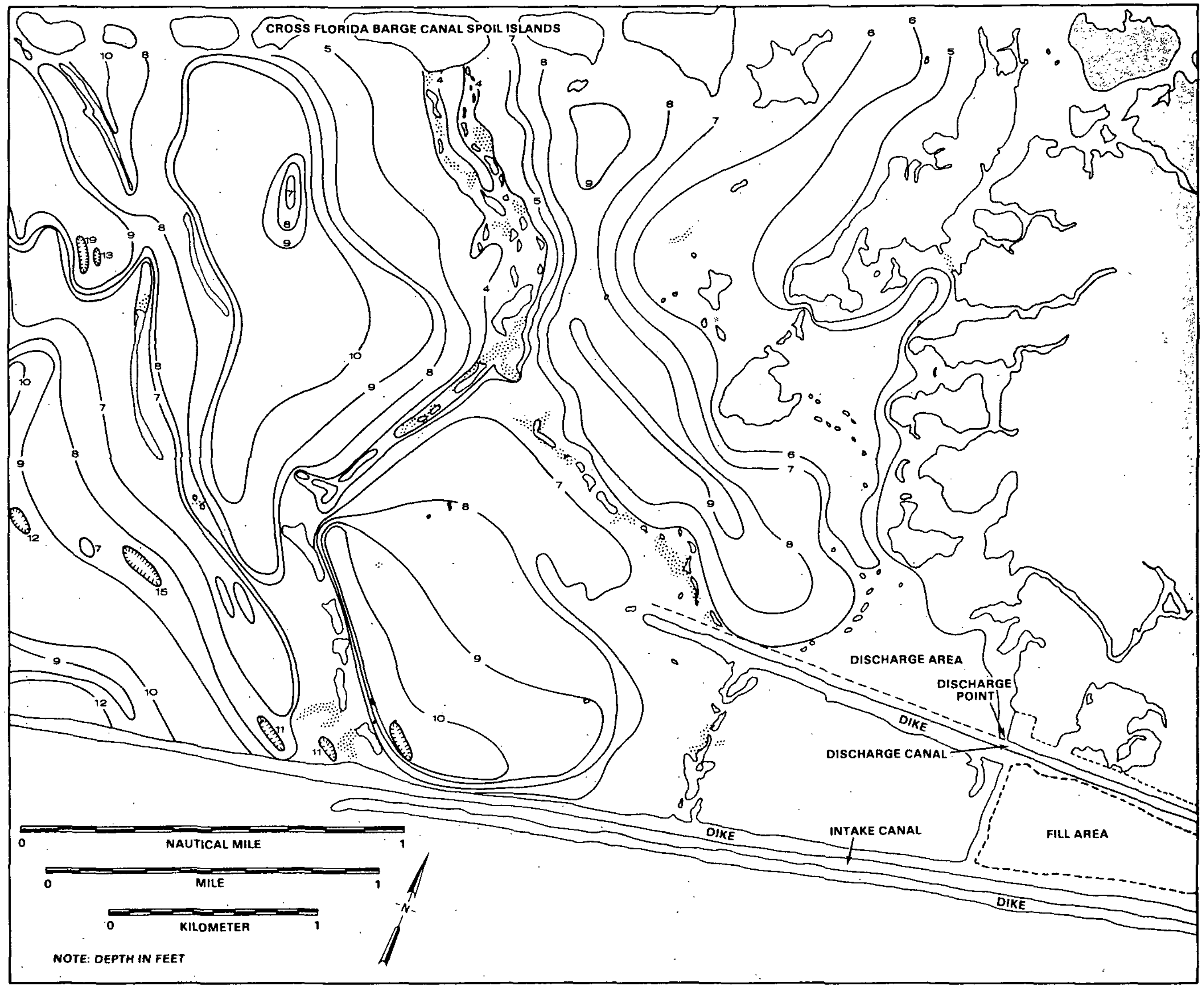


FIGURE D.1 BATHYMETRY AND PHYSICAL FEATURES OF THE AQUATIC ENVIRONMENT NORTH OF THE CANAL SYSTEM extension produced a chain of spoil islands extending 8 nautical miles into the Gulf. The spoil bank from the existing plant intake canal extends into the Gulf for 6.5 miles and is continuous for the first 4.5 miles from shore except for a small gap 3 miles offshore. This canal is 150' wide and has a depth of 15' below mean low water (MLW). The spoil bank from the plant discharge canal extends offshore about one mile and is 125' wide with a depth of 10' below MLW). Initial dredging of the intake and discharge canals and the formation of fly ash retention areas between them altered 330 acres of former marsh land and nearshore bottom land. New land-sea interfaces were created by the spoil dikes formed by the dredging. The spoil bank dikes have a perimeter of some 15 miles in length, which is in addition to the natural state. The dikes provide new substrate for algae and encrusting organisms that may be used as food by fishes and other marine animals. Aggregates of juvenile spottail finfish, permit and other juvenile fish now occur along the spoil bank dikes.

Water temperatures and salinities obtained by the U.S. Coast and Geographic Survey[105] at Cedar Keys, about 20 nautical miles to the northwest, correspond to those in the seawater influx off the Crystal River site. Mean and extreme values of temperature at Cedar Keys from 1945 to 1962 are plotted in Figure D.2. Peak seasonal temperatures occur from June to September and the maximum recorded temperature is 92°F (33.3°C). The mean maximum is 89.3°F (31.8°C) for July, which has a mean monthly value of 85.3°F (29.6°C). Comparison of these values with intake temperatures at the existing Crystal River plant in 1969 and 1970 (Figure D.3) show that seawater temperatures at both locations are similar. The condenser inlet temperatures measured for 1971 are shown in Figure D.4. The highest temperature observed is 92°F. This maximum is 4°F higher than was reached in 1969 and 1970, but agrees with that observed over a longer time period at Cedar Keys (Figure D.2).

The thermal plume from the Crystal River complex is presently under study by the Marine Science Institute, University of South Florida, Tampa and a number of studies have been completed. They show[106-109] that tidal fluctuations are the controlling factor in determining flow patterns in the discharge area. During ebb tide, net water flow is seaward and the heated plume forms a tongue to the west. Maximum temperatures occur 3 ft or more from the surface and may be 3 to 4°F higher than the surface temperature. During the flood tide, the heated water flows north and west along the shore line. A hot salt wedge is formed under the less

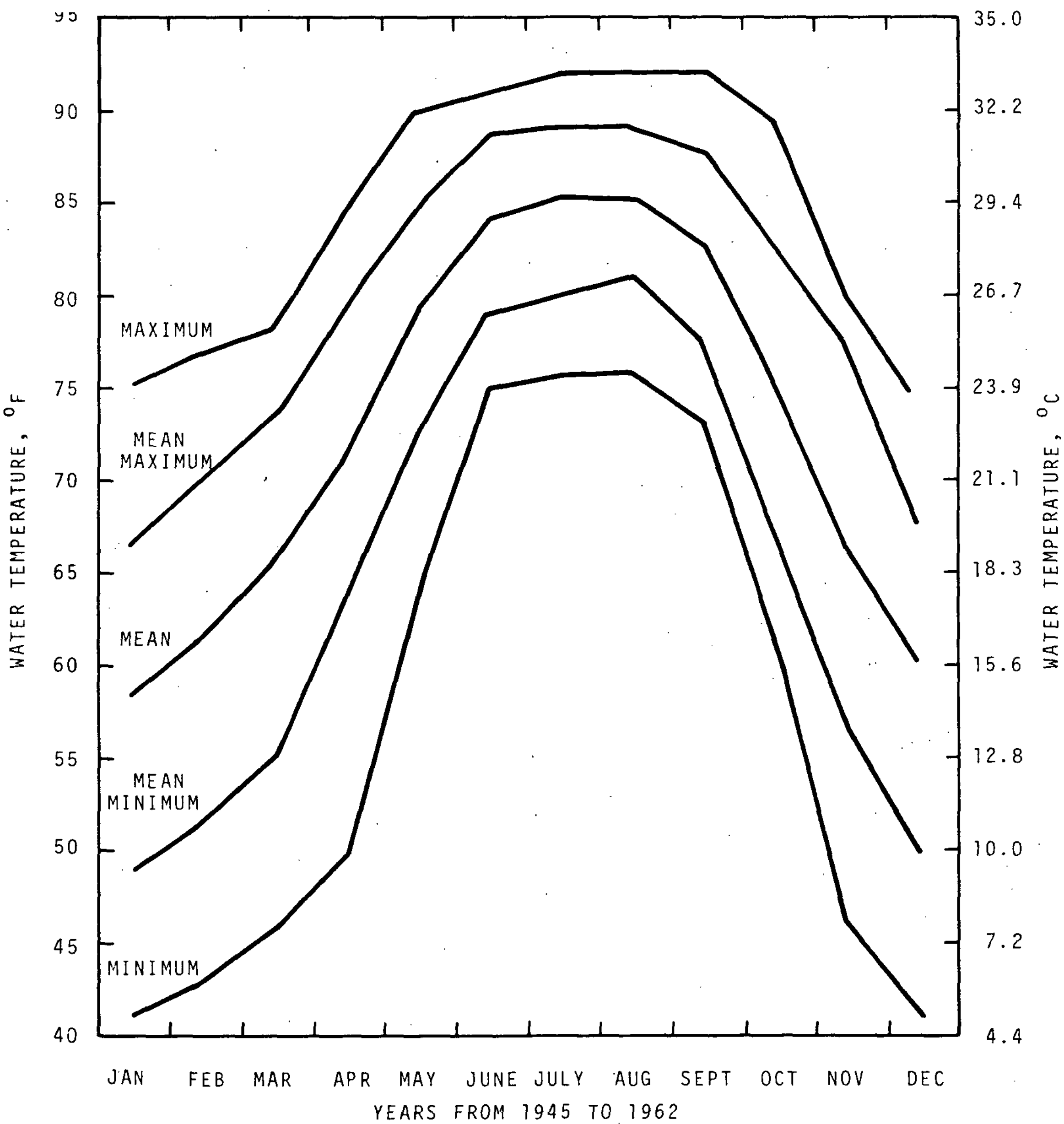


FIGURE D.2 SURFACE WATER TEMPERATURES, CEDAR KEYS, FLORIDA

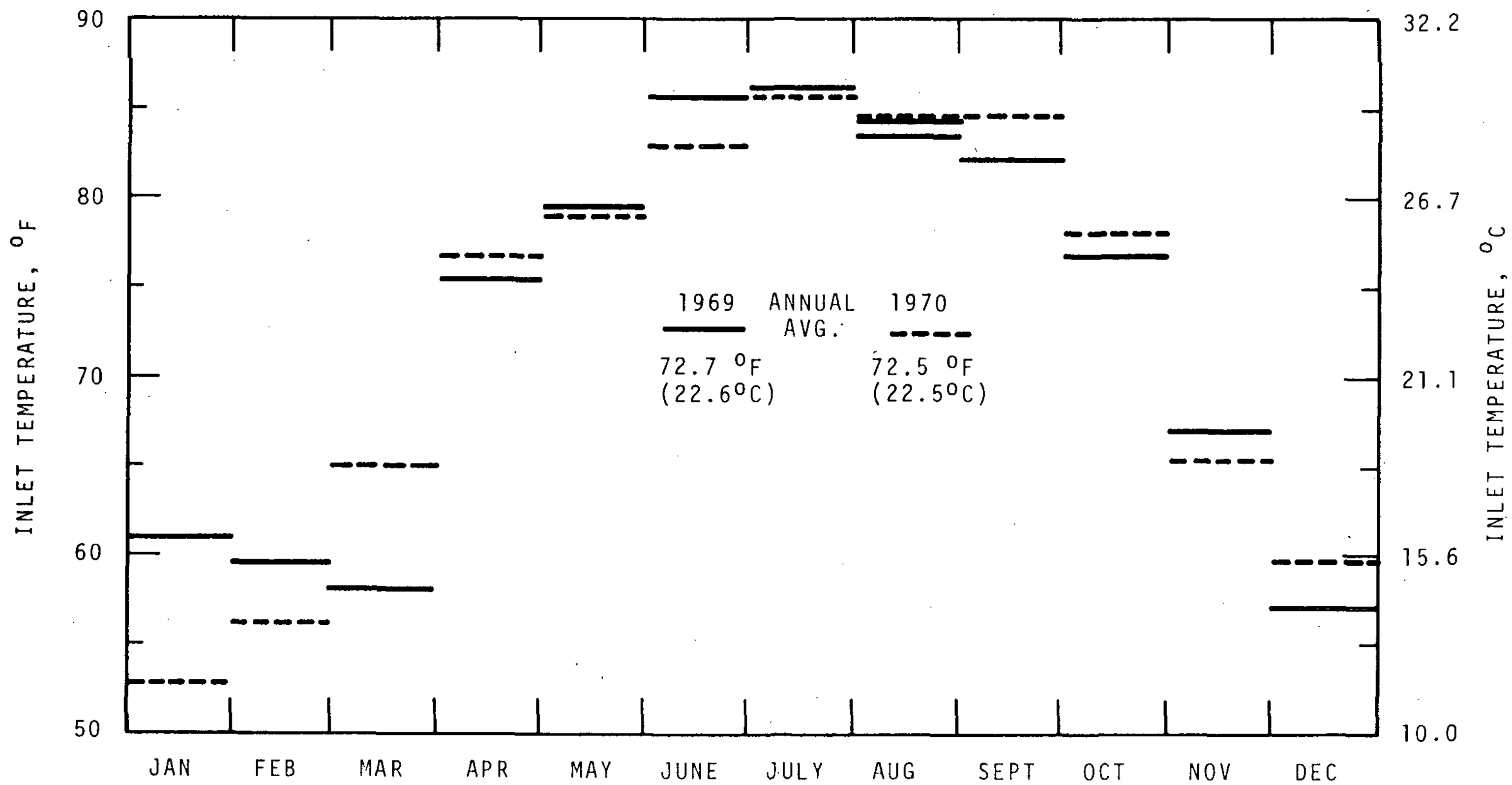


FIGURE D.3 CRYSTAL RIVER CONDENSER INLET TEMPERATURES - MONTHLY MEAN

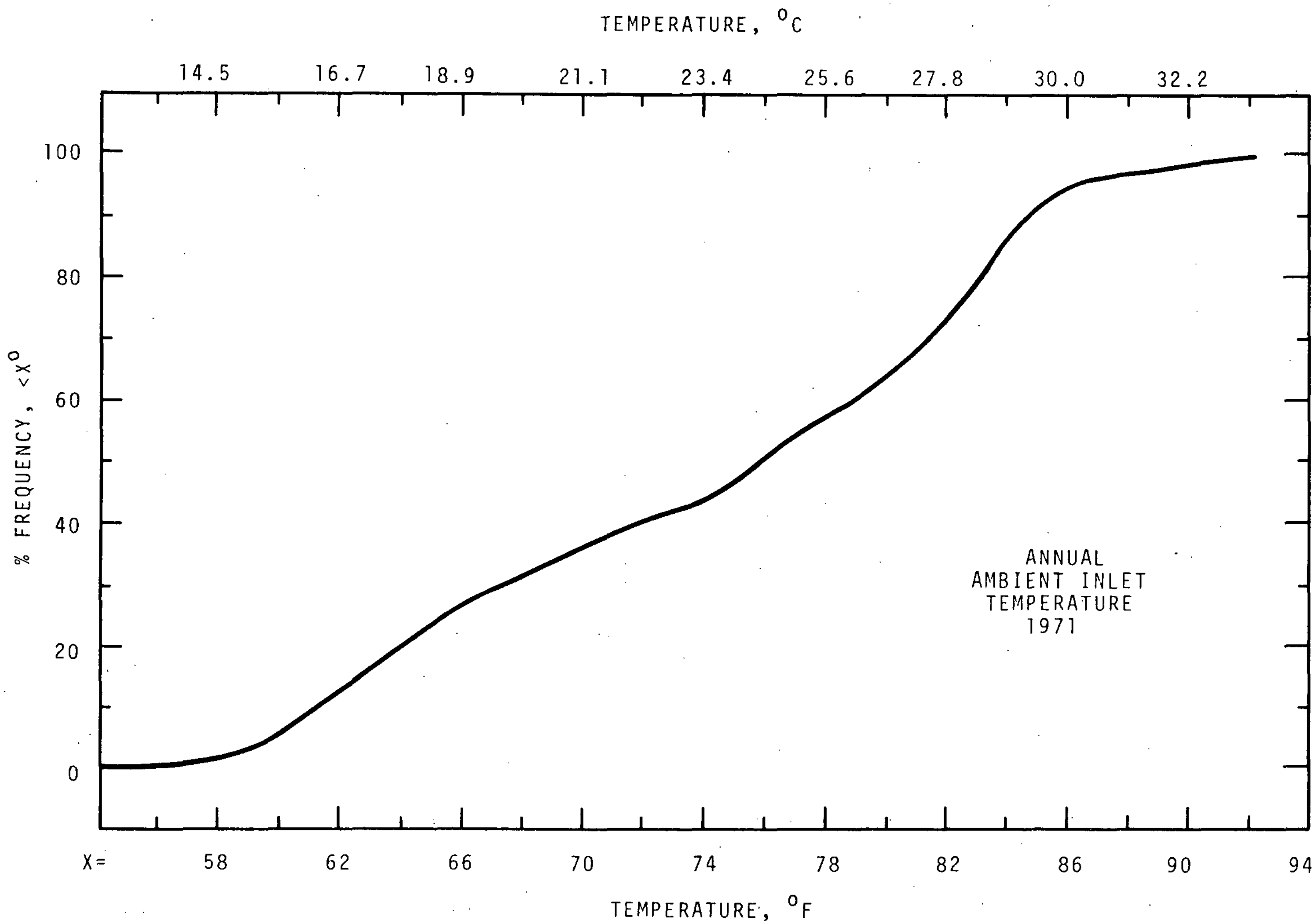


FIGURE D.4 CONDENSER INLET TEMPERATURES, 1971 saline water as a result of mixing of heated sea water with fresh water from the Withlacoochee River and the Cross Florida Barge Canal. Diagrams illustrating the location and extent of the thermal plumes due to effluent discharge from Units 1 and 2 are shown in Figures D.5–D.8.[106]

These diagrams (Figures D.5–D.8) are to be considered typical only and do not represent the maximum temperatures which occur with Units 1 and 2 operating at full power. The power levels were not specified by the applicant, but on the basis of the highest temperature difference noted (Figures D.5 and D.6), 8.6°F (4.8°C), the power level is estimated by the staff to be about 75% of full power. At full power for Units 1 and 2, the temperature rise across the condenser of the cooling water would be 11.5°F (6.4°C).

A mathematical model is being developed by the Marine Science Institute of the University of South Florida to predict temperature distributions that will prevail after Unit 3 would become operational. The model is similar to one developed by Mungall[110] for a tidal estuary, which uses as basic input the tidal sinusoid, prevailing wind conditions, and boundary conditions that describe the mixing basin. Bottom friction is accounted for empirically.

The average area covered by the incremental 5°F (2.8°C) isotherm for Units 1 and 2 at full load is about 360 acres. This estimate is based on the experimental measurements shown in Figures D.5–D.8 using the method described later in this Appendix. Florida Power Corporation,[111] in an initial estimate[109] of plume size, estimated that on the average, 900 acres of the Gulf would be encompassed by the 5°F ΔT isotherm with the addition of Unit 3.

Isotherms in the mixing zone were determined by the staff independently for the case of the operation of Units 1 and 2 at 100% power level. This was done to compare findings with those of the applicant for other power levels (see preceding figures) and with those of the staff for the case after the addition of Unit No. 3. Existing[109] experimental data were used.

The temperature patterns were predicted from a model in which it is assumed that the reduced temperature in the plume (reduced temperature is defined as temperature rise at a specified location divided by temperature rise at the discharge point) is a

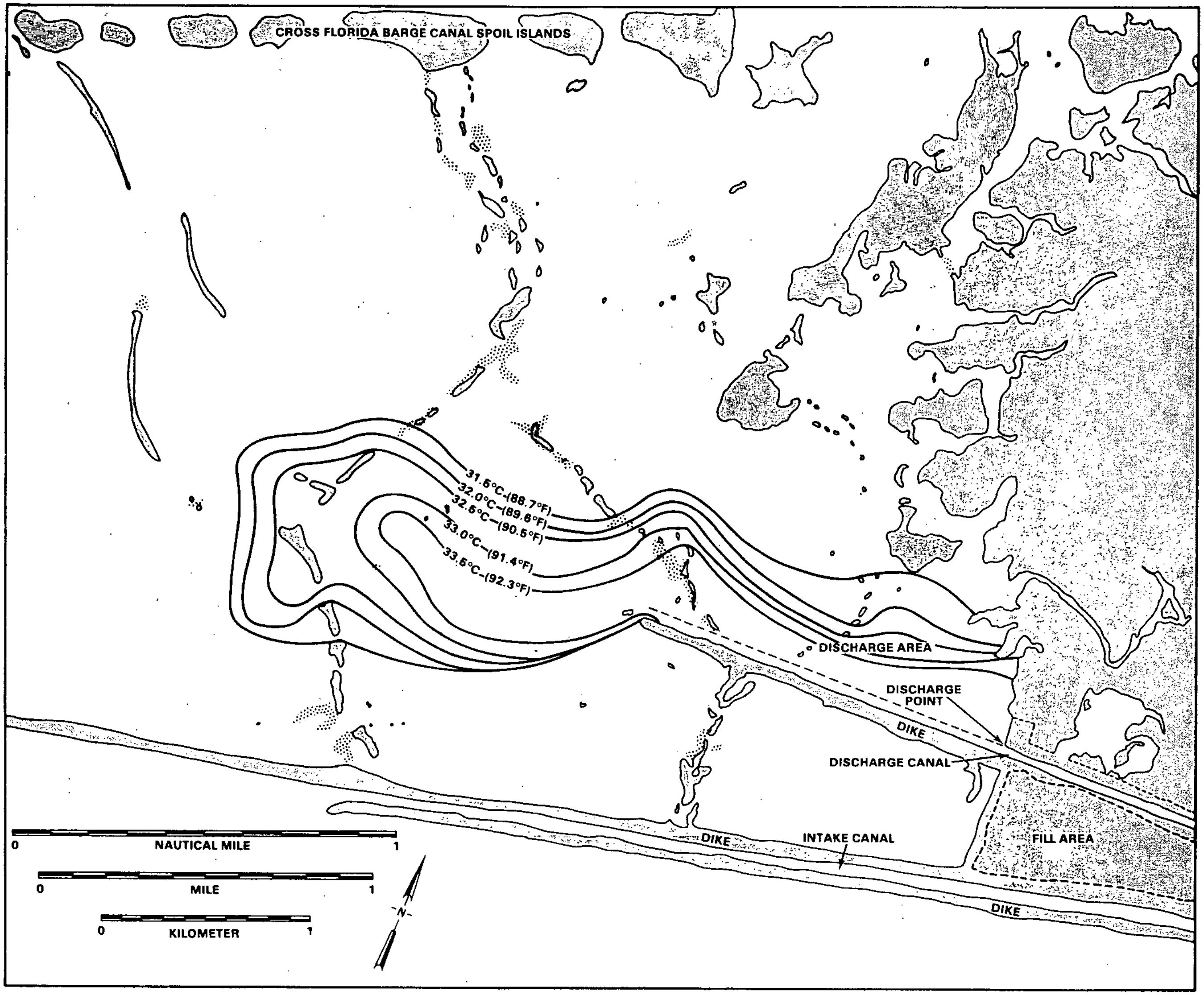


FIGURE D.5 TEMPERATURES IN THE DISCHARGE AREA, EBB TIDE, SURFACE.

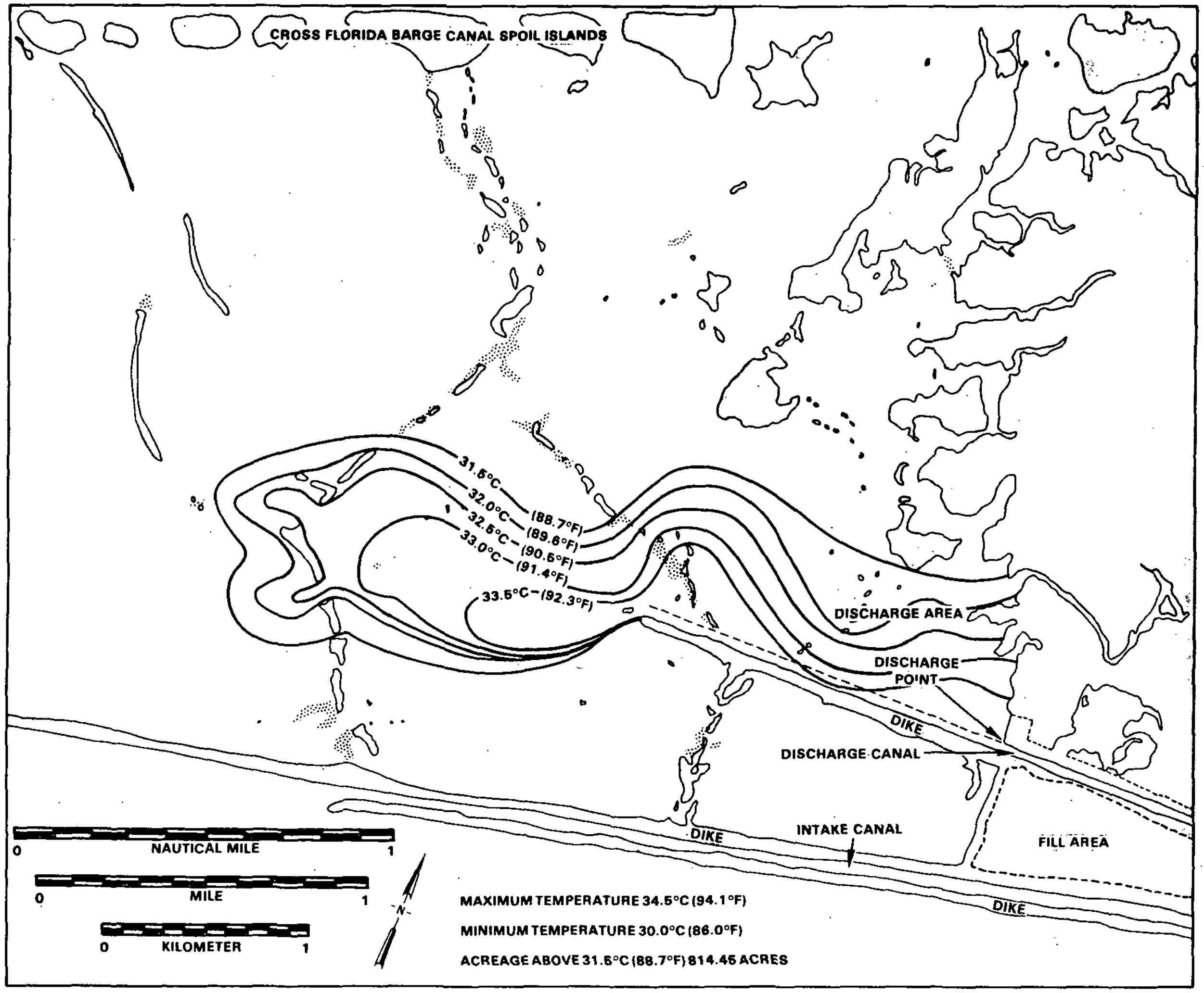


FIGURE D.6 TEMPERATURES IN THE DISCHARGE AREA, EBB TIDE, 3 FT DEPTH

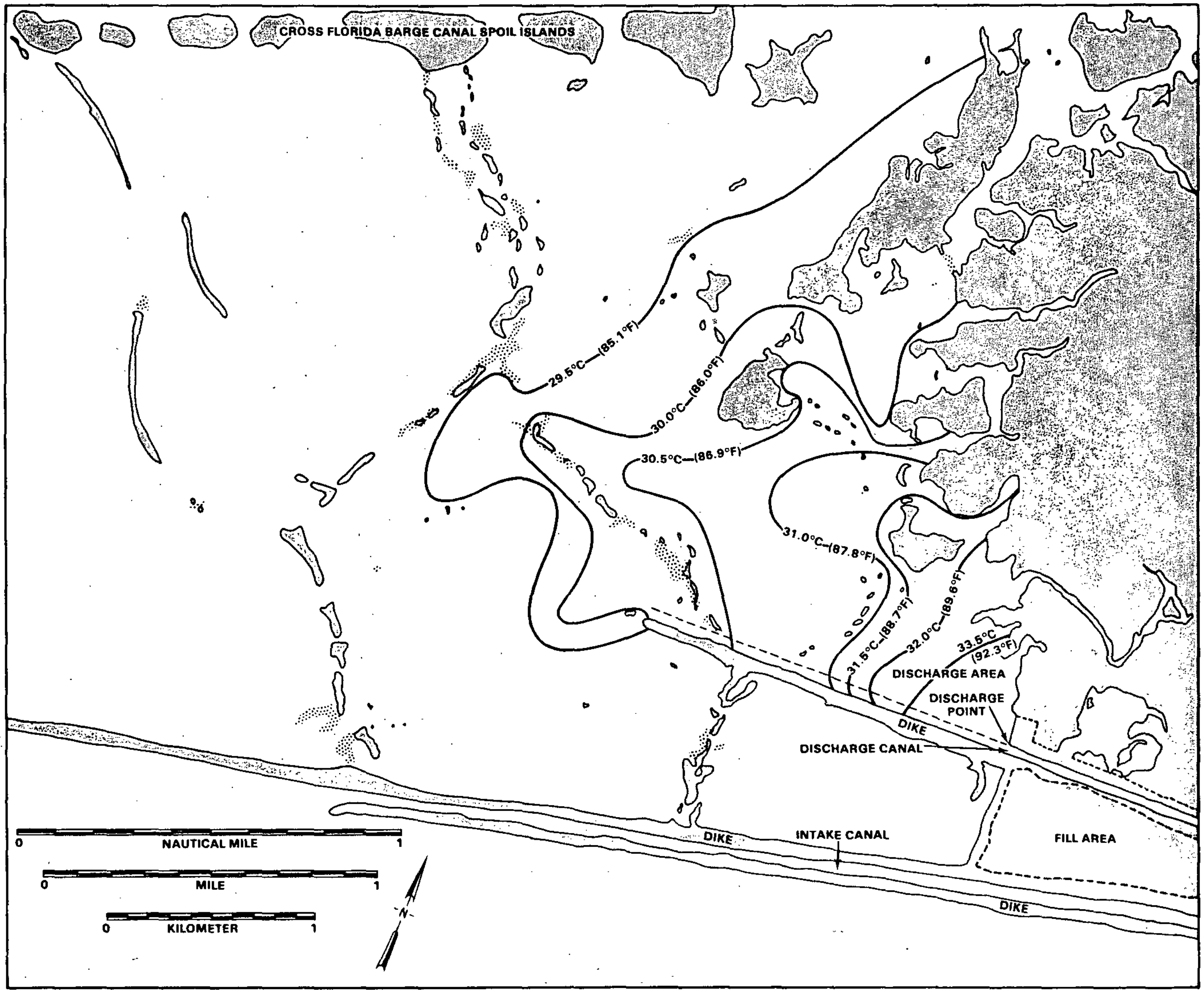


FIGURE D.7 TEMPERATURES IN THE DISCHARGE AREA, FLOOD TIDE, SURFACE

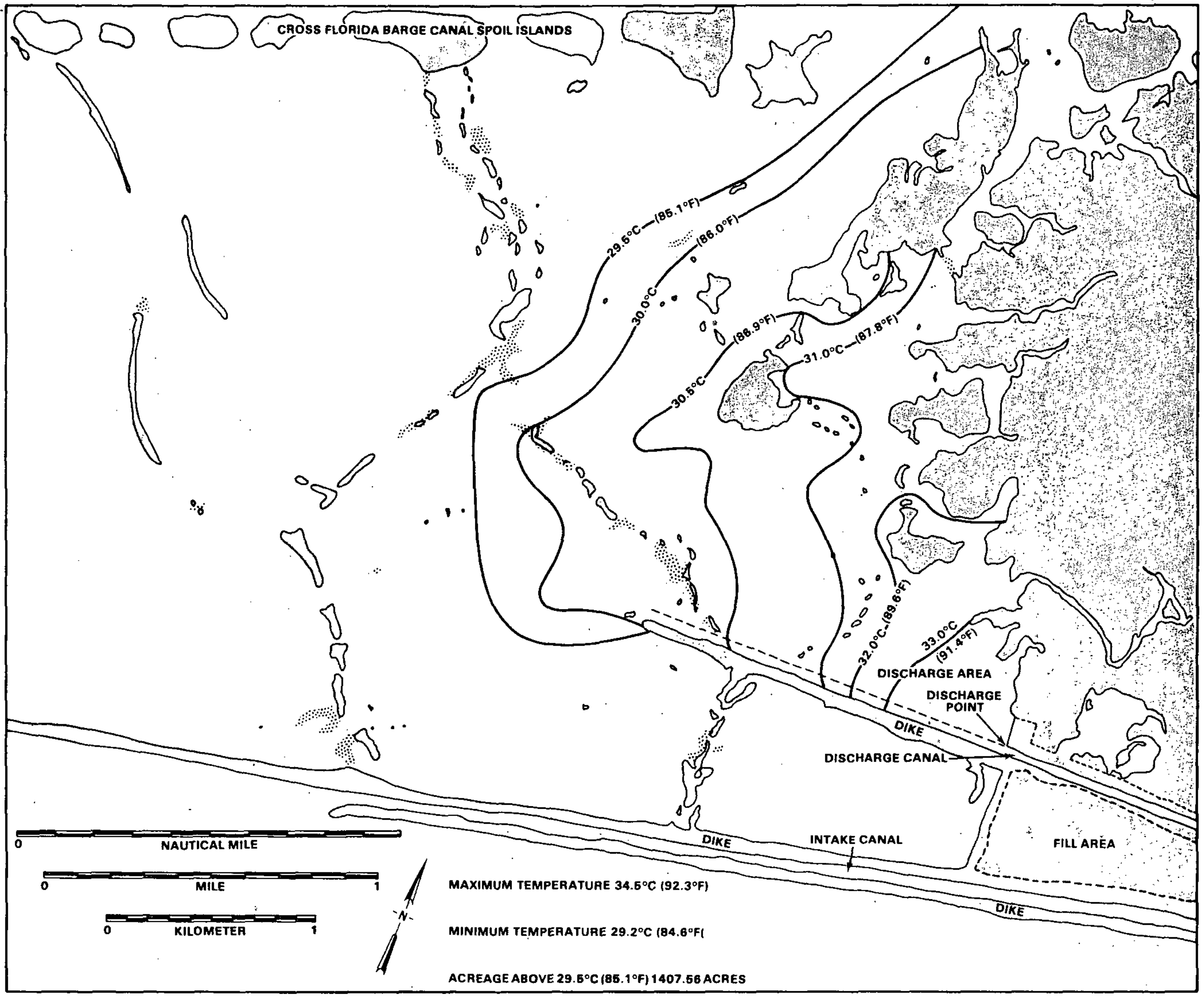


FIGURE D.8 TEMPERATURES IN THE DISCHARGE AREA, FLOOD TIDE, 3 FT DEPTH function of the ratio of surface area covered to the flow rate of the hot water discharge. This model utilizing this assumption has been shown to represent adequately the experimental measurements presented by Asbury and Frigo.[112] The precise functional relationship between temperature rise and surface area was obtained from data published by Carder and associates[106] describing the thermal plume at Crystal River for Units 1 and 2. Acreage for operation of Units 1 and 2 (and later in Section 5 for Unit 3) was predicted by using the temperature rise and flow rate which apply to full power operation of the units in the model described above. It was assumed that the shape of the isotherms for these cases would be similar to those for the present operation.

The excess temperature pattern predicted for flood tide is shown in Figure D.9. Areas covered by specific isotherms are obviously much smaller than will be the case after Unit 3 would become operative. This is especially important for the flood tide condition because the highest temperatures are then experienced in the nearshore areas north of the discharge canal outfall. Acreages covered by heated water from Units 1 and 2 at full power are shown in Table D.1.

TABLE D.1

ACREAGE COVERED BY THE THERMAL PLUME FOR OPERATION OF UNITS 1 AND 2 AT 100% POWER FOR FLOOD TIDE

Excess Temperature	Acreage
1°F (0.5°C)	1230
2°F (1.1°C)	870
4°F (2.2°C)	420
6°F (3.3°C)	200
8°F (4.4°C)	90

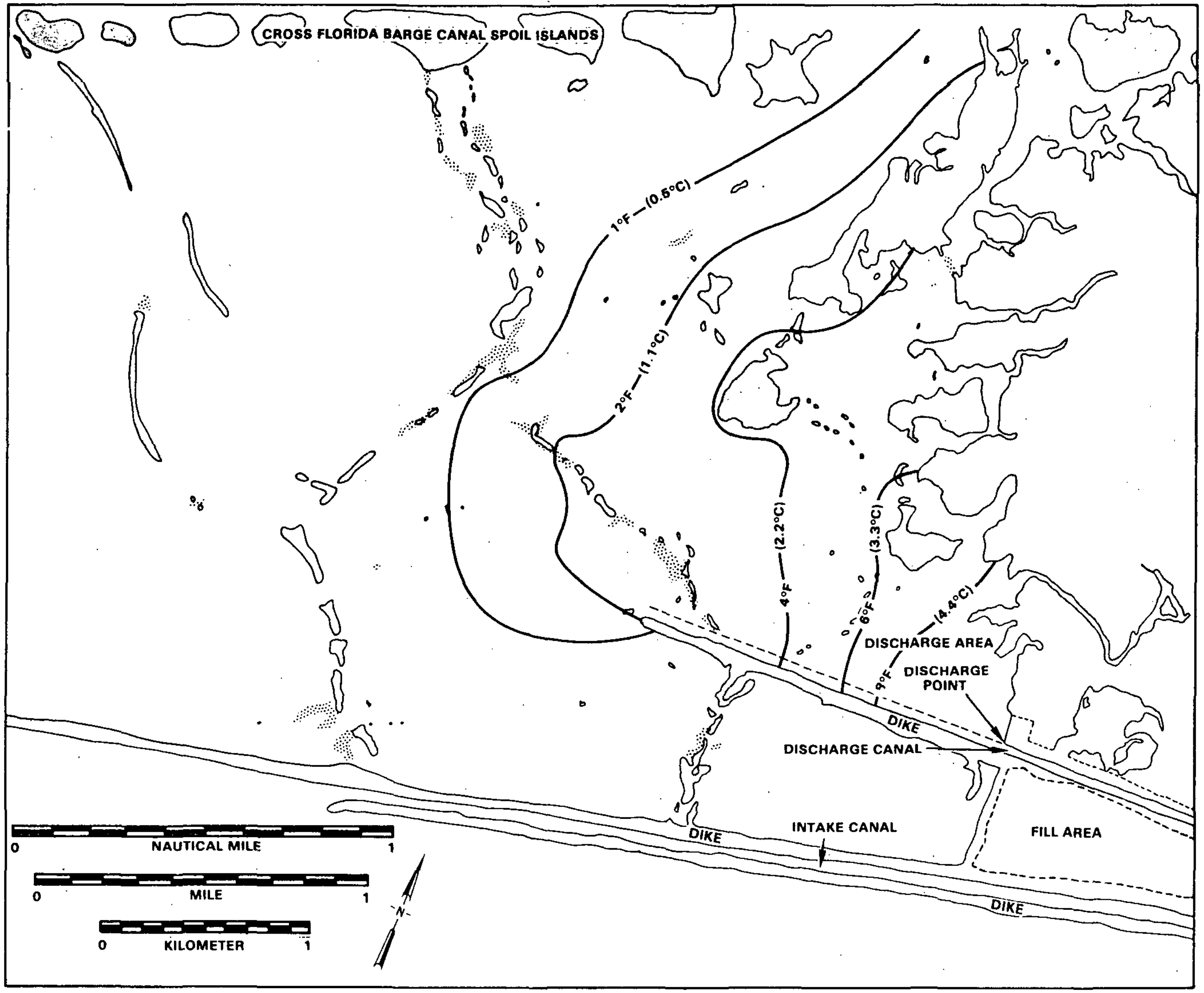


FIGURE D.9 PREDICTED TEMPERATURE INCREMENTS ABOVE AMBIENT IN THE DISCHARGE AREA, UNITS 1 AND 2, 100% POWER LEVEL, FLOOD TIDE

For ebb tide, the excess temperature profiles are shown in Figure D.10. For this case, the highest temperatures occur near the north side of the discharge canal dike and as such impinge on less productive areas than for flood tide. Acreage covered by heated water from Units 1 and 2 at full power during ebb tide is shown in Table D.2.

TABLE D.2

ACREAGE COVERED BY THE THERMAL PLUME
FOR OPERATION OF UNITS 1 AND 2 AT 100% POWER FOR EBB TIDE

Excess Temperature	Acreage
1°F (0.5°C)	1620
2°F (1.1°C)	1140
4°F (2.2°C)	650
6°F (3.3°C)	360
8°F (4.4°C)	160

The area impinged upon during a full tidal cycle was estimated by blending the isotherms for the ebb and flood tide situations. The excess temperature profiles for a full tide cycle are shown in Figure D.11. Acreage covered by heated water from Units 1 and 2 operating at full power for a complete tidal cycle is shown in Table D.3.

TABLE D.3

ACREAGE COVERED BY THE THERMAL PLUME FOR OPERATION
OF UNITS 1 AND 2 AT 100% POWER FOR A FULL TIDAL CYCLE

Excess Temperature	Acreage
1°F (0.5°C)	2350
2°F (1.1°C)	1700

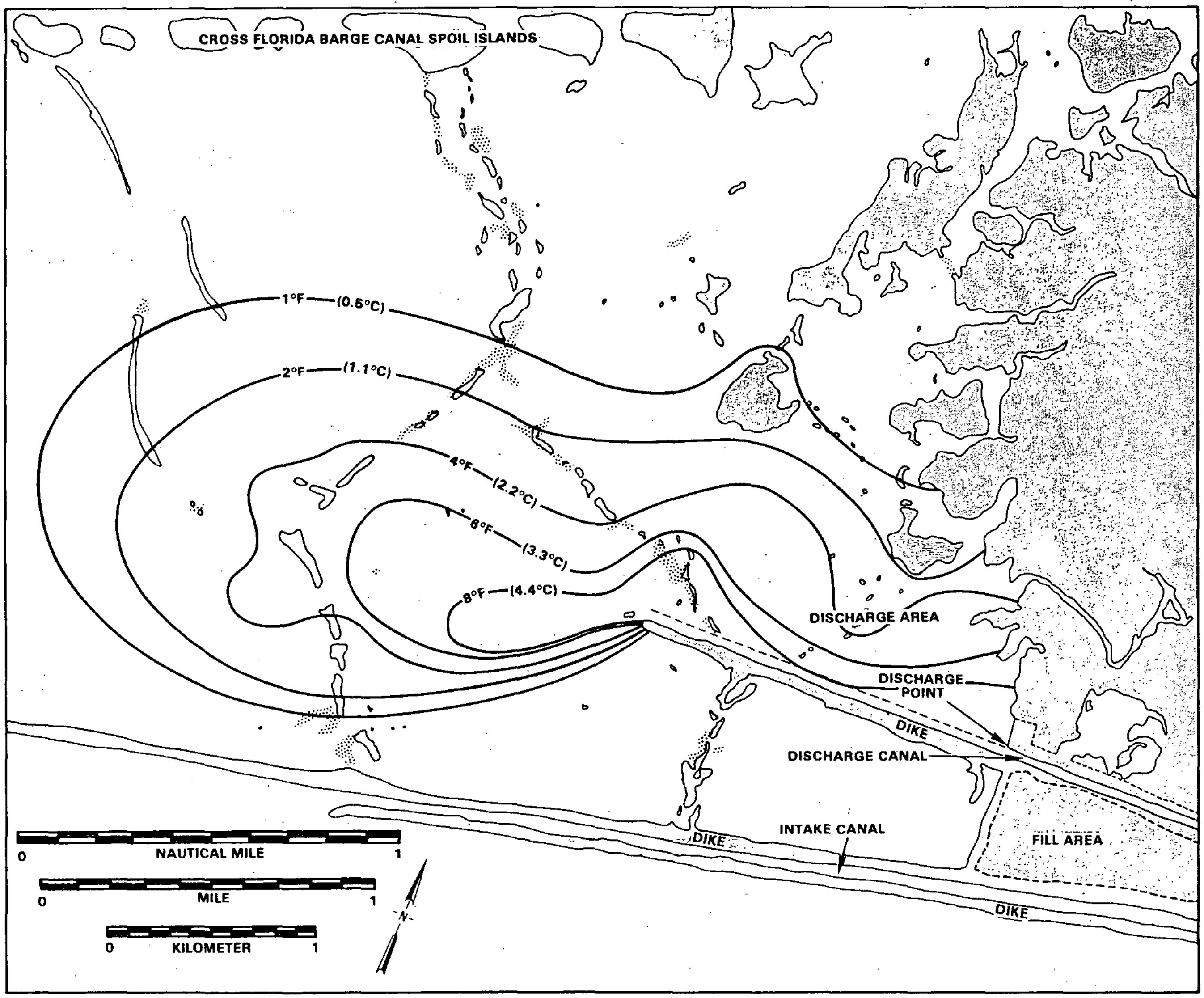


FIGURE D.10 PREDICTED TEMPERATURE INCREMENTS ABOVE AMBIENT IN THE DISCHARGE AREA, UNITS 1 AND 2, 100% POWER LEVEL, EBB TIDE

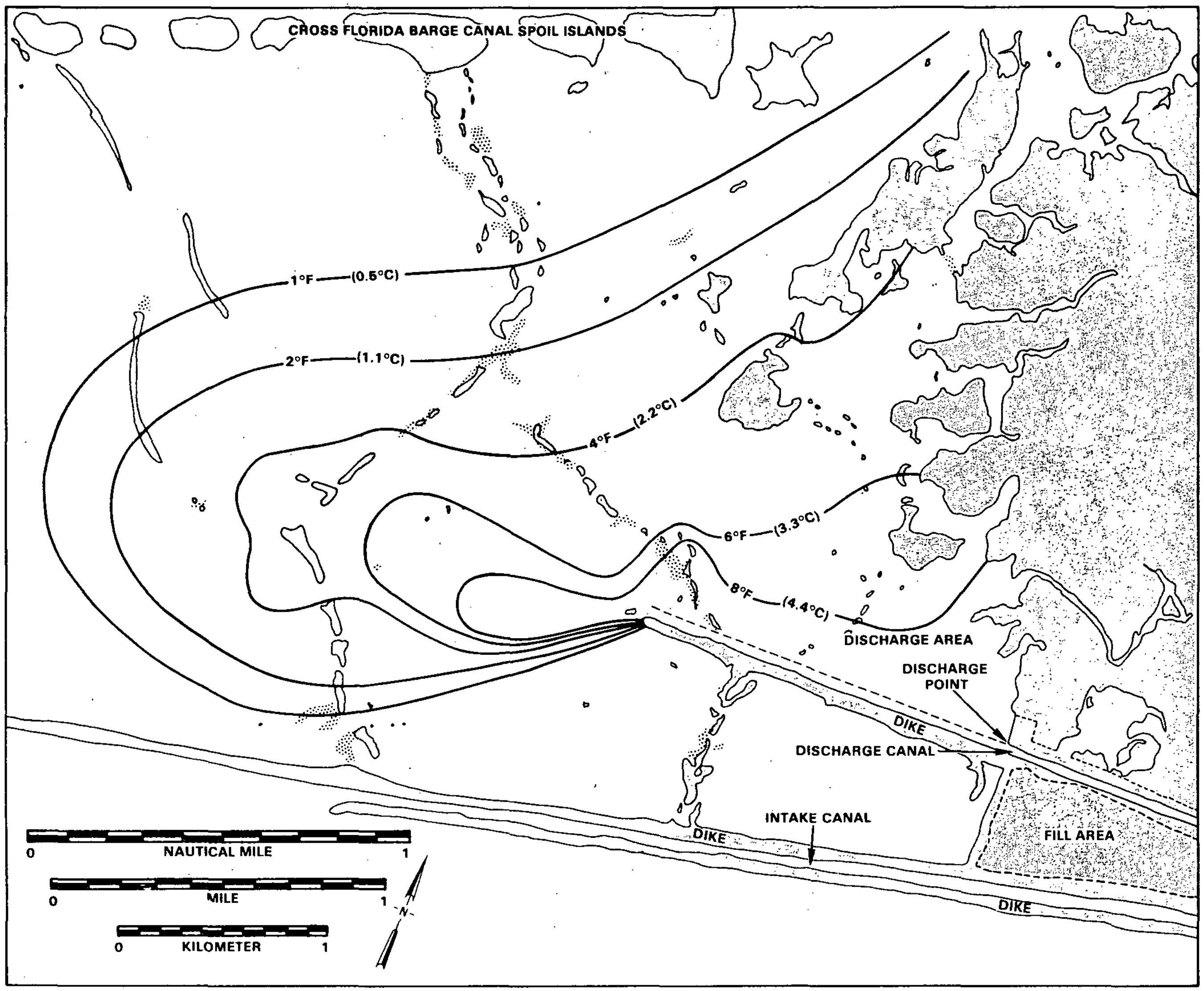


FIGURE D.11 PREDICTED TEMPERATURE INCREMENTS ABOVE AMBIENT IN THE DISCHARGE AREA, UNITS 1 AND 2, 100% POWER LEVEL, FULL TIDAL CYCLE

TABLE D.3 (Cont'd)

Excess Temperature	Acreage
4°F (2.2°C)	1050
6°F (3.3°C)	510
8°F (4.4°C)	220

Salinity in the area of the plant varies quite widely with season, location, state of the tide and as a result of fresh water introduction from the Withlacoochee River and the Cross Florida Barge Canal. The maximum salinity of 35 parts per thousand (°/oo) exists in deeper water 8-10 miles offshore. Minimum values occur near the point of entrance of the fresh water. Values in the vicinity of the plant discharge generally range from 22 to 29 parts per thousand, reflecting the variable mixing of fresh and salt water.

Fresh water moving southward along the shore from the Cross Florida Barge Canal-Withlacoochee River floats on top of the Gulf waters as a result of salinity-caused density differences. During high tide, the fresh waters are diverted into the plant discharge basin. The warmer discharge water has a density higher than that of the fresh water, causing the warm water plume to form a wedge extending under the lighter fresh water. Diagrams illustrating[6] salinity distributions in the area near the plant outfall are shown in Figures D.12-D.15 with Units 1 and 2 in operation.

The projected residence times of water in the discharge grid area at ebb and flood tide were calculated by the Marine Science Institute, University of South Florida, using their computer program. During maximum ebb and flood, the residence times were 18.4 and 38.7 hrs, respectively. The mean value of 28.6 hrs reflects the effect of diurnal tidal cycles. The present volume of water discharged by Units 1 and 2 (638,000 gpm), as a percentage of the total grid area, varies from 5.1% at ebb to 10.3% at flood. The future volume discharged from all operating units (1,318,000 gpm) will vary between 9.7 and 18.8% at ebb and flood tides, respectively, assuming that the plants were discharging into an enclosed reservoir.

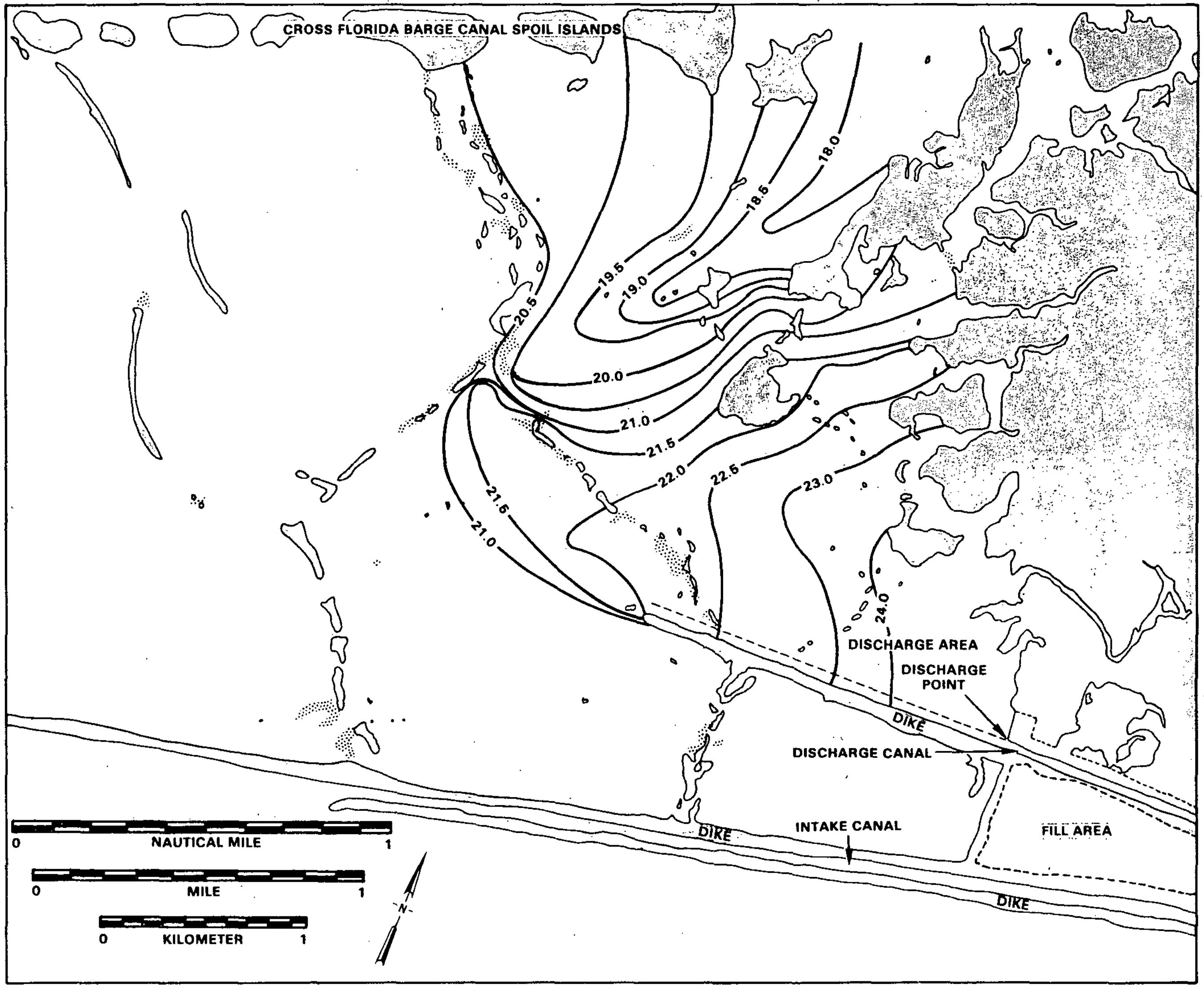


FIGURE D.12 SALINITY IN THE DISCHARGE AREA, FLOOD TIDE, SURFACE

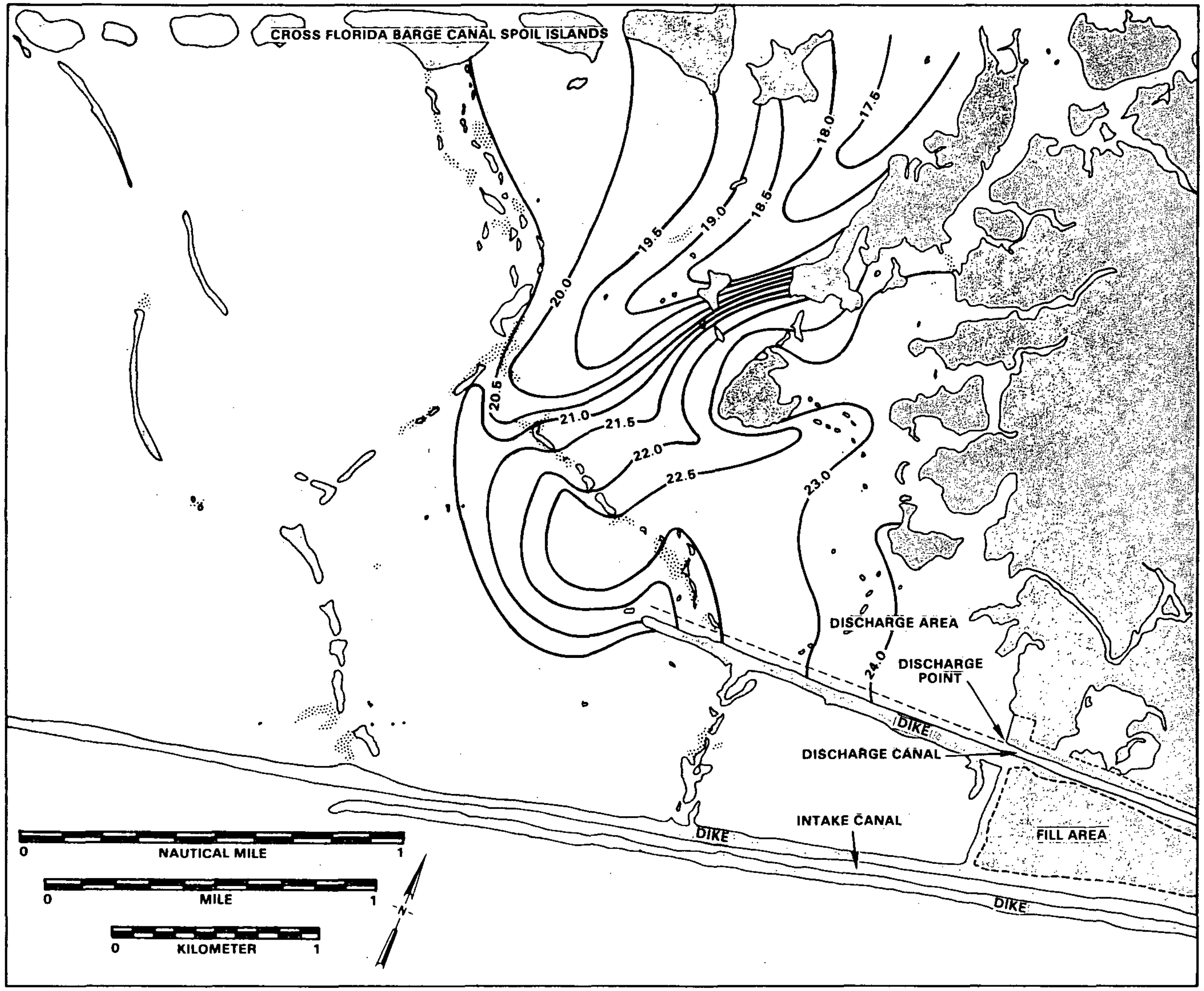


FIGURE D.13 SALINITY IN THE DISCHARGE AREA, FLOOD TIDE, 3 FT DEPTH

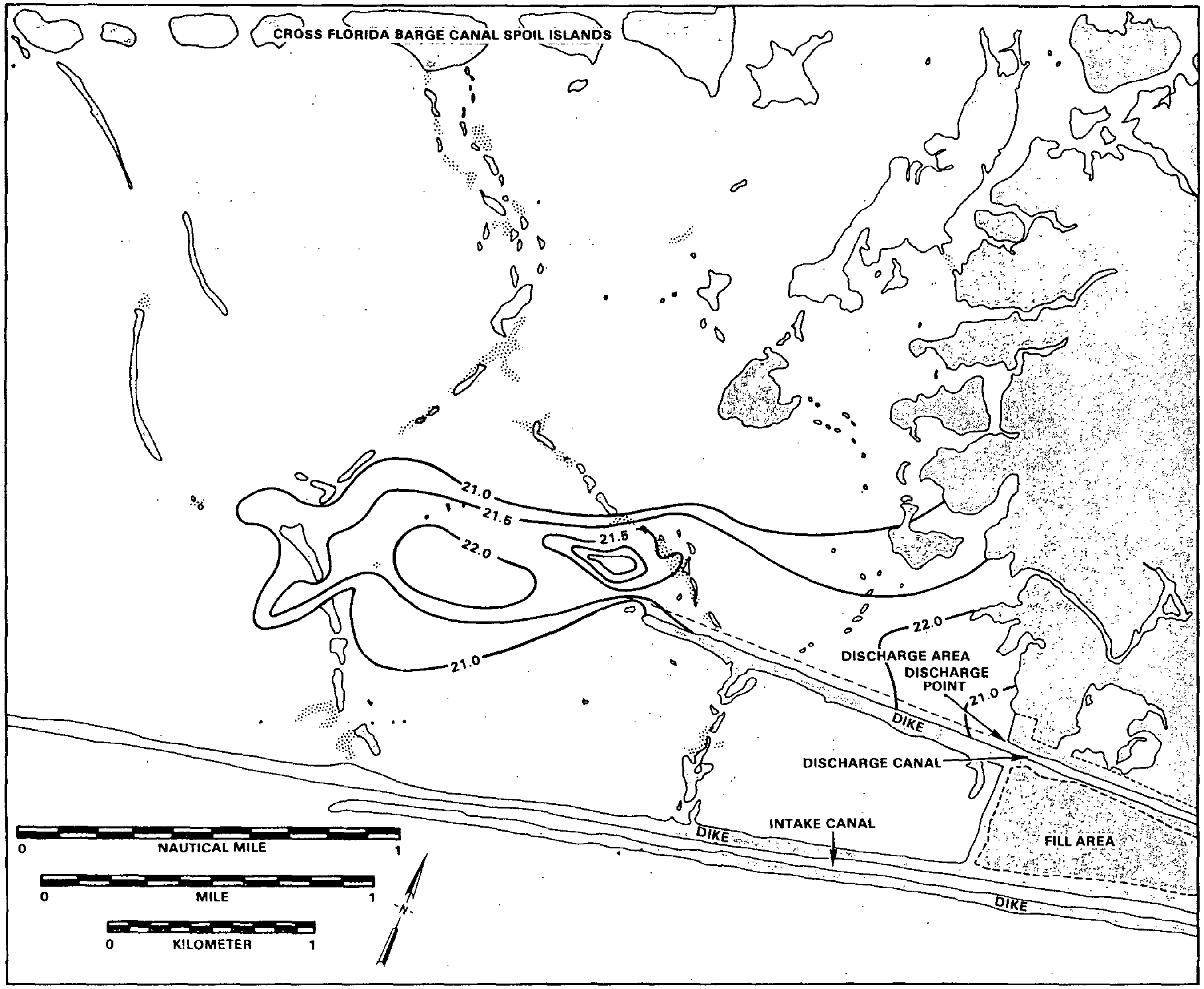


FIGURE D.14 SALINITY IN THE DISCHARGE AREA, EBB TIDE, SURFACE

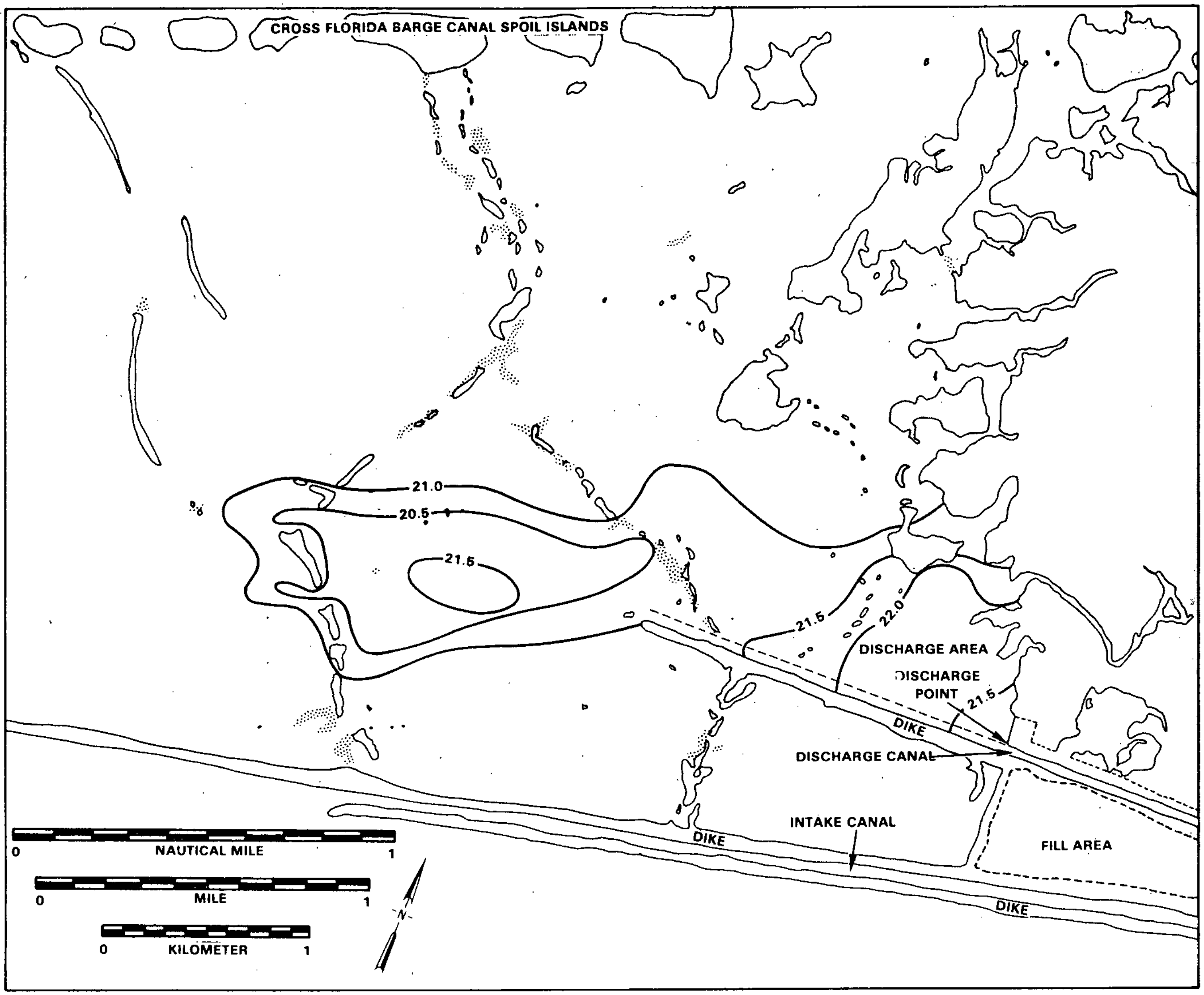


FIGURE D.15 SALINITY IN THE DISCHARGE AREA, EBB TIDE, 3 FT DEPTH

Turbidity in the inshore ecosystem is due largely to local bottom sediments that provide small particles for suspension during strong tidal flows or winds.[106] The turbidity of the nearshore marine ecosystem as a whole is between 30 and 100 times that of the clearest open ocean water, and between 10 and 20 times that of typical surface water from the Gulf. The principal source of turbidity is the Withlacoochee River-Cross Florida Barge Canal network. Salinity patterns during flood tide show a strong southerly flow from the barge canal along the western edge of the marshlands. A certain amount of deposition occurs during slack water, especially in grassy areas. These areas then provide a source of fine sediments for resuspension during periods of peak water movement or increasing winds.

Scouring of sediments in the discharge canal causes a decrease in water clarity[106] and changes in the local bathymetry.[107] Turbidity in the discharge canal[106] is higher than in the intake canal, but of the same order as that in the discharge basin where fresh water influx is a source of turbidity. Scouring has apparently[107] altered the bottom profile in the discharge canal and the oyster bars located near the outfall. The addition of Unit 3 discharge water would cause an approximate doubling of exit velocity, and possibly more scouring in the exit canal and the inshore oyster bars.

Most sediment entrained from the discharge canal would be expected to deposit about a mile and a half down the canal and to the west where the currents diverge.

The prevailing winds are relatively unimportant compared to tidal fluctuations in determining flow patterns in the Gulf near the plant site. However, winds associated with hurricanes cause extremes in the tidal levels. The "Maximum Probable Hurricane" is one which approaches the coast from the south, with onshore winds having a maximum speed of 138.5 mph. It is predicted to produce a water level of 21 ft above mean high tide. Superimposed on this high tide would be wind-driven waves having a maximum height of 11.7 ft. At the opposite extreme would be a hurricane positioned to produce offshore winds of the same order of magnitude. For the latter, the minimum ebb tide is predicted to be 4.7 ft below mean low tide.

General plant elevations are 8-10 ft above mean tide. Thus, the "Maximum Probable Hurricane" would lead to inundation of the plant site. Protective fill is to be placed around Unit 3 to guarantee that hurricane-induced tides will not damage the plant. At a minimum the applicant must make provisions for safe shutdown of Unit 3 at the maximum expected water levels and be able to maintain the plant in that condition.

Appendix E

COMMENTS ON THE DRAFT

ENVIRONMENTAL STATEMENT

Regulatory File Cy.

State of Florida

DEPARTMENT OF NATURAL RESOURCES

RANDOLPH HODGES
Executive Director

LARSON BUILDING / TALLAHASSEE 32304 / TELEPHONE 224-7141

September 11, 1972

50-302

SEP 19 1972

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 will acknowledge receipt of your letter of September 11, 1972, by which you provided the Draft Environmental Impact Documentation pertaining to Florida Power Corporation's Crystal River Unit No. 3, for our review and comment.

Coordination with the staff of the Division of State Planning, who operates the state clearinghouse for such matters, indicates that the Department of Natural Resources should provide its review comments to the Division of State Planning for a consolidated state position. Accordingly, the Department of Natural Resources will provide its comments through the Division of State Planning.

Sincerely,

Randolph Hodges

Randolph Hodges
Executive Director

RH/jsw

DOCKETED
USAEC
SEP 19 1972
REGULATORY
MAIL SECTION
DOCKET CLERK

1161 Fairway Dr.
Dunedin, Fla. 33528
October 19, 1972

Directorate of Licensing
U. S. Atomic Energy Commission
Washington, D. C. 20545

Gentlemen:

It is my understanding that the AEC is seeking comments from the public on the construction of a nuclear power reactor as an addition to the two existing oil-fueled generating units at Florida Power Corp.'s Crystal River power plant.

I have been a resident for nearly three years in the area served by the Corp. I have no interest of any sort in Florida Power, but I am very much interested in being supplied with electrical power in a continuing manner as the Florida Power Corp. has so effectively done in the past.

I cannot pose as being representative of the public-at-large as I have been privileged to have had experience in several of the herein related areas, briefly:

1. I have a PhD in Chemistry (1937, Univ. of Wis.).
2. I have been in the employ of Esso Research and Engr. Co. for 35 years and am now retired.
3. My early work related to problems encountered in the use of fuel oils including the heavy bunker-type fuel used by ships and utilities.
4. Later work related to radio isotopes. I have made personal visits to the Brookhaven and Oak Ridge reactors and have briefly handled a small neutron source intended for activation analysis.
5. In the recent years I assisted a g roup of six engineers in the preparation of a report for the National Air Pollution Control Administration under contract No. PH 22-68-55 entitled "Systems Study of Nitrogen Oxide Control Methods for Stationary Sources."

6. In compiling the report's bibliography I had intimate contact with all literature in the specialized field of interest of each engineer.
7. In retirement I am a regular subscriber to "Environmental Science and Technology" magazine.
8. I have perused the "Draft Environmental Statement by the Directorate of Licensing, U.S. Atomic Energy Commission related to the Propesed Operation of Crystal River Unit 3, issued Sept. 1972.

I understand the Florida Power Corp. has recently decided not to proceed further on the construction of a nuclear reactor power unit at Crystal River as the delays caused by environmental studies and other requirements made it impossible to complete it in time to meet the future demands. If this abandonment is correct, I hope my comments will be considered as applicable to the power industry nationwide.

My position is that nuclear reactor power is the preferred means of generating electrical energy over all other presently known means. I feel assured, based on operating experience to date, that the essential features in nuclear reactor operation have been proven to be practical and safe. However, I hope that reactor safety will receive continuing attention.

Accordingly, there only remains the environmental problems of site location and thermal pollution. As to the former, I am much less concerned with the possible environmental impact than with the practical aspects related to plant operation and cost control. The present exclusion area required around a nuclear plant permits the site location to be in moderately populated areas. The Crystal River site is certainly acceptable. In my opinion, nature follows the line of least resistance, and more often than not, the results are obnoxious to man. Nature needs man's help to produce an orderly environment. However, the evidence of empty beer cans, old tires, abandoned autos, etc. indicates that a fairly large segment of mankind also insists in following the least resistance route. In short, I am saying that a nuclear plant located in a large maintained area is a pleasure to observe and a credit to the nation's technological accomplishment.

The term "thermal pollution" immediately conveys the impression of something bad, but recent studies show that the "heated discharge water" from power plants has caused little harm. (See Environ. Sci. Technol. 6, 1, 224-30, 1972). On the other hand, it is entirely possible that this discharge can be turned into an asset, e.g., aqua culture. (See ibid 6, 1, 233-7, 1972). Such advantage is currently being taken at the Crystal River site by the Ralston Purina Co., starting with shrimp culture. If the future electrical demand requires an addition to the present units, more heated water will be discharged regardless of unit type. The nuclear reactor will double the discharge increase vs a fossil-fueled unit. This additional discharge, which may be roughly 25% of the total, cannot be expected to produce sufficiently more damage to marine life to be the reason to abandon the nuclear reactor. In my opinon, the availability of sufficient electrical energy at reasonable cost for all people in the service area greatly overshadows any loss of marine life, if such occurs, or displeasure on the part of sports fishermen.

Further, it is my opinion that power companies are being unduly harassed by minority interests to the detriment of the great majority who are purchasers of electrical energy. The current outlook is for higher cost and limited supply, and the power companies will get the blame and least deserve it.

Included in my classification of minority interests are the environmental alarmists or ecology nuts who have suddenly been able to hinder reasonable progress. To their ranks I add the numerous government agencies that have suddenly gotten in on the act and whose licenses and permits are slowing/or making impossible worthwhile projects. They appear to be "empire builders" that like to imagine that the public demands their services. Regretably, it is these influences that probably have causedFlorida Power to abandone its nuclear reactor project.

In seeking to determine if a majority of the general public either favors the installation or not of a nuclear reactor at Crystal River, consideration must be given to the availability of information should they choose to be interested. Probably all such knowledge is obtained from local newspapers and periodicals which usually have an alarmist slant. Accordingly any decision will involve sulfur dioxide and particulate pollution by fossil-fueled generators vs radiation hazard and thermal discharge damage by a nuclear reactor. In balancing one against the other, the final judgment could be for an adequate supply of electricity at the lowest possible cost, with the hope that the decisions will be made by scientists, engineers, and politicians who should be best qualified.

Very truly yours,

Chauncey C. Hale

Chauncey C. Hale

cc Florida Power Corp.

**ADVISORY COUNCIL
ON
HISTORIC PRESERVATION**

WASHINGTON, D.C. 20240

50-302

October 18, 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 September 11, 1972, for comments on the environmental statement for Crystal River Unit No. 3 in Citrus County, Florida, 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 in Florida is Mr. Robert Williams, Director, Division of Archives, History and Records Management, Department of State, 401 East Gaines Street, Tallahassee, Florida 32304.

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 Robert S. Gamble of the Advisory Council staff.

Sincerely yours,

John D. McDermott
Acting Executive Secretary

cc:
Mr. Robert Williams, Tallahassee, Florida

THE COUNCIL, an independent agency of the Executive Branch of the Federal Government, is charged by the Act of October 15, 1966, with advising the President and Congress in the field of Historic Preservation, commenting on Federal, federally assisted, and federally licensed undertakings having an effect upon properties listed in the National Register of Historic Places, recommending measures to coordinate governmental with private activities, advising on the dissemination of information, encouraging public interest and participation, recommending the conduct of special studies, advising in the preparation of legislation, and encouraging specialized training and education, and guiding the United States membership in the International Centre for the Study of the Preservation and the Restoration of Cultural Property in Rome, Italy.

DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD

MAILING ADDRESS:
U.S. COAST GUARD (GWS)
400 SEVENTH STREET SW.
WASHINGTON, D.C. 20590
PHONE: 202-426-2262

RECEIVED
OCT 26 1972
U.S. ATOMIC ENERGY COMMISSION
Regulatory
Mail Section

24 OCT 1972

50-302

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 11 September 1972 addressed to Mr. John E. Hirten, Assistant Secretary for Environment and Urban Systems, regarding the draft environmental impact statement, environmental report and other pertinent papers on the Crystal River, Unit 3, Nuclear Project, Citrus County, Florida.

The concerned operating administrations and staffs of the Department of Transportation have reviewed the material submitted.

Noted in the review of the Federal Railroad Administration is the following:

"The Federal Railroad Administration notes that the route description of the transmission system gives considerable attention to highway locations but mentions only briefly that railroads are involved in the corridor. Figure III-2 fails to locate these railroads but again emphasizes highway location. While we realize that existing easements will be used, it is felt that the higher voltage of the new lines may alter the situation in the vicinity of the involved railroads.

"The problem of inductive coupling, direct faulting or flash-over 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 for serious accidents exist."

The Federal Aviation Administration noted:

"Reference is made that the Federal Aviation Administration (FAA) has been contacted in relation to this project. No information is identified in the report that states what FAA's action was. Phone calls were made on 28 September 1972 to Mr. Steve Brill, ASO-600, FAA, Atlanta, Georgia, Mr. Dick Durden, ASO-530, and Mr. James Howes of the Miami Airports District Office. None of the offices were familiar with the project. Concern was expressed as to local fogging which may result from this project causing a hazard and from the obstruction the facility itself may present to low flying aircraft. We suggest the following:

1. It is suggested that airspace review and clearance be made.

2. The FAA office that was contacted should be named as well as the date, the nature of the contact, and the nature and extent of the reply."

The Department of Transportation has no further comments to offer. We have no objection to this project. We do feel however, that both the concerns of the Federal Railroad Administration and the Federal Aviation Administration should be seriously addressed in the final statement. The possible problem areas regarding the fogging hazards and airspace clearances must be cleared up to the satisfaction of the Federal Aviation Administration. It is recommended that this aspect be coordinated directly with the FAA regional office in Atlanta, Georgia; address as follows:

Mr. William J. McGill
Chief, Airports Division, FAA
P. O. Box 20636
Atlanta, Georgia 30320
tele 404-526-7224

The opportunity for the Department of Transportation to review and comment on the Crystal River, Unit 3, Nuclear project is appreciated.

Sincerely,

J. D. McCANN
Captain, U. S. Coast Guard
Acting Chief, Office of Marine
Environment and Systems

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

50-302

RECEIVED
OCT 31 1972
U.S. ATOMIC ENERGY COMMISSION
Regulatory Mail Section

October 30, 1972

Mr. Daniel R. Muller
Director of Licensing
Atomic Energy Commission
Washington, D. C. 20545

Dear Mr. Muller:

We have had the draft environmental impact statement for the Florida Power Corporation's Crystal River Unit No. 3 reviewed in the relevant agencies of the Department of Agriculture. Comments from the Soil Conservation Service, an agency of the Department, are enclosed.

The Forest Service, also an agency of the Department, has not yet completed its review. Forest Service will communicate with you directly if it has comments.

Sincerely,

Fred H. Tschirley

FRED H. TSCHIRLEY
Assistant Coordinator
Environmental Quality Activities

Enclosure

Soil Conservation Service, USDA
Comments on Draft Environmental Statement prepared by Florida Power Corporation and U. S. Atomic Energy Commission for Crystal River Unit 3 (Operating License Stage).

The Environmental Report consisting of five volumes prepared by the Florida Power Corporation and the Draft Environmental Statement prepared by the U. S. Atomic Energy Commission for the Crystal River Unit 3 has been reviewed by the Soil Conservation Service.

The report is no doubt correct when the statement is made on page V-16 that a ground water withdrawal of less than 1 million gallons per day (listed in the AEC Report as 0.6 MGD) will have a negligible impact, but the analysis seems to over state the situation by referring to a recharge area considerably larger than that contributing ground water to the plant site. A more meaningful comparison might show the probable amount of ground water entering the area of the power plant balanced against the other points of major ground water withdrawals, natural or man-made, from the same source.

The increased velocity in the discharge canal resulting from the Unit 3 addition is discussed on page V-64. Mention is made of the probability that the resulting canal scouring will produce turbid water conditions. Elsewhere, in the report (pages V-14 and V-102 for example) it is stated that the discharge canal is to be enlarged, but it is not clear what effect the enlargement will have on the velocity in the canal. If the enlargement reduces the velocity to a non-scouring magnitude, this should be stated in Section V. However, in the event that turbid water conditions will exist even after canal enlargement, the impact of this occurrence should be either outlined in Section V or an explanation should be presented in Section VIII of why it cannot be avoided. We suggest that the mechanics of degradation of stream channels is reasonably well understood and that design parameters exist that when applied to proportioning canals for the movement of water, essentially all scouring is eliminated in the resulting product.

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

October 30, 1972

50-302

RECEIVED
OCT 31 1972
U.S. ATOMIC ENERGY COMMISSION
Regulatory Mail Section

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 "Crystal River Unit No. 3 and Supplements No. 2 and 3 to Environmental Report/Volume 5" which accompanied your letter of September 11, 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 statement adequately describes the expected impact of the proposed project on the aquatic resources. Our comments are directed to specific areas that require further discussion and/or explanation.

2.6.2. Aquatic Ecology

2.6.2.1. Shoreline Marshland Ecosystem

Page 2-24, second paragraph, second sentence. The vital role of nursery areas in the continued productivity of these species and shrimp, is well-documented and should be mentioned.

2.6.2.3. Finfish and Shellfish Population

Page 2-33, first sentence, last paragraph. Shrimp, one of the most important species, should be included. Also, the term "juvenile" is incorrect. Some species enter inshore waters in earlier stages (larval, post-larval, mysis). The sentence should read: "Early life stages of finfish and shrimp arrive in inshore waters within one or two months following the spawning of adults."

2.6.2.6. Commercial and Sport Fishing

Page 2-54. Although shrimp are not taken commercially in Citrus County waters for human consumption, there is a commercial bait-shrimp fishery that should be discussed. Bait-shrimp are not sold by the pound, but as individual shrimp. Surveys of the bait-shrimp fishery in Florida were not begun until 1963. Citrus County statistics from that year through 1970 are given below:

Year	Num ber of Individual Shrimp	Value
1963	3,113,030	$ 39,241
1964	3,826,615	43,055
1965	944,347	12,407
1966	549,550	9,192
1967	8,079,000	88,746
1968	10,413,450	124,297
1969	7,824,500	89,078
1970	12,123,000	187,266

Shrimp are the most popular "all-around" bait in Florida, and the rapid growth of salt-water sport fishing is certain to place increased demands on the bait-shrimp fishery. Considering declining yields of this fishery elsewhere along the coast, caused in great part by man-made alterations of the estuarine habitat to satisfy various desires of a bourgeoning population, the Citrus County fishery should become more important with each passing year.

Page 2-55, In making a comparison between the commercial catches off the west coast of Florida and Citrus County, it should be noted that fish and shellfish (shrimp) originating in the waters of Citrus County move up and down the coast and contribute in varying degree to catches of other coastal counties.

The radiological monitoring program appears to be adequate. However, considering the data produced by field surveys (pp. 2-24 to 2-56), more details on the selection of species for radiological analysis would be desirable.

7. Adverse Effects Which Cannot Be Avoided.

Page 7-1. Seventh paragraph.

Recent studies, made by St. Petersburg Beach Laboratory biologists, showed the average volume of zooplankton present in Crystal Bay area waters to be 0.25 milliliters per cubic meter. The present flow of water through the plant is approximately 600,000 gallons per minute. With the addition of Unit No. 3, the flow will be approximately 1,250,000 gallons per minute. Assuming total kill of zooplankton, dead organisms will accumulate at a rate of about 2 cubic yards per day. By weight, this amounts to a daily loss of 1.4 tons of zooplankton.

To more graphically show the magnitude of the volume of water required for the plant's cooling system, a comparison was made of this need with the quantity of water enclosed within natural geographical boundaries south of the site. Spoil areas adjoining the intake channel extend for slightly more than 4 miles into the Gulf. Long Point lies 6 miles to the south (see attached chart). The waters shoreward of a line from Long Point to the outermost spoil bank comprise a semi-enclosed area encompassing oyster bars and the mouth of the Crystal River, and has a volume of about 21 billion gallons. With Unit No. 3, in operation, the plant will require approximately 1,728 million gallons of cooling water per day, or the equivalent of all the waters in this "bay" every 16 days.

In view of the foregoing, we do not agree that the loss of planktonic forms during plant operation will have a negligible effect on the overall productivity of the in-shore marine ecosystem. The basis for arriving at this conclusion should be thoroughly discussed, together with presentation of substantiating data.

Spelling errata.

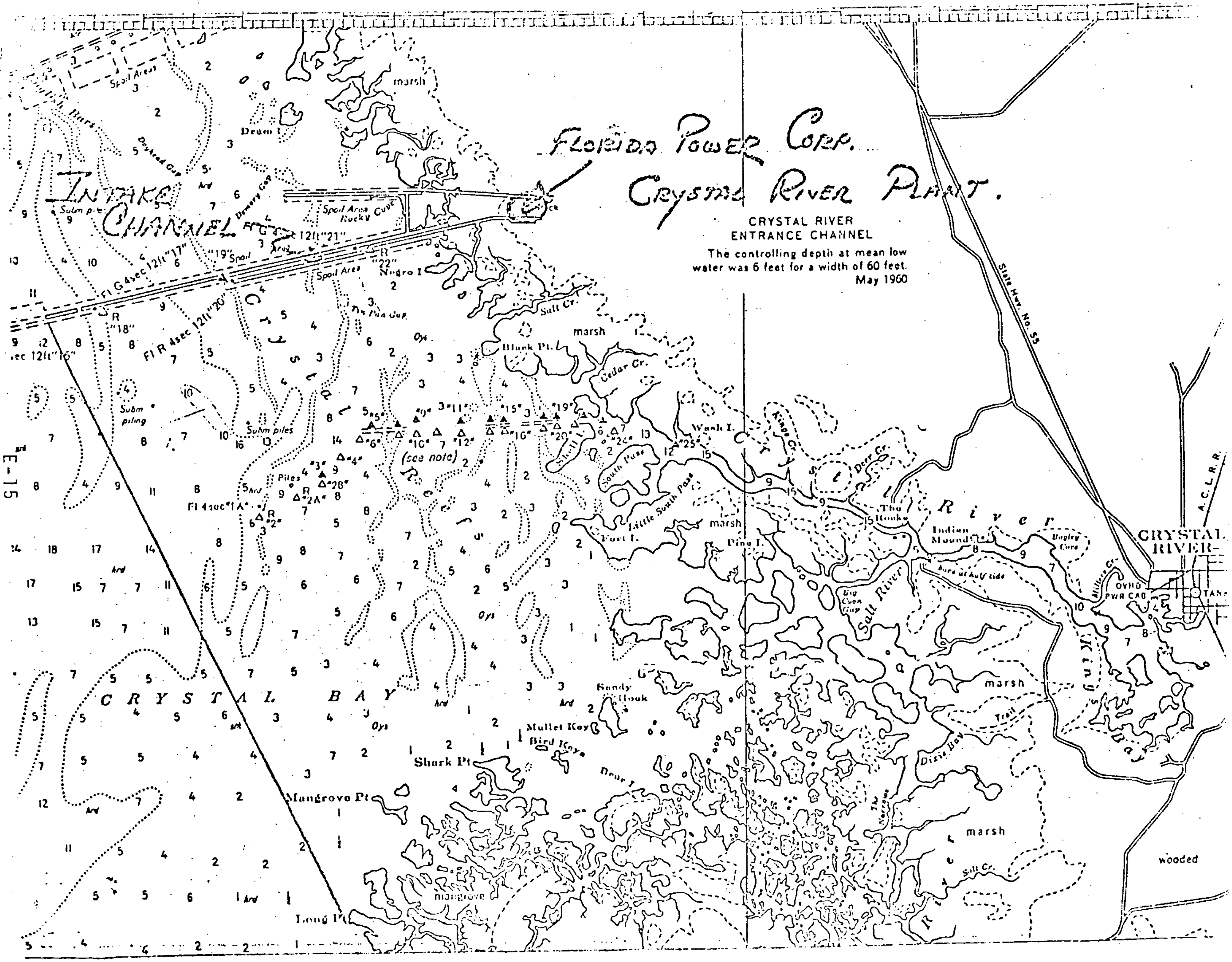
Page 2-30 Table 2.5

Lobotes surinamensis

Page 2-31 Table 2.5

Sciaenops ocellata

Sphyraena barracuda



FLORIDA POWER CORP.
CRYSTAL RIVER PLANT.
INTAKE CHANNEL
CRYSTAL RIVER
ENTRANCE CHANNEL
The controlling depth at mean low water was 6 feet for a width of 60 feet.
May 1960
CRYSTAL RIVER
Crystal River
Crystal Reef
CRYSTAL BAY
Kings Bay
Salt River
State Hwy. No. 55
A.C.L.R.R.
Drum I.
Negro I.
Black Pt.
Cedar Cr.
Salt Cr.
Wash I.
Kings Cr.
Deer Cr.
South Pass
Little South Pass
Fort I.
Pine I.
The Rocks
Indian Mound
Sandy Hook
Mullet Key
Bird Keys
Shark Pt
Mangrove Pt
Long Pt
marsh
wooded
Spoil Areas
Spoil Area
Rocky Cove
Subm piles
Subm piling
(see note)
E-15

Page 2-32 Table 2.5

Mackerel (King and Spanish)

Paralichthys albigutta

Page 2-34 Table 2.6

Centropristes striata

Archosargus probatocephalus

Page 2-35 Table 2.6

Paralichthys albigutta

Page 2-55 Finfish (table)

Angelfish

Spanish Mackerel

Page 5-31 Productivity

Considering the proposed location of the plant, it was noteworthy that the potentially overriding hydrometeorological impact of storm surge was overlooked. The statistics cited with regard to hurricane frequency appeared essentially correct. However, it is suggested that these data be further examined.

Section II, Item D2, indicates a small probability of hurricane occurrence in Florida--ranging from zero to five in individual years and averaging only 1.6 per year during the period 1885 to 1958. This occurrence index cannot be disputed. However, a space/time stratification of similar data would suggest a higher probability of hurricane produced meteorological impacts.

For example, during the period 1900 to 1969, the United States (south of 35° N) experienced 19 hurricanes which had central pressures $\leq$ 950 millibars at landfall. Sugg[1] has developed a mean profile of these storms with probable

[1]Sugg, Arnold L. "A Mean Storm Surge Profile," Weather Service Southern Region, Technical Memorandum WBTM SR=49, Dec. 1969.

occurrences of storm surges of 16 feet, although heights up to 23 feet have been recorded. More important, a rectangular plot of the profile exhibits a roughly normal curve of lateral extent of storm surge versus height. As an illustration, eight-foot surges would have a horizontal extent of approximately 100 NM--mostly south of the hurricane "eye".

Therefore, it is suspected that the frequency of important storm surge effects on a plant situated on an outer bank island in southern Florida would be statistically significant. This may suggest that the section on Postulated Accidents should consider hydrometeorological effects.

We agree with the AEC staff's computation of the average annual relative concentration as applied to routine releases.

We are unable to evaluate the AEC staff's analysis of the impact of accidental releases of radioactivity because the meteorological assumptions, the resulting relative concentration, and the probability of occurrence of such a concentration is not specified.

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

ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF THE ADMINISTRATOR

NOV 1 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 statement for Crystal River Unit 3 Nuclear Power Plant and we are pleased to provide our comments.

It appears that use of the radioactive waste management equipment described for the plant should result in off-site doses consistent with the "as low as practicable" concept. It is not apparent, however, that the secondary system gaseous and liquid discharges will be adequately treated. We believe the final statement should discuss these discharges as they relate to the environment and to the "as low as practicable" philosophy.

The EPA feels that in order to comply with state water quality standards, it may be necessary to modify the proposed Unit 3 by incorporating a closed-cycle cooling system. Further consideration should be given to such a system in the final statement.

The proposed intake structures will also require modification to prevent the entrainment of large numbers of fish and other aquatic species. The final statement should discuss reasonable measures that could be adopted to lessen the adverse impact on aquatic biota.

We will be pleased to discuss our comments with you or members of your staff.

Sincerely,

Sheldon Meyers

Sheldon Meyers
Director
Office of Federal Activities

D-AEC-EPA-00069-29

ENVIRONMENTAL PROTECTION AGENCY

Washington, D.C. 20460

October 1972

ENVIRONMENTAL IMPACT STATEMENT COMMENTS

Crystal River Unit 3 Nuclear Power Plant

TABLE OF CONTENTS

INTRODUCTION AND CONCLUSIONS

The Environmental Protection Agency (EPA) has reviewed the draft environmental statement for Crystal River Unit 3 Nuclear Power Plant prepared by the U.S. Atomic Energy Commission (AEC) and issued on September 11, 1972. Following are our major conclusions:

1. In most respects the capabilities provided by radioactive waste management equipment for Crystal River Unit 3 should result in off-site doses consistent with the "as low as practicable" concept. However, it is not apparent that secondary system gaseous discharges via the condenser air ejector and steam dumping, and liquid discharges via secondary system condensate leakage will be adequately treated. Thus, the final statement should discuss the handling and treatment of secondary system liquids in relation to environmental releases and the "as low as practicable" philosophy.

2. Analysis of available information indicates that the addition of Unit 3 to the Crystal River power station while employing the proposed once-through cooling system may not permit operation at full capacity that is, at all times, in compliance with existing Federally approved state water quality standards. We suggest, therefore, that it may be necessary to modify Unit 3 to incorporate a closed-cycle cooling system. The final statement should discuss this possibility and indicate the means by which compliance will be accomplished.

3. The intake structure, as presently designed, will entrain large numbers of fish and other aquatic species. We recommend, therefore, that this structure be modified to lower the rate of entrainment. The final statement should describe feasible modifications and other measures that could be reasonably adopted to prevent a significant, adverse impact on aquatic biota.

RADIOLOGICAL ASPECTS

Radioactive Waste Management

In most respects the capabilities provided by the waste management equipment for Crystal River Unit 3 should result in off-site doses consistent with the "as low as practicable" concept. However, it is not apparent that all secondary system liquid effluents will be adequately treated prior to discharge.

The draft statement and FSAR indicate condensate leakage will not be treated prior to discharge. However, secondary system water will be continuously treated for solids control by condensate demineralizers. This method of solids control is used in place of the blowing down of water from the steam generators, a method employed for solids control in most PWR steam generators. This type of control, if effective, will also significantly reduce the concentrations of radioactivity in the secondary system water to levels which may not require treatment prior to discharge. However, information presented in the draft statement is not adequate to determine the effectiveness of the demineralizers in controlling secondary system radioactivity concentrations. Also the statement did not present estimates of the radioactivity to be released from condensenate leakage. Consequently, it is not obvious that the discharge of untreated condensate leakage to the environment is consistent with the concept of "as low as practicable."

The draft statement should discuss the maintenance of secondary system components such as the steam generator and condensers. Maintenance of these components may result in the generation of large volumes of radio-activily contaminated liquids which may require treatment prior to discharge.

The draft statement indicates that condenser air-ejector exhaust will be monitored, but there will be no treatment provisions for radioiodine. However, the draft statement estimated radioiodine discharge from the air ejector to be minimal. The assumptions utilized by the AEC to estimate the air ejector radioiodine source term were not presented in the draft statement. Since the air ejector could be a major pathway for radioiodine discharged from the plant, it is important that the draft statement discuss the credit, if any, taken for radio-iodine removal from the secondary system by the condensate demineralizers and discuss other assumptions made to estimate radioiodine discharges from this source.

Neither the draft statement nor the environmental report have addressed iodine releases during expected operational occurrences, such as steam dumping. We note that the proposed Appendix I to 10 CFR 50 and the present AEC regulations (10 CFR Part 50.36a) apply to "... discharges ... during normal reactor operations, including expected operational occurrences ... .", but the AEC has not detailed which operational occurrences are to be evaluated relative to the guidelines proposed in Appendix I. Operating experience indicates secondary system steam is routinely dumped to the atmosphere to remove process heat during transients and to remove decay heat during hot and cold shutdowns. Thus, it appears that the 10 CFR Part 50 regulations should be applied to atmospheric steam dumping. The AEC should discuss the relationship of their regulations to operational occurrences at a PWR and evaluate the environmental effects of iodine release during steam dumping.

In conclusion, the final statement should discuss in more detail the handling and treatment of secondary system gaseous and liquid releases, including: (1) the expected decontamination factors of the condensate demineralizers for removing iodine, cesium, and other radionuclides from secondary system water; (2) the criteria for routing condensate leakage to the waste treatment system for additional treatment; (3) the criteria for treating radioactive liquids generated during maintenance of secondary system components; (4) an evaluation of the anticipated volume, the activities, and the treatment of condensate leakage and the large volume of radioactive liquids generated during secondary system component maintenance; (5) the assumptions and their bases for the estimated radioiodine discharges (page 3-17 of the draft statement) from the condenser air ejector; (6) an evaluation of the activity and environmental impact of discharging radioiodine to the atmosphere as a consequence of steam dumping; and (7) the relationship of radionuclide discharges from anticipated operational occurrences to "as low as practicable" concepts.

Tritium Buildup

Since the Crystal River station will not blow down liquids from the secondary system, a high concentration of tritium will buildup in the secondary system water as a result of leakage of tritium from the primary system. This buildup of tritium may be common to any PWR which has no process, such as blowdown, for removing tritium from the secondary system. Therefore, the final statement should discuss (1) the expected concentration of tritium in the secondary system water, (2) the anticipated volume of secondary system water contaminated by tritium, and (3) the ultimate disposition of this tritiated water.

Good Management Procedures

The discharge of most radioactive liquids and gases to the environment largely depends upon (1) administrative controls imposed by the applicant over the daily operation of the facility and (2) waste treatment equipment performance. Except for the treatment of secondary system discharges previously discussed, the treatment of the radioactive gaseous and liquid wastes are expected to be consistent with the "as low as practicable" philosoply if the waste treatment equipment provided is operated and maintained in a manner consistent with the AEC regulations specified in 10 CFR 50.36a. The final statement should provide criteria for utilization of waste treatment equipment and for the discharge of waste to the environment. In addition, the final statement should include such information as criteria for dilution, radioactive discharge rates, and concentrations of radioactivity in the discharge canal. Also, in order for the radioactive liquid discharges to comply with 10 CFR Part 20 regulations and the proposed 10 CFR Part 50 Appendix I guidelines, we believe the applicant should only take credit for dilution flow equivalent to that available from Unit 3. Since the environmental impact of the plant will be related to the plant's technical specifications, the final statement should discuss, at least in general terms, the portions of the technical specifications which directly relate to the environmental impact of the facility.

Transportation and Reactor Accidents

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 accidenst 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

Thermal Effects

As indicated in the draft statement, the nuclear powered Crystal River Unit 3 will be located on a site already occupied by two operating oil-fueled electrical generating plants (Units 1 and 2).

All three units will withdraw cooling water from the shallow, nearshore waters of the Gulf of Mexico through a common intake canal extending into the Gulf and diked on both sides. The system will discharge heated water back into the Gulf through a canal to the north of the intake canal and diked along its southern side only. The addition of Unit 3 to this station will increase the cooling water flow by 107 percent and the total waste heat load by 160 percent (from 1420 cfs at delta 11.5°F to 2940 cfs at delta 14.5°F). Although preoperational thermal model studies conducted by the applicant and revised by the AEC may not provide definitive predictions, analysis of currently available information indicates that the once-through cooling system of Units 1 and 2, when augmented by Unit 3, will probably not enable the Crystal River facility to operate at full capacity at all times and remain in compliance with thermal restrictions of the existing Federally-approved state water quality standards. Should this occur, it may be necessary to adopt an alternate closed-cycle cooling system for Unit 3. The final statement should discuss this possibility and indicate how compliance will be achieved.

In this regard and according to AEC estimates, once Unit 3 goes into operation the acreage covered by the thermal plume will increase from 2350 acres to 4600 acres. Apparently, this area will be considered the mixing zone and will be bounded by the delta 1°F isotherm. The

AEC expects the most severe ecological impact to occur during the season when the combination of ambient and incremental temperatures exceed 95°F. In addition, it is estimated that this condition can be expected to occur approximately 53 percent of the time. According to AEC analyses, the primary impact area will most probably be bounded by the delta 6°F isotherm and, on the average, with the additional thermal effect of Unit 3, will occupy approximately 1500 acres.

Federally-approved water quality standards for the State of Florida do not specify mixing zone size. An acceptable mixing zone is determined on a case-by-case basis (see attachment A). In our opinion, however, a mixing zone as large as that estimated by AEC may fail to meet other aspects of the standards. For example, the antidegradation statement included in the water quality standards prohibits "a new or increased source of pollution" from degrading existing water quality (see attachment B). In addition, revisions to the Florida Water Quality Standards adopted by the Florida Department of Pollution Control on July 25, 1972, (not yet approved by EPA) require that existing discharges (including those under construction which have a state permit), "shall not increase the temperature of the receiving body of water so as to cause damage or harm to the aquatic life or vegetation therein ... ." Also, off-stream cooling or other approved methods are required in the event that monitoring produces evidence of substantial damage.

Thus, in view of the large increase in thermal release to the ecologically valuable, near-shore waters of the Gulf by the addition of Unit 3 and the apparent underestimate of thermal plume size by the applicant, we believe that the site may not be compatible with a once-through cooling system, with or without supplemental cooling or dilution. We realize that the addition of a closed-cycle system may involve other environmental impacts (i.e., salt spray, destruction of marsh lands, dredging). In spite of these impacts, however, the applicant and the AEC should, in our opinion, reevaluate such systems and the final statement should include the details of any evaluations performed.

With regard to the alternative systems discussed in the draft statement, the AEC proposes that the discharge canal be extended some 6000 feet. In our opinion, however, this modification of the proposed once-through system may not sufficiently remove the heated discharge water from the vulnerable near-shore area or guarantee compliance with standards. In order for this proposal to be effective, a greater extension would probably be necessary. Since such an extension would involve additional dredging and the resulting structure would further impede the already restricted along-shore circulation, we do not believe this alternative represents a useful solution to the thermal problems of the Crystal River plant.

One alternative that was not mentioned in the draft statement is the spray module assisted cooling pond. Although both cooling ponds and the use of spray modules (e.g., located in the discharge canal) were discussed, the combination alternative was not evaluated. The combination system has the advantage that the size of the pond required is significantly reduced over that needed for an unassisted cooling pond. In addition, if such a system were located in the uplands region instead of the marsh area, destruction of this valuable resource could be avoided. Also, since the plant is located on a 4,738 acre site and is more than a mile from the property boundary, and since the site is already under the natural influence of the coastal environment, potential problems associated with fogging or salt water drift should not cause serious concern.

Thus, we recommend that this alternative, along with other feasible closed-cycle systems (e.g., mechanical draft towers), be fully evaluated in the final statement. In this regard, with the possible exception of hurricane forces affecting the natural draft tower alternative, we can see no serious impediments to the use of closed-cycle cooling devices at this site.

Biological Effects

The draft statement indicated there will be considerable entrainment of fish and other organisms that swim or drift in the vicinity of the plant intake. At present an estimated 32,000 lbs. of finfish and 4,000 lbs. of shellfish are destroyed annually on the intake screens of Units 1 and 2.

Finfish and shellfish losses may increase considerable (by more than a factor of two upon doubling of the intake canal velocity to 1.3 fts and intake canal volume to 2940 cfs) when Unit 3 becomes operable. Entrainment will be increased due to the doubling in volume of inflow and the inability of fish to escape because of greater water velocities. Such a possibility is accentuated by the fact that the marsh habitat in the plant vicinity, as well as elsewhere along the western Florida coast, serves as a nursery area for finfish species such as mullet, spot, black drum, redfish, croaker, mojarra, and silversides. The young of these species would be expected to be very susceptible to entrainment by increased intake velocity.

We recommend that the applicant consider modifing the intake structure in order to reduce or eliminate the increased fish destruction incurred by the additive effect of Unit 3. Suggested remedial changes that might be considered are as follows:

a. the present velocity of intake water (i.e., with two units) could be maintained or even decreased by widening and/or deepening the intake canal prior to operations of Unit 3,

b. intake racks and horizontally moving screens could be provided with a sluice to transport trapped living biota back directly to ambient-temperature Gulf waters,

c. the addition of bubble or electric rod curtains should be considered at the intake canal entrance as a possible deterrent to fish entry.

Analysis of the value of fish killed by the intake screens should be re-evaluated for a number of reasons. For example, values are based on poundage of fish and shellfish at dockside price, but this evaluation introduces significant error. Significant numbers of juvenile fish are killed, but the analysis does not evaluate this loss at a mature fish weight and value. Additionally, the analysis does not project the value of these fish in the total economy.

Recently, EPA observers have discovered damage to the oyster reef communities southeast of Drum Island and approximately one mile west of the tip of the 1.5-mile discharge dike. This damage is within the thermal plume area. The larger animals were dead and a profusion of bluegreen algae covered the reefs in a thick coating (abnormal for April when this observation was made). Such conditions were not observed in waters south or west of this area. The area to the south is apparently protected from the thermal plume by the 6.5-mile intake canal dike. In addition, unusual quantities of Caulerpa (alga) developed in the plume ares. Caulerpa appeared outside this area in lesser abundance and in generally more diverse communities of algae and seagrasses. Nudibranches and brittle stars were not observed in effluent affected areas although they were seen elsewhere in the area. Thus, in our opinion, these situations indicate that the thermal discharge from Units 1 and 2 may have already induced abnormal changes in the marine ecosystem surrounding the plant.

The list of the applicant's baseline studies at the Crystal River site is impressive. As indicated in the draft statement, however, in some cases the studies are preliminary or incomplete. Specific details should be provided on parameters such as frequency of sampling, sampling locations, and sampling methods which would allow an evaluation of the baseline studies program. In addition to the checklist of plants and animals in the area, the applicant should provide quantitative data on the (a) abundance, (b) distribution, and (c) condition of species present. Particularly important categories for which this information need be given are:

(a) phytoplankton

(b) zooplankton

(c) invertebrate larvae

(d) fish larvae and juveniles

(e) polychaete worms

(f) mollusks (all families, not just "shellfish")

(g) seagrasses and algae

(h) echinoderms

(i) crustaceans.

Abundance, distribution, and condition might be illustrated most clearly as bar-graphs on an area map for each major species along with summary figures for categories of organisms. Also, we agree with the comment in the draft statement that the applicant should be required to monitor and record, by number and species, the fish caught in the plant intake structure.

The scope of baseline studies and any monitoring program should be such that an assessment can be made of any significant environmental damages and changes which may result from operation of the facility. Since the action under consideration is the issuance of an operating license for Crystal River Unit 3, sufficient detail should be presented to ensure that the adequacy of both preoperational and postoperational baseline and monitoring efforts can be assessed. We recommend that this information be provided in the final statement.

Chemical Impact on Biota

The applicant is to be commended on the decision to use a closed-cycle liquid chemical waste system for the entire Crystal River plant. We believe, therefore, that the use of this system will probably enable the plant to operate in compliance with applicable chemical water quality standards.

The draft statement indicated that two percolating ponds are expected to be used. Presumably they will be part of the closed-cycle, waste-chemical disposal system. The use of these ponds is unclear, however. If, in fact, they are to be used for the disposal of pollutants, the final statement should indicate the type of pollutant, the effects of soil percolation on the pollutants (some chemicals are converted and others are not by soil percolation), the possibility of groundwater pollution, and the potential effect due to the direction of groundwater flow.

AIR QUALITY

The non-radioactive air quality effects of a nuclear generation facility do not compare in magnitude to problems of other environmental concern. However, air quality effects do comprise a portion of the total environmental impact of the facility and as such must be considered. The final statement should dicuss the environmental effects of air contaminants which will be released during the construction and operation of the facility and it should therefore present the following information:

(1) a discussion of the air quality aspects of any auxiliary boilers and/or emergency generating equipment to be used at this facility. The discussion should include the following: (a) size, type, and number of units; (b) fuel type; (c) fuel analysis including percent sulfur; (d) annual fuel use rate; and (e) estimated composition and concentration of the emissions.

(2) a discussion of the methods to be employed for dust control at the site during the remainder of construction.

(3) a discussion of the particulate control methods to be utilized for the use of any on-site concrete batch plant.

(4) a description of the provisions that have been made for disposal of non-radioactive combustible construction debris and solid wastes generated at this facility during construction and operation.

(5) a discussion of the potential air quality effects produced by the combined effects of a cooling tower vapor plume (if cooling towers are employed at the site) and the emissions from the oil fired generating units at this site.

(6) a discussion of the potential environmental impact of ozone produced by the high voltage transmission lines. Since little information concerning the production of ozone by high voltage transmission lines is available, EPA is preparing to study this problem. It would also be desirable for the AEC to provide any available information concerning ozone the utility companies may have.

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 Crystal River Unit 3 Nuclear Power Plant. The cumulative effects, however, could be significant. It would, therefore, be helpful in determining the impact of the plant if the following information were included in the final statement:

1. The draft statement indicates that shrimp will be commercially grown in the heated discharge waters from the plant. The final statement should discuss the potential radiological impact of this project.

2. The draft statement provides no information assessing the environmental noise impact of the project. An acoustical survey is recommended to estimate the maximum sound pressure level of the nuclear plant along its boundary to insure compliance with the U.S. Department of Housing and Urban Development Circular No. 1390.2, Noise Abatement and Control; Departmental Policy, Implementation Responsibilities, and Standards. If the noise criteria are exceeded in existing or proposed residential areas, then a detailed discussion of noise abatement techniques should be included in the final statement.

3. Insufficient consideration has been given to disposal of solid waste from Crystal River Unit 3 Nuclear Power Plant. Land clearing waste, construction debris, excavation materials, operations refuse, and other non-radioactive wastes could present

short-term adverse environmental impacts unless disposed of in accordance with state solid waste management rules and regulations. Plans of the disposal procedures should be discussed in detail in the final statement. The plans should also be submitted to and approved by the state solid waste management program.

4. Adequate storage capacity should be provided for containment of closed cooling loop wastes which contain dichromate and other chemicals until processing by the closed-cycle system can be achieved. Such storage should be discussed in the final statement.

5. Discharge canal velocities will be increased from 1.1 fps at present to 2.4 fps under the proposed discharge scheme. Significant increase in scouring is anticipated due to this velocity; an estimate of the type and amount of canal material susceptible to scour should be presented in the final statement.

6. Final disposition of solid waste from the closed-cycle chemical system is currently under investigation. In our opinion the results of such investigations should be included in the final statement. In addition, the procedure for disposing of sanitary sludge from the extended aeration facility should be discussed.

7. The freshwater outflow from the Withlacoochee River-Cross Florida Barge Canal (annual flow - 1170 cfs) tends to reduce the salinity in the thermal discharge area through dilution. This freshwater dilution effect is not felt in the area of the cooling-water intake because the northern dike of the intake canal blocks

the freshwater intrusion. Therefore, water drawn through the intake canal and later discharged is more saline than ambient waters in the discharge area. The addition of Unit 3 may increase this saline discharge. The possibility of adverse ecological effects due to this saline discharge should be considered in the final statement.

8. As indicated previously, oil is presently used for fuel in Units 1 and 2. Possible effects of an oil spill should be evaluated and discussed. Unloading of over 2,500,000 gallons of oil every other day, from tankers docked in the plant's intake canal, could lead to a significant oil spill. Procedures and equipment for control of potential oil spills should be discussed. In addition, should oil spills prove to be a problem, consideration should be given to relocating the docking facilities in the discharge canal. Such considerations sould be included in the final statement.

Attachment A

1700-5.05 Water Quality Standards; Specifics. - (1) The criteria of water quality hereinafter provided will be applied only after reasonable opportunity for mixture of wastes with receiving waters has been afforded; the reasonableness of the opportunity for mixture of wastes and receiving waters shall be determined on the basis of the physical characteristics of the receiving waters and the methods in which the discharge is physically made shall be approved by the regulatory agency. (2) The following water quality standards shall be the criteria for pollution when concentrations exceed the following limitations:

(a) Fluorides - shall not exceed 1.4 to 1.6 mg/l as fluoride ion, depending on annual average daily air temperature for at least a five-year period for sources of Class 1 public water supplies measured immediately above or adjacent to raw water intake.

(b) Fluorides - for waters not used for public water supplies, shall not exceed 10.0 mg/l as fluoride ion or will not interfere with other beneficial uses. (Amended 1-16-69)

(c) Chlorides - chlorides shall not exceed two hundred fifty (250) mg/l in streams considered to be fresh water streams; in other waters of brackish or saline nature the chloride content shall not be increased more than ten percent (10%) above normal background chloride content.

(d) Turbidity - shall not exceed fifty (50) Jackson units as related to standard candle turbidimeter above background.

(e) Dissolved Oxygen - shall not be artificially depressed below the value of four (4.0) ppm (unless backgound information available to the regulatory agency indicated prior existence under unpolluted conditions of lower values.) In such cases, lower limits may be utilized after approval by the regulatory authority.

(f) BOD - shall not be altered to exceed values which would cause dissolved oxygen to be depressed below the limit listed above and, in no case, shall it be great enough to produce nuisance conditions.

(g) Temperature shall not be increased so as to cause any damage or harm to the aquatic life or vegetation of the receiving water or interfere with any beneficial use assigned to such waters. (Amended 1-16-69)

Attachment B

AMENDMENT NO 1 (In part)

Section 28-5.01 FAC, is amended to read as follows:

The policy inherent in the standards shall be to protect water quality existing at the time these water quality standards were adopted or to upgrade or enhance water quality within the State of Florida. In any event where a new or increased source of pollution poses a possibility of degrading existing high water quality, such project development shall not be issued a Commission permit until the Commission is satisfied that such development will not be detrimental to the best interest of the state and necessary to its social and economic development. In administering the policy, high quality receiving waters will be protected by requiring as a part of the initial project design the highest and best practicable treatment available under existing technology.

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
P. O. BOX 4970
JACKSONVILLE, FLORIDA 32201

50-302

SAJWE

26 October 1972

RECEIVED
NOV 3 1972
U.S. ATOMIC ENERGY COMMISSION
Regulatory
Mail Section

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

Dear Mr. Muller:

In reference to your letter of 11 September 1972 transmitting the Draft Environmental Statement on Crystal River Unit 3, the following comments are submitted.

Summary: The draft statement is adequate and complies with the National Environmental Policy Act of 1969. Other specific comments on the statement offered for your consideration are as follows:

(1) Page 2-11. "Due to its remote location, the character of the shoreline, and the low population density, the site itself originally had only marginal recreational value." It may not be advisable to refer to this area in such terms considering a previous description of the site on page 2.0, which states:

"The region of the site is characterized by gradually rising terrain from mangrove swamp and marshlands at the coast to gently rolling hills about 16 miles inland to the east. The plant site itself was primarily hardwood hammock forest and marshland, see figure 2.1, with a variety of vegetation ranging from swamp grass to large trees." Such a natural area does not have marginal recreational value solely because it is not utilized to the maximum extent possible. A second reference is made on page 2-54.

(2) Page 2-22. Table 2.4 could be improved by adding more typical bird species to the list.

(3) Page 2-26. Paragraph 2 states "Because of the small standing crop of producers..." This statement should be clarified as salt-marsh ecosystems are characterized by a large-standing crop of producers.

(4) Page 2-26. In Figure 2.5 the trophic pathways as presented are misleading; for example, oysters generally obtain their energy from filter feeding of detritus, rather than phytoplankton. Killifishes are thought to feed upon larval insects, primarily mosquito larvae, and Leiostomus xanthurus are not detritus feeders. Although many crabs are detritus feeders, those of importance to man, as Callinectes sapidus, are generally considered to be predators or scavengers. Table 2.6 has similar deficiencies. Inclusion of the category "bottom dwelling invertebrates," such as mollusks annelids and crustaceans, as the primary consumer organisems of detritus is suggested.

(5) Page 2-26. Spartina alterniflora and Salicornia are misspelled.

(6) Pages 2-31, 32. Mugil cephalus, Sphyraena barracuda, Scomberomorus cavalla, and S. maculatus are misspelled.

(7) Several of the figures presented in the last column of table 2.7 are incorrect, based on the assumptions and data presented. The results of our calculations are as follows:

Species	Major Dietary Items	% Composition of Diet	Amt.(g) of E Item Consumed/Yr.	
			Year 1	Year 2
Callinectes Sapidus	Detritus	26	117	663
	Micro-invertebrates	52	234	1326
	Macro-invertebrates	14	63	357
Cynoscion nebulosus	Macro-invertebrates	13	240	364
	Fish	79	1461	2212
Lagodon rhomboides	Vascular plants	41	50	173
	Detritus	20	25	84
	Crustaceans	27	33	114
Sciaenops ocellata	Macro-invertebrates	63	2104	7466
	Fish	17	568	2014
Cynoscion arenarius adults	Fish	87	1610	2436
	Detritus	8	148	224
	Crustaceans	5	93	140

(8) Page 2-46. Sargassum is misspelld.

(9) Page 2-53. Table 2.12 could use an explanation of the units of measurement used to present the data.

(10) Page 2-54. A reference made to "rock crab" which apparently refers to Menippe mercenaria, usually known as stone crab.

(11) Page 5-7, last paragraph. The figure on page D-6 indicates a temperature of 81^{o} F or above is to be expected approximately one-third of the year. We suggest it be noted here.

(12) Pages 5-24 and 5-25. Three typographical errors were noted:

a. "Turkey Point plant, Biscayne Bay, northeast Florida,..."

b. "Porifera LET_{75} and Fish UET_{50}..."

c. "Salinities of 2-2 % had little effect..."

(13) Page 5-28. The applicant states that small releases of radionuclides in the form of processed liquid waste will be released from the plant on a batch basis via nuclear services seawater system and discharge canal into the Gulf of Mexico. As the radioactive wastes have exceedingly long half-lives, consideration should be given to including the reasons for not removing this waste to approved burial areas rather than releases into the marine environment where it may accumulate in the sediments of the discharge canal.

(14) Appendix A References. Several references omit pertinent data and should be reviewed for adequacy; i.e. numbers 14, 51, 52, 55, 56, 57, 58, 60, 62, 63, 64, etc.

(15) Radioactive wastes should be expressed in terms of maximum concentration per hour and microcuries/ml.

(16) The Environmental setting should include background concentrations of radiation in terms of microcuries/ml and a discussion of the impact of the added concentrations along with a comparison with the standards.

(17) The effluent temperature appears to violate state standards for coastal waters. The report states that a temperature difference of 8.1^{o}C. above influent temp will be discharged. The standards state that heated water more than 2^{o}F(3.6^{o}C) shall not be discharged into coastal waters in any zone during the months of June, July, August, and September. At other times the temp difference cannot exceed 4^{o}F(7.2^{o}C).

SAJWE 26 October 1972
Mr. Daniel R. Muller

(18) The actual temperature of effluent should also be noted.

We appreciate the opportunity to comment on the EIS.

Sincerely yours,

JAMES L. GARLAND
Chief, Engineering Division

STATE OF FLORIDA
Department of State
THE CAPITOL
TALLAHASSEE 32304

50-302

RICHARD (DICK) STONE
SECRETARY OF STATE

ROBERT WILLIAMS, DIRECTOR
DIVISION OF ARCHIVES, HISTORY, AND
RECORDS MANAGEMENT

October 30, 1972

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

Dear Mr. Muller:

I am in receipt of a copy of the letter sent to you by Mr. John D. McDermott, Acting Executive Secretary of the Advisory Council on Historic Preservation, concerning Crystal River Unit No. 3 in Citrus County, Florida. I am pleased to inform you that the Florida Power Corporation has cooperated completely with our agency in coordinating this project, including their authorization to conduct a complete archaeological and historical inventory of the Crystal River Plant site and adjacent areas. This survey was conducted this past summer and resulted in the discovery of a number of previously unrecorded archaeological sites. Fortunately, the construction of Crystal River Unit No. 3 will not physically encroach on any known archaeological, historical, or architecturally significant properties. We are completely satisfied with the procedures instituted by Florida Power Corporation in assessing the potential adverse effects resulting from this project, relative to historic preservation.

Sincerely,

Robert Williams
State Liaison Officer

RW:Pgl

cc: Mr. John D. McDermott

RECEIVED NOV 3 1972

50-302

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20201

NOV 7 1972

RECEIVED
NOV 1972
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 September 11, 1972, wherein you requested comments on the draft environmental impact statement for the Crystal River Unit No. 3, Florida Power Corporation, Docket Number 50-302.

The Department of Health, Education, and Welfare has reviewed the health aspects of the above project as presented in the documents submitted. This project does not appear to represent a hazard to public health and safety.

The opportunity to review the draft environmental impact statement is appreciated.

Sincerely yours,

Merlin K. DuVal, M.D.
Assistant Secretary for
Health and Scientific Affairs

United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

50-302

NOV 27 1972

RECEIVED
NOV 28 1972
U.S. ATOMIC ENERGY COMMISSION
Regulatory Mail Section

ER-72/1091

Dear Mr. Muller:

This is in response to your letter of September 11, 1972, requesting our comments on the Atomic Energy Commission's draft statement, dated September 1972, on environmental considerations for Crystal River Nuclear Generating Plant, Unit 3, Citrus County, Florida.

General

During the last two calendar years the Bureau of Sport Fisheries and Wildlife and the Geological Survey, both of this Department, have participated in discussions with AEC and the applicant and have made suggestions and comments within the limits of their jurisdiction and expertise. Concerns for probable adverse environmental impacts resulting from the operation of Unit 3 and adequacy of the environmental studies were expressed several times during this period. The draft environmental statement does not adequately reflect improvement in the studies or in the plant design as a result of these discussions. It appears to us that the plant is poorly sited from an environmental standpoint, the impacts resulting from the use of once-through cooling are intolerable, and the construction and maintenance of the navigation canal and its unbroken spoil dike is a further adverse impact on the natural environment of the area.

The major aquatic environmental problems could be solved by the use of a closed-cycle cooling system. This would eliminate the need for most of the withdrawals and discharges of water and waste heat to aquatic environment. This would also permit a breaching of the navigation channel spoil dikes at several points to permit water circulation and free passage of aquatic organisms.

The statement should provide the chronology of the physical development of Units 1, 2, and 3 at the site in order for the baseline environmental assessments to have value. The assessments of the existing conditions at Crystal River are inadequate in that the construction and operation impacts of Units 1 and 2 and the accessory facilities, such as the navigation and intake channel, are not clearly defined. Units 1 and 2 created major impacts on the environment of the Crystal River area when the navigation channel was constructed with its extensive dike system. The construction of a diked channel several miles into the Gulf undoubtedly had a significant impact on the hydrology of the area. The ecological system has probably been in a state of change for several years as a result of the physical and ecological changes and therefore an adequate recognition of this changing baseline situation is necessary to properly evaluate the impacts of Unit 3. We think that an effective evaluation of the impacts of Unit 3 can be made only when they are superimposed upon the effects of Units 1 and 2. Therefore, we are in agreement with the operating license stipulation given on page iv requiring the applicant to establish adequate baseline ecological data.

In our view, the assessment of the entrainment impact of Crystal River Units 1, 2, and 3 has been grossly under-investigated. Observations made at the Crystal River site by staff members of the Bureau of Sport Fisheries and Wildlife and the National Marine Fisheries Service in early May of 1972 showed clearly that thousands of fish fry were gathered in the slack water eddies at the intake structure of Crystal River Units 1 and 2 and fish larvae were taken in plankton tows. Large numbers of predatory fish were feeding heavily upon smaller organisms being brought by the intake channel to the intakes of the plant. The victims apparently included fish fry and juveniles entrained in the plant's intake flow. This type of entrainment with the probable billions of fish fry and larvae entrained there have not been adequately investigated according to any of the data made available to our reviewers thus far.

In view of the apparent inadequacies in the physical descriptions of the impact of the project, an immediate question is raised as to the adequacy of any assessments of biological impacts, since biological impacts largely result from the physical changes created by the project. The obvious lack of sufficient sampling information and insufficient evaluation of the impacts of the existing

Units 1 and 2 leaves little room to conclude other than that the Crystal River plant is already having a tremendous adverse impact on the estuarine values of this site even though the extent of damage has not been quantified by the detailed studies which should have been performed. The addition of Unit 3 to this operation will unquestionably escalate the damages from entrainment, from impingement of large organisms, and from various adverse impacts on the physical oceanography and the biology of the site. The potential for entrainment of large numbers of juvenile fish and the larval and juvenile forms of other important sport and commercial species is inadequately assessed in this report and undoubtedly cannot be fully assessed based on the limited data available in the impact statement.

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

Historical Significance

The final environmental statement should include evidence that the State Liaison Officer for Historic Preservation was contacted concerning possible effects of the proposed action on historic properties which are under consideration for nomination to the National Register of Historic Places.

The statement discusses several areas and sites of archeological and paleontological importance in the general area of the plant but it does not show that the site was surveyed by professional archeologists prior to the initiation of construction. Since construction of the plant is well underway, most of the impacts of site preparation and construction have already occurred; therefore, these impacts remain unknown.

Geology

As a result of procedures previously established between the Geological Survey of this Department and the AEC, a comprehensive review of the geologic and hydrologic aspects of the site as presented in the applicant's Preliminary Safety Analysis Report to the AEC was performed. The results of this review was transmitted to the AEC on April 2, 1968. We think that the inclusion of some of the data presented in this report should be included in the final environmental statement. The brief description of the geology of the site presented in the draft statement is inadequate for an independent assessment of the geologic environment relevant to the construction of the plant.

Hydrology

One of the most important aquifers in the Country is located beneath this plant. As stated on page 2-19, the limestone aquifer is highly porous and surface waters located above the water table will filter into the ground-water table very rapidly. The effects of leakage or spillage of radioactive wastes on this aquifer should be addressed in the final environmental statement.

Terrestrial Ecology

The faunal lists given on page 2-22 and page 2-23 are incomplete. We suggest that important upland game birds such as turkey and mourning dove, various waterfowl species including shore and wading birds, raptores, reptiles, and amphibians be added to that list. More complete lists are referred to on page 2-24; but we think that these lists should be included in the environmental statement.

The list of fishes appears to be reasonably complete.

Planktonic Organisms

Page 2-46 of the impact statement refers to plankton sampling conducted in April and June and July of 1971 at the Crystal River intake and discharge canals. We have referred to the Crystal River Environmental Status Report for July through December 1971 issued by the company. We assume that the plankton studies referred to on page 2-47 in the statement are those discussed under chlorination studies by Dr. Lackey in section 6 of the Environmental Status Report. The sampling conducted there appears to consist of dipping 200 liters of water from the canal with a bucket and pouring it through a hand-held plankton net. This type of sampling would sample no more than an extremely minimal volume of surface water, and would frighten away free-swimming organisms such as fish fry which frequently appear in zooplankton samples. Certainly, this type of sampling would not provide a valid representation of all the planktonic life occurring in the canals at all the various depths, at all the various times of the day or night, or different seasons or phases of the moon and tide cycles. However, these samples do reveal a substantial zooplankton population.

Effluent System

It is indicated in the first paragraph on page 3-7 that the velocity in the intake canal of 1.3 fps at ebb tide may be sufficiently low to prevent serious entrapment of fish. This might be true for larger individuals of the more rapid swimming species which do not have tendencies to follow currents at the time and which are not seeking dark hiding places. However, for virtually all larval and juvenile fish which are incapable of even swimming at speeds of 1.3 fps, there is no possibility of their escape when they have entered the intake canal. They are doomed to entrainment unless they can exist in the intake canal, an unlikely circumstance for more than a tiny faction of these fish and an impossibility for most of them. Practically all fish smaller than 1.5 inches have difficulty swimming at a sustained rate of 1.3 fps for more than about 2 seconds.

Heat Dissipation System

This section or the section on Effects of the Intake Structure should indicate the manner of disposal for dead fish, trash, and debris collected on the racks and screens. We suggest that this information be included in the final statement.

Solid Waste

It is indicated on page 3-16 that solid wastes are to be packaged in drums and shipped to an AEC-licensed burial site. Also, it is indicated on page V-46 of the applicant's environmental report that low-level radioactive solid wastes include such materials as paper, rags, clothing, plastics, and particulate and charcoal filters. We recommend that the final environmental statement contain the details on emergency procedures which will be used for maximum containment of these waste and for minimum contamination of personnel under conditions where a severe accident might result in the spill of low-level wastes.

Site Preparation and Plant Construction

The impacts resulting from the erection of transmission towers and stringing of lines on 2,140 acres of existing rights-of-way should be assessed in this section.

Effects of the Intake Structure

The AEC staff estimate of 200,000 finfish presently being destroyed at the intakes appears to be largely based on 24-hour samples taken 1 day per month. Sampling only 1 day per month could miss any peak impingement brought on by seasonal abundance of fish or particular seasonal or climatic conditions. Evidence at other plants and statements made at the Crystal River briefings, held twice each year by the company, suggest that major portions of the annual losses for some species may occur on a relatively small number of days. The baseline ecological study which the applicant will perform as a condition to the operating license should provide more accurate data.

A doubling of the estimated present losses is predicted when Unit 3 goes on line, an assumption based on the doubled volume of cooling water. Since the velocity in the intake canal will nearly double, the assumption that fish losses will only double is undoubtedly conservative. The impact is considerably greater than simple function of the volume of water being strained through the plant. It is one of swimming speed of fish. Fish which might escape from a fraction of a foot per second current drawing them into the intake canal may not escape when that rate is doubled. There is considerable possibility that many species not now taken at the plant will appear on the screens when the velocities are doubled. The number of individuals of the species now taken may very well double, but additional species may cause the total number of fish taken to escalate significantly.

Aquatic Ecology

The applicant's estimate of the thermal plume size is given on page 5-17 for Units 1, 2, and 3. We agree with the AEC staff that the affected areas will be much larger than projected by the applicant.

We also concur with the AEC staff that other cooling alternatives or modifications to the present method should be considered. We suggest that consideration be given to the discharge of the cooling water from Unit 3 through a submerged pipeline crossing the existing intake canal in a southernly direction. Dual discharge points could serve to physically disperse the two heat loads, that for Units 1 and 2 to the northwest and that for Unit 3 to the south.

Effects on Aquatic Life

The discussion of impact of waste heat discharges on aquatic life does not include recognition of the possible effect of increased predation on organisms subjected to significant increases in temperature in the warmed area nor does it consider possible increases in disease or parasite infestation of organisms spending prolonged periods in the warmed area. Also, it does not consider the possibility of failure of sex products to develop normally in adults spending prolonged periods in the heated plume area. While little is known about the probability of this in the warm climates of Florida, there are distinct possibilities that critical effects could take place.

Eutrophication

Discussions given by the company's study technicians at Crystal River in the past have indicated increased growth of certain benthic diatoms occurring in the discharge zone. The enlargement of the zone of discharge and the increase in temperature coupled with a probable additional supply of nutrients from entrained organisms killed by the plant certainly suggest that the periphyton may very definitely be increased by additional heat discharges from Unit 3. Destruction of beds of seagrass by the excessive temperatures will cause biological loss far beyond that expected from exceeding exclusion temperatures for some mobile organisms.

Biological Impact

The impacts on aquatic life resulting from pumping cooling water from the embayment area south of the intake canal dike and discharging it into the embayment area to the north of the dike should be analyzed. The area south of the dike includes the mouth of Crystal River and is somewhat enclosed by the many oyster reefs. The area enclosed by a line drawn from Long Point which is about 6 miles south of the dike to a point on the dike approximately 3 miles from shore would include a semienclosed bay area approximately 4 miles wide and 6 miles long. The volume of water involved would be approximately 21 billion gallons. When the three units are operating at full load, a volume of water equal to this semienclosed bay would be pumped through the plant in 11 days. It is understood that much of the water will come from offshore; however, the effects on aquatic life resulting from the transfer of this large amount of water from the south side of the dike to the north side are expected to be significant and should be assessed.

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 tables 6-1 and 6-2 could result in releases to Gulf of Mexico 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 Gulf, which could persist for centuries and affect millions of people and other life species. We think that consideration of the possible impacts of Class 9 accidents should have a bearing on alternatives to the proposal.

Irreversible and Irretrievable Commitment of Resources

This section ignores the unique and high value of the Crystal River aquatic environment and its complicated, yet delicately balanced, ecological associations. Many of these damages are irretrievable. Although the statement refers to living forms killed as irretrievable, it does not consider loss or change of habitat and possible loss of aquatic productivity.

Alternative Cooling Methods

Technology for salt water cooling towers and other closed cycle cooling systems is advancing at a rapid rate.

The recently released draft environmental statement for the Forked River Nuclear Station, Unit 1, in New Jersey, includes a salt water cooling tower for the 1,093 megawatt nuclear unit. Salinities in that area are similar to those at Crystal River and salt drift predictions for the Forked River Unit is at a sufficiently low level to suggest that such a tower might be considered for the Crystal River Units.

Studies in connection with the Forked River plant appear to show that the drift factor and the salt deposition from this drift may be much less severe than has previously been thought, especially in coastal areas where there is already a normally high salt deposition rate with which the ecological system is in balance.

It is our understanding that a cooling tower is now under construction at Chalk Point Plant on the Patuxent River in Maryland and the manufacturer guarantees a drift factor no greater than 0.002 percent of the total cooling flow.

In view of the availability of this technology, it appears that a more thorough discussion and evaluation of closed-cycle cooling techniques is fully warranted in the environmental impact statement. In addition to the salt water towers, there should be a discussion of fresh water towers or other closed-cycle devices using makeup water from the Withlacoochee and Crystal Rivers.

In our view, the use of a closed-cycle cooling system would eliminate the majority of the problems related to operation of Units 1, 2, and 3 if the cooling system were applied to all three units. It would essentially eliminate the intake problems with the entrainment and impingement now occurring and likely to increase at the site; the destruction of the natural balances of salinity and temperature which are much affected by the huge volumes of water circulating in the area, and reduce the impact of the plume on the discharge area since the plume would be essentially eliminated. Additionally, the use of a closed-cycle system would permit a breaching of the long dikes extending into the Gulf permitting once again a natural circulation of water and aquatic organisms through the area.

We conclude that the natural resources involved are so significant that they must receive first consideration in the licensing of the operation of Unit 3. It further appears unreasonable to permit the existing damages of Units 1 and 2 to be continued if it is technically feasible to correct the serious environmental problems with these units simultaneously with measures adopted to correct the environmental problems expected from Crystal River, Unit 3.

We consider the discussed alternative of dilution unacceptable since it accentuates the already identified major problem of entraining aquatic organisms and of destroying the physical composition of an irreplaceable unit of aquatic habitat.

The alternative of a holdup pond is undesirable because of the further usurpation of the publicly owned bottom of the bay by the proposed circulation system. Further, this does not eliminate the entrainment and physical habitat destruction problems involved in once-through cooling.

A closed-cycle spray module system deserves additional investigation and more comment than is given in section 11 of this statement. A spray module unit on a once-through cooling basis in the existing canal will not eliminate the problems of entrainment of organisms nor the physical displacement and destruction of the habitat.

The discussed modification of the discharge canal as set forth on page 11-16 is highly undesirable. The construction of such a canal extension merely compounds the already serious existing problem of a prolonged dike which interferes with current and organism movements in the coastal area at Crystal River. If this canal were constructed as proposed, it would completely foreclose any opportunity for correcting the existing problem. The use of this canal would merely move the area of impact of the plume and would not eliminate the entrainment and physical environment damage which are so serious at Crystal River already.

The use of a cooling pond as discussed on page 11-5 appears to have questionable advantages since it would involve several adverse impacts discussed there. More acreage of wetland might be destroyed in addition to the 330 acres already lost.

Recommendations

Based on our concerns for the environmental impacts of the proposed project, we recommend that the operating license for Crystal River No. 3 contain the following stipulations in addition to, or in lieu of when appropriate, those given in the Summary and Conclusions of the statement.

1. Within 6 months after issuance of the operating license, the applicant shall present to the AEC completed plans for an alternate cooling system which will significantly reduce the entrainment and other damage to aquatic life.

2. After AEC approval, the applicant shall construct and place in operation at the earliest possible time, and in no case later than 3 years, after issuance of the operating license the cooling system required in stipulation No. 1 above.

3. Full operation of Unit 3 shall not be permitted until the alternate cooling system is functional.

4. The applicant should be required to adopt and employ all practical measures which may be developed in order to minimize any adverse impacts of the plant operation on the biota during the interim period.

We hope these comments will be helpful 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

STATE OF FLORIDA

Department of Administration

Division of State Planning

725 SOUTH BRONOUGH

TALLAHASSEE

32304

(904) 224-3117

Earl M. Starnes
STATE PLANNING DIRECTOR

Reubin O'D. Askew
GOVERNOR

L. K. Ireland, Jr.
SECRETARY OF ADMINISTRATION

November 20, 1972

RECEIVED
NOV 29 1972
U.S. ATOMIC ENERGY COMMISSION
Regulatory Mail Section

Mr. A. Schwencer, Chief
Pressurized Water Reactors Branch No. 4
Directorate of Liscensing
U. S. Atomic Energy Commission
Washington, D. C. 20545

Dear Mr. Schwencer:

Functioning as the state planning and development clearinghouse contemplated in U. S. Office of Management and Budget Circular A-95, we have reviewed the environmental reports and the draft environmental impact statement on the following project:

Atomic Energy Commission: Florida Power Corporation
Crystal River Unit 3, Docket No. 50-302. SAI Project Nos.
73-0341, 72-0800, and 72-0540.

During our review, we referred the reports and environmental impact statement to state agencies, which we have identified as interested in the environmental effects of the project or in developing or enforcing standards relating to these effects and to the Environmental Information Center through which we received comments by individuals.

Agencies were requested to review the statement and comment on the adequacy of treatment of environmental matters of their concern, additional alternatives which should be considered, and project modifications or special control measures to reduce or avoid adverse environmental effects.

We are forwarding herewith letters of comment on this statement and project by governmental and private organizations and individuals. Most of the comments made by agencies were in response to our request for comments on various documents relating to the project received from Florida Power Corporation. Letters are enclosed from the: Department of Agriculture and Consumer Services; Board of Trustees of the Internal Improvement Trust Fund; Department of Commerce; Department of Community Affairs; Department of Health and Rehabilitative Services - Division of Health; Department of Insurance; Department of Legal Affairs; Department of Natural Resources; Department of Pollution Control; Public Service Commission; Department of State - Division of Archives, History, and Records Management; and from Mr. A. R. Quillinan; Ms. Karen K. Vogt; Mr. Larry Brock; Ms. June Rouseff; Ms. Anne Hains; Mr. Eric Reints; and Ms. Jennifer Boone. We also requested that the Game and Fresh Water Fish Commission review the statement; no reply was received from the Commission.

In accordance with the Council on Environmental Quality guidelines concerning statements on proposed federal actions affecting the environment, as required by the National Policy Act of 1969, and U. S. Office of Management and Budget Circular A-95, this letter, with attachments, should be appended to the final environmental impact statement on this project. Comments regarding this statement and project contained herein or attached hereto should be addressed in the statement.

We request to be forwarded one copy of the final environmental statement submitted to the Council on Environmental Quality.

Sincerely,

Don L. Spicer
Chief
Bureau of Intergovernmental Relations

DLS/wnb
Enclosures

cc: Hon. Tom Adams
Mr. John Bethea
Ms. Jennifer Boone
Mr. Larry Brock
Hon. Doyle Conner
Ms. Anne Hains
Mr. Mabry T. Ervin
Mr. Randolph Hodges
Mr. Joel Kuperberg
Hon. Thomas O'Malley
Mr. Eric Reints
Ms. June Rouseff
Mr. A. R. Quillinan
Mr. David H. Scott
Mr. R. Charles Shepherd
Hon. Robert Shevin
Dr. Wade Stephens
Ms. Karen K. Vogt
Mr. H. E. Wallace
Mr. Robert Williams

DIVISION OF STATE PLANNING
Bureau Of
Intergovernmental Relations
OCT 5 1972
RECEIVED
SAI NO. 73-0341

TO: Mr. Don L. Spicer, Chief, Bureau of Intergovernmental Relations
725 South Bronough Street, Tallahassee, Florida 32304

FROM: Honorable Doyle Conner
Commissioner of Agriculture

RE: U. S. Atomic Energy Commission - Florida Power and Light Company: DEIS on Supplement to Crystal River Unit 3 Nuclear Generating Station. SAI Project No. 73-0341. Comments due by October 12, 1972

We have reviewed the above environmental impact statement and comment as to the adequacy of treatment of physical, ecological, and sociological effects of concern to us as shown below:

	Check (✓) for each item	
	None	Comment enclosed
1. Additional specific effects which should be assessed:	✓	
2. Additional alternatives which should be considered:	✓	
3. Better or more appropriate measures and standards which should be used to evaluate environmental effects:	✓	
4. Additional control measures which should be applied to reduce adverse environmental effects or to avoid the irreversible or irretrievable commitment of resources:	✓	
5. Our assessment of how serious the environmental damage from this project might be, using the best alternative and control measures:	✓	
6. We identify issues which require further discussion or resolution as shown:	✓	

This agency ☐ does wish / ☒ does not wish to review the final environmental impact statement on this project.

(Name & title of authenticating official)

Enclosure(s) ☐ None
☐ Attached

STATE PLANNING AND DEVELOPMENT CLEARINGHOUSE
FEB 9 1972
RECEIVED
SPDC NO. 72-0540

TO: Homer E. Still, Jr., State Planning and Development Clearinghouse
725 South Bronough Street, Tallahassee, Florida 32304

FROM: Honorable Doyle Conner
Commissioner of Agriculture

Re: Atomic Energy Commission: Crystal River, Unit 3 Nuclear Generating Plant Environmental Report. SPDC Project No. 72-0540

We have reviewed the above environmental report and comment as to the adequacy of treatment of physical, ecological, and sociological effects of concern to us as shown below:

	Check (✓) for each item: None	Check (✓) for each item: Comment enclosed
1. Additional specific effects which should be assessed:	✓	
2. Additional alternatives which should be considered:	✓	
3. Better or more appropriate measures and standards which should be used to evaluate environmental effects:	✓	
4. Additional control measures which should be applied to reduce adverse environmental effects or to avoid the irreversible or irretrievable commitment of resources:	✓	
5. Our assessment of how serious the environmental damage from this project might be, using the best alternative and control measures:	✓	
6. We identify issues which require further discussion or resolution as shown:	✓	

This agency ☑ does wish / ☐ does not wish to review the draft environmental impact statement on this project.

Charles F. Blaser
(Name & title of authenticating official)

Enclosure(s) ☑ None
☐ Attached

STATE PLANNING AND DEVELOPMENT CLEARINGHOUSE
APR 7 1972
RECEIVED
SPDC NO. 72-0800

TO: Homer E. Still, Jr., State Planning and Development Clearinghouse
725 South Bronough Street, Tallahassee, Florida 32304

FROM: Honorable Doyle Conner
Commissioner of Agriculture
Department of Agriculture and Consumer Services

RE: U. S. Atomic Energy Commission - Florida Power & Light Company:
Crystal River Unit 3, Applicant's Environmental Report, Operating
License Stage, Citrus County
SPDC Project No. 72-0800.

We have reviewed the above environmental impact statement and comment as to the adequacy of treatment of physical, ecological, and sociological effects of concern to us as shown below:

	Check (✓) for each item: None	Comment enclosed
1. Additional specific effects which should be assessed:	✓	
2. Additional alternatives which should be considered:	✓	
3. Better or more appropriate measures and standards which should be used to evaluate environmental effects:	✓	
4. Additional control measures which should be applied to reduce adverse environmental effects or to avoid the irreversible or irretrievable commitment of resources:	✓	
5. Our assessment of how serious the environmental damage from this project might be, using the best alternative and control measures:	✓	
6. We identify issues which require further discussion or resolution as shown:	✓	

This agency ☑ does wish / ☐ does not wish to review the final environmental impact statement on this project.

[signature]
(Name & title of authenticating official)

Enclosure(s) ☐ None
☐ Attached

DEIS 4/28/71

STATE OF FLORIDA

BOARD OF TRUSTEES OF THE INTERNAL IMPROVEMENT TRUST FUND

ELLIOT BUILDING — TALLAHASSEE, FLORIDA 32304

Joel Kuperberg
Executive Director

TELEPHONE 224-2101

November 17, 1972

DIVISION OF STATE PLANNING,
Bureau Of
Intergovernmental Relations
NOV 20 1972
RECEIVED
SAI NO. 73-0341

Mr. Don L. Spicer, Chief
Bureau of Intergovernmental Relations
Department of Administration
Division of State Planning
725 South Bronough Street
Tallahassee, Florida 32304

Dear Mr. Spicer:

U.S. Atomic Energy Commission - Florida Power Company: Draft Environmental Impact Statement on Supplement to Crystal River Unit Nuclear Generating Station. SAI Project Number 73-0341.

The Trustees' staff has reviewed the draft environmental impact statement regarding the proposed operational licensing of the Florida Power Company Crystal River Nuclear Power Generating Station. The Atomic Energy Commission has compiled an excellent review of the environmental aspects of this plant. The following comments are submitted:

1) We are concerned about the long range effects increased water temperatures may have on an estuarine environment and endorse the idea of monitoring this area to determine what these effects may be.

2) This plant is in close proximity to the St. Martins Marsh Aquatic Preserve (G-8). We urge expansion of the study to determine the possible effects of this plant on the preserve.

We would like to review any further information on this project.

Sincerely,

Joel Kuperberg
Executive Director

JK/bjl

STATE PLANNING AND DEVELOPMENT
CLEARINGHOUSE
MAR 16 1972
RECEIVED
SPDC NO. 72-0800

STATE OF FLORIDA

BOARD OF TRUSTEES OF THE INTERNAL IMPROVEMENT TRUST FUND

ELLIOT BUILDING — TALLAHASSEE, FLORIDA 32304

Joel Kuperberg
Executive Director

TELEPHONE 224-2101

March 13, 1972

Mr. Homer E. Still, Jr.
State Planning and Development
Clearinghouse
725 South Bronough Street
Tallahassee, Florida 32304

Dear Mr. Still:

Florida Power Corporation
Crystal River Unit No. 3
SPDC Project No. 72-0800

Your attention is called to our February 28 response to this project, a copy of which is enclosed. Our comment on this project remains the same.

Sincerely,

Joel Kuperberg
Executive Director

JK/xdb

Enclosure

STATE OF FLORIDA
BOARD OF TRUSTEES OF THE INTERNAL IMPROVEMENT TRUST FUND
ELLIOT BUILDING — TALLAHASSEE, FLORIDA 32304

Joel Kuperberg
Executive Director

TELEPHONE 224-2101

February 28, 1972

STATE PLANNING AND DEVELOPMENT
CLEARINGHOUSE
FEB 29 1972
RECEIVED
SPDC NO. 72-0540

Mr. Homer E. Still, Jr.
State Planning and Development
Clearinghouse
Department of Administration
725 South Bronough
Tallahassee, Florida 32304

Dear Mr. Still:

Crystal River Unit #3
Florida Power Corporation
SPDC Project No. 72-0540

Staff review finds an objection to the maximum cooling water discharge temperature as presented. A differential of 5°F over ambient may result in discharges in excess of 95°F. We are opposed to discharge in excess of 95°F in light of present-day knowledge.

We understand that the Department of Pollution Control is formulating thermal standards for the state. This project should be in compliance with these standards when issued.

Sincerely,

Joel Kuperberg
Executive Director

JK/xdb

TO: Mr. Don L. Spicer, Chief, Bureau of Intergovernmental Relations
725 South Bronough Street, Tallahassee, Florida 32304

FROM: Lt. Governor Tom Adams
Department of Commerce

RE: U. S. Atomic Energy Commission - Florida Power and Light Company: DEIS on Supplement to Crystal River Unit 3 Nuclear Generating Station. SAI Project No. 73-0341. Comments due by October 12, 1972

We have reviewed the above environmental impact statement and comment as to the adequacy of treatment of physical, ecological, and sociological effects of concern to us as shown below:

	Check (✓) for each item: None	Check (✓) for each item: Comment enclosed
1. Additional specific effects which should be assessed:	✓	
2. Additional alternatives which should be considered:	✓	
3. Better or more appropriate measures and standards which should be used to evaluate environmental effects:	✓	
4. Additional control measures which should be applied to reduce adverse environmental effects or to avoid the irreversible or irretrievable commitment of resources:	✓	
5. Our assessment of how serious the environmental damage from this project might be, using the best alternative and control measures:	✓	
6. We identify issues which require further discussion or resolution as shown:	✓	

This agency ☒ does wish / ☐ does not wish to review the final environmental impact statement on this project.

(Name & title of authenticating official)

Enclosure(s) ☒ None / ☐ Attached

DEIS 6/28/71

MEMORANDUM
FLORIDA DEPARTMENT OF COMMERCE

STATE PLANNING AND DEVELOPMENT
CLEARINGHOUSE
APR 25 1972
RECEIVED
SPDC NO. 72-0800

Date April 13, 1972

To Mr. Homer E. Still, Jr.

From Morris Ford

Subject U. S. Atomic Energy Commission, Crystal River Unit 3, SPDC Project No. 72-0800

We have reviewed the subject draft and within the limits of our capabilities we find nothing detrimental to the State of Florida in those specific areas of concern to the Department of Commerce.

Questionnaire attached.

MF/jcr

attachment

TO: Homer E. Still, Jr., State Planning and Development Clearinghouse
725 South Bronough Street, Tallahassee, Florida 32304

FROM: Lt. Governor Tom Adams
Secretary of Commerce

RE: U. S. Atomic Energy Commission - Florida Power & Light Company: Crystal River Unit 3, Applicant's Environmental Report, Operating License Stage, Citrus County
SPDC Project No. 72-0800.

We have reviewed the above environmental impact statement and comment as to the adequacy of treatment of physical, ecological, and sociological effects of concern to us as shown below:

	Check (✓) for each item: None	Comment enclosed
1. Additional specific effects which should be assessed:	X	
2. Additional alternatives which should be considered:	X	
3. Better or more appropriate measures and standards which should be used to evaluate environmental effects:	X	
4. Additional control measures which should be applied to reduce adverse environmental effects or to avoid the irreversible or irretrievable commitment of resources:	X	
5. Our assessment of how serious the environmental damage from this project might be, using the best alternative and control measures:	X	
6. We identify issues which require further discussion or resolution as shown:	X	

This agency ☒ does wish / ☐ does not wish to review the final environmental impact statement on this project.

Morris Ford, Director
(Name & title of authenticating official)

Enclosure(s) ☐ None ☒ Attached

DEIS 4/28/71

Secretary of Commerce
Lieutenant Governor Tom Adams

STATE OF FLORIDA DEPARTMENT OF COMMERCE

Collins Building, Tallahassee, Florida 32304

February 22, 1972

STATE PLANNING AND DEVELOPMENT CLEARINGHOUSE
FEB 24 1972
RECEIVED
SPDC NO. 72-0540

Mr. Homer E. Still, Jr.
Department of Administration
State Planning and Development
  Clearinghouse
Johns Building
Tallahassee, Florida 32304

Dear Mr. Still:

The environmental report, SPDC Project Number 72-0540, concerning the Crystal River Unit Three, Nuclear Generating Plant, submitted to me February 4, 1972, has been reviewed as requested.

We find that all aspects concerning the technical operation of the plant which might effect the environment, commitment of resources and necessary protection of people and property are comprehensively covered in this report.

In checking with the agencies of state government responsible for safety, environmental and pollution control, we found them to be well informed and familiar with the required operational control procedures called for.

The responsibility of the Department of Commerce, under the dictates of Chapter 290 of the Florida Nuclear Code, is hereby discharged by acceptance of this Environmental Report as submitted.

Sincerely,

Lieutenant Governor

TA/cvs

Divisions: Administrative Services / Commercial Development / Labor and Employment Opportunities

TO: Homer E. Still, Jr., State Planning and Development Clearinghouse
725 South Bronough Street, Tallahassee, Florida 32304

FROM: Mrs. M. Athalie Range, Secretary
Department of Community Affairs

re: U. S. Atomic Energy Commission: Crystal River, Unit 3, Nuclear Generating Plant, Environmental Report. SPDC Project 72-0540

STATE PLANNING AND DEVELOPMENT CLEARINGHOUSE
FEB 14 1972
RECEIVED
SPDC NO. 72-0540

We have reviewed the above environmental report and comment as to the adequacy of treatment of physical, ecological, and sociological effects of concern to us as shown below:

	Check (✓) for each item: None	Comment enclosed
1. Additional specific effects which should be assessed:	✓	
2. Additional alternatives which should be considered:	✓	
3. Better or more appropriate measures and standards which should be used to evaluate environmental effects:	✓	
4. Additional control measures which should be applied to reduce adverse environmental effects or to avoid the irreversible or irretrievable commitment of resources:	✓	
5. Our assessment of how serious the environmental damage from this project might be, using the best alternative and control measures:	✓	
6. We identify issues which require further discussion or resolution as shown:	✓	

This agency ☐ does wish ☐ does not wish to review the draft environmental impact statement on this project.

H. Schmertmann
(Name & title of authenticating official)
Chief, Bur. of Community Development

Enclosure(s) ☒ None ☐ Attached

DIVISION OF STATE PLANNING,
Bureau Of
Intergovernmental Relations
OCT 11 1972
RECEIVED
SAI NO. 73-0341

TO: Mr. Don L. Spicer, Chief, Bureau of Intergovernmental Relations
725 South Bronough Street, Tallahassee, Florida 32304

FROM: Mrs. M. Athalie Range, Secretary
Department of Community Affairs

RE: U. S. Atomic Energy Commission - Florida Power and Light Company: DEIS on Supplement to Crystal River Unit 3 Nuclear Generating Station. SAI Project No. 73-0341. Comments due by October 12, 1972

We have reviewed the above environmental impact statement and comment as to the adequacy of treatment of physical, ecological, and sociological effects of concern to us as shown below:

	Check (✓) for each item None	Comment enclosed
1. Additional specific effects which should be assessed:	✓	
2. Additional alternatives which should be considered:	✓	
3. Better or more appropriate measures and standards which should be used to evaluate environmental effects:	✓	
4. Additional control measures which should be applied to reduce adverse environmental effects or to avoid the irreversible or irretrievable commitment of resources:	✓	
5. Our assessment of how serious the environmental damage from this project might be, using the best alternative and control measures:	✓	
6. We identify issues which require further discussion or resolution as shown:	✓	

This agency ☐ does wish ☒ does not wish to review the final environmental impact statement on this project.

H. Schmertmann
(Name & title of authenticating official)
Chief, Bureau of Community Development

Enclosure(s) ☒ None ☐ Attached

DEIS 4/28/71

DEPARTMENT OF HEALTH AND REHABILITATIVE SERVICES • • • • • • • • STATE OF FLORIDA
Emmett S. Roberts, Secretary
Reubin O'D Askew, Governor
DIVISION OF HEALTH
POST OFFICE BOX 210 • JACKSONVILLE, FLORIDA 32201 • PHONE (904) 354-3961
Wilson T. Sowder, M.D., M.P.H., Director

STATE PLANNING AND DEVELOPMENT
CLEARINGHOUSE
MAR 28 1972
RECEIVED
SPDC NO. 72-0800

March 24, 1972

MEMORANDUM

TO: Homer E. Still, Jr., State Planning and Development Clearinghouse

THRU: Wade N. Stephens, M.D., Planning
Division of Health

FROM: Chester L. Nayfield, M.D., Administrator
Radiological and Occupational Health Section

RE: U. S. Atomic Energy Commission - Florida Power Corporation: Crystal River Unit 3, Applicant's Environmental Report, Operating License State, Citrus County - SPDC Project No. 72-0800,

Enclosed are comments concerning Item #6 of the attached Environmental Statement:

> Details of solid wastes procedures should be carefully scruitinized to determine amounts per shipment of radioactive materials and to insure proper packaging for safety purposes.

CLN/sgm

Encl

cc: Dr. Stephens

TO: Homer E. Still, Jr., State Planning and Development Clearinghouse
725 South Bronough Street, Tallahassee, Florida 32304

FROM: Dr. Wade Stephens
Division of Health

RE: U. S. Atomic Energy Commission - ~~Florida Power & Light Company:~~ Florida Power Corporation:
Crystal River Unit 3, Applicant's Environmental Report, Operating License Stage, Citrus County
SPDC Project No. 72-0800.

We have reviewed the above environmental impact statement and comment as to the adequacy of treatment of physical, ecological, and sociological effects of concern to us as shown below:

	Check (✓) for each item: None	Check (✓) for each item: Comment enclosed
1. Additional specific effects which should be assessed:	✓	
2. Additional alternatives which should be considered:	✓	
3. Better or more appropriate measures and standards which should be used to evaluate environmental effects:	✓	
4. Additional control measures which should be applied to reduce adverse environmental effects or to avoid the irreversible or irretrievable commitment of resources:	✓	
5. Our assessment of how serious the environmental damage from this project might be, using the best alternative and control measures:	✓	
6. We identify issues which require further discussion or resolution as shown:		✓

This agency ☑ does wish / ☐ does not wish to review the final environmental impact statement on this project.

C. R. Mayfield [signature]
(Name & title of authenticating official)

Enclosure(s) ☐ None ☐ Attached

DEIS 4/28/71

Thomas D. O'Malley
STATE TREASURER
INSURANCE COMMISSIONER
FIRE MARSHAL

Office of Treasurer
Insurance Commissioner
STATE OF FLORIDA
TALLAHASSEE 32304

February 11, 1972

Mr. Homer E. Still, Jr.
State Planning and Development
Clearinghouse
Department of Administration
725 South Bronough
Tallahassee, Florida 32304

STATE PLANNING AND DEVELOPMENT
CLEARINGHOUSE
FEB 14 1972
RECEIVED
SPDC NO. 72-0540

RE: U. S. Atomic Energy Commission: Crystal River, Unit 3, Nuclear Generating Plant, Environmental Report. SPDC Project No. 72-0540 Comments due by February 18, 1972.

Dear Mr. Still:

We are returning the above Invironmental Report as requested.

Please direct all future requests for invironmental reports to the undersigned in order that their handling may be expedited.

Very truly yours,

Jack D. Kane
Executive Assistant

JDK:bb

Enclosure

TO: Homer E. Still, Jr., State Planning and Development Clearinghouse
725 South Bronough Street, Tallahassee, Florida 32304

FROM: Mr. Thomas R. Brown
Division of Insurance

Re: U. S. Atomic Energy Commission: Crystal River, Unit 3, Nuclear Generating Plant, Environmental Report. SPDC Project No .72-0540

We have reviewed the above environmental report and comment as to the adequacy of treatment of physical, ecological, and sociological effects of concern to us as shown below:

	Check (✓) for each item: None	Check (✓) for each item: Comment enclosed
1. Additional specific effects which should be assessed:		
2. Additional alternatives which should be considered:		
3. Better or more appropriate measures and standards which should be used to evaluate environmental effects:		
4. Additional control measures which should be applied to reduce adverse environmental effects or to avoid the irreversible or irretrievable commitment of resources:		
5. Our assessment of how serious the environmental damage from this project might be, using the best alternative and control measures:		
6. We identify issues which require further discussion or resolution as shown:		

This agency ☐ does wish / ☒ does not wish to review the draft environmental impact statement on this project.

(Name & title of authenticating official)
EXECUTIVE ASST.

Enclosure(s) ☒ None
☐ Attached

ROBERT L. SHEVIN
ATTORNEY GENERAL

STATE OF FLORIDA
DEPARTMENT OF LEGAL AFFAIRS
OFFICE OF THE ATTORNEY GENERAL
THE CAPITOL
TALLAHASSEE, FLORIDA 32304

DIVISION OF STATE PLANNING,
Bureau Of
Intergovernmental Relations
NOV 7 1972
RECEIVED
SAI NO. 73-0341

November 6, 1972

Mr. Don L. Spicer, Chief
Bureau of Intergovernmental Relations
Division of State Planning
Department of Administration
725 South Bronough Street
Tallahassee, Florida 32304

Re: U. S. Atomic Energy Commission - Florida Power Corporation Draft Environmental Impact Statement on Supplement to Crystal River Unit 3 Nuclear Generating Plant. SAI Project No. 73-0341

Dear Mr. Spicer:

Although the Crystal River Unit 3 Nuclear Generating Plant may be meeting environmental control criteria, there appears here, as in most power plant construction applications, a basic flaw. That flaw is the continuing assumption that there cannot be a stabilization or cut-back in the need for power. Such a stabilization could be procured through advertising by power companies in an attempt to persuade the public to use less power, rather than more. There is considerable debate in the scientific community concerning what are acceptable levels of radioactive discharge. Because of this potentially dangerous unknown factor, the construction of nuclear power plants should not be approved on the questionable basis that a little radioactivity is better than air pollution caused by the burning of fossil fuels.

Furthermore, although it may be a proper trade-off detrimentally affecting approximately 1,000 acres, and permanently removing 30 acres from a natural habitat for the greater good of electric power generated, the Atomic Energy Commission should assure in any permit that operation of the facility must cease if danger is more widespread than proposed.

Sincerely,

ROBERT L. SHEVIN
Attorney General

RLS/Hg

DIVISION OF STATE PLANNING
Bureau Of
Intergovernmental Relations
NOV 7 1972
RECEIVED
SAI NO. 73-0341

TO: Mr. Don L. Spicer, Chief, Bureau of Intergovernmental Relations
725 South Bronough Street, Tallahassee, Florida 32304

FROM: Honorable Robert L. Shevin
Attorney General

RE: U. S. Atomic Energy Commission - Florida Power and Light Company: DEIS on Supplement to Crystal River Unit 3 Nuclear Generating Station. SAI Project No. 73-0341. Comments due by October 12, 1972

We have reviewed the above environmental impact statement and comment as to the adequacy of treatment of physical, ecological, and sociological effects of concern to us as shown below:

	Check (✓) for each item: None	Check (✓) for each item: Comment enclosed
1. Additional specific effects which should be assessed:	✓	
2. Additional alternatives which should be considered:	✓	
3. Better or more appropriate measures and standards which should be used to evaluate environmental effects:	✓	
4. Additional control measures which should be applied to reduce adverse environmental effects or to avoid the irreversible or irretrievable commitment of resources:	✓	
5. Our assessment of how serious the environmental damage from this project might be, using the best alternative and control measures:	✓	
6. We identify issues which require further discussion or resolution as shown:		✓

This agency ☑ does wish ☐ does not wish to review the final environmental impact statement on this project.

Robert Shevin

(Name & title of authenticating official)

Enclosure(s) ☐ None ☑ Attached

DEIS 4/28/71

DIVISION OF STATE PLANNING
Bureau of
Intergovernmental Relations
OCT 18 1972
RECEIVED
SAI NO. 73-0341

TO: Mr. Don L. Spicer, Chief, Bureau of Intergovernmental Relations
725 South Bronough Street, Tallahassee, Florida 32304

FROM: Mr. Randolph Hodges, Executive Director
Department of Natural Resources

RE: U. S. Atomic Energy Commission - Florida Power and Light Company: DEIS on Supplement to Crystal River Unit 3 Nuclear Generating Station. SAI Project No. 73-0341. Comments due by October 12, 1972

We have reviewed the above environmental impact statement and comment as to the adequacy of treatment of physical, ecological, and sociological effects of concern to us as shown below:

	Check (✓) for each item: None	Comment enclosed
1. Additional specific effects which should be assessed:	✓	
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3. Better or more appropriate measures and standards which should be used to evaluate environmental effects:	✓	
4. Additional control measures which should be applied to reduce adverse environmental effects or to avoid the irreversible or irretrievable commitment of resources:	✓	
5. Our assessment of how serious the environmental damage from this project might be, using the best alternative and control measures:	✓	
6. We identify issues which require further discussion or resolution as shown:	✓	

This agency ☑ does wish ☐ does not wish to review the final environmental impact statement on this project.

James B. Smith
(Name & title of authenticating official)
Administrative Assistant

10/18/72

Enclosure(s) ☑ None ☐ Attached

DEIS 4/28/71

DIVISION OF STATE PLANNING
Bureau of
Intergovernmental Relations
SEP 5 1972
RECEIVED
SAI NO. 72-0800

TO: Mr. Don L. Spicer, Chief, Bureau of Intergovernmental Relations
725 South Bronough Street, Tallahassee, Florida 32304

FROM: Mr. Randolph Hodges, Executive Director
Department of Natural Resources

Re: US Atomic Energy Commission - Florida Power and Light Company: Crystal River Unit 3, Applicants Environmental Report, Operating License Stage, Citrus County. SPDC 72-0800

We have reviewed the above environmental impact statement and comment as to the adequacy of treatment of physical, ecological, and sociological effects of concern to us as shown below:

	Check (✓) for each item: None	Comment enclosed
1. Additional specific effects which should be assessed:	✓	
2. Additional alternatives which should be considered:	✓	
3. Better or more appropriate measures and standards which should be used to evaluate environmental effects:	✓	
4. Additional control measures which should be applied to reduce adverse environmental effects or to avoid the irreversible or irretrievable commitment of resources:	✓	
5. Our assessment of how serious the environmental damage from this project might be, using the best alternative and control measures:	✓	
6. We identify issues which require further discussion or resolution as shown:	✓	

This agency ☑ does wish ☐ does not wish to review the final environmental impact statement on this project.

James G. Smith, Admin Asst
(Name & title of authenticating official)
9-1-72

Enclosure(s) ☑ None ☐ Attached

STATE PLANNING AND DEVELOPMENT CLEARING HOUSE
MAR 30 1972
RECEIVED
SPDC NO. 72-0800

TO: Homer E. Still, Jr., State Planning and Development Clearinghouse
725 South Bronough Street, Tallahassee, Florida 32304

FROM: Mr. Randolph Hodges, Executive Director
Department of Natural Resources

RE: U. S. Atomic Energy Commission - Florida Power & Light Company: Crystal River Unit 3, Applicant's Environmental Report, Operating License Stage, Citrus County
SPDC Project No. 72-0800.

We have reviewed the above environmental impact statement and comment as to the adequacy of treatment of physical, ecological, and sociological effects of concern to us as shown below:

	Check (✓) for each item: None	Check (✓) for each item: Comment enclosed
1. Additional specific effects which should be assessed:	✓	
2. Additional alternatives which should be considered:	✓	
3. Better or more appropriate measures and standards which should be used to evaluate environmental effects:	✓	
4. Additional control measures which should be applied to reduce adverse environmental effects or to avoid the irreversible or irretrievable commitment of resources:	✓	
5. Our assessment of how serious the environmental damage from this project might be, using the best alternative and control measures:	✓	
6. We identify issues which require further discussion or resolution as shown:		✓

This agency ☑ does wish ☐ does not wish to review the final environmental impact statement on this project.

James A. Smith, Admin Ass't
(Name & title of authenticating official)
3-28-72

Enclosure(s) ☐ None ☑ Attached

Re: U. S. Atomic Energy Commission - Florida Power & Light Company: Crystal River Unit 3, Applicant's Environmental Report, Operating SPDC Project No. 72-0800

The following comment is keyed to Item 6.

The environmental report does not adequately cover the effects of entrainment of planktonic organisms through the power plant. In our opinion data could have been gathered from the existing plant which would show the number and types of organisms destroyed. Such studies would be especially important during the times of the year when larval forms of marine animals which are important to sport and commercial fisheries are moving into the estuarine areas.

STATE PLANNING AND DEVELOPMENT
CLEARINGHOUSE
FEB 18 1972
RECEIVED
SPDC NO. 72-0540

TO: Homer E. Still, Jr., State Planning and Development Clearinghouse
725 South Bronough Street, Tallahassee, Florida 32304

FROM: Randolph Hodges, Executive Director
Department of Natural Resources

Re: U.S. Atomic Energy Commission: Crystal River, Unit3, Nuclear Generating Plant, Environmental Report. SPDC Project No. 72-0540

We have reviewed the above environmental report and comment as to the adequacy of treatment of physical, ecological, and sociological effects of concern to us as shown below:

	Check (✓) for each item: None	Comment enclosed
1. Additional specific effects which should be assessed:	✓	
2. Additional alternatives which should be considered:	✓	
3. Better or more appropriate measures and standards which should be used to evaluate environmental effects:	✓	
4. Additional control measures which should be applied to reduce adverse environmental effects or to avoid the irreversible or irretrievable commitment of resources:	✓	
5. Our assessment of how serious the environmental damage from this project might be, using the best alternative and control measures:	✓	
6. We identify issues which require further discussion or resolution as shown:		✓

This agency ☑ does wish / ☐ does not wish to review the draft environmental impact statement on this project.

James G. Smith, Admin Asst
(Name & title of authenticating official)
2-17-72

Enclosure(s) ☐ None
☑ Attached

REFERENCE: SPDC Project No. 72-0540
Item 6, "We identify issues which require further discussion or resolution . . ."

The environmental report covering Crystal River, Unit 3, Nuclear Generating Plant does not adequately cover the total effects of heated effluent on the marine environment. While it mentions the ongoing studies that are designed to monitor the marine environment of the power plant after construction, it does not adequately treat the possible environmental impact of the heated affluent based on the results of onsite studies as well as the other studies that have been accomplished in the different parts of the State.

The statement included in the report concerning mechanical trash rakes and 3/8 inch square screen openings; i.e. "These screens, combined with low inlet velocity of less than 1 fps, remove the possibility of fish and large crustaceans being drawn into the cooling water intake," is somewhat misleading. Most of Florida's marine animals occur in the plankton as eggs or larvae. These small life forms would easily pass through a 3/8 inch screen and be destroyed in very large numbers upon passage through the plant's cooling system.

JGS:mw

STATE OF FLORIDA
DEPARTMENT OF POLLUTION CONTROL
SUITE 300, TALLAHASSEE BANK BUILDING
315 SOUTH CALHOUN STREET, TALLAHASSEE, FLORIDA 32301

August 29, 1972

VINCENT D. PATTON
EXECUTIVE DIRECTOR

DAVID H. LEVIN
CHAIRMAN

Citrus County
FPC Citrus River #3
SPDC Project No. 72-0800

DIVISION OF STATE PLANNING,
Bureau Of
Intergovernmental Relations
AUG 31 1972
RECEIVED
SAI NO. 72-0800

Mr. Don L. Spicer, Chief
Bureau of Intergovernmental Relations
725 South Bronough Street
Tallahassee, Florida 32304

Dear Mr. Spicer:

This pertains to Amendment No. 20 to application by Florida Power Corporation for construction permit and license for a nuclear electric generating unit at Crystal River.

The Department of Pollution Control has no adverse comments regarding this amendment. It is recognized that conditions forecast for low tides under certain hurricane configurations could create critical thermal discharges. It would be expected, however, that general wind conditions under such circumstances would cause reduction, if not complete shutdown, of energy output from the site.

Sincerely,

David H. Scott
David H. Scott
Director
Division of Planning

DHS:wmj

STATE OF FLORIDA
DEPARTMENT OF POLLUTION CONTROL
SUITE 300, TALLAHASSEE BANK BUILDING
315 SOUTH CALHOUN STREET, TALLAHASSEE, FLORIDA 32301

VINCENT D. PATTON
EXECUTIVE DIRECTOR

February 14, 1972

Citrus County - Clearinghouse
Crystal River EIS Unit 3
SPDC 72-0540

STATE PLANNING AND DEVELOPMENT CLEARINGHOUSE
DAVID H. ... CHAIRMAN
FEB 16 1972
RECEIVED
SPDC NO. 2-054

Mr. Homer E. Still, Jr.
State Planning and Development
Clearinghouse
725 South Bronough Street
Tallahassee, Florida 32304

Dear Mr. Still:

The "Crystal River Unit 3 Nuclear Generating Plant Environmental Report, February, 1971" has been superseded by "Crystal River Unit 3 Applicant's Environmental Report, Operating License Stage" which was delivered to us in January, 1972. The later document is in three volumes and is very much more comprehensive. We have three sets and would be pleased to give you a set if you have use for it.

This project was permitted for construction by our predecessor agency's Permit No. 1113 dated September 2?, 1968. It is in compliance with the statutes and regulations then existing and still current. This Department does not contemplate further action on this project until applicable state statutes or regulations are changed or until application is made for the State's operating permit.

We have no comment on the February, 1971 document. If you have need for additional response from us please advise.

Very truly yours,

David H. Scott

David H. Scott
Director
Division of Planning

DHS:s:df/sc
cc: Bureau of Permitting

DIVISION OF STATE PLANNING
Bureau Of
Intergovernmental Relations
11 1972
RECEIVED
SAI NO. 73-0341

TO: Mr. Don L. Spicer, Chief, Bureau of Intergovernmental Relations
725 South Bronough Street, Tallahassee, Florida 32304

FROM: Mr. Jess Yarbrough
Florida Public Service Commission

RE: U. S. Atomic Energy Commission - Florida Power and Light Company: DEIS on Supplement to Crystal River Unit 3 Nuclear Generating Station. SAI Project No. 73-0341. Comments due by October 12, 1972

We have reviewed the above environmental impact statement and comment as to the adequacy of treatment of physical, ecological, and sociological effects of concern to us as shown below:

	Check (✓) for each item: None	Check (✓) for each item: Comment enclosed
1. Additional specific effects which should be assessed:	✓	
2. Additional alternatives which should be considered:	✓	
3. Better or more appropriate measures and standards which should be used to evaluate environmental effects:	✓	
4. Additional control measures which should be applied to reduce adverse environmental effects or to avoid the irreversible or irretrievable commitment of resources:	✓	
5. Our assessment of how serious the environmental damage from this project might be, using the best alternative and control measures:	✓	
6. We identify issues which require further discussion or resolution as shown:	✓	

This agency ☐ does wish ☑ does not wish to review the final environmental impact statement on this project.

W. E. James, Director Engineering
(Name & title of authenticating official)

Enclosure(s) ☑ None ☐ Attached

DEIS 4/28/71

TO: Homer E. Still, Jr., State Planning and Development Clearinghouse
725 South Bronough Street, Tallahassee, Florida 32304

STATE PLANNING AND DEVELOPMENT CLEARINGHOUSE
MAR 15 1972
RECEIVED
SPDC NO. 72-0800

FROM: Mr. T. Marby Ervin, Executive Director
Public Service Commission

RE: U. S. Atomic Energy Commission - Florida Power & Light Company: Crystal River Unit 3, Applicant's Environmental Report, Operating License Stage, Citrus County. SPDC Project No. 72-0800.

We have reviewed the above environmental impact statement and comment as to the adequacy of treatment of physical, ecological, and sociological effects of concern to us as shown below:

	Check (✓) for each item: None	Comment enclosed
1. Additional specific effects which should be assessed:	✓	
2. Additional alternatives which should be considered:	✓	
3. Better or more appropriate measures and standards which should be used to evaluate environmental effects:	✓	
4. Additional control measures which should be applied to reduce adverse environmental effects or to avoid the irreversible or irretrievable commitment of resources:	✓	
5. Our assessment of how serious the environmental damage from this project might be, using the best alternative and control measures:	✓	
6. We identify issues which require further discussion or resolution as shown:	✓	

This agency ☐ does wish / ☑ does not wish to review the final environmental impact statement on this project.

W. E. James
(Name & title of authenticating official)

Enclosure(s) ☑ None
☐ Attached

DEIS 4/28/71

FLORIDA PUBLIC SERVICE COMMISSION

COMMISSIONERS:
JESS YARBOROUGH, CHAIRMAN
WILLIAM T. MAYO
BILL BEVIS

700 SOUTH ADAMS STREET
TALLAHASSEE 32304
TELEPHONE 904 – 599-5622

March 13, 1972

STATE PLANNING AND DEVELOPMENT
CLEARINGHOUSE
MAR 16 1972
RECEIVED
SPDC NO. 72-0800

Mr. Homer E. Still, Jr.
Chief, Bureau of Planning
Department of Administration
725 South Bronough
Tallahassee, Florida 32304

Dear Mr. Still:

Thank you for the recently received environmental reports regarding Florida Power and Light Company. This information is being forwarded to Mr. H. E. Janes, Director of the Commission's Engineering Department, for his attention.

Yours very truly,

T. Mabry Ervin

T. Mabry Ervin, Sr.
Executive Director

TME:ln
cc: Mr. H. E. Janes w/a

STATE PLANNING AND DEVELOPMENT
CLEARINGHOUSE
FEB 18 1972
RECEIVED
SPDC NO. 72-0540

TO: Homer E. Still, Jr., State Planning and Development Clearinghouse
725 South Bronough Street, Tallahassee, Florida 32304

FROM: Mr. T. Mabry Ervin, Executive Director
Public Service Commission

re: U. S. Atomic Energy Commission: Crystal River, Unit 3, Nuclear Generating Plant, Environmental Report. SPDC Project No. 72-0540

We have reviewed the above environmental report and comment as to the adequacy of treatment of physical, ecological, and sociological effects of concern to us as shown below:

	Check (✓) for each item	
	None	Comment enclosed
1. Additional specific effects which should be assessed:		
2. Additional alternatives which should be considered:		
3. Better or more appropriate measures and standards which should be used to evaluate environmental effects:		
4. Additional control measures which should be applied to reduce adverse environmental effects or to avoid the irreversible or irretrievable commitment of resources:		
5. Our assessment of how serious the environmental damage from this project might be, using the best alternative and control measures:		
6. We identify issues which require further discussion or resolution as shown:		

This agency ☐ does wish / ☒ does not wish to review the draft environmental impact statement on this project.

T. Mabry Ervin
(Name & title of authenticating official)

Enclosure(s) ☐ None
☐ Attached

STATE OF FLORIDA

Department of State

THE CAPITOL
TALLAHASSEE 32304

RICHARD (DICK) STONE
SECRETARY OF STATE

DIVISION OF STATE PLANNING,
Bureau Of
Intergovernmental Relations
OCT 16 1972
RECEIVED
SAI NO. 73-0341

ROBERT WILLIAMS, DIRECTOR
DIVISION OF ARCHIVES, HISTORY, AND RECORDS MANAGEMENT

October 13, 1972

Mr. Don L. Spicer, Chief
Bureau of Intergovernmental Relations
Department of Administration
725 South Bronough
Tallahassee, Florida 32304

Re: Florida Power and Light Company
DEIS on Supplement to Crystal River Unit 3
Nuclear Generating Station - SAI Project No. 73-0341

Dear Mr. Spicer:

This is to advise that this agency has no adverse comments in reference to the above mentioned project. However, should suspect areas of archaeological or historical nature appear during preliminary operations, this office should be notified as soon as possible.

Thank you for your cooperation in this matter.

Sincerely,

L. Ross Morrell
State Archaeologist & Chief,
Bureau of Historic Sites & Properties

LRM:pmo
Enclosure

TO: Mr. Don L. Spicer, Chief, Bureau of Intergovernmental Relations
725 South Bronough Street, Tallahassee, Florida 32304

FROM: Mr. Robert Williams, Director
Division of Archives, History and Records Management

RE: U. S. Atomic Energy Commission - Florida Power and Light Company: DEIS on Supplement to Crystal River Unit 3 Nuclear Generating Station. SAI Project No. 73-0341. Comments due by October 12, 1972

We have reviewed the above environmental impact statement and comment as to the adequacy of treatment of physical, ecological, and sociological effects of concern to us as shown below:

	Check (✓) for each item: None	Comment enclosed
1. Additional specific effects which should be assessed:	✓	
2. Additional alternatives which should be considered:	✓	
3. Better or more appropriate measures and standards which should be used to evaluate environmental effects:	✓	
4. Additional control measures which should be applied to reduce adverse environmental effects or to avoid the irreversible or irretrievable commitment of resources:	✓	
5. Our assessment of how serious the environmental damage from this project might be, using the best alternative and control measures:	✓	
6. We identify issues which require further discussion or resolution as shown:	✓	

This agency ☑ does wish / ☐ does not wish to review the final environmental impact statement on this project.

Daniel T. Penton
(Name & title of authenticating official)
Historic Sites Specialist

Enclosure(s) ☑ None
☐ Attached

DIVISION OF STATE PLANNING,
Bureau Of
Intergovernmental Relations
AUG 21 1972
RECEIVED
SAI NO. 72-0800

STATE OF FLORIDA
Department of State
THE CAPITOL
TALLAHASSEE 32304

RICHARD (DICK) STONE
SECRETARY OF STATE

ROBERT WILLIAMS, DIRECTOR
DIVISION OF ARCHIVES, HISTORY, AND
RECORDS MANAGEMENT

August 17, 1972

Mr. Don L. Spicer, Chief
Bureau of Intergovernmental Relations
Department of Administration
725 South Bronough
Tallahassee, Florida 32304

Re: Florida Power and Light Company: Crystal River
Unit 3, Applicant's Environmental Report,
Operating License Stage, Citrus County.
SPDC Project No. 72-0800

Dear Mr. Spicer:

This is to advise that this agency has no adverse comments in reference to the above mentioned project. However, should suspect areas of archaeological or historical nature appear during preliminary operations, this office should be notified as soon as possible.

Sincerely,

Ross

L. Ross Morrell
State Archaeologist & Chief,
Bureau of Historic Sites &
Properties

LRM:pmo

STATE OF FLORIDA

Department of State

THE CAPITOL
TALLAHASSEE 32304

RICHARD (DICK) STONE
SECRETARY OF STATE

ROBERT WILLIAMS, DIRECTOR
DIVISION OF ARCHIVES, HISTORY, AND
RECORDS MANAGEMENT

March 30, 1972

STATE PLANNING AND DEVELOPMENT
CLEARINGHOUSE
APR 13 1972
RECEIVED
SPDC NO. 72-0800

Mr. Homer E. Still, Jr.
State Planning and Development
Clearinghouse
725 South Bronough
Tallahassee, Florida 32304

Re: Crystal River Nuclear Plant
Environmental Impact Statement
SPDC Project 72-0800

Dear Homer:

The environmental impact statement prepared by the Florida Power Corporation contends that the Crystal River Indian Mounds are the only historically significant remains within the immediate vicinity. This assumption is based on their inclusion in the National Register of Historic Places. This does not take into account the possibility that other sites of equal importance may lie within the plant vicinity. In fact, Citrus County contains at least two other sites of National Register stature. These two sites are the Yulee Sugar Mill Ruins, near Old Homosassa, and Fort Cooper, south of Inverness. There quite probably are other sites of historic interest in the area, which merit National Register consideration in addition to sites of lesser importance. We feel that an environmental impact statement especially relative to historical and/or archaeological resources, should not be deemed adequate when the National Register of Historic Places is used as the primary sample of the historically significant sites in any given area, and is not intended to serve as a complete inventory of such sites. The state archaeological survey files are used for this purpose, but unfortunately, these are also deficient.

Due to the incomplete nature of our state-wide archaeological survey, some areas within the state are relatively unknown. With the exception of a very few localities within the state, we would not be able to give an unqualified approval to any large-scale construction activity prior to an intensive, on-the-ground survey of the area. This is especially true of the Crystal River area. This region is relatively unknown from archaeological and historical viewpoint, due primarily to the rugged environmental situation. We do know, however, that the coastal salt marshes and adjacent estuarine areas in this part of Florida furnished one of the most favorable ecological niches available to the prehistoric inhabitants of the region. Topographic maps of the area owned by Florida Power Corporation indicate the probable existence of aboriginal sites at Black Point, Salt Creek, Tony Creek, Little Rocky Creek, and other areas within this tract. In addition, aboriginal sites are suspected in the area immediately south of this parcel, and include Shell Island, Wash Island, and Fort Island. To adequately fulfill the requirements of the environmental impact statement, we recommend that Florida Power Corporation contract for an intensive archaeological survey of their Crystal River properties. Such an in-depth inventory would facilitate our evaluation of possible detrimental results without compromising a portion of Florida's irreplaceable heritage.

Sincerely,

Robert Williams
Director

RW:Mpmo

TO: Homer E. Still, Jr., State Planning and Development Clearinghouse
725 South Bronough Street, Tallahassee, Florida 32304

FROM: Mr. Robert Williams, Director
Division of Archives, History, and Records Management

RE: U. S. Atomic Energy Commission - Florida Power & Light Company: Crystal River Unit 3, Applicant's Environmental Report, Operating License Stage, Citrus County
SPDC Project No. 72-0800.

We have reviewed the above environmental impact statement and comment as to the adequacy of treatment of physical, ecological, and sociological effects of concern to us as shown below:

	Check (✓) for each item: None	Comment enclosed
1. Additional specific effects which should be assessed:	✓	
2. Additional alternatives which should be considered:	✓	
3. Better or more appropriate measures and standards which should be used to evaluate environmental effects:		✓
4. Additional control measures which should be applied to reduce adverse environmental effects or to avoid the irreversible or irretrievable commitment of resources:	✓	
5. Our assessment of how serious the environmental damage from this project might be, using the best alternative and control measures:	✓	
6. We identify issues which require further discussion or resolution as shown:		✓

This agency ☐ does wish ☐ does not wish to review the final environmental impact statement on this project.

Daniel T. Penton
(Name & title of authenticating official)
Historic Sites Specialist

Enclosure(s) ☐ None ☐ Attached

STATE OF FLORIDA
Department of State
THE CAPITOL
TALLAHASSEE 32304

STATE PLANN[illegible] [illegible]OPMENT
C[illegible] E
[illegible] 1972
RECEIVED
SPDC NO. 72-0540

RICHARD (DICK) STONE
SECRETARY OF STATE

ROBERT WILLIAMS, DIRECTOR
DIVISION OF ARCHIVES, HISTORY, AND
RECORDS MANAGEMENT

February 28, 1972

Mr. Homer E. Still, Jr.
Chief, Bureau of Planning
Department of Administration
725 South Bronough
Tallahassee, Florida 32304

Re: Crystal River, Unit 3, Nuclear Generation Plant, Environmental Report SPDC Project No. 72-0540

Dear Homer:

The above referenced SPDC Project Environmental Report has been reviewed. Please consider the attached memorandum as our response and reflects our concern for an area where insufficient archaeological survey is indicated.

Sincerely,

Bob

Robert Williams
Director

RW:Mpmo

Enclosure

RICHARD (DICK) STONE
SECRETARY OF STATE

M E M O R A N D U M

TO: L. Ross Morrell, State Archaeologist & Chief., Bureau of Historic Sites & Properties

Date: 2-25-72

FROM: Daniel T. Penton, Historic Sites Specialist, Historic Preservation Section.

SUBJECT: CRYSTAL RIVER, UNIT 3 ENVIRONMENTAL REPORT SPDC PROJECT NO. 72-0540 - COMMENTS

In response to the environmental impact statement issued by Florida Power Corporation on the Crystal River Unit #3 Nuclear Plant, there appears to be a degree of inconsistency. This report states that "archaeological activities at the Crystal River site were conducted by scientists of the Florida State Museum, associated with the University of Florida, during the latter part of 1969" (p. 7). After a number of telephone calls to the Florida State Museum and the University of Florida, it was determined that the actual construction site had not been examined relative to possible archaeological remains. Mr. Ripley Bullen, Archaeologist at the Florida State Museum, stated that he excavated one site at the mouth of the barge canal, but had not examined other areas involved in the project. Dr. Charles Fairbanks, of the University of Florida, said he had not conducted any research in the area. From these two statements, it appears that the major portions of the construction site have not been adequately examined from an archaeological standpoint. Consequently, we cannot comment favorably on the environmental statement, without additional archaeological survey in the construction area.

DTP:pmo

gen-19
1-5-71

COPY

August 26, 1972

Mr. Donald Albright
State Planning and Development Clearinghouse
702 South Duval
Tallahassee, Fla. 32304

Dear Mr. Albright:

The Environmental Information Center has provided me for comment a copy of the "102" statement on Amendment #20 of the report on Florida Power Corp. Crystal River Unit #3 (SPDC No. 72-0800).

Lacking a competence in such fields as meteorology, hydrology, geology and structural engineering, I would not presume to question the data and conclusions of the specialists who contributed to the compilation of this Amendment.

There are a few points, however, which are not clear to me, though the specialists concerned might answer them very readily.

1. This major hurricane threat is considered as comming on a NE course from the SW, and the embankment slope protection refers only to the South side of the plant.

   In recent years, a few hurricanes have been very erratic. Is it not possible that a hurricane might swing and approach from the NW, expending its tide and wave action against the

COPY

COPY

North and West sides of the plant? If so, would these sides be protected by an adequate embankment?

2. It is stated that bedrock is approximately 20 feet beneath the present ground surface. If high tides persisted for several hours before the hurricane reached its peak, would there not be a tendency for soil saturation beneath the embankment and, if so, would the stability of the structure be affected?

Sincerely,

/s/

A. R. Quillinan
640 Bayshore Drive
Tarpon Springs, Florida 33589

COPY

COPY

Nov. 2, 1972

Dear Sir,

This is to inform you that I oppose the construction of a second nuclear power plant in the Crystal River area as well as the massive industrial complex planned for this section.

This is one of the last undisturbed and unpolluted tidal areas on the Gulf of Mexico. This area is necessary for salt water nurseries.

Sincerely,

/s/

Karen K. Vogt
1549 Drexel N.E.
Winter Haven
Florida 33880

Karen K. Vogt
1549 Drexel N.E.
Winter Haven
Florida 33880

COPY

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May 2, 1972

Dear Sir:

This is to inform you that I oppose the construction of a second nuclear power plant in the Crystal River area as well as the massive industrial complex planned for this section.

This is one of the last undisturbed and unpolluted tidal areas on the Gulf of Mexico. This area is necessary for salt water nurseries. Give the fish a chance PLEASE.

Sincerely,

/s/

Larry Beck
2209 34th St. N.W.
Winter Haven

COPY

COPY

Nov. 2, 1972

Dear Sir:

This is to inform you that I oppose the construction of a second nuclear power plant in the Crystal River area as well as the massive industrial complex planned for this section.

This is one of the last undisturbed and unpolluted tidal areas on the Gulf of Mexico. This area is necessary for salt water nurseries.

Sincerely,

/s/

(Mrs.)June Rouseff
909A Lake Jessie Dr.
Winter Haven, Fla. 33880

909A Lake Jessie Dr.
Winter Haven, Fla. 33880

COPY

COPY

Nov. 2, 1972

Dear Sir:

This is to inform you that I oppose the construction of a second nuclear power plant in the Crystal River area as well as the massive industrial complex planned for this section.

This is one of the last undisturbed and unpolluted tidal areas on the Gulf of Mexico. This area is necessary for salt water nurseries.

Sincerely,

/s/

Anne Hains
P. O. Box 2351
Winter Haven

Anne Hains
P. O. Box 2351
Winter Haven, Fla 33880

COPY

COPY

Dear Sir:

This is to inform you that I oppose the construction of a 2nd nuclear power plant in the Crystal River area as well as the massive industrial complex planned for this section.

This is one of the last undisturbed tidal areas on the Gulf of Mexico. This area is necessary for salt water nurseries.

Sincerely,

/s/

Eric B_____
850 Ave. "Y" N.W.
Winter Haven, Fla.

COPY

COPY

Nov. 2, 1972

Dear Sir,

This is to inform you that I oppose the construction of a second nuclear power plant in the Crystal River area as well as the massive industrial complex planned for this section.

This is one of the last undisturbed and unpolluted tidal areas on the Gulf of Mexico. This area is necessary for salt water nurseries.

Sincerely,

/s/

Jennifer Boone
Rt. 6, Box 201

Rt. 6, Box 201
Lakeland, Fla. 33801

FEDERAL POWER COMMISSION
WASHINGTON, D.C. 20426
December 1, 1972

IN REPLY REFER TO:

50-302

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 reference to your letter dated September 11, 1972, requesting comments on the AEC Draft Environmental Statement related to the proposed continuation of the Provisional Construction Permit CPPR-51 and the issuance of an operating license to the Florida Power Corporation for the Crystal River Nuclear Unit No. 3, Docket No. 50-302.

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 Detailed Statement; the Applicant's Environmental Report and Supplement 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 staff's analysis of these documents together with related information from other FPC reports. 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 critical load period immediately following the availability of the facility.

Need for the Facility

The Florida Power Corporation's Crystal River Generating Unit No. 3 is an 825 megawatt pressurized-water reactor type. The Crystal River site already contains the 387-megawatt fossil-fueled steam generating Unit No. 1 and the 510-megawatt fossil-fueled steam generating Unit No. 2.

Mr. Daniel R. Muller

Crystal River Unit No. 3, originally scheduled for commercial operation in April 1972, was delayed and is presently scheduled for commercial service in October 1974. It is expected to be available in time to assist in meeting the 1974-75 winter and 1975 summer peak loads. The Florida Power Corporation has been forced to take temporary measures for supplying the expected demand during the summer of 1973 due to the thirty-month delay in the 825 megawatt Crystal River unit. These measures included the purchase of 200 megawatts of gas turbine capacity and the purchase from neighboring utilities of an additional 350 megawatts of capacity.

The Applicant is one of seven interconnected systems 1/ operating throughout the State of Florida belonging to the Florida Subregion of the Southeastern Electric Reliability Council (SERC). In this interconnected system network, a capacity problem that affects one utility will affect the entire Subregion's electric power supply. The Florida utilities state that they operate on the concept of helping their neighbor whenever possible, however each utility is responsible for protecting its own system before that of its neighbor.

The current generation expansion program of large generating units for the Florida Subregion for completion during the years 1972 through 1975 is tabulated below:

1/ The other systems are: Florida Power and Light Company, Tampa Electric Company, Jacksonville Electric Authority, Orlando Utilities Commission, City of Tallahassee and the City of Lakeland.

Mr. Daniel R. Muller

GENERATION EXPANSION PROGRAM - FLORIDA SUB-REGION

Estimated Commercial In-Service Date	Station	Type 1/	Capability (MW)
December 1972 2/	Turkey Pt. No. 3	N	725
March 1973	Turkey Pt. No. 4	N	725
January 1973	Sanford No. 5	F	398
February 1973	Big Bend No. 2	F	400
June 1973	Indian River No. 3	F	325
October 1974	Crystal River No. 3	N	825
May 1974	Anclote No. 1	F	515
May 1975	Hutchinson Island No. 1	N	850
May 1975	Port Manatee	F	825
March 1975	Big Bend No. 3	F	400
June 1975	Northside No. 3	F	550
April 1975	Anclote No. 2	F	515

1/ F-Fossil, N-Nuclear.

2/ Currently in operation and is expected to attain 520 MW in November 1972.

The Applicant's and the Florida Subregion's systems normally experience 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, the summer peak load periods are considered the more hazardous peak periods. The following tabulation shows the electric system loads to be served by the Applicant and by the systems of the Florida Subregion of SERC, including the Applicant, and the relationship of the electric output of the Crystal River Unit No. 3 to the available reserve capacities on the Applicant's and Florida Subregion's systems at the time of the 1974-75 winter and the succeeding 1975 summer peak load period. These are the anticipated initial service periods of the new 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.

Mr. Daniel R. Muller

FLORIDA POWER CORPORATION PEAK LOAD - SUPPLY SITUATION

	1974-75 Winter Peak	1975 Summer Peak
Conditions With Crystal River Unit No. 3 (825 Megawatts)		
Net Total Capability - Megawatts	4,032	4,492 1/
Net Peak Load - Megawatts	3,090	3,130
Reserve Margin - Megawatts	942	1,362
Reserve Margin - Percent of Peak Load	30.5	43.5
Conditions Without Crystal River Unit No. 3		
Net Total Capability - Megawatts	3,207	3,667 1/
Net Peak Load - Megawatts	3,090	3,130
Reserve Margin - Megawatts	117	537
Reserve Margin - Percent of Peak Load	3.8	17.2
Reserve Margin Needs - Based on 25 Percent Criterion - Megawatts	773	783
Reserve Margin Deficiency - Based on 25 Percent Criterion - Megawatts	656	246

1/ Includes Anclote No. 2, 515 Megawatts. Reduced by 55 megawatts retired capacity.

Mr. Daniel R. Muller

FLORIDA SUBREGION OF SERC PEAK LOAD - SUPPLY SITUATION

	1974-75 Winter Peak	1975 Summer Peak
Conditions With Crystal River Unit No. 3 (825 Megawatts)		
Net Total Capability - Megawatts	17,477	20,258
Net Peak Load - Megawatts	14,319	15,337
Reserve Margin - Megawatts	3,158	4,921
Reserve Margin - Percent of Peak Load	22.1	32.1
Reserve Margin Needs - Based on 25 Percent Criterion - Megawatts	3,580	3,834
Reserve Margin Deficiency - Based on 25 Percent Criterion - Megawatts	422	--
Conditions Without Crystal River Unit No. 3		
Net Total Capability - Megawatts	16,652	19,433
Net Peak Load - Megawatts	14,319	15,337
Reserve Margin - Megawatts	2,333	4,096
Reserve Margin - Percent of Peak Load	16.3	26.7
Reserve Margin Needs - Based on 25 Percent Criterion - Megawatts	3,580	3,834
Reserve Margin Deficiency - Based on 25 Percent Criterion - Megawatts	1,247	--

The staff of the Bureau of Power is of the opinion that peninsular Florida, due to its lack of adequate transmission capability with adjoining states, its generating unit types and sizes and minimal seasonal diversity, needs reserves of about 25 percent of peak load. Except for the Florida Subregion's 26.7 percent reserve for the summer of 1975, this minimum reserve margin criterion of 25 percent of peak load is not present on the Applicant's or the Florida Subregion's systems without Crystal River Unit No. 3 being available, even with all other existing and scheduled generating capacity available as scheduled.

Mr. Daniel R. Muller

The availability of Crystal River Unit No. 3 for winter 1974-75 would provide the Applicant with an expected system reserve margin of 942 megawatts or 30.5 percent of peak load. However, any delay which results in the unavailability of Crystal River Unit No. 3 for the 1974-75 winter peak load period would reduce system reserves to 117 megawatts or 3.8 percent of peak load. The Applicant's 1975 summer peak load situation improves with the availability of the 515 megawatt fossil-fired Anclote Unit No. 2 scheduled for commercial operation in April 1975. With the availability of Crystal River Unit No. 3 for the summer of 1975, the Applicant would have an expected system reserve margin of 1,362 megawatts or 43.5 percent of peak load. Without the Crystal River unit, system reserves would be reduced to 537 megawatts or 17.2 percent of peak load, and forecasts based on this condition indicate a reserve margin deficiency of 656 and 246 megawatts for the 1974-75 winter and 1975 summer peak periods respectively in relation to a minimum reserve margin criterion of 25 percent of peak load. Any delay or outage resulting in the unavailability of either of the scheduled Anclote Units would increase the severity of the effect on system reserves.

With respect to the total Florida Subregion, the availability of Crystal River Unit No. 3 for the 1974-75 winter and 1975 summer peak load periods would provide a reserve margin of 22.1 and 32.1 percent of peak load, respectively. Should delays make the unit unavailable for the 1974-75 winter and 1975 summer peak load periods, the Florida systems forecast a reserve margin of 16.3 and 26.7 percent of peak load, respectively, a reserve deficiency of 1,247 megawatts for the 1974-75 winter peak period based on a minimum reserve margin criterion of 25 percent of peak load.

The adequacy and reliability of the Florida systems in 1974 and 1975 are not only dependent upon the timely commercial operation of Crystal River Unit No. 3 but also on the timely operation of all the units in the Florida Systems' current construction program. Current information indicates that delays are being experienced in bringing many large units into commercial operation and this trend may continue for some time.

The reserve margins indicated in the foregoing tabulations 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 outages and any that might be needed to meet unforeseen demands due to errors in load forecasting and exceptional weather.

Mr. Daniel R. Muller

The Southeastern Electric Reliability Council (SERC) in which the Applicant and the Florida Systems are members, reports reserve margins of 30.0 and 25.9 percent of peak load for the 1974-75 winter and 1975 summer periods respectively; however, a large portion of these reserves are vested in large new generating units not yet in operation. The Council's main function is the furthering of bulk power system reliability in the SERC area through coordination of the member's expansion plans. 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, base-load capacity within the member's system. In this particular case, the limited interconnection capacity between Florida and adjoining areas would prohibit large power transfers even if surplus capacity were available. In order to provide adequate reserves for the region, a proportionate reserve should be maintained by each system, based on its own load.

Transmission Facilities

The transmission line additions necessary as a result of the construction of Crystal River Unit No. 3, are two 500-kilovolt lines 53 and 72 miles long emanating from the Crystal River Plant switchyard and terminating at the Central Florida Substation and the Lake Tarpon Substation respectively. The 500-kilovolt lines will utilize the vacant section of the right-of-way adjacent to the existing 230-kilovolt double circuit lines constructed for Crystal River Units Nos. 1 and 2.

The Applicant states the existing right-of-way and tower structures were carefully selected to minimize their resulting impact on the environment.

Alternates to the Proposed Facilities and Costs

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), the purchase of power, environmental effects and economics. The final decision rested between a base-load nuclear-fueled plant and a base-load fossil-fired plant. Economics and environmental considerations led to the selection of the nuclear-fueled plant over the fossil-fired plant.

Mr. Daniel R. Muller

The Applicant discussed only in general terms alternative sources of power generation and their associated costs and benefits. The Bureau of Power staff's studies have shown that no practical sources of purchased power are available in the magnitude necessary to replace Crystal River Unit No. 3.

Conclusions

The staff of the Bureau of Power concludes that the electric power output represented by the Crystal River Unit No. 3 is needed to implement the Applicant's and the Florida systems' generation expansion programs for meeting projected loads and to provide some reasonable measure of reserve margin capacity for the 1974-75 winter and 1975 summer peak periods.

Very truly yours,

T. A. Phillips
Chief, Bureau of Power