NUREG-0779

Final Environmental Statement related to the operation of Waterford Steam Electric Station, Unit No. 3

Docket No. 50-382

Louisiana Power and Light Company

U.S. Nuclear Regulatory Commission

Office of Nuclear Reactor Regulation

September 1981

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Final Environmental Statement

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SUMMARY AND CONCLUSIONS

This Environmental Statement - Operating Phase was prepared by the U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation (the staff).

1. The action is administrative.

2. The proposed action is the issuance of an operating license to the Louisiana Power and Light Company for the startup and operation of Unit 3 of the Waterford Steam Electric Station (Docket No. 50-382) located near the Mississippi River in St. Charles Parish, about 40 km (25 mi) west of New Orleans, Louisiana.

   The facility will employ a pressurized-water reactor to produce 3410 megawatts thermal (MWt). A steam turbine-generator will use this heat to provide 1153 megawatts electric (MWe gross). The maximum design thermal output is 3560 MWt, with a corresponding maximum calculated net electrical output of 1104 MWe. The exhaust steam will be condensed by a once-through flow of water taken from and returned to the Mississippi River.

3. The evaluation in this statement represents the second assessment of the environmental impact associated with the Waterford Steam Electric Station, Unit 3, pursuant to the requirements of the National Environmental Policy Act of 1969 (NEPA) and 10 CFR Part 51 of the Commission's Regulations. After receipt of an application in 1970 to construct this station, the staff carried out a review of impact that would occur during its construction and operation. This evaluation was issued as a Final Environmental Statement - Construction Phase in March 1973. After this environmental review, a safety review, an evaluation by the Advisory Committee on Reactor Safeguards, and public hearings in New Orleans, LA, the U.S. Atomic Energy Commission (now U.S. Nuclear Regulatory Commission) issued a permit in November 1974 for the construction of Waterford 3. As of July 1981, the construction of the unit was 90% complete. With a proposed fuel-loading date of October 1982, the applicant has applied for a license to operate the unit and has submitted (September 1978) the required safety and environmental reports[1,2] (FSAR, ER-OL) in support of the application. The staff has reviewed the activities associated with the proposed operation of the station and the potential environmental impacts from operation, both beneficial and adverse, are summarized as follows:

   a. The Waterford 3 site is located on 1440 ha (3560 acres) which are owned by Louisiana Power & Light Company. There were no offsite transmission lines built specifically for this plant (Sec. 4.2.5).

   b. Controlled and/or treated releases of heat, chemical wastes, and sanitary wastes into the Mississippi River will be rapidly assimilated; thus, adverse impacts on downstream water users or aquatic biota will be absent or negligible (Secs. 5.3 and 5.6).

c. No measurable radiological impact on man or biota other than man is expected to result from routine operation. The risk associated with accidental radiation exposures is very low (Sec. 5.9.2).

d. No adverse impacts on the terrestrial environment of the project area will occur because of increased noise levels or other factors attributable to station operation (Sec. 5.5).

e. Heated water will slightly increase the water temperature of the Mississippi River in the vicinity of the discharge, but the effects on river biota will be minimal (Secs. 4.2, 5.3, and 5.5).

f. Chemical releases into the Mississippi River are not expected to exceed water-quality criteria levels (Sec. 5.3.3), and will not adversely impact river biota.

g. The designs of the intake and discharge structures have been modified to reduce adverse impacts to the biota (Secs. 4.2.2, 4.3.4, 5.3.2, and 5.5).

h. A reassessment of the socioeconomic impacts of the operation of the plant has disclosed only minimal adverse impacts on the delivery of medical and firefighting services (Sec. 5.8); all other publicly provided services will experience negligible impacts as a result of operational workers and their families moving into the area. The staff is currently seeking a determination of eligibility of areas 3, 4, and 5 for inclusion in the National Register of Historic Places (Sec. 5.7).

i. The geological aspects of the Waterford 3 area were addressed in the FES-CP, pages II-8 through II-11. The applicant has continued to obtain information on geology, seismicity and soils in the area (ER-OL, Sec. 6.1.4). For example, satellite infrared imagery, and high-altitude color photography data have been obtained. The new data are essentially in agreement with the information presented in the FES-CP.

j. The staff has updated the evaluation of need for power based on information presently available (Sec. 2). It concludes that operation of the station will be less expensive than any other generation alternative and could also be used to reduce dependence on oil- and gas-fired generation.

4. Areas of controversy relating to environmental impacts in the operating license hearing are: (1) need for power, (2) cost of operating Waterford 3, and (3) synergistic and cumulative effects of low-level radiation and carcinogens.

5. The Draft Environmental Statement was made available to the agencies specified in Section 8 and to the public.

   Comments on the Draft Environmental Statement were received from the following:

U.S. Department of Argiculture
U.S. Department of the Interior
Federal Energy Regulatory Commission
Department of Housing and Urban Development (Region VI)
Louisiana Power & Light (Applicant)
Department of Health and Human Services, Food and Drug Administration
U.S. Environmental Protection Agency
Department of Housing and Urban Development
State of Louisiana, Department of Culture, Recreation and Tourism
Department of the Army, Corps of Engineers
U.S. Department of Transportation
W. A. Lochstet, Ph.D

6. This Final Environmental Statement was made available to the public, to the Environmental Protection Agency, and to other specified agencies.

7. On the basis of the analysis and evaluation set forth in this statement, and after weighing the environmental, economic, technical, and other benefits against environmental and economic costs, and after considering available alternatives at the operation stage, it is concluded that the action called for under NEPA and 10 CFR Part 51 is the issuance of an operating license for Unit 3 of the Waterford Steam Electric Station, subject to the following conditions for the protection of the environment:

    a. Before engaging in additional construction or operational activities that may result in a significant adverse environmental impact that was not evaluated or that is significantly greater than that evaluated in this statement, the applicant shall provide written notification to, and obtain prior written approval from, the Director of the Office of Nuclear Reactor Regulation.

    b. The applicant shall carry out the environmental (thermal, meteorological, chemical, radiological, and ecological) monitoring programs outlined in this statement as modified and approved by the staff and implemented in the environmental protection plan and technical specifications incorporated in the operating license for the Waterford Steam Electric Station, Unit 3 (Sec. 6)

    c. If harmful effects or evidence of irreversible damage are detected during the operating life of the station, the applicant shall immediately provide the staff with an analysis of the problem and a proposed course of action to alleviate it.

REFERENCES FOR SUMMARY AND CONCLUSIONS

1. Louisiana Power and Light Company, Waterford Steam Electric Station, Unit Number 3, Final Safety Analysis Report, Docket No. 50-382, 1978.

2. Louisiana Power and Light Company, Waterford Steam Electric Station, Unit Number 3, Environmental Report, Operating License Stage, Docket No. 50-382, 1978.

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FOREWORD

This environmental statement was prepared by the U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation (the staff) in accordance with the Commission's regulation, 10 CFR Part 51, which implements 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:

1. The environmental impact of the proposed action,
2. Any adverse environmental effects which cannot be avoided should the proposal be implemented,
3. Alternatives to the proposed action,
4. The relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and
5. Any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented.

An environmental report accompanies each application for a construction permit or a full-power operating license. A public announcement of the availability of the report is made. Any comments on the report by interested persons are considered by the staff. In conducting the required NEPA review, the staff meets with the applicant to discuss items of information in the environmental report, to seek new information from the applicant that might be needed for an adequate assessment, and generally to ensure that the staff has a thorough understanding of the proposed project. In addition, the staff seeks information from other sources that will assist in the evaluation and visits and inspects the project site and surrounding vicinity. Members of the staff may meet with State and local officials who are charged with protecting State and local interests. On the basis of all the foregoing and other such activities or inquiries as are deemed useful and appropriate, the staff makes an independent assessment of the considerations specified in Section 102(2)(C) of the NEPA and 10 CFR Part 51.

This evaluation leads to the publication of a draft environmental statement, prepared by the Office of Nuclear Reactor Regulation, which is then circulated to Federal, State, and local government agencies for comment. A summary notice is published in the Federal Register of the availability of the applicant's environmental report and the draft environmental 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 benefit-cost analysis 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. Finally, a conclusion is made as to whether--after the environmental, economic, technical, and other benefits are weighed against environmental costs, and after available alternatives have been considered--the action called for, with respect to environmental issues, is the issuance or denial of the proposed permit or license or its appropriate conditioning to protect environmental values. This final environmental statement and the safety evaluation report prepared by the staff are submitted to the Atomic Safety and Licensing Board for its consideration in reaching a decision on the application.

This environmental review deals with the impact of operation of Waterford 3. Assessments that are found in this statement supplement those relating to operation described in the Final Environmental Statement (FES-CP) that was issued in March 1973 in support of issuance of a construction permit for the unit. The information to be found in the various sections of this Statement updates the FES-CP in four ways: (1) by identifying differences between environmental effects of operation (including those which would enhance as well as degrade the environment) currently projected and the impacts that were described in the preconstruction review; (2) by reporting the results of studies relating to operation that had not been completed at the time of issuance of the FES-CP and which were under mandate from the NRC staff to be completed before initiation of the operational review; (3) by evaluating the applicant's preoperational monitoring program and factoring the results of this program into the design of a postoperational surveillance program and into the development of the technical specifications and the environmental protection plan; and (4) by identifying studies being performed by the applicant that will yield additional information relevant to the environmental impacts of operating Waterford 3.

Copies of this Statement are available for inspection at the Commission's Public Document Room, 1717 H Street N.W., Washington, D.C. 20555, and at the University of New Orleans Library, Louisiana Collection, Lakefront, New Orleans, La. Copies of this Statement may be obtained as indicated on the inside front cover.

Suzanne Black is the NRC Project Manager for Waterford 3. Mrs. Black may be reached at (301) 492-7119.

1 INTRODUCTION

1.1 RESUME

The proposed action is the issuance of an operating license to the Louisiana Power and Light Company (the applicant) for the startup and operation of Waterford Unit 3, located near the Mississippi River in St. Charles Parish, Louisiana, 40 km (25 miles) west of New Orleans. Waterford 3 will employ a pressurized water reactor manufactured by Combustion-Engineering and will have an initial net electrical capacity of 1104 megawatts.

In July 1981 construction of Unit 3 was 90 percent complete.

1.2 ADMINISTRATIVE HISTORY

1.2.1 Prior Staff Action

This operating license review is the second assessment of the environmental impact associated with Waterford 3. After receiving an application, in 1970, to construct this plant, the staff reviewed impacts that would occur during the construction and operation of this plant. This evaluation was issued as a Final Environmental Statement (FES-CP) in March 1973. As a result of this environmental review, a safety review, an evaluation by the Advisory Committee on Reactor Safeguards, and a public hearing in New Orleans, Louisiana, the AEC (now NRC) issued a permit, in November 1974, for the construction of Waterford 3. With a proposed fuel-loading date of October 1982, the applicant has applied for a license to operate the unit, and in September 1978 submitted safety and environmental reports to substantiate this application.

1.2.2 Public Participation

In January 1979 the NRC published a Federal Register Notice of "Receipt of Application for Facility Operating License; Availability of Applicant's Environmental Report; Consideration of Issuance of Facility Operating License; and Opportunity for Hearing." This notice provided an opportunity for any person whose interest might be affected by this proceeding to request a hearing and file a petition for leave to intervene. Three intervenor groups filed two separate petitions. In April 1979, a special prehearing conference was held in New Orleans to:

a. Permit identification of the key issues in the proceeding,

b. Take any steps necessary for further identification of the issues,

c. Consider all intervention petitions to allow the presiding officer to make such preliminary or final determination as to the parties to the proceeding, as may be appropriate,

d. Establish a schedule for further actions in the proceeding.

In September 1979 the Atomic Safety and Licensing Board admitted the intervenor groups as parties in the proceeding and ruled on the admissibility of the intervenors' contentions.

1.3 STATUS OF REVIEWS AND APPROVALS

The status of licenses, permits, and other approvals which are required for the operation of Waterford 3 is presented in Table 1.1.

There are no non-NRC licensing activities that would preclude or significantly delay the scheduled operation of this plant.

Table 1.1 Licenses, Permits, and Other Approvals Required for the Operation of Waterford 3

Agency	Authorization Required	Statute or Authority	Status
WATER			
United States Army Corps of Engineers	Permit to construct on a navigable waterway	River and Harbors Act Sect. 10 33 CFR 209	Permit granted 7/72, Revised 9/77
	Permit to discharge in waterway dredge and fill material	P.L. 92-500 Sect. 404	Permit granted 4/77
Environmental Protection Agency	Approval of State certification of compliance with effluent limitations	P.L. 92-500 Sect. 401	Permit granted 9/73
	National Pollutant Discharge Elimination System (NPDES) permit	P.L. 92-500 Sect. 402	Permit granted 7/80. Permit renewed 5/81.
	Approval of less stringent effluent limitation for thermal pollution	P.L. 92-500 Sect. 316(a)	Low Potential Impact Type III Demonstration submitted 4/79.
	Approval of intake structure	P.L. 92-500 Sect. 316(b)	Demonstration submitted 4/79.
	Resource Conservation and Recovery Act	P.L. 94-580	Notification of Hazardous Waste Activity Form submitted 8/80
Louisiana Stream Control Commission	Permit to discharge to adhere to State Water Quality Standards	Louisiana Revised Statutes Acts 1975 No. 512 Section 1435, regulations	Permit granted 9/73
	State certification that discharge complies with Sections 301, 302, 306 and 307 of P.L. 92-500	P.L. 92-500 Sect. 401	Permit granted 9/73.
United States Coast Guard	Permit to establish private aid to navigation	14 U.S.C. 81; 33 CFR 66	Application approved 10/77 (annual)

Table 1.1 (continued)

Agency	Authorization Required	Statute or Authority	Status
AIR			
Federal Aviation Administration	Federal air navigation approval	80 Statute 932; 14 CFR 77	Permit for plant stack, auxiliary boiler, diesel generators, and fire pumps granted 9/79. Issued 7/81.
Air Quality Division, Department of Natural Resources	Approval for construction/ operation of emission source	Louisiana Air Control Law Acts 1964 No. 259 Section 1, Regulations Sect. 6.0	Permit for onsite oil storage tanks granted 1/80
LAND			
United States Nuclear Regulatory Commission	Construction permit	68 Stat. 919; 10 CFR 50	Permit received 11/74
	Operating license	68 Stat. 919; 10 CFR 50	Application submitted 9/78
	Special Nuclear Material License	68 Stat. 919; 10 CFR 70	Application submitted 7/81
	Source Nuclear Material License	68 Stat. 919; 10 CFR 40	Approved 1979.
	Byproduct Nuclear Material License	68 Stat. 919; 10 CFR 30	Approved 1979.
Advisory Council on Historic Preservation	Determination that site does not infringe on Federal landmark	National Historic Preservation Act of 1966.	Information provided 9/77
	Determination that site is not an archeologically significant land	Historical and Archeological Preservation Act of 1974.	
United States Department of Interior	Determine no violation of Sect. 7 by NRC	Endangered Species Act of 1973.	Information provided 9/77 (see Sec. 2.2)
Police Jury of St. Charles Parish	New utility construction authorization	Louisiana Zoning Ordinance Law Act 116 Sect. 2 of 1971	Authorized 2/77

Source: ER-OL, Table 12.1-1.

2 PURPOSE OF AND NEED FOR ACTION

2.1 RESUME

When the construction permit was issued in November 1974, the staff concluded that Waterford 3 should be allowed to operate to ensure the reliability of service on the Louisiana Power & Light (LP&L) and the Middle South Utilities (MSU) systems. At that time Waterford 3 was scheduled to begin commercial operation in 1977. This online date was predicated on an expected growth rate in annual peak demand between 1972 and 1977 on the MSU and LP&L service areas of about 9.9 percent and 11.5 percent a year, respectively. However, the actual growth rate for MSU and LP&L from 1972 to 1979 was only about 3.8 percent and 6.8 percent a year, respectively. This decline in the expected growth rate of electricity demand is not unique to the MSU service area; rather, it is representative of a national trend, attributable in part to higher prices for electricity, to conservation, and to an overall slowdown in economic growth. One response by utilities has been to adjust the projected expansion of capacity by delaying planned additions to their systems. It is in this context that the applicant has delayed the commercial availability of Waterford 3. Current scheduling calls for Waterford 3 to begin commercial operation on March 31, 1983.

In this Statement the staff evaluates the purpose and need for Waterford 3 in the context of (1) overall system production costs for generating electricity; (2) availability of alternative fuels; and (3) reliability of the power supply for the LP&L and MSU service areas. The conclusions drawn from this review will be factored into the staff's decision regarding the issuance of an operating license for Waterford 3.

2.2 PRODUCTION COSTS

Waterford 3 was constructed to provide an economical source of baseload energy. Because the substantial capital as well as the environmental costs associated with construction have already been incurred, the only economic factors* that are relevant for consideration now are fuel costs and operation and maintenance (O&M) costs, because these expenses will be affected by whether or not the units operate. A comparison of system production costs available to the system with and without Waterford 3 shows strong economic reasons why an operating license should be issued and operating plans should proceed as scheduled. The staff views an analysis from the MSU perspective as controlling because LP&L is a wholly owned subsidiary and energy is dispatched centrally to service the MSU load.

The MSU system is currently heavily dependent on fossil fuels for generating electricity for its customers. In 1979, 90 percent of MSU's electrical energy was generated by either natural gas or oil. The remaining 10 percent was supplied by nuclear power (9.5 percent) and hydropower (0.5 percent). The MSU system has traditionally burned natural gas as its primary fuel, but in recent years it has been forced to use increasing amounts of fuel oil, which is more

*Environmental costs associated with operation are discussed in subsequent sections of this statement.

expensive. In 1972, natural gas accounted for 88 percent of MSU's total electrical generation; oil accounted for 11 percent. By 1979, natural gas accounted for slightly less than 57 percent, and oil's share was just over 33 percent. This rather dramatic shift was not induced by economic incentives, because oil is significantly more expensive than natural gas. Rather, the shift was caused by gas-supply curtailments which were imposed on the MSU system and by the fact that much of MSU's capacity comes from boilers which can be fired only by gas or oil.

Because MSU is heavily dependent on gas- and oil-fired capacity, and because gas supplies to the MSU system are not adequate to meet its needs, the staff has concluded that the replacement for any energy not produced by Waterford 3 would have to come predominantly from oil-fired generation. This conclusion is consistent with the applicant's own assessment of the source of replacement energy should Waterford 3 not be allowed to operate.

The staff has estimated the first year's fuel cost differential at about 4 cents per kWh. This represents the estimated difference between the cost to the utility (in 1983) of residual oil and nuclear fuel. The fuel oil cost is based on actual delivered values to LP&L in June 1980 and an average plant heat rate of 11,000 Btu/kWh for oil-fired units. This cost was then escalated to 1983 at 10 percent per year to reflect estimated costs in the 1983 time frame. The nuclear fuel cost is based on assumptions contained in Table 11 of NUREG-0480, "Coal and Nuclear: A Comparison of the Cost of Generating Baseload Electricity by Region." This nuclear fuel cost estimate assumes no recycling.

Assuming Waterford 3 would be capable of operating at an average capacity factor of 60 percent during its first year of operation, a decision to deny operation would displace about 5.8 billion kWh. The fuel-cost differential for that one year alone would thus approximate $230 million. This cost differential would be expected to increase in subsequent years because oil escalation is projected to increase faster than the nuclear fuel cost, and because fuel-price escalation is applied to such a larger value in the case of oil as compared to nuclear.

Recent events further support the economic advantage of nuclear fuel over hydrocarbons. Real dollar prices for uranium have been declining over the last several years and even nominal dollar prices have declined most recently. Present prices for oil and gas, however, are projected to increase rapidly; hydrocarbon costs increased 19 percent in 1978 and were up 13 percent in 1979. Furthermore, there is ample domestic supply of uranium whereas it is anticipated that both oil and gas will be subject to restrictive use because of domestic scarcity, thus making their use as base-load boiler fuel inappropriate.

A production-cost analysis should also include the differential in variable O&M costs between Waterford 3 and the units that would provide the replacement energy. However, these cost items are quite small in relation to the fuel-cost differential and would not alter the ultimate cost differential to any meaningful degree.

In addition, a decision to operate Waterford 3 will necessitate a decommissioning expense once the unit is retired from service. In Section 5.10 of this Statement, the staff discusses the different decommissioning methods available and their estimated cost. For a large PWR unit (such as Waterford 3) the decommissioning cost is estimated to range from about $21 million to $43 million (in 1978 dollars).

The operation of Waterford 3 also will result in environmental impacts and increased risk. These have been evaluated by the staff, and the findings are presented in the remaining sections of this report.

In conclusion, the staff finds that considerable savings will occur with the operation of Waterford 3. This result would not be altered to any significant extent even if the demand for electricity were to grow at a much lower rate than currently projected, because MSU's marginal energy source would continue to be oil. Although the staff has only estimated first-year savings, fuel-cost savings would continue as long as Waterford 3 is capable of operating--a period of approximately 30 years.

2.3 DIVERSITY OF SUPPLY

It is to the advantage of a public utility to have diverse sources of power available. Any number of problems could arise regarding the availability of fuel to generate electricity. If imported oil were not available, if further limits were placed on the use of natural gas as a boiler fuel, if coal piles were to freeze, or if shortages of enrichment facilities were to develop, too much reliance on one or two fuels--especially for baseload operations--could necessitate cutbacks in power to the power-supply grid. Currently, slightly more than 80 percent of MSU's generating capacity and 100 percent of LP&L's generating capacity comes from natural gas or oil. With Waterford 3 in operation, MSU and LP&L would be better prepared to meet unexpected changes in the supply of these scarce fossil fuels. The fact that operation of Waterford 3 will improve the diversity of fuel supply for the service area is an important factor in support of issuing an operating license.

2.4 RELIABILITY ANALYSIS

Between 1965 and 1973, MSU's electrical-energy output and peak-load demand grew at extremely high average annual rates of 10.1 percent and 9.8 percent, respectively. Since 1973, these rates have slowed considerably, although they have remained considerably higher than the growth experienced in the United States as a whole. For example, between 1973 and 1979, peak load on the MSU system grew at an average annual rate of about 5 percent; for the United States it grew at an average annual rate of approximately 3.5 percent. Comparable figures for net energy requirement were 6 percent for the MSU system and 3.1 percent for the United States as a whole.

Current official projections for the MSU system call for average annual rates of increase of 1.9 percent for peak load and 2.8 percent for net energy requirements from 1978 to 1986. Comparable values for LP&L for peak-load demand and net energy requirements are 3.8 percent and 3.1 percent, respectively.

Table 2.1 shows MSU's reserve margins with and without Waterford 3 in operation in the 1983 through 1986 time period. The peak-load responsibility values reported here reflect the official forecasts for system-maximum hourly load, adjusted downward for firm purchases. System capacity reflects capacity owned by the systems (adjusted downward for natural gas curtailments) plus purchases that are not firm.

LP&L and MSU have identified a 25 percent reserve margin as necessary to maintain minimum acceptable reliability. This standard is consistent with the 15 to 25 percent reserve margin recommended by the Federal Energy Regulatory Commission.

This reliability assessment assumes that 2977 MWe of new capacity, other than Waterford 3, will be added to the MSU system in 1980 through 1985 as scheduled. It also assumes that approximately 500 MWe of purchased power will be available in the 1984 through 1986 peak-use seasons. The conclusions of the reliability assessment could be altered by unavoidable slippages in or decisions to delay any of these subsequent additions, or by the uncertainty associated with MSU's reliance on these outside purchases.

Table 2.1 Data Showing Effect on Reserve Margin of MSU System Operations with and without Waterford 3 and the Load and Capability of LP&L for the Years 1983 through 1986

a. MSU Reserve Margin

	With Waterford 3			Without Waterford 3		
Year	Total Capability, MW	Load Responsibility, MW	Reserve Margin, %	Total Capability, MW	Load Responsibility, MW	Reserve Margin, %
1983	15882	10744	48	14778	10744	38
1984	15758	11364	39	14654	11364	29
1985	16118	11841	36	15014	11841	27
1986	15849	12225	30	14745	12225	21

b. LP&L Load and Capability (with Waterford 3)

Year	Total Capability, MW	Load Responsibility MW
1983	5324	4553
1984	5280	4652
1985	5280	4824
1986	5280	5042

Several additional factors could also limit the availability of installed capacity thereby reducing the reserve margin. Among these factors are the following:

2.4.1 Fuel Uncertainties

Most of the existing MSU system capacity and nearly all of the LP&L capacity were designed for natural gas fuel. Natural gas, as supplied under firm contracts, has been curtailed in the past. Based upon supply forecasts and current curtailment proceedings, it is expected that such gas supplies may be further curtailed and that acceptable replacement fuels will be difficult to acquire.

The Power Plant and Industrial Fuel Use Act of 1978 prohibits the use of natural gas as a primary fuel in utility boilers by 1990. Thus, not only do utilities face potential reduction in their use of gas (for base load) by curtailment, but future use of gas faces prohibition.

Although oil can be used in many existing or planned units, adequate supplies of oil for generating electricity are uncertain.

2.4.2 Increased Outage Rates

Increased forced outage rates are experienced when using oil as a replacement for natural gas in generating plants designed primarily to use natural gas as fuel.

Forced outage rates are generally higher on newly installed units. Because of the number of large units going on line in the MSU system in the early 1980's, this factor could become important.

Increased forced outage rates are experienced when gas turbines are operated continuously at outputs near maximum ratings.

2.4.3 Reduced Unit Capability

Because of the original design for natural gas, the capability of many boiler units is reduced when burning oil.

Even if fuel is available, its quality and grade may not be optimal for the unit as designed.

Reductions of unit capability might be necessary to conform to environmental restrictions.

The staff concludes that Waterford 3 will be needed by about 1984 to contribute to the desired reliability levels on the LP&L system; however adequate reserves from MSU should be available to meet any deficiencies. Although higher-than-normal reserve margins result with the addition of Waterford 3, the improvement in system operating economies justifies maintaining these larger reserve margins. On balance, however, reliability is not found to be a primary consideration in the timing of the initial operation of this unit.

2.5 CONCLUSIONS

The results of the staff's assessment of purpose and need support a decision to issue the operating license of Waterford 3 in the time frame proposed by the applicant. The fact of overriding importance is that the addition of this unit to the MSU system is expected to result in significant savings in system production costs. Furthermore, the operation of this unit will decrease MSU's dependence on fuel supplies of uncertain availability and will increase system reliability.

2.6 IMPACT OF PROPOSED UTILITY CONSOLIDATION

Louisiana Power and Light has announced plans to consolidate with another Middle South Utilities operating subsidiary, New Orleans Public Service, Inc. (NOPSI).

The staff has analyzed the effect of this proposed consolidation on the need for Waterford 3. Because the staff's need for power analysis is based on the entire MSU system, and LP&L and NOPSI are both operating subsidiaries of MSU, the proposed consolidation has no impact on our conclusion regarding the need for Waterford 3.

3 ALTERNATIVES TO THE PROPOSED ACTION

3.1 RESUME

During the construction permit (CP) stage of the licensing process, the staff analyzed alternative sites, alternative plant designs, and alternative sources of generation, including the alternative of not adding new production capacity. The staff concluded based on its analysis of these alternatives, as well as on a cost-benefit analysis, that additional capacity was needed, that a nuclear fueled plant would be an environmentally acceptable means of providing the capacity, and that Waterford 3, at a specified site and of a specified design, was acceptable from both economic and environmental perspectives. Since that time, construction of Waterford 3 has been nearly completed; and many of the economic and environmental costs associated with the construction of the plant have already been incurred and must be viewed as "sunk costs" in any prospective assessment. Since the CP stage, there has been some new information with regard to the generating capacity available to the applicant, which is discussed in Section 2 regarding need for the action.

3.2 ALTERNATIVES

The Staff believes the only reasonable alternative to the proposed action of granting an operating license for Waterford 3 available for consideration at the operating license stage is denying the license for operation of the facility and thereby not permitting the constructed nuclear facility to be added to the applicant's generating system.

Alternatives such as construction at alternative sites, extensive station modification, or construction of facilities utilizing different energy sources would each require additional construction activity with its accompanying economic and environmental costs, whereas operation of the already constructed plant would not create these costs. Therefore, unless major safety or environmental concerns resulting from operating the plant are revealed that were not evident and considered during the CP review, these alternatives are unreasonable as compared to operating the already constructed plant. No such concerns have been revealed with regard to operation of Waterford 3.

With respect to the proposed action of operating the facility, it was shown in Chapter 2 that the addition of Waterford 3 to the MSU system is expected to result in savings in system production costs of about $230 million the first year of operation. Further, as stated in Chapter 2, operation of this unit will provide diversity of fuel sources, thereby decreasing MSU dependence on fuel supplies of uncertain availability (gas and oil) and will contribute to increased system reliability. The environmental impacts of operation are reassessed in Chapter 5. As discussed in Section 6.6.4, as a result of this reassessment, the Staff has been able to forecast more accurately the effects of operation of Waterford 3 and has determined that the station will operate with only minimal environmental impact.

The alternative of not operating the facility will require the utility to substitute approximately 5.8 billion kWh per year of electrical energy that would have been provided by Waterford 3 with other sources of energy which have a greater economic cost and have an equal or greater environmental cost. The environmental impact of alternative energy sources was considered in Section XI of the FES-CP. The staff is not aware of any new information which would change the staff's finding stated in the FES-CP. As indicated above, the additional economic cost has been estimated at approximately $230 million for the first year of operation.

After weighing the above described options, the Staff concludes the preferable choice is operation of Waterford 3 and adding it to the MSU generating system.

4 THE AFFECTED ENVIRONMENT

4.1 RESUME

Major changes in the applicant's plan for cooling-water use and the design of intake and discharge structures are described in Section 4.2.2. Except for the redesign of the sanitary waste complex, only minor changes have been made in the nonradioactive waste systems since the FES-CP was published. This latter change will result in no increased impact. There is now a greater design capacity, and a smaller concurrent anticipated increase in sanitary wastes. There have been no significant changes in land or water use, and none in terrestrial ecology. The staff noted that although the American alligator has been reclassified as "threatened," it is subject to controlled harvests in St. Charles Parish.

Additional background information relating to terrestrial and aquatic biota within the site environs is provided in Sections 4.3.4 and 4.3.5. Historic and cultural sites are considered in Section 4.3.6. As shown in Section 4.3.7, the demographic and land-use characteristics of the region have been updated.

4.2 PROJECT DESCRIPTIONS

4.2.1 External Appearance and Plant Layout

A description of the expected external appearance of the plant was given in the FES-CP, page III-1, and an artistic rendering of an aerial view of Waterford 3 is presented in Figure 3.1-4 of the applicant's ER-OL. The plant layout is also shown in the ER-OL, Figures 3.1-1, and described on ER-OL pages 2.1-2 and 3.1-1.

4.2.2 Plant Cooling System

4.2.2.1 General Description

The plant cooling system at Waterford 3 consists of two major components: (1) the circulating water system and (2) the component cooling water system. The circulating water system is basically a once-through system. The general plan is shown in Figure 4.1 (ER-OL, Figure 3.4-1). The cooling water will be withdrawn from the Mississippi River via an intake canal leading from the river to an intake structure containing four water pumps. It will be pumped through the condenser and various heat exchangers to the discharge canal and then returned to the river through the discharge structure. The component cooling water system is a closed loop that utilizes wet- and dry-type mechanical-draft cooling towers to indirectly cool the reactor coolant and the reactor auxiliary system components. This closed system will discharge no heated water to the environment, and therefore is not discussed in detail.

Since the issuance of the environmental statement for the construction permit in 1973, the applicant has revised the plan for plant-cooling-water use and has modified the designs of the plant intake and discharge systems. The newly designed plant cooling system is described in the following sections.

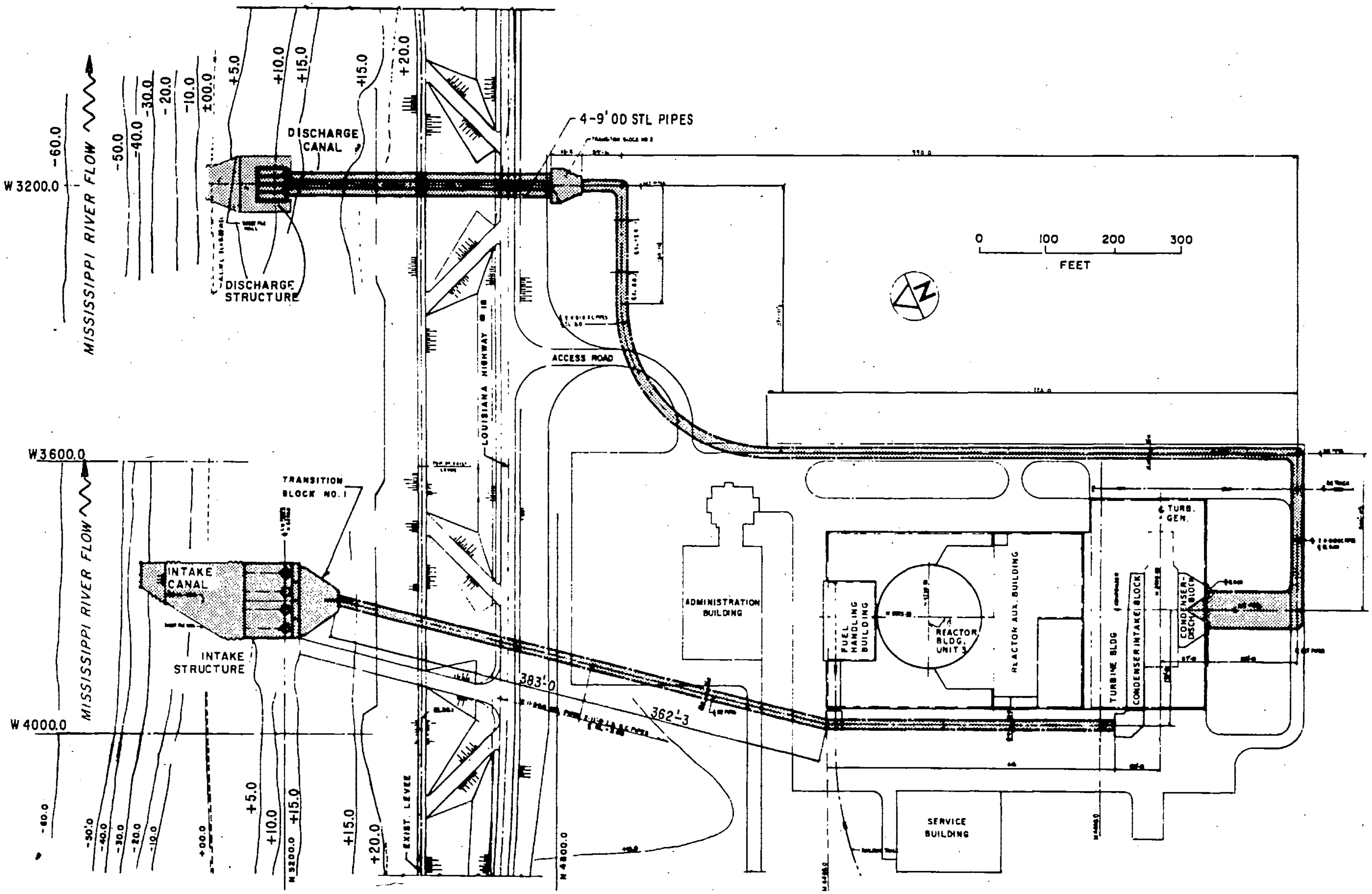

Fig. 4.1. General Plan of the Circulating Water System. From the ER-OL, Fig. 3.4-1.

4.2.2.2 Cooling-Water Use

During the normal plant operating condition, water will be withdrawn from the Mississippi River, at a design flow rate of 63.3 m^3/sec (1,003,404 gpm), which includes 63.2 m^3/sec (1,003,200 gpm) of circulating water. Of this flow, 61.5 m^3/sec (975,100 gpm) will be used in the circulating water system for dissipating heat from the steam condenser, and 1.8 m^3/sec (28,100 gpm) will be used in the closed system for cooling the turbine and the steam-generator blowdown system heat exchangers.

When operating at full power (1153 MWe), the station will produce approximately 8.4 x 10^{12} J/hr (8.0 x 10^9 Btu/hr) of waste heat, which will be transferred to 61.5 m^3/sec (975,100 gpm) of circulating cooling water and will raise the water temperature about 9.1°C (16.4°F) above the intake water temperature. The 1.8 m^3/sec (28,100 gpm) of heat-exchanger cooling water will also undergo a temperature rise of about 4.2°C (7.6°F). The combination of the circulating cooling water and other plant process waste waters will result in a total returned flow of 63.3 m^3/sec (1,003,700 gpm) to the Mississippi River. At the point of discharge, the resultant temperature increase of the combined flow will be about 8.9°C (16.1°F).

The average flow velocities and travel times for various portions of the circulating water system, for average high, and average low water levels, and during various pumping modes are presented in Table 4.1 (ER-OL, Table 3.4-2). The thermal plume in the river is characterized by this type of information and the data are used to predict thermal impacts on the biota.

4.2.2.3 Water Intake System

The cooling water will be withdrawn from the river through a canal 49.4 m (162 ft) long with sides made from sheet piles. The design details of the intake canal are shown in Figure 4.2 (ER-OL, Fig. 3.4-2). The canal width at the river end is about 11.3 m (37 ft) and increases uniformly shoreward over the first 37.2 m (122 ft) to about 36.6 m (120 ft). The latter width is maintained over the last 12 m (40 ft) to the intake structure. The bottom elevation of the canal is at -10.7 m (-35.0 ft) mean sea level (MSL) and slopes upward along the first 16 m (52 ft) to an elevation of -7.3 m (-24.0 ft) MSL which is maintained for the remaining 33.5 m (110 ft). The average low and high water levels in the river are 0.27 m (0.90 ft) and 5.67 m (18.60 ft) MSL, respectively. At the river entrance to the canal, a 4.9 m (16 ft) deep skimmer wall is provided with its bottom extended down to elevation -0.3 m (-1.0 ft) MSL to prevent entry of large floating debris and to withdraw water from a depth below the river surface at average low water level condition. The maximum entrance velocity of water through the 10.4 m (34 ft) high opening beneath the skimmer wall will be about 0.54 m/sec (1.78 ft/sec).

The intake structure is illustrated in Figure 4.3 (ER-OL, Figure 3.4-3). Incoming water from canal to intake structure will pass under another skimmer wall and through a trash rack to stop any large objects from entering the condenser. The water will then flow into eight bays, each equipped with a 0.63 cm (0.25 in.) mesh traveling water screen to prevent smaller objects from passing through. Slots are provided for inserting a fixed screen of similar

Table 4.1 Average Velocities and Travel Times in Circulating Water System[a]

Circulating Water System	Water Level	4-Pump Operation V m/sec	4-Pump Operation V (ft/sec)	4-Pump Operation T sec	3-Pump Operation V m/sec	3-Pump Operation V (ft/sec)	3-Pump Operation T sec	2-Pump Operation V m/sec	2-Pump Operation V (ft/sec	2-Pump Operation T sec
Intake canal	AHWL[b]	0.18	(0.59)	275	0.15	(0.50)	325	0.11	(0.37)	443
	ALWL[c]	0.30	(1.0)	163	0.25	(0.83)	195	0.19	(0.62)	261
Intake structure	AHWL	0.18	(0.59)	101	0.18	(0.59)	101	0.18	(0.59)	101
	ALWL	0.30	(1.0)	60	0.30	(1.0)	60	0.30	(1.0)	60
Piping upstream of condenser[d]	AHWL	3.81	(12.50)	103	3.16	(10.36)	124	2.28	(7.47)	172
	ALWL	3.58	(11.73)	110	2.99	(9.8)	130	2.13	(7.0)	182
Condenser	AHWL	2.4	(8.0)	7	2.0	(6.7)	8	1.5	(4.9)	11
	ALWL	2.4	(8.0)	7	2.0	(6.7)	8	1.5	(4.9)	11
Piping downstream of condenser	AHWL	3.61	(11.84)	181	2.95	(9.68)	222	2.07	(6.79)	316
	ALWL	3.4	(11.1)	189	2.84	(9.1)	236	1.92	(6.31)	340
Discharge structure and canal	AHWL	0.44	(1.43)	134	0.37	(1.21)	159	0.27	(0.88)	217
	ALWL	1.39	(4.57)	42	1.17	(3.84)	50	0.86	(2.82)	68
Total time after addition of heat	AHWL			330			393			532
	ALWL			238			284			383

Source: ER-OL, Amendment No. 2, Table 3.4-2.

[a]Averages based on volume and length of each portion of the system.

[b]AHWL - Average high-water level, 18.60 ft MSL.

[c]ALWL - Average low-water level, 0.80 ft MSL.

[d]Based on discharge point at midtransition block.

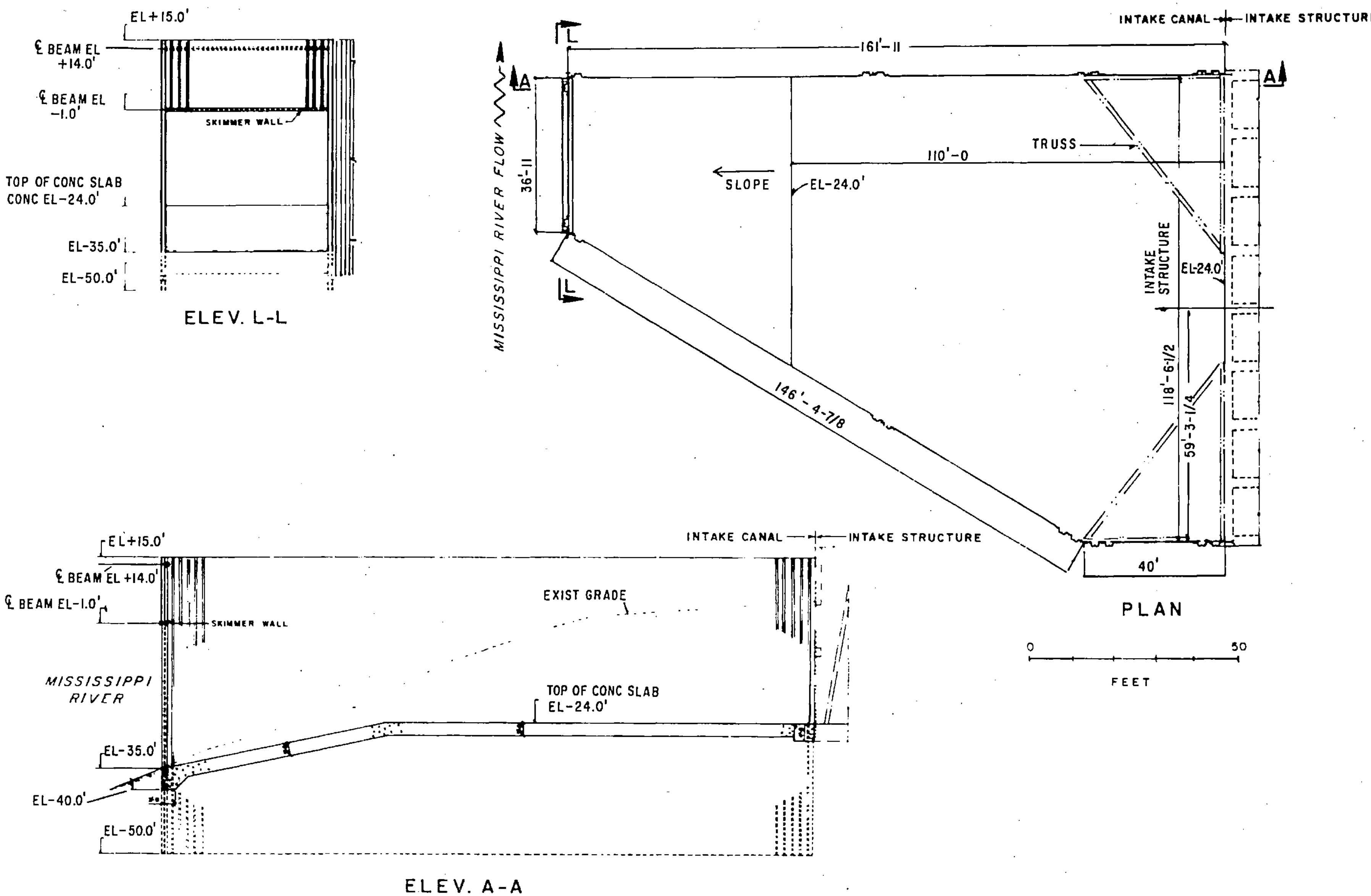

Fig. 4.2. Diagram of the Intake Canal. From the ER-OL, Fig. 3.4-2.

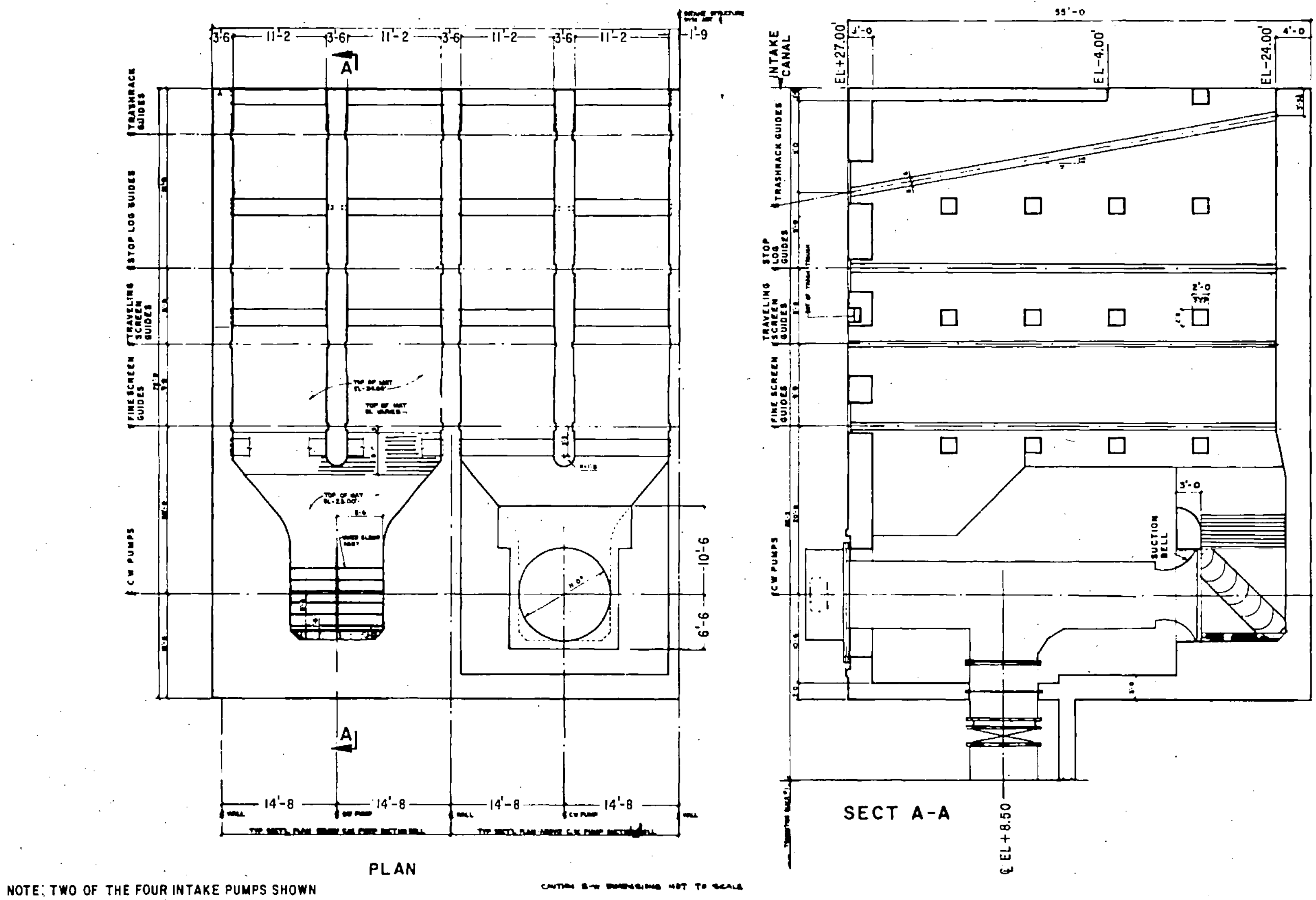

Fig. 4.3. Diagram of the Intake Structure. From the ER-OL, Fig. 3.4-3.

mesh downstream of any traveling screen which might fail. The debris stopped by the traveling screens will be washed into a trough and then sluiced to the river at a point downstream of the Waterford 3 intake. Stop logs can be inserted in guides provided between the trash rack and the traveling screens to permit dewatering of individual bays for maintenance.

4.2.2.4 Water Discharge System

The discharge facility (Fig. 4.1) is located about 210 m (700 ft) downstream of the intake facility. Details of the discharge facility are shown in Figure 4.4 (ER-OL, Fig. 3.4-4). The heated water from the condenser will flow into seal wells through four 2.7-m (9-ft) diameter steel pipes, over a 29-m (85-ft) long weir, and into the discharge canal. The discharge canal has a rectangular cross section with sides formed by sheet piles. The canal bottom is constructed at elevation -1.5 m (-5.0 ft) MSL and is concrete-lined to prevent erosion. Starting from the landward end, the canal maintains a constant width of 25 m (81 ft) along the first 25 m (81 ft) of canal length and then contracts symmetrically over a distance of about 29 m (95 ft) to a width of 15 m (50 ft) at the river end.

For surface discharge conditions, the discharge velocity is affected by the rate of plant discharge flow and by the seasonal variations in river stages. The applicant has calculated the average plant discharge velocities at Waterford 3 for various river flow conditions and the results are shown in Table 4.2 (ER-OL, Tables 5.1-1 and 5.1-2). The temperature distribution of the discharged heat in the Mississippi River and its potential environmental impact are discussed in Section 5.3.2.

4.2.3 Radioactive Waste Treatment

Section 50.34a of Title 10 of the Code of Federal Regulations (10 CFR) requires an applicant for a permit to operate a nuclear power reactor to include a description of the design of equipment to be installed for keeping levels of radioactive materials in effluents to unrestricted areas as low as is reasonably achievable. The term "as low as is reasonably achievable" (ALARA) means as low as is reasonably achievable taking into account the state of technology and the economics of improvement in relation to benefits to the public health and safety and other societal and socioeconomic considerations and in relation to the utilization of atomic energy in the public interest. Appendix I to 10 CFR Part 50 provides numerical guidance on design objectives for light-water-cooled nuclear power reactors to meet the requirements that radioactive materials in effluents released to unrestricted areas be kept as low as is reasonably achievable.

To meet the requirements of 10 CFR Section 50.34a, the applicant has provided final designs of radwaste systems and effluent control measures for keeping levels of radioactive materials in effluents to unrestricted areas within the design objectives of Appendix I to 10 CFR Part 50. The applicant elected to meet the requirements of the Annex to Appendix I dated September 4, 1975, in lieu of performing a cost-benefit analysis as required by Section II.D of Appendix I. In addition, the applicant has provided an estimate of the quantity of each principal radionuclide expected to be released annually to unrestricted areas in liquid and gaseous effluents produced during normal operation, including anticipated operational occurrences.

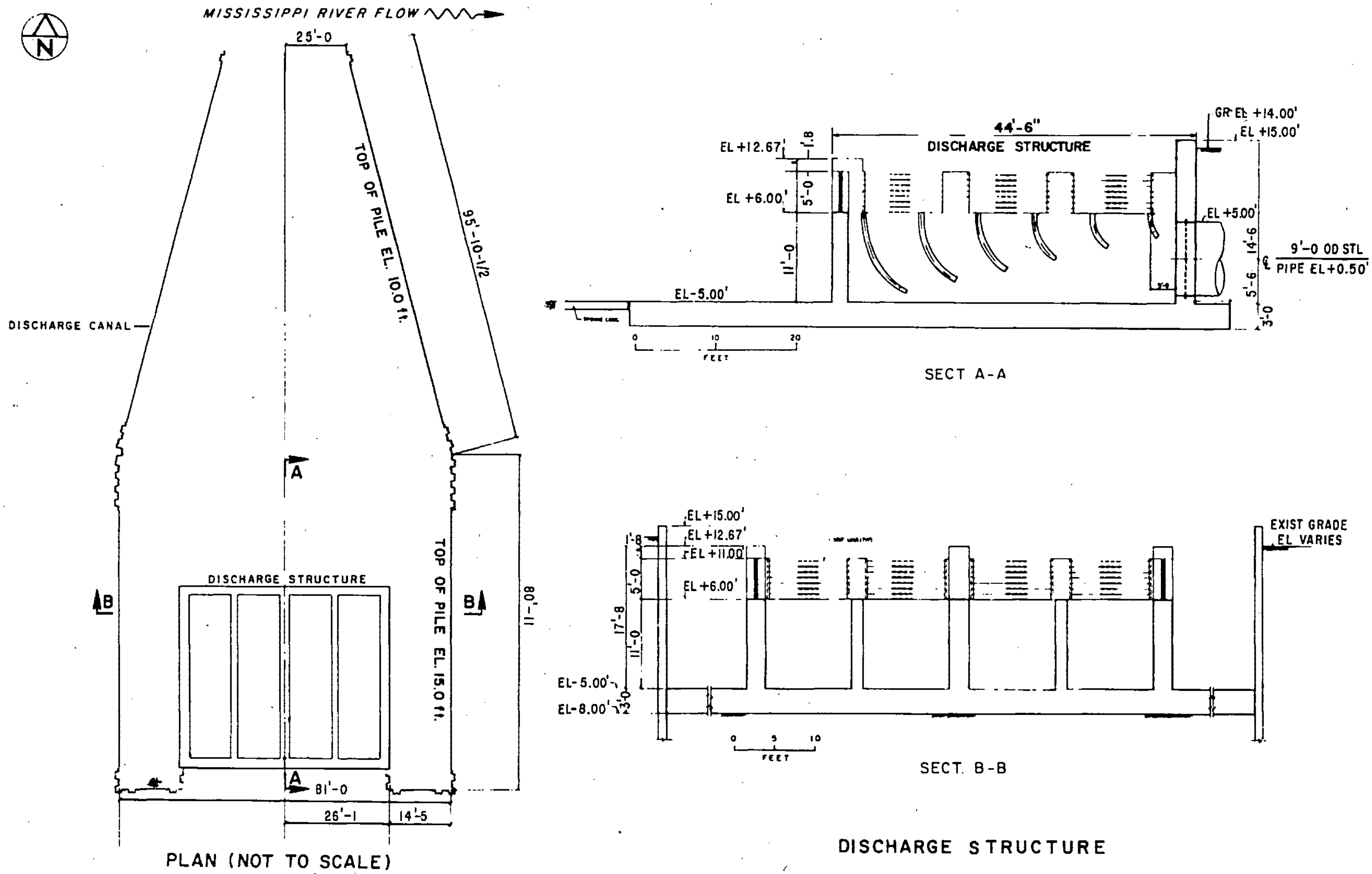

Fig. 4.4. Diagram of the Discharge Structure and Canal. From the ER-OL, Fig. 3.4-4.

Table 4.2 Average Plant Discharge Velocities for Various River Flow Conditions

River Flow Condition	Average Plant Discharge Flow		River Stage (MSL)		Average Plant Discharge Velocity	
	m^3/sec	cfs	m	ft	m/sec	ft/sec
Average winter	39.2	1384	3.2	10.4	0.55	1.8
Average spring	59.5	2114	3.6	11.8	0.58	1.9
Average summer	63.3	2235	1.2	4.0	1.52	5.0
Average fall	51.8	1831	0.9	3.0	1.40	4.6
Typical low flow	63.3	2235	0.7	2.3	1.86	6.1
Extreme low flow	51.8	1831	0.15	0.5	2.04	6.7

Source: ER-OL, Tables 5.1-1 and 5.1-2

The staff's detailed evaluation of the liquid and gaseous radwaste systems and the capability of these systems to meet the requirements of Appendix I was presented in Chapter 11 of the Safety Evaluation Report which was issued on July 9, 1981. The quantities of radioactive material calculated by the staff to be released from the plant are also presented in Chapter 11 of the Safety Evaluation Report and are discussed in Section 5.9 of this environmental statement, along with the calculated doses to individuals and to the population that will result from these effluent quanitities.

Prior to the issuance of the operating license, the applicant will be required to submit technical specifications that will establish release rates for radioactive material in liquid and gaseous effluents. These specifications will also provide for the routine monitoring and measurement of all principal release points to assure that the facility operator is in conformance with the requirements of Appendix I to 10 CFR Part 50.

4.2.4 Nonradioactive Waste Systems

Estimated concentrations of the nonradioactive chemicals and the volumes of wastewater discharged are listed in Table 4.3.

4.2.4.1 Reactor Coolant Chemicals

Approximately 26 kg/yr (57 lb/yr) of boron are discharged from the boron management system to the circulating water system discharge canal at a frequency of approximately once every ten days. The concentration of boron in the boric acid distillate is 10 ppm before dilution. The dilution factor in the circulating water system is a minimum of 460,000, resulting in a boron concentration at the discharge point of less than 2×10^{-5} ppm.

Hydrazine and ammonia are released periodically from condenser feedwater equipment drains in the turbine building at a rate of 230,000 L/yr (60,000 gal/yr) total solution (Table 4.3). The dilution factor in the circulating water system is a minimum of 5.4×10^{6}. Hydrazine, used as an oxygen scavenger, is released at a concentration of approximately 0.05 ppm. Ammonia, used for pH control in the secondary system, is released at a maximum concentration of 1 ppm. The feedwater drain wastes are discharged into the circulating water system discharge canal, where hydrazine is diluted to approximately 9.5×10^{-9} ppm and ammonia to approximately 1.9×10^{-7} ppm. The annual releases are 0.011 kg (0.024 lb) hydrazine and 0.23 kg (0.51 lb) ammonia.

4.2.4.2 Water Treatment Wastes

Wastes from the primary water treatment plant consist of filter flush (backwash) solutions that are sent to the circulating water system discharge canal. The filter is flushed for 10 minutes two or three times daily. The filter flush solutions contain suspended solids, polyelectrolytes, and residual chlorine. Residual chlorine discharged during filter flush will be diluted to 2×10^{-4} ppm in the circulating water system discharge canal.

Wastes from the demineralized water system consist of spent regenerant solution. The regenerant solution, containing up to 10,000 ppm total dissolved solids

Table 4.3 Chemical Waste Discharge Summary[a]

Type of Waste	Source	Frequency of Discharge	Quantity, gal/yr	Chemical and Pollutant Content	Estimated Concentration in Waste, ppm	Estimated Average Concentration After Treatment, ppm	Released to:
Reactor coolant[b]	Boron management system	Periodically	685,000[c]	Boron	10	10	Waterford 3 circulating water system discharge[d]
Nonrecoverable water[e]	Waste management system (miscellaneous waste)	Periodically	400,000[f]	Dirt	10	10	Waterford 3 circulating water system discharge
Detergent waste	Waste management system (laundry wastes)	Periodically	131,400[f]	Detergent, dirt	1000	30	Waterford 3 circulating water system discharge
Regenerative solutions[g]	Steam generator blowdown system	Periodically	145,000[g]	TDS Sulfates pH	0-10,000 0-5000 5-9	0-10,000 0-5000 6-9	Waterford 1 and 2 metal waste pond[h]
Electromagetic filter flush	Steam generator blowdown ststem	Periodically	20,000[i]	TSS	0-1000	30	Waterford 1 and 2 metal waste pond[h]
Turbine building drains	Condenser feedwater equipment drains	Daily	60,000	Hydrazine Ammonia	0.05 0-1	0.05 0-1	Waterford 3 circulating water system discharge
	Floor drains[j]	Daily	67,000	Detergent,dirt Oil and grease TSS	0.1 20 >30	0.1 15 30	Waterford 3 storm water drainage system
Regenerative solutions[k]	Demineralized water system	Periodically	365,000	TDS Sulfates pH	0-10,000 0-5000 5-9	0-10,000 0-5000 6-9	Waterford 1 and 2 low-volume waste treatment system[h]
Filter flush water[l]	Primary water treatment plant	Daily (2-3 times/day, 10 min each)	13,140,000	TSS Polyelectrolyte Residual chlorine	1000 1-2 0-0.1	1000 1-2 0-0.1	Waterford 3 circulating water system discharge
Sanitary	Station sewage treatment plant	Continuous	3,650,000	Residual chlorine BOD TSS	0-0.5 250 250	0-0.5 30 30	Waterford 1 and 2 low-volume waste treatment system[h]

Table 4.3 (Continued)

Type of Waste	Source	Frequency of Discharge	Quantity, gal/yr	Chemical and Pollutant Content	Estimated Concentration in Waste, ppm	Estimated Average Concentration After Treatment, ppm	Released to:
Sanitary	Administration building sewage treatment plant	Continuous	1,460,000	Residual chlorine BOD TSS	0-0.5 250 250	0-0.5 30 30	Waterford 3 storm water drainage system
Sanitary	Auxiliary Office Trailer Sewage Treatment Plant	Continuous	1,533,000	Residual Chlorine BOD Total Suspended Solids	0-.5 250 250	0-.5 30 30	Waterford 3 storm water drainage system
Chemical cleaning solutions	Secondary system[m]	Once at the start of plant	1,800,000	Hydrazine TSS	50-90 30	Not known[n] 30	Waterford 1 and 2 low-volume waste treatment system[h]
HVAC cooling tower blowdown	Supplementary chilled water system (HVAC)	Daily	2,097,000	TSS	650	30	Waterford 1 and 2 low-volume waste treatment system[h]

[a]From ER-OL Amendment No. 1, Table 3.6-1.

[b]Due to fuel burnup, hot and cold shutdowns and refueling. Condensate from boric acid concentrator may be reused if it meets plant chemistry requirements.

[c]Does not include 184,000 gallons of waste due to back-to-back cold shutdowns and startup at 85% of core life. Maximum of 144,000 gal/day discharged.

[d]Normal Waterford 3 discharge flow is approximately 1,003,700 gpm. Normal Waterford 1 and 2 circulating water flow is approximately 435,000 gpm.

[e]This does not include spent regenerant from the steam generator blowdown demineralizer.

[f]Maximum combined treated laundry (10,000 gal/day) and waste management (60,000 gal/day) discharge is 70,000 gal/day.

[g]At a volume of 17,000 gallons wastes per regeneration.

[h]Releases to these Waterford 1 and 2 treatment systems eventually go to the Waterford 1 and 2 circulating water system discharge.

[i]Approximately 1000 gallons per flush.

[j]Includes leakage from the turbine closed cooling water system.

[k]At 50,000 gallons per regeneration.

[l]Hydrostatic testing and flushing will be done during initial startup.

[m]Volume of secondary system is approximately 300,000 gallons.

[n]Not possible to predict.

Note: To convert gallons to liters, multiply by 3.7854.

and 5,000 ppm sulfates, is discharged to the Waterford 1 and 2 low-volume waste treatment system (FES-CP, Figure III-9). The spent regenerant solution will ultimately increase the sulfate concentration in the Mississippi River downstream by about 9 ppb (ER-OL, page 3.6-2, Amendment 1).

4.2.4.3 Closed Cooling Water Loops

No significant chemical discharges from closed-cooling water loops are anticipated. Any such wastes, as from a leakage, would be evaporated and the concentrates pumped to a drumming station for solidification and subsequent offsite disposal.

4.2.4.4 Condenser Cooling System Output

The heavy silt load in the lower Mississippi River provides a continuous scour in the condenser tubes. The scouring action controls fouling from nuisance organisms. Based on operating experience at the Little Gypsy Generating Station and at Waterford 1 and 2, chlorination is expected to occur at Waterford 3 approximately 20 days/yr. Chlorination will be controlled to restrict free residual chlorine at the condenser outlet to a concentration of 0.2 to 0.5 ppm. Chlorine will not be discharged for more than 2 hours per day.

4.2.4.5 Laboratory and Decontamination Solutions

For a discussion of laundry and nonrecoverable wastes, refer to FES-CP, p. III-25.

Drainage from the chemistry and radiation measurement laboratory sinks is collected in a drain tank, treated in the waste management system and then discharged into the circulating water system discharge.

4.2.4.6 Nonradioactive Oil Wastes

Nonradioactive oil wastes are treated in either the yard oil separator or the service building oil separator. The effluent from the oil separators is released to the storm water drainage system, which discharges to the 40 Arpent Canal. Removed oil is collected in tanks for offsite treatment and disposal.

4.2.4.7 Sanitary Wastes

The sanitary-waste-treatment system for the Waterford 3 facility consists of three package-type extended-aeration treatment plants. Administration building wastes will be treated in a 16,000-L/day (4200-gal/day) capacity plant. Treated effluent from this plant will be discharged to the site drainage system and ultimately drained to the 40 Arpent Canal. Other sanitary wastes will be routed by subsurface pipe to two treatment plants with a combined capacity of 38,000 L/day (10,000 gal/day). This design capacity is based on a labor force of 267 employees generating 189 L (50 gal) of sewage per person per shift. The treated effluent from these two plants will be collected along with demineralized regenerant wastes. The combined wastes will be treated in the Waterford 1 and 2 low-volume waste-treatment system, and then released with the Waterford 1 and 2 cooling water discharge (FES-CP, Figure III-9).

The raw sewage will contain an estimated 5-day biochemical oxygen demand (BOD_5) and suspended solids concentration of 250 mg/L. The processes used to treat the wastes in both plants are aeration, clarification, continuous sludge recirculation, and chlorination--resulting in an 85 percent to 90 percent reduction in BOD_5 and suspended solids. The excess sludge undergoes aerobic digestion and is disposed of offsite approximately once per year.

4.2.4.8 Combustion Effluents

The sources of gaseous effluents are three diesel generating units, two diesel fire pumps, and an auxiliary boiler. The total gaseous effluents from the generators and the boiler are reported in Table 4.4.

Two of the diesel generators are 4400-kW units. When operating at full capacity, each generator will require approximately 1230 L/hr (325 gal/hr) of diesel fuel. The third generator, a 160-kW unit, which will be used during a complete blackout at the station, requires 42 L/hr (11 gal/hr) of diesel fuel. The three units will ordinarily be operated for routine test purposes approximately 1 hr/mo.

The auxiliary boiler will normally operate for 200 hr/yr and is fired by No. 2 fuel oil. The boiler will also be used during preoperational steam cleaning for 6 to 8 months.

The two diesel fire pumps will each require 42 L/hr (11 gal/hr) of diesel fuel, and will be tested approximately 1 hr/yr.

4.2.5 Power Transmission System

The power transmission requirements of the plant were described in the FES-CP, Section III.B. The only offsite line described in the FES-CP as being required by the plant is the Churchill-Waterford line, which is to be completed in May 1983. This line is necessary for the three other power-generating facilities in the Waterford 3 area and for improving system reliability. It is therefore being constructed independently of the Waterford 3 project, although the latter, if licensed, will also use it to some extent. Environmental impacts of operation of this line are not assessed in this environmental statement.

4.3 PROJECT-RELATED ENVIRONMENTAL DESCRIPTIONS

4.3.1 Land Use (see also Section 4.3.7.2)

Land use in the area and region of the site was discussed in the FES-CP, pages II-1 through II-8, and V-1. Land use on LP&L property is updated in this subsection; current land use in the surrounding region, and changes that have occurred since the FES-CP was issued, are presented in Subsection 4.3.7.2.

The Louisiana Power and Light Company property, which includes the Waterford 3 site, encompasses 1440 ha (3560 acres). A map showing existing land use on this property appears in Figure 4.5, with a summary given in Table 4.5.

Table 4.4 Gaseous Effluents Produced During Operation of Waterford 3, kg/yr

Effluent	160-kW Diesel Generator[a]	4400-kw Diesel Generators[a,b]	Auxiliary Boiler[c]
Carbon monoxide	6	538	--
Nitrogen oxides	28	1659	2,540
Sulfur oxides	2	110	907
Hydrocarbons	2	133	--
Particulates	2	118	0
Aldehydes	0.4	25	--

[a]Modified from ER-OL, Table 3.7-1, to reflect the applicant's estimate of 1hr/mo operation.
[b]Gaseous effluents from both 4400-kW diesel generators.
[c]Modified from ER-OL, Table 3.7-2, to reflect the applicant's estimate of 200 hr/yr operation.

Note: To convert kg/hr to lb/hr, multiply by 2.2046.

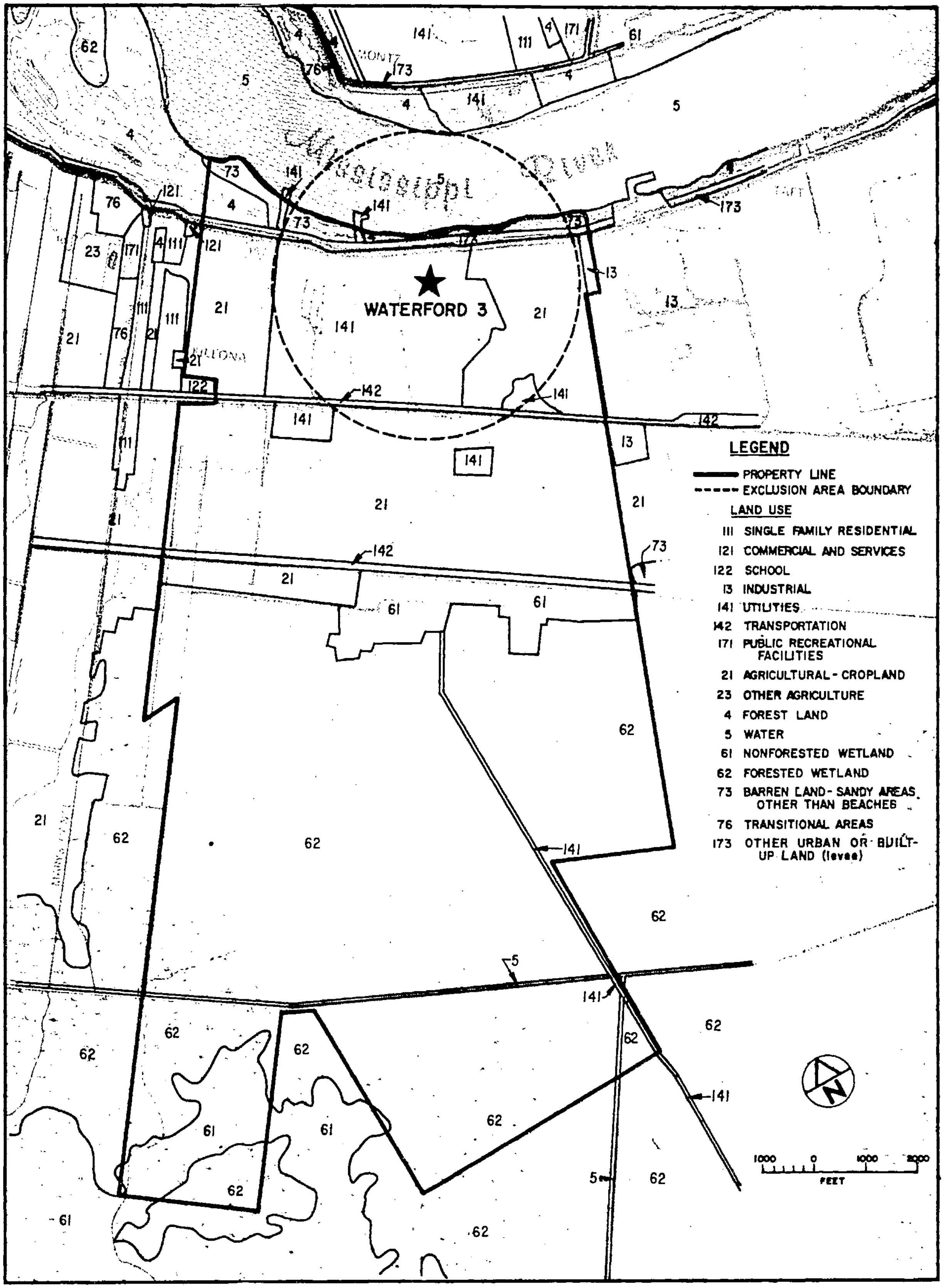

Fig. 4.5. Land Uses in the Vicinity of the Applicant's Property. From ER-OL, Fig. 4.2.1.1.

Table 4.5 Land Use on the Waterford Property[a]

Classification Number[b]	Land-Use Classification	Area, hectares (acres)	Percent of Total
13	Industrial	3.7 (9.2)	0.3
141	Utilities	162.7 (402.0)	11.3
142	Transportation	40.8 (100.8)	2.8
173	Other urban or builtup land (levee)	18.5 (45.8)	1.3
21	Agricultural - cropland	317.7 (785.0)	22.0
4	Forest land	25.9 (64.1)	1.8
5	Water (canal)	22.3 (55.0)	1.5
61	Nonforested wetland	81.6 (201.5)	5.7
62	Forested wetland	756.2 (1868.6)	52.5
73	Barren land - sandy areas other than beaches	11.9 (29.3)	0.8
	Total	1441.3 (3561.3)	100.0

[a]Adapted from ER-OL, Table 2.1-10.

[b]See Figure 4.5 for a map showing the location of each of these land-use classifications.

Wetlands are the largest land-use category, covering 58.2 percent of the LP&L property; all of it is south of Louisiana Highway 3127. Agriculture is the next largest land-use category, covering 22 percent of the property, most of it north of the highway. Agriculture has consisted mostly of sugar cane production, with a few areas planted in soybeans. Transportation routes crossing the property include Louisiana Highways 18 and 3217, and the Missouri Pacific Railroad. Utility facilities cover 11.3 percent of the property, most of it in the exclusion area. Other land use on the property includes the levees, forest land on the batture, barren lands on the batture, and a canal in the southern portion of the property. There is no residential or recreational land on the property.

4.3.2 Water

4.3.2.1 Surface Water

The surface water descriptions presented in Sections II-D-3 and II-D-4 of the FES-CP are still valid with the following additions and discussions.

Mississippi River discharge data acquired since the FES-CP was published show a minor increase in the Mississippi River mean annual flow for 77 years of record; it is shown to be 13,990 m^3/sec (494,000 cfs). On the average, flows are generally above this mean from mid-December to July and below the mean for the remainder of the year. The Mississippi River has a mean annual low flow of about 4390 m^3/sec (155,000 cfs), based on 77 years of record. Table 4.6 shows the average and extreme values of the flow for the Mississippi River in the vicinity of the site for the years 1970 through 1976. This table augments Table II-3 in the FES-CP, which contains similar data for the period 1960 through 1969.

There have been two major floods in the Mississippi River since the FES-CP was issued. These occurred in 1973 and 1975. Operation of numerous upstream flood-control projects on the Mississippi River and its tributaries effectively reduced the destructive impact of these floods.

4.3.2.2 Groundwater

The hydrologic engineering descriptions of groundwater conditions at the site as presented in Section II.D.3 of the FES-CP are still valid, except for the identification of a silty sand layer containing groundwater at an elevation of -23 meters (-77 feet) MSL. Usage of groundwater is restricted because the sand layer is of limited extent, has low permeability, and yields poor quality water. There were no groundwater users identified as using this sand layer.

4.3.3 Air

4.3.3.1 Meteorology

The climatology and meteorology presented in Section II.D.2 of the Waterford FES-CP has not changed; therefore, no new information is provided here.

Relative concentrations (χ/Q) of gaseous effluent were estimated according to the guidance in Regulatory Guide 1.111 using the constant mean wind direction model. A ground-level release was assumed and the topography around the site

Table 4.6 Streamflow in the Mississippi River at Tarbert Landing, Mississippi

Year	Maximum	Minimum	Mean
1970	27.8 (980)	5.0 (178)	12.8 (451)
1971	29.3 (1036)	4.9 (174)	9.6 (338)
1972	26.6 (938)	6.2 (218)	13.6 (480)
1973	42.4 (1498)	5.8 (204)	20.4 (721)
1974	33.2 (1174)	5.3 (187)	16.6 (586)
1975	34.4 (1216)	6.5 (230)	15.9 (563)
1976	20.4 (721)	4.5 (158)	10.3 (364)

[a]Army Corps of Engineers data. Values are in thousands of m^3/sec and in parentheses, thousands of ft^3/sec.

was treated as being uniformly flat. The meteorological data collected onsite for the periods July 1972 to June 1975 and February 1977 to February 1978 were used in the χ/Q calculations. The results are used in the dose calculations that are presented in Section 5 of this Statement.

4.3.3.2 Air Quality

St. Charles Parish has been designated as a nonattainment area for primary oxidant (ozone) levels. As a nuclear-fueled generating station, Waterford 3 will not significantly affect this situation. The pollutant levels generally meet all local ambient air quality standards.

4.3.4 Terrestrial Ecology

4.3.4.1 Site and Soils

The Waterford 3 site is located on 1440 ha (3560 acres) of property owned by Louisiana Power & Light Company. It is a roughly rectangular plot of land, fronting on the Mississippi River (Figure 4.6).

The site is composed of two distinct habitats. The first is the natural levee, which covers more than half the site, and the second is the wetlands, which covers the remainder. The land on the natural levee has soil of the Commerce-Convent Association, composed of nearly level poorly drained alkaline loamy soils.[1] The wetlands have soil designated as a Swamp Association, composed of organic and mineral swampland.[1] A description of the general types of soils distributed on the site is shown in Figure 4.6.

4.3.4.2 Vegetation

Dominant or common vegetation found in each of the communities mapped in Figure 4.7 is discussed in sequence going south from the river. The forested portion of the batture, (area between the artificial levee and the riverbank) 26 ha (64.1 acres) is likely to have black willow, cottonwood, and sycamore, whereas the sandy area [12 ha (29.3 acres)], is likely to have fleabane, alfalfa, ragwort, and sow thistle.[2] The area devoted to agriculture is planted to sugar cane and soybeans. The dominant swamp species is bald cypress.

4.3.4.3 Fauna

A list of 8 amphibians and 15 reptiles seen or trapped on the batture near the site is shown in ER-OL, Appendix 2-2, Tables A.2.2.1-2 and A.2.2.1-3.

Birds seen on the project site (ER-OL, Sec. 6.1.4.3.2) are listed in Tables A.2.2.1-4 and A.2.2.1-5 of the ER-OL, Appendix 2-2. Of the 411 bird species observed in Louisiana,[3] half have been seen in the vicinity of Waterford 3 (ER-OL, Sec. 2.2.1.1-3).

Thirty-five species of mammals that could be found on the site[4] are listed in Tables A.2.2.1-6 and A.2.2.1-7 of the ER-OL, Appendix 2-2.

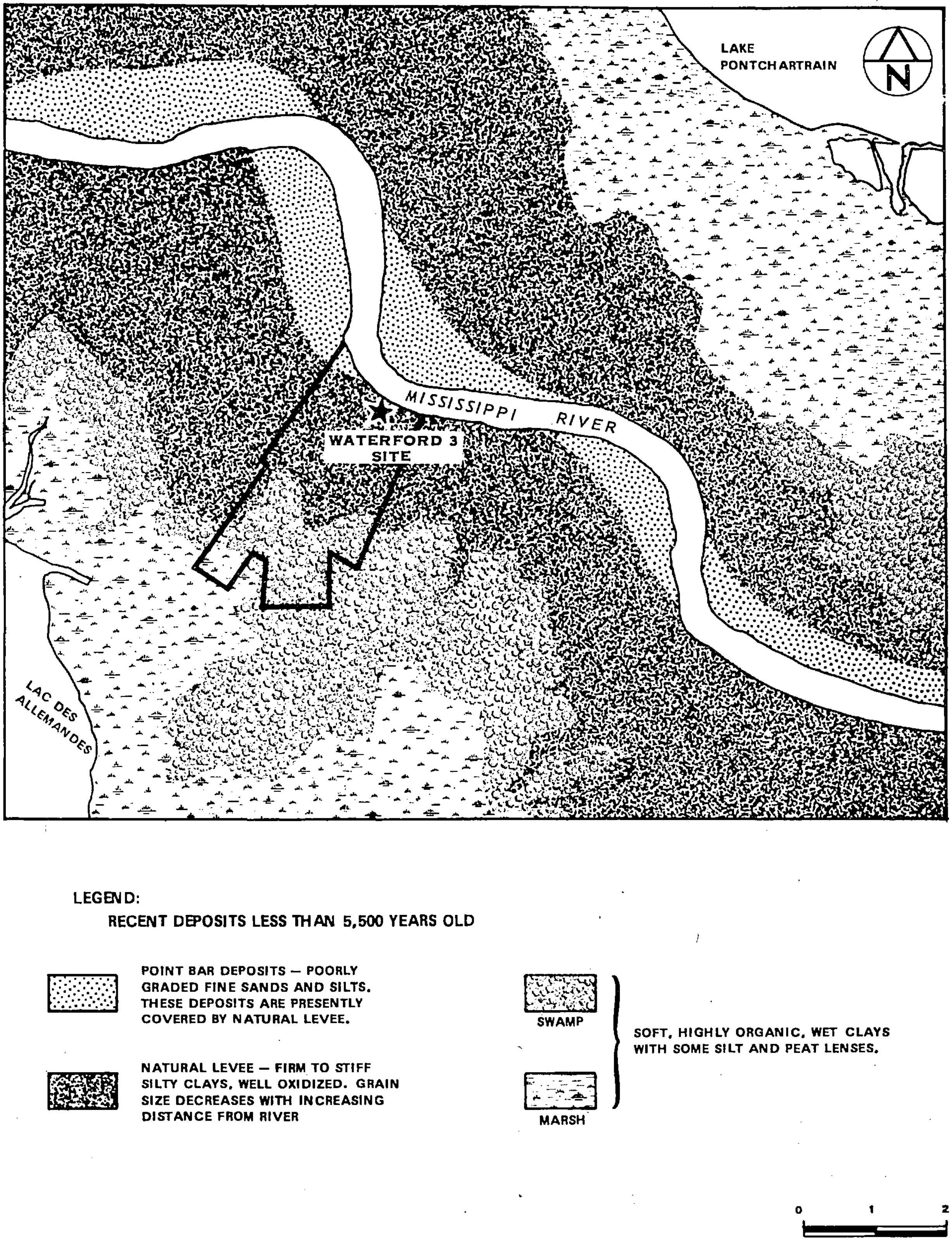

Fig. 4.6. Site-Area Surficial Geology. From ER-OL, Fig. 4.2.4-1.

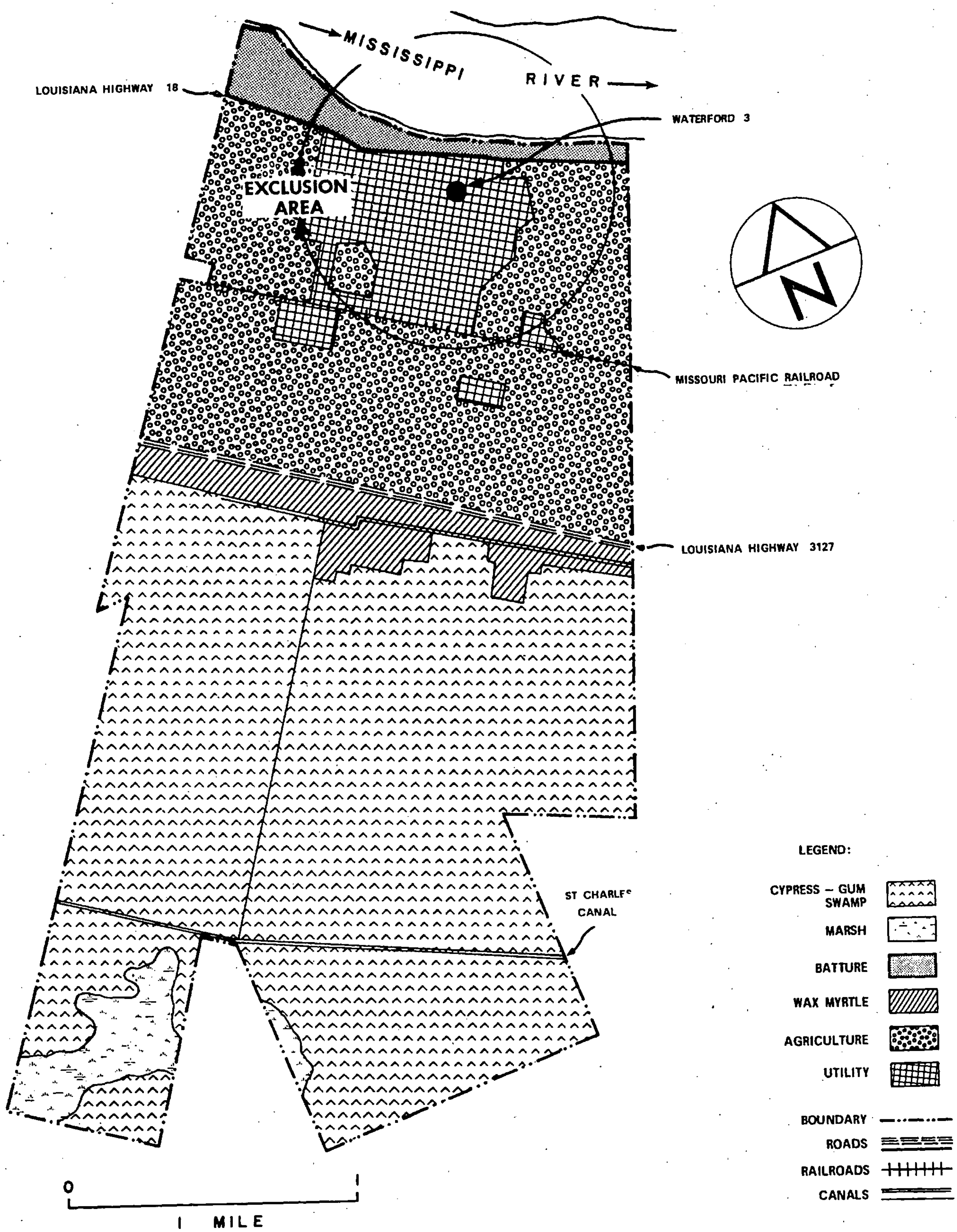

Fig. 4.7. Principal Plant Communities. From ER-OL, Fig. 4.2.4-2.

4.3.4.4 Endangered Species

None of the federally listed threatened or endangered species of plants, amphibians, or insects are known to occur in Louisiana.[5,6].

Several species of birds included in the "List of Endangered and Threatened Wildlife and Plants"[5] might occur in the area of Waterford 3. These endangered species are the southern bald eagle (Haliaeetus leucocephalus leucocephalus), the American peregrine falcon (Falco peregrinus anatum), the Arctic peregrine falcon (Falco peregrinus tundrius), the American ivory-billed woodpecker (Campephilus principalis principalis), Bachman's warbler (Vermivora bachmanii), and the brown pelican (Pelecanus occidentalis).

The bald eagle and the peregrine falcon may migrate or winter near the site (ER-OL, Table A.2.2.1-4, App. 2-2). Although the wetlands portion of the site provides habitat for the southern bald eagle,[7] the ivory-billed woodpecker,[8] and Bachman's warbler,[9] none of these birds has been observed to breed there (ER-OL, Sec. 2.2.1.2). The brown pelican feeds and breeds primarily in coastal waters and lakes[10] and consequently would be expected onsite only as a visitor.

The American alligator is the only reptile on the Federal list of threatened and endangered species,[5] that occurs in the area of the Waterford site.[4] As of September 6, 1979, the U.S. Department of the Interior reclassified alligators in St. Charles Parish, as threatened under the Similarity of Appearance clause, but subject to controlled harvests.[11] The cypress-gum swamp area of the Waterford site provides excellent habitat for the alligator, and several have been seen.

Three mammals, the west Indian manatee (Trichechus manatus), the Florida panther (Felis concolor coryi), and the red wolf (Canis rufus) are on the endangered list for Louisiana.[5] Of the three, only the red wolf's range is included in the area of the site. Wolves have been reported in small numbers in southwest Louisiana, about 150 miles from the site.[4]

4.3.5 Aquatic Ecology

Since the publication of the FES-CP in March 1973, additional information on the river ecology in the region of the site [River Mile (RM) 129.6], has been obtained. Site-specific work, which the applicant began in April 1973, was completed in September 1976 (ER-OL, pp. 2.2-10 to 35; Tables 2.2-2 to 36; Figs. 2.2-2 and 3; Table 5.1-10; Appendices 2-4; 6-2). The 316(a) and 316(b) demonstrations were completed in April 1979.[12,13] The effective NPDES permit indicates that the thermal discharge and intake structure for Waterford Unit 3 are approved by EPA. A Baton Rouge area dredging study (RM 238) was published by the U.S. Army Corps of Engineers in 1976.[14] Additionally, an ecological study of river biota was done for the River Bend Nuclear Power Station, Units 1 and 2 (RM 262) in 1974.[15]

Although the river in the Waterford site region supports aquatic biota ranging from microorganisms and various plankton to rather large commercial finfish, the resources are quite limited compared with those of less polluted rivers (ER-OL, pp. 2.2-10, 11, 12).[12,13,16-18] Biological productivity is low in the site area because water quality is poor. Heavy river traffic, high current velocities, floods, polluted land runoff, and municipal and industrial water effluents are contributing causes. Aquatic species in the site area of the Mississippi River are not on the endangered species list of the Fish and Wildlife Service (ER-OL, pp. 301.19-1; 2.2-28 and 29).[6,7]

4.3.5.1 Phytoplankton, Periphyton, and Macrophytes

The primary producers in the river are rather severely limited in growth by high turbidity and widely fluctuating water levels. The relatively high density of suspended sediments and other particulates, as well as the fast currents tend to limit the penetration of sunlight into the water. This provides greatly reduced light-exposure regimes for the planktonic and submerged primary producers (FES-CP and ER-OL, p. 2.2-13).[12-14] For these reasons both periphyton and macrophytes are sparse in the region of the site (ER-OL, Table 2.2-6; Table A2-4-2; pp. 2.2-10 through 20). The phytoplankton are likewise quite limited in quantity (FES-CP and ER-OL, Table A2.4-1; Secs. 2.2.2.2.1 and 2.2.2.3.1);[14,15] those present are derived in a large part from tributary streams and backwaters. The average current velocity is 2.5 km/hr (2.3 fps or 1.6 mph) and the plankton drift through the Waterford 1, 2, and 3 area in about an hour[12] (ER-OL, p. 2.4-5).

The phytoplankton in the site area are dominated during most of the year by diatoms, including Cyclotella and/or Melosira. During the 1973-1976 study they were the most abundant genera ($\geq$ 20 percent) each month except August during 1973-1974; Melosira was also dominant during 1975 and 1976. Other relatively abundant genera at various times were: Scenedesmus, Coscinodiscus, Chrysococcus, and Trachelomonas. About 20 genera were represented each year. Phytoplankton densities averaged from a low of about 1×10^5 organisms/L (1×10^5/0.264 gal) to somewhat less than 4×10^5 during the 3-year study.[12]

The dominant phytoplankton genera near St. Francisville, La. (about 48 km or 30 mi north of Baton Rouge) were fairly similar to those at the site (e.g., Cyclotella and Melosira), but average overall densities were greater, about 5×10^6/L (5×10^6/0.264 gal) in the last quarter of 1975 and 3.8×10^5/L (3.8×10^5/0.264 gal) during the first three-quarters of 1976.[19]

Downstream, in the river mainstem at New Orleans, the phytoplankton density was also greater than in the site area. The centric diatoms, Cyclotella and Melosira were dominant, as in the site area. In 1976, the same species were dominant during the first four months, but dominance was shared through the summer with green and blue-green algae. By September 1976, the centrics (Cyclotella and Melosira) were again dominant (85 percent of total).[19]

The important species of diatoms, green, and blue-green algae are listed in the ER-OL, pp. 2.2-13 and 14, Table A2-4-1 and in other studies (FES-CP).[12-15,23] Due to the generally depressed growth of phytoplankton, they contribute less energy to the aquatic ecosystem than is frequently seen in lakes and rivers. The blue-green algae (Cyanophyta) populations are expected to remain at their present low proportions after Waterford 3 begins operation.[12]

4.3.5.2 Zooplankton

The applicant found low densities of zooplankton in the site area (RM 129.6) (ER-OL, pp. 2.2-10; 2.4-14; Table 2.2-7 to 10).[10,11] From June 1973 to May 1974 there was an average of 921 zooplankton organisms/m^3 (26/ft^3) in the site area of the river; from June 1974 to August 1974 the average was 1056/m^3 (30/ft^3), and from October 1975 to September 1976, it was 298/m^3 (8/ft^3) (ER-OL, pp. 2.2-20 to 22, Table 2.2-8, and Tables 3 and 4 in Ref. 15).

The zooplankton were randomly distributed at the Waterford site throughout the different sampling stations, as well as vertically in the water column (ER-OL, pp. 2.2-20 to 22, Table A2-4-3, and Tables 2.2-8 and 9). On the other hand, they were not randomly distributed throughout time (monthly or yearly; ER-OL, Table 2.2-10). However, the peaks and valleys of zooplankton abundances were essentially simultaneous at all sampling stations.

Important species of zooplankton at the site, other than rotifers and protozoa, were the copepods and cladocerans, normally found in the zooplankton of rivers and lakes. Calanoid and cyclopoid copepods were dominant. The common cladocerans were Daphnia, Ceriodaphnia, Bosmina, and Diaphanosoma. Some decapod larvae (river shrimp) appeared in the summer zooplankton. None of the species of zooplankton were rare, threatened, or endangered, and none is commercially important.[5,12,13]

4.3.5.3 Benthic and Pelagic Macroinvertebrates

The benthic macroinvertebrates collected in the vicinity of the site in the 1973-1976 time period are presented in the ER-OL, Tables 2.2-13; A.2.5-1 through 6. Aquatic worms (Oligochaetes) and asiatic clams (Corbicula) were the most abundant. However, these organisms were present in relatively low numbers. For example, during the first year of sampling (1973-1974), the average density of all benthic organisms was 59/m^2 (6/ft^2). The 3-year average (1973-1976) was somewhat higher, 92/m^2 (8.5/ft^2). The increase was due primarily to more aquatic worms at stations near Waterford 1 and 2, and across the river just upstream of the Little Gypsy power facility (ER-OL, Table 2.2-14, Sheet 3 of 4; Fig. 6.1.1-1).

Pelagic (open water) macroinvertebrates were composed mainly of river shrimp (Macrobrachium ohione), which were universally distributed in the lower Mississippi River (ER-OL, pp. 2.2-11 through 24).[14,15,16,22] Other invertebrates sampled, for example, were dragonfly larvae (Odonata), blue crabs (Callinectes), mayfly larvae (Ephemeroptera), midge larvae (Diptera), snails (Gastropoda), and clams (pelecypods including Corbiculidae and Sphaeriidae) (ER-OL, Table 2.2-13). These species are a part of the food web, and a large fraction of the populations are consumed by fish. Human consumption of invertebrates and fish within an 81 km (50-mile) radius of the plant is also substantial (ER-OL, pp. 332.3-1 and 2).

4.3.5.4 Fish

The more abundant fish in the Waterford area are gizzard shad, threadfin shad, and a related species of Clupeidae, the skipjack herring. All of these fish have a statewide distribution.[21] Blue catfish, channel catfish, freshwater drum, and striped mullet are also somewhat abundant in the site area. Significant differences in the distribution of dominant fish, between sampling stations, within years, or between years I and III could not be found (ER-OL, Tables A-2-4-6).[13] The channel catfish has been the most profitable species in commercial catches between Baton Rouge and the Gulf of Mexico (1973-1975 data) (ER-OL, Table 2.2-33).

Occasionally, a number of other fish species were collected (ER-OL, Tables 2.2-18 through 22; 2.2-24 through 32). Freshwater catfish and drum were the only commercial species that were common in the vicinity of Waterford, but bay anchovy and gulf menhaden appear when the river discharge is very low (ER-OL, p. 2.2-11 and 12). A total of 61 fish species were identified by the applicant over a 3-year period. These observations are similar to those described in the FES-CP. None of the fish sampled in the Waterford area was endangered or threatened, according to the U.S. Fish and Wildlife Services List (ER-OL, pp. 301.19-1; 2.2-16 to 18; 2.2-24 to 32).[5,6,12,13,22] Furthermore, no unique fish habitats in the river near Waterford 3 exist, and there are no typically good spawning areas. Evidence indicates only limited spawning activity. The shads, minnows, carp, catfish, sunfish, and drum spawn to a small extent in the site area (ER-OL, pp. 2.2-12; 2.2-24 to 30; Tables 2.2-26 through 28; A2-4-8).[12,16] Most of the fish species sampled at the site are also found upstream in the River Bend (RM 262)[15] and Grand Gulf (RM 406)[20] reaches of the river.

4.3.5.5 Ichthyoplankton

Ichthyoplankton appeared in the river samples from March through August, and the peak densities occurred in the months from May through July, averaging $0.043/m^3$ ($0.033/yd^3$). Densities of fish larvae were low in the Waterford area throughout the 1974-1976 sampling period (ER-OL, pp. 2.2-26 to 28; Tables 2.2-29, 30, and Fig. 2.2-3).[13] There were no important differences in the spatial distribution of the ichthyoplankton in the river in the Waterford vicinity. Species represented belonged to the following families: Clupeidae or herrings (shads and skipjack herring); Cyprinidae or minnow family (carp, chubs, minnows, and shiners); Ictaluridae or catfish family, includes blue and channel catfish larvae; Centrarchidae or sunfish family (sunfish, bass, and crappies) and Sciaenidae (freshwater drum).

4.3.6 Cultural Resources on the Waterford Site

Historic and prehistoric sites in the area are summarized in Chapter II, Section C of the CP-FES.

The applicant conducted a survey on a transmission corridor (Fig. 4.8) and in several fields that are on the plant property. The methods used to evaluate this corridor included walkover and 30-cm augering tests along transect lines. No cultural items were recovered.

Following consultations between the State Historic Preservation Office (SHPO) and the NRC, the SHPO observed (see Appendix C) that there are no historically significant old buildings in or adjacent to the project area; also since much of the rest of the property is in backswamp, the likelihood of finding prehistoric Indian sites in this area was low and that a detailed literature search

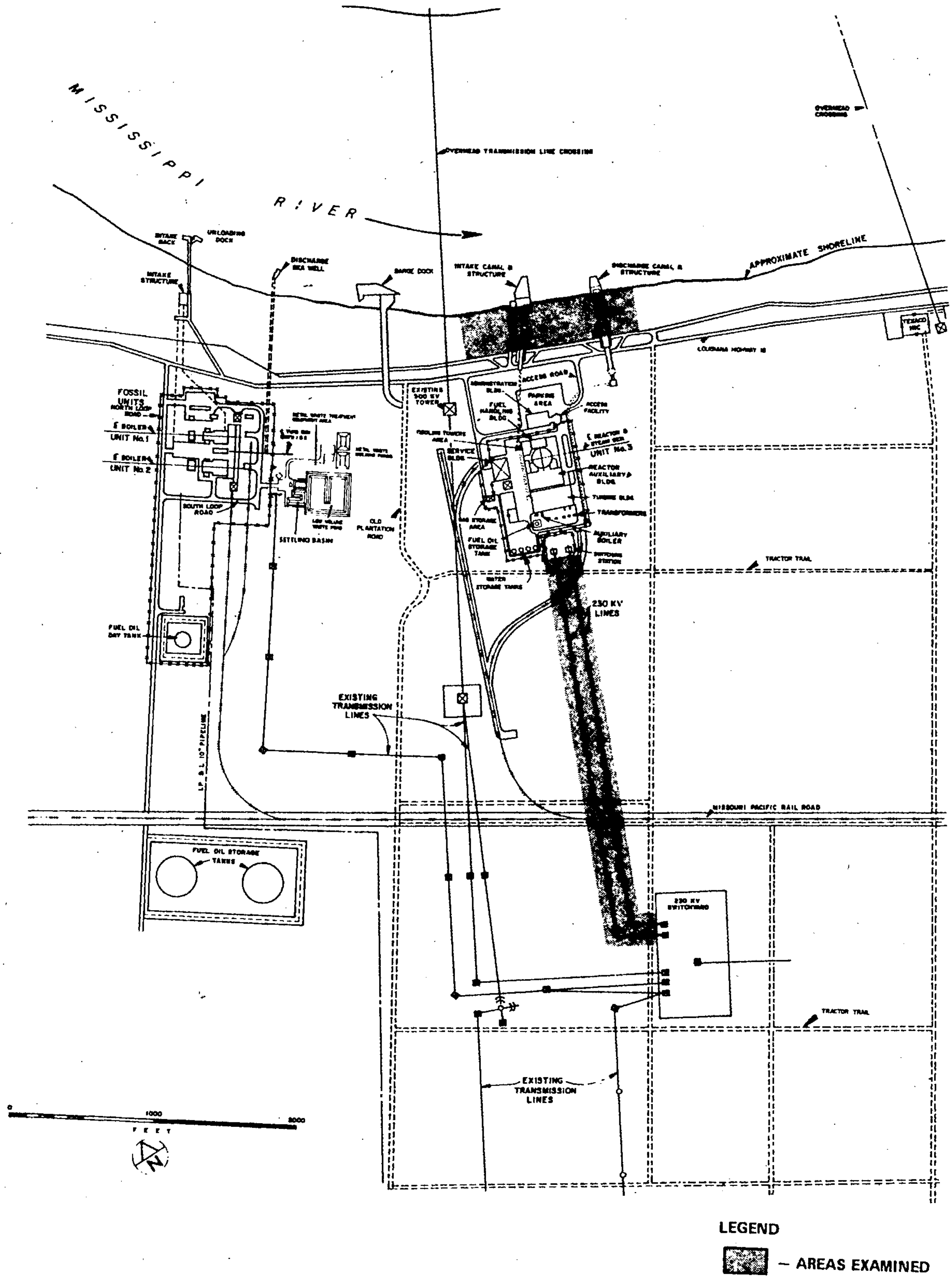

Fig. 4.8. Onsite Areas Scheduled to be Disturbed By Waterford 3 Construction Activity at the Time of the 1977 Cultural Resources Survey. From ER-OL Fig. 2.6-2.

of the Waterford property should be conducted. The SHPO further recommended that, if the literature search did not reveal any significant information, an on-the-ground survey would not be necessary.

In 1980, another survey was conducted at the request of the NRC and in cooperation with the State Historic Preservation Officer to determine the presence of any historical resources connected with the Waterford sugar plantation known to have existed at the site. A literature search revealed that the plantation was in operation from about 1721 to at least 1917; the plantation was demolished sometime before 1953. An 1894 map of the plantation showed six clusters of buildings. These were checked in the field. Areas 1 and 2 were deemed to have been totally destroyed by highway and levee construction work, as well as channel migration. Areas 3, 4, and 5 were subjected to small shovel tests of unreported dimensions, sometimes accompanied by shovel profiles scraped randomly in existing ditches. Areas 3 and 4, yielded intact midden deposits, but no datable artifacts. Area 5 had been heavily disturbed. In area 6 the intact piers of a probable irrigation pump and gate structure were found.

The field tests confirmed the presence of deposits reflecting the structures shown on the 1894 map. Some deposits were undisturbed. The site was not systematically searched for historical resources not noted or extant when the 1894 map was made. The nearly complete generating facility partially precluded this. The tests, as performed, were valuable in confirming the presence and location of possible significant historical remains in Areas 3, 4, and 5 (see Figure 4.9).

4.3.7 Demography and Land Use

4.3.7.1 Demography

The demographic characteristics of the area within 81 km (50 mi) of the plant site are presented in the ER-OL Table 2.1-1 for 1981, just prior to plant operation, and for 2030.

St. Charles Parish had a 1977 population of 34,000 and St. John the Baptist Parish had a population of 26,000. The populations of towns with over 1000 persons within 16 km (10 mi) of Waterford 3 are given in the ER-OL, Table 2.1-2, and the populations of communities with over 10,000 persons within 81 km (50 mi) of the plant are given in the ER-OL, Table 2.1-3. Major urban centers in the region are New Orleans [about 40 km (25 mi) east of the site] and Baton Rouge [about 81 km (50 mi) west-northwest (ER-OL)].

The resident population within 16.1 km (10 mi) of the plant is expected to increase by 26 percent, from 53,451 persons in 1980 to 72,591 persons in the year 2000 (ER-OL, Table 2.1-1). The estimated 1980 resident population living between 16.1 and 81 km (10 and 50 miles) of the plant is 1,653,706; this population is expected to grow to 2,056,977 in the year 2000. The bulk of the population within 81 km (50 mi) of the Waterford site is concentrated in and around the New Orleans metropolitan area which is located to the east and east-southeast of the station (ER-OL, Figure 2.1-7).

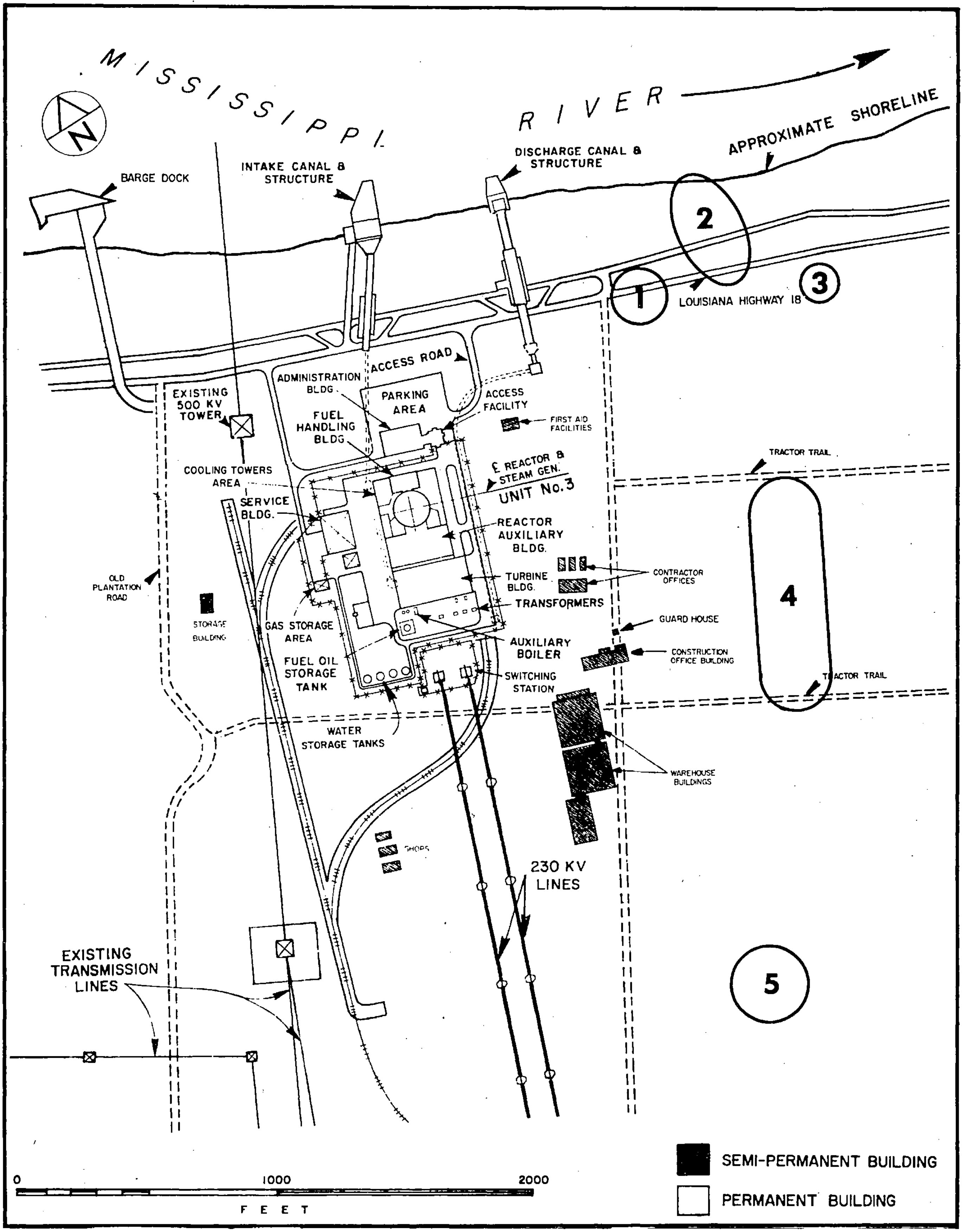

Fig. 4.9. Location of Archaeological Remains Associated With the Waterford Plantation. From ER-OL Fig. 2.6-3.

The applicant has also estimated the peak transient population within 16.1 km (10 mi) of the site which would be generated by recreational, industrial, and transportation activities between 1980 and 2030 (ER-OL, Section 2.1.2.3). According to the applicant, the transient population within 16.1 km (10 mi) of the site consists, in general, of industrial employees, visitors to festivals, attendees at sporting events, and people traveling through the area on transportation arteries. It is very difficult, when accounting for transient populations of these types, to distinguish residents from nonresidents. Therefore, the applicant's data are not precise with respect to double counting among transients or to distinguishing between residents and nonresidents. The staff recognizes that during peak periods of transient population movement, the local resident population is increased by persons traveling into the 16.1-km (10-mi) area around the site for the purposes of recreation or employment. However, this population group may be balanced by people residing within 16.1 km (10 mi) of the Waterford 3 site who travel outside the area for the same purposes. However, to achieve a measure of conservatism in the analysis of accident effects (Sec. 5.9.2) the staff has assumed that all industrial employees within 16.1 km (10 mi) of the site are residents of areas beyond 16.1 km (10 mi) of the Waterford station.

4.3.7.2 Land Use

Land use was addressed in the FES-CP, pages II-1 through II-8.

Land uses in the area within 8 km (5 mi) of Waterford 3 were inventoried in more detail by the applicant in 1977. Much of this area is wetlands, (38 percent) both forested and nonforested. Urban or builtup land and agricultural land are generally concentrated within 1.6 to 3.2 km (1 to 2 mi) of the Mississippi River. Urban land covers 14 percent of the total within 8 km (5 mi). Nearly 30 percent of this category is industrial, composed of large refineries and petrochemical complexes along the banks of the river. Residential acreage is next largest in the urban or builtup category, composed primarily of communities flanking the river.

Agricultural land comprises 21 percent of the total area within 8 km (5 mi). The richest agricultural land lies between the Mississippi River and the wetlands Up to the present time, most of this land has been planted in sugar cane and, to a lesser extent, soybeans. Other categories of land use include forest land, water (primarily the Mississippi River), and barren lands (transitional areas, open batture, and sand pits). These account for 27 percent of the area within 5 miles of the plant (ER-OL, Table 2.1-18). Land use within St. Charles Parish is shown in Table 4.7.

Future land use is expected to reflect a continuation of past trends: the urbanization and industrialization of the area primarily at the expense of agricultural land. Additions to the regional highway network which improve access to New Orleans suggest growth in the vicinity of Waterford during coming years.

In general, industrial development is projected to continue to take place along the Mississippi River in the vicinity of Waterford 3. Several large industrial sites within 4.8 km (3 mi) of Waterford 3 can be expected to be developed for industrial use during the life of the plant. These properties include the

Table 4.7 Existing Land Use in St. Charles Parish--1976

Category	Hectares	(Acres)	Percent of Total
Residential	783	(1,936)	0.72
Commercial	100	(247)	0.09
Industrial	3,596	(8,887)	3.30
Transportation	1,520	(3,755)	1.39
Public/semipublic	1,279	(3,144)	1.15
Total developed land	7,278	(17,969)	6.64
Water	34,346	(84,870)	31.50
Marsh	28,160	(69,584)	25.82
Marsh and forest	22,900	(56,790)	21.08
Forest	7,659	(18,925)	7.02
Agriculture/vacant	8,653	(21,382)	7.94
Total undeveloped land	101,718	(251,551)	93.36
Total land	108,996	(269,520)	100.00

Source: South Central Planning and Development Commission, 1976:12.

Note: Numbers may not add, because of rounding.

1,255-ha (3100-acre) parcel owned by Koch Industries immediately to the west of Killona, and the undeveloped portions of the Hooker Chemical and Union Carbide properties (ER-OL).

Residential growth alone is expected to require an additional 819 ha (2024 acres) by 1985. One reason for this demand may be the completion of I-410 which will provide access to I-10, US 90, and US 61 so that residents of St. Charles Parish can commute to their places of employment in the Greater New Orleans area. Another reason may be the difficulty Jefferson Parish will have in providing sufficient housing to accommodate growth.

The property on which the Waterford 3 site is located contains 100 acres of prime farmland. However, the plant structures are not located on this prime farmland and therefore although it may be temporarily removed from agricultural use, it will not be permanently lost.

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5 ENVIRONMENTAL CONSEQUENCES OF THE PROPOSED ACTION

5.1 RESUME

Very little change in land use is expected in addition to that presented in the FES-CP. Two lanes will be added to Louisiana Highway 3127, which traverses the site, but this is unrelated to plant operation. Consumptive use of surface and groundwater will not be significant. Hydrologic changes and floodplain effects of Waterford 3 will be negligible.

The applicant's revised hydrothermal analyses and the staff's independent analysis and assessment of the thermal impacts on the water environment are presented in Section 5.3.2. Only minor differences in water-quality impacts will occur as compared to those anticipated in the FES-CP. No changes are expected in terrestrial ecology impacts. Section 5.6 contains new information on aquatic impacts based on a change in the cooling-water system.

Additional historic resources have been identified on the site which could be impacted by plant operation; this is discussed in Section 5.7. Socioeconomic impacts have been updated and described in Section 5.8.

5.2 LAND-USE IMPACTS (See also Secs. 4.3.1 and 5.5.2)

Operation of Waterford 3 is not expected to have any adverse effects on land use, other than an irretrievable commitment of 61 ha (150 acres) to be occupied by the plant and its associated facilities. This use represents a loss of about 1.5 percent of the total cropland and pasture within 8 km (5 mi) of the site (ER-OL, Sec. 5.7.2.1). Thus, after decommissioning, 1380 ha (3410 acres) of 1440 ha (3560 acres) of the site could be restored to previous land uses. However, with adequate effort at some future time the land could be further modified or restored for useful purposes.

The transmission lines, about 1 km (0.6 mi) in length, will be entirely on site. The environmental effects of operating and maintaining these transmission lines are expected to be insignificant.[1] No herbicides or pesticides will be used within the corridor or along access roads. Land in the corridor will be mowed as required, except for those areas maintained under cultivation. Where the line crosses cropland, agricultural use will continue.

5.3 WATER-USE AND HYDROLOGIC IMPACTS

5.3.1 <u>Water Use</u>

5.3.1.1 Surface Water

The Mississippi River is the principal water source of all municipal, industrial, and agricultural use for towns and water districts downstream of Baton Rouge, Louisiana. The average daily production for municipal and industrial uses downstream of the Waterford site is about 19 million m^3/day or 220 m^3/sec (7760 cfs). This is only about 5 percent of the mean annual low flow of 4390 m^3/sec (155,000 cfs) in the Mississippi River. The nearest downstream municipal water supply using river water is the St. Charles Parish

Waterworks, which has two river intakes located 7.2 and 14.5 km (4.5 and 9 mi) downstream of Waterford 3. This water district serves a population of about 23,200 and withdraws an average of about 17,400 m^3/day (6.5 cfs).

All of the water required for plant operation, except potable water, will be withdrawn from the Mississippi River at an average rate of about 63.3 m^3/sec (2236 cfs). Consumptive use will be negligible, amounting to only 0.01 percent of the water withdrawn.

Because of this, operation of Waterford 3 will not affect availability of water to downstream water users. Potable water is obtained from the St. Charles Parish Waterworks. The anticipated potable water demand by Waterford 3 is about 37.9 m^3/day (10,000 gal/day).

5.3.1.2 Groundwater

Groundwater is a much less significant water source for Waterford 3 than surface water. The applicant identified 164 wells in St. Charles Parish; 89 of these had either been destroyed, abandoned, or were unused and only 5 were being used for domestic water supply. Within a 1.6-km (1-mi) radius of the reactor building, there are 20 wells. None of these is used for domestic water supply and 13 are destroyed, abandoned, or unused. Of the remaining 7 wells, 3 are used for watering stock, 3 for industrial purposes and 1 is an observation well. Groundwater is not utilized at the plant for any purpose.

Since 1966, total groundwater pumpage in St. Charles Parish has been decreasing. Alternately, surface water pumpage has increased. Latest records show that groundwater pumpage represents less than 1 percent of the total water requirements.

As described in Section 4.3.2.2, there is a silty sand layer at elevation -23 meters (-77 feet) that contains groundwater. This groundwater could be contaminated by leakage of radioactive or other plant wastes. However, any contaminants entering this sand layer would not flow into the Mississippi River because groundwater flow in this sand layer is away from the river in a southerly direction. Although the sand layer could be contaminated, it is unlikely that this would result in public radiation exposure and environmental contamination because the groundwater is of poor quality, and the extent of the sand layer is limited.

Extensive subsurface exploration at the site indicates that the deep aquifers described in Section II.D.3 of the FES-CP are effectively isolated from groundwater recharge from above, by a nearly impervious sequence of stiff clay layers interbedded with dense sand. Thus, it is highly improbable that groundwater in the deep aquifers could be contaminated by leakage of radioactive or other plant wastes.

Section 5.9.2.5(5) presents a discussion of the potential consequences of a postulated plant accident causing groundwater contamination.

5.3.1.3 Hydrologic Alterations and Floodplain Effects

Portions of the Waterford project will partially encroach on the floodplain of the Mississippi River. Therefore, an evaluation of the project's impact on the floodplain was made in accordance with the guidance of Executive Order 11988 on Floodplain Management.

The Mississippi River is highly regulated by flood control projects on the main stem and on its tributaries. Hydrologic studies by the Corps of Engineers show that because of this upstream regulation, floods having recurrence intervals ranging from once in 16 years to once in about 100 years, will all result in a maximum river stage of 7.3 m (24 ft) above mean sea level in the vicinity of the Waterford site. This is about 1.8 m (6 ft) lower than the existing levee grade of 9.1 m (30 ft) above mean sea level. Executive Order 11988 defines the floodplain as that area subject to a 1 percent or greater chance of flooding in any given year (the 100-year floodplain); therefore, any structures located inside the levees, below elevation 7.3 m (24 ft) MSL are in the floodplain. The circulating water intake and discharge structures are the only facilities located below elevation 7.3 m (24 ft) MSL. Although these structures are located in the floodplain, they will not constrict flows or raise water levels in any measurable way because the river is about 869 m (2850 ft) wide with a maximum depth of about 37 m (120 ft) MSL in the vicinity of Waterford 3 and the intake and discharge facilities would offer very small constrictions by comparison.

5.3.2 <u>Thermal Discharge Impacts</u>

5.3.2.1 General

As described in Section 4.2.2, the cooling system that the applicant has adopted for the Waterford 3 Station is a once-through system. The heated effluent from the station cooling systems will be discharged to the Mississippi River through a surface discharge canal. The thermal characteristics in the river resulting from the designed surface discharge depend largely on the ambient river flow conditions and on the station operating modes. The Waterford 3 Station is located on the outer bank of a river bend at River Mile 129.6. Because of the centrifugal force effect, the flow around the river bend creates spiral secondary currents and transverse (across the width) fluid motion. This complex flow pattern can significantly influence the mixing process of the heat discharged into the river. In addition, there is an effect related to the possible thermal interference from the nearby station thermal discharges. The location of the Waterford 3 Station is approximately 0.8 km (0.5 mi) downstream from the existing Waterford 1 and 2 Generating Station (882 MWe fossil-fueled) on the same side of the river and is almost directly across the river from the Little Gypsy Station (1229 MWe fossil-fueled). These stations are owned and operated by the applicant.

Because of the complexity of the thermal regime at the Waterford site, the applicant has conducted extensive field and analytical studies to ensure that the combined thermal plume distributions produced by the simultaneous operation of all nearby electric generating stations will comply with the thermal standards of the State of Louisiana.[2] These standards, as contained in

Louisiana Water Quality Criteria, 1977, require that effluents not elevate river temperature more than 2.8°C (5°F) nor cause the river temperature to exceed 32.2°C (90°F) beyond the established mixing zone. The mixing zone, which is also defined in the same criteria, is limited to no more than 25 percent of the cross-sectional area and/or volume of flow of the river stream, leaving at least 75 percent of the cross-section free to allow passage of free-swimming and drifting organisms with no significant effects produced on their populations.

In 1970-1973, the applicant conducted analyses of the thermal plume distribution in the Mississippi River resulting from heated water release by the Waterford 1 and 2, Little Gypsy, and Waterford 3 Stations for the Construction Permit Environmental Report. The hydrothermal analyses were reviewed and commented upon by the staff with its evaluation presented in the FES-CP.

However, since the issuance of the FES-CP in March 1973, the applicant has reevaluated the Waterford 3 thermal plume predictions because of (a) the revision of its plan for cooling water use and the modification of the discharge-structure design, (b) the availability of additional hydrothermal field data obtained near the Waterford site, and (c) the advances in thermal field predictive techniques. Consequently, an environmental review of the operational impacts of the newly designed cooling system is warranted.

In the following sections, an overview of the applicant's revised hydrothermal analyses for Waterford site is presented, followed by the staff's independent analysis and assessment of the thermal impacts and the conclusions.

5.3.2.2 Applicant's Hydrothermal Analysis

The applicant's analysis of the temperature changes in the lower Mississippi River as a result of the combined thermal discharges of Waterford 1 and 2, Little Gypsy, and Waterford 3 consisted of both field surveys and computer simulations. During the years 1970-1977, the applicant instituted a hydrothermal field program to monitor the thermal plumes attributable to the Waterford 1 and 2 and the Little Gypsy discharges. One of the objectives of this field program was to investigate the mixing characteristics of the Mississippi River in the vicinity of the Waterford site. The program was also designed as part of the Waterford 3 preoperational monitoring program. River flows during most of the field measurements were close to the typical low flow in the Mississippi River which is about 5600 m^3/sec (200,000 cfs). Therefore, some of the measured temperature data were directly used by the applicant for Waterford 1 and 2 and Little Gypsy stations in predicting the combined temperature distributions during low-flow conditions. The applicant examined the field data and observed that for several field studies, there was a back eddy current in the vicinity of the Waterford 1 and 2 intake and discharge structures. The back eddy current was strongest during periods of low flow and appeared to vary greatly with wind speed and direction and also with shoreline configuration. The construction of Waterford 3 has significantly altered the shoreline in the back eddy area and, hence, the current movement would also be modified.

The applicant's computer simulations consisted of near-field and far-field analyses of the thermal plume using Prych-Davis-Shirazi (PDS) near-field model[3] and Edinger-Polk (EP) far-field model.[4] Both models assumed steady-state condition. In theory, a near-field analysis is required when the heated effluent enters the receiving water as a jet which possesses velocity disparity with respect to the ambient fluid. The dilution of the discharged heat within the receiving-water body is, therefore, governed by jet mixing. In contrast to the near-field analysis, the far-field analysis is valid only when the thermal plume has become passive. That is, the jet momentum has decreased to the point at which its dilution is characterized by turbulence of ambient flow and heat dissipation from the plume surface. The PDS near-field model uses the assumed profiles for jet velocity and temperature and solves the three-dimensional equations of mass, momentum, and energy conservation to obtain the temperature distribution and the jet width and thickness. The EP far-field model treats the three-dimensional surface discharge by considering it as a continuous point source of heat on the boundary of a uniform flowing stream which is infinitely wide and deep. With these basic assumptions, the model then solves the energy conservation equation to obtain the three-dimensional temperature distribution.

Six cases representing a wide range of plant-operating and river flow conditions were analyzed. The conditions are illustrated in Table 5.1 (ER-OL, Tables 5.1-1 and 5.1-2). Note that the discharge rate and the excess temperature of the Waterford 3 circulating water system varied in the analysis. This variation from the design discharge condition of 63.3 m^3/sec (2235 cfs) at an excess temperature of 8.9°C (16.1°F) was made in accordance with expected pumping modes which, as the applicant proposed, would vary with the intake-water temperature in the river and plant-load conditions. For the purpose of this presentation, all analyses assumed maximum plant-load conditions.

Based on the station discharge conditions and the ambient river flow conditions the applicant then selected either the PDS model or the EP model to calculate the temperature isotherms for each individual case listed in Table 5.1. A summary of the applicant's model selection is given in Table 5.2. The physical parameters contained in the EP model were determined by calibrating the model against the field temperature data previously obtained by the applicant under known station and river discharge conditions. The calibrated parameters were then translated to other discharge conditions of interest for thermal predictions. For the PDS model, no field data were available at Waterford 3 or at Little Gypsy for calibrating the physical parameters. Therefore, the applicant adopted the parameters obtained by the Environmental Protection Agency. Having determined the model parameters and other input data such as river flow conditions and plant-operating modes required for the predictive models, the applicant then calculated and analyzed both individual and combined thermal impacts from heated discharges released by Waterford 3 and the other two existing plants.

The possible effects of heat recirculation at various intakes were examined under a variety of flow conditions. The applicant indicated that for low-flow conditions, the water temperatures at the Waterford 1 and 2 and the Little Gypsy intakes would be increased because of upstream thermal wedge intrusion of the respective heated discharges. This recirculation of heat would influence the near-field temperatures but was judged by the applicant to have negligible impacts on the far-field temperature distributions near the Waterford 3 discharge.

Table 5.1 Summary of Flow and Plant-Operating Conditions Used in Applicant's Hydrothermal Analysis

River Flow Condition	River Flow		Discharge Flow, m³/sec (cfs)			Excess Temperature, °C (°F)		
	m³/sec	(cfs x 1000)	W 1 and 2	LG	W 3	W 1 and 2	LG	W 3
Average winter	16.4	(580)	27.1 (956)	40.9 (1444)	39.2 (1384)	10.6 (19)	10.2 (18.4)	14.4 (26.0)
Average spring	18.4	(650)	27.1 (956)	40.9 (1444)	59.9 (2114)	10.6 (19)	10.2 (18.4)	9.4 (17.0)
Average summer	7.9	(280)	27.1 (956)	40.9 (1444)	63.3 (2235)	10.6 (19)	10.2 (18.4)	8.9 (16.1)
Average fall	6.8	(240)	27.1 (956)	40.9 (1444)	51.8 (1831)	10.6 (19)	10.2 (18.4)	10.9 (19.7)
Typical low flow	5.8	(205)	27.3 (963)	41.0 (1448)	63.3 (2235)	10.8 (19.5)	12.1 (21.7)	8.9 (16.1)
Extreme low flow	2.8	(100)	27.1 (956)	40.9 (1444)	51.8 (1831)	10.6 (19)	01.2 (18.4)	10.9 (19.7)

Source: ER-OL, Tables 5.1-1 and 5.1-2.

Note: W 1 and 2 represents Waterford 1 and 2.
LG represents Little Gypsy.
W 3 represents Waterford 3.

Table 5.2 Summary of Applicant's Model Selection

River Flow Condition	Waterford 1 and 2	Little Gypsy	Waterford 3
Average winter	Edinger-Polk Model	Edinger-Polk Model	Edinger-Polk Model
Average spring	Edinger-Polk Model	Edinger-Polk Model	Edinger-Polk Model
Average summer	Edinger-Polk Model	Edinger-Polk Model	Prych-Davis-Shirazi Model
Average fall	Edinger-Polk Model	Edinger-Polk Model	Prych-Davis-Shirazi Model
Typical low flow	Field data	Field data	Prych-Davis-Shirazi Model
Extreme low flow	Edinger-Polk Model	Prych-Davis-Shirazi Model	Prych-Davis-Shirazi Model

Also, at the intake for Waterford 3, recirculation from Waterford 1 and 2 was anticipated. The applicant estimated, at the staff's request, that the effects of recirculation from Waterford 1 and 2 would increase the Waterford 3 discharge temperature by only about 4 to 5 percent during the summer and fall seasons and by about 1 to 2 percent during winter and spring seasons. These increases were considered insignificant.

In addition to the recirculation effect, another problem of concern is the possible plume interference attributable to the simultaneous operation of all three power stations and, thus, the creation of thermal block to the river biota.

The applicant assessed this problem by examining the combined temperature distributions for all the river flow and the plant-operating conditions listed in Table 5.1. The combined temperature distributions were obtained by linearly superimposing the distribution generated by the independent operation of each plant. This type of mathematical treatment implicitly assumes that the plumes would not hydrodynamically interact with one another. In other words, the superimposing technique is valid only when the plumes are in the far-field region and the temperature distribution can be simply described by only the linear equation of energy conservation. The applicant claimed that this would be the case for the Waterford site and further demonstrated that the superimposed temperature fields were conservative estimates. The results of the calculated plume characteristics for the combined discharges of all three plants are given in Table 5.3 (ER-OL, Table 5.1-4) for three excess temperatures, 5.6°C (10°F), 2.8°C (5°F), and 2.0°C (3.6°F), respectively. As previously mentioned, the temperature distributions resulting from the discharges of Waterford 1 and 2 and Little Gypsy under low river-flow conditions were taken directly from field survey data. The surveyed results were then superimposed on the

Table 5.3 Applicant's Predicted Thermal Impacts of Waterford 1 and 2, Waterford 3, and Little Gypsy Discharges

	5.6°C (10°F)							2.8°C (5°F)							2.0°C (3.6°F)						
Season	Zm, ft	Xm, ft	Ym, ft	Tm, 1000 sec	Ac/Ar, %	Vol., a-ft	As, a	Zm, ft	Xm, ft	Ym, ft	Tm, 1000 sec	Ac/Ar %	Vol., a-ft	As, a	Zm, ft	Xm, ft	Ym, ft	Tm, 1000 sec	Ac/Ar %	Vol., a-ft	As, a
Predicted					Average Seasonal River Flow Conditions (see Table 5.1 for the definition)																
Winter	6.0	1,800	635	2.0	1.5	14.7	28	7.0	4,000	1,000	3.8	3.0	73	87	8.5	5,700	1,400	5.3	4.8	154	137
Spring	3.4	1,900	610	1.8	0.9	12.0	27	4.8	3,400	1,150	4.8	2.2	59	73	5.6	5,000	1,400	5.4	3.4	124	126
Summer	6.8	3,000	870	6.5	2.2	89.0	59	9.9	6,200	1,700	14.0	4.5	472	174	11.1	8,400	Wr	20.3	8.0	1,136	367
Fall	7.1	3,600	1,000	9.7	2.6	132.0	81	9.7	7,600	1,700	20.6	6.6	852	257	11.0	10,800	Wr	31.8	10.0	1,897	459
Survey							Typical Low River Flow Conditions of 200,000 cfs														
9/9/76	3.0	2,700	1,100	7.7	1.1	<150.0	50	8.0	7,200	Wr	24.0	4.2	<1,752	219	11.0	8,900	Wr	30.0	5.5	<3,641	331
9/10/76	2.5	1,850	700	6.0	0.7	<63.0	25	12.0	3,300	1,300	10.0	2.2	<888	74	14.0	5,300	1,400	17.0	2.7	<1,694	121

Source: ER-OL, Table 5.1-4.

Zm = Maximum vertical spread
Xm = Maximum longitudinal spread
Ym = Maximum lateral spread
Tm - Maximum travel time (a particle drift time through the longest plume length)
Ac = Maximum cross-sectional area for a given excess temperature
Ar = Cross-sectional area of the river at Waterford 3 discharge location
Vol. = Volume occupied by excess temperatures higher than that indicated
As = Surface area
Wr = River width (about 2,000 ft for average Summer/Fall seasons and for typical low-flow seasons)
a-ft = Acre-ft (equals 43,560 ft^3)
a = Acre

Note: To convert feet to meters, multiply by 0.3048.

Waterford 3 plumes predicted by the model. For other flow conditions, predictive models were utilized for all the plume predictions. The two sets of field data shown in Table 5.3 were obtained under identical station discharge and river-flow conditions existing on both September 9 and 10, 1976. However, as the results indicate, the extent of the combined thermal distribution in the river was quite different. This difference, as the applicant speculated, could be attributed to the wind effect. Indeed the variation in wind speed and direction could significantly affect plume dispersion, particularly in regions of relatively low river velocity. The results shown in Table 5.3 also indicate that for average seasonal and typical low river-flow conditions, a combined mixing zone defined by the 2.8°C (5°F) excess temperature isotherm would enclose not more than about 6.6 percent of the river cross-sectional area. Note that the combined plume description for the extreme low-flow condition of 2800 m^3/sec (100,000 cfs) was not given in Table 5.3. The applicant indicated in the Amendment No. 1 to the ER-OL, that for extremely low river flow, the 2.8°C (5°F) excess temperature isotherm would occupy a maximum of 15 percent of the river cross-section. Therefore, in all cases studied, the predicted mixing zones were well below the allowable limit of 25 percent of the river cross-section. For demonstration purposes, only the surface temperature distributions for the plant operating under average spring and typical low-flow conditions are shown in Figures 5.1 and 5.2 (ER-OL, Figs. 5.1-3 and 5.1-7). The cross-sectional extent of the combined thermal discharges at River Mile 129.2 is also shown in Figure 5.3 (ER, Fig. 5.1-9) for the typical low-flow conditions. The applicant's predicted temperature distributions for other flow conditions can be found in the ER-OL.

The applicant realized that its selected models cannot directly treat the complex flow field induced by the river bend and the complicated boundary conditions due to simultaneous operation of all three nearby power stations. However, the applicant believes that its modeling approach would yield conservative (worst case) results mainly because (a) all plants were assumed operating at maximum load for the temperature calculations, (b) the models were calibrated against the largest plumes observed, and (c) the surface heat exchange effect was neglected.

5.3.2.3 Staff's Hydrothermal Analysis

In view of the complexity of the thermal regime at Waterford site, the staff concluded that an independent assessment of the thermal impacts using a different and presumably more suitable model to predict temperature isotherms was essential. For this purpose, the staff used with some modifications, the Waldrop-Farmer plume model[5] which numerically solves the time-dependent equations of motion and the energy equation. Unlike the applicant's thermal model, this plume model solves for velocity and temperature in three dimensions and includes the curvature of the river. Furthermore, this model is capable of handling multiple intake and discharge boundary conditions such as the case at the Waterford site. The Waldrop-Farmer plume model is classified as a complete-field model which treats both the near and far fields so the entire flow field can be obtained if desired. The surface heat loss and the wind effects were not considered in the model. However, the omission of surface heat transfer to the atmosphere would give conservative predictions of the temperature distribution.

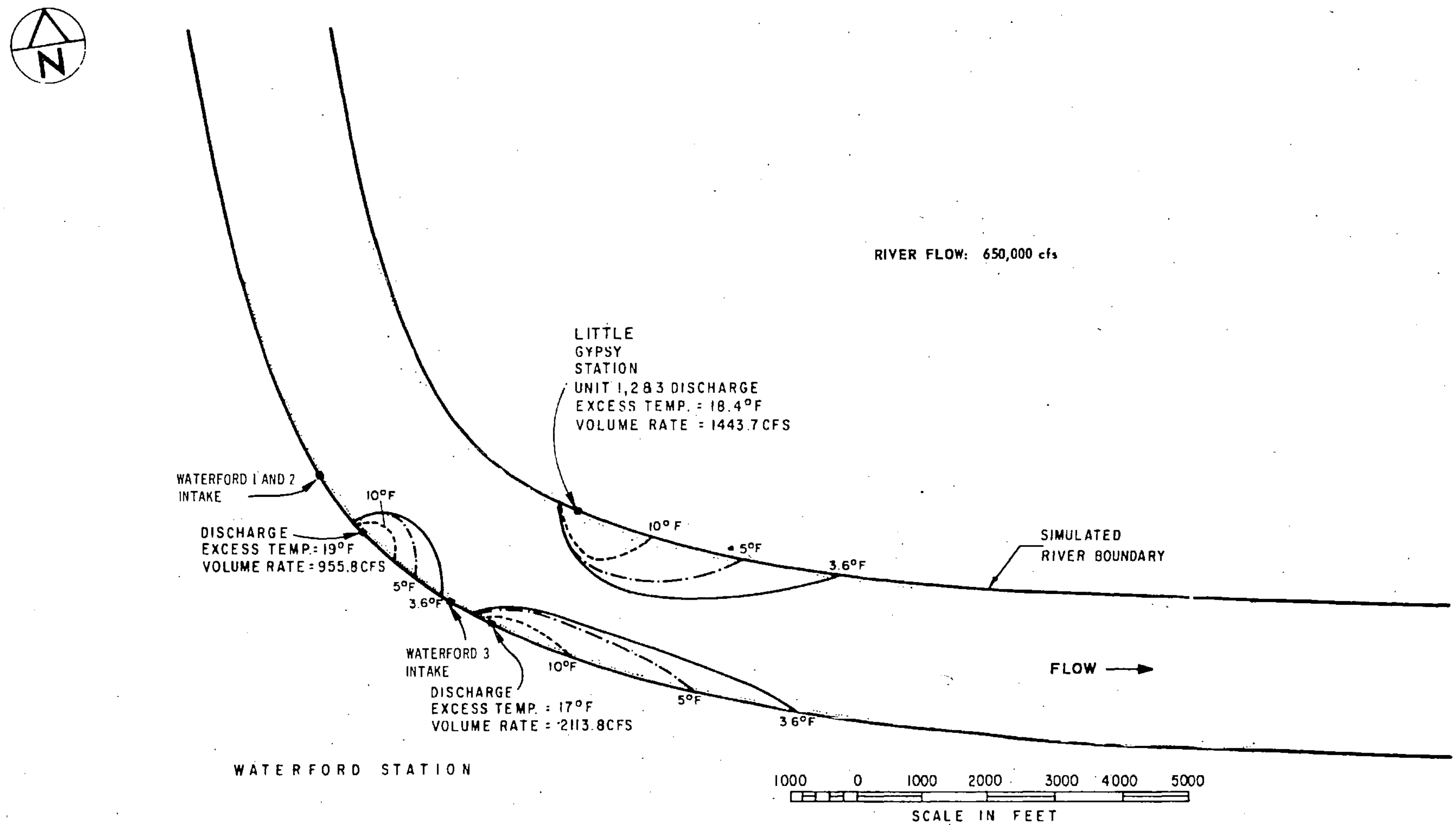

Fig. 5.1. Applicant's Predicted Surface Temperature Isotherms for Average Spring Flow Conditions. From ER-OL, Fig. 5.1-3.

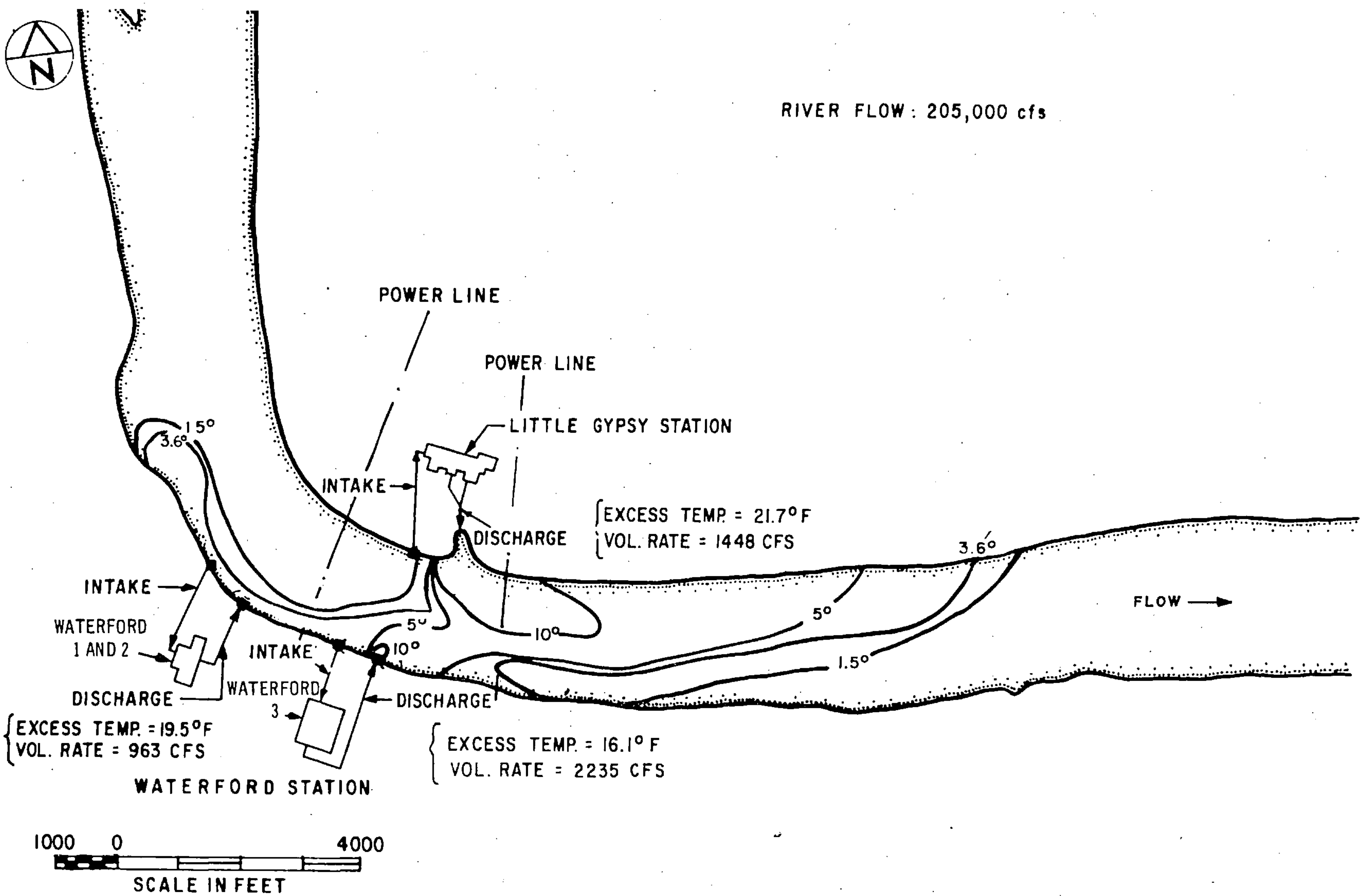

Fig. 5.2. Applicant's Predicted Surface Temperature Isotherms for Typical Low-Flow Conditions. From ER-OL, Fig. 5.1-7.

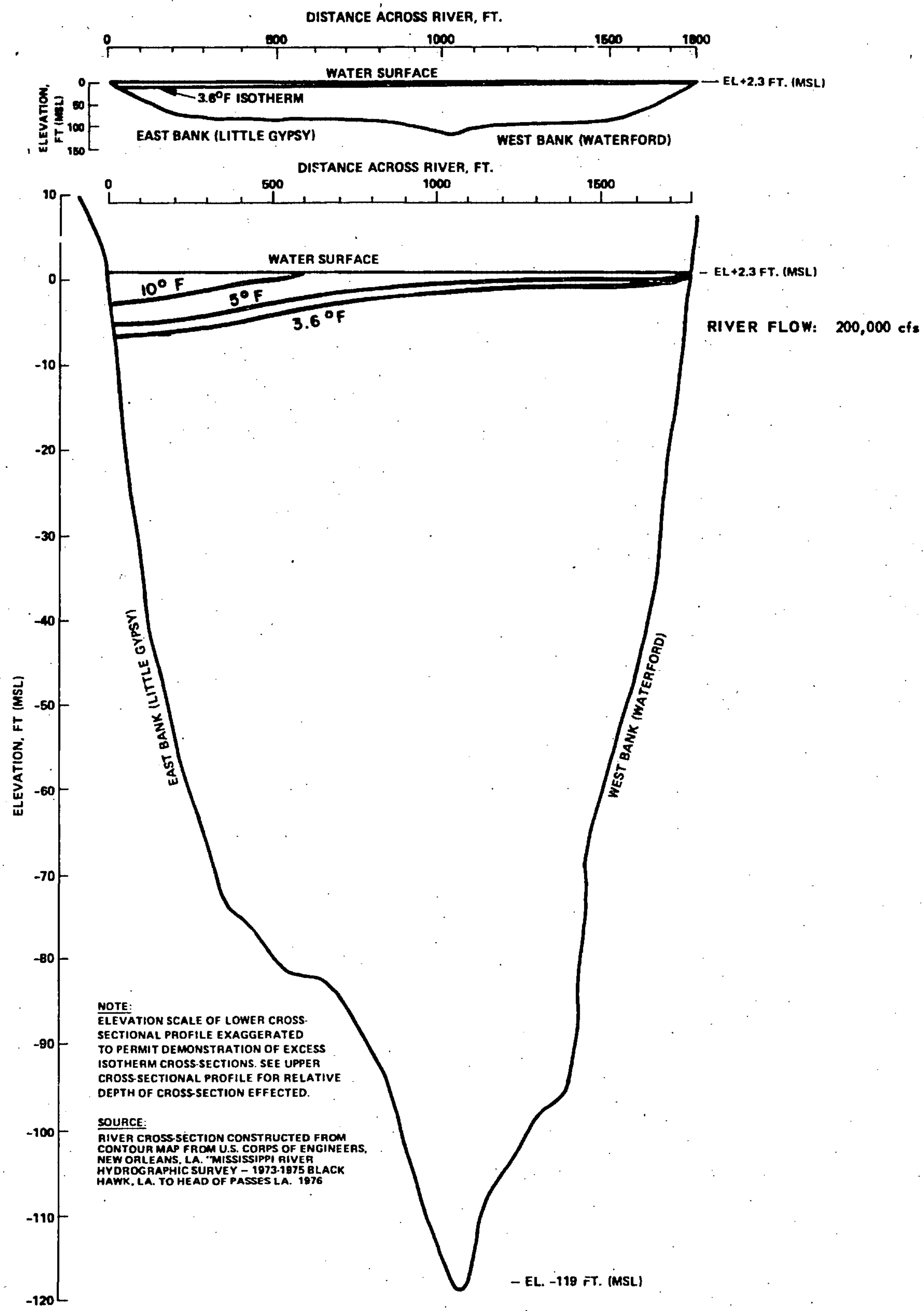

Fig. 5.3. Applicant's Predicted Cross-Sectional Excess Temperature Isotherms for Typical Low-Flow Conditions. From ER-OL, Fig. 5.1-9.

Based on the applicant's analysis of the thermal plume, it was found that the thermal impacts of the combined discharges of Waterford 1 and 2, Waterford 3 and Little Gypsy became significant as the river flow decreased. The staff then selected for analysis the case of typical low flow of 5600 m^3/sec (200,000 cfs) rather than the case of extreme low flow of 2800 m^3/sec (100,000 cfs). The typical low flow was estimated by the applicant to have a recurrence interval of about 6.7 years and to be exceeded approximately 85 percent of the time. This means that low flows of similar magnitude would be experienced during the planned 40-year operational life of Waterford 3. The extreme low flow on the contrary was considered not likely to occur because of the upstream river control works. For the low-flow condition, the computer program was run over a river section about 1.6 km (1 mile) upstream of the Waterford 1 and 2 intake location and about 2.4 km (1.5 mi) downstream of the Waterford 3 discharge location. This section was chosen to cover the entire river bend at the plant site. As part of the program input, the river bottom topographs were determined from the applicant's river-depth contour map shown in ER-OL, Figure 5.1-1. The plant operational conditions used for the computation were similar to those indicated in Table 5.1 under typical low-flow conditions. Prior to applying the Waldrop plume model to study thermal plume characteristics in the Mississippi River near the Waterford site, the model was utilized to simulate a river flow condition for which field data had obtained by the applicant. The predicted results compared reasonably well with the measured isotherms. This comparison served as verification of the computational procedure.

The results of the staff's computations are presented in Figures 5.4 and 5.5. These plots contain the excess temperature distributions at the surface of the river and at the cross-section near Little Gypsy Station (location indicated in Fig. 5.4). Note that the excess temperature isotherms in Figures 5.4 and 5.5 are somewhat different from those predicted by the applicant (see Figs. 5.2 and 5.3). The major difference is the upstream thermal intrusion at Waterford 1 and 2 intake which was observed in the applicant's field data but was not predicted by the staff's numerical model. This thermal wedge as previously mentioned was mainly due to the wind effect, which was not considered in the model. More comparisons of the staff's and the applicant's predicted thermal extents can be seen in Table 5.4. In general, the results indicate that the isotherm fields predicted by the staff are deeper and more extended in length downstream than those predicted by the applicant. The staff predicted that the 2.8°C (5°F) excess temperature isotherm would enclose about 7.3 percent (rather than 4.2 percent as estimated by the applicant) of the river's cross-sectional area. It should be mentioned that part of the applicant's results were surveyed data which generally are less conservative. Nevertheless, the larger area of the staff's calculations is still well below the mixing-zone area allowed by the Louisiana Water Quality Criteria. The applicant did not specifically indicate whether the river temperature ever would exceed the maximum allowable temperature of 32.2°C (90°F) because of the combined thermal discharges. In evaluating the compliance of this standard, the staff analyzed its own calculated temperature data for the typical low-flow condition and the applicant's predicted results for other flow conditions and believes that because of (a) the predicted small mixing-zone area and (b) the applicant's proposed plant operating modes for various flow conditions, the plant impacts would be within the allowable temperature limit. The possible heat recirculation

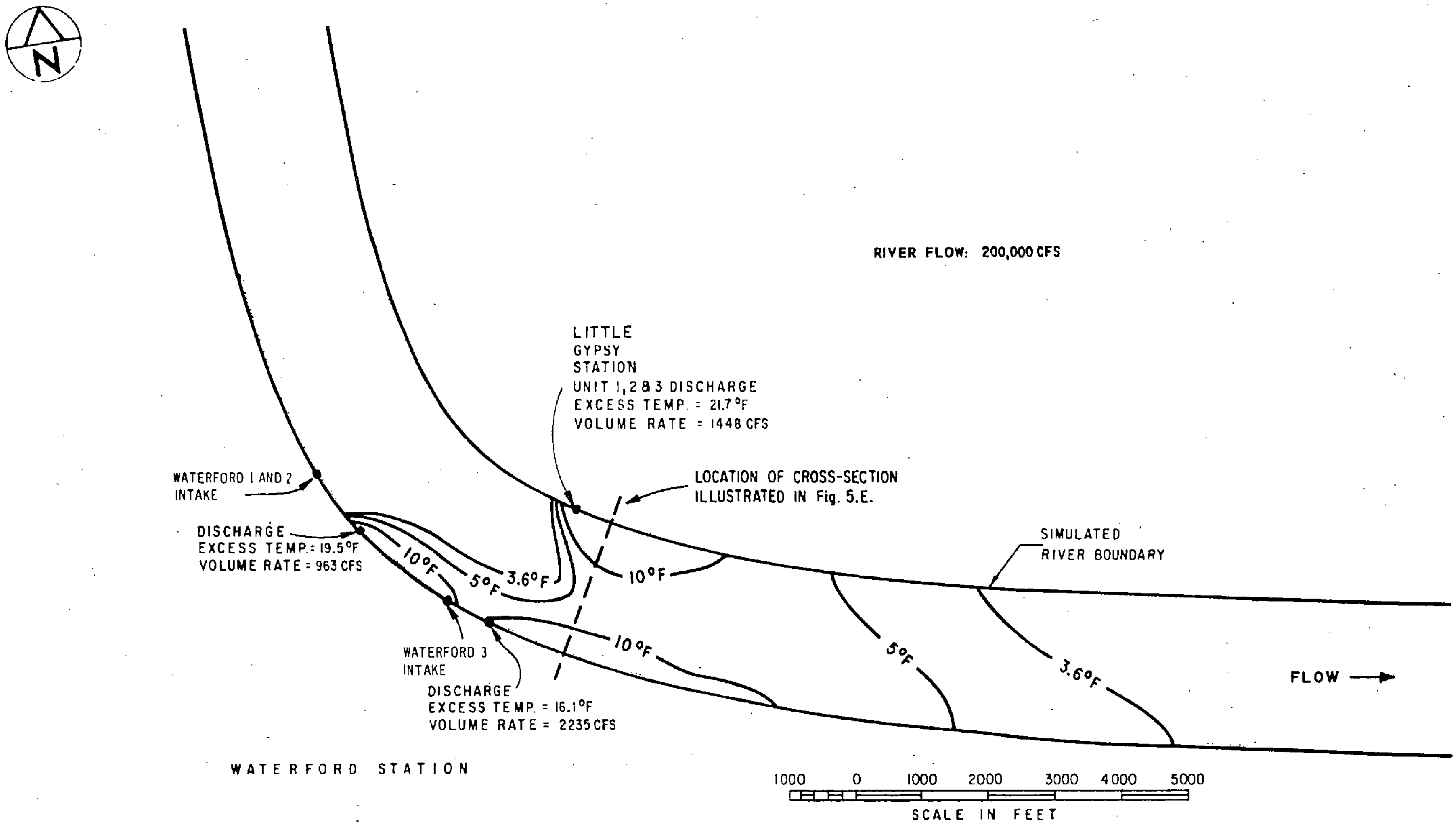

Fig. 5.4. Staff's Predicted Excess Surface Temperature Isotherms for Typical Low-Flow Conditions. Modified from ER-OL, Fig. 5.1-3.

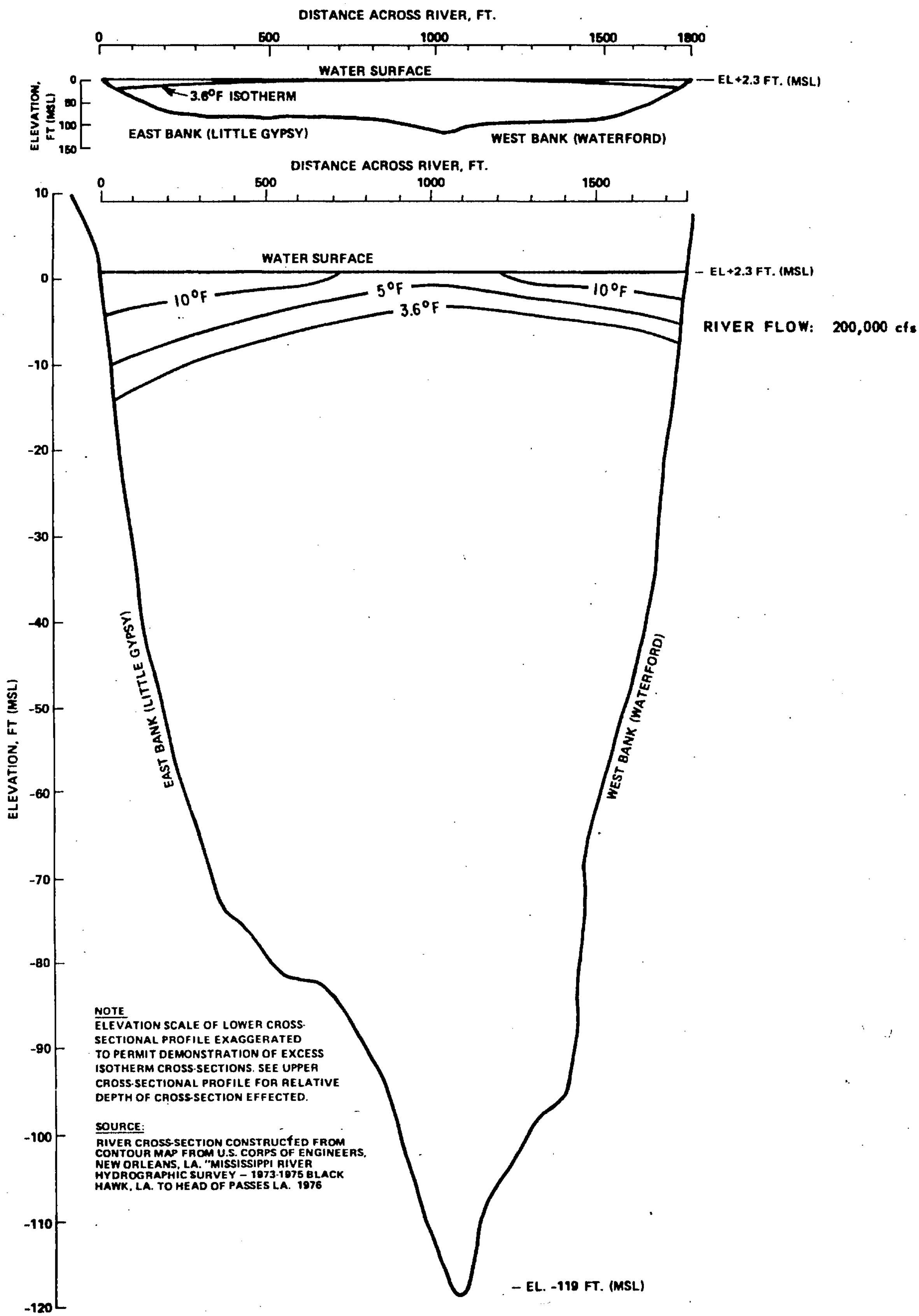

Fig. 5.5 Staff's Predicted Cross-Sectional Excess Temperature Isotherms for Typical Low-Flow Conditions. Modified from ER-OL, Figure 5.1-9.

Table 5.4 Comparison of Applicant's and Staff's Thermal Analyses for Typical Low-Flow Conditions

Results	5.6°C (10°F)				2.8°C (5°F)				2.0°C (3.6°F)			
	Zm, ft	Xm, ft	Ym, ft	Ac/Ar, %	Zm, ft	Xm, ft	Ym, ft	Ac/Ar, %	Zm, ft	Xm, ft	Ym, ft	Ac/Ar, %
Applicant's results	3.0	2,700	1,100	1.1	8.0	7,200	2,000	4.2	11.0	8,900		2,000
Staff's results	6.0	3,900	1,200	2.4	10.5	7,600	2,000	7.3	15.0	10,800		2,000

Zm = Maximum vertical spread.
Xm = Maximum logitudinal spread.
Ym = Maximum lateral spread.
Ac = Maximum cross-sectional area for a given excess temperature.
Ar = Cross-sectional area of the river at Waterford 3 discharge location.

Note: To convert feet to meters, multiply by 0.3048 between the Waterford 1 and 2 discharge and Waterford 3 intake was also investigated. The staff calculated that for typical low-flow conditions, water temperature as high as 1.1°C (2°F) above ambient rather than 0.56°C (1°F) as estimated by the applicant might be swept into the Waterford 3 intake. As the flow increases, the recirculating tendency of the effluent would tend to be reduced and the plume from the upstream station would be expected to hug the downstream shore. This can be seen by comparing the results shown in Figure 5.1 with those in Figure 5.2.

5.3.2.4 Conclusions

The applicant's and the staff's hydrothermal analyses were presented in the preceding sections. In many respects, the models were different, but the results obtained from them for the case with typical low-flow conditions were generally in agreement. Although the comparison was made only for one flow condition, the staff believes that the general plume behavior for other flow conditions can be inferred from this case. The staff agrees with the applicant's contention that as the river flow increases, the mixing of the thermal plume is expected to become more dominated by the ambient flow and the plume distributions on either side of the river will tend to remain more separated from each other. The cross-sectional area of the river enclosed within the 2.8°C (5°F) excess temperature isotherm would only occupy about 7.3 percent (4.2 percent as estimated by the applicant) of the river cross-section for typical low-flow conditions and will diminish as the river flow increases. Also, because of the predicted small mixing zone and the applicant's proposed plant-operating modes under various river-flow conditions, the maximum temperature outside the mixing-zone area would be lower than the allowable maximum temperature of 32.2°C (90°F). The staff, therefore, concurs with the applicant that the surface discharge design of the Waterford 3 and its operation will be in compliance with the Louisiana Water Quality Criteria relating to temperature.

5.3.3 <u>Water Quality Impacts</u>

For a discussion of the effect of chemical discharge on aquatic life, refer to the FES-CP, pp. V-23 through 25. During the development of the FES-CP, the staff concluded that the controlled release of the chemical wastes from the plant, in the concentrations given, would not have a significant impact on the aquatic biota of the river, and that it would not adversely affect the uses of the water down stream.

Chlorination of the condenser cooling water will be required on about 20 days per year (ER-OL, p. 301.8-1). The concentration of chlorine will be limited to 0.2 to 0.5 ppm of free available chlorine at the condenser outlet by dose control. Chlorination will be limited to less than 2 hours per day (ER-OL, Sec. 3.6.3); this concentration range will satisfy Federal effluent limitation guidelines.[6] Dilution with river water and reaction with chlorine-demanding substances in the water will further reduce the chlorine concentration.

As described in Section 4.2.4, other chemicals released to the circulating cooling water system will be boron (2×10^{-5} ppm), hydrazine (9.5×10^{-5} ppm), and ammonia (1.9×10^{-7} ppm). Boron is considered mildly toxic to fish. Wallen et al. found that in turbid waters 5600 ppm of boric acid or 3600 ppm of sodium borate were needed to kill 50 percent of test mosquito-fish in 96 hours.[7] Hydrazine is reported to be harmful to aquatic life in very low concentrations. The estimated permissible concentration of hydrazine is 0.018 ppm.[8] Ammonia, NH_3, has also been reported as toxic to some species of freshwater aquatic life. The lethal concentrations for a variety of fish species are in the range of 0.2 to 2.0 ppm NH^3.[9] Because the concentrations of chemicals occurring in the plant discharge to the Mississippi River are well below those considered harmful, the staff expects no adverse impact.

Disposal of sodium sulfate from the demineralizer system will increase the sulfate concentration downstream in the Mississippi River by only 9×10^{-3} ppm. Sodium sulfate is toxic to aquatic life only over prolonged exposures and at concentrations above 1000 ppm;[11] there should be no adverse impact.

Sanitary wastes are treated by secondary extended aeration; the process should reduce BOD_5 and suspended solids concentrations by 85 to 90 percent. Following secondary treatment, with the exception of the treated waste from the administration building, the wastes are mixed with demineralizer regenerant wastes and treated in the waste collection basin. The administration building waste undergoes similar treatment and the effluent is ultimately released to the 40 Arpent Canal. The wastes will ultimately be discharged to the Mississippi River but the increased load of BOD_5 and suspended solids should not be measurable.

5.4 AIR QUALITY IMPACTS

The gaseous effluents released during plant operation are well below the USEPA "significance" levels and are not expected to have a noticeable effect on the ambient air quality in the region.

5.5 TERRESTRIAL ECOLOGY IMPACTS

5.5.1 Plant Site

The staff foresees no stresses on the resident biota from the operation of plant that were not considered and found acceptable in the FES-CP. Should additional land near the plant be needed for the construction of roads, routes could be chosen that would have little long-term effect on the existing biota in the vicinity. Occasional bird collisions with the buildings and structures that are erected will undoubtedly occur, but no more frequently than at other similar structures along the river. All nonsanitary wastes will be contained or disposed of offsite in an approved manner. No impacts from such wastes to the terrestrial biota of the plant site are expected.

Continuous and intermittent production of noise is discussed in the ER-OL, Section 5.6. The estimated noise levels during operation will be about 55 dB(A) at the edge of the exclusion area and about 45 dB(A) at the near edge of the wetlands, which are relatively undisturbed by human activity (ER-OL, Fig. 5.6-1). These outdoor noise levels do not interfere with normal conversation and impose no known mental or physiological stress upon humans and vertebrate biota.[11,12] Also, there will be minimal impact from testing of sirens to be installed as part of emergency preparedness plan.

5.5.2 Transmission Line

Two 230-kV transmission lines will be built between the plant and the switchyard on the site, a distance of about 1 km (0.6 mi) along a corridor 70 m (76 yd) wide, covering an area of about 7 ha (17 acres) (Fig. 5.6). The line is almost entirely within the exclusion area and passes over areas designated for utilities or agriculture. The only foreseeable long-term impact that this line will have on fauna will be that new roosting sites will be provided for birds. There is no threat of electrocution to birds with a large wingspread, because the distance between the closest energized conductor and the grounded steel tower is 2.13m (8 ft) (ER-OL, Sec. 3.9.1). No long-term effects on the resident biota are expected.

5.5.3 Endangered Species

None of the endangered terrestrial species, including alligators which have been seen onsite (Sec. 4.3.4.4), is known to inhabit or regularly use the parts of the site that will be affected by operational activities. Consequently, none is likely to be impacted.

5.6 AQUATIC ECOLOGY IMPACTS

The construction impacts on aquatic biota appear to have been confined principally to the site vicinity. The intake structure was built within a coffer dam. The construction work on the discharge structures, the placement of mooring dolphins, and installation of sheet piling in the Mississippi River caused only local, temporary disturbances in the benthic and other biotic communities (ER-OL, pp. 301.18-1; 4.3-1).

5.6.1 Intake Impacts

5.6.1.1 Impingement

Predictions of fish and river shrimp impingement [collision of aquatic organisms with the 0.64-cm (1/4-in.) mesh traveling intake screens] at Waterford 3 are based on a number of physical and biological variables, and the impingement rates at other plants (ER-OL, pp. 301.30-1 through 301.31-3). At the CP stage, the staff used data from the Little Gypsy plant, and other information, to predict that impingement would involve mostly small or juvenile fish (FES-CP, pp. V-1 12, 13). The prediction was that about 703 kg (1550 lb) of fish and 45 kg (100 lb) of river shrimp per year would be lost at Waterford 3 because of impingement.

Since publication of the FES-CP, the applicant has made additional studies of the probable impingement of fishes and river shrimp at Waterford 3, based on data from the environmental surveillance program, data from Waterford 1 and 2, and a review of other ecological work on the lower Mississippi River. Later studies have shown that not only the fish species seen at Waterford, but also the river shrimp are widely distributed in the Mississippi River through several midwestern and southern states.[13,14] According to Gross,[15] impingement rates can be reliably estimated at a new plant if there are adequate data

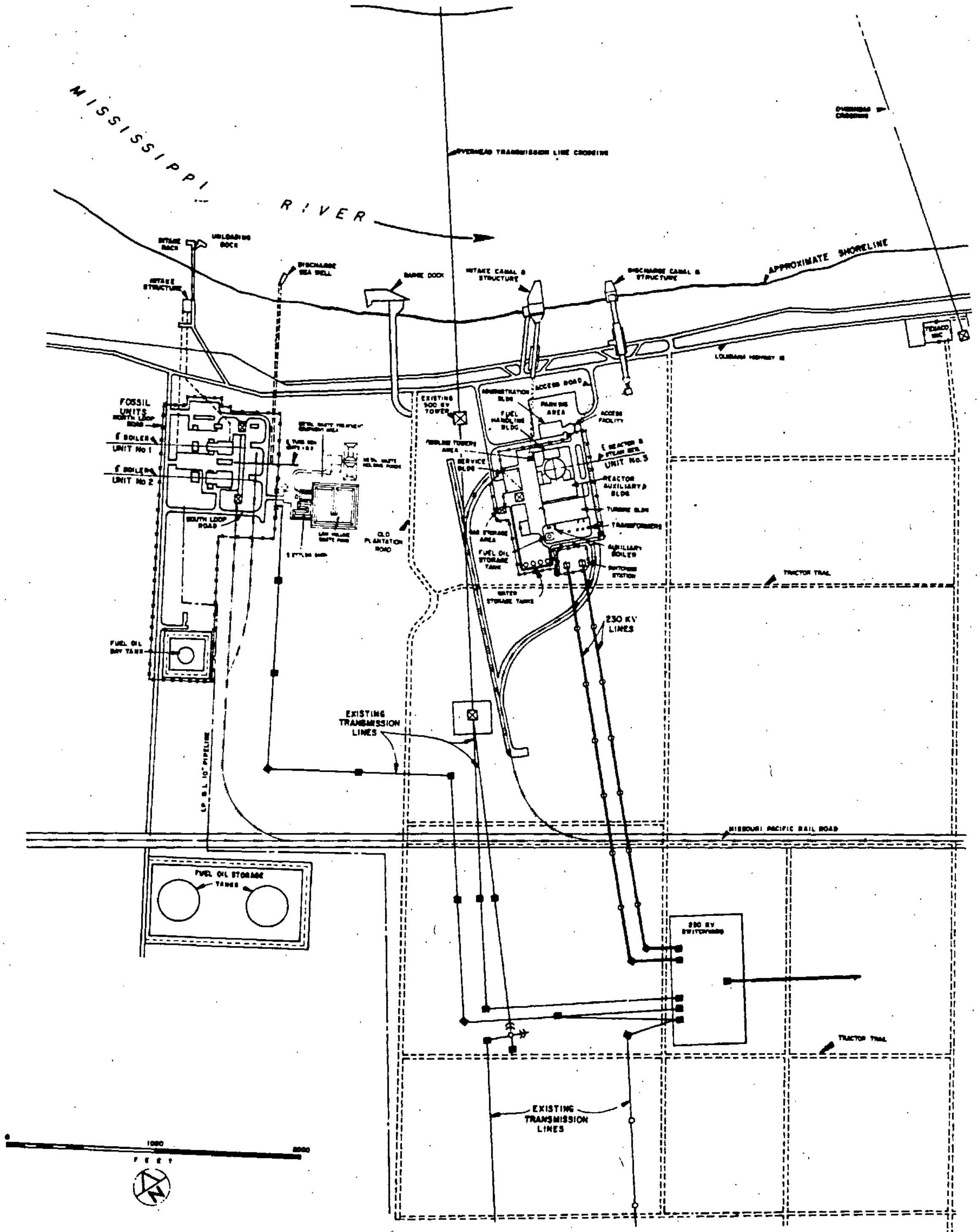

Fig. 5.6. Location of 230-kV Transmission Lines on the Waterford 3 Site. From ER-OL, Fig. 5.4-1.

from a similar intake in operation nearby. The Waterford 1 and 2 power facilities are near Waterford 3, and they have become operational since the publication of the FES-CP. Their intakes have both similarities and differences when compared with Waterford 3 (ER-OL, pp. 5.1-5 to 5.1-10).[16]

In 1976, about 266 kg (587 lb) of river shrimp were impinged at Waterford 1 and 2. The 1976 data at Waterford 1 and 2 showed that about 3950 kg (8700 lb) of finfish per year were impinged, which included 1635 kg (3600 lb) of catfish and 590 kg (1300 lb) of freshwater drum. The rate of impingement at both units (total) was 0.73 kg (1.6 lb) and 11 kg (24 lb)/24-hr day, respectively, of shrimp and finfish (ER-OL, p. 5.1-7 and 8). Blue catfish, channel catfish, and freshwater drum were the dominant commercial fish impinged, but gizzard shad and threadfin shad were also commonly found. If shrimp and fish are impinged at Waterford 3 at the rate (per unit of intake volume) that occurred at Units 1 and 2 in 1976, the average impingement rate at Waterford 3 will be about 1.7 kg (3.7 lb)/day or 612 kg (1350 lb)/yr of shrimp and 25 kg (55 lb)/day or 9072 kg (20,000 lb)/yr of finfish or about 9684 kg (21,350 lb)/yr total. This is based on the approximation that the average intake capacity of Waterford 3 is 2.3 times that of Waterford Units 1 and 2 combined (FES-CP and ER-OL, pp. 5.1-8, -10).[17] The intake capacity of Waterford 3 is about 3,785,000 L/min (1 million gal/min). The actual fish impinged at Waterford 3 will probably have a lower fraction of catfish and drum since the intake will draw from a larger part of the water column, including higher water levels. Also, the total annual impingement losses of fish and river shrimp will be lower than otherwise predicted if the sluice functions as designed,[16-18] and if there is no recycling of fish. Based on the species present and their swimming speeds at various temperatures, the impinged fish will likely be juvenile or very young adult fish. The young fish that enter the water strongly influenced by the Waterford 3 intake will have difficulty because the intake velocities are in a relatively high range (1.1 to 1.8 fps).

At one time, the applicant predicted an annual loss at Waterford 3 of about 1814 kg (4000 lb)/yr (total) of catfish, gizzard shad, drum, and shrimp (ER, p. 5.1-10). Other estimates by the applicant for annual fish losses ranged from a maximum of 12,700 kg (28,000 lb) (about 460,000 fish at 0.06 lb/fish) to a more likely yearly average of 7260 kg (16,000 lb) (about 260,000 fish).[16] Maximum shrimp loss estimates were 454 kg (1000 lb) (about 260,000 shrimp at 0.004 lb/ shrimp) to about 90 kg (200 lb) (about 50,000 shrimp) per year.[16]

The applicant's most recent estimate of probable fish and shrimp impingement rates at Waterford 3 is in the range of 300,000 to 700,000 organisms per year.[19] It is assumed by the applicant that half of these organisms will be shad and/or shrimp. No estimate was made of the number of these organisms that would be dead from other causes prior to impingement. If the nonshad fish weigh 20.7 g (0.05 lb) apiece, and each shad weighs an average of 36.3 g (0.08 lb),[16] the average impingement rate would approximate 14,740 kg/yr (32,500 lb/yr). If it is assumed that shad fish and shrimp are lost, regardless of the sluiceway, and half of the remaining organisms survive, then total loss per year should be less than or equal to 10,200 kg (22,500 lb or 11 tons).

Predicted impingement losses at Waterford 3 can be compared with commercial fishing hauls in the Baton Rouge-Gulf reach of the river. In 1975, 1900 kg

(4200 lb) of river shrimp and 680,400 kg (1.5 million lb) of freshwater fish (excluding shad) were caught (ER-OL, p. 5.1-8 and 9). The staff concludes that a loss up to about 14,000 kg (30,000 lb)/yr, mostly fish (including shad and invertebrates), probably will not cause significant damage to the river populations of fishes and river shrimp. Continuous operation of the traveling screens (i.e., continuous rotation and backflushing when fish densities are high) could increase the survival rate of fish and macroinvertebrates.[18,20]

The NPDES permit (in Part III.H) indicates that the intake structure is approved pursuant to Section 316(b) of the Clean Water Act. No impingement monitoring is required as a condition of the NPDES permit.

5.6.1.2 Entrainment Through the Condensers

The staff addressed this issue in the FES-CP and found no likely source of significant impact on the biota. Since then, more information at the Waterford 3 site has been obtained (ER-OL, pp. 5.1-10 to -16; Ref. 17; Secs. 3.4, 4.0, and pp. 5-1 through -4). Phytoplankton communities are not diverse in the site area, and they are low in density. The river food chain is based on detritus rather than on the primary producers (Ref. 16 and observations made during staff site visit on March 20, 1979). The physical and chemical impacts owing to entrainment of the phytoplankton are not expected to have significant effects. About 1 percent of the river flow will be entrained, and the losses that occur will be replaced by the phytoplankton remaining in the river.

The entrainment of zooplankton at Waterford 3 would likewise affect about 1 percent of those organisms in the river's normal flow. These include the rotifers, copepods, cladocerans, insect larvae, river shrimp larvae, ichthyoplankton, including very small juvenile fishes, and other meroplanktonic forms (Sec. 4.3.5). The meroplankton (early transient stages in developing aquatic organisms) are usually present during only part of the year; for example, the river shrimp larvae are present from May to September. Most of these entrained biota will likely be lost during the warmest months when the ambient water temperature is highest (ER-OL, Table 2.4-14, FES-CP, and Ref. 21). These months are July-September when ambient river water is 30.6-32°C (87-90°F). During the remaining months, October-June, smaller fractions of zooplankton will be lost. Zooplankton densities are low in the Waterford area of the Mississippi River all year (Secs. 4.3.5.2).[18] Like the phytoplankton, the zooplankton that remain in the river will compensate for (replace) the zooplankton lost by way of plant entrainment.[16,22]

Most of the fish in the Waterford area spawn in the spring when water levels are high, and smaller fractions (<1 percent) of the river are entrained. Except for the freshwater drum, fish of importance in the area spawn eggs that are demersal, i.e., they fall to the bottom where many adhere. Thus, most of them are not available for entrainment. The staff concludes that entrainment losses of ichthyoplankton and other meroplankton, as well as zooplankton and phytoplankton, will not have significant impacts on the fish and adult macroinvertebrate populations. Entrainment of drum eggs or larvae is not expected to exceed 1 percent of the number in the river during the spawning season.

Since the river is a poor spawning area for drum, relatively low numbers of drum ichthyoplankton will be present for entrainment and the impact of the losses that do occur will be of no significance to populations of drum, or to the organisms that depend on them for food.

The applicant has studied the cumulative effects of entrainment of Waterford 1 and 2, Waterford 3, and Little Gypsy (ER-OL, pp. 5.1-15,5.1 -16). During a typical low-flow condition [5664 m^3 (200,000 cfs)], all four plants combined would withdraw 2.3 percent of the river flow, if each unit operated at full capacity. No significant impact was predicted because of this combined entrainment effect. The staff is in essential agreement (see: Waterford-3 Hearing Record, Docket No. 50-382, p. 101, 4/30/74).

5.6.2 Effects of Thermal Discharge

5.6.2.1 Phytoplankton, Zooplankton, and Macroinvertebrates

The staff addressed the probable biotic impacts of the thermal plume in considerable detail for the FES-CP stage. More recently, and with additional information, the applicant has discussed this in the ER-OL (pp. 5.1-16 through 5.1-21; 301.23-1 through 301.25-3, and 301.29-1), and 316(a) demonstration.[16] The dispersion of the Waterford 3 thermal plume and three other nearby power facility plumes is presented in the ER-OL, Table 5.1-4 and Figs. 5.1-2 through 5.1-11 (see also Sec. 5.3.2, this document). Although summer temperature within the 5.6°C (10°F) excess isotherm will frequently exceed the optimum for the dominant phytoplankton (diatoms), the normal time required for passage through the 5.6°C (10°F) excess temperature waters will only be about an hour. Evidence from the literature shows that this temperature and length of exposure are not sufficient to adversely affect the phytoplankton characteristic of the river in the Waterford area. Furthermore, only a relatively small fraction of the plankton will be exposed to the thermal plume, particularly the warmest part.

In an average summer, the river cross-sectional area with a 5.6°C (10°F) excess isotherm caused by the power station plumes will be approximately 2.2 percent. Blooms of nuisance species of blue-green algae are not expected by the staff because the exposure will be too brief.

Some of the zooplankton, including portions of the ichthyoplankton and other meroplankton populations, will also drift through the thermal plumes of the three power facilities, including the Waterford 3 thermal discharge. These combined thermal plumes are not expected to form a lethal barrier to the zooplankton-meroplankton drift because the thermal plumes rise (ER-OL, Fig. 5A-21; p. 5.1-17) and the plankton will be widely dispersed in three dimensions in the river, as well as in time; only a relatively small fraction will pass through the warmest part of the plume(s).[16] Those that do drift through the 5.6°C (10°F) excess isotherms of the Waterford 1 and 2, Waterford 3, and/or the Gypsy plume, will be exposed for about an hour under normal conditions. There will be some variation in impacts depending upon the species present, time of year, flood or low water periods, and the percentage of full power generation occurring at the various facilities on a given day. However, some aspects of the physical and biological dynamics at Waterford 3 are expected to be relatively constant. These include the absence of rare and endangered aquatic species, low densities of commercially important as well as forage species, lack of good fish-spawning habitat, and the presence of low-quality milieu for growth of primary producers[16] (Sec. 4.2.5; ER-OL, Sec. 2.2.2).

Consequently, no impacts of major consequence to the zooplankton are expected. The adult macroinvertebrates of concern at Waterford 3 are the river shrimp and Asiatic clam, Corbicula. Both species have wide distributions in the river system, and the Waterford 3 habitat is not unique.[13,23] Both species have wide tolerances in spawning habitat. Corbicula has a high tolerance to heat at 34°C (about 93°F maximum), and the river shrimp (Macrobrachium) has an upper temperature tolerance of about 30°C (86°F)/24 hr (ER-OL, p. 5.1-18). These macroinvertebrates live in the substratum and in the drift, more or less ubiquitously distributed. Passage in the drift through the Waterford 1 and 2, and Waterford 3 plumes, and/or that of the Gypsy plume will require about an hour. The staff concludes that no significant damage to the macroinvertebrate populations will be caused by the thermal discharge from Waterford 3.

5.6.2.2 Fish

As stated by the staff in the FES-CP, the organisms occurring in the river near Waterford are warm-water species seasonally adapted to relatively high temperatures, with a high level of thermal tolerance. None of the site area fishes is on the threatened or endangered species list.[24,25] Most of the fish in the applicant's Waterford 3 surveillance samples (1973-1976) were juveniles of blue catfish, gizzard shad, threadfin shad, and freshwater drum. Striped mullet was also frequently found.

Thermal tolerance limits for fish in the site area are presented in the FES-CP (Table V-5), and in the ER-OL, Table A2.2.2-1 (13 pages). Young gizzard shad, for example, can tolerate water warmed to 36.5°C (97.7°F). The maximum summer habitat temperature for striped mullet is 38.5°C (101.3°F). Catfish and freshwater drum also have high thermal tolerances [36°C (96°F)].[16] The thermal plumes predicted by the applicant are shown in the ER-OL, Figures 5.1-2 through 11, and in the 316(a) demonstration, Figures 4-16,[16] and those predicted by the staff are described in Section 5.3.2 of this document.[24] The discharge temperature change during the warmest months will be ΔT 8.9°C (16°F), or 10°C-12°C (18°F-20°F) if the Waterford 1 and 2 effluents raise the intake temperature at Waterford 3 by 1.8°C to 2.2°C (3.2°F to 4.0°F) (see Sec. 5.3.2).

In addition to thermal tolerance, fish behavior is important in an analysis of thermal impacts in the Waterford area (ER-OL, pp. 301.23-1 through 301.25-3). The commercial species are primarily bottom or deep-water fish.[16] The other species will tend to seek preferential areas and avoid the warmest parts of the plume, especially during summer and early fall when ambient river temperatures are the highest.[26-33] Fish that do not avoid the plume will be exposed for rather limited durations (1/2 to 1 hour) unless they actively seek a given preferred temperature in the plume. The possibility of escape is available to any of the fishes. Fish spawning is very limited at the Waterford site (Sec. 4.3.5), and all but one species that spawn have demersal eggs, which fall and usually adhere to the bottom out of range of the power plant plumes. Eggs of the freshwater drum are suspended in the water, consequently some of them will be exposed to the warmed water plume.[16] However, no significant impacts on the drum populations are expected as a result because of the high fecundity of freshwater drum, the low number of eggs and larvae normally found in the Waterford area, and the ubiquity of this species in the lower Mississippi River.[13,14]

Another factor that minimizes the importance of the thermal impact is the relatively short duration of natural ambient river surface temperatures above 30°C (86°F). This amounts to 2.5 percent of the year, and occurs during July and/or August (ER-OL, Fig. 2.4-21). The cross-sectional area of the river affected by the 5.6°C (10°F) excess thermal plume is 2.2 percent, and the depth will be limited to 2.1 m (7 ft). Therefore, there is a very wide zone of passage. During average flow, the zone of passage will be 90 percent of the cross-section in the fall, and about 97 percent during spring. When all three plants are at peak load during extreme low flow conditions, an adequate (83 percent of the river cross-section) zone of passage will still remain (ER-OL, p. 5.1-20).

Cold shock, although possible 20 percent of the year, is not a serious threat at the Waterford site. Shock would be limited to an area of about 0.8 ha (2 acres) mostly downstream from the Waterford discharge (ER-OL, pp. 5.1-19 and 5.1-20).[16,32] Gizzard shad and threadfin shad (both small forage fish) would be most likely affected (ER-OL, pp. 301.23-3; 301.27-1).

5.7 IMPACTS ON CULTURAL RESOURCES

Upon review of the 1980 survey described in Section 4.3.6, the State Historic Preservation Office felt that areas 3, 4, and 5 may contain significant cultural resources (see letter from Robert B. DeBlieux, State Historic Preservation Officer to L. V. Maurin, Louisiana Power and Light Company, November 14, 1980 in Appendix C). The NRC, in consultation with the SHPO, is seeking a determination of eligibility for inclusion in the National Register of Historic Places (see letter from Robert L. Tedesco, Assistant Director for Licensing, Division of Licensing, NRC to L. V. Maurin, Louisiana Power and Light Company, July 10, 1981 and letter from Robert B. DeBlieux, State Historic Preservation Officer to Frank J. Miraglia, Chief, Licensing Branch No. 3, NRC, July 1, 1981 in Appendix C). The applicant is taking appropriate measures to protect the area during this process (ER-OL, page 2.6-2). If these sites are determined eligible and any ground disturbance of these areas become necessary in the future, the applicant will notify the NRC and will consult with the SHPO to develop an appropriate mitigation plan. At this time the staff believes the possibility of operational disturbances is remote.

5.8 SOCIOECONOMIC IMPACTS

5.8.1 Social Impacts

The total operational work force at the Waterford 3 Station will be about 267 people; more than 110 are already at the plant (Ref. 34 and applicant's comments on DES). Therefore, the demands from the Waterford 3 operating force on housing, land use, industry, recreation, social services (including schools, water, sewage, police protection) should be only negligible. A recent study of public services indicated hospital facilities and medical staff in the area were already close to operating capacity and that firefighting staff and equipment were marginally sufficient.[35] Under these circumstances the staff concludes that in-moving households could have a minimal adverse impact on the delivery of medical and fire fighting services.

5.8.2 Economic Impacts

5.8.2.1 Employment and Income

Because the Waterford region is undergoing economic change as a result of extensive industrial development, the staff cannot identify major adverse impacts resulting from increased employment and income as a result of Waterford 3. The applicant indicates that 5.5 million will be spent annually as payroll for the 267 members of the operations staff, which could induce $206 million in 1983 dollars in the regional economy over a 40-year period (ER-OL, Section 8.1.2.1) Also there will be about $1.9 million generated in the region's nonbasic employment sectors, resulting in about $7.4 million in total annual income effect.

5.8.2.2 Taxes

LP&L expects to pay $2186 million in taxes (in 1983 dollars) during the life of the plant excluding real estate taxes (ER-OL, Section 8.1.2.2). About 10% of this amount is paid to the State government and the rest is paid as Federal taxes.

LP&L has paid no local property taxes during construction. Also Louisiana's 10-year tax-exemption law provides that any manufacturing establishment expanding its Louisiana facilities is eligible to receive exemption on buildings and equipment from State, parish (county), and local property taxes for a period of 10 years.[36]

The Louisiana Board of Commerce and Industry, under Contract No. 4990, has granted LP&L exemption for its first 5 years of operation[37] and LP&L expects to receive an exemption for the second 5-year period as well (ER-OL). If the plant is assumed to have a 30-year operational period only 20 years of its operation will be taxed by the local parish. Because of uncertainties about future taxation policies of local jurisdictions (and final assessed value of the Waterford 3 plant) neither the applicant (ER-OL) nor the staff can provide an estimate of the local property taxes which will be paid by LP&L in the final 20 years of operation.

5.8.3 Emergency Planning Impacts

The applicant is currently finalizing the Emergency Plan for Waterford 3 in accordance with 10 CFR Part 50, as amended July 23, 1980, as well as the recommended criteria contained in NUREG-0654, "Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants." The staff believes the only noteworthy potential source of impact on the public from emergency planning would be associated with the siren alert system. The system will be designed to provide a minimum 10db dissonant differential from the ambient noise levels. The maximum sound level received by any member of the public should be lower than 123 db. A complete cycle test will be required annually. The test requirements and alarm noise levels are consistant with those used for existing alert systems; therefore, the staff concludes that the noise impacts associated with the siren alert system will be infrequent and insignificant.

The emergency operations facility will be located in an existing LP&L office building, and therefore its construction will not involve any environmental impacts.

5.9 RADIOLOGICAL IMPACTS

(1) Regulatory Requirements

Nuclear power reactors in the United States must comply with certain regulatory requirements in order to operate. The permissible levels of radiation in unrestricted areas and the radioactivity in effluents to unrestricted areas are spelled out in 10 CFR Part 20, Standards for Protection Against Radiation.[38] These regulations specify limits on levels of radiation and limits on concentrations of radionuclides in the station's effluent releases to the air and water (above natural background), under which the reactor must operate. These regulations state that no member of the general public in unrestricted areas shall receive a radiation dose, due to Station operation, of more than 0.5 rems/yr (or 2 mrems/hr or 100 mrems/7 days) to the total body. These radiation dose limits are established to be consistent with considerations of the health and safety of the public.

In addition to the Radiation Protection Standards of 10 CFR Part 20, there are spelled out in 10 CFR Part 50.36a[39] license requirements that are to be imposed on licensees in the form of Technical Specifications on Effluents from Nuclear Power Reactors to keep releases of radioactive materials to unrestricted areas during normal operations, including expected operational occurrences, as low as is reasonably achievable (ALARA). Appendix I of 10 CFR Part 50 provides numerical guidance on design objectives and limiting conditions for operation of LWRs to meet this ALARA requirement. Applicants for permits to construct and licenses to operate an LWR shall provide reasonable assurance that the following dose design objectives will be met: 3 mrems/yr to the total body or 10 mrems/yr to any organ from liquid effluents; 10 mrads/yr gamma radiation or 20 mrads/yr beta radiation from gaseous effluents--and/or 5 mrems/yr to the total body or 15 mrems/yr to the skin from gaseous effluents; and 15 mrems/yr to any organ from the airborne effluents that include the radioiodines, carbon-14, tritium, and the particulates.

Experience with the design, construction and operation of nuclear power reactors indicates that compliance with such design objectives will keep average annual releases of radioactive material in effluents at small percentages of the limits specified in 10 CFR Part 20, and in fact, generally below the design objective values of Appendix I. At the same time, the licensee is permitted the flexibility of operation, compatible with considerations of health and safety, to assure that the public is provided a dependable source of power even under unusual operating conditions which may temporarily result in releases higher than such small percentages, but still well within the limits specified in 10 CFR Part 20.

In addition to the impact created by station radioactive effluents as discussed above, within the NRC policy and procedures for environmental protection spelled out in 10 CFR Part 51 there are generic treatments of environmental effects of all aspects of the Uranium Fuel Cycle. These environmental data have been summarized in Table S-3 (Table 5.13) and are discussed later in this report in Section 5.9.3 In the same manner the environmental impact of transportation of fuel and waste to and from an LWR is summarized in Table S-4 (Table 5.6) of Section 5.9.1.

Recently an additional operational requirement for Uranium Fuel Cycle Facilities including nuclear power plants has been established by the EPA in 40 CFR Part 190.[40] This regulation limits annual doses (excluding radon and daughters) for members of the public to 25 mrems total body, 75 mrems thyroid, and 25 mrems other organs from all fuel cycle facility contributions that may impact a specific individual in the public.

(2) Operational Overview

During normal operation of Waterford 3, small quantities of fission products and induced radioactivities will be released to the environment. As required by NEPA, the staff has determined the dose estimated to members of the public outside of the plant boundaries due to the radiation from these radioisotope releases and relative to natural background radiation dose levels.

These station-generated environmental dose levels are estimated to be very small due to plant design and the development of a conscious program which will be implemented at the station to contain and control all radioactive emissions and effluents. As mentioned above, highly efficient radioactive-waste management systems are incorporated into the plant design and are specified in detail in the Technical Specifications for the station. The effectiveness of these systems will be measured by process and effluent radiological monitoring systems that permanently record the amounts of radioactive constitutents remaining in the various airborne and waterborne process and effluent streams. The amounts of radioactivity released through vents and discharge points to be further dispersed and diluted to points outside the plant boundaries are to be recorded and published semiannually in the Radioactive Effluent Release Reports of each facility.

The small amounts of airborne effluents that are released will diffuse in the atmosphere in a fashion determined by the prevalent meteorological conditions and are thus much dispersed and diluted by the time they reach unrestricted areas that are open to the public. Similarly, the small amounts of waterborne effluents released will be diluted with plant waste water and then further diluted as they are discharged into the Mississippi River beyond the plant boundaries.

Any radioisotopes in the station's effluents that finally enter unrestricted areas will produce dose effects through their radiations on members of the general public similar to the dose effects from background radiations (i.e., cosmic/terrestrial and internal radiations), which also include radiation from nuclear weapons fallout. These radiation dose effects can be calculated for the many potential radiological exposure pathways specific to the environment around the station, such as direct radiation doses from the airborne or waterborne effluent streams outside of the plant boundaries, or internal radiation dose commitments from radioactive contaminants that might have been deposited on vegetation, or in meat and fish products eaten by people, or that might be present in drinking water outside the plant, or incorporated into milk from cows at nearby farms.

These doses, calculated for the "maximally exposed" individual (i.e., the hypothetical individual potentially subject to maximum exposure), form the basis of the NRC staff's evaluation of impacts. These estimates are for a fictitious or "maximally exposed" person, since assumptions are made that tend to overestimate the dose that would actually accrue to members of the public outside the plant boundaries. For example, if this "maximally exposed" individual were to receive the dose calculated at the plant boundary, he/she is assumed to be physically at that boundary for 100% of the year, and outside (unshielded from gamma radiation) 50% of the year, an unlikely occurrence.

Site specific values for the various parameters involved in each dose pathway are used in the calculations. These include calculated or observed values for the amounts of radioisotopes released in the gaseous and liquid effluents, meteorological information (e.g., wind speed and direction) specific to the site topography and effluent release points, and hydrological information relative to dilution and "flushing" of the liquid effluents as they are discharged.

A periodic land census, to be required by the Radiological Technical Specifications of the operating license, will require that as use of the land surrounding the site boundary changes, revised calculations be made to ensure that this dose estimate for gaseous effluents always represents the highest dose for any individual member of the public for each applicable foodchain pathway. The estimate considers, for example, where people live, where vegetable gardens are located, where cows are pastured, etc.

For Waterford 3, in addition to the direct effluent monitoring, measurements will be made on a number of types of samples from the surrounding area to determine the possible presence of radioactive contaminants which, for example, might be deposited on vegetation, or be present in drinking water outside the plant, or incorporated into cow's milk from nearby farms.

5.9.1 Radiological Impacts from Routine Operations

5.9.1.1 Radiation Exposure Pathways: Dose Commitments

There are many environmental pathways through which persons may be exposed to radiation originating in a nuclear power reactor. All of the potentially meaningful exposure pathways are shown schematically in Figure 5.7. When an individual is exposed via one of these pathways, his dose is determined in part by the amount of time he is in the vicinity of the source, or the amount of time the radioactivity is retained in his body. The actual effect of the radiation or radioactivity is determined by calculating the dose commitment. This dose commitment represents the total dose that would be received over a 50-yr period, following the intake of radioactivity for 1 yr under the conditions existing 15 yrs after the station begins operation (i.e., the mid-point of station operation).

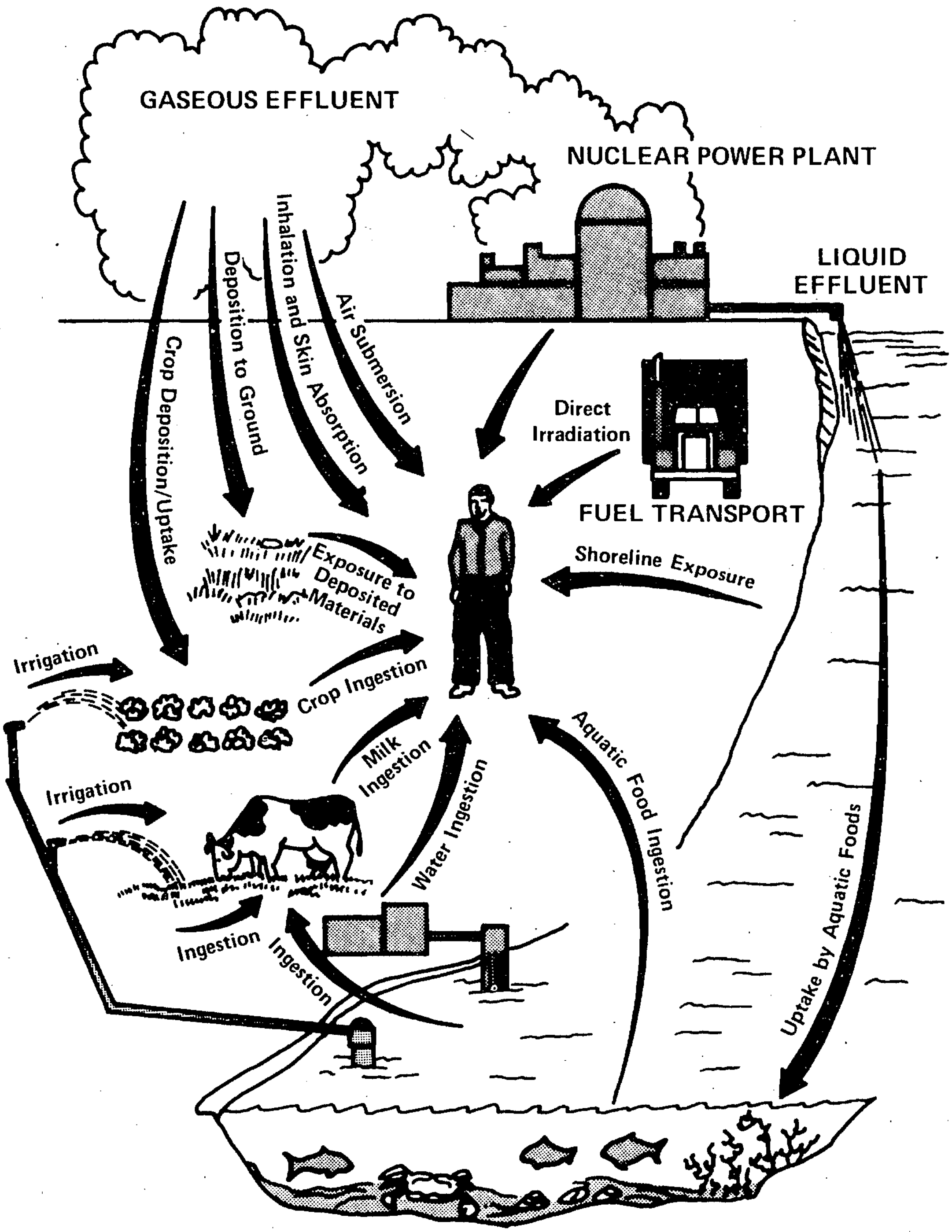

Figure 5.7 Potentially Meaningful Exposure Pathways to Humans

There are a number of possible exposure pathways to man that can be studied to determine whether the routine releases at the Waterford site are likely to have any significant impact on members of the general public living and working outside of the site boundaries, and whether the releases will in fact meet regulatory requirements. A detailed listing of these possibilities would include external radiation exposure from the gaseous effluents, inhalation of iodines and particulate contaminants in the air, drinking milk from a cow or eating meat from an animal that feeds on open pasture near the site on which iodines or particulates may have deposited, eating vegetables from a garden near the site that may be contaminated by similar deposits, drinking water and eating fish caught near the point of discharge of liquid effluents.

Other less significant pathways include: external irradiation from radionuclides deposited on the ground surface, eating animals and food crops raised near the site using irrigation water that may contain liquid effluents, shoreline activities near lakes or streams that may be contaminated by effluents, and direct radiation from within the plant itself.

Calculations of the effects for most pathways are limited to a radius of 80 km (50 miles). This limitation is based on several facts. Experience has shown that all significant dose commitments (>0.1 mrems/yr) for radioactive effluents are accounted for within a radius of 80 km from the plant. Beyond 80 km the doses are smaller than 0.1 mrems/yr, which is far below natural background doses, and the doses are subject to substantial uncertainty because of limitations of predictive mathematical models.

The NRC staff has made a detailed study of all of the above significant pathways and has evaluated the radiation dose commitments both to the plant workers and the general public for these pathways resulting from routine operation of the Station. A discussion of these evaluations follows.

5.9.1.1.1 Occupational Radiation Exposure

The dose to nuclear plant workers varies from reactor to reactor and can be projected for environmental-impact purposes by using the experience to date with modern PWRs. Most of the dose to nuclear plant workers is due to external exposure to radiation from radioactive materials outside the body rather than from internal exposure from inhaled or ingested radioactive materials. Recently licensed 1000-MWe PWRs are designed and operated in a manner consistent with new (post-1975) regulatory requirements and guidelines. These new requirements and guidelines place increased emphasis on maintaining occupational exposure at nuclear power plants as low as is reasonably achievable (ALARA), and are outlined in 10 CFR Part 20,[38] Standard Review Plan Chapter 12,[41] and Regulatory Guide 8.8.[42] The applicant's proposed implementation of these requirements and guidelines is reviewed by the staff at the construction-permit stage, the operating-license stage, and during actual operation. Approval is granted only after the review indicates that an ALARA program can actually be implemented.

Based on actual operating experience, it has been observed that occupational dose has varied considerably from plant to plant and from year to year. Average collective occupational dose information from 239 PWR reactor-years of operation is available for those plants operating between 1974 and 1980. (The year 1974 was chosen as a starting date for these data because the total average rated capacity for reactors for years prior to 1974 was below 500 MWe.) These data indicate that the average reactor annual dose at PWRs has been about 440 person-rems, with particular plants experiencing an average lifetime annual dose to date as high as 1300 person-rems.[43] These dose averages are based on widely varying yearly doses at PWRs. For example, annual collective doses for PWRs have ranged from 18 to 5262 person-rems per reactor, and the average annual dose per nuclear-plant worker has been about 0.8 rem.[44]

The wide range of annual doses (18 to 5262 person-rems) experienced at PWRs in the U.S. is dependent on a number of factors such as the amount of required routine and special maintenance, and the degree of reactor operations and inplant surveillance. Because these factors can vary in an unpredictable manner, it is impossible to determine in advance a specific year-to-year or average annual occupational radiation dose for a particular plant over its operating lifetime. The need to accept high doses can occur, even at plants with radiation-protection programs that have been developed to assure that occupational radiation doses will be kept at levels that are ALARA. Consequently, the staff occupational-dose estimates for environmental-impact purposes for Waterford 3 are based on the conservative assumption that the station may have a higher-than-average level of special maintenance work. Based on the staff's review of the applicant's Final Safety Analysis Report as well as occupational-dose data from 239 PWR reactor-years of operation, we project that the occupational doses at Waterford 3 could average as much as 1300 person-rems/yr when averaged over the life of the station. However, actual year-to-year doses may differ greatly from this average, depending on actual operating conditions.

The risks of various occupations, including nuclear plant workers, are given in Table 5.5. Based on the comparisons in this table, the staff concludes that the risk to nuclear plant workers from plant operation is comparable to the risks associated with other occupations.

5.9.1.1.2 Public Radiation Exposure

(1) Transportation of Radioactive Materials

The transportation of "cold" (unirradiated) nuclear fuel to the reactor, of spent irradiated fuel from the reactor to a fuel reprocessing plant, and of solid radioactive wastes from the reactor to waste burial grounds is considered in 10 CFR Section 51.20.[76] The contribution of the environmental effects of such transportation to the environmental costs of licensing the nuclear power reactor is set forth in Summary Table S-4 from 10 CFR Section 51.20, reproduced herein as Table 5.6. The cumulative dose to the exposed population as summarized in Table S-4 is very small when compared to the annual dose of 26,000,000 person-rems to this same population from background radiation.

(2) Direct Radiation

Radiation fields are produced around nuclear plants as a result of radioactivity within the reactor and its associated components, as well as a result of small radioactive effluent releases. Direct radiation from sources within the plant are due primarily to nitrogen-16, a radionuclide produced in the reactor core.

Table 5.5 Incidence of Job-Related Fatalities

Occupational Group	Fatality Incidence Rates (premature deaths per 10^5 person-years)
Underground metal miners[a]	1275
Uranium miners[a]	422
Smelter workers[a]	194
Mining[b]	61
Agriculture, forestry, and fisheries[b]	35
Contract construction[b]	33
Transportation and public utilities	24
Nuclear-plant worker[c]	23
Manufacturing	7
Wholesale and retail trade[b]	6
Finance, insurance, and real estate[b]	3
Services[b]	3
Total private sector[b]	10

[a]The President's Report on Occupational Safety and Health, "Report on Occupational Safety and Health by the U.S. Department of Health, Education, and Welfare," E. L. Richardson, Secretary, May 1972 (Reference 52).

[b]U.S. Bureau of Labor Statistics, "Occupational Injuries and Illness in the United States by Industry, 1975," Bulletin 1981, 1978 (Reference 53).

[c]The fatality incident rate for nuclear-plant workers is based on an annual exposure of 0.8 rem to the average worker, and the nonradiation-related fatalities for seven large U.S. electrical utilities over the period 1970-1979.[42] About half of the estimated fatality incidence rate for nuclear-plant workers is potential, rather than actual, premature deaths that might be caused by radiation exposure.

Table 5.6 Environmental Impact of Transportation of Fuel and Waste To and From One Light-Water-Cooled Nuclear Power Reactor[1]

NORMAL CONDITIONS OF TRANSPORT

	Environmental impact
Heat (perirradiated fuel cask in transit)	250,000 Btu/hr.
Weight (governed by Federal or State restrictions)	73,000 lbs per truck; 100 tons per cask per rail car.
Traffic density:	
Truck	Less than 1 per day.
Rail	Less than 3 per month.

Exposed population	Estimated number of persons exposed	Range of doses to exposed individuals[2] (per reactor year)	Cumulative dose to exposed population (per reactor year)[3]
Transportation workers	200	0.01 to 300 millirem	4 person-rem
General public:			
Onlookers	1,100	0.003 to 1.3 millirem	3 person-rem
Along Route	600,000	0.0001 to 0.06 millirem.	

ACCIDENTS IN TRANSPORT

	Environmental risk
Radiological effects	Small[4]
Common (nonradiological causes)	1 fatal injury in 100 reactor years; 1 nonfatal injury in 10 reactor years; $475 property damage per reactor year.

[1]Data supporting this table are given in the Commission's "Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants," WASH-1238, December 1972, and Supp. 1, NUREG-75/038, April 1975. Both documents are available for inspection and copying at the Commission's Public Document Room, 1717 H Street, NW., Washington, D.C., and may be obtained from National Technical Information Service, Springfield, VA 22161. WASH-1238 is available from NTIS at a cost of $5.45 (microfiche, $2.25) and NUREG-75/038 is available at a cost of $3.25 (microfiche, $2.25).

[2]The Federal Radiation Council has recommended that the radiation doses from all sources of radiation other than natural background and medical exposures should be limited to 5,000 millirem per year for individuals as a result of occupational exposure and should be limited to 500 millirem per year for individuals in the general population. The dose to individuals due to average natural background radiation is about 130 millirem per year.

[3]Person-rem is an expression for the summation of whole body doses to individuals in a group. Thus, if each member of a population group of 1,000 people were to receive a dose of 0.001 rem (1 millirem), or if 2 people were to receive a dose of 0.5 rem (500 millirem) each, the total person-rem dose in each case would be 1 person-rem.

[4]Although the environmental risk of radiological effects stemming from transportation accidents is currently incapable of being numerically quantified, the risk remains small regardless of whether it is being applied to a single reactor or a multireactor site.

Because the primary coolant of a PWR is contained in a heavily shielded area, dose rates in the vicinity of PWRs are generally undetectable (less than 5 mrems/yr).

Low-level radioactivity storage containers outside the plant are estimated to make a dose contribution at the site boundary of less than 0.1% of that due to the direct radiation described above.

(3) Radioactive Effluent Releases: Air and Water

As pointed out in section 4.2.3, all effluents from the station will be subject to extensive decontamination, but small controlled quantities of radioactive effluents will be released to the atmosphere and to the hydrosphere during normal operations. Estimates of site-specific radioisotope release values have been developed on the basis of the description of operational and radwaste systems in the applicant's ER and FSAR and by using the calculational model and parameters developed in NUREG-0017.[45] This has been supplemented by extensive use of the applicant's site and environmental data in the ER and in subsequent answers to NRC staff questions, to obtain a complete picture of airborne and waterborne releases from the station.

These small amounts of effluents are then highly diluted by the air and water into which they are released before they reach areas in which they interact with activities of the general public.

Radioactive effluents can be divided into several groups. Among the airborne effluents the radioisotopes of the noble gases--krypton, xenon, and argon--do not deposit on the ground or interact with living organisms; therefore, the noble gas effluents act primarily as a source of direct external radiation emanating from the effluent plume. Dose calculations are performed for the site boundary where the highest external radiation doses to a member of the public as a result of gaseous effluents have been estimated to occur; these include the annual beta and gamma air doses as well as the total body and skin doses from the plume at that boundary location.

Another group of airborne radioactive effluents--the radioiodines, carbon-14, and tritium--are also gaseous but tend to be deposited on the ground and/or absorbed into the body during inhalation. For this class of effluents, estimates of direct external radiation doses from deposits on the ground, and of internal radiation doses to total body, thyroid, bone, and other organs from inhalation, from vegetable consumption, from milk consumption, and from meat consumption are made. Concentrations of iodine in the thyroid and of carbon-14 in bone are of particular significance here.

A third group of airborne effluents, consisting of particulates that remain after filtration of the effluents, could include fission products such as cesium and barium and corrosion products such as cobalt and chromium. The calculational model determines the direct external radiation dose and the internal radiation doses for these contaminants through the same pathways as described above for the radioiodines, carbon-14, and tritium. Doses from the particulates are combined with those of the radioiodines, carbon-14, and tritium for comparison to one of the design objectives of Appendix I to 10 CFR Part 50.

The waterborne radioactive effluent constituents could include fission products such as strontium and iodine; corrosion and activation products, such as sodium and manganese; and tritium as tritiated water. Calculations estimate the internal doses (if any) from fish consumption, from water ingestion (as drinking water), and from eating of meat or vegetables raised near the site on irrigation water, as well as any direct external radiation from recreational use of the water past the point of discharge.

The release values for each group of effluents along with site-specific meteorological and hydrological data, serve as input to computerized radiation-dose models that estimate the maximum radiation dose that would be received outside the facility via a number of pathways for individual members of the public and for the general public as a whole. These models and the radiation dose calculations are discussed in Regulatory Guide 1.109[46] and in Appendix H of this statement.

Examples of site-specific dose assessment calculations and discussions of parameters involved are given in Appendix J. Doses from all airborne effluents except the noble gases are calculated for the location (e.g., site boundary, garden, residence, milk cow, meat animal) where the highest radiation dose to a member of the public from all applicable pathways has been established. Only those pathways associated with airborne effluents that are known to exist at a single location, are combined to calculate the total maximum exposure to an exposed individual. Pathways associated with liquid effluents are combined without regard to location, but they are assumed to be associated with maximum exposure to an individual other than through gaseous-effluent pathways.

5.9.1.2 Radiological Impact on Humans

Although the doses calculated in Appendix J are based on radioactive-waste treatment system capability, the actual radiological impact associated with the operation of the station will depend, in part, on the manner in which the radioactive waste treatment system is operated. Based on its evaluation of the potential performance of the ventilation and radwaste treatment systems, the NRC staff has concluded that the systems as now proposed are capable of controlling effluent releases to meet the dose design objectives of Appendix I to 10 CFR Part 50.[39]

The Station's operation will be governed by operating license Technical Specifications which will be based on the dose <u>design objectives</u> of Appendix I to 10 CFR Part 50.[39] Since these design objective values were chosen to permit flexibility of operation while still ensuring that plant operations are ALARA, the actual radiological impact of plant operation may result in doses close to the dose design objectives. Even if this situation exists, the individual doses for the member of the public subject to maximum exposure will still be very small when compared to natural background doses (~100 mrems/yr) or the dose limits specified in 10 CFR Part 20 (500 mrems/yr - whole body). As a result, the staff concluded that there will be no measurable radiological impact on members of the public from routine operation of the station.

Operating standards of 40 CFR Part 190, the Environmental Protection Agency's Environmental Radiation Protection Standards for Nuclear Power Operations,[40] specify that the annual dose equivalent must not exceed 25 mrems to the whole body, 75 mrems to the thyroid, and 25 mrems to any other organ of any member of the public as the result of exposures to planned discharges of radioactive materials (radon and its daughters excepted) to the general environment from all uranium-fuel-cycle operations and radiation from these operations that can be expected to affect a given individual. The NRC staff concludes that under normal operations Waterford 3 is capable of operating within these standards.

The radiological effects of a nuclear power plant are well known and documented. Accurate measurements of radiation and radioactive contaminants can be made with very high sensitivity so that much smaller amounts of radioisotopes can be recorded than can be associated with any possible known ill effects. Furthermore, the effects of radiation on living systems have for decades been subject to intensive investigation and consideration by individual scientists as well as by select committees, occasionally constituted to objectively and independently assess radiation dose effects. Although, as in the case of chemical contaminants, there is debate about the exact extent of the effects of very low levels of radiation, the limits of deleterious effects are well established and amenable to standard methods of risk analysis. Thus the risks to the maximally exposed member of the public outside of the site boundaries can be readily quantified. Further, the impacts on, and risks to, the total population outside of the boundaries can also be readily calculated and recorded.

5.9.1.3 Radiological Impacts on Biota Other Than Humans

Depending on the pathway and radiation source, terrestrial and aquatic biota will receive doses that are approximately the same or somewhat higher than humans receive. Although guidelines have not been established for acceptable limits for radiation exposure to species other than human, it is generally agreed that the limits established for humans are conservative for other species. Experience has shown that it is the maintenance of population stability that is crucial to the survival of a species, and species in most ecosystems suffer rather high mortality rates from natural causes.

While the existence of extremely radiosensitive biota is possible, and while increased radiosensitivity in organisms may result from environmental interactions with other stresses (for example, heat or biocides), no biota have yet been discovered that show a sensitivity (in terms of increased morbidity or mortality) to radiation exposures as low as those expected in the area surrounding the station. Furthermore, at all nuclear plants for which radiation exposure to biota other than humans has been analyzed,[47] there have been no cases of exposure that can be considered significant in terms of harm to the species, or that approach the limits for exposure to members of the public that are permitted by 10 CFR Part 20.[38] The 1972 BEIR Report[48] concluded that the evidence to date indicates that no other living organisms are very much more radiosensitive than humans; therefore, no measurable radiological impact on populations of biota is expected as a result of the routine operation of this station.

5.9.1.4 Radiological Monitoring

Radiological environmental monitoring programs are established to provide data on measurable levels of radiation and radioactive materials in the site environs. Such monitoring programs are conducted to verify the effectiveness of in-plant systems used to control the release of radioactive materials and to ensure that unanticipated buildups of radioactivity will not occur in the environment. Secondarily, the monitoring programs could identify the highly unlikely existence of previously undetected releases of radioactivity. A surveillance (Land Census) program is established to identify changes in the use of unrestricted areas to provide a basis for modifications of the monitoring programs.

These programs are discussed in greater detail in NRC Regulatory Guide 4.1, Rev. 1, "Programs for Monitoring Radioactivity in the Environs of Nuclear Power Plants,"[49] and the Radiological Assessment Branch Technical Position, Rev. 1, November 1979, "An Acceptable Radiological Environmental Monitoring Program."[50]

5.9.1.4.1 Preoperational

The preoperational phase of the monitoring program should provide for the measurement of background levels of radioactivity and radiation and their variations along the anticipated important pathways in the areas surrounding the station, the training of personnel and the evaluation of procedures, equipment and techniques. The applicant proposed a radiological environmental-monitoring program to meet these objectives in the ER-CP and it was discussed in the FES-CP. This early program has been updated and expanded; it is presented in Section 6.1.5 of the applicant's ER-OL and is summarized here in Table 5.7.

The applicant states that the preoperational program has been implemented, at least two years prior to initial criticality of Waterford 3, to document background levels of direct radiation and concentrations of radionuclides that exist in the environment. The preoperational program will continue up to the initial criticality of Waterford 3 at which time the operational radiological monitoring program will commence.

The staff has reviewed the preoperational environmental monitoring plan of the applicant and finds that it is acceptable as presented.

5.9.1.4.2 Operational

The operational, offsite radiological-monitoring program is conducted to measure radiation levels and radioactivity in plant environs. It assists and provides backup support to the effluent-monitoring program as recommended in NRC Regulatory Guide 1.21, "Measuring, Evaluating and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid and Gaseous Effluents from Light-Water Cooled Nuclear Power Plants."[51]

The applicant states that the operational program will in essence be a continuation of the preoperational program described above with some adjustment of sampling frequencies in expected critical exposure pathways, such as increasing milk sampling frequency and deletion of fruit, vegetable, soil, and gamma radiation survey samples. The proposed operational program will be reviewed prior to plant operation. Modification will be based upon anomalies and/or exposure pathway variations observed during the preoperational program.

Table 5.7 Radiological Environmental Monitoring Program for Waterford

Exposure pathway and/or sample type	Number of samples[a] and locations	Sampling and collection frequency	Type of frequency of analysis
AIRBORNE			
Radioiodine and particulates	3 offsite locations (in different sectors) of the highest calculated annual average ground level D/Q (A8-N, A16-S, A17-NW)[b] 1 sample from the vicinity of Killona, a community having the highest calculated annual average ground level D/Q. 1 sample from the vicinity of Norco (A13) and 1 sample from LaPlace (A14) • 1 sample from Desallemond (A12, SSE) • 1 sample from Luling (A11-E), a control location 10-20 miles distant and in a least prevalent wind direction[e]	Continuous sampler operation with sample collection weekly or as required by dust loading, whichever is more frequent	Radioiodine cartridge: Analyze weekly for I-131 Particulate sampler: Gross beta radioactivity following filter change, composite (by location) for gamma isotopic quarterly
DIRECT RADIATION			
TLD	• 4 stations at ~500 ft in W, WNW, S, and NW sectors. • 8 stations 1 mile from plant in SSE, S, SSW, WSW, W, NW, N, and NE sectors • Norco (W) • LaPlace • Luling (E) • Desallemond (SSE) • 4 stations located in special interest areas.	Quarterly, semi-annually	Gamma dose quarterly
WATERBORNE			
Surface[a]	• 1 upstream sample (~2 miles)[g] • 1 downstream sample (~1000 meters) • 1 sample from intake structure	Composite sample over 1 month period[h]	Gamma isotopic analysis monthly. Composite for tritium analysis quarterly
Ground	• Riverside of plant (G1) • Lakeside of plant (G2)	Quarterly	Gamma isotopic and tritium analysis quarterly
Drinking	• 1 sample from Union Carbide (W7) • 1 sample from St. Charles Parish (W8)	Monthly composite taken at each municipal facility	Gross beta and gamma isotopic isotopic analysis monthly. Composition for tritium analysis quarterly
Rooted aquatic plants & shoreline sediments	• 1 sample 1000 meters downstream • 1 sample 2 miles upstream	Semiannual	Gamma isotopic analysis semiannually
Bottom sediments	• 1 sample 1000 meters downstream • 1 sample 2 miles upstream	Semiannual	Gamma isotopic analysis semiannually

Table 5.7 Continued

Exposure pathway and/or sample type	Number of samples[a] and locations	Sampling and collection frequency	Type of frequency of analysis
INGESTION			
Fish and invertebrates	• 1 sample 1000 meters downstream • 1 sample 2 mi upstream	Semiannual	Gamma isotopic analysis of edible portions
Fruits and vegetables	Samples from following locations • 1 mile NW (A15) • 1 mile NE (A19) • 1 mile N (A20) • 1.7 mile N (A20) • 1.3 mile W(A21) • Luling • Desallemond	At time of harvest[k]	Gamma isotopic analysis of edible portions
Milk	Samples from following locations: • 1 mile NW (A15) • 1.7 mile N (A20) • 1.3 mile W (A21) • Luling • Desallemond	Semimonthly when animals are on pasture, monthly at other times	Gamma isotopic and I-131 analyses semimonthly when animals are on pasture, monthly otherwise
Meat animals	Samples from following locations: • 1 mile NE (A19) • Luling • Desallemond	Semiannually for wildlife.	Gamma isotopic analysis on edible sections semiannually

[a]The number, media, frequency, and location of samples may vary. It is recognized that, at times, it may not be possible or practical to obtain samples of the media of choice at the most desired location or time. In these instances suitable alternative media and locations may be chosen for the particular pathway in question and submitted for acceptance.

[b]The parenthetical symbols correspond to the location identification specified in Figures 6.1.5-2 and 6.1.5-3 of the applicant's Environmental Report.

[c]Particulate sample filters are analyzed for gross beta radioactivity 24 hours or more after sampling to allow for radon and thoron daughter decay. If gross beta activity in air or water is greater than ten times the yearly mean of control samples for any medium, gamma isotopic analysis will be performed on the individual samples.

[d]Gamma isotopic analysis means the identification and quantification of gamma-emitting radionuclides that may be attributable to the effluents from the facility.

[e]The purpose of this sample is to obtain background information.

[f]Regulatory Guide 4.13 provides minimum acceptable performance criteria for TLD systems used for environmental monitoring. One or more instruments, such as a pressurized ion chamber, for measuring and recording dose rate continuously, may be used in place of, or in addition to, integrating dosimeters. For the purpose of this table, a thermoluminescent dosimeter may be considered to be one phosphorus and two or more phosors in a packet may be considered as two or more dosimters. The 40 stations are not an absolute number.

[g]The "upstream sample" will be taken at a distance beyond significant influence of the discharge. The "downstream" sample will be taken in an area beyond but near the mixing zone.

[h]Composite samples will be collected with equipment (or equivalent) which is capable of collecting an aliquot at time intervals which are very short (e.g., hourly) relative to the compositing period (e.g., monthly).

[i]Groundwater samples will be taken when this source is tapped for drinking or irrigation purposes in areas where the hydraulic gradient or recharge properties are suitable for contamination.

[j]The dose will be calculated for the maximum organ and age group, using the methodology contained in Regulatory Guide 1.109, and the actual parameters particular to the site.

[k]If harvest occurs more than once a year, sampling will be performed during each discrete harvest. If harvest occurs continuously, sampling will be monthly. Attention will be paid to including samples of tuborous and root food products.

The final operational-monitoring program proposed by the applicant will be reviewed in detail by the NRC staff, and the specifics of the required monitoring program will be incorporated into the Operating License Radiological Technical Specifications.

5.9.2 ENVIRONMENTAL IMPACT OF POSTULATED ACCIDENTS

5.9.2.1 Plant Accidents

The staff has considered the potential radiological impacts on the environment of possible accidents at the Waterford Steam Electric Station Unit 3 in accordance with a Statement of Interim Policy published by the Nuclear Regulatory Commission on June 13, 1980.[54] The following discussion reflects these considerations and conclusions.

Section 5.9.2.2 deals with general characteristics of nuclear power plant accidents including a brief summary of safety measures to minimize the probability of their occurrence and to mitigate their consequences if they should occur. Also described are the important properties of radioactive materials and the pathways by which they could be transported to become environmental hazards. Potential adverse health effects and impacts on society associated with actions to avoid such health effects are also identified.

Next, actual experience with nuclear power plant accidents and their observed health effects and other societal impacts are described. This is followed by a summary review of safety features of the Waterford Unit 3 facility and of the site that act to mitigate the consequences of accidents.

The results of calculations of the potential consequences of accidents that have been postulated in the design basis are then given. Also described are the results of calculations for the Waterford Unit 3 site using probabilistic methods to estimate the possible impacts and the risks associated with severe accident sequences of exceedingly low probability of occurrence.

5.9.2.2 General Characteristics of Accidents

The term "accident," as used in this section, refers to any unintentional event not addressed in Section 5.9.1 that results in a release of radioactive materials into the environment. The predominant focus, therefore, is on events that can lead to releases substantially in excess of permissible limits for normal operation. Such limits are specified in the Commission's regulations at 10 CFR Part 20, and 10 CFR Part 50, Appendix I.

There are several features that combine to reduce the risk associated with accidents at nuclear power plants. Safety features in the design, construction, and operation comprising the first line of defense are to a very large extent devoted to the prevention of the release of these radioactive materials from their normal places of confinement within the plant. There are also a number of additional lines of defenses that are designed to mitigate the consequences of failures in the first line. Descriptions of these features for the Waterford Unit 3 plant may be found in the applicant's Final Safety Analysis Report,[55] and in the staff's Safety Evaluation Report.[56] The most important mitigative features are described in Section 5.9.2.4(1) below.

These safety features are designed taking into consideration the specific locations of radioactive materials within the plant, their amounts, their nuclear, physical, and chemical properties, and their relative tendency to be transported into and for creating biological hazards in the environment.

(1) Fission Product Characteristics

By far the largest inventory of radioactive material in a nuclear power plant is produced as a byproduct of the fission process and is located in the uranium oxide fuel pellets in the reactor core in the form of fission products. During periodic refueling shutdowns, the assemblies containing these fuel pellets are transferred to a spent-fuel storage pool so that the second largest inventory of radioactive material is located in this storage area. Much smaller inventories of radioactive materials are also normally present in the water that circulates in the reactor coolant system and in the systems used to process gaseous and liquid radioactive wastes in the plant.

These radioactive materials exist in a variety of physical and chemical forms. Their potential for dispersion into the environment depends not only on mechanical forces that might physically transport them, but also upon their inherent properties, particularly their volatility. The majority of these materials exist as nonvolatile solids over a wide range of temperatures. Some, however, are relatively volatile solids and a few are gaseous in nature. These characteristics have a significant bearing upon the assessment of the environmental radiological impact of accidents.

The gaseous materials include radioactive forms of the chemically inert noble gases krypton and xenon. These have the highest potential for release into the atmosphere. If a reactor accident were to occur involving degradation of the fuel cladding, the release of substantial quantities of these radioactive gases from the fuel is a virtual certainty. Such accidents are very low frequency but credible events (see Section 5.9.2.3). It is for this reason that the safety analysis of each nuclear power plant incorporates a hypothetical design-basis accident that postulates the release of the entire contained inventory of radioactive noble gases from the fuel into the containment structure. If further released to the environment as a possible result of failure of safety features, the hazard to individuals from these noble gases would arise predominantly through the external gamma radiation from the airborne plume. The reactor containment structure is designed to minimize this type of release.

Radioactive forms of iodine are formed in substantial quantities in the fuel by the fission process and in some chemical forms may be quite volatile. For these reasons, they have traditionally been regarded as having a relatively high potential for release from the fuel. If released to the environment, the principal radiological hazard associated with the radioiodines is ingestion into the human body and subsequent concentration in the thyroid gland. Because of this, its potential for release to the atmosphere is reduced by the use of special systems designed to retain the iodine.

The chemical forms in which the fission product radioiodines are found are generally solid materials at room temperatures, however, so that they have a strong tendency to condense (or "plate out") upon cooler surfaces. In addition, most of the iodine compounds are quite soluble in, or chemically reactive with, water. Although these properties do not inhibit the release of radioiodines from degraded fuel, they do act to mitigate the release from containment structures that have large internal surface areas and that contain large quantities of water as a result of an accident. The same properties affect the behavior of radioiodines that may "escape" into the atmosphere. Thus, if rainfall occurs during a release, or if there is moisture on exposed surfaces, e.g., dew, the radioiodines will show a strong tendency to be absorbed by the moisture.

Other radioactive materials formed during the operation of a nuclear power plant have lower volatilities and therefore, by comparison with the noble gases and iodine, a much smaller tendency to escape from degraded fuel unless the temperature of the fuel becomes very high. By the same token, such materials, if they escape by volatilization from the fuel, tend to condense quite rapidly to solid form again when transported to a lower temperature region and/or dissolve in water when present. The former mechanism can have the result of producing some solid particles of sufficiently small size to be carried some distance by a moving stream of gas or air. If such particulate materials are dispersed into the atmosphere as a result of failure of the containment barrier, they will tend to be carried downwind and deposit on surface features by gravitational settling or by precipitation (fallout), where they will become "contamination" hazards in the environment.

All of these radioactive materials exhibit the property of radioactive decay with characteristic half-lives ranging from fractions of a second to many days or years (see Table 5.8). Many of them decay through a sequence or chain of decay processes and all eventually become stable (nonradioactive) materials. The radiation emitted during these decay processes is the reason that they are hazardous materials.

(2) Exposure Pathways

The radiation exposure (hazard) to individuals is determined by their proximity to the radioactive material, the duration of exposure, and factors that act to shield the individual from the radiation. Pathways for the transport of radiation and radioactive materials that lead to radiation exposure hazards to humans are generally the same for accidental as for "normal" releases. These are depicted in Section 5.9.1, Figure 5.7. There are two additional possible pathways that could be significant for accident releases that are not shown in Figure. 5.7. One of these is the fallout onto open bodies of water of radioactivity initially carried in the air. The second would be unique to an accident that results in temperatures inside the reactor core sufficiently high to cause melting and subsequent penetration of the basemat underlying the reactor by the molten core debris. This creates the potential for the release of radioactive material into the hydrosphere through contact with ground water. These pathways may lead to external exposure to radiation, and to internal exposures if radioactive material is inhaled or ingested from contaminated food or water.

It is characteristic of these pathways that during the transport of radioactive material by wind or by water, the material tends to spread and disperse,

Table 5.8 Activity of Radionuclides in a Waterford Unit 3 Reactor Core at 3560 MWt

Group/Radionuclide	Radioactive Inventory in Millions of Curies	Half-Life (Days)
A. NOBLE GASES		
Krypton-85	0.63	3,950
Krypton-85m	27	0.183
Krypton-87	52	0.0528
Krypton-88	76	0.117
Xenon-133	190	5.28
Xenon-135	38	0.384
B. IODINES		
Iodine-131	95	8.05
Iodine-132	130	0.0958
Iodine-133	190	0.875
Iodine-134	210	0.0366
Iodine-135	170	0.280
C. ALKALI METALS		
Rubidium-86	0.029	18.7
Cesium-134	8.3	750
Cesium-136	3.3	13.0
Cesium-137	5.2	11,000
D. TELLURIUM-ANTIMONY		
Tellurium-127	6.6	0.391
Tellurium-127m	1.2	109
Tellurium-129	34	0.048
Tellurium-129m	5.9	34.0
Tellurium-131m	14	1.25
Tellurium-132	130	3.25
Antimony-127	6.8	3.88
Antimony-129	37	0.179
E. AKALINE EARTHS		
Strontium-89	100	52.1
Strontium-90	4.1	11,030
Strontium-91	120	0.403
Barium-140	180	12.8
F. COBALT AND NOBLE METALS		
Cobalt-58	0.87	71.0
Cobalt-60	0.32	1,920
Molybdenum-99	180	2.8
Technetium-99m	160	0.25
Ruthenium-103	120	39.5
Ruthenium-105	80	0.185
Ruthenium-106	28	366
Rhodium-105	55	1.50
G. RARE EARTHS, REFRACTORY OXIDES AND TRANSURANICS		
Yttrium-90	4.3	2.67
Yttrium-91	130	59.0
Zirconium-95	170	65.2
Zirconium-97	170	0.71
Niobium-95	170	35.0
Lanthanum-140	180	1.67
Cerium-141	170	32.3
Cerium-143	150	1.38
Cerium-144	95	284
Praseodymium-143	150	13.7
Neodymium-147	67	11.1
Neptunium-239	1800	2.35
Plutonium-238	0.063	32,500
Plutonium-239	0.023	8.9×10^6
Plutonium-240	0.023	2.4×10^6
Plutonium-241	3.8	5,350
Americium-241	0.0019	1.5×10^5
Curium-242	0.56	163
Curium-244	0.026	6,630

Note: The above grouping of radionuclides corresponds to that in Table 5.19.

like a plume of smoke from a smokestack, becoming less concentrated in larger volumes of air or water. The result of these natural processes is to lessen the intensity of exposure to individuals downwind or downstream of the point of release, but they also tend to increase the number who may be exposed. For a release into the atmosphere, the degree to which dispersion reduces the concentration in the plume at any downwind point is governed by the turbulence characteristics of the atmosphere which vary considerably with time and from place to place.

This fact, taken in conjunction with the variability of wind direction and the presence or absence of precipitation, means that accident consequences are very much dependent upon the weather conditions existing at the time.

(3) Health Effects

The cause-and-effect relationships between radiation exposure and adverse health effects are quite complex[57,58] but they have been more exhaustively studied than any other environmental contaminant.

Whole-body radiation exposure resulting in a dose greater than about 10 rems for a few persons and about 25 rems for nearly all people over a short period of time (hours) is necessary before any physiological effects to an individual are clinically detectable. Doses about 10 to 20 times larger than the latter dose, also received over a relatively short period of time (hours to a few days), can be expected to cause some fatal injuries. At the severe, but extremely low probability end of the accident spectrum, exposures of these magnitudes are theoretically possible for persons in the close proximity of such accidents if measures are not or cannot be taken to provide protection, e.g., by sheltering or evacuation.

Lower levels of exposures may also constitute a health risk but the ability to define a direct cause-and-effect relationship between any given health effect and a known exposure to radiation is difficult given the backdrop of the many other possible reasons why a particular effect is observed in a specific individual. For this reason, it is necessary to assess such effects on a statistical basis. Such effects include randomly occurring cancer in the exposed population and genetic changes in future generations after exposure of a prospective parent. Cancer in the exposed population may begin to develop only after a lapse of 2 to 15 years (latent period) from the time of exposure and then continue over a period of about 30 years (plateau period). However, in the case of exposure of fetuses (in utero), cancer may begin to develop at birth (no latent period) and end at age 10 (i.e., the plateau period is 10 years). The health consequences model currently being used is based on the 1972 BEIR Report of the National Academy of Sciences.[59]

Most authorities agree that a reasonable, and probably conservative estimate of the randomly occurring number of health effects of low levels of radiation exposure to a large number of people is within the range of about 10 to 500 potential cancer deaths (although zero is not excluded by the data) per million person-rems. The range comes from the latest NAS BEIR III Report[60] (1980) which also indicates a probable value of about 150. This value is virtually identical to the value of about 140 used in the current NRC health-effects models. In addition, approximately 220 genetic changes per million person-rems would be projected by BEIR III over succeeding generations. That also compares well with the value of about 260 per million person-rems currently used by the NRC staff.

(4) Health-Effects Avoidance

Radiation hazards in the environment tend to disappear by the natural process of radioactive decay. Where the decay process is a slow one, however, and where the material becomes relatively fixed in its location as an environmental contaminant (e.g., in soil), the hazard can continue to exist for a relatively long period of time--months, years, or even decades. Thus, a possible consequential environmental societal impact of severe accidents is the avoidance of the health hazard rather than the health hazard itself, by restrictions on the use of the contaminated property or contaminated foodstuffs, milk, and drinking water. The potential economic impacts that this can cause are discussed below.

5.9.2.3 Accident Experience and Observed Impacts

The evidence of accident frequency and impacts in the past is a useful indicator of future probabilities and impacts. As of mid-1980, there were 69 commercial nuclear power reactor units licensed for operation in the United States at 48 sites with power-generating capacities ranging from 50 to 1130 MWe. (The Waterford Unit 3 plant is designed for 1153 MWe.) The combined experience with these units represents approximately 500 reactor years of operation over an elapsed time of about 20 years. Accidents have occurred at several of these facilities.[61,62] Some of these have resulted in releases of radioactive material to the environment, ranging from very small fractions of a curie to a few million curies. None is known to have caused any radiation injury or fatality to any member of the public, nor any significant individual or collective public radiation exposure, nor any significant contamination of the environment. This experience base is not large enough to permit a reliable quantitative statistical inference. It does, however, suggest that significant environmental impacts caused by accidents are very unlikely to occur over time periods of a few decades.

Melting or severe degradation of reactor fuel has occurred in only one of these units, during the accident at Three Mile Island Unit 2 (TMI-2) on March 28, 1979. In addition to the release of a few million curies of xenon-133, it has been estimated that approximately 15 Ci of radioiodine was also released to the environment at TMI-2.[63] This amount represents an extremely minute fraction of the total radioiodine inventory present in the reactor at the time of the accident. No other radioactive fission products were released in measurable quantity.

It has been estimated that the maximum cumulative offsite radiation dose to an individual was less than 100 millirems.[63,64] The total population exposure has been estimated to be in the range from about 1000 to 3000 person-rems. This exposure could produce between none and one additional fatal cancer over the lifetime of the population. The same population receives each year from natural background radiation about 240,000 person-rems and approximately a half-million cancers are expected to develop in this group over its lifetime,[63,64] primarily from causes other than radiation. Trace quantities (barely above the limit of detectability) of radioiodine were found in a few samples of milk produced in the area. No other food or water supplies were impacted.

Accidents at nuclear power plants have also caused occupational injuries and a few fatalities but none attributed to radiation exposure. Individual worker exposures have ranged up to about 4 rems as a direct consequence of accidents, but the collective worker exposure levels (person-rems) are a small fraction of the exposures experienced during normal routine operations that average about 440 to 1300 person-rems in a PWR and 740 to 1650 person-rems in a BWR per reactor-year.

Accidents have also occurred at other nuclear reactor facilities in the United States and in other countries.[61,62] Because of inherent differences in design, construction, operation, and purpose of most of these other facilities, their accident record has only indirect relevance to current nuclear power plants. Melting of reactor fuel occurred in at least seven of these accidents, including the one in 1966 at the Enrico Fermi Atomic Power Plant Unit 1. This was a sodium-cooled fast breeder demonstration reactor designed to generate 61 MWe. The damages were repaired and the reactor reached full power in 4 years following the accident. It operated successfully and completed its mission in 1973. This accident did not release any radioactivity to the environment.

A reactor accident in 1957 at Windscale, England, released a significant quantity of radioiodine, approximately 20,000 Ci, to the environment. This reactor, which was not operated to generate electricity, used air rather than water to cool the uranium fuel. During a special operation to heat the large amount of graphite in this reactor, the fuel overheated and radioiodine and noble gases were released directly to the atmosphere from a 405-ft stack. Milk produced in a 200-mi^2 area around the facility was impounded for up to 44 days. This kind of accident cannot occur in a water-cooled reactor like Waterford Unit 3, however.

5.9.2.4 Mitigation of Accident Consequences

Pursuant to the Atomic Energy Act of 1954, the Nuclear Regulatory Commission has conducted a safety evaluation of the application to operate Waterford Steam Electric Station Unit 3. Although this evaluation contains more detailed information on plant design, the principal design features are presented in the following section.

(1) Design Features

The Waterford Steam Electric Station Unit 3 contains features designed to prevent accidental release of radioactive fission products from the fuel and to lessen the consequences should such a release occur. Many of the design and operating specifications of these features are derived from the analysis of postulated events known as design-basis accidents. These accident preventive and mitigative features are collectively referred to as engineered safety features (ESF). The possibilities or probabilities of failure of these systems is incorporated in the assessments discussed in Section 5.9.2.5(2).

The steel containment vessel surrounded by the reinforced concrete shield building is a passive mitigating system which is designed to minimize accidental radioactivity releases to the environment. Safety injection systems are incorporated to provide cooling water to the reactor core during an accident to prevent or minimize fuel damage. Cooling fans provide heat-removal capability inside the containment following steam release in accidents and help to prevent containment failure due to overpressure. Similarly, the containment spray system is designed to spray cool water into the containment atmosphere. The spray water also contains an additive (hydrazine) which will chemically react with any airborne radioiodine to remove it from the containment atmosphere and prevent its release to the environment.

All the mechanical systems mentioned above are supplied with emergency power from onsite diesel generators in the event that normal offsite station power is interrupted.

The fuel-handling building also has accident-mitigating systems. The safety-grade ventilation system contains both charcoal and high efficiency particulate filters. This ventilation system is also designed to keep the area around the spent-fuel pool below the prevailing barometric pressure during fuel-handling operations so that outleakage won't occur through building openings. If radioactivity were to be released into the building, it would be drawn through the ventilation system and any radioactive iodine and particulate fission products would be removed from the flow stream before exhausting to the outdoor atmosphere.

There are features of the plant that are necessary for its power-generation function that can also play a role in mitigating certain accident consequences. For example, the main condenser, although not classified as an ESF, can act to mitigate the consequences of accidents involving leakage from the primary to the secondary side of the steam generators (such as steam generator-tube ruptures). If normal offsite power is maintained, the ability of the plant to send contaminated steam to the condenser instead of releasing it through the safety valves or atmospheric dump valves can significantly reduce the amount of radioactivity released to the environment. In this case, the fission-product-removal capability of the normally operating offgas treatment system would come into play.

Much more extensive discussions of the safety features and characteristics of the Waterford Unit 3 may be found in the applicant's Final Safety Analysis Report.[53] The staff evaluation of these features are addressed in the Safety Evaluation Report.[56] In addition, the implementation of the lessons learned from the TMI-2 accident, in the form of improvements in design, and procedures and operator training, will significantly reduce the likelihood of a degraded core accident which could result in large releases of fission products to the containment. Specifically, the applicant will be required to meet those TMI-related requirements specified in NUREG-0737.[65] As noted in Section 5.9.2.5(7), no credit has been taken for these actions and improvements in discussing the radiological risk of accidents.

(2) Site Features

In the process of considering the suitability of the site of the Waterford Steam Electric Station Unit 3, pursuant to NRC's Reactor Site Criteria in 10 CFR Part 100, consideration was given to certain factors that tend to minimize the risk and the potential impact of accidents. First, the site has an exclusion area as provided in 10 CFR Part 100. The purpose of the exclusion area is twofold: to assure that activities that might be hazardous to the plant cannot be located too close to it, and to exclude residential or transient use of the close-in property that might involve an unnecessarily large number of people. The circular 262-ha (648.5-acre) exclusion area, centered on the reactor, has a radius of 914 m (about 3000 ft). The applicant owns all land and surface mineral rights within the exclusion area and, except for a small area located near the southwest edge of the exclusion boundary, also owns all of the sub-surface mineral rights. The applicant has the authority to control all activities within the exclusion area, as discussed in the staff's Safety Evaluation Report.[56] The exclusion area is traversed by State Highway 18, which is about 140 m (460 ft) from the plant; a river levee about 183 m (600 ft) from the plant; the Missouri Pacific (formerly the Texas and Pacific) railroad about 700 m (2300 ft) from the plant; and the Mississippi River shoreline about 305 m (1000 ft) from the plant. The applicant has made arrangements with the St. Charles Parish Sheriff's Office and the Louisiana Department of Public Safety, Office of State Police, to control traffic on that portion of State Highway 18, traversing the exclusion area, in the event of an emergency. Similarly, arrangements have been made for control of traffic in the Mississippi River and the railroad with the United States Coast Guard and the Missouri Pacific Railroad Company, respectively. An agreement has been executed with the Board of Commissioners, Lafourche Basin Levee District, to provide the applicant with the authority to restrict access to the Mississippi River Levee traversing the exclusion area.

Second, beyond and surrounding the exclusion area is a low population zone (LPZ), as required by Part 100. This is a circular area of 3.2 km (2 mi) outer radius, also centered on the reactor. The purpose of this zone is also twofold, to assure that the total number and density of residents are such that there is a reasonable probability that appropriate protective measures could be taken in their behalf in the event of a serious accident, and to assure that the nearest population center containing more than about 25,000 persons is outside this zone. Current and projected population densities in the LPZ are lower than current regulatory guidelines which are intended to minimize accident risk. Out to 48 km (30 mi) distant, the current population density is less than 430 persons/mi^2 and the projected density is not expected to exceed 630 persons/mi^2 at any time during the operating life of the facility.

The major residential area within the LPZ is the town of Killona, with a 1977 population of about 1200 persons and located to the northwest of the plant site.

Another population concentration within the LPZ is the community of Montz, located about 1.6 km (1 mi) north of the plant across the Mississippi River. There is one school within the LPZ, Killona Elementary School, which is about a mile from the plant, with a 1977 enrollment of 152 students. There are three major industrial facilities within the LPZ: Beker Industries (144 employees/shift), the Hooker Chemical Company (528 employees/shift), and the Union Carbide Company (1225 employees/shift). These industries constitute the principal source of the transient population within the LPZ. The transient population is about the same in number as the resident population. For example, in 1977 the resident population within the LPZ was 1774 persons whereas the transient population was 1714 persons. In case of a radiological emergency, the applicant has made arrangements with the State and local governments to control all traffic on the railroad and roadways, and with the United States Coast Guard to control the Mississippi River traffic.

Third, 10 CFR Part 100 also requires that the nearest population center of about 25,000 or more persons be no closer than one and one-third times the outer radius of the LPZ. The purpose of this criterion is to provide for protection against excessive exposure doses to people in large centers. The basis for this is the recognition that accidents of greater hazard potential than those commonly postulated as representing an upper limit are conceivable, although highly improbable.

The nearest population center, as defined in 10 CFR Part 100, is Kenner which is 20.9 km (13 miles) ESE of the plant and had a 1970 population of about 30,000. The city of New Orleans, with a 1970 population of about 600,000, is located about 40 km (25 mi) ESE of the plant.

The safety evaulation of the Waterford Unit 3 site has also included a review of potential external hazards, i.e., activities offsite that might adversely affect the operation of the plant and cause an accident. This review encompassed nearby industrial, transportation, and military facilities that might create explosive, missile, toxic gas, or similar hazards. The staff evaluated ship explosives on the Mississippi River at the construction permit stage and determined that the overpressure from an explosion of a ship must be accommodated, as part of the plant design basis, for Waterford Unit 3. Other offsite hazards, including those associated with the various hydrocarbon and toxic substance pipelines, rail and truck traffic, nearby aircraft activity, and oil and gas fields in the vicinity of Waterford Unit 3, have been reviewed by the staff. The results of the evaluation of these hazards are reported in the staff's Safety Evaluation Report, as supplemented.

(3) Emergency Preparedness

Emergency preparedness plans including protective action measures for the Waterford Unit 3 facility and environs are in an advanced, but not yet fully completed stage. In accordance with the provisions of 10 CFR Section 50.47, effective November 3, 1980, no operating license will be issued to the applicant unless a finding is made by the NRC that the state of onsite and offsite emergency preparedness provides reasonable assurance that adequate protective measures can and will be taken in the event of a radiological emergency. Among the standards that must be met by these plans are provisions for two Emergency Planning Zones (EPZ). A plume exposure pathway EPZ of about 16 km (10 mi) in radius and an ingestion exposure pathway EPZ of about 80 km (50 mi) in radius are required. Other standards include appropriate ranges of protective actions for each of these zones, provisions for dissemination to the public of basic emergency planning information, provisions for rapid notification of the public during a serious reactor emergency, and methods, systems, and equipment for assessing and monitoring actual or potential offsite consequences in the EPZs of a radiological emergency condition.

NRC findings will be based upon a review of the Federal Emergency Management Agency (FEMA) findings and determinations as to whether State and local government emergency plans are adequate and capable of being implemented, and on the NRC assessment as to whether the applicant's onsite plans are adequate and capable of being implemented. NRC staff findings are reported in the staff's Safety Evaluation Report.[56] Although the presence of adequate and tested emergency plans cannot prevent the occurrence of an accident, it is the judgment of the staff that such plans can and will substantially mitigate the consequences to the public if one should occur.

5.9.2.5 Accident Risk and Impact Assessment

(1) Design-Basis Accidents

As a means of assuring that certain features of the Waterford Unit 3 plant meet acceptable design and performance criteria, both the applicant and the staff have analyzed the potential consequences of a number of postulated accidents. Some of these could lead to significant releases of radioactive materials to the environment and calculations have been performed to estimate the potential radiological consequences to persons offsite. For each postulated initiating event, the potential radiological consequences cover a considerable range of values depending upon the particular course taken by the accident and the conditions, including wind direction and weather, prevalent during the accident.

In the safety analysis and evaluation of the Waterford Unit 3 plant, three categories of accidents have been considered. These categories are based upon their probability of occurrence and include (a) incidents of moderate frequency, i.e., events that can reasonably be expected to occur during any year of operation, (b) infrequent accidents, i.e., events that might occur once during the lifetime of the plant, and (c) limiting faults, i.e., accidents not expected to occur but that have the potential for significant releases of radioactivity. The radiological consequences of incidents in the first category, also called anticipated operational occurences, are discussed in Section 5.9.1. Some of the initiating events postulated in the second and third categories for the Waterford Unit 3 plant are shown in Table 5.9. These events are designated design-basis accidents in that specific design and operating features as described above in Section 5.9.2.4(1) are provided to limit their potential radiological consequences. Approximate radiation doses that might be received by a person at the boundary of the plant exclusion area, which is about 914 m (0.6 mi) distant from the reactor, during the first 2 hours of the accident are also shown in the table. The results shown in the table reflect the expectation that engineered safety and operating features designed to mitigate the consequences of the postulated accidents would function as intended. An important implication of this expectation is that the releases considered are limited to noble gases and radioiodines and that any other radioactive materials, e.g. in particulate form, are not expected to be released. The results are also quasi-probabilistic in nature in the sense that the meteorological dispersion conditions are taken to be neither the best nor the worst for the site, but rather at an average value determined by actual site measurements. In order to contrast the results of these calculations with those using more pessimistic, or conservative, assumptions described below, the doses shown in Table 5.9 are sometimes referred to as "realistic" doses.

Table 5.9 Approximate 2-Hour Radiation Doses From Design Basis Accidents at Exclusion Area Boundary

	Dose (rem) at 914 meters[a]	
Infrequent Accidents	Whole Body	Thyroid
Waste Gas Tank Failure	0.001	nil
Small-Break LOCA[b]	0.002	< 0.001[c]
Steam Generator Tube Rupture[d]	0.01	< 0.001
Fuel-Handling Accident	0.01	nil
<u>Limiting Faults</u>		
Main Steam Line Break	0.001	< 0.001
Control Rod Ejection	0.01	0.1
Large-Break LOCA	1.3	0.2

[a]Plant Exclusion Area Boundary Distance.

[b]LOCA-Loss of Coolant Accident; the TMI-2 accident was one kind of a small-break LOCA.

[c]< means "less than".

[d]See NUREG-0651 (Ref. 62) for descriptions of three steam generator tube rupture accidents that have occurred in the United States.

Calculated population exposures for these events range from a small fraction of a person-rem to about 30 person-rems for the population within 80 km (50 mi) of the Waterford Unit 3 plant. These calculations for both individual and population exposures indicate that the risk of incurring any adverse health effects as a consequence of these events is exceedingly small. By comparison with the estimates of radiological impact for normal operations discussed in Section 5.9.1, we also conclude that radiation exposures from design-basis accidents are roughly comparable to the exposures to individuals and the population from normal station operations over the expected lifetime of the plant.

The staff has also carried out calculations to estimate the potential upper bounds for individual exposures from the same initiating accidents in Table 5.9 for the purpose of implementing the provisions of 10 CFR Part 100, "Reactor Site Criteria." For these calculations, much more pessimistic (conservative or worst-case) assumptions are made as to the course taken by the accident and the prevailing conditions. These assumptions include much larger amounts of radioactive material released by the initiating events, additional single failures in equipment, operation of ESFs in a degraded mode,* and very poor meteorological dispersion conditions. The results of these calculations show that for these events the limiting whole-body exposures are not expected to exceed 8 rems and most would not exceed 1 rem to any individual at the site boundary.[56] They also show that radioiodine releases have the potential for offsite exposures ranging up to about 270 rems to the thyroid. For such an exposure to occur, an individual would have to be located at a point on the site boundary where the radioiodine concentration in the plume has its highest value and inhale at a breathing rate characteristic of a person jogging, for a period of 2 hr. The health risk to an individual receiving such an exposure to the thyroid is the potential appearence of benign or malignant thyroid nodules in about 9 out of 100 cases, and the development of a fatal thyroid cancer in about 4 out of 1,000 cases.

None of the calculations of the impacts of design-basis accidents described in this section takes into consideration possible reductions in individual or population exposures as a result of taking any protective actions.

(2) Probabilistic Assessment of Severe Accidents

In this and the following three sections, there is a discussion of the probabilities and consequences of accidents of greater severity than the design-basis accidents discussed in the previous section. As a class, they are considered less likely to occur, but their consequences could be more severe, both for the plant itself and for the environment. These severe accidents, heretofore frequently called Class 9 accidents, can be distinguished from design-basis accidents in two primary respects; they involve substantial physical deterioration of the fuel in the reactor core, including overheating to the point of melting, and they involve deterioration of the capability of the containment structure to perform its intended function of limiting the release of radioactive materials to the environment.

The assessment methodology employed is that described in the Reactor Safety Study (RSS) which was published in 1975.[66]** However, the sets of accident sequences that were found in the RSS to be the dominant contributors to the risk in the prototype PWR (Westinghouse designed Surry Unit 1) have recently been updated[67] ("rebaselined"). The rebaselining has been done largely to incorporate peer group comments,[68] and better data and analytical techniques resulting from research and development after the publication of the RSS. Entailed in the rebaselining effort was the evaluation of the individual dominant accident sequences--as they are understood to evolve. The earlier technique of grouping a number of accident sequences into the encompassing "Release Categories" as was done in the RSS has been largely (but not completely) eliminated.

*The containment structure, however, is assumed to prevent leakage in excess of that which can be demonstrated by testing, as provided in 10 CFR Section 100.11(a).

**Because this report has been the subject of considerable controversy, a discussion of the uncertainties surrounding it is provided in Section 5.9.2.5(7).

The Waterford Unit 3 is a Combustion Engineering designed PWR having similar design and operating characteristics to the RSS prototype PWR. Therefore, the present assessment for Waterford Unit 3 has used as its starting point the rebaselined accident sequences and release categories referred to above, and more fully described in Appendix F. Characteristics of the sequences (and release categories) used (all of which involve partial to complete melting of the reactor core) are shown in Table 5.10. Sequences initiated by natural phenomena such as tornadoes, floods, or seismic events and those that could be initiated by deliberate acts of sabotage are not included in these event sequences. The radiological consequences of such events would not be different in kind from those which have been treated. Moreover, it is the staff's judgment, based upon design requirements of 10 CFR Part 50, Appendix A, relating to effects of natural phenomena, and safeguards requirements of 10 CFR Part 73, that these events do not contribute significantly to risk.

Calculated probability per reactor-year associated with each accident sequence (or release category) used is shown in the second column in Table 5.10. As in the RSS there are substantial uncertainties in these probabilities. This is due, in part, to difficulties associated with the quantification of human error and to inadequacies in the data base on failure rates of individual plant components that were used to calculate the probabilities.[68] The probability of accident sequences from the Surry plant were used to give a perspective of the societal risk at Waterford Unit 3 because, although the probabilities of particular accident sequences may be substantially different and even improved for Waterford Unit 3, the overall effect of all sequences taken together is likely to be within the uncertainties (see Section 5.7.2.5(7) for discussion of uncertainties in risk estimates).

The magnitudes (curies) of radioactivity release for each accident sequence or release category are obtained by multiplying the release fractions shown in Table 5.10 by the amounts that would be present in the core at the time of the hypothetical accident. These are shown in Table 5.8 for the Waterford Unit 3 plant at the core thermal power level of 3560 MWt.

The potential radiological consequences of these releases have been calculated by the consequence model used in the RSS[69] adapted and modified as described below to apply to a specific site. The essential elements are shown in schematic form in Figure 5.8. Environmental parameters specific to the site of the Waterford Unit 3 facility have been used and include the following:

- Meteorological data for the site representing a full year of consecutive hourly measurements and seasonal variations,

- Projected population for the year 2000 extending throughout regions of 80-km (50-mi) and 563-km (350-mi) radius from the site,

- The habitable land fraction within the 563-km (350-mi) radius, and

- Land-use statistics, on a statewide basis, including farm land values, farm product values including dairy production, and growing season information, for the State of Louisiana and each surrounding state within the 563-km (350-mi) region.

Table 5.10 Summary of Atmospheric Releases in Hypothetical Accident Sequences in a PWR (Rebaselined)

Accident Sequence or Sequence Group[b]	Probability (reactor-yr^{-1})	Fraction of Core Inventory Released[a]						
		Xe-Kr	I	Cs-Rb	Te-Sb	Ba-Sr	Ru[c]	La[d]
Event V	2.0×10^{-6}	1.0	0.64	0.82	0.41	0.1	0.04	0.006
TMLB'	3.0×10^{-6}	1.0	0.31	0.39	0.15	0.044	0.018	0.002
PWR3	3.0×10^{-6}	0.8	0.2	0.2	0.3	0.02	0.03	0.003
PWR7	4.0×10^{-5}	6×10^{-3}	2×10^{-5}	1×10^{-5}	2×10^{-5}	1×10^{-6}	1×10^{-6}	2×10^{-7}

[a]Background on the isotope groups and release mechanisms is presented in Appendix VII, WASH 1400.[66]

[b]See Appendix F for description of the accident sequences and Release Categories.

[c]Includes Ru, Rh, Co, Mo, Tc.

[d]Includes Y, La, Zr, Nb, Ce, Pr, Nd, Np, Pu, Am, Cm.

Note: Please refer to Section 5.9.2.5(7) for a discussion of uncertainties in risk estimates.

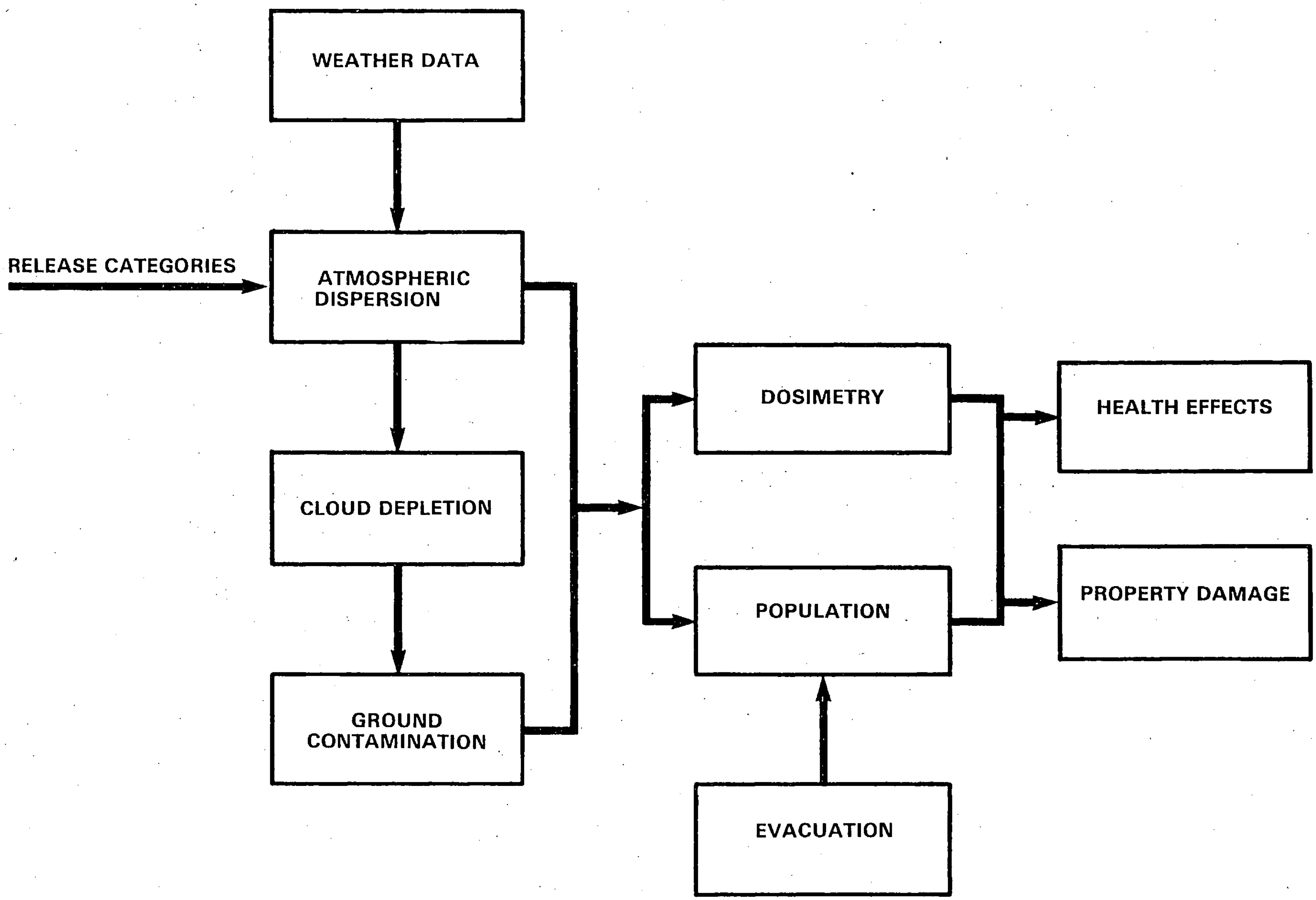

Fig. 5.8 Schematic Outline of Consequence Model,

To obtain a probability distribution of consequences, the calculations are performed assuming the occurrence of each accident-release sequence at each of 91 different "start" times throughout a 1-year period. Each calculation utilizes the site-specific hourly meteorological data and seasonal information for the time period following each "start" time. The consequence model also contains provisions for incorporating the consequence reduction benefits of evacuation and other protective actions. Early evacuation of people would considerably reduce the exposure from the radioactive cloud and the contaminated ground in the wake of the cloud passage. The evacuation model used (see Appendix G) has been revised from that used in the RSS for better site-specific application. The quantitative characteristics of the evacuation model used for the Waterford site are best-estimate values made by the staff and based upon evacuation time estimates prepared by the applicant. Actual evacuation effectiveness could be greater or less than that characterized but would not be expected to be very much less.

The other protective actions include: (a) either complete denial of use (interdiction), or permitting use only at a sufficiently later time after appropriate decontamination of food stuffs such as crops and milk, (b) decontamination of severely contaminated environment (land and property) when it is considered to be economically feasible to lower the levels of contamination to protective action guide (PAG) levels, and (c) denial of use (interdiction) of severely contaminated land and property for varying periods of time until the contamination levels reduce to such values by radioactive decay and weathering so that land and property can be economically decontaminated as in (b) above. These actions would reduce the radiological exposure to the people from immediate and/or subsequent use of or living in the contaminated environment.

Early evacuation within the plume exposure pathway EPZ and other protective actions as mentioned above are considered as essential sequels to serious nuclear reactor accidents involving significant release of radioactivity to the atmosphere. Therefore, the results shown for Waterford Unit 3 reactor include the benefits of these protective actions.

There are also uncertainties in the estimates of consequences and the error bounds may be as large as they are for the probabilities. It is the judgment of the staff, however, that it is more likely that the calculated results are overestimates of consequences rather than underestimates.

The results of the calculations using this consequence model are radiological doses to individuals and to populations, health effects that might result from these exposures, costs of implementing protective actions, and costs associated with property damage by radioactive contamination.

(3) Dose and Health Impacts of Atmospheric Releases

The results of the calculations of dose and health impacts performed for the Waterford Unit 3 facility and site are presented in the form of probability distributions in Figures 5.9 through 5.12 and are included in the impact Summary Table 5.11. All of the accident sequences and release categories shown in Table 5.10 contribute to the results, the consequences from each being weighted by its associated probability.

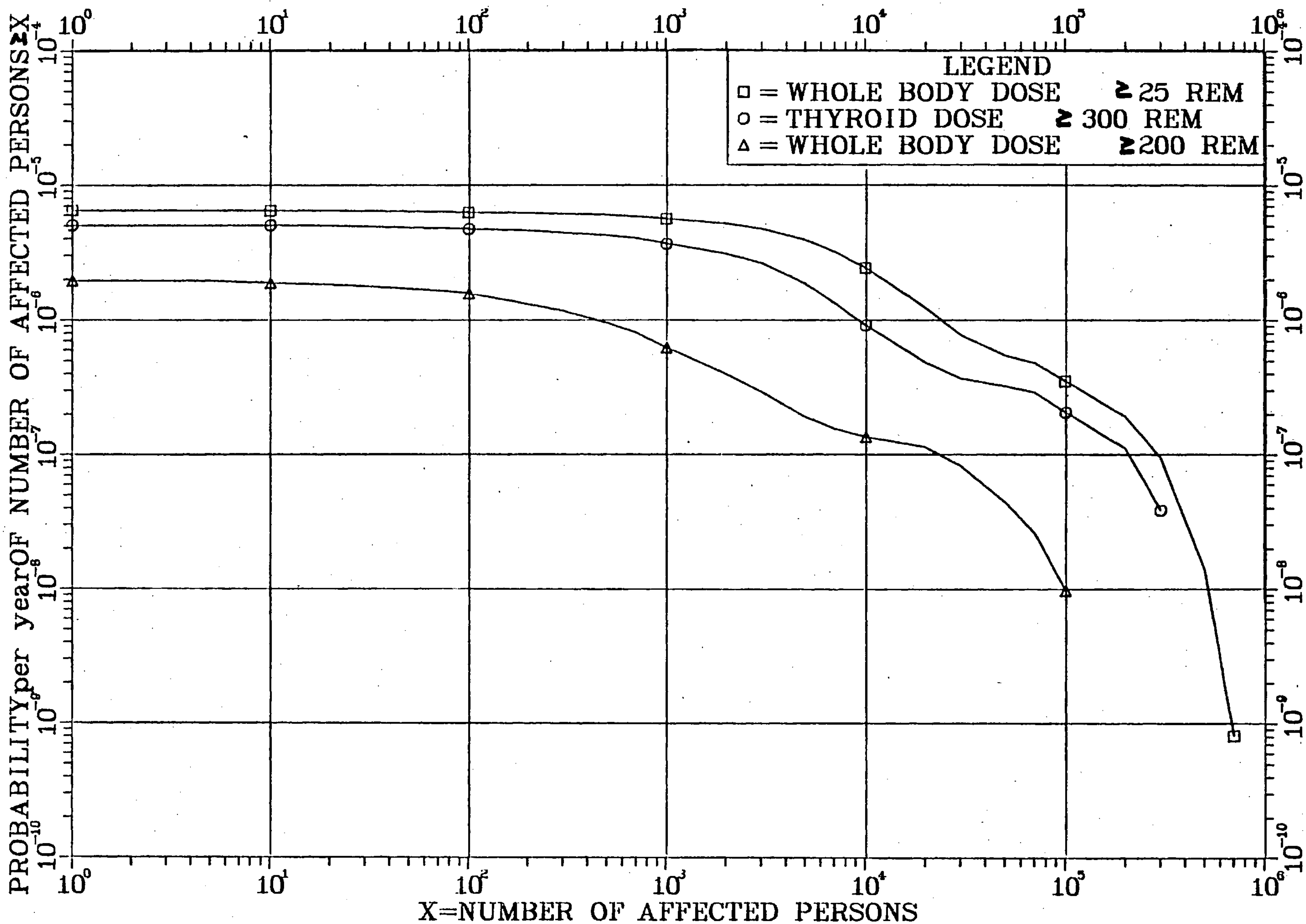

Figure 5.9 Probability Distributions of Individual Dose Impacts.
NOTE: Please see Section 5.9.2.5(7) for discussion of uncertainties in risk estimates.

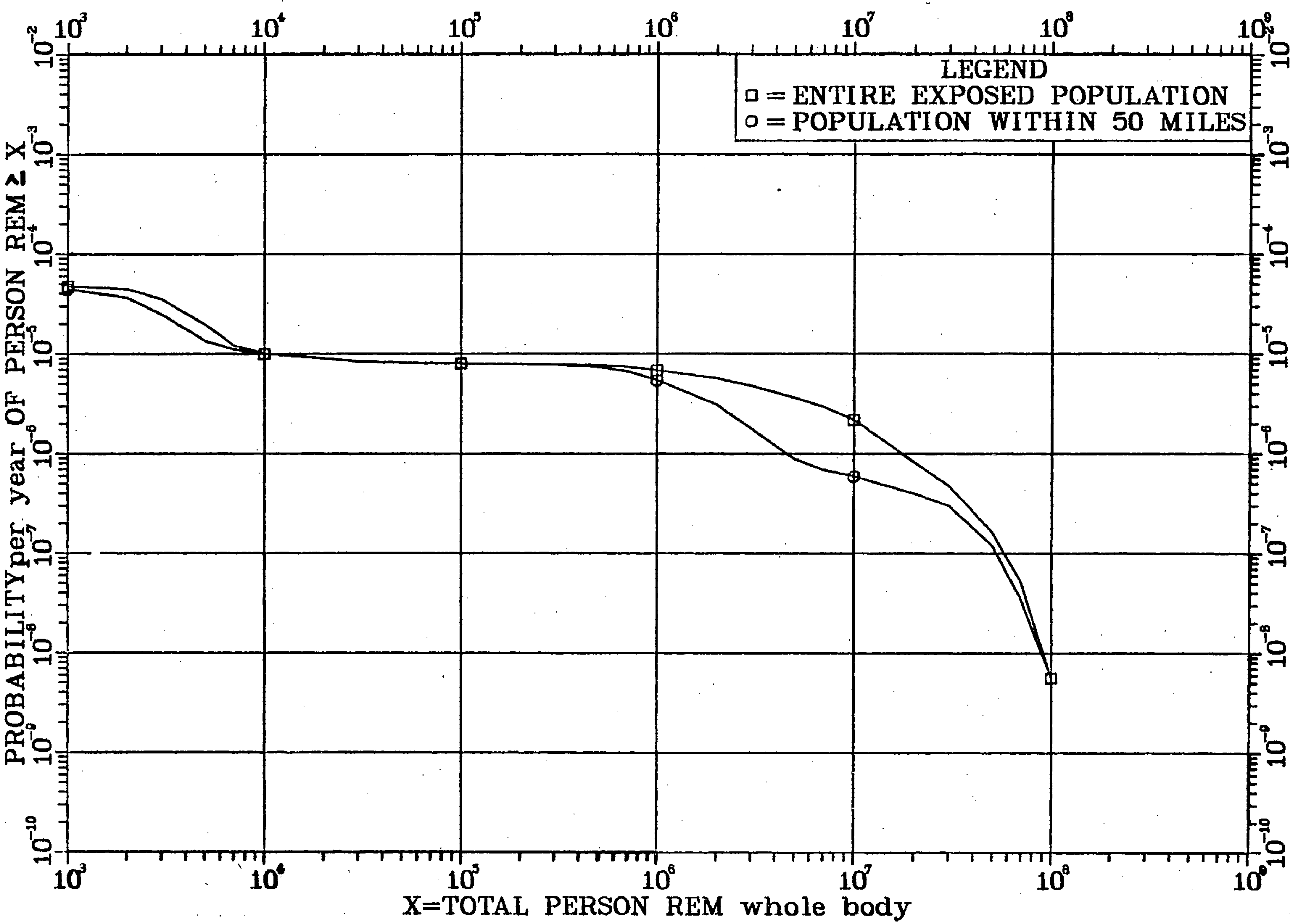

Figure 5.10 Probability Distributions of Population Exposures.
NOTE: Please see Section 5.9.2.5(7) for discussion of uncertainties in risk estimates.

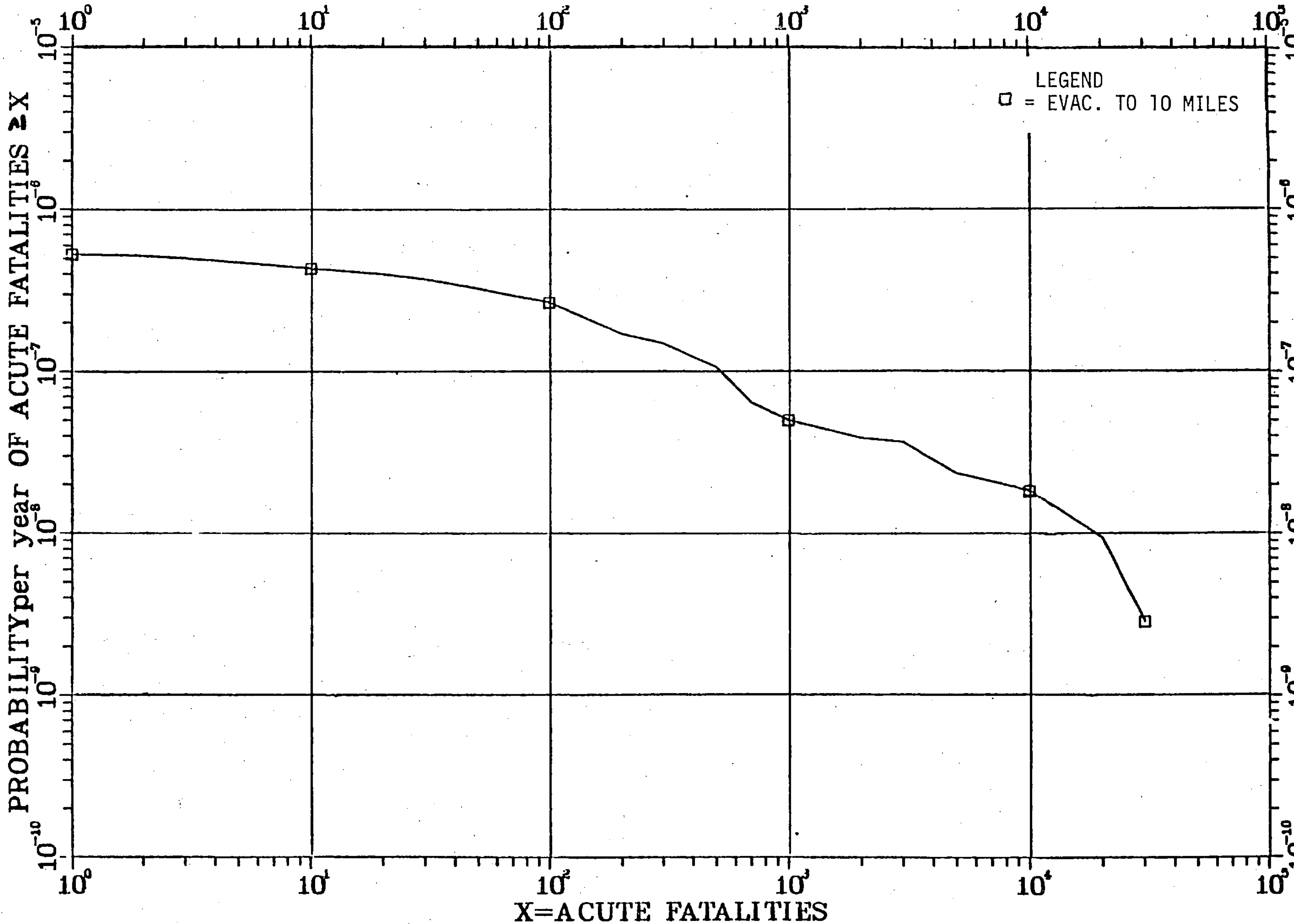

Figure 5.11 Probability Distribution of Acute Fatalities.
NOTE: Please see Section 5.9.2.5(7) for discussion of uncertainties in risk estimates.

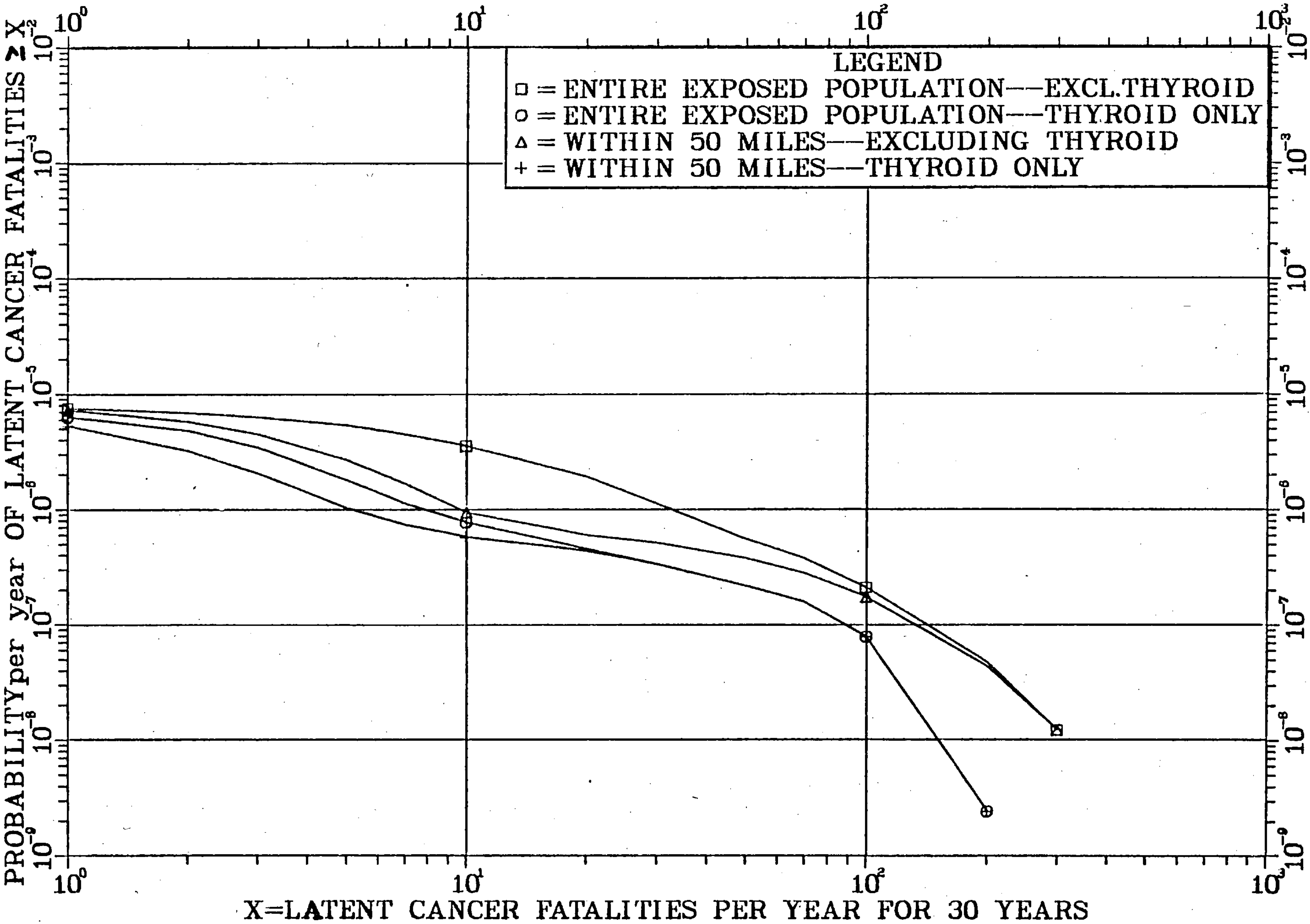

Figure 5.12 Probability Distributions of Cancer Fatalities.
NOTE: Please see Section 5.9.2.5(7) for discussion of uncertainties in risk estimates.

Table 5.11 Summary of Environmental Impacts and Probabilities

Probability of Impact Per Reactor-Year	Persons Exposed over 200 rem	Persons Exposed over 25 rem	Acute Fatalities	Population Exposure Millions of person-rem 50 mi/Total	Latent[a] Cancers 50 mi/ Total	Cost of Offsite Mitigating Actions Millions of Dollars
10^{-4}	0	0	0	0/0	0/0	0
10^{-5}	0	0	0	0.01/0.01	<60/<60	9
5×10^{-6}	0	2,100	0	1/2.7	100/200	130
10^{-6}	450	25,000	<1	4.5/17	450/1,200	800
10^{-7}	21,000	300,000	500	50/60	6,900/7,200	5,000
10^{-8}	100,000	500,000	19,000	90/90	4,800/4,800[b]	-
Related Figure	5.9	5.9	5.11	5.10	5.12	5.13

[a]Includes cancers of all organs. Thirty times the values shown in the Figure 5.12 are shown in this column reflecting the 30-yr period over which cancers might occur. Genetic effects would be approximately twice the number of latent cancers.

[b]Thyroid cancers only. Cancers of all other organs do not contribute at this probability level.

Note: Please refer to Section 5.9.2.5(7) for a discussion of uncertainties in risk estimates.

Figure 5.9 shows the probability distribution for the number of persons who might receive whole-body doses equal to or greater than 200 rems and 25 rems, and thyroid doses equal to or greater than 300 rems from early exposure,* all on a per-reactor-year basis. The 200-rem whole-body dose figure corresponds approximately to a threshold value for which hospitalization would be indicated for the treatment of radiation injury. The 25-rem whole-body (which has been identified earlier as the lower limit for a clinically observable physiological effect in nearly all people) and 300-rem thyroid figures correspond to the Commission's guideline values for reactor siting in 10 CFR Part 100.

The figure shows in the left-hand portion that there are approximately 7 chances in 1,000,000 (i.e., 7×10^{-6}) per reactor year that one or more persons may receive doses equal to or greater than any of the doses specified. The fact that the three curves run almost parallel in horizontal lines initially shows that if one person were to receive such doses, the chances are about the same that several tens to hundreds would be so exposed. The chances of larger numbers of persons being exposed at those levels are seen to be considerably smaller. For example, the chances are about 1 in 100,000,000 (i.e., 10^{-8}) that 100,000 or more people might receive doses of 200 rems or greater. A majority of the exposures reflected in this figure would be expected to occur to persons within an 80-km (50-mi) radius of the plant. Virtually all would occur within a 160-km (100-mi) radius.

Figure 5.10 shows the probability distribution for the total population exposure in person-rems, i.e., the probability per reactor-year that the total population exposure will equal or exceed the values given. Most of the population exposure up to 10 million person-rems would occur within 50 mi but the more severe releases (as in the first two accident sequences in Table 5.10) would result in exposure to persons beyond the 50-mile range as shown.

For perspective, population doses shown in Figure 5.10 may be compared with the annual average dose to the population within 50 mi of the Waterford Unit 3 site due to natural background radiation of 180,000 person-rems, and to the anticipated annual population dose to the general public from normal station operation of 60 person-rems (excluding plant workers) (Appendix J, Tables J-5 and J-7).

Figure 5.11 shows the probability distributions for acute fatalities, representing radiation injuries that would produce fatalities within about one year after exposure. Virtually all of the acute fatalities would be expected to occur within the 40 km (25-mi) radius. The results of the calculations shown in this figure and in Table 5.11 reflect the effect of evacuation within the 10-mile plume exposure pathway EPZ only. For the very low probability accidents having the potential for causing radiation exposures above the threshold for acute fatality at distances beyond 16.1 km (10 mi), it would be realistic to expect that authorities would evacuate persons at all distances at which such exposures might occur. Acute fatality consequences would, therefore, reasonably

*Early exposure to an individual includes external doses from the radioactive cloud and the contaminated ground, and the dose from internally deposited radionuclides from inhalation of contaminated air during the cloud passage. Other pathways of exposure are excluded.

be expected to be very much less than the numbers shown. (Figure G-1 of Appendix G illustrates the potential benefits of evacuation within 32.2 km (20 mi). Calculations predict zero acute fatality for evacuation within 40.2 km (25 mi).)

Figure 5.12 represents the statistical relationship between population exposure and the induction of fatal cancers that might appear over a period of many years following exposure. The impacts on the total population and the population within 81 km (50 mi) are shown separately. Further, the fatal, latent cancers have been subdivided into those attributable to exposures of the thyroid and all other organs.

(4) Economic and Societal Impacts

As noted in Section 5.9.2.2, the various measures for avoidance of adverse health effects including those due to residual radioactive contamination in the environment are possible consequential impacts of severe accidents. Calculations of the probabilities and magnitudes of such impacts for the Waterford Unit 3 facility and environs have also been made. Unlike the radiation exposure and health effect impacts discussed above, impacts associated with adverse health effects avoidance are more readily transformed into economic impacts.

The results are shown as the probability distribution for cost of offsite mitigating actions in Figure 5.13 and are included in the impact Summary Table 5.11. The factors contributing to these estimated costs include the following:

- Evacuation costs
- Value of crops contaminated and condemned
- Value of milk contaminated and condemned
- Costs of decontamination of property where practical
- Indirect costs due to loss of use of property and incomes derived therefrom.

The last-named cost would derive from the necessity for interdiction to prevent the use of property until it is either free of contamination or can be economically decontaminated.

Figure 5.13 shows that at the extreme end of the accident spectrum these costs could exceed several billion dollars but that the probability that this would occur is exceedingly small, less than one chance in a million per reactor-year.

Additional economic impacts that can be monetized include costs of decontamination of the facility itself and the costs of replacement power. Probability distributions for these impacts have not been calculated but they are included in the discussion of risk considerations in Section 5.9.2.5(6) below.

(5) Releases to Groundwater

As identified in Section 5.9.2.2(2), accidental release of radioactivity to groundwater could provide a pathway of public radiation exposure and environmental

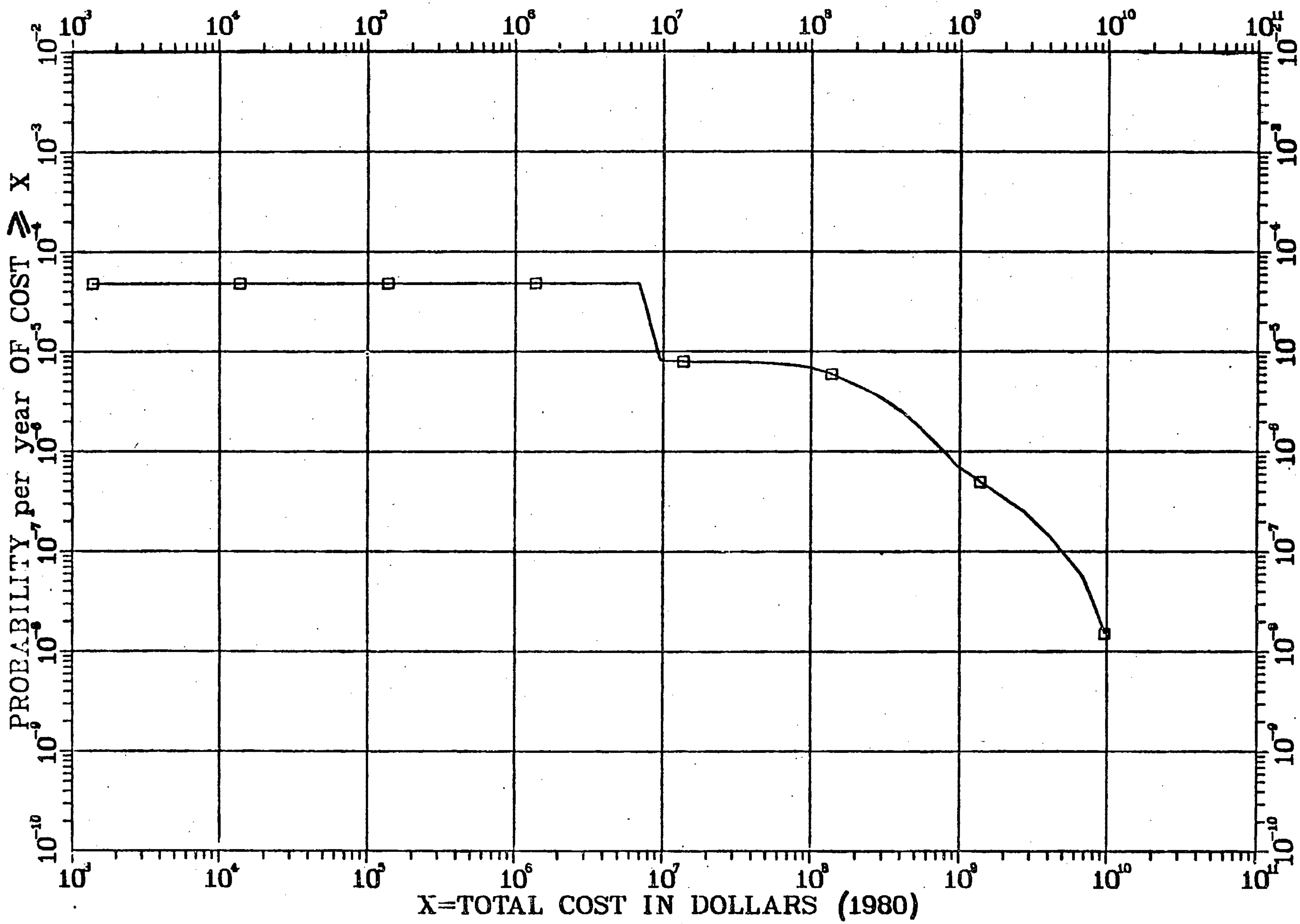

Figure 5.13 Probability Distribution of Mitigation Measures Cost.
NOTE: Please see Section 5.9.2.5(7) for disucssion of uncertainties in risk estimates.

contamination. Consideration has been given to the potential environmental impact of this pathway for the Waterford Unit 3 plant. The principal contributors to the risk are the core-melt accidents. The penetration of the basemat of the containment buildings can release molten core debris to the strata beneath the plant. Soluble radionuclides in this debris can be leached and transported with groundwater to downgradient domestic wells used for drinking or to surface water bodies used for aquatic food and recreation. In pressurized water reactors, such as the Waterford Unit 3, there is an additional opportunity for groundwater contamination due to the release of contaminated sump water to the ground through a breach in the containment.

An analysis of the potential consequences of a liquid pathway release of radioactivity for generic sites was presented in the "Liquid Pathway Generic Study" (LPGS).[70] The LPGS compared the risk of accidents involving the liquid pathway (drinking water, irrigation, aquatic food, swimming, and shoreline usage) for four conventional, generic land-based nuclear plants and a floating nuclear plant, for which the nuclear reactors would be mounted on a barge and moored in a water body. Parameters for the land-based sites were chosen to represent averages for a wide range of real sites and are thus "typical," but represented no real site in particular.

The discussion in this section is an analysis to determine whether or not the Waterford Unit 3 site liquid pathway consequences would be unique when compared to land-based sites considered in the LPGS.

The Waterford Unit 3 station is underlain by a deposit of clay, silt and sand (Zone 1) which extends about 16 m (52.5 ft) below plant grade to an elevation of -12 m (-39 ft) mean sea level (MSL).

Beneath this deposit is an aquiclude of fairly uniform Pleistocene clay (Zone 2) with occasional discontinuous silt lenses. The reactor foundation mat bears upon this clay at elevation -14 m (-46 ft) MSL. This zone exhibits a very low permeability, averaging about 10^{-8} cm/sec.

A continuous dense to very dense silty sand layer (Zone 3) with some clay, approximately 5 m (16 ft) thick, is situated immediately beneath the Pleistocene clay, starting at elevation -23 m (-75 ft) MSL. Laboratory tests of material from this layer indicate an average permeability of about 3.0×10^{-5} cm/sec. The Mississippi River adjacent to the station has a thalweg depth of -37 m (-121 ft) MSL, thus the groundwater regime of the upper three zones described above will not be affected by the groundwater regime on the opposite side of the river.

A stiff clay stratum (Zone 4), which underlies the Zone 3 sand layer and extends to approximately elevation -101 m (-332 ft) MSL, behaves as a local aquiclude. Beneath this clay layer is the Norco aquifer which is the only aquifer encountered in the subsurface investigation beneath the site. This aquifer is used mainly for industrial purposes. The closest area of concentrated pumpage is in the Norco well field about three miles northeast of the station and on the opposite side of the Mississippi River.

In the event of a breach in the containment, there could be a release of radioactivity to the clay strata below the reactor. However, in order for the Norco aquifer to become contaminated, radioactive water would have to travel through more than 85 m (279 ft) of soil, most of this [80 m (262 ft)] being highly impermeable clay. It is extremely unlikely that a core-soil mass would penetrate to this depth. Using boundary-heat-transfer calculations, the Reactor Safety Study[70] estimated that the core-soil mass would form a cylinder about 15 m (49 ft) high with a diameter of about 21 m (69 ft). The core-soil mass would thus be expected to remain about 70 m (230 ft) above the Norco aquifer. In addition, the Norco aquifer is under artesian pressure so any penetration of the overlying clay aquitard would induce outward flow from the Norco aquifer.

The Zone 3 silty sand layer at elevation -23 m (-75 ft) MSL appears to be hydraulically connected with the Mississippi River. During construction dewatering, it was found that water level fluctuations in the Mississippi River resulted in corresponding fluctuations in the piezometric levels measured in this layer. Piezometric monitoring since June 1972 shows that groundwater movement is away from the Mississippi River at all stages of flow; therefore, if the sand layer were to be contaminated, groundwater flow would be in a southerly direction away from the Mississippi River.

Using a coefficient of permeability of 10^{-5} cm/sec as determined by the applicant in the FSAR,[55] the staff estimated that it would take about 17,000 years for contaminated water to move to the site boundary through the sand layer. However, based on pumping rates measured during construction dewatering, the staff determined that the coefficient of permeability could be as high as 1000 times greater than the laboratory value determined by the applicant. Using this more conservative coefficient of permeability, the staff estimated a minimum travel time of 17 years for groundwater to migrate to the site boundary. The movement of most of the radioactivity dissolved in the groundwater would be much slower than the groundwater itself because of the process of sorption.

There are no groundwater users identified as using the sand layer. Groundwater in this layer is of poor quality and the sand layer is of limited extent. Therefore, there are no credible liquid pathways for public radiation exposure and environmental contamination.

The staff, however, has performed an analysis for the hypothetical situation that all inhabitants outside of the site boundary derive all of their drinking water from the contaminated sand layer. A population density of 205 people/mi^2 was used. The analysis parallels that performed for the "dry site" in the LPGS.* Conservative coefficients for the transport model were chosen based on known properties of analogous groundwater situations. The calculated population dose via the hypothetical drinking water pathway for the Waterford Site was two to three orders of magnitude less than the population dose estimated for the LPGS "dry site."

We therefore conclude that the Waterford liquid pathway contribution to population dose from a postulated core-melt accident would be orders of magnitude less than that predicated for the LPGS site. Additionally, in the event of a breach of containment, there would be ample time to implement measures to

*The population dose comparison to the LPGS dry site was made because only groundwater users could be affected at the Waterford site. The LPGS dry site was the only case for which direct use of groundwater was taken into account.

isolate groundwater contamination (such as dewatering or slurry walls) before it could migrate offsite. The staff therefore concludes that the Waterford Unit 3 site is not unique in its liquid pathway contribution to risk when compared with other land-based sites.

(6) Risk Considerations

The foregoing discussions have dealt with both the frequency (or likelihood of occurrence) of accidents and their impacts (or consequences). Since the ranges of both factors are quite broad, it is also useful to combine them to obtain average measures of environmental risk. Such averages can be particularly instructive as an aid to the comparison of radiological risks associated with accident releases and with normal operational releases.

A common way in which this combination of factors is used to estimate risk is to multiply the probabilities by the consequences. The resultant risk is then expressed as a number of consequences expected per unit of time. Such a quantification of risk does not at all mean that there is universal agreement that peoples' attitudes about risk, or what constitutes an acceptable risk, can or should be governed solely by such a measure. At best, it can be a contributing factor to a risk judgment, but not necessarily a decisive factor.

In Table 5.12 are shown average values of risk associated with population dose, acute fatalities, latent fatalities, and costs for evacuation and other protective actions. These average values are obtained by summing the probabilities multiplied by the consequences over the entire range of distributions. Since the probabilities are on a per-reactor-year basis, the averages shown are also on a per-reactor-year basis.

The population exposures and latent cancer fatality risks may be compared with those for normal operation. The comparison (excluding exposure to the plant personnel) shows that the accident risks are comparable to those for normal operation.

There are no acute fatality nor economic risks associated with protective actions and decontamination for normal releases, therefore, these risks are unique for accidents. For perspective and understanding of the meaning of the acute fatality risk of 0.0006/yr, however, we note that to a good approximation the population at risk is that within about 16 km (10 mi) of the plant, about 73,000 persons in the year 2000. Accidental fatalities per year for a population of this size, based upon overall averages for the United States, are approximately 16 from motor vehicle accidents, 5.6 from falls, 2.3 from drowning, 2.1 from burns, 0.9 from firearms (p. 577 of Ref. 57).

Figure 5.14 shows the calculated risk expressed as whole-body dose to an individual from early exposure as a function of the downwind distance from the plant within the plume exposure pathway EPZ. The values are on a per-reactor-year basis and all accident sequences and release categories in Table 5.10 contributed to the dose, weighted by their associated probabilities.

Within the 16-km (10-mi) radius plume exposure pathway EPZ the calculations show that the best-estimate evacuation can reduce the risk of acute fatality

Table 5.12 Average Values of Environmental Risks Due to Accidents per Reactor-Year

Environmental risk	Average value
Population exposure	
Person-rems within 50 miles	33
Total person-rems	69
Acute fatalities	0.00057
Latent cancer fatalities	
All organs excluding thyroid	0.0043
Thyroid only	0.0016
Cost of protective actions and decontamination	$4,500*

*1980 dollars

NOTE: Please see Section 5.9.2.5(7) for discussions of uncertainties in risk estimates.

to an individual to near zero. Evacuation and other protective actions also reduce the risk to an individual of latent cancer fatality. Figure 5.15 shows curves of constant risks per reactor-year to an individual, living within the plume exposure pathway EPZ of the Waterford Unit 3 plant, of death from latent cancer as functions of distance due to potential accidents in the reactor. Directional variation of these curves reflect the variation in the average fraction of the year the wind would be blowing into different directions from the plant. For comparison the following risks of fatality per year to an individual living in the United States may be noted (p. 577 of Ref. 57): automobile accident 2.2×10^{-4}, falls 7.7×10^{-5}, drowning 3.1×10^{-5}, burning 2.9×10^{-5}, and firearms 1.2×10^{-5}.

The economic risk associated with evacuation and other protective actions could be compared with property damage costs associated with alternative energy generation technologies. The use of fossil fuels, coal or oil, for example, would emit substantial quantities of sulfur dioxide and nitrogen oxides into the atmosphere, and, among other things, lead to environmental, and ecological damage through the phenomenon of acid rain (pp.559-560 of Ref. 57). This effect has not, however, been sufficiently quantified to draw a useful comparison at this time.

There are other economic impacts and risks that can be monetized that are not included in the cost calculations discussed in Section 5.9.2.5(4). These are accident impacts on the facility itself that result in added costs to the

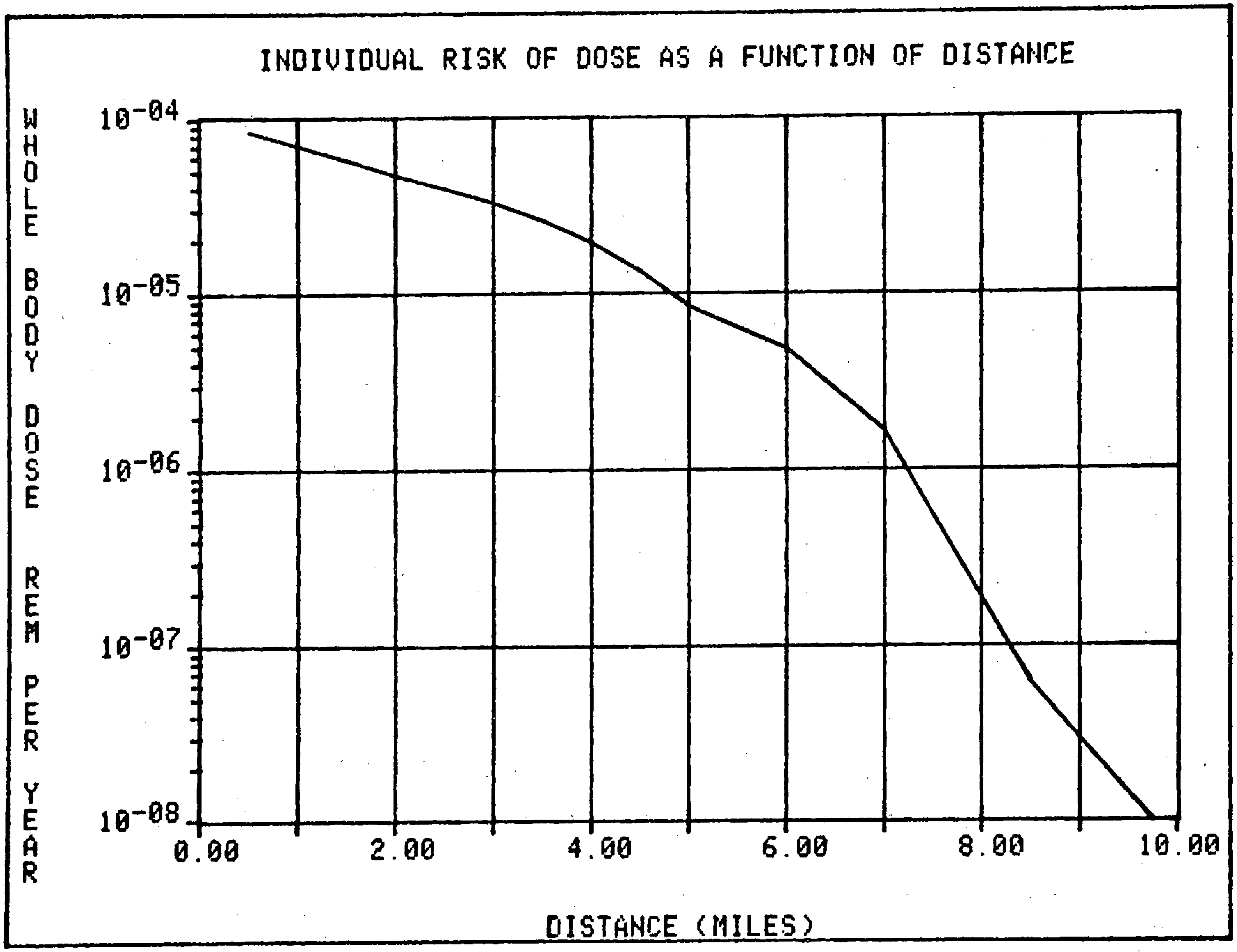

Figure 5.14 Individual Risk of Dose as a Function of Distance.
NOTE: Please see Section 5.9.2.5(7) for discussion of uncertainties in risk estimates.

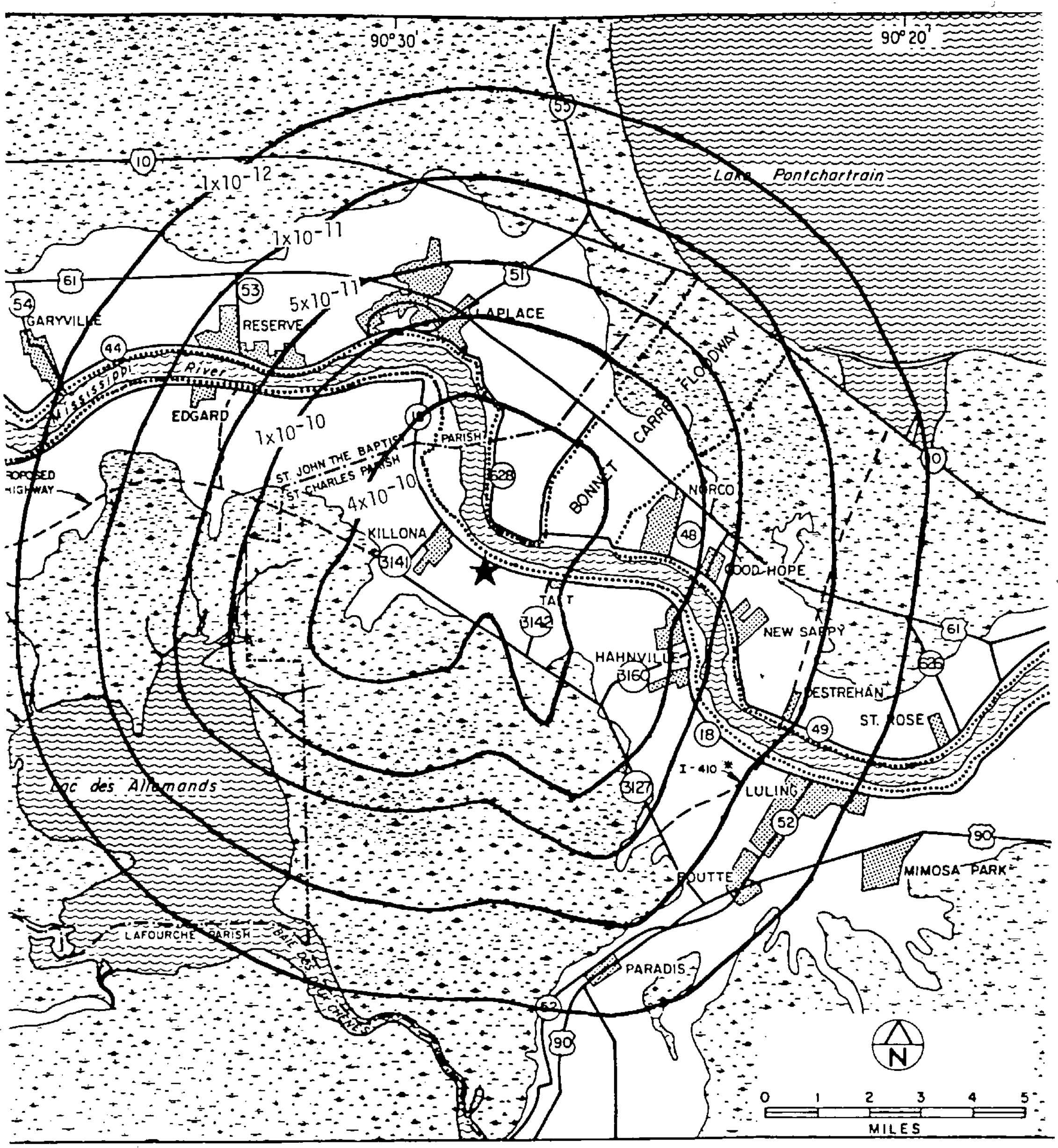

Figure 5.15 Isopleths of Risk of Latent Cancer Fatality per Reactor-Year to an Individual.

NOTE: Please see Section 5.9.2.5(7) for discussion of uncertainties in risk estimates.

public, i.e., ratepayers, taxpayers, and/or shareholders. These are costs associated with decontamination of the facility itself and costs for replacement power.

No detailed methodology has been developed for estimating the contribution to economic risk to the licensee associated with cleanup and decontamination of a nuclear power plant that has undergone a serious accident toward either a decommissioning or a resumption of operation. Experience with such costs is currently being accumulated as a result of the Three Mile Island accident. It is already clear however, that such costs can approach or even exceed the original capital cost of such a facility. In addition to damage to or loss of the facility resulting from accidents, the other major additional cost is that of replacement power.

These costs are affected by the point in the lifetime of the plant at which an accident might occur. The present worth cost is highest for an accident occurring at the beginning of the plant operating life and decreasing over the plant life. It is assumed for these calculations, that a totally disabling accident occurs at Waterford Unit 3; it is decontaminated and brought back to service after 8 years at a cost of $1 billion. For illustrative purposes, the costs and economic risk have been estimated for the 1104 MWe Waterford Unit 3 plant by postulating the accident in the first year of a projected 30 year operating life. Net replacement power cost of 40 mills/kwh is assumed. Using a 60 percent capacity factor, the annual cost of replacement power would be $235 million in 1980 dollars. The additional capital costs as a result of decontamination and cleanup are $63 million/yr spread over 22 years, again in 1980 dollars.

If the probability of sustaining a total loss of the original facility is taken as the probability of the occurrence of a core-melt accident (approximated by the sum of the probabilities for the accident sequences and release categories in Table 5.10, i.e., about 5 chances in 100,000/yr), then the average contribution to economic risk that would result from a loss early in the operating life of Waterford Unit 3 is about $14,000/yr for added fuel and capital costs until the damaged unit is returned to service, and $3,000/yr additional capital costs for the assumed remaining 22 years of plant service. A worse situation not evaluated here, is one where the plant must be decontaminated for safety reasons, but is not put back in operation. A new plant then has to be built. Decontamination cost in that case, however, should be somewhat less than the case where the plant is made suitable for operation.

(7) Uncertainties

The foregoing probabilistic and risk assessment discussion has been based upon the methodology presented in the Reactor Safety Study which was published in 1975.

In July 1977, the NRC organized an Independent Risk Assessment Review Group to (a) clarify the achievements and limitations of the Reactor Safety Study, (b) assess the peer comments thereon and the responses to the comments, (c) study the current state of such risk assessment methodology, and (d) recommend to the Commission how and whether such methodology can be used in the regulatory and licensing process. The results of this study were issued September 1978.[68]

This report, called the Lewis Report, contains several findings and recommendations concerning the RSS. Some of the more significant findings are summarized below.

- A number of sources, both conservative and nonconservative in the probability calculations in RSS, were found, which were very difficult to balance. The Review Group was unable to determine whether the overall probability of a core-melt given in the RSS was high or low, but they did conclude that the error bands were understated.

- The methodology, which was an important advance over earlier methodologies that had been applied to reactor risk, was sound.

- It is very difficult to follow the detailed thread of calculations through the RSS. In particular, the Executive Summary is a poor description of the contents of the report, should not be used as such, and has lent itself to misuse in the discussion of reactor risk.

On January 19, 1979 the Commission issued a statement of policy concerning the RSS and the Review Group Report. The Commission accepted the findings of the Review Group.

The accident at Three Mile Island occurred in March 1979 at a time when the accumulated experience record was about 400 reactor-years. It is of interest to note that this was within the range of frequencies estimated by the RSS for an accident of this severity (p. 553 of Ref. 57). It should also be noted that the Three Mile Island accident has resulted in a very comprehensive evaluation of reactor accidents like that one, by a significant number of investigative groups both within NRC and outside of it. Actions to improve the safety of nuclear power plants have come out of these investigations, including those from the President's Commission on the Accident at Three Mile Island, and NRC staff investigations and task forces. A comprehensive "NRC Action Plan Developed as a Result of the TMI-2 Accident," NUREG-0660, Vol. I, May 1980[71] collects the various recommendations of these groups and describes them under the subject areas of: Operational Safety; Siting and Design; Emergency Preparedness and Radiation Effects; Practices and Procedures; and NRC Policy, Organization, and Management. The action plan presents a sequence of actions, some already taken, that will result in a gradually increasing improvement in safety as individual actions are completed. The Waterford Unit 3 plant is receiving and will receive the benefit of these actions on the schedule indicated in NUREG-0660. The improvement in safety from these actions has not been quantified, however, and the radiological risk of accidents discussed in this chapter does not reflect these improvements.

5.9.2.6 Conclusions

The foregoing sections consider the potential environmental impacts from accidents at the Waterford 3 facility. These have covered a broad spectrum of possible accidental releases of radioactive materials into the environment by atmospheric and groundwater pathways. Included in the considerations are postulated design-basis accidents and more severe accident sequences that lead to a severely damaged reactor core or core-melt.

The environmental impacts that have been considered include potential radiation exposures to individuals and to the population as a whole, the risk of near- and long-term adverse health effects that such exposures could entail, and the potential economic and societal consequences of accidental contamination of the environment. These impacts could be severe but the likelihood of their occurrence is judged to be small. This conclusion is based on (a) the fact that considerable experience has been gained with the operation of similar facilities without significant degradation of the environment, (b) that, in order to obtain a license to operate the Waterford 3 facility, it must comply with the applicable Commission regulations and requirements, and (c) a probabilistic assessment of the risk based upon the methodology developed in the Reactor Safety Study. The overall assessment of environmental risk of accidents, assuming protective action, shows that it is roughly comparable to the risk from normal operation although accidents have a potential for acute fatalities and economic costs that cannot arise from normal operations. The risks of acute fatality from potential accidents at the site are small in comparison with risks of acute fatality from other human activities in a comparatively sized population.

We have concluded that there are no special or unique circumstances about the Waterford 3 site and environs that would warrant special mitigation features for the Waterford Unit 3 plant.

5.9.3 Impacts from the Uranium Fuel Cycle

The Uranium Fuel Cycle rule, 10 CFR Section 51.20 (44 FR 45362), reflects the latest information relative to the reprocessing of spent fuel and to radioactive waste management as discussed in NUREG-0116, Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle,[72] and NUREG-0216,[73] which presents staff responses to comments on NUREG-0116. The rule also considers other environmental factors of the uranium fuel cycle, including aspects of mining and milling, isotopic enrichment, fuel fabrication, and management of low- and high-level wastes. These are described in the AEC report WASH-1248, Environmental Survey of the Uranium Fuel Cycle.[74] The Commission also directed that an explanatory narrative be developed that would convey in understandable terms the significance of releases in the table. The narrative was also to address such important fuel cycle impacts as environmental dose commitments and health effects, socioeconomic impacts and cumulative impacts, where these are appropriate for generic treatment. This explanatory narrative was published in the Federal Register on March 4, 1981 (46 FR 15154-15175). Appendix I to this Statement contains a number of sections that address those impacts of the fuel cycle that reasonably appear to have significance for individual reactor licensing sufficient to warrant attention for NEPA purposes.

Table S-3 of the final rule is reproduced in its entirety as Table 5.12 herein. Specific categories of natural resource use included in the table relate to land use, water consumption and thermal effluents, radioactive releases, burial of transuranic and high- and low-level wastes, and radiation doses from transportation and occupational exposures. The contributions in the table for

Table 5.13 Table of Uranium Fuel Cycle Environmental Data[1]

[Normalized to model LWR annual fuel requirement [WASH-1248] or reference reactor year [NUREG-0116]]

Environmental considerations	Total	Maximum effect per annual fuel requirement or reference reactor year of model 1,000 MWe LWR
NATURAL RESOURCES USE		
Land (acres):		
Temporarily committed [2]	100	
Undisturbed area	79	
Disturbed area	22	Equivalent to a 110 MWe coal-fired power plant.
Permanently committed	13	
Overburden moved (millions of MT)	2.8	Equivalent to 95 MWe coal-fired power plant.
Water (millions of gallons):		
Discharged to air	160	=2 percent of model 1,000 MWe LWR with cooling tower.
Discharged to water bodies	11,090	
Discharged to ground	127	
Total	11,377	<4 percent of model 1,000 MWe LWR with once-through cooling.
Fossil fuel:		
Electrical energy (thousands of MW-hour)	323	<5 percent of model 1,000 MWe LWR output.
Equivalent coal (thousands of MT)	118	Equivalent to the consumption of a 45 MWe coal-fired power plant.
Natural gas (millions of scf)	135	<0.4 percent of model 1,000 MWe energy output.
EFFLUENTS—CHEMICAL (MT)		
Gases (including entrainment): [3]		
SO_x	4,400	
NO_x [4]	1,190	Equivalent to emissions from 45 MWe coal-fired plant for a year.
Hydrocarbons	14	
CO	29.6	
Particulates	1,154	
Other gases:		
F	.67	Principally from UF_6 production, enrichment, and reprocessing. Concentration within range of state standards—below level that has effects on human health.
HC1	.014	
Liquids:		
SO^-_4	9.9	From enrichment, fuel fabrication, and reprocessing steps. Components that constitute a potential for adverse environmental effect are present in dilute concentrations and receive additional dilution by receiving bodies of water to levels below permissible standards. The constituents that require dilution and the flow of dilution water are: NH_3—600 cfs. NO_3—20 cfs. Fluoride—70 cfs.
NO^-_3	25.8	
Fluoride	12.9	
Ca^{++}	5.4	
$C1^-$	8.5	
Na^+	12.1	
NH_3	10.0	
Fe	.4	
Tailings solutions (thousands of MT)	240	From mills only—no significant effluents to environment.
Solids	91,000	Principally from mills—no significant effluents to environment.

Table 5.13 - Continued

[Normalized to model LWR annual fuel requirement [WASH-1248] or reference reactor year [NUREG-0116]]

Environmental considerations	Total	Maximum effect per annual fuel requirement or reference reactor year of model 1,000 MWe LWR
EFFLUENTS—RADIOLOGICAL (CURIES)		
Gases (including entrainment):		
Rn-222		Presently under reconsideration by the Commission.
Ra-226	.02	
Th-230	.02	
Uranium	.034	
Tritium (thousands)	18.1	
C-14	24	
Kr-85 (thousands)	400	
Ru-106	.14	Principally from fuel reprocessing plants.
I-129	1.3	
I-131	.83	
Tc-99		Presently under consideration by the Commission.
Fission products and transuranics	.203	
Liquids:		
Uranium and daughters	2.1	Principally from milling—included tailings liquor and returned to ground—no effluents; therefore, no effect on environment.
Ra-226	.0034	From UF_6 production.
Th-230	.0015	
Th-234	.01	From fuel fabrication plants—concentration 10 percent of 10 CFR 20 for total processing 26 annual fuel requirements for model LWR.
Fission and activation products	5.9×10^{-6}	
Solids (buried on site):		
Other than high level (shallow)	11,300	9,100 Ci comes from low level reactor wastes and 1,500 Ci comes from reactor decontamination and decommissioning—buried at land burial facilities. 600 Ci comes from mills—included in tailings returned to ground. Approximately 60 Ci comes from conversion and spent fuel storage. No significant effluent to the environment.
TRU and HLW (deep)	1.1×10^{7}	Buried at Federal Repository.
Effluents—thermal (billions of British thermal units)	4,063	<5 percent of model 1,000 MWe LWR.
Transportation (person-rem):		
Exposure of workers and general public	2.5	
Occupational exposure (person-rem)	22.6	From reprocessing and waste management.

[1] In some cases where no entry appears it is clear from the background documents that the matter was addressed and that, in effect, the Table should be read as if a specific zero entry had been made. However, there are other areas that are not addressed at all in the Table. Table S-3 does not include health effects from the effluents described in the Table, or estimates of releases of Radon-222 from the uranium fuel cycle or estimates of Technetium-99 released from waste management or reprocessing activities. These issues may be the subject of litigation in the individual licensing proceedings.

Data supporting this table are given in the "Environmental Survey of the Uranium Fuel Cycle," WASH-1248, April 1974; the "Environmental Survey of the Reprocessing and Waste Management Portion of the LWR Fuel Cycle," NUREG-0116 (Supp. 1 to WASH-1248); the "Public Comments and Task Force Responses Regarding the Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle," NUREG-0216 (Supp. 2 to WASH-1248); and in the record of the final rulemaking pertaining to Uranium Fuel Cycle Impacts from Spent Fuel Reprocessing and Radioactive Waste Management, Docket RM-50-3. The contributions from reprocessing, waste management and transportation of wastes are maximized for either of the two fuel cycles (uranium only and no recycle). The contribution from transportation excludes transportation of cold fuel to a reactor and of irradiated fuel and radioactive wastes from a reactor which are considered in Table S-4 of § 51.20(g) The contributions from the other steps of the fuel cycle are given in columns A-E of Table S-3A of WASH-1248.

[2] The contributions to temporarily committed land from reprocessing are not prorated over 30 years, since the complete temporary impact accrues regardless of whether the plant services one reactor for one year or 57 reactors for 30 years.

[3] Estimated effluents based upon combustion of equivalent coal for power generation.

[4] 1.2 percent from natural gas use and process.

reprocessing, waste management, and transportation of wastes are maximized for either of the two fuel cycles (uranium only and no recycle); that is, the cycle that results in the greater impact is used.

Appendix I to this Statement contains a description of the environmental impact assessment of the uranium fuel cycle as related to the operation of Waterford 3. The environmental impacts are based on the values given in Table S-3, and on an analysis of the radiological impact from radon releases. The NRC staff has determined that the environmental impact of the station on the U.S. population from radioactive gaseous and liquid releases (including radon) due to the uranium fuel cycle is insignificant when compared with the impact of natural background radiation. In addition, the nonradiological impacts of the uranium fuel cycle have been found to be acceptable.

5.10 DECOMMISSIONING*

The technology for decommissioning nuclear facilities is well in hand, and, while technical improvements in decommissioning techniques are to be expected, at the present time decommissioning can be performed safely and at reasonable cost. Radiation doses to the public as a result of decommissioning activities should be very small and would primarily come from the transportation of decommissioning waste to waste burial grounds. Radiation doses to decommissioning workers should be a small fraction of the worker exposure over the operating lifetime of the facility; these doses will be well within the occupational exposure limits imposed by regulatory requirements. Decommissioning costs are, at least for the larger facilities such as reactors, a small fraction of the present worth commissioning costs.

Decommissioning of nuclear facilities is not an imminent health and safety problem. However, planning for decommissioning can have an impact on health and safety as well as cost. Essential to such planning activity is the decommissioning alternative to be used and timing. Also to be considered are (1) acceptable residual radioactivity levels for unrestricted use of the facility, (2) financial assurance that funds will be available for performing required decommissioning activities at the end of facility operation (including premature closure), and (3) the facilitation of decommissioning. Decommissioning of a nuclear facility generally has a positive environmental impact. At the end of facility life, termination of a nuclear license is required.

Such termination requires decontamination of the facility so that the level of any residual radioactivity remaining in the facility or on the site is low enough to allow either unrestricted use of the facility and site or recommissioning of the facility as a nuclear or nonnuclear power plant.

Compared to operational requirements, the commitment of resources for decommissioning is generally small. The major environmental impact of decommissioning is the commitment of small amounts of land for the burial of waste. This is in exchange for being able to reuse the facility and site for other nuclear or

*The material in this section is based on USNRC, "Draft Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities," NUREG-0586, January 1981.[75]

nonnuclear purposes. Because in many instances (such as at a reactor facility) the land has valuable resource capability, the return of this land to the commercial or public sector is highly desirable. In decommissioning nuclear facilities, the objective of NRC regulatory policy is to ensure that proper and explicit procedures are followed to mitigate any potential for adverse impact on public health and safety or on the environment.

Three alternative methods can be and have been used to decommission reactors. "DECON" means to remove immediately all radioactive materials down to levels which would permit the property to be released for unrestricted use. "SAFSTOR" is defined as those activities required to place and maintain a radioactive facility in such condition that (1) the risk to safety is within acceptable bounds and (2) the facility can be safely stored for as long a time as desired and subsequently decontaminated to levels which would permit release of the facility for unrestricted use. SAFSTOR consists of a short period of preparation for safe storage; a variable length safe-storage period of continuing care consisting of security, surveillance, and maintenance (up to 100 years); and a short period of deferred decontamintion. Several variations of SAFSTOR are possible. "ENTOMB" means to encase and maintain property in a strong and structurally long-lived material to ensure retention until radioactivity decays to a level acceptable for releasing the facility for unrestricted use. ENTOMB is intended for use where the residual radioactivity will decay to levels permitting unrestricted release of the facility within reasonable time periods.

Estimated costs of decommissioning vary, depending on the characteristics of the particular reactor and the decommissioning mode chosen. For a large PWR, DECON is estimated to cost $33.3 million (in 1978 dollars); SAFSTOR is estimated to cost $42.8 million with a 30-yr safe-storage period and $41.8 million with a 100-yr safe-storage period. ENTOMB is estimated to cost $21.0 million with the pressure vessel and its internals retained plus a $40,000 annual maintenance and surveillance cost in both cases.

5.11 PROJECT MODIFICATIONS TO AVOID OR MITIGATE IMPACTS

A sluiceway from the traveling screens to the river has been designed and built to reduce the kills of fish and macroinvertebrates that would otherwise occur from impingement on the traveling screens (see Sec. 5.6). The effectiveness of the sluiceway will depend upon a number of variables, such as the species of fish and their condition as they leave the traveling screens; the amount and force of the water used on the screens, in the trough, and in the sluiceway; the water temperature; the predator impacts; fish infections, etc.

As mentioned in the FES-CP (p. V-22), the applicant redesigned the discharge structure (built at the river's edge) to facilitate a more rapid mixing of waste heat into the river water. The cooling water will now be discharged at a more rapid velocity of about 128 m/min (7 fps). Because of the smaller size of the thermal plume, fewer organisms in the river will be exposed; also, those organisms that are exposed to the plume will remain in it for a shorter time.

5.12 CONFLICTS WITH THE PROPOSED ACTION

The staff finds no conflict between environmental concerns and the proposed action which would at this time preclude granting an operating license for Waterford 3.

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61. H. W. Bertini et al., Nuclear Safety Information Center, Oak Ridge National Laboratory, "Descriptions of Selected Accidents That Have Occurred at Nuclear Reactor Facilities," ORNL/NSIC-176, April 1980.

62. L. B. Marsh, U. S. Nuclear Regulatory Commission Report "Evaluation of Steam Generator Tube Rupture Accidents," NUREG-0651, March 1980.

63. "Three Mile Island - A Report to the Commissioners and the Public," Vol. I, Mitchell Rogovin, Director, Nuclear Regulatory Commission Special Inquiry Group, January 1980, Summary Section 9. (NUREG/CR-1250, Vol. I)

64. "Report of the President's Commission on the Accident at Three Mile Island," October 1979, Commission Findings B, Health Effects.

65. U.S. Nuclear Regulatory Commission, "Clarification of TMI Action Plan Requirements," USNRC Report NUREG-0737, November 1980.

66. U.S. Nuclear Regulatory Commission, "Reactor Safety Study--An Assessment," WASH-1400 (NUREG-75/014), October 1975.

67. "Task Force Report on Interim Operations of Indian Point," NUREG-0715, August 1980.

68. "Risk Assessment Review Group Report to the U.S. Nuclear Regulatory Commission," H. W. Lewis et al., NUREG/CR-0400, September 1978.

69. U.S. Nuclear Regulatory Commission, "Overview of the Reactor Safety Study Consequences Model," USNRC Report NUREG-0340, October 1977.

70. U.S. Nuclear Regulatory Commission, "Liquid Pathway Generic Study," USNRC Report NUREG-0440, February 1978.

71. U.S. Nuclear Regulatory Commission, "NRC Action Plan Developed as a Result of the TMI-2 Accident," Vol. I, USNRC Report NUREG-0660, May 1980.

72. U.S. Nuclear Regulatory Commission, "Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle," NUREG-0116 (Supplement 1 to WASH-1248), October 1976.

73. U.S. Nuclear Regulatory Commission, "Public Comments and Task Force Responses Regarding the Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle," NUREG-0216 (Supplement 2 to WASH-1248), March 1977.

74. U.S. Atomic Energy Commission, "Environmental Survey of the Uranium Fuel Cycle," WASH-1248, April 1974.

75. U.S. Nuclear Regulatory Commission, "Draft Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities," USNRC Report NUREG-0586, January 1981.

76. Title 10 Code of Federal Regulations Part 51, "Licensing and Regulatory Policy and Procedures for Environmental Protection," U.S. Nuclear Regulatory Commission, January 1, 1981.

6 EVALUATION OF THE PROPOSED ACTION

6.1 RESUME

After the FES-CP was issued, changes were made in the station's intake and discharge designs to reduce adverse impacts on aquatic biota (Section 6.2.1). Certain operational practices could further reduce potential adverse effects on aquatic biota (Section 6.2.2). Effluent limitations and monitoring of non-radiological discharges are established by the effective NPDES permit (Section 6.2.3.1). The preoperational monitoring program for the site's forested wetlands, proposed February 23, 1979, is described in Section 6.2.3.2.

A benefit-cost summary, based on recent information, is presented in Section 6.6.

6.2 MEASURES AND CONTROLS TO LIMIT ADVERSE IMPACTS

6.2.1 Project Design

The intake-structure design features described in Section 4.2.2.3 will tend to ameliorate entrainment and impingement impacts on the benthic macroinvertebrates and the bottom-dwelling fishes, such as the blue and channel catfishes. Some of the shad will be drawn into the intake and impinged, since they are more of a pelagic species. However, a sluiceway is available to remove impinged fish and macroinvertebrates from the traveling screens and return them to the river (Section 5.11), which may lower the impingement mortality rate to less than that which would otherwise be anticipated.

The discharge structure has been designed to augment rapid thermal dispersion of the effluent; it will form a 128-m/min (7-fps) jet stream (Sec. 4.2.2 and 5.3) during typical low flows (FES-CP, pp. V-4, and XII-3), reducing potential thermal stress on aquatic biota.

6.2.2 Operating Practices

During scheduled shutdowns in the colder months, a gradual reduction in power could reduce the potential for coldshock among fishes that may have become acclimated to the warmed water.

The effective NPDES permit restricts the discharge of free available chlorine from the once-through cooling system to 0.2 mg/L (daily average) and 0.5 mg/L (daily maximum). Neither free available chlorine nor total residual chlorine may be discharged for more than 2 hours in any one day (NPDES permit, Part III.F). Since the applicant plans to chlorinate the cooling-water system only about 20 days/yr (ER-OL, p. 301.8-1), the potential impacts on aquatic biota as a result of chlorination should be minimal.

6.2.3 Nonradiological Monitoring Programs

6.2.3.1 Aquatic Program

The applicant's preoperational environmental program is described in the ER-OL (pp. 6.1.1-1 to 15, Tables 6.1.1-1 to 9 and Figures 6.1.1-1 to 4). Aspects of the surface waters are discussed as well as the monitoring of physical, chemical, and biological parameters. Results of the study program have been used in the environmental descriptions and assessments presented in Sections 4 and 5 of this impact statement. The applicant, also, has used the results in making successful demonstrations to EPA regarding the thermal discharge and the intake structure pursuant to Sections 316(a) and 316(b) of the Clean Water Act.

EPA's approvals of the thermal discharge and intake structure are granted without condition for operational monitoring (see NPDES permit, Part III.G and H; copy provided as Appendix E). Effluent limitations and monitoring of other nonradiological discharges are established solely via the NPDES permit and the State water quality certification. The NRC will be relying on the State and EPA for protection of the aquatic environment from nonradiological discharges and cooling system impacts.

6.2.3.2 Terrestrial Program

The terrestrial vegetation monitoring program is limited to preoperational assessments. A 3-year surveillance program, April 1973 to August 1976, was conducted on the batture (land between the levee and river) northwest of the site. Systematic transect studies of the vegetation covered the six plant communities in the study area. This study area is triangular in shape (ER-OL, Fig. 6.1.4-2). It is bounded by the artificial levee and the river for a distance of about 3.2 km (1.9 mi); the apex of the triangle lies about 400 m (433 yd) northwest of the site. The base of the triangle, which runs between the artificial levee and the river, is about 1.2 km (0.7 mi) long.

Faunal studies were carried out during a 3-year period, 1974 - 1976, in each of the four seasons. Survey plots, 0.4 ha (1 acre), were established to study amphibians and reptiles. Supplemental surveys consisting of monitoring frog calls and nighttime spotlighting were also done. Bird surveys, made by walking transects and mist netting, were used to assess the bird population. Small and large mammals were trapped and sightings, tracks, and nighttime spotlighting were used. The transects, as well as the trapping and netting sites, are shown in Figure 6.1.4-2 of the ER-OL.

An expansion of the terrestrial ecology preoperational monitoring program for the forested wetlands portion of the site was proposed by the applicant on February 23, 1979.[1] Aside from the proposed expansion, the applicant has no further plans for surveys or monitoring. The staff agrees that there is no need for terrestrial monitoring programs because the operational impact is not expected to have any long-term effects on the terrestrial biota (see Sec. 5.5).

6.2.4 <u>Radiological Monitoring Programs</u>

6.2.4.1 Preoperational Monitoring

Radiological environmental monitoring programs are established to provide data on measurable levels of radiation and radioactive materials in the site environs. Appendix I to 10 CFR Part 50 requires that the relationship between quantities of radioactive material released in effluents during normal operation be evaluated, including anticipated operational occurrences and resultant radioactive doses to individuals from principal pathways of exposure. Monitoring programs are conducted to verify the in-station controls used for controlling the releases of radioactive materials and to provide public reassurance that undetected radioactivity will not build up in the environment. Surveillance is established to identify changes in the use of unrestricted areas to provide a basis for modification of the monitoring programs.

The preoperational phase of the monitoring program provides for measuring background levels and their variations along the anticipated important pathways in the area surrounding the station, training personnel, and evaluating procedures, equipment, and techniques.

This is discussed in greater detail in NRC Regulatory Guide 4.1, Rev. 1, "Programs for Monitoring Radioactivity in the Environs of Nuclear Power Plants," and the Radiological Assessment Branch Technical Position, August 1977, "Standard Technical Specification for Radiological Environmental Monitoring Program."

The preoperational radiological environmental monitoring program being followed by the applicant is summarized in Table 5.7 and described in more detail in Chapter 6 of the applicant's Environmental Report.

The staff concludes that the preoperational monitoring program by the applicant for the Waterford Station is acceptable.

6.2.4.2 Operational Monitoring

The operational offsite radiological monitoring program is conducted to measure radiation levels in the station environs. It assists and provides backup support to the detailed effluent monitoring (as recommended in NRC Regulatory Guide 1.21, "Measuring, Evaluating, and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid and Gaseous Effluents from Light- Water Cooled Nuclear Power Plants"), which is needed to evaluate individual and population exposures and verify projected or anticipated radioactivity concentrations.

The applicant plans essentially to continue the preoperational program during the operational period (see Table 5.7). However the thermoluminescent dosimeter (TLD) locations will be updated to reflect the 1979 Branch Technical Position, Revision 1. Other refinements may be made in the program to reflect changes in land use, preoperational monitoring experience and revisions to NUREG-0472, "Radiological Effluent Technical Specifications for PWRs."

6.3 UNAVOIDABLE ADVERSE IMPACTS

The staff has reassessed the physical, social, and economic impacts that can be attributed to the operation of Waterford 3. It has not identified any additional adverse effects that will be caused by plant operation. According to the FES-CP (Sec. III) the applicant planned to build a 230-kV line for Waterford 3 operation to traverse 37.8 km (23.5 mi) of wetland to its termination at the Churchill substation. This line is independent of the Waterford 3 project (ER-OL, Sec. 3.9.1). The applicant already has three power-generating facilities near Waterford 3 that will use the line. However, if Waterford 3 is licensed, it will also use the new line.

6.4 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

There has been no change in the staff's assessment of the impacts of the irreversible and irretrievable commitments of resources since the earlier review (FES-CP, p. IX-1), except that the continuing escalation of costs has increased the dollar values of the materials used for constructing and fueling the plant.

6.5 RELATIONSHIP BETWEEN SHORT-TERM USES AND LONG-TERM PRODUCTIVITY OF THE ENVIRONMENT

The staff's evaluation of the use of land for the site of Waterford 3 has not changed significantly since the preconstruction environmental review. Construction of the station has removed parish land from other industrial, swampland, timberland, and agricultural uses.

6.6 BENEFIT-COST SUMMARY

6.6.1 Overview

Sections that follow summarize the economic, environmental, and social benefits and costs which are associated with the operation of Waterford 3. The benefits and costs are shown in Table 6.1.

6.6.2 Benefits

The electrical energy generated by Waterford 3 will be the primary benefit from the project. Assuming an annual average capacity factor of 60 percent, Waterford 3 will produce about 5.8 billion kWh per year.

Primary benefits also include improved reliability brought about by the addition of 1104 MWe of generating capacity to the system and greater fuel diversification. The 1983 fuel cost savings associated with the operation of Waterford 3 are estimated at about $230 million.

6.6.3 Cost Description of the Proposed Facility

6.6.3.1 Environmental Costs

The environmental costs (summarized in Table 6.1) of Waterford 3 station operation are as follows:

a. Fish larvae, plankton, and drift macroinvertebrates are expected to be entrained in the cooling system. The impact of the accompanying entrainment loss is considered minor because of its limited magnitude and the subsequent recruitment from unaffected populations.

b. Some fish and river shrimp will be killed upon impingement with the intake screens; however, the staff believes that the fish loss in itself will be a minor environmental cost.

c. Some birds will be killed upon collision with the station buildings during certain meteorological conditions. Although the number killed will be small in relation to the number of birds in the flyway, the staff considers the loss to be an environmental cost.

Table 6.1 Benefit-Cost Summary

BENEFITS	
Electric energy to be supplied	5.8 billion kWh/yr
Generating capacity	1104 MWe
ENVIRONMENTAL COSTS[a]	
Aquatic biota	Minor-acceptable (Section 5.6)
Thermal discharge	Below Louisiana water quality criteria
Chemical discharge	Negligible (Section 5.3.5)
Land use	1440 ha (3560 acres)[b,c]
Socioeconomic impacts	Negligible-minimal (Section 5.8.1)
ECONOMIC COSTS	
Fuel (first year)	8.91 mills/kWh
Operating and maintenance (first year)	5.32 mills/kWh
Decommissioning cost (1978 dollars)	$21 - $43 million
Economic risk of accident--decontamination, repairs, and replacement energy multiplied by probability factor	$62,000 per year
RADIOLOGICAL IMPACT	
Occupation dose	440 man-rems/yr
Population dose (within 80-km radius)	12 man-rems/yr

[a]Most impacts cannot be quantified for comparison with economic costs and benefits; the staff concludes that the ecological impacts, although measurable, will be acceptable.

[b]61 hectares (150 acres) disturbed during construction.

[c]This includes the Waterford 1 and 2 site.

d. The in-movement of households to the area surrounding Waterford 3 may have a minimal adverse impact on the delivery of medical and firefighting services (Sec. 5.8.1).

6.6.3.2 Economic Costs

The economic costs associated with plant operation include fuel costs and operation and maintenance costs, which in the first year of operation, amount to 8.91 mills/kWh and 5.32 mills/kWh. The cost of decommissioning is a small additional cost of operation. The staff estimate for decommissioning Waterford 3 ranges from $21 million to $43 million in 1978 dollars.

6.6.3.3 Radiological Costs

The radiological impacts resulting from Waterford 3 operation have been reestimated on the basis of new information and the results presented in Section 5.9.1. In Section 5.9.2 the staff assessed the impact of plant accidents and concluded that the environmental risk is comparable to the risk from normal operation. The staff concluded that the risk to the public health and safety from exposure to radioactive effluents from both normal operation of Waterford 3 and plant accidents will not be significant and therefore will not alter the cost-benefit balance.

6.6.3.4 Environmental Costs of the Fuel Cycle

The environmental costs associated with the uranium fuel cycle are summarized in Section 5.9.3. The staff has assessed the fuel-cycle effects presented in Table S-3 of the 10 CFR Part 51 (Table 5.13 in this statement) to determine their contribution to the overall environmental costs, and has concluded that the impacts presented in this table are sufficiently small for the case of "no reprocessing" of spent fuel. When superimposed upon the other assessed environmental impacts associated with the proposed Waterford 3, they do not appreciably change the overall environmental impacts, and the conclusion of the benefit-cost balance is not affected.

6.6.3.5 Environmental Costs of Transportation

The environmental effects of transportation of fuel and waste to and from the plant are summarized in Section 5.9.3. The impact of those effects is sufficiently small so as not to affect significantly the conclusions of the benefit-cost balance. The staff has assumed there would be no reprocessing of spent fuel from Waterford 3.

6.6.4 <u>Conclusions</u>

As a result of the analysis and review of potential environmental, technical, economic, and social impacts, the staff has been able to forecast more accurately the effects of the operation of Waterford 3. No new information has been obtained that alters the overall balancing of the benefits of station operation versus the environmental costs. Consequently, the staff has determined that the station will most likely operate with only minimal environmental impact. The staff finds that the primary benefits of minimizing system production costs and increasing baseload generating capacity by 1104 MWe greatly outweigh the environmental, social, and economic costs. Benefits and costs are summarized in Table 6.1.

REFERENCE FOR SECTION 6

1. Letter from D. A. Aswell, LP&L, to P. Cota, NRC, February 23, 1979, Docket 50-382, Subject: Expanded terrestrial ecology program.

7 LIST OF CONTRIBUTORS

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8 AGENCIES AND ORGANIZATIONS TO WHICH COPIES OF THE DRAFT ENVIRONMENTAL STATEMENT WERE SENT

Copies of this document were sent to the following on initial distribution:

Advisory Council on Historic Preservation
Department of Argiculture
Department of the Army, Corps of Engineers
Department of Commerce
Department of Energy
Evnironmental Protection Agency
Federal Emergency Management Agency
Department of Health and Human Services
Department of Housing and Urban Development
Department of the Interior
Department of Transportation
Attorney General, Louisiana
Louisiana Board of Nuclear Energy
The Policy Jury of St. Charles Parish, Louisiana
Office of State Clearinghouse, State of Louisiana

9. STAFF RESPONSES TO COMMENTS ON THE DRAFT ENVIRONMENTAL STATEMENT

Pursuant to 10 CFR Part 51, the draft environmental statement related to the operation of the Waterford Steam Electric Station, Unit No. 3 was transmitted, with a request for comments, to those agencies listed in Section 8.

In addition, the NRC requested comments on the draft environmental statement from interested persons by a notice published in the FEDERAL REGISTER on May 15, 1981 (46 FR 26959). In response to the requests referred to above, comments were received from:

U.S. Department of Agriculture
U.S. Department of the Interior
Federal Energy Regulatory Commission
Department of Housing and Urban Development, Region VI
Louisiana Power & Light (Applicant)
Department of Health and Human Services, Food and Drug Administration
U.S. Environmental Protection Agency
Department of Housing and Urban Development
State of Louisiana, Department of Culture, Recreation and Tourism
Department of the Army, Corps of Engineers
U.S. Department of Transportation
W.A. Lochstet, Ph.D

The letters of comment are reproduced in this statement as Appendix A. The staff's consideration of the comments received and its disposition of the issues involved are reflected in part by revised text in the pertinent sections of this final environmental statement and in part by the following discussions. Following each heading, the page on which the comment appears is indicated.

9.1 DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE (A-2)

The staff is in essential agreement with this comment regarding land use. No response is necessary.

9.2 U.S. DEPARTMENT OF THE INTERIOR, OFFICE OF THE SECRETARY (A-2)

No response is necessary.

9.3 FEDERAL ENERGY REGULATORY COMMISSION (A-3)

No response is necessary.

9.4 DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT, REGION VI (A-3)

No response is necessary.

9.5 LOUISIANA POWER & LIGHT COMPANY (A-4)

Comment 1 (Regarding the NPDES):

Appropriate changes have been made in Section 1 and in Appendix E.

Comment 2 (Regarding reliability analysis):

Appropriate changes have been made in Section 2.4.

Comment 3 (Regarding fuel uncertainties):

The text has been corrected.

Comment 4 (Regarding cooling water use):

Table 4.1 has been corrected.

Comment 5 (Regarding plant discharge velocities):

Table 4.2 has been corrected.

Comment 6 (Regarding laboratory and decontamination solutions):

The text of Section 4.2.4.5 has been revised.

Comment 7 (Regarding cultural resources):

Section 4.3.6 has been revised.

Comment 8 (Regarding demography):

Appropriate changes have been made in the text of Section 4.3.7.1.

Comment 9 (Regarding land use):

The text of Section 4.3.7.2 has been revised.

Comment 10 (Regarding land use):

The applicant may be correct within exactly 8 km (5 mi). However, the statement refers to St. Charles Parish based upon "Regional Housing Study, Louisiana South Central Planning and Development Commission," May 1975. As the applicant's prediction is based on a 1973 document and as such projections may be unreliable at this time, no change has been made in the FES.

Comment 11 (Regarding the staff's hydrothermal analysis):

The text of Section 5.3.2.3 has been revised.

Comment 12 (Regarding cultural resources):

Section 5.7 has been revised.

Comment 13 (Regarding size of operational work force):

The text of Section 5.8 has been revised as appropriate.

Comment 14 (Regarding impact of operational work force):

Prior independent information (in 1977 by the Louisiana South Central Planning and Development Commission) and a staff survey subsequent to that of LP&L indicates that public services in the area were generally marginal. In any case, LP&L's conclusion is the same as the staff's--LP&L workers will minimally or insignificantly impact the social services system. LP&L states it is because the services are adequate; the staff states it is because the services, though inadequate, will be impacted by so much other industrial and commercial activity that the Waterford operation will have marginal impact. Therefore, no text change has been made.

Comment 15 (Regarding economic impacts):

Section 5.8.2.1 has been updated.

Comment 16 (Regarding economic impacts):

Section 5.8.2.2 has been revised.

Comment 17 (Regarding radiological impact of operation):

All releases from the plant stack were assumed to pass through a 4 inch charcoal adsorber and thus received credit for an iodine removal efficiency of 90%.

In the case of the condenser vacuum pumps, at the time of the DES no commitment has been made by LP&L to divert the condenser vacuum pump flow to the stack at any particular release rate of iodine. Since the publication of the DES, LP&L has committed to divert flow from the condenser vacuum pumps to the plant stack when the release rate of I-131 would be equivalent to an unfiltered release rate of 5×10^{-3} Ci/yr (2×10^{-4} μCi/sec). The FES presents a revised table of radioactive gaseous effluents which reflects this commitment to divert the condenser vacuum pump flow to the plant stack at the above I-131 release rate.

Comment 18 (Regarding radiological impact of operation):

Section 5.9.1 has been revised.

Comment 19 (Regarding radiological impact of operation - synergism):

The staff will address this concern to the extent necessary, in testimony at the Operating License hearing.

Comment 20 (Regarding plant design):

The text of Section 6.2.1 has been revised as suggested.

Comment 21 (Regarding radiological monitoring program):

The text of Section 6.2.4.1 has been revised as suggested.

Comment 22 (Regarding radiological monitoring program):

The text of Section 6.2.4.2 has been revised as suggested.

Comment 23 (Regarding cost-benefit analysis):

Section 6.6.2 has been revised as suggested.

9.6 DEPARTMENT OF HEALTH AND HUMAN SERVICES (A-13)

Comment 1 (Regarding radiological releases):

No response is necessary.

Comment 2 (Regarding radiological releases):

No response is necessary.

Comment 3 (Regarding emergency planning):

An operating license will not be issued to the applicant unless a finding is made by the NRC staff that the onsite and offsite emergency preparedness plan provides reasonable assurance that protective actions can and will be taken in the event of a radiological emergency.

The text in the Section 5.9.2.4(3) is a very simplified outline of emergency preparedness plan, in general terms. The details of evaluation of site's emergency preparedness plan will be fully covered in the staff's Safety Evaluation Report, as supplemented.

Comment 4 (Regarding radiological monitoring program):

No response is necessary.

Comment 5 (Regarding environmental effects of the uranium fuel cycle):

No response is necessary.

9.7 U.S. ENVIRONMENTAL PROTECTION AGENCY, REGION VI (A-14)

Generic Comment: No response necessary.

Radioactive Waste Treatment System:

Confirmatory items in the initial draft of the SER did not appear in the SER since the confirmatory information became available prior to the publication of the SER. The SER reflects the capability of the liquid, gaseous, and solid radwaste systems to meet the various regulatory requirements. The findings presented in the SER should not negate EPA's initial conclusion with respect to these systems.

Reactor accidents:

Accidents bounded by the envelope of the design basis accidents are not significant contributors to environmental risk, and therefore have not been subjected to the same kind of probabilistic analysis.

Decommissioning:

The Commission policy on reactor decommissioning, including funding methods for decommissioning, is as stated in the regulations under 10 CFR 50.33(f), 50.82, and Appendix F to Part 50. Guidance is also provided under Regulatory Guide 1.86. The NRC regulations do not require the applicant to submit specific decommissioning plans at the time the application for an operating license is filed. At the end of the station's useful lifetime, the applicant will be required to prepare a proposed decommissioning plan for review and approval by the NRC. The plan will be required to comply with NRC rules and regulations then in effect.

With regard to funding decommissioning, the Commission requires that "the applicant possesses or has reasonable assurance of obtaining the funds necessary to cover the estimated costs of operation for the period of the license or for 5 years, whichever is greater, plus the estimated costs of permanently shutting the facility down and maintaining it in a safe condition." (10 CFR 50.33(f)). Historically, the Commission in evaluating the financial qualifications of an applicant has concluded that if an applicant for a reactor operating license is financially qualified to construct or operate a facility, it is also financially qualified to shut it down. Consequently, the Commission has not prescribed specific methods to set aside funds for decommissioning. However, the NRC has undertaken a comprehensive reevaluation regarding decommissioning and, as part of this reevaluation, the staff has been reexamining the extent to which the Commission's regulations and policies assure that adequate funds will be available to decommission a nuclear facility after its operating life has ended.

The staff has identified four realistic methods for setting aside funds for decommissioning a reactor. These are as follows:

1. Prepayment of decommissioning costs is made prior to reactor startup, most likely into a trust account;

2. A funded reserve is accumulated over the estimated life of the plant, most likely into a trust account;

3. An unfunded reserve is established generally using negative net salvage value depreciation in the licensee's accounting system;

4. Surety mechanisms, including insurance, are established separately or in conjunction with the first three methods.

Analyses of these alternatives are available in an NRC staff study, Assuring the Availability of Funds for Decommissioning Nuclear Facilities (NUREG-0584, Rev. 2, October 1980) and an NRC commissioned report, Financing Strategies for Nuclear Power Plant Decommissioning (NUREG/CR-1481, July 1980).

The licensee's financial responsibilities are terminated only after the site is judged acceptable for unrestricted access based on the findings of a final termination survey. In the case of SAFSTOR, which allows deferral of decontamination for up to 100 years, the licensee's financial responsibility would remain in effect throughout this period. However, it should be noted that for operating reactors, the NRC staff recommends the SAFSTOR option with up to 30 years deferral for decontamination. The 100 year deferral is only a reasonable option for other nuclear facilities whose fission product residuals have longer half-lives.

Economic Risks:

Table 6.2 has been revised to accommodate this concern.

Safety Evaluation Report:

The NRC will not issue an operating license for Waterford 3 until all issues in the safety evaluation have been adequately addressed, and we have reasonable assurance that the plant's operation will not endanger the public health and safety. The NEPA analysis we have performed is based on the NRC staff satisfactory completing its evaluation of the safe design, construction, and operation of Waterford 3. The outcome of the ongoing staff review of safety issues has no potential for significantly altering the staff's conclusions regarding the environmental impact of the operation of Waterford 3.

Additional Comments (Regarding radiological impacts):

1. Please see the revised text in the second paragraph in Section 5.9.2.2(3) in FES.

2. The guidelines for environmental monitoring sample locations are contained in the 1979 Branch Technical Position, Revision 1. In

accordance with these guidelines, the licensee is not required to sample within the intake structure or the discharge canal. However, in accordance with the technical specification guidelines contained in NUREG-0472, Revision 2, Radiological Effluent Technical Specifications for PWRs, July 1979, the licensee is required to sample the liquid waste treatment system to determine the concentration of radioactivity prior to the liquid effluent being released. Table 6.1 has been clarified to reflect this comment.

3. The text has been revised.

4. The text has been revised.

9.8 DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT (A-17)

No response is necessary.

9.9 STATE OF LOUISIANA, DEPARTMENT OF CULTURE, RECREATION AND TOURISM (STATE HISTORIC PRESERVATION OFFICER) (A-18)

(Regarding cultural resources)

No response is necessary.

9.10 DEPARTMENT OF THE ARMY, NEW ORLEANS DISTRICT CORPS OF ENGINEERS (A-18)

Comment a (Regarding chemical releases):

Reactor coolant chemicals are discharged at such low concentrations that effect of temperature on coolant chemicals is meaningless. From the DES, page 4-10, the anticipated discharge concentrations of the coolant chemicals are as follows:

Hydrazine	9.5×10^{-9} ppm
Ammonia	1.9×10^{-7} ppm
Boron	2×10^{-5} ppm

Dilution in the river further reduces these concentrations.

Sulfate is discharged at higher concentrations than the coolant chemicals. However, after dilution in the river, the net effect is an increase in sulfate concentration in the river downstream of the plant of 9×10^{-3} ppm (page 5-17).

The effect of temperature on chemical equilibrium will be limited to the discharge plume area. The planktonic primary producers would move into, through, and out of the plume relatively continuously and would not be subjected to prolonged exposure to any difference in carbonate equilibrium which might exist. The direct effect of plume temperature on organism metabolism is likely to overshadow any secondary effect of plume chemical equilibrium.

Comment b (Regarding COE permit date):

Table 1.1 has been corrected to reflect the date shown in the Corps' records.

9.11 U.S. DEPARTMENT OF TRANSPORTATION, REGION 6 (A-19)

No response is necessary.

9.12 W.A. Lochstet, Ph.D. (A-20)

(Regarding long-term health consequences)

Dr. Lochstet's basic contention is that "the health consequences of radon-222 emissions from the uranium fuel cycle are improperly evaluated" in the Waterford Draft Environmental Statement (DES, NUREG-0779). The basis for his contention is that the staff has arbitrarily evaluated the health impacts of radon-222 releases from the wastes generated in the fuel cycle for 1000 years or less, rather than for "the entire toxic life of the wastes." Dr. Lochstet then estimates that radon-222 emissions from the wastes from each annual reactor fuel requirement will cause about 600,000 to 12 million deaths over a period of more than 1 billion years.

The major difference between the staff's estimated number of health effects from radon-222 emissions and Dr. Lochstet's estimated values is the issue of the time period over which dose commitments and health effects from long-lived radioactive effluents should be evaluated. Dr. Lochstet has integrated dose commitments and health effects over what amounts to an infinite time interval, whereas the staff has integrated dose commitments from radon-222 releases over a 100-year period, a 500-year period, and a 1000-year period.

The staff has not estimated health effects from radon-222 emissions beyond 1000 years for the following reasons. Predictions over time periods greater than 100 years are subject to great uncertainties. These uncertainties result from, but are not limited to, political and social considerations, population size, health characteristics, and, for time periods on the order of thousands of years, geologic and climatologic effects. In contrast to Dr. Lochstet's conclusion, some authors estimate that the long-term (thousands of years) impacts from the uranium used in reactors will be less than the long-term impacts from an equivalent amount of uranium left undistributed in the ground. Consequently, the staff has limited its period of consideration to 1,000 years or less for decision-making and impact-calculational purposes.

REFERENCE FOR SECTION 9

1. B. L. Cohen, "Radon: Characteristics, Natural Occurrence, Technological Enhancement, and Health Effects," Vol. 4, Progress in Nuclear Energy, 1979.

APPENDIX A

COMMENTS ON THE DRAFT ENVIRONMENTAL STATEMENT

TABLE OF CONTENTS

United States Department of Agriculture
Soil Conservation Service

3737 Government Street
Alexandria, LA 71301

June 8, 1981

Ms. Suzanne Black
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Ms. Black:

Re: Draft EIS, Operation of Waterford Steam Electric Station
Unit No. 3, LA Power and Light

As requested, we have reviewed the draft EIS on the operation of Waterford Steam Electric Station, Unit No. 3.

The approximately 100 acres of land that will be utilized during construction and operation are classified as prime farmland.

Prime farmlands are those whose value derives from their general advantage as cropland due to soil and water conditions. This land does not have to be presently in row crops to be classified as prime farmland. Prime farmland can be cropland, pastureland, forestland, or other land, but not urban builtup land.

We appreciate the opportunity to provide these comments on the draft EIS.

Sincerely,

Harry A. Lusher
Alton Mangum Acting
State Conservationist

cc: Norman Berg, Chief, SCS, Washington
Edward E. Thomas, Assistant Chief, SE, SCS, Washington, D.C.
Billy M. Johnson, Director, STSC, SCS, Fort Worth
Director, Environmental Services, SCS Washington, D.C.

RECEIVED JUN 12 1981 U.S. NUCLEAR REGULATORY COMMISSION

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The Soil Conservation Service is an agency of the Department of Agriculture

SCS-10-79

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United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

ER 81/946

JUN 17 1981

RECEIVED JUN 22 1981 U.S. NUCLEAR REGULATORY COMMISSION

Mr. Frank J. Miraglia
Acting Chief, Licensing Branch No. 3
Division of Licensing
Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Miraglia:

We have reviewed the Draft Environmental Statement related to the operation of the Waterford Steam Electric Station, Unit No. 3, St. Charles Parish, Louisiana and find that it adequately analyzes the impacts of the proposal from our jurisdiction and expertise. The opportunity to review this document is appreciated.

Sincerely,

CECIL S. HOFFMANN
Special Assistant to
Assistant SECRETARY

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FEDERAL ENERGY REGULATORY COMMISSION
WASHINGTON 20426

IN REPLY REFER TO:

June 18, 1981

Mr. Frank J. Miraglia
Acting Chief, Licensing Branch No. 3
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Miraglia:

I am replying to your request of May 8, 1981 to the Federal Energy Regulatory Commission for comments on the Draft Environmental Impact Statement for the Waterford Steam Electric Station, Unit No. 3. This Draft EIS has been reviewed by appropriate FERC staff components upon whose evaluation this response is based.

This staff concentrates its review of other agencies' environmental impact statements basically on those areas of the electric power, natural gas, and oil pipeline industries for which the Commission has jurisdiction by law, or where staff has special expertise in evaluating environmental impacts involed with the proposed action. It does not appear that there would be any significant impacts in these areas of concern nor serious conflicts with this agency's responsibilities should this action be undertaken.

Thank you for the opportunity to review this statement.

Sincerely,

Jack M. Heinemann
Advisor on Environmental Quality

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REGION VI

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
FORT WORTH REGIONAL OFFICE
221 WEST LANCASTER AVENUE
P.O. BOX 2905
FORT WORTH, TEXAS 76113

IN REPLY REFER TO:

June 26, 1981

Mr. Frank J. Miraglia
Acting Chief
Licensing Branch No. 3
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Miraglia:

The draft Environmental Impact Statement Related to the Operation of Waterford Steam Electric Station, Unit No. 3, ST. Charles Parish, Louisiana, has been reviewed in the Department of Housing and Urban Development's New Orleans Area Office and Fort Worth Regional Office and we do not have comments on the statement.

Sincerely,

FOR Victor J. Hancock
Environmental Clearance Officer

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AREA OFFICES
DALLAS, TEXAS • LITTLE ROCK, ARKANSAS • NEW ORLEANS, LOUISIANA • OKLAHOMA CITY, OKLAHOMA • SAN ANTONIO, TEXAS

LOUISIANA POWER & LIGHT / 142 DELARONDE STREET
P. O. BOX 6008 • NEW ORLEANS, LOUISIANA 70174 • (504) 366-2345
MIDDLE SOUTH UTILITIES SYSTEM

June 26, 1981

W3P81-1565
Q-3-A30
3-A1.01.04

Director, Division of Licensing
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

SUBJECT: Waterford 3 SES
Docket No. 50-382
Draft Environmental Statement

Dear Sir:

Enclosed are the formal comments of the applicant, Louisiana Power & Light Company, on the Waterford 3 Draft Environmental Statement. We appreciate the opportunity to review and comment on the draft statement, and if there are any questions in this matter, please contact Mr. Roy Prados at (504) 363-8773.

We would also appreciate an opportunity to review and respond to any other comments filed in connection with the DES.

Yours very truly,

L. V. Maurin
Assistant Vice President
Nuclear Operations

LVM/MPF/sm

Enclosure

cc: S. Black, E. L. Blake, W. M. Stevenson

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Comment 1: Table 1.1 (page 1-3) and Appendix E - NPDES Permit should be updated to reflect the renewal of the original NPDES permit.

(a) For Table 1.1, the following changes to the "Status" column for the "Environmental Protection Agency" - "National Pollutant Discharge Elimination System (NPDES) Permit" Should be made:

"Permit renewed 5/25/81 and effective until 5/24/86"

(b) The former NPDES permit should be replaced with the renewed NPDES permit and presented in Appendix E.

Comment 2: Section 2.4 (Reliability Analysis) should be updated in the FES to include the results of the most recent MSU electrical load forecasts which were made in May, 1981. Load forecasts are discussed in Section 2.4 and are presented for the years 1983 to 1986 in Table 2.1. In addition, this section implies that LP&L's reserves are independent of MSU's reserves. However, based on the system agreement, MSU's and LP&L's reserves are identical. Finally, Section 2.4 on page 2-4 states that 4170 MWe of new capacity will be added to the MSU system between 1980 and 1985, not including Waterford 3. Present schedules include 2977 MWe during this period. Therefore, starting with the second paragraph of Section 2.4 (page 2-3) and continuing through the third complete paragraph of page 2-4, and including Table 2.1, the following should be substituted into the FES to incorporate these updates and to clarify the MSU agreement:

- 1 -

"Current official projections for the MSU system call for average annual rates of increase of 1.9 percent for peak load and 2.8 percent for net energy requirements from 1978 to 1986. Comparable values for LP&L for peak-load demand and net energy requirements are 3.8 percent and 3.1 percent, respectively.

Table 2.1 shows MSU's reserve margins with and without Waterford 3 in operation in the 1983 through 1986 time period. The peak-load responsibility values reported here reflect the official forecasts for system-maximum hourly load, adjusted downward for firm purchases. System capacity reflects capacity owned by the systems (adjusted downward for natural gas curtailments) plus purchases that are not firm.

LP&L and MSU have identified a 25 percent reserve margin as necessary to maintain minimum acceptable reliability. This standard is consistent with the 15 to 25 percent reserve margin recommended by the Federal Energy Regulatory Commission.

This reliability assessment assumes that 2977 MWe of new capacity, other than Waterford 3, will be added to the MSU system in 1980 through 1985 as scheduled. It also assumes that approximately 500 MWe of purchased power will be available in the 1984 through 1986 peak-use seasons. The conclusions of the reliability assessment could be altered by unavoidable slippages in or decisions to delay any of these subsequent additions, or by the uncertainty associated with MSU's reliance on these outside purchases."

Table 2.1 Data Showing Effect on Reserve Margin of MSU System Operations with and without Waterford 3 and the Load and Capability of LP&L for the Years 1983 through 1986

a. MSU Reserve Margin

	With Waterford 3			Without Waterford 3		
Year	Total Capability, MW	Load Responsibility, MW	Reserve Margin, %	Total Capability, MW	Load Responsibility, MW	Reserve Margin, %
1983	15882	10744	48	14778	10744	38
1984	15758	11364	39	14654	11364	29
1985	16118	11841	36	15014	11841	27
1986	15849	12225	30	14745	12225	21

b. LP&L Load and Capability (with Waterford 3)

Year	Total Capability, MW	Load Responsibility, MW
1983	5324	4553
1984	5280	4652
1985	5280	4824
1986	5280	5042

Comment 3: In Section 2.4.1 - Fuel Uncertainties (page 2-4) it should be specifically mentioned that The Power Plant and Industrial Fuel Use Act of 1978, prohibits the use of natural gas as a primary fuel in utility boilers by 1990. The mentioning of the act clearly illustrates that legislation already exists that can prohibit the use of natural gas, whereas the phrase "current curtailment proceedings" in Section 2.4.1 implies that the regulation of natural gas usage as a utility fuel currently is being considered.

Comment 4: In Table 4.1 (page 4-4) there appears to be a typographical error. The total time after heat addition for the average low water level condition should be 383 seconds instead of 532 seconds.

Comment 5: There appears to be a typographical error in Table 4.2 (page 4-9) concerning plant discharge velocities. The average spring discharge velocity should be 0.58 m/sec (1.9 ft/sec) instead of .0.78 m/sec (2.5 ft/sec).

Comment 6: Since the subject of Section 4.2.4.5, "Laboratory and Decontamination Solutions" concerns a source of potentially radioactive wastes, it would be more appropriate to include this discussion in Section 4.2.3 "Radioactive Waste Treatment". In addition, the first sentence of the second paragraph in Section 4.2.4.5 (page 4-13) would be more correct if modified to the following:

> "Drainage from the chemistry and radiation measurement laboratory sinks is collected in a drain tank, treated in the waste management system and then discharged into the circulating water system discharge".

Comment 7: Figure 4.8 depicts site areas investigated in the 1977 Cultural Resources survey and it neglects to present those areas surveyed in 1980 which are the subject of a major portion of Section 4.3.6 (Cultural Resources of the Waterford Site). Therefore, in order to clarify this situation, it is suggested to add ER-OL Figure 2.6-3 - "Location of Archaeological Remains Associated with the Waterford Plantation" and to replace the title of DES Figure 4.8 with the following:

> "Onsite Areas Scheduled to be Disturbed By Waterford 3 Construction Activity at the Time of the 1977 Cultural Resources Survey."

Comment 8: It is suggested that the second sentence of the first paragraph (Section 4.3.7.1) on page 4-29 would be more easily understood by the public if it were replaced with the following two sentences:

> "Transient population within 16.1 km (10 mi) of the site consists, in general, of industrial employees, visitors to festivals, attendees at sporting events, and people traveling through the area on transportation arteries. It is very difficult, when accounting for transient populations of these types, to distinguish residents from nonresidents."

Comment 9: The fifth paragraph of Section 4.3.7.2 on page 4-29 states that "...industrial development is projected to take place southeast and northeast of Waterford 3." However, industrial development in the vicinity of Waterford 3 is taking place both west and northwest of the plant, as well as to the southeast and northeast. Therefore, the first sentence in this paragraph should be modified, as follows, to reflect this fact:

"In general, industrial development is projected to continue to take place along the Mississippi River in the vicinity of Waterford 3."

Comment 10: Because the first sentence of paragraph 1 on page 4-31 does not give an indication of the population density requiring the indicated land area, it is suggested that the sentence should be replaced with the following:

"Additional residential growth is expected to take place within 8 km (5 mi) of Waterford 3. The population in this area is expected to grow by 3,558 persons, or 19.6%, between 1980 and 1990. If one assumes a density of 17.3 persons per ha (7 persons per acre)*, an increase of 206 ha (508 acres) of residential land will result during this time period".

*Source: ER-OL, Section 6.1.4.2

Comment 11: The hydrothermal analysis performed by the staff and described in Section 5.3.2.3 of the DES, does not incorporate several engineering and site specific hydrologic phenomenon. This exclusion renders the staff's analysis overly conservative in the opinion of the applicant. The considerations excluded from the staff's analysis are the following: (a) the high velocity jet-type discharge resulting in a relatively fast temperature decay in the nearfield; (b) the observed "back eddy" current in the vicinity of the Waterford 1 and 2 discharge which causes an upstream

excursion of a portion of the Waterford 1 and 2 thermal discharge; and (c) correlation of the hydrothermal model predictions with actual measured data from the existing units. The applicant therefore believes that, based on these exclusions, in the staff's analysis and the applicant's conservative input assumptions, his analysis provides reasonably conservative, yet realistic results. Furthermore, as stated in the final sentence of Section 5.3.2.2 of the DES, the applicant's analysis is considered to be sufficiently conservative since it was based on all plants operating at maximum load for the temperature calculations, the models were calibrated against the largest plume observed and the surface heat exchange effect was neglected

Comment 12: Section 2.6.1 (page 2.6-2) of the ER-OL describes the procedure that LP&L is using to protect identified cultural resources associated with the Waterford Plantation. This section indicates that the applicant is taking appropriate measures to ensure that the identified cultural resources will be protected. The DES should be modified to include the applicant's commitment. Therefore, the third sentence of the first paragraph of page 5-25 should be replaced with the following, and the additional statement should be inserted as noted below.

"The applicant is taking appropriate measures to protect the area during this process. Should any ground disturbance of these areas become necessary in the future, the applicant will consult with the SHPO and develop an approved mitigation plan. Operation of Waterford 3..." continue with the remainder of the paragraph.

Comment 13: The number of operatonal work force employees at Waterford 3 presented in section 5.8.1 (page 5-25), fails to include security and other non-technical workers. The total operational work-force (technical and non-technical) for 1979 is 131 (the year cited in the DES - see reference 34 to Chapter 5 of DES) and for the first year of commercial operation (1983) is 267.

The omission of these nontechnical workers from the total operational work-force results in an under estimation of the benefits derived from these workers income that will be accrued within the region's non-basic (indirect or secondary) employment sectors.

Comment 14: In September of 1979, the applicant conducted two surveys in response to NRC Question No. 301.34 and 301.35 and included those responses with Amendent No 1 to the ER-OL (Docket No. 50-382). These questions considered the impact of both immigrant construction and operational workers associated with Waterford 3 upon local public services (e.g. fire, police, water, sewer, schools, etc.) in the area within 0-10 miles of the facility. The results of this analysis projected different impacts upon public services than those cited in DES Section 5.8.1.

The basis for the determination of the effect of immigrant workers and their associated population upon public services is two recent surveys. A "Construction Worker Survey" was conducted on June 6 and 7, 1979 and an "Operational Worker Survey" was conducted between May 1 to 15, 1979. The results of these two surveys, with the aid of a fiscal impact model, were used to predict the impact of the

immigrant population upon public services from 1979 to 1982. At the time of the survey, 1982 was the expected operational date for Waterford 3. Since this analysis, the commercial operation of Waterford 3 has been delayed until March, 1983. However, even with this delay, the immigrant worker impacts upon public services for 1982 should remain representative for 1983 and therefore the survey results are still considered valid.

All the appropriate public service functions for the portion of St. Charles Parish that is within 10 miles of Waterford 3, exhibit excess capacities and have the ability to absorb the immigrant population's service demands. In the portion of St. John the Baptist Parish that is within 10 miles of Waterford 3, the applicant's analysis showed that all public service functions, except for the general control and library service functions, demonstrate excess capacities and have the ability to absorb the immigrant population's service demands during the operational phase. For these two above mentioned affected public service functions, the immigrant population service demand will have a marginal adverse impact. Furthermore, the hospital facilities, medical staff, and the firefighting staff and equipment were found to have sufficient existing excess capacity to absorb the immigrant service demand for the additional workforce from Waterford 3.

Therefore, the third sentence of Section 5.8.1 (page 5-25) should be replaced with the following sentence:

"A recent study which included the results of a field survey utilizing the aid of a fiscal impact model indicated that all public service functions within a 10 mile radius of Waterford 3 are adequate to serve the operation phase workers at Waterford 3 with the exception of the general control and library service functions within the adjacent St John the Baptist Parish. These service functions within St John the Baptist Parish will only be insignificantly impacted by Waterford 3."

Comment 15: The monetary values that are expressed in section 5.8.2.1 (page 5-25) for both annual payroll ($2.8 million) and induced expenditures ($257.7 million) are taken from Chapter 8.0 of the original ER-OL which was submitted to the Nuclear Regulatory Commission in 1978. Since the original submission, these values have been revised in Amendment No. 18 to the FSAR (dated 5/81). These revisions are based upon a 1983 commercial operation of Waterford 3, as well as a 267 member operations staff. Therefore, the annual income that will be generated by the operations staff is expected to be about $5.5 million (1983 dollars). Also there is anticipated to be about $1.9 million (1983) generated in the region's non-basic employment sectors, resulting in an total annual income affect of about $7.4 million (1983 dollars).

The induced expenditure level of $257.7 million, presented in the DES is based upon the effect of the operational staff's accumulated payroll over the operational life (40 year) of the plant will have upon various sectors of the region's economy (regional product or output). Amendment No. 2 to the ER-OL utilized a somewhat different approach, by examining

the additional income that will be generated in both the region's basic and non-basic sectors from the operation of Waterford 3. This approach resulted in an additional income figure of $205.8 million (discounted to 1983 dollars) for the entire operational phase.

Comment 16: In Section 5.8.2.2, the level of tax revenue ($1,963 million) is derived from the original ER-OL. In Amendment No. 2 to the ER-OL, the revised level of tax revenue for local, state and Federal governments generated during the operational phase of Waterford 3 was revised to about $2,186 million (discounted to 1983 dollars). Of this total amount, about 10 percent is expected to go to the state government.

Comment 17: The plant stack and air ejector charcoal filter has a 90% iodine removal efficiency. The calculated releases of radioactive materials in gaseous effluents from Waterford 3, as presented in Table 5.6 (page 5-30) should be revised to reflect the 90% removal efficiency. In addition, Table 5.3 contains a typographical error under the waste decay tanks heading. The word "continous" should be changed to "continuous".

Comment 18: Based on the applicants most recent survey, (see ER-OL Section 2.1.3.4) the nearest milk goat is located at 3.1 miles in the east direction, And the nearest milk cow is located 1.1 miles in the northeast direction from Waterford 3. Therefore, Tables 5.7, 5.8 and 5.9 should be revised to reflect this information.

Comment 19: In order to evaluate one of the expressed areas of controversy, it is suggested that the following be added at the end of the second paragraph on page 5-46:

"One of the areas of controversy pertaining to the issuance of the operating license for Waterford 3 is the synergistic and cumulative effects of low level radiation and carcinogens. This issue has arisen because of prevalence and retrospective studies which have reported an increase in death rates due to cancer (e.g. lung cancer) in southern Louisiana relative to the national average[85]. With such a pre-existing condition, concern has been expressed regarding the need to evaluate possible synergistic effects between existing environmental carcinogens which may be responsible for the elevated cancer incidence, and the low level radiation exposures which may be associated with the routine operation of the Waterford 3 facility.

In responding to this concern, consideration must be given to several factors concerning potential synergistic effects. First, consideration should be given to the exposure limits under which the Waterford 3 plant is required to operate as compared to other radiation exposures to which members of the general public are routinely exposed. This comparison is provided in Table 5.16 of the FES, which shows that the routine exposures associated with the operation of the station are required to be a small fraction of existing exposures, and well within the variability of natural background.

In addition, studies have either failed to find a synergistic effect, or have observed some synergistic effects only at much higher exposures than allowed for the Waterford station. For example, the exposures at which some synergistic effects have been experimentally observed were in excess of 10,000 mrem delivered over a short period of time [86 - 93]. This is to be compared to the guidelines set forth in Appendix I to 10 CFR 50 of 5 mrem/yr to the whole body and 15 mrem/yr to the thyroid gland. This information provides considerable assurance that any such effects associated with Waterford 3 would be either vanishingly small or non existent.

Furthermore, it is also noted that:

'when considering to what extent chemicals can cause synergistic effects even in the dose range relevant for radiological protection, it should be remembered that generally all experiments, investigations and tests for toxicological effects, cancerogenicity and mutagenicity of chemical substances are always carried out in combination with the influence of ionizing radiation, since natural exposure to radiation is present everywhere and at all times.

Thus since each determination of the hazard potential of chemicals is necessarily always carried out under a possible synergistic effect of ionizing radiation, this factor is included. It is thus certain that no unforeseen intensification of the effects can be caused by additional radiation exposure of the order of magnitude of natural radiation exposure.' "[94]

REFERENCES (FOR COMMENT 19)

85 Mason, T.J.M. et al. "Atlas of Cancer Mortality for U.S. Counties: 1950-1969 DHEW Publication No. (NJH) 75-780.

86 Moroson, H and M Quintiliani (Eds.). (1970). Radiation Protection and Sensitization. Proceedings of the Second International Symposium on Radiosensitizing and Radioprotective Drugs. Taylor and Francis, Ltd, London; barnes and Noble, Inc, New York.

87 Streffer, C. Interaction Measurements of Radioactive, Chemical and Thermal Releases from the Nuclear Industry: Methodology for Considering Cooperative Effects. In "Combined Effects of Radioactive, Chemical and Thermal Releases to the Environment." IAEA, 1975 (STI/PUB/404).

88 Leehousts, H P and K H Chadwick (1978). Interaction of Chemical Mutagens and Radiation in the Induction of Malignancy. In: Late Biological Effects of Ionizing Radiation." IAEA, 1978 (STI/PUB/489)

89 Lindell, B (Chairman) (1975). Panel Discussion on the Significance of Synergistic and Combination EFfects in the Future Development of Nuclear Power Programmers, and the Need for Future Studies. In: IAEA, 1975 (STI/PUB/404)

90 Michel, C and H Fritz-Niggli (1978). Radiation-Induced Developmental Anomalies in Mammalian Embryos by Low Doses and Interaction with Drugs, Stress and Genetic Factors. In: IAEA (1978); SIT/PUB/489.

91 Lurie, A G and R M Rippey (1978). Low Level Radiation-Induced Alterations of Functional Haemodynamics in Normal and DMBA-Trented, Tumour-Bearing Hamster Check Pouch Epithelium. In: IAEA (1978); STI/PUB/489.

92 Myers, D K et al (1978). DNA Repair and the Assessment of the Biological Hazards of Ionizing Radiation. In: IAEA (1978); STI/PUB/489.

93 Streffer, C et al (1978). In Vitro Culture of Pre-Implanted Mouse Embroys. A model system for studying combined effects. In: IAEA (1978) STI/PUB/489.

94 Synergism and Radiological Protection Comments of the Radiological Protection Commission September, 1977. Translated as of August 1978. Printed by Gesellschaft Fur Reaktorsicherheit (GRS) mbH Glockergasse 2.5000 Koln 1.

Comment 20: It is suggested that the last sentence of the third paragraph of Section 6.2.1 (page 6-1) would be clearer if reworded as follows:

> "However, a sluiceway is available to remove impinged fish and macroinvertebrates from the traveling screens and return them to the river (Section 5.11), which can be expected to lower the impingement mortality rate to less than that which would otherwise be aniticipated."

Comment 21: In Section 6.2.4.1, on page 6-3 in the third complete paragraph it is noted that the preoperational program proposed by the applicant is summarized in Table 6.1. Since the preoperational program has been in effect since 1977 and is no longer proposed, the following sentence should be substituted for the first sentence:

> "The preoperational radiological environmental monitoring program being followed by the applicant is..."

Comment 22: Section 6.2.4.2, on page 6-3, second paragraph, it is stated that the applicant plans to essentially continue the proposed preoperational monitoring program during the operational period. Since the preoperational program has begun, the word "proposed" should be deleted. In addition, this sentence references Table 5.3 which presents thermal impact information. The correct reference is Table 6.1. Finally, the third sentence of this paragraph should be modified to include references to NUREG 0472. Therefore, this paragraph should read as follows:

> "The applicant plans essentially to continue the preoperational program during the operational period (see Table 6.1). However, the TLD locations will be updated to reflect the 1979 Branch Technical Position, Revision 1. Other refinements may be made in the program to reflect changes in land use, preoperational monitoring experience and revisions to NUREG 0472, "Radiological Effluent Technical Specifications for PWR's"."

Comment 23: In Section 6.6.2 - Benefits (page 6-6), the inclusion of data pertaining to the customer class percentage use of electrical energy is not pertinent to the discussion of benefits derived from Waterford 3. Therefore, it is suggested to delete this tabular data from the FES.

50-382

DEPARTMENT OF HEALTH & HUMAN SERVICES

Food and Drug Administration

Public Health Service

Food and Drug Administration
Rockville MD 20857

JUN 29 1981

Mr. Frank J. Miraglia, Acting Chief
Licensing Branch No. 3
Division of Licensing - NRR
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Miraglia:

Staff of the Bureau of Radiological Health of the Food and Drug Adminstration have reviewed the health aspects of the Draft Environmental Statement (DES) relating to operations of the Waterford Stream Electric Station, Unit 3, NUREG-0779, April 1981.

In reviewing the DES for Waterford-3, it is recognized that a DES is an administrative action for the eventual issuance of an operating license. DHHS comments were provided on the Draft DES - Construction Phase in January 1973 (Appendix B-13 and B-14, pages B-120-121), prior to issuance of the construction permit in November 1974. We note that as of February 1981, the construction of Waterford-3 was 83 percent complete. Bureau of Radiological Health staff have reevaluated the health aspects associated with the proposed operation of the plant and have the following comments to offer:

1. It appears that the design objectives of 10 CFR 50, Appendix I, and the proposed operating plan of Waterford-3 provide adequate assurance that the potential individual and population radiation exposures meet current radiation protection standards.

2. The environmental pathways identified in Section 5.9.1 and Figure 5.7 on page 5-27, and discussed in Appendix D, as well as pages B-61-65 of Appendix B of the Final Environmental Statement - Construction Phase, give all the possible emission pathways that could impact on the population in the environs of the facility. The dose computational methodology and models used in the estimation of the radiation doses to individuals near the plant and to populations within 80 km. of the plant have provided a reasonable estimate of the projected doses resulting from normal operating conditions as well as hypothetical accident situations at the facility. Results of these calculations have been given in Tables 5.9, 5.10, 5.11, 5-12, and 5-14. They confirm our assessment.

3. The discussion in Section 5.9.2 on the environmental impact of postulated radiological accidents at Waterford-3 is considered to be an adequate assessment of the radiological exposure pathways and dose and health impacts of atmospheric releases.

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Mr. Frank J. Miraglia, NRC - Page 2

However, we believe that, by itself, the emergency preparedness section (5.9.2.1.3(3)) is not adequate. We will forego further comment on this aspect, realizing that the process of granting an operating license to the facility will include an adequate review of emergency preparedness (FEMA-NRC Memorandum of Understanding, Regional RAC's, criteria in NUREG-0654).

In view of some of the monitoring problems during the Three Mile Island-2 accident, we suggest the preparedness plan might be modified to address in particular the problems of monitoring gaseous radioiodines in the presence of radio-noble gasses. This could be accomplished by reference to FEMA-REP-2, a document on instrumentation systems prepared with input from NRC.

Considering the extensive lessons learned from the accident at TMI-2, it would be helpful to expand Section 5 (Emergency Preparedness) to include a brief presentation of the critical public health and safety actions that NRC has taken since TMI-2, or plans to take in the near future, to improve nuclear reactor safety and to mitigate the consequences of potential accidents at commercial nuclear power plants. The discussion in paragraph 4, page 5-57, is a possible introduction to the proposed modified section.

4. The operational monitoring program is planned to be a continuation of the preoperational program. It appears that the program will provide adequate sampling and analysis for measuring the extent of emissions from the plant, and to verify that such emissions meet applicable radiation protection standards.

5. The Section 5.9.3 discussion of the environmental effects of the Uranium Fuel Cycle is a reasonable assessment of population dose commitment and health effects associated with the UFC.

Thank you for the opportunity to review and comment on this draft document.

Sincerely yours,

John C. Villforth
Director
Bureau of Radiological Health

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION VI
1201 ELM STREET
DALLAS, TEXAS 75270

June 30, 1981

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U.S. NUCLEAR REGULATORY COMMISSION

Mr. Frank J. Miraglia
Acting Chief, Licensing Branch No. 3
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Miraglia:

We have completed our review of the Draft Environmental Impact Statement (EIS) related to the operation of the Waterford Steam Electric Station, Unit No. 3, (Docket No. 50-382) St. Charles Parish, Louisiana. The proposed action is to issue an operating license for the start up and operation of Unit 3. The Unit will be built by the Louisiana Power and Light Company about 25 miles west of New Orleans, Louisiana, and is scheduled for fuel-loading in 1982.

The following comments are provided for your consideration when preparing the Final EIS:

Generic Comments

In our past reviews of Draft EIS's related to light-water nuclear power facilities, we have included generic comments which are applicable to all such facilities. As a result of the Three Mile Island accident and other recent activities, we have decided that we must revise our generic comments to consider these events and activities. We will provide our revised generic comments to the Nuclear Regulatory Commission (NRC) as soon as they are completed. Generic areas undergoing review are:

Population dose commitments
Reactor accidents
Fuel cycle and long-term dose assessments
High-level radioactive waste management
Transportation impacts
Decommissioning

Radioactive Waste Treatment Systems

The Draft EIS does not contain detailed descriptions of the radioactive waste treatment systems or the NRC staff's detailed evaluations. Such matters are referenced to the Safety Evaluation Report (SER), which has not yet been issued. On request, however, we were supplied an advance copy of draft sections on the ventilation and radioactive waste treatment systems. We appreciate being supplied this information.

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It appears that the radioactive waste treatment systems are capable of controlling emissions to levels such that, when direct radiation is also considered, operations will be within EPA's Environmental Radiation Standards, 40 CFR 190. However, we note that the pre-draft SER identifies certain unspecified "confirmatory" information which has not yet been provided by the applicant. Pending receipt of this information and NRC staff review, the Liquid Waste Processing System, the Gaseous Waste Processing System, and the Solid Radioactive Waste Treatment System are all considered confirmatory issues. We therefore consider our conclusions, regarding the capabilities of these systems, to be contingent on the successful resolution of the confirmatory items by the NRC staff.

We believe the Final EIS should include an evaluation and full discussion of any confirmatory items not resolved by the time it is issued.

Reactor Accidents

When discussing accident risk and impacts of design basis accidents, the Draft EIS addresses probabilities of occurrence qualitatively. Yet, when discussing more severe core melt accidents, the probabilities of occurrence are quantified (Table 5.19). For consistency in the presentation of all environmental risks, we believe the probabilities of occurrence of infrequent accidents and limiting fault design basis accidents should also be provided.

Safety Evaluation Report

The practice of issuing the Draft EIS in advance of the SER has prevented our performing a complete review of the environmental impacts of the Waterford-3 station. As discussed in our comments on radioactive waste treatment systems, we were provided advance copies of draft SER sections on those systems, so the problem was alleviated, although we do not consider this pre-draft information to be formal documentation. Also, the Draft EIS refers to the SER in several other important areas which are still under NRC review. These include:

1. Site features. The authority of the applicant to control all activities within the exclusion area is still under NRC staff review. Also, nearby off-site hazards, including those associated with hydrocarbon and toxic substances pipelines, train, truck, and aircraft traffic, and oil and gas fields are still under review. Exclusion area activities will be evaluated in the SER, but the evaluation of off-site hazards will not be completed until later and included in a supplement to the SER.

2. Emergency preparedness. Facility emergency plans and State and local plans are reported to be in an advanced, but not yet fully completed stage. NRC staff findings of adequacy and implementability, for both the on-site and off-site plans, will be reported in the SER.

In view of the above, the conclusion stated in Section 5.12 regarding no conflict between environmental concerns and the proposed action, would seem to be contingent on favorable results on some important ongoing staff reviews and hence premature. The Final EIS should be withheld until the above-mentioned reviews are completed, or should specifically evaluate any of the areas which are still undergoing review.

We urge the NRC to ensure that, in the future, the Safety Evaluation Report is available before issuing the Draft EIS. Material incorporated into an EIS by reference should be reasonably available for inspection within the time allowed for comment (40 CFR 1502.21). We do not believe the citations of missing but forthcoming information in the SER constitutes a "reference" in the common meaning of that word.

Decommissioning

The Draft EIS states that planning for decommissioning can have an impact on health and safety as well as cost, and that financial assurance that funds will be available, when required, is a factor to be considered. We concur in this assessment, but were unable to find in the Draft EIS arrangements for financing decommissioning costs. Although decommissioning costs are noted to be a small fraction of present worth commissioning costs, they will still represent a large cost burden when needed, if not set aside out of revenues during the plant's operating lifetime. The Final EIS should explain what arrangements have been made, or are planned, to assure that funds will be available when required.

In this connection, it is not clear at what point the licensee's financial responsibility is to be terminated. Termination of the nuclear license is required at the end of facility life, and this requires decontamination of the facility such that unrestricted use can be allowed. One option to achieve such decontamination is SAFSTOR, which allows deferral of decontamination for up to 100 years. It is not clear, in such a case, whether license termination would occur prior to or at the end of such an extended storage period. If termination occurs at the beginning of the storage period, financial arrangements evidently will be necessary to pay for the deferred decontamination. The Final EIS should clarify this point.

Economic Risks

As the Three Mile Island accident demonstrated, the cost of reactor building decontamination and replacement power following an accident can be sizable. This underscores the need to develop standard methodologies for estimating the contribution of these costs to economic risks. Economic risks are addressed in Section 5.9.2.1.4(6) of the Draft EIS (under Station Accidents). Based on low probability, annualized risk is shown to be modest. Because of the potentially severe economic costs; however, we believe these risks should be mentioned explicitly in the benefit-cost summary, Section 6.6.

Additional Comments

1. The statement on page 5-54 that a dose greater than about 25 rems over a short period of time is necessary before any physiological effects are clinically detectable, should be reviewed. Information contained in the World Health Organization technical report No. 123 would seem to indicate that physiological changes can occur at exposures as low as 10 rems.

2. Table 6.1 lists water samples to be taken from the intake structure, but none from the discharge canal which would provide a measure of the radioactivity discharged from the facility. This should be explained. Also, in this same table, it is not clear whether the thermoluminescent dosimeters (TLD) are to be collected on a quarterly schedule which could change to a semi-annual schedule, or whether some TLD's will be collected quarterly and some semi-annually. These points should be clarified in the Final EIS.

3. In Table 5.14 population dose is labeled as "mrem" and should be "man-rem." Also, in the same table, truck vs. rail traffic density is unclear.

4. The footnote under Table 5.24 appears to be misplaced.

In view of the information provided and our comments on the Draft EIS, we classify the proposed project action as ER-2 (Environmental Reservations, Insufficient Information). We ask that the Final EIS and supporting documents be strengthened in the areas our preceding detailed comments have identified.

Our rating is based on our evaluation of the EIS, advance copies of pre-draft SER sections and other important areas which are still undergoing NRC review as discussed earlier. We reserve the right to change our rating if published information is substantially changed from what we have reviewed.

Our classification will be published in the Federal Register according to our responsibility to inform the public of our views on proposed Federal actions, under Section 309 of the Clean Air Act.

Definitions of the categories are provided on the enclosure. Our procedure is to categorize the EIS on both the environmental consequences of the proposed action and on the adequacy of the EIS at the draft stage, whenever possible.

We appreciated the opportunity to review the Draft EIS. Please send our office five (5) copies of the Final EIS at the same time it is sent to the Office of Federal Activities, U.S. Environmental Protection Agency, Washington, D.C.

Sincerely,

Frances E. Phillips

Frances E. Phillips
Acting Regional Administrator

Enclosure

ENVIRONMENTAL IMPACT OF THE ACTION

LO - Lack of Objections

EPA has no objections to the proposed action as described in the draft impact statement; or suggests only minor changes in the proposed action.

ER - Environmental Reservations

EPA has reservations concerning the environmental effects of certain aspects of the proposed action. EPA believes that further study of suggested alternatives or modifications is required and has asked the originating Federal agency to re-assess these aspects.

EU - Environmentally Unsatisfactory

EPA believes that the proposed action is unsatisfactory because of its potentially harmful effect on the environment. Furthermore, the Agency believes that the potential safeguards which might be utilized may not adequately protect the environment from hazards arising from this action. The Agency recommends that alternatives to the action be analyzed further (including the possibility of no action at all).

ADEQUACY OF THE IMPACT STATEMENT

Category 1 - Adequate

The draft impact statement adequately sets forth the environmental impact of the proposed project or action as well as alternatives reasonably available to the project or action.

Category 2 - Insufficient Information

EPA believes the draft impact statement does not contain sufficient information to assess fully the environmental impact of the proposed project or action. However, from the information submitted, the Agency is able to make a preliminary determination of the impact on the environment. EPA has requested that the originator provide the information that was not included in the draft statement.

Category 3 - Inadequate

EPA believes that the draft impact statement does not adequately assess the environmental impact of the proposed project or action, or that the statement inadequately analyzes reasonably available alternatives. The Agency has requested more information and analysis concerning the potential environmental hazards and has asked that substantial revision be made to the impact statement. If a draft statement is assigned a Category 3, no rating will be made of the project or action, since a basis does not generally exist on which to make a determination.

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
WASHINGTON, D.C. 20410

OFFICE OF THE ASSISTANT SECRETARY
FOR COMMUNITY PLANNING AND DEVELOPMENT

30

RECEIVED JUL 07 1981 U.S. NUCLEAR REGULATORY COMMISSION

IN REPLY REFER TO:

Mr. Frank J. Miraglia
Acting Chief, Licensing Branch No. 3
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Mr. Miraglia:

Subject: (DEIS) Waterford Steam Electric Station
Unit No. 3, Louisiana Power and Light Company
New Orleans, Louisiana

Thank you for providing us the opportunity to review the above draft Environmental Impact Statement (EIS). In accordance with 24 CFR Part 50 Protection and Enhancement of Environmental Quality, Department of Housing and Urban Development procedures, particularly Section 50.61 of our Regulations, we are forwarding the EIS to the responsible HUD Regional Environmental Officer. He will review and comment as appropriate, directly to you by your due date.

If non-HUD EIS's are sent directly to the Office with review responsibility, it would assure more prompt and thorough review. You should send copies of all future EIS's as follows:

1. All EIS's on legislative proposals, regulations, or policy documents of national or multi-state programmatic significance are reviewed by HUD Headquarters and should be sent to Mr. Richard H. Broun, Director, Office of Environmental Quality, HUD, Washington, D. C. 20410; and

2. All other site specific activities or project EIS's should be forwarded to the appropriate HUD Regional Office for comment. We have enclosed a list of our Regional Environmental Officers and their addresses.

If you have any questions in this regard, please feel free to contact me at (202) 755-6300.

Sincerely,

for Frances G. Haas
Richard H. Broun
Director
Office of Environmental Quality

Enclosure

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Region I	David Prescott Environmental Officer Department of Housing & Urban Development John F. Kennedy Building Room 800 Boston, Massachusetts 02203	States: Massachusetts, Maine, Vermont, R.I., New Hampshire, Conn.
Region II	Marvin Krotenberg Environmental Officer Department of Housing & Urban Development 26 Federal Plaza New York, New York 10007	States: New York, Puerto Rico, New Jersey, Virgin Islands
Region III	Larry Levine Environmental Officer Department of Housing & Urban Development Curtis Building 6th and Walnut Streets Philadelphia, Pa. 19106	States: Pa., Delaware, Maryland, Va., West Virginia, D.C.
Region IV	Ivar Iverson Environmental Officer Department of Housing & Urban Development Richard B. Russell Fed. Bldg. 75 Spring Street, S.W. Atlanta, Georgia 30303	States: Florida, Ga., Ala., Miss., Tenn., Ky., N.C., S.C.
Region V	Harry Blus Environmental Officer Department of Housing & Urban Development 300 South Wacker Drive Chicago, Illinois 60606	States: Ill., Ind., Mich., Minn., Ohio, Wisconsin
Region VI	Otis Trimble Environmental Officer Department of Housing & Urban Development 221 W. Lancaster Avenue P.O. Box 2905 Fort Worth, Texas 76113	States: Texas, New Mexico, Oklahoma Arkansas, Louisiana
Region VII	Gary Ultican Environmental Officer Department of Housing & Urban Development Federal Office Building 911 Walnut St., Room 300 Kansas City, Kansas 64106	States: Missouri, Kansas, Iowa, Nebraska
Region VIII	Walter Kelm Environmental Officer Department of Housing & Urban Development Executive Tower Building 1405 Curtis Street Denver, Colorado 80202	States: Montana, Wyoming, Colorado, N. Dakota, S. Dakota, Utah
Region IX	Dale James Environmental Officer Department of Housing & Urban Development 450 Golden Gate Avenue Box 36003 San Francisco, Ca. 94102	States: Calif., Arizona, Nevada, Hawaii, Guam, American Samoa, Trust Territories
Region X	Ry Tanino Environmental Officer Department of Housing & Urban Development 3003 Arcade Plaza Bldg. 1321 Second Avenue Seattle, Washington 98101	States: Wash., Oregon, Idaho, Alaska

STATE OF LOUISIANA
DEPARTMENT OF CULTURE, RECREATION AND TOURISM
OFFICE OF PROGRAM DEVELOPMENT

DAVID C. TREEN, Governor — ROBERT B. DeBLIEUX, Assistant Secretary — MRS. LAWRENCE H. FOX, Secretary

July 1, 1981

RECEIVED JUL 13 1981 U.S. NUCLEAR REGULATORY COMMISSION

Mr. Frank J. Miraglia, Acting Chief
Licensing Branch No. 3
Division of Licensing
United States Nuclear Regulatory Commission
Washington, D.C. 20555

Re: Draft Environmental Statement
Waterford 3 SES
St. Charles Parish, Louisiana

Dear Mr. Miraglia:

My staff has reviewed the above-referenced document and we are pleased to note that your agency is seeking determinations of eligibility for cultural areas 3, 4, and 5. We concur that these areas should be protected from major disturbance during the determination process.

We will be happy to comment on the effect of this project on those areas, if any, that are determined eligible for listing in the National Register of Historic Places during the determination of effect procedure, as outlined in Federal Regulations 36CFR800.

If you have any questions, please contact my staff at the Division of Archaeology and Historic Preservation.

Sincerely,

Robert B. DeBlieux
Robert B. DeBlieux
State Historic Preservation Officer

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DIVISION OF ARCHAEOLOGY AND HISTORIC PRESERVATION
44247 Baton Rouge, La. 70804 504 342-6682

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DEPARTMENT OF THE ARMY
NEW ORLEANS DISTRICT, CORPS OF ENGINEERS
P. O. BOX 60267
NEW ORLEANS, LOUISIANA 70160

IN REPLY REFER TO
LMNPD-RE

2 July 1981

RECEIVED JUL 13 1981 U.S. NUCLEAR REGULATORY COMMISSION

Mr. Frank J. Miraglia, Acting Chief
Licensing Branch No. 3
Division of Licensing
US Regulatory Commission
Washington, DC 20555

Dear Mr. Miraglia:

This is in reply to your letter, dated 8 May 1981, to Mr. Bruce Barrett, US Department of Commerce, requesting review and comments on the Draft Environmental Statement (DES) related to the operation of the Waterford Steam Electric Station, Unit No. 3.

We have reviewed the document in accordance with our areas of responsibility and expertise as outlined in the Council on Environmental Quality Regulations, Title 49, CFR, Part 1500, published in the "Federal Register" dated 29 November 1978; and US Army Corps of Engineers administrative procedures for permit activities in navigable waters or ocean waters, Title 33, CFR, Parts 320-329, published in the "Federal Register" dated 19 July 1977.

We have the following comments to offer:

a. The effect of plant operation on water temperatures is discussed in Section 4.2.2.2 (page 4-3). The effect of these increased temperatures on reactor coolant chemicals (Section 4.2.4.1, page 4-10), however, is not discussed. Temperature changes influence river pH and alkalinity through shifts in the chemical equilibria of carbonate, sulfate, borate, and phosphate. Changes in DO and additions of boron and sulfates (Table 4.3) further complicate the situation. The carbonate equilibrium is particularly important since CO_2 levels help determine the degree of eutrophication and the health of aquatic animals. The impact of Waterford 3 on pH and alkalinity along with the resulting changes in the chemical equilibria should be fully discussed in this DES.

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LMNPD-RE
Mr. Frank J. Miraglia

2 July 1981

b. In Table 1.1, the US Army Corps of Engineers permit is dated 4/77. According to our records, this should be 9/77.

Thank you for the opportunity to review and comment on this DES.

Sincerely,

Thomas A. Sands

THOMAS A. SANDS
Colonel, CE
Commander and District Engineer

Copy Furnished:
Environmental Protection Agency
Room 537 West Tower
401 M Street, SW Mail Code A-104
Washington, DC 20460

2

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
P. O. BOX 3829
BATON ROUGE, LOUISIANA 70821

REGION 6

July 10, 1981

IN REPLY REFER TO

Draft Environmental Impact Statement
Nuclear Regulatory Commission
Docket No. 50-382
Waterford Steam Electric Station, Unit No. 3
St. Charles Parish, Louisiana

RECEIVED JUL 13 1981 U.S. NUCLEAR REGULATORY COMMISSION

Director, Division of Licensing
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Sir:

We have no comments on the draft EIS. Thank you for the opportunity to comment.

Sincerely yours,

J. N. McDonald

J. N. McDonald
Division Administrator

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104 Davey Laboratory
The Penn. State University
University Park
Pa., 16802
13 July 1981

Director, Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, D.C.
20555

Dear Director:

Attached are my comments on the Draft Environmental Statement on the operation of the Waterford Station, Unit 3, NUREG-0779. Please note that the opinions and calculations are my own, and not necessarily those of the Pennsylvania State University, which affiliation is given for identification purposes only.

I should note that I requested a copy of the Draft from Document Control on 23 June, but did not receive it until 10 July. It is particularly distressing to see the discussion of accidents in section 5.9.2 without the kind of peer review that the NRC admitted was necessary as related to WASH-1400 in its January 18, 1979 statement: "NRC Statement on Risk Assessment and the Reactor Safety Study Report in light of the Risk Assessment Review Group Report". (Page 3).

I hope these comments are useful in developing the Final EIS as is required by NEPA.

Sincerely,
William A. Lochstet
W.A. Lochstet, Ph.D.

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The Long Term Health Consequences of Waterford Station, Unit 3

by

William A. Lochstet

The Pennsylvania State University*

July 1981

The Nuclear Regulatory Commission (NRC) has attempted to evaluate the health consequences of the operation of the Waterford Steam Electric Station, Unit 3 in its draft EIS, NUREG-0779. The health consequences of radon-222 emissions from Uranium mill tailings and open pit mines are evaluated for the first 1000 years from the present in section 5.9.3. This evaluation suggests that radon emissions increase with time, and give no suggestion that they will decrease or stop after 1000 years.

The fact is that these radon emissions are governed by the 80,000 year half life of thorium-230 and the 4,5 billion year half life of uranium-238. The thorium situation has been discussed in detail by Pohl (Search, 7(5),345-350, August 1976). The impact of radon from the uranium-238 was recognized in GESMO (NUREG-0002, of 1976) and is discussed in the Final Environmental Statement for the Split Rock Mill (NUREG-0639, at Pages A-57 to A-60). The result is that the activity necessary to supply one 1000 MWe plant at 80 % capacity factor with fuel for one year leaves behind mill tailings that are estimated to cause 200,000 deaths due to radon-222 emissions. This is much more than the consequences listed in the Draft, NUREG-0779.

* The opinions and calculations presented here are my own and not necessarily those of the Pennsylvania State University. My affiliation is given for identification purposes only.

APPENDIX B

FINAL ENVIRONMENTAL STATEMENT
RELATED TO CONSTRUCTION OF
WATERFORD STEAM ELECTRIC STATION UNIT 3

A copy of this document was reprinted in the Draft Environmental Statement for the convenience of the reader.

APPENDIX C

ARCHEOLOGY

1. Letter from E. Bernard Carrier, Office of Program Development. Department of Culture, Recreation, and Tourism, State of Louisianna, to William H. Reagan, Jr., U.S. Nuclear Regulatory Commission, dated February 14, 1980.

2. Letter from Robert B. DeBlieux, State Historic Preservation Officer, Office of Program Development, Department of Culture, Recreation, and Tourism, State of Louisiana to L. V. Maurin, Louisiana Power & Light Company, dated November 14, 1980.

3. Letter from Robert L. Tedesco, Assistant Director for Licensing, Division of Licensing to L. V. Maurin, Louisiana Power & Light Company, dated July 10, 1981.

4. Letter from Robert B. DeBlieux, State Historic Preservation Officer, Office of Program Development, Department of Culture, Reservation and Tourism, State of Louisiana to Frank J. Miraglia, U.S. Nuclear Regulatory Commission, dated July 1, 1981.

STATE OF LOUISIANA

DEPARTMENT OF CULTURE, RECREATION AND TOURISM

OFFICE OF PROGRAM DEVELOPMENT

EDWIN W. EDWARDS
Governor

E. BERNARD CARRIER, PhD
Assistant Secretary

J. LARRY CRAIN, PhD
Secretary

February 14, 1980

Mr. William H. Reagan, Jr.
Acting Assistant Director for Environmental
Projects & Technology
Division of Site Safety and Environmental
Analyses
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Re: Louisiana Power and Light Company
Waterford Steam Electric Station
Unit 3
St. Charles Parish, Louisiana

Dear Mr. Reagan:

At the request of the Louisiana Power and Light Company, members of my staff met with Louisiana Power and Light and their archaeological consultant, Envirosphere, Inc., on February 7, 1980 at the Waterford site.

Based on this on site inspection, we offer the following observations for your consideration:

(1) No significant old buildings are in or adjacent to the project area; and since the area is heavily industrialized, this project will have no additional visual impact on any other structures in the area.

(2) Since much of the remaining property is in backswamp, the likelihood of finding prehistoric Indian sites in this area is low.

(3) It now appears that the Waterford Plantation has been destroyed by construction activities, and that little, if any, remnants of the site still exist.

DIVISION OF ARCHAEOLOGY AND HISTORIC PRESERVATION
P. O. Box 44247 Baton Rouge, La. 70804 504 342-6682

Based on these findings, we wish to modify our recommendations outlined in our letter of December 27, 1979, and suggest that only a detailed literature search of the Waterford property be conducted. If this research should indicate areas which might contain undisturbed cultural deposits, then additional archaeological testing may be warranted. However, if the literature search does not reveal any significant information, then an on-the-ground survey would not be necessary.

If you have any questions concerning our review, please contact my staff in the Division of Archaeology and Historic Preservation.

Sincerely,

E. Bernard Carrier
State Historic Preservation Officer

EBC:GHM:lm

cc: Louisiana Power and Light Company, 1001 Virgil St., Gretna LA 70053

Envirosphere, Inc., 2 World Trade Center, 90th Floor, New York NY 10048

STATE OF LOUISIANA
DEPARTMENT OF CULTURE, RECREATION AND TOURISM
OFFICE OF PROGRAM DEVELOPMENT

DAVID C. TREEN
Governor

ROBERT B. DeBLIEUX
Assistant Secretary

MRS. LAWRENCE H. FOX
Secretary

November 14, 1980

Mr. L.V. Maurin
Project Director
Louisiana Power and Light
P.O. Box 6008
New Orleans, LA 70174

Re: Cultural Resources Evaluation
of the Waterford 3 Electric
Generating Plant Site
St. Charles Parish, Louisiana

Dear Mr. Maurin:

My staff has reviewed the above-referenced cultural resources report, and we feel that the Waterford property may contain significant cultural resources (Areas 3, 4, and 5) eligible for inclusion in the National Register of Historic Places. Therefore, in accordance with Federal Regulations 36 CFR 63, we recommend that the lead federal agency initiate a determination of eligibility for these areas of cultural resources. If these areas are determined to be eligible, then we request that the lead federal agency seek a determination of effect of the operation of the plant on these resources in accordance with federal regulations 36 CFR 800.

If we may be of any further assistance, please feel free to contact my staff in the Division of Archaeology and Historic Preservation.

Sincerely,

Robert B. DeBlieux
State Historic Preservation Officer

RBD:JKK:bb

cc: Mr. William H. Reagan, Jr.✓
Nuclear Regulatory Commission

DIVISION OF ARCHAEOLOGY AND HISTORIC PRESERVATION
P. O. Box 44247 Baton Rouge, La. 70804 504 342-6682

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

JUL 10 1981

Docket Nos.: 50-382

Mr. L. V. Maurin
Assistant Vice President - Nuclear Operations
Louisiana Power & Light Company
142 Delaronde Street
New Orleans, Louisiana 70174

Dear Mr. Maurin:

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION/WATERFORD 3

Pursuant to our responsibility under 36 CFR 63 as licensing agency for the operation of Waterford Steam Electric Station Unit 3, the NRC requests information necessary to initiate a determination of eligibility request to the Keeper of the National Register. The information requested is in regard to areas 3, 4, and 5 identified in the cultural resources evaluation report prepared by you in 1980.

In reviewing the report the Louisiana State Historic Preservation Officer felt that the three areas may contain significant cultural resources eligible for inclusion in the National Register of Historic Places and recommended that NRC initiate a determination of eligibility request for these areas (see letter from Robert B. DeBlieux, State Historic Preservation Officer, Louisiana to Mr. L. V. Maurin, Project Director, Louisiana Power and Light Company dated November 14, 1980).

As discussed in a telephone conversation with Mr. Roy Prados on June 29, 1981, the U. S. Department of Interior form (FHR-8-300) entitled, "National Register of Historic Places Inventory-Nomination Form" may be used and should be filled out in detail with appropriate maps and other materials for each of the three areas and returned to the NRC. Item 12 of the form does not need to be filled out. The NRC requests that you take appropriate measures to protect the areas during the determination of eligibility process.

Sincerely,

Robert L. Tedesco, Assistant Director
for Licensing
Division of Licensing

cc: See next page

JUL 10 1981

Mr. I. V. Maurin
Assistant Vice President - Nuclear Operations
Louisiana Power & Light Company
142 Delaronde Street
New Orleans, Louisiana 70174

W. Malcolm Stevenson, Esq.
Monroe & Lemann
1424 Whitney Building
New Orleans, Louisiana 70130

Mr. E. Blake
Shaw, Pittman, Potts and Trowbridge
1800 M Street, N. W.
Washington, D.C. 20036

Mr. D. L. Aswell
Vice President, Power Production
Louisiana Power & Light Company
142 Delaronde Street
New Orleans, Louisiana 70174

Mr. F. J. Drummond
Project Manager - Nuclear
Louisiana Power & Light Company
142 Delaronde Street
New Orleans, Louisiana 70174

Mr. D. B. Lester
Production Engineer
Louisiana Power & Light Company
142 Delaronde Street
New Orleans, Louisiana 70174

Lyman L. Jones, Jr., Esq.
Gillespie & Jones
P. O. Box 9216
Metairie, Louisiana 70005

Luke Fontana, Esq.
Gillespie & Jones
824 Esplanade Ave.
New Orleans, Louisiana 70116

Stephen M. Irving, Esq.
535 North 6th Street
Baton Rouge, Louisiana 70802

Resident Inspector/Waterford NPS
P. O. Box 822
Killona, Louisiana 70066

Dr. Krishna R. Iyengar
Middle South Services, Inc.
P. O. Box 61000
New Orleans, Louisiana 70161

STATE OF LOUISIANA
DEPARTMENT OF CULTURE, RECREATION AND TOURISM
OFFICE OF PROGRAM DEVELOPMENT

DAVID C. TREEN
Governor

ROBERT B. DeBLIEUX
Assistant Secretary

MRS. LAWRENCE H. FOX
Secretary

July 1, 1981

RECEIVED
JUL 13 1981
U.S. NUCLEAR REGULATORY COMMISSION

Mr. Frank J. Miraglia, Acting Chief
Licensing Branch No. 3
Division of Licensing
United States Nuclear Regulatory Commission
Washington, D.C. 20555

Re: Draft Environmental Statement
Waterford 3 SES
St. Charles Parish, Louisiana

Dear Mr. Miraglia:

My staff has reviewed the above-referenced document and we are pleased to note that your agency is seeking determinations of eligibility for cultural areas 3, 4, and 5. We concur that these areas should be protected from major disturbance during the determination process.

We will be happy to comment on the effect of this project on those areas, if any, that are determined eligible for listing in the National Register of Historic Places during the determination of effect procedure, as outlined in Federal Regulations 36CFR800.

If you have any questions, please contact my staff at the Division of Archaeology and Historic Preservation.

Sincerely,

Robert B. DeBlieux
Robert B. DeBlieux
State Historic Preservation Officer

RBD/JKK/mb

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DIVISION OF ARCHAEOLOGY AND HISTORIC PRESERVATION
44247 Baton Rouge, La. 70804 504 342-6682

APPENDIX D

ENDANGERED SPECIES

Letter from Dennis B. Jordan, Area Endangered Species Supervisor, U.S. Department of the Interior, Fish and Wildlife Service, Jackson, Mississippi, to Ronald L. Ballard, Chief, Environmental Projects Branch 1, Division of Site Safety and Environmental Analysis, U.S. Nuclear Regulatory Commission, Washington, D.C., January 30, 1980.

UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
200 EAST PASCAGOULA STREET, SUITE 300
JACKSON, MISSISSIPPI 39201

January 30, 1980

Mr. Ronald L. Ballard, Chief
Environmental Projects Branch 1
Division of Site Safety and
Environmental Analysis
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Mr. Ballard:

This is in reference to your correspondence of December 31, 1979, requesting information on endangered, threatened, or proposed to be listed species that may be present in the area of the construction of the Waterford Steam Electric Station Unit No. 3 in St. Charles Parish, Louisiana (Log number 4-3-80-A-60).

We are unaware of any Federally listed species that may be present in the area of the aforementioned project.

We appreciate your concern for endangered species and look forward to further assistance.

Sincerely yours,

Ernest Douglas
for Dennis B. Jordan
Area Endangered Species Supervisor

cc: RD, FWS, Atlanta, GA. (AFA/SE)
ES, FWS, Lafayette, LA.
Director, Department of Wildlife
and Fisheries, New Orleans, LA.

C002 ES, 1/0

545

APPENDIX E

NPDES PERMIT

Permit No. LA0007374
Application No. LA0007374

AUTHORIZATION TO DISCHARGE UNDER THE
NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

In compliance with the provisions of the Federal Water Pollution Control Act, as amended, (33 U.S.C. 1251 et. seq; the "Act"),

Louisiana Power & Light Company
142 Delaronde Street
New Orleans, Louisiana 70174

is authorized to discharge from a facility located at

Waterford Steam Electric Station Unit 3
Killona, St. Charles Parish, Louisiana

to receiving waters named

40 Arpent Canal and the Mississippi River

in accordance with effluent limitations, monitoring requirements and other conditions set forth in Parts I, II, and III hereof.

This permit shall become effective on May 25, 1981

This permit and the authorization to discharge shall expire at midnight, May 24, 1986

Signed this 24th day of April 1981

for Bill Hathaway
Diana Dutton
Director
Enforcement Division (6AE)

EPA Form 3560-2 (2-74) REPLACES EPA FORM 3320-4 (10-73) WHICH MAY BE USED UNTIL SUPPLY IS EXHAUSTED

A-1 EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

During the period beginning the effective date and lasting through June 30, 1984 the permittee is authorized to discharge from outfall(s) serial number(s) 001, Unit 3 once through cooling water and previously monitored waste streams.

Such discharges shall be limited and monitored by the permittee as specified below:

Effluent Characteristic	Discharge Limitations				Monitoring Requirements	
	kg/day (lbs/day)		Other Units (Specify)			
	Daily Avg	Daily Max	Daily Avg	Daily Max	Measurement Frequency	Sample Type
Flow—m^3/Day (MGD)	N/A	N/A	(*)	(1445)	Continuous[1]	Record
Temperature	N/A	N/A	*[2]	43.3°C(110°F)[3]	Continuous	Record
Heat[4]	N/A	N/A	N/A	8.5 x 10^9 BTU/Hour[5]	Continuous	Record
Free Available Chlorine[6]	91.3(201)	228.2(502)	0.2 mg/l	0.5 mg/l	one/week[7]	Grab

*Report

[1]See Part III, Paragraph C.
[2]See Part III, Paragraph D.
[3]Instantaneous maximum.
[4]See Part III, Paragraph J.
[5]See Part III, Paragraph E.
[6]See Part III, Paragraph F.
[7]Monitoring shall be representative of periods of chlorination.

The pH shall not be less than N/A standard units nor greater than N/A standard units and shall be monitored N/A

There shall be no discharge of floating solids or visible foam in other than trace amounts.

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): Prior to discharge to the Mississippi River.

A-2 EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

During the period beginning July 1, 1984 and lasting through the expiration of this permit the permittee is authorized to discharge from outfall(s) serial number(s) 001, Unit 3 once through cooling water and previously monitored waste streams.

Such discharges shall be limited and monitored by the permittee as specified below:

Effluent Characteristic	Discharge Limitations				Monitoring Requirements	
	kg/day (lbs/day)		Other Units (Specify)			
	Daily Avg	Daily Max	Daily Avg	Daily Max	Measurement Frequency	Sample Type
Flow—m^3/Day (MGD)	N/A	N/A	(*)	(1445)	Continuous[1]	Record
Temperature	N/A	N/A	*[2]	43.3°C(110°F)[3]	Continuous	Record
Heat[4]	N/A	N/A	N/A	8.5 x 10^9 BTU/Hour[5]	Continuous	Record
Total Residual Chlorine[6]	N/A	228.2(502)	N/A	0.5 mg/l	One/Week[7]	Grab

1 See Part III, Paragraph C. *Report
2 See Part III, Paragraph D.
3 Instantaneous maximum.
4 See Part III, Paragraph J.
5 See Part III, Paragraph E.
6 See Part III, Paragraphs F & G.
7 Monitoring shall be representative of periods of chlorination.

The pH shall not be less than N/A standard units nor greater than N/A standard units and shall be monitored N/A

There shall be no discharge of floating solids or visible foam in other than trace amounts.

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): Prior to discharge to the Mississippi River.

A-3 EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

During the period beginning the effective date and lasting through the expiration of this permit, the permittee is authorized to discharge from outfall(s) serial number(s) 01A (Control point), waste management system and laundry wastes.
Such discharges shall be limited and monitored by the permittee as specified below:

Effluent Characteristic	Discharge Limitations				Monitoring Requirements	
	kg/day (lbs/day)		Other Units (Specify)			
	Daily Avg	Daily Max	Daily Avg	Daily Max	Measurement Frequency	Sample Type
Flow—m^3/Day (MGD)	N/A	N/A	(.0093)	(*)	Daily	Totalized
Surfactants	N/A	N/A	30 mg/l	30 mg/l	1/batch	Grab
Oil & Grease	N/A	N/A	15 mg/l	20 mg/l	1/batch	Grab
Total Suspended Solids	N/A	N/A	30 mg/l	100 mg/l	1/batch	Grab

*Report

E-4

The pH shall not be less than 6.0 standard units nor greater than 9.0 standard units and shall be monitored 1/batch by grab sample.

There shall be no discharge of floating solids or visible foam in other than trace amounts.

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): Prior to mixing with the circulating cooling water.

A-4 EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

During the period beginning the effective date and lasting through the expiration of this permit the permittee is authorized to discharge from outfall(s) serial number(s) 01B (Control point), boron management system.

Such discharges shall be limited and monitored by the permittee as specified below:

Effluent Characteristic	Discharge Limitations				Monitoring Requirements	
	kg/day (lbs/day)		Other Units (Specify)			
	Daily Avg	Daily Max	Daily Avg	Daily Max	Measurement Frequency	Sample Type
Flow—m^3/Day (MGD)	N/A	N/A	(.0144)	(*)	Daily	Totalized
Boron	N/A	N/A	10 mg/l	10 mg/l	1/batch	Grab
Oil & Grease	N/A	N/A	15 mg/l	20 mg/l	1/batch	Grab
Total Suspended Solids	N/A	N/A	30 mg/l	100 mg/l	1/batch	Grab

*Report

The pH shall not be less than 6.0 standard units nor greater than 9.0 standard units and shall be monitored 1/batch by grab sample.

There shall be no discharge of floating solids or visible foam in other than trace amounts.

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): Prior to mixing with the circulating cooling water.

A-5 EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

During the period beginning the effective date and lasting through the expiration of this permit, the permittee is authorized to discharge from outfall(s) serial number(s) 01C (Control point), filter flush water from primary water treatment plant.
Such discharges shall be limited and monitored by the permittee as specified below:

Effluent Characteristic	Discharge Limitations kg/day (lbs/day) Daily Avg	Daily Max	Other Units (Specify) Daily Avg	Daily Max	Monitoring Requirements Measurement Frequency	Sample Type
Flow—m³/Day (MGD)	N/A	N/A	(0.720)	(0.960)	Daily	Totalized
Total Suspended Solids	*	*	N/A	N/A	1/week	Grab
Total Organic Carbon	*	*	N/A	N/A	1/week	Grab
Alkalinity, Phenolphthalein Method	*	*	N/A	N/A	1/week	Grab
Clarifying Agents Used	*	N/A	N/A	N/A	1/month	Record

E-6

*Report
See Part III, Paragraph K.

The pH shall not be less than * standard units nor greater than * standard units and shall be monitored 1/week by grab sample.

There shall be no discharge of floating solids or visible foam in other than trace amounts.

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s):
Prior to mixing with the circulating cooling water.

A-6 EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

During the period beginning the effective date and lasting through the expiration of this permit, the permittee is authorized to discharge from outfall(s) serial number(s) 002, floor drainage (yard oil/water separator).

Such discharges shall be limited and monitored by the permittee as specified below:

Effluent Characteristic	Discharge Limitations				Monitoring Requirements	
	kg/day (lbs/day)		Other Units (Specify)			
	Daily Avg	Daily Max	Daily Avg	Daily Max	Measurement Frequency	Sample Type
Flow—m^3/Day (MGD)	N/A	N/A	(.147)	(.232)	Daily	Totalized
Total Suspended Solids	N/A	N/A	30 mg/l	100 mg/l	1/week	Grab
Oil and Grease	N/A	N/A	15 mg/l	20 mg/l	1/week	Grab

The pH shall not be less than 6.0 standard units nor greater than 9.0 standard units and shall be monitored 1/week by grab sample.

There shall be no discharge of floating solids or visible foam in other than trace amounts.

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): Prior to discharge to 40 Arpent Canal.

A-7 EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

During the period beginning the effective date and lasting through the expiration of this permit, the permittee is authorized to discharge from outfall(s) serial number(s) 003 service building floor drainage.

Such discharges shall be limited and monitored by the permittee as specified below:

Effluent Characteristic	Discharge Limitations				Monitoring Requirements	
	kg/day (lbs/day)		Other Units (Specify)			
	Daily Avg	Daily Max	Daily Avg	Daily Max	Measurement Frequency	Sample Type
Flow—m^3/Day (MGD)	N/A	N/A	(.05)	(.05)	Daily	Totalized
Total Suspended Solids	N/A	N/A	30 mg/l	100 mg/l	1/week	Grab
Oil & Grease	N/A	N/A	15 mg/l	20 mg/l	1/week	Grab

The pH shall not be less than 6.0 standard units nor greater than 9.0 standard units and shall be monitored 1/week by grab sample.

There shall be no discharge of floating solids or visible foam in other than trace amounts.

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): Prior to discharge to 40 Arpent Canal.

A-8 EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

During the period beginning the effective date and lasting through the expiration of this permit. the permittee is authorized to discharge from outfall(s) serial number(s) 004, administration building sanitary discharge and 005 on-site offices discharge.

Such discharges shall be limited and monitored by the permittee as specified below:

Effluent Characteristic	Discharge Limitations				Monitoring Requirements	
	kg/day (lbs/day)		Other Units (Specify)			
	Daily Avg	Daily Max	Daily Avg	Daily Max	Measurement Frequency	Sample Type
Flow—m^3/Day (MGD)	N/A	N/A	(*)	(*)	Daily	Totalized
Biochemical Oxygen Demand (5-day)	0.5(1.0)	0.95(2.1)	30 mg/l	45 mg/l	1/week	Grab
Total Suspended Solids	0.5(1.0)	0.95(2.1)	30 mg/l	45 mg/l	1/week	Grab

The pH shall not be less than 6.0 standard units nor greater than 9.0 standard units and shall be monitored 1/week by Grab sample.

There shall be no discharge of floating solids or visible foam in other than trace amounts.

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): Prior to discharge to 40 Arpent Canal.

B. SCHEDULE OF COMPLIANCE Serial No. 001

1. The permittee shall achieve compliance with the effluent limitations specified for discharges in accordance with the following schedule:

Progress Report	06-30-82
Progress Report	12-31-82
Progress Report	06-30-83
Progress Report	12-31-83
Progress Report	03-31-84
Achieve Compliance	07-01-84

2. No later than 14 calendar days following a date identified in the above schedule of compliance, the permittee shall submit either a report of progress or, in the case of specific actions being required by identified dates, a written notice of compliance or noncompliance. In the latter case, the notice shall include the cause of noncompliance, any remedial actions taken, and the probability of meeting the next scheduled requirement.

C. MONITORING AND REPORTING

1. *Representative Sampling*

Samples and measurements taken as required herein shall be representative of the volume and nature of the monitored discharge.

2. *Reporting*

Monitoring results obtained during the previous 3 months shall be summarized for each month and reported on a Discharge Monitoring Report Form (EPA No. 3320-1), postmarked no later than the 28th day of the month following the completed reporting period. The first report is due on July 28, 1981 Duplicate signed copies of these, and all other reports required herein, shall be submitted to the Regional Administrator and the State at the following addresses:

Diana Dutton, Director
Enforcement Division (6AE)
U.S. Environmental Protection Agency
First International Building
1201 Elm Street
Dallas, Texas 75270

J. Dale Givens, Administrator
Water Pollution Control Division
Office of Environmental Affairs
Louisiana Dept. of Natural Resources
P. O. Box 44066
Baton Rouge, Louisiana 70804

3. *Definitions*

a. The "daily average" discharge means the total discharge by weight during a calendar month divided by the number of days in the month that the production or commercial facility was operating. Where less than daily sampling is required by this permit, the daily average discharge shall be determined by the summation of all the measured daily discharges by weight divided by the number of days during the calendar month when the measurements were made.

b. The "daily maximum" discharge means the total discharge by weight during any calendar day.

4. *Test Procedures*

Test procedures for the analysis of pollutants shall conform to regulations published pursuant to Section 304(g) of the Act, under which such procedures may be required.

5. *Recording of Results*

For each measurement or sample taken pursuant to the requirements of this permit, the permittee shall record the following information:

a. The exact place, date, and time of sampling;

b. The dates the analyses were performed;

c. The person(s) who performed the analyses;

d. The analytical techniques or methods used; and

e. The results of all required analyses.

6. *Additional Monitoring by Permittee*

If the permittee monitors any pollutant at the location(s) designated herein more frequently than required by this permit, using approved analytical methods as specified above, the results of such monitoring shall be included in the calculation and reporting of the values required in the Discharge Monitoring Report Form (EPA No. 3320-1). Such increased frequency shall also be indicated.

7. *Records Retention*

All records and information resulting from the monitoring activities required by this permit including all records of analyses performed and calibration and maintenance of instrumentation and recordings from continuous monitoring instrumentation shall be retained for a minimum of three (3) years, or longer if requested by the Regional Administrator or the State water pollution control agency.

A. MANAGEMENT REQUIREMENTS

1. *Change in Discharge*

All discharges authorized herein shall be consistent with the terms and conditions of this permit. The discharge of any pollutant identified in this permit more frequently than or at a level in excess of that authorized shall constitute a violation of the permit. Any anticipated facility expansions, production increases, or process modifications which will result in new, different, or increased discharges of pollutants must be reported by submission of a new NPDES application or, if such changes will not violate the effluent limitations specified in this permit, by notice to the permit issuing authority of such changes. Following such notice, the permit may be modified to specify and limit any pollutants not previously limited.

2. *Noncompliance Notification*

If, for any reason, the permittee does not comply with or will be unable to comply with any daily maximum effluent limitation specified in this permit, the permittee shall provide the Regional Administrator and the State with the following information, in writing, within five (5) days of becoming aware of such condition:

a. A description of the discharge and cause of noncompliance; and

b. The period of noncompliance, including exact dates and times; or, if not corrected, the anticipated time the noncompliance is expected to continue, and steps being taken to reduce, eliminate and prevent recurrence of the noncomplying discharge.

3. *Facilities Operation*

The permittee shall at all times maintain in good working order and operate as efficiently as possible all treatment or control facilities or systems installed or used by the permittee to achieve compliance with the terms and conditions of this permit.

4. *Adverse Impact*

The permittee shall take all reasonable steps to minimize any adverse impact to navigable waters resulting from noncompliance with any effluent limitations specified in this permit, including such accelerated or additional monitoring as necessary to determine the nature and impact of the noncomplying discharge.

5. *Bypassing*

Any diversion from or bypass of facilities necessary to maintain compliance with the terms and conditions of this permit is prohibited, except (i) where unavoidable to prevent loss of life or severe property damage, or (ii) where excessive storm drainage or runoff would damage any facilities necessary for compliance with the effluent limitations and prohibitions of this permit. The permittee shall promptly notify the Regional Administrator and the State in writing of each such diversion or bypass.

6. *Removed Substances*

Solids, sludges, filter backwash, or other pollutants removed in the course of treatment or control of wastewaters shall be disposed of in a manner such as to prevent any pollutant from such materials from entering navigable waters.

7. *Power Failures*

In order to maintain compliance with the effluent limitations and prohibitions of this permit, the permittee shall either:

a. In accordance with the Schedule of Compliance contained in Part I, provide an alternative power source sufficient to operate the wastewater control facilities;

or, if such alternative power source is not in existence, and no date for its implementation appears in Part I,

b. Halt, reduce or otherwise control production and/or all discharges upon the reduction, loss, or failure of the primary source of power to the wastewater control facilities.

B. RESPONSIBILITIES

1. *Right of Entry*

The permittee shall allow the head of the State water pollution control agency, the Regional Administrator, and/or their authorized representatives, upon the presentation of credentials:

a. To enter upon the permittee's premises where an effluent source is located or in which any records are required to be kept under the terms and conditions of this permit; and

b. At reasonable times to have access to and copy any records required to be kept under the terms and conditions of this permit; to inspect any monitoring equipment or monitoring method required in this permit; and to sample any discharge of pollutants.

2. *Transfer of Ownership or Control*

In the event of any change in control or ownership of facilities from which the authorized discharges emanate, the permittee shall notify the succeeding owner or controller of the existence of this permit by letter, a copy of which shall be forwarded to the Regional Administrator and the State water pollution control agency.

3. *Availability of Reports*

Except for data determined to be confidential under Section 308 of the Act, all reports prepared in accordance with the terms of this permit shall be available for public inspection at the offices of the State water pollution control agency and the Regional Administrator. As required by the Act, effluent data shall not be considered confidential. Knowingly making any false statement on any such report may result in the imposition of criminal penalties as provided for in Section 309 of the Act.

4. *Permit Modification*

After notice and opportunity for a hearing, this permit may be modified, suspended, or revoked in whole or in part during its term for cause including, but not limited to, the following:

a. Violation of any terms or conditions of this permit;

b. Obtaining this permit by misrepresentation or failure to disclose fully all relevant facts; or

c. A change in any condition that requires either a temporary or permanent reduction or elimination of the authorized discharge.

5. *Toxic Pollutants*

Notwithstanding Part II, B-4 above, if a toxic effluent standard or prohibition (including any schedule of compliance specified in such effluent standard or prohibition) is established under Section 307(a) of the Act for a toxic pollutant which is present in the discharge and such standard or prohibition is more stringent than any limitation for such pollutant in this permit, this permit shall be revised or modified in accordance with the toxic effluent standard or prohibition and the permittee so notified.

6. *Civil and Criminal Liability*

Except as provided in permit conditions on "Bypassing" (Part II, A-5) an "Power Failures" (Part II, A-7), nothing in this permit shall be construed to relieve the pe mittee from civil or criminal penalties for noncompliance.

7. *Oil and Hazardous Substance Liability*

Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities, or penalties to which the permittee is or may be subject under Section 311 of the Act.

8. *State Laws*

Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities, or penalties established pursuant to any applicable State law or regulation under authority preserved by Section 510 of the Act.

9. *Property Rights*

The issuance of this permit does not convey any property rights in either real or personal property, or any exclusive privileges, nor does it authorize any injury to private property or any invasion of personal rights, nor any infringement of Federal, State or local laws or regulations.

10. *Severability*

The provisions of this permit are severable, and if any provision of this permit, or the application of any provision of this permit to any circumstance, is held invalid, the application of such provision to other circumstances, and the remainder of this permit, shall not be affected thereby.

PART III

OTHER REQUIREMENTS

A. There shall be no discharge of polychlorinated biphenyl transformer fluid.

B. The "daily average" concentration means the arithmetic average (weighted by flow value) of all the daily determinations of concentration made during a calendar month. Daily determinations of concentration made using a composite sample shall be the concentration of the composite sample. When grab samples are used, the daily determination of concentration shall be the arithmetic average (weighted by flow value) of all the samples collected during that calendar day.

The "daily maximum" concentration means the daily determination of concentration for any calendar day.

C. Discharge flow may be derived from calibrated pumping curves.

D. Daily average temperature shall be calculated and recorded on a daily basis as the average in a 24-hour period of temperatures at intervals not greater than two hours.

E. Discharge of heat shall be continuously calculated and recorded as:

Instantaneous ΔT (circulating water temperature rise through plant, °F) x Instantaneous flow rate (MGD) x 3.48×10^5.

F. The term "free available chlorine" shall mean the value obtained using the amperometric titration method for free available chlorine described in "Standard Methods for examination of Water and Wastewater", page 112 (13th edition).

Neither free available chlorine nor total residual chlorine may be discharged from any unit for more than two hours in any one day.

G. The term "total residual chlorine" (or total residual oxidants for intake water with bromides) means the value obtained using the amperometric method for total residual chlorine described in "Standard Methods for the Examination of Water and Wastewater." p. 112 (13th edition).

I. The thermal effluent limitations of the permit are approved in accordance with Section 316(a) of the Clean Water Act (33 U.S.C. Section 1326).

J. The intake structure is approved pursuant to Section 316(b) of the Clean Water Act (33 U.S.C. Section 1326).

K. Water treatment clarifier sludge wates may be returned to the stream without treatment if not previously combined with any other untreated waste source, including demineralizer and softener wastes.

L. Noncompliance reporting for upsets and bypasses shall be made within 24 hours to EPA Region 6 followed by a written report in five days. Violations of daily maximum limitations for pollutants listed below will also be reported in 24 hours followed by a written report in five days. Violations of daily maximum limitations for all other pollutants identified elsewhere in this permit shall be reported in writing within five days.

M. The conditions applicable to all permits under 40 CFR 122.7, 122.15, 122.60, 122.61 and 122.62 (as promulgated in the May 19, 1980, Federal Register) are hereby incorporated into this permit and prevail over any inconsistent requirements of this permit.

N. Certain non-radioactive chemical wastewaters from this facility (including demineralizer regenerants, sanitary wastes, HVAC cooling tower blowdown, metal cleaning and blowdown wastes) are not covered by this permit. These wastes will be commingled and treated with similar wastes from Waterford Units 1 and 2 and controlled under terms of NPDES permit number LA0007439.

APPENDIX F

REBASELINING OF THE RSS RESULTS FOR PWRs

The results of the Reactor Safety Study (RSS) have been updated. The update was done largely to incorporate results of research and development conducted after the October 1975 publication of the RSS and to provide a baseline against which the risk associated with various LWRs could be consistently compared.

Primarily, the rebaselined RSS results reflect use of advanced modeling of the processes involved in meltdown accidents, i.e., the MARCH computer code modeling for transient and LOCA initiated sequences and the CORRAL code used for calculating magnitudes of release accompanying various accident sequences. These codes* have led to a capability to predict the transient and small LOCA initiated sequences that is considerably advanced beyond what existed at the time the Reactor Safety Study was completed. The advanced accident process models (MARCH and CORRAL) produced some changes in our estimates of the release magnitudes from various accident sequences in WASH-1400. These changes primarily involved release magnitudes for the iodine, cesium and tellurium families of isotopes. In general, a decrease in the iodines was predicted for many of the dominant accident sequences while some increases in the release magnitudes for the cesium and tellurium isotopes were predicted.

Entailed in this rebaselining effort was the evaluation of individual dominant accident sequences as we understand them to evolve rather than the technique of grouping large numbers of accident sequences into encompassing, but synthetic, release categories as was done in WASH-1400. The rebaselining of the RSS also eliminated the "smoothing technique" that was criticized in the report by the Risk Assessment Review Group (sometimes known as the Lewis Report; NUREG/CR-0400).

In both of the RSS designs (PWR and BWR), the likelihood of an accident sequence leading to the occurrence of a steam explosion (α) in the reactor vessel was decreased. This was done to reflect both experimental and calculational indications that such explosions are unlikely to occur in those sequences involving small size LOCAs and transients because of the high pressures and temperatures expected to exist within the reactor coolant system during these scenarios. Furthermore, if such an explosion were to occur, there are indications that it would be unlikely to produce as much energy and the massive missile-caused breach of containment as was postulated in WASH-1400.

For rebaselining of the RSS PWR design, the release magnitudes for the risk dominating sequences, e.g., Event V, TMLB' δ, γ and $S_2C\delta$ (described later) were explicitly calculated and used in the consequence modelling rather than being lumped into release categories as was done in WASH-1400. The rebaselining led to a small decrease in the predicted risk to an individual of early fatality or latent cancer fatality relative to the original RSS-PWR predictions. This

*It should be noted that the MARCH code was used on a number of scenarios in connection with the TMI-2 recovery efforts and for post-TMI-2 investigations to explore possible alternative scenarios that TMI-2 could have experienced.

result is believed to be largely attributable to the decreased likelihood of occurrence for sequences involving severe steam explosions (α) that breached containment. (In WASH-1400, the sequences involving severe steam explosions (α) were artificially elevated in their risk significance (i.e., made more likely) by use of the "smoothing technique.")

In summary, the rebaselining of the RSS results led to small overall differences from the predictions in WASH-1400. It should be recognized that these small differences due to the rebaselining efforts are likely to be far outweighed by the uncertainties associated with such analyses.

The accident sequences which are expected to dominate risk from the RSS-PWR design are described below. Accident sequences are designated by strings of identification characters in the same manner as in the RSS (See the table of these symbols on page F-5). Each of the characters represents a failure in one or more of the important plant systems or features that ultimately would result in melting of the reactor core and a significant release of radioactive materials from containment.*

Event V (Interfacing System LOCA)

During the Reactor Safety Study a potentially large risk contributor was identified due to the configuration of the multiple check valve barriers used to separate the high pressure reactor coolant system from the low design pressure portions of the ECCS (i.e., the low pressure injection subsystem - LPIS). If these valve barriers were to fail in various modes, such as leak-rupture or rupture-rupture, and suddenly exposed the LPIS to high overpressures and dynamic loadings, the RSS judged that a high probability of LPIS rupture would exist. Since the LPIS is largely located outside of containment, the Event V scenario would be a LOCA that bypassed containment and those mitigating features (e.g., sprays) within containment. The RSS assumed that if the rupture of LPIS did not entirely fail the LPIS makeup function (which would ultimately be needed to prevent core damage), the LOCA environment (flooding, steam) would. Predictions of the release magnitude and consequences associated with Event V have indicated that this scenario represents one of the largest risk contributors from the RSS-PWR design. The NRC has recognized this RSS finding, and has taken steps to reduce the probability of occurrence of Event V scenarios in both existing and future LWR designs by requiring periodic surveillance testing of the interfacing valves to assure that these valves are properly functioning as pressure boundary isolation barriers during plant operations. Accordingly, Event V predictions for the RSS-PWR are likely to be conservative relative to the design and operation of the Waterford Unit 3 PWR.

TMLB'-δ, γ

This sequence essentially considers the loss and nonrestoration of all AC power sources available to the plant along with an independent failure of the steam turbine driven auxiliary feedwater train which would be required to operate to remove shutdown heat from the reactor core. The transient event is initiated by loss of offsite AC power sources which would result in plant trip (scram) and the loss of the normal way that the plant removes heat from the reactor

*For additional information detail see Reactor Safety Study (WASH-1400), Appendix V.

core (i.e., via the power conversion system consisting of the turbine, condenser, the condenser cooling system, and the main feedwater and condensate delivery system that supplies water to the steam generators). This initiating event would then demand operation of the standby onsite emergency AC power supplies (2 diesel generators) and the standby auxiliary feedwater system, 2 trains of which are electrically driven by either onsite or offsite AC power. With failure and nonrestoration of AC and the failure of the steam turbine driven auxiliary feedwater train to remove shutdown heat, the core would ultimately uncover and melt. If restoration of AC was not successful during (or following) melt, the containment heat removal and fission product mitigating systems would not be operational to prevent the ultimate overpressure (δ, γ) failure of containment and a rather large, energetic release of activity from the containment. Next to the Event V sequence, TMLB'δ, γ is predicted to dominate the overall accident risks in the RSS-PWR design.

S_2C-δ (PWR 3)

In the RSS the S_2C-δ sequence was placed into PWR release Category 3 and it actually dominated all other sequences in Category 3 in terms of probability and release magnitudes. The rebaselining entailed explicit calculations of the consequences from S_2C-δ and the results indicated that it was next in overall risk importance following Event V and TMLB'δ, γ.

The S_2C-δ sequence included a rather complex series of dependencies and interactions that are believed to be somewhat unique to the containment systems (subatmospheric) employed in the RSS PWR design.

In essence, the S_2C-δ sequence included a small loss-of-coolant accident occurring in a specific region of the plant (reactor vessel cavity); failure of the recirculating containment heat removal systems (CSRS-F) because of a dependence on water draining to the recirculation sump from the LOCA and a resulting dependence imposed on the quench spray injection system (CSIS-C) to provide water to the sump. The failure of the CSIS(C) resulted in eventual overpressure failure of containment (δ) due to the loss of CSRS(F). Given the overpressure failure of containment the RSS assumed that the ECCS functions would be lost due either to the cavitation of ECCS pumps or from the rather severe mechanical loads that could result from the overpressure failure of containment. The core was then assumed to melt in a breached containment leading to a significant release of radioactive materials.

Approximately 20% of the iodines and 20% of the alkali metals present in the core at the time of release would be released to the atmosphere. Most of the release would occur over a period of about 1.5 hours. The release of radioactive material from containment would be caused by the sweeping action of gases generated by the reaction of the molten fuel with concrete. Since these gases would be initially heated by contact with the melt, the rate of sensible energy release to the atmosphere would be moderately high.

PWR 7

This is the same as the PWR release category #7 of the original RSS which was made up of several sequences such as S_2D-ε (the dominant contributor to the risk in this category), S_1D-ε, S_2H-ε, S_1H-ε, AD-ε, AH-ε, TML-ε, and TKQ-ε. All of these sequences involved a containment base mat melt-through as the containment failure mode. With exception of TML-ε and TKQ-ε, all involve the potential failure of the emergency core cooling system following occurrence of a LOCA with the containment ESFs continuing to operate as designed until the base mat was penetrated. Containment sprays would operate to reduce the containment temperature and pressure as well as the amount of airborne radioactivity. The containment barrier would retain its integrity until the molten core proceeded to melt through the concrete containment base mat. The radioactive materials would be released into the ground, with some leakage to the atmosphere occurring upward through the ground. Most of the release would occur continuously over a period of about 10 hours. The release would include approximately 0.002% of the iodines and 0.001% of alkali metals present in the core at the time of release. Because leakage from containment to the atmosphere would be low and gases escaping through the ground would be cooled by contact with the soil, the energy release rate would be very low.

KEY TO PWR ACCIDENT SEQUENCE SYMBOLS

A - Intermediate to large LOCA.

B - Failure of electric power to ESFs.

B′ - Failure to recover either onside or offsite electric power within about 1 to 3 hours following an initiating transient which is a loss of offsite AC power.

C - Failure of the containment spray injection system.

D - Failure of the emergency core cooling injection system.

F - Failure of the containment spray recirculation system.

G - Failure of the containment heat removal system.

H - Failure of the emergency core cooling recirculation system.

K - Failure of the reactor protection system.

L - Failure of the secondary system relief valves and the auxiliary feedwater system.

M - Failure of the secondary system steam relief valves and the power conversion system.

Q - Failure of the primary system safety relief valves to reclose after opening.

R - Massive rupture of the reactor vessel.

S_1 - A small LOCA with an equivalent diameter of about 2 to 6 inches.

S_2 - A small LOCA with an equivalent diameter of about 1/2 to 2 inches.

T - Transient event.

V - LPIS check valve failure.

α - Containment rupture due to a reactor vessel steam explosion.

β - Containment failure resulting from inadequate isolation of containment openings and penetrations.

γ - Containment failure due to hydrogen burning.

δ - Containment failure due to overpressure.

ε - Containment vessel melt-through.

APPENDIX G

EVACUATION MODEL

"Evacuation," used in the context of offsite emergency response in the event of substantial amount of radioactivity release to the atmosphere in a reactor accident, denotes an early and expeditious movement of people to avoid exposure to the passing radioactive cloud and/or to acute ground contamination in the wake of the cloud passage. It should be distinguished from "relocation" which denotes a post-accident response to reduce exposure from long term ground contamination. The Reactor Safety Study[1] (RSS) consequence model contains provision for incorporating radiological consequence reduction benefits of public evacuation. Benefits of a properly planned and expeditiously carried out public evacuation would be well manifested in reduction of acute health effects associated with early exposure; namely, in number of cases of acute fatality and acute radiation sickness which would require hospitalization. The evacuation model originally used in the RSS consequence model is described in WASH-1400[1] as well as in NUREG-0340.[2] However, the evacuation model which has been used herein is a modified version[3] of the RSS model and is, to a certain extent, site emergency planning oriented. The modified version is briefly outlined below:

The model utilizes a circular area with a specified radius (such as a 10 mile plume exposure pathway Emergency Planning Zone (EPZ)), with the reactor at the center. It is assumed that people living within portions of this area would evacuate if an accident should occur involving imminent or actual release of significant quantities of radioactivity to the atmosphere.

Significant atmospheric releases of radioactivity would in general be preceded by one or more hours of warning time (postulated as the time interval between the awareness of impending core melt and the beginning of the release of radioactivity from the containment building). For the purpose of calculation of radiological exposure, the model assumes that all people who live in a fan-shaped area (fanning out from the reactor), within the circular zone with the down-wind direction as its median - i.e., those people who would potentially be under the radioactive cloud that would develop following the release - would leave their residences after lapse of a specified amount of delay time* and then evacuate. The delay time is reckoned from the beginning of the warning time and is recognized as the sum of the time required by the reactor operators to notify the responsible authorities, time required by the authorities to interpret the data, decide to evacuate, and direct the people to evacuate, and time required for the people to mobilize and get underway.

While leaving the area, the model assumes that each evacuee would move radially out and in the downwind direction with an average effective speed* (obtained by dividing the zone radius by the average time taken to clear the zone after the delay time) over a fixed distance* from the evacuee's starting point.

*Assumed to be of a constant value which would be the same for all evacuees.

This distance is selected to be 15 miles (which is 5 miles more than the 10-mile plume exposure pathway EPZ radius). After reaching the end of the travel distance the evacuee is assumed to receive no further radiation exposure. (An important assumption incorporated in the RSS consequence model is that if the calculated ground dose to the total marrow over a 7-day period would exceed 200 rems in the regions beyond the evacuation zone, then this high dose rate would be detected by actual field measurements following the accident and people from those regions would be relocated immediately. Therefore, the model limits the period for ground-dose calculation to only 24 hours for those regions. When no evacuation at all is assumed, this manner of ground-dose calculations applies to all regions, beginning from the reactor's location. CRAC code implements this feature irrespective of the evacuation model used.)

The model incorporates a finite length of the radioactive cloud in the downwind direction which would be determined by the product of the duration over which the atmospheric release would take place and the average windspeed during the release. It is assumed that the front and the back of the cloud formed would move with an equal speed which would be the same as the prevailing windspeed; therefore, its length would remain constant at its initial value. At any time after the release, the concentration of radioactivity is assumed to be uniform over the length of the cloud. If the delay time would be less than the warning time, then all evacuees would have a head-start, i.e., the cloud would be trailing behind the evacuees initially. On the other hand, if the delay time would be more than the warning time, then depending on initial locations of the evacuees there are possibilities that (a) an evacuee will still have a head-start, or (b) the cloud would be already overhead when an evacuee starts out to leave, or (c) an evacuee would be initially trailing behind the cloud. However, this initial picture of cloud-people disposition would change as the evacuees travel depending on the relative speed and positions between the cloud and people. It may become possible that the cloud and an evacuee would overtake one another one or more number of times before the evacuee would reach his or her destination. In the model, the radial position of an evacuating person, while stationary or in transit, is compared to the front and the back of the cloud as a function of time to determine a realistic period of exposure to airborne radionuclides. The model calculates the time periods during which people are exposed to radionuclides on the ground while they are stationary and while they are evacuating. Because radionuclides would be deposited continually from the cloud as it passed a given location, a person while under the cloud would be exposed to ground contamination less concentrated than if the cloud had completely passed. To account for this, at least in part, the revised model assumes that persons are exposed to the total ground contamination concentration, calculated to exist after complete passage of the cloud, when completely passed by the cloud; to one half the calculated concentration when anywhere under the cloud; and to no concentration when in front of the cloud. The model provides for use of different values of the shielding protection factors for exposure from airborne radioactivity and contaminated ground, and the breathing rates for stationary and moving evacuees during delay and transit periods.

It is realistic to expect that authorities would evacuate persons at distances from the site where exposures above the threshold for causing acute fatalities could occur regardless of the plume exposure pathway EPZ distance. Figure G-1 illustrates the reduction in acute fatalities that can occur by extending evacuation to a larger distance such as 20 mi, from the Waterford Unit 3 site. Calculation shows that if the evacuation distance is increased to 25 mi, there would be no acute fatalities at all probability levels for this site. Also illustrated in Figure G-1 is a pessimistic case for which no early evacuation is assumed and all persons are assumed to be exposed for the first 24 hours following an accident and are then relocated.

The model has the same provision for calculation of the economic cost associated with implementation of evacuation as in the orginal RSS model. For this purpose, the model assumes that for atmospheric releases of durations three hours or less, all people living within a circular area of 5-mile radius centered at the reactor plus all people within a 45° angular sector within the plume exposure pathway EPZ and centered on the downwind direction will be evacuated and temporarily relocated. However, if the duration of release would exceed three hours, the cost of evacuation is based on the assumption that all people within the entire plume exposure pathway EPZ would be evacuated and temporarily relocated. For either of these situations, the cost of evacuation and relocation is assumed to be $125 (1980 dollar) per person which includes cost of food and temporary sheltering for a period of one week.

REFERENCES FOR APPENDIX G

1. "Reactor Safety Study," WASH-1400 (NUREG-75/014), October 1975.

2. "Overview of the Reactor Safety Study Consequences Model," NUREG-0340, October 1977.

3. "A Model of Public Evacuation for Atmospheric Radiological Releases," SAND 78-0092, June 1978.

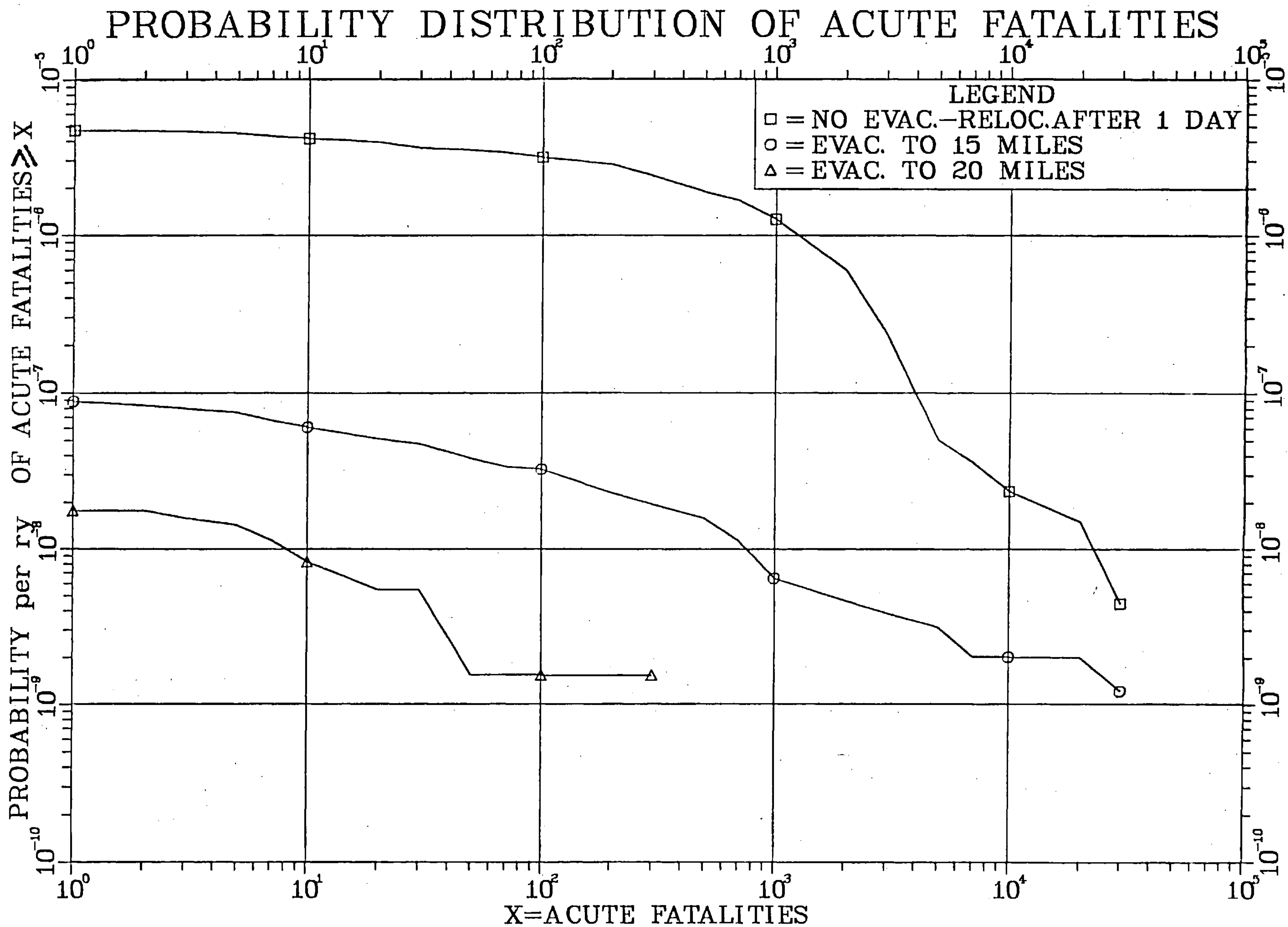

Fig. G-1 Sensitivity of Probability Distribution of Acute Fatality to Evacuation Distance.
Note 1: For evacuation to 25 miles no fatality is predicted.
Note 2: Please see Section 5.9.2.5(7) for uncertainties in risk estimates.

APPENDIX H

NEPA POPULATION-DOSE ASSESSMENT

Population-dose commitments are calculated for all individuals living within 80 km (50 miles) of Waterford 3, employing the same models used for individual doses (see Regulatory Guide 1.109, Rev. 1)[1], for the purpose of meeting the "as low as reasonably achievable" (ALARA) requirements of 10 CFR, Part 50, Appendix I.[2] In addition, dose commitments to the population residing beyond the 80-km region, associated with the export of food crops produced within the 80-km region and with the atmospheric and hydrospheric transport of the more mobile effluent species, such as noble gases, tritium, and carbon-14, are taken into consideration for the purpose of meeting the requirements of the National Environmental Policy Act, 1969 (NEPA). This appendix describes the methods used to make these NEPA population dose estimates.

1. Iodines and Particulates Released to the Atmosphere

Effluent nuclides in this category deposit on the ground as the effluent moves downwind, thus the concentration of these nuclides remaining in the plume is continuously being reduced. Within 80 km of the facility, the deposition model in Regulatory Guide 1.111, Rev. 1,[3] is used in conjunction with the dose models in Regulatory Guide 1.109, Rev. 1.[1] Site specific data concerning production and consumption of foods within 80 km of the reactor are used. For estimates of population doses beyond 80 km it is assumed that excess food not consumed within the 80-km area will be consumed by the population beyond 80 km. It is further assumed that none, or very few, of the particulates released from the facility will be transported beyond the 80-km distance; thus they will make no contribution to the population dose outside the 80-km region. This assumption was tested and found to be reasonable for Waterford 3.

2. Noble Gases, Carbon-14, and Tritium Released to the Atmosphere

For locations within 80 km (50 miles) of the reactor facility, exposures to these effluents are calculated with a constant mean wind-direction model according to the guidance provided in Regulatory Guide 1.111, Rev. 1, and the dose models described in Regulatory Guide 1.109, Rev. 1. For estimating the dose commitment from these radionuclides to the U.S. population residing beyond the 80-km region, two dispersion regimes are considered. These are referred to as the first-pass dispersion regime and the world-wide dispersion regime. The model for the first-pass dispersion regime estimates the dose commitment to the population from the radioactive plume as it leaves the facility and drifts across the continental United States to the northeastern corner of the U.S. The model for the world-wide dispersion regime estimates the dose commitment to the U.S. population after the released radionuclides mix uniformly in the world's atmosphere or oceans.

a. First-Pass Dispersion

For estimating the dose commitment to the U.S. population residing beyond the 80-km region due to the first pass of radioactive pollutants, it is assumed that the pollutants disperse in the lateral and vertical directions along the plume path. The direction of movement of the plume is assumed to be from the facility toward the northeast corner of the U.S. The extent of vertical dispersion is assumed to be limited by the ground plane and the stable atmospheric layer aloft, the height of which determines the mixing depth. The shape of such a plume geometry can be visualized as a right cylindrical wedge whose height is equal to the mixing depth. Under the assumption of constant population density, the population dose associated with such a plume geometry is independent of the extent of lateral dispersion, and is only dependent upon the mixing depth and other nongeometrical related factors.[4] The mixing depth is estimated to be 1000m, and a uniform population density of 62 persons/km^2 is assumed along the plume path, with an average plume transport velocity of 2 m/s.

The total-body population dose commitment from the first-pass of radioactive effluents is due principally to external exposure from gamma-emitting noble gases, and to internal exposure from inhalation of air containing tritium and from ingestion of food containing carbon-14 and tritium.

b. World-Wide Dispersion

For estimating the dose commitment to the U.S. population after the first-pass, world-wide dispersion is assumed. Nondepositing radionuclides with half-lives greater than one year are considered. Noble gases and carbon-14 are assumed to mix uniformly in the world's atmosphere (3.8×10^{18} m^3), and radioactive decay is taken into consideration. The world-wide dispersion model estimates the activity of each nuclide at the end of a 15-year release period (midpoint of reactor life) and estimates the annual population dose commitment at that point in time, taking into consideration radioactive decay.

The total-body population dose commitment from the noble gases is due mainly to external exposure from gamma-emitting nuclides, while from carbon-14 it is due mainly to internal exposure from ingestion of food containing carbon-14.

The population dose commitment due to tritium releases is estimated in a manner similar to that for carbon-14, except that after the first-pass, all of the tritium is assumed to be absorbed by the world's oceans (2.7×10^{16} m^3). The concentration of tritium in the world's oceans is estimated at the point in time after 15 years of releases have occurred, taking into consideration radioactive decay; the population dose commitment estimates are based on the incremental concentration at that point in time. The total-body population dose commitment from tritium is due mainly to internal exposure from the consumption of food grown with irrigation water.

3. Liquid Effluents

Population dose commitments due to effluents in the receiving water within 80 km (50 miles) of the facility are calculated as described in Regulatory Guide 1.109. It is assumed that no depletion by sedimentation of the nuclides present in the receiving water occurs within 80 km. It also is assumed that aquatic biota concentrate radioactivity in the same manner as was assumed for the ALARA maximumally exposed individual evaluation. However, food consumption values appropriate for the average, rather than the maximum, individual are used. It is further assumed that all the sport and commercial fish and shellfish caught within the 80-km area are eaten by the U.S. population.

Beyond 80 km, it is assumed that all the liquid-effluent nuclides except tritium have deposited on the sediments so that they make no further contribution to population exposures. The tritium is assumed to mix uniformly in the hydrosphere and to result in an exposure to the U.S. population in the same manner as discussed for tritium in gaseous effluents.

REFERENCES FOR APPENDIX H

(1) U.S. Nuclear Regulatory Commission, "Regulatory Guide 1.109: Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," Revision 1, October 1977.

(2) Title 10 Code of Federal Regulations Part 50, "Domestic Licensing of Production and Utilization Facilities," January 1981.

(3) U.S. Nuclear Regulatory Commission, "Regulatory Guide 1.111: Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Reactors," Revision 1, July 1977.

(4) K. F. Eckerman, et. al., "User's Guide to GASPAR Code," U.S. Nuclear Regulatory Commission report NUREG-0597, June 1980.

APPENDIX I

IMPACT OF THE URANIUM FUEL CYCLE

The following assessment of the environmental impacts of the fuel cycle as related to the operation of the proposed project is based on the values given in Table S-3 (Section 5.9) and the NRC staff's analysis of the radiological impact from radon releases. For the sake of consistency, the analysis of fuel cycle impacts has been cast in terms of a model 1000-MWe light-water-cooled reactor (LWR) operating at an annual capacity factor of 80%. In the following review and evaluation of the environmental impacts of the fuel cycle, the staff's analysis and conclusions would not be altered if the analysis were to be based on the net electrical power output of Waterford 3.

1. Land Use

The total annual land requirement for the fuel cycle supporting a model 1000-MWe LWR is about 460,000 m^2 (113 acres). Approximately 53,000 m^2 (13 acres) per year are permanently committed land, and 405,000 m^2 (100 acres) per year are temporarily committed. (A "temporary" land commitment is a commitment for the life of the specific fuel cycle plant, e.g., mill, enrichment plant, or succeeding plants. On abandonment or decommissioning, such land can be used for any purpose. "Permanent" commitments represent land that may not be released for use after plant shutdown and/or decommissioning.) Of the 405,000 m^2 per year of temporarily committed land, 320,000 m^2 are undisturbed and 90,000 m^2 are disturbed. Considering common classes of land use in the United States,* fuel cycle land use requirements to support the model 1000-MWe LWR do not represent a significant impact.

2. Water Use

The principal water use requirement for the fuel cycle supporting a model 1000-MWe LWR is that required to remove waste heat from the power stations supplying electrical energy to the enrichment step of this cycle. Of the total annual requirement of 43 x 10^6 m^3 (11.4 x 10^9 gal), about 42 x 10^6 m^3 are required for this purpose, assuming that these plants use once-through cooling. Other water uses involve the discharge to air (e.g., evaporation losses in process cooling) of about 0.6 x 10^6 m^3 (16 x 10^7 gal) per year and water discharged to the ground (e.g., mine drainage) of about 0.5 x 10^6 m^3 per year.

On a thermal effluent basis, annual discharges from the nuclear fuel cycle are about 4% of the model 1000-MWe LWR using once-through cooling. The consumptive water use of 0.6 x 10^6 m^3 per year is about 2% of the model 1000-MWe LWR using cooling towers. The maximum consumptive water use (assuming that all plants supplying electrical energy to the nuclear fuel cycle used cooling towers) would be about 6% of the model 1000-MWe LWR using cooling towers. Under this condition, thermal effluents would be negligible. The staff finds that these combinations of thermal loadings and water consumption are acceptable relative to the water use and thermal discharges of the station.

*A coal-fired plant of 1000-MWe capacity using strip-mined coal requires the disturbance of about 810,000 m^2 (200 acres) per year for fuel alone.

3. Fossil Fuel Consumption

Electrical energy and process heat are required during various phases of the fuel cycle process. The electrical energy is usually produced by the combustion of fossil fuel at conventional power plants. Electrical energy associated with the fuel cycle represents about 5% of the annual electrical power production of the model 1000-MWe LWR. Process heat is primarily generated by the combustion of natural gas. This gas consumption, if used to generate electricity, would be less than 0.3% of the electrical output from the model plant. The staff finds that the direct and indirect consumptions of electrical energy for fuel cycle operations are small and acceptable relative to the net power production of the station.

4. Chemical Effluents

The quantities of chemical, gaseous, and particulate effluents associated with fuel cycle processes are given in Table S-3. The principal species are SOx NO_x, and the particulates. Judging from data in a Council on Environmental Quality report,[1] the NRC staff finds that these emissions constitute an extremely small additional atmospheric loading in comparison with these emissions from the stationery fuel-combustion and transportation sectors in the United States, that is, about 0.02% of the annual national releases for each of these species. The staff believes such small increases in releases of these pollutants are acceptable.

Liquid chemical effluents produced in fuel cycle processes are related to fuel enrichment, fabrication, and reprocessing operations and may be released to receiving waters. These effluents are usually present in dilute concentrations such that only small amounts of dilution water are required to reach levels of concentration that are within established standards. Table S-3 specifies the flow of dilution water required for specific constituents. Additionally, all liquid discharges into the navigable waters of the United States from plants associated with the fuel cycle operations will be subject to requirements and limitations set forth in the NPDES permit.

Tailings solutions and solids are generated during the milling process. These solutions and solids are not released in quantities sufficient to have a significant impact on the environment.

5. Radioactive Effluents

Radioactive effluents estimated to be released to the environment from reprocessing and waste management activities and certain other phases of the fuel cycle process are set forth in Table S-3. Using these data, the staff has calculated the 100-year involuntary environmental dose commitment* to the U.S. population.

These calculations estimate that the overall involuntary total-body gaseous dose commitment to the U.S. population from the fuel cycle (excluding reactor releases and the dose commitment due to radon-222) would be approximately

*The environmental dose commitment (EDC) is the integrated population dose for 100 years; that is, it represents the sum of the annual population doses for a total of 100 years. The population dose varies with time, and it is not practical to calculate this dose for every year.

400 person-rems per year of operation of the model 1000-MWe LWR. Based on Table S-3 values, the additional involuntary total body-dose commitments to the U.S. population from radioactive liquid effluents due to all fuel cycle operations other than reactor operation would be approximately 100 person-rems per year of operation. Thus the estimated involuntary 100-year environmental dose commitment to the U.S. population from radioactive gaseous and liquid releases due to these portions of the fuel cycle is approximately 500 person-rems (whole-body) per year of operation of the model 1000-MWe LWR.

At this time Table S-3 does not address the radiological impacts associated with radon-222 releases. Principal radon releases occur during mining and milling operations and as emissions from mill tailings. The staff has determined that releases from these operations for each year of operation of the model 1000-MWe LWR are as given in Table I-1.

The staff has calculated population dose commitments for these sources of radon-222 using the RABGAD computer code described in Appendix A of Chap. IV, Sec. J, of NUREG-002.[2] The results of these calculations for mining and milling activities prior to tailings stabilization are listed in Table I-2.

When added to the 500 person-rems total-body dose commitment for the balance of the fuel cycle, the overall estimated total-body involuntary 100-year environmental dose commitment to the U.S. population from the fuel cycle for the model 1000-MWe LWR is approximately 640 person-rems. Over this period of dose is equivalent to 0.00002% of the natural background dose of about 3 billion person-rems to the U.S. population.*

The staff has considered the health effects associated with the releases of radon-222, including both the short-term effects of mining and milling, and active tailings, and the potential long-term effects from unreclaimed open-pit mines and stabilized tailings. The staff has assumed that after completion of active mining underground mines will be sealed, returning releases of radon-222 to background levels. For purposes of providing an upper-bound impact assessment, the staff has assumed that open-pit mines will be unreclaimed and has calculated that if all ore were produced from open-pit mines, releases from them would be 110 Ci per year per reference reactor year (RRY). However, because the distribution of uranium ore reserves available by conventional mining methods is 66.8% underground and 32.2% open pit,[3] the staff has further assumed that uranium to fuel LWRs will be produced by conventional mining methods in these proportions. This means that long-term releases from unreclaimed open-pit mines will be 0.332 x 110 or 37 Ci per year per RRY.

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*Based on an annual average natural background individual dose commitment of 100 millirems and a stabilized U.S. population of 300 million.

Table I-1 Radon releases for each year of operation of the model 1000-MWe LWR*

Radon source	Quantity released	Source
Mining	4060 Ci	a
Milling and tailings (during active mining)	780 Ci	b
Inactive tailings (prior to stabilization)	350 Ci	b
Stabilized tailings (several hundred years)	1 to 10 Ci/year	b
Stabilized tailings (after several hundred years)	110 Ci/year	b

[a] R. Wilde, U.S. Nuclear Regulatory Commission transcript of direct testimony given "In the Matter of Duke Power Company Company (Perkins Nuclear Station), Docket No. 50-488, April 17, 1978.

[b] P. Magno, U.S. Nuclear Regulatory Commission transcript of direct testimony given "In the Matter of Duke Power Company (Perkins Nuclear Station)," Docket No. 50-448, April 17, 1978.

*After three days of hearings before the Atomic Safety and Licensing Appeal Board (ASLAB) using the Perkins record in a "lead case" approach, the ASLAB issued a decision on May 13, 1981 (ALAB-640) on the radon-222 release source term for the Uranium Fuel Cycle. The decision, among other matters, produced new source term numbers based on the record developed at the hearings. These new numbers did not differ significantly from those in the Perkins record which are the values set forth in this Table. Any health effects relative to radon-222 are still under consideration before the ASLAB. Since the source term numbers in ALAB-640 do not differ significantly from those in the Perkins record, the staff continues to conclude that "both the dose commitments and health effects of the uranium fuel cycle are insignificant when compared to dose commitments and potential health effects to the U.S. population resulting from all natural background sources." (see page I-7)

Table I-2 Estimated 100-year environmental dose commitment per year of operation of the model 1000-MWe LWR

Radon Source	Releases (Ci)	Dosage (person-rems)		
		Total Body	Bone	Lung (Bronchial epithelium)
Mining	4100	110	2800	2300
Milling and active tailings	1100	29	750	620
Total		140	3600	2900

Based on the above, the radon released from unreclaimed open-pit mines over 100- and 1000-year periods would be about 3700 Ci and 37,000 Ci per RRY respectively. The total dose commitments for a 100 to 1000-year period would be as follows:

Time span (years)	Releases (Ci)	Population dose commitments (person-rems)		
		Total body	Bone	Lung (bronchial epithelium)
100	3,700	96	2,500	2,000
500	19,000	480	13,000	11,000
1,000	37,000	960	25,000	20,000

The above dose commitments represent a worst-case situation in that no mitigating circumstances are assumed. However, state and Federal laws currently require reclamation of strip and open-pit coal mines, and it is very probable that similar reclamation will be required for uranium open-pit mines. If so, long-term releases from such mines should approach background levels.

For long-term radon releases from stabilized tailings piles, the staff has assumed that these tailings would emit, per RRY, 1 Ci per year for 100 years, 10 Ci per year for the next 400 years and 100 Ci per year for periods beyond 500 years. With these assumptions, the cumulative radon-222 release from stabilized tailings piles per RRY would be 100 Ci in 100 years and 4090 Ci in 500 years and 53,800 Ci in 1000 years.[4] The total-body, bone, and bronchial epithelium dose commitments for these periods are as follows:

Time span (years)	Releases (Ci)	Population dose commitments (person-rems)		
		Total body	Bone	Lung (bronchial epithelium)
100	100	2.6	68	56
500	4,090	110	2,800	2,300
1,000	53,800	1,400	37,000	30,000

If risk estimators of 135, 6.9, and 22 cancer deaths per million person-rems for total-body, bone, and lung exposures, respectively, are used, the estimated risk of cancer mortality resulting from mining, milling, and active tailings emissions of radon-222 is about 0.11 cancer fatalities per RRY. When this risk from radon-222 emissions from stabilized tailings over a 100-year release period is added, the estimated risk of cancer mortality over a 100-year period is unchanged. Similarly, a risk of about 1.2 cancer fatalities is estimated over a 1000-year release period per RRY. When potential radon releases from reclaimed and unreclaimed open-pit mines are included, the overall risks of radon induced cancer fatalities per RRY range as follows: 0.11 to 0.19 fatalities for a 100-year period, 0.19 to 0.57 fatalities for a 500-year period, and 1.2 to 2.0 fatalities for a 1000-year period.

To illustrate: A single-model 1000-MWe LWR operating at an 80% capacity factor for 30 years would be predicted to induce between 3.3 and 5.7 cancer fatalities in 100 yr, 5.7 and 17 in 500 yr, and 36 and 60 in 1000 yr as a result of releases of radon-222.

These doses and predicted health effects have been compared with those that can be expected from natural-background emissions of radon-222. Calculated using data from the National Council on Radiation Protection (NCRP)[5] the average radon-222 concentration in air in the contiguous United States is about 150 pCi/m^3, which the NCRP estimates will result in an annual dose to the bronchial epithelium of 450 millirems. For a stabilized future U.S. population of 300 million, this represents a total lung dose commitment of 135 million person-rems per year. If the same risk estimator of 22.2 lung cancer fatalities per million person-lung-rems used to predict cancer fatalities for the model 1000 MWe LWR is used, estimated lung cancer fatalities alone from background radon-222 in the air can be calculated to be about 3000 per year, or 300,000 to 3,000,000 lung cancer deaths over periods of 100 to 1000 years respectively.

In addition to the radon-related potential health effects from the fuel cycle, other nuclides produced in the cycle, such as carbon-14, will contribute to population exposures. It is estimated that 0.08 to 0.12 additional cancer deaths may occur per RRY (assuming that no cure or prevention of cancer is ever developed) over the next 100 to 1000 years, respectively, from exposures to these other nuclides.

The latter exposures can also be compared with those from naturally occurring terrestrial and cosmic-ray sources. These average about 100 millirems. Therefore, for a stable future population of 300 million persons, the whole-body dose commitment would be about 30 million person-rems per year, or 3 billion person-rems and 30 billion person-rems for periods of 100 and 1000 years respectively. These dose commitments could produce about 400,000 and 4,000,000 cancer deaths during the same time periods. From the above analysis, the NRC staff concludes that both the dose commitments and health effects of the uranium fuel cycle are insignificant when compared to dose commitments and potential health effects to the U.S. population resulting from all natural-background sources.

6. Radioactive Wastes

The quantities of buried radioactive waste material (low-level, high-level, and transuranic wastes) are specified in Table S-3. For low-level waste disposal at land burial facilities, the Commission notes in Table S-3 that there will be no significant radioactive releases to the environment. The Commission notes that high-level and transuranic wastes are to be buried at a Federal Repository and that no release to the environment is associated with such disposal. NUREG-0116,[6] which provides background and context for the high-level and transuranic Table S-3 values established by the Commission, indicates that these high-level and transuranic wastes will be buried and will not be released to the biosphere. No radiological environmental impact is anticipated from such disposal.

7. Occupational Dose

The annual occupational dose attributable to all phases of the fuel cycle for the model 1000-MWe LWR is about 200 person-rems. The NRC staff concludes that this occupational dose will not have a significant environmental impact.

8. Transportation

The transportation dose to workers and the public is specified in Table S-3. This dose is small and not considered significant in comparison to the natural-background dose.

9. Fuel Cycle

The staff's analysis of the uranium fuel cycle did not depend on the selected fuel cycle (no recycle or uranium-only recycle), because the data provided in Table S-3 include maximum recycle option impact for each element of the fuel cycle. Thus the staff's conclusions as to acceptability of the environmental impacts of the fuel cycle are not affected by the specific fuel cycle selected.

REFERENCES FOR APPENDIX I

(1) Council on Environmental Quality, "The Seventh Annual Report of the Council on Environmental Quality," September 1976, Figs. 11-27 and 11-28, pp. 238-239.

(2) U.S. Nuclear Regulatory Commission, "Final Generic Environmental Statement on the Use of Recycle Plutonium in Mixed Oxide Fuel in Light-Water-Cooled Reactors, Report NUREG-0002,Washington, D.C., August 1976.

(3) U.S. Department of Energy, "Statistical Data of the Uranium Industry," Report GJO-100(8-78), January 1, 1978.

(4) R. Gotchy, U.S. Nuclear Regulatory Commission, transcript of direct testimony given "In the Matter of Duke Power Company" (Perkins Nuclear Station), Docket No. 50-448, April 17, 1978.

(5) National Council on Radiation Protection and Measurements "Natural Background Radiation in the United States," Publication No. 45, November 1975.

(6) U.S. Nuclear Regulatory Commission, "Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle," Report NUREG-0116 (Supplement 1 to WASH-1248), Washington, D.C., October 1976.

APPENDIX J

EXAMPLES OF SITE-SPECIFIC DOSE ASSESSMENT CALCULATIONS

1. Calculational Approach

As mentioned in the text the quantities of radioactive material that may be released annually from the Waterford 3 are estimated on the basis of the description of the radwaste systems in the applicant's ER and FSAR and by using the calculational model and parameters described in NUREG-0017.[1] These estimated effluent release values along with the applicant's site and environmental data in the ER and in subsequent answers to NRC staff questions are used in the calculation of radiation doses and dose commitments.

The models and considerations for environmental pathways that lead to estimates of radiation doses and dose commitments to individual members of the public near the plant and of cumulative doses and dose commitments to the entire population within an 80-km radius of the plant as a result of plant operations are discussed in detail in Regulatory Guide 1.109.[2] Use of these models with additional assumptions for environmental pathways that lead to exposure to the general population outside the 80-km (50 mile) radius are described in Appendix H of this Statement.

The calculations performed by the staff for the potentially contaminated atmosphere and hydrosphere provide total integrated dose commitments to the entire population within 80 km of the station based on the projected population distribution in the year 2000. The dose commitments represent the total dose that would be received over a 50-yr period, following the intake of radioactivity for 1 yr under the conditions existing 15 years after the station begins operation (i.e., the mid-point of station operation). For younger persons, changes in organ mass and metabolic parameters with age after the initial intake of radioactivity are accounted for.

2. Dose Commitments from Radioactive Effluent Releases

Radioactive effluents released to the atmosphere and to the hydrosphere from the Station will result in very small radiation dose commitments to individual members of the public and to the general population. The NRC staff estimates of the expected gaseous and particulate releases (listed in Table J-1) and the expected liquid releases (listed in Table J-8) along with the site meteorological and hydrological considerations (summarized in Tables J-2 and J-9 respectively) were used to estimate radiation doses and dose commitments.

Four years of meteorological data were used in the calculation of relative concentrations of effluents. The data were collected onsite from July 1972 to June 1975 and from February 1977 to February 1978. The long-term diffusion estimates were made using the procedure described in Regulatory Guide 1.111, Revision 1.[3] Open terrain recirculation factors were used by the staff in the computer model.

(a) Radiation Dose Commitments to Individual Members of the Public

As explained in the text, calculations are made for a hypothetical individual member of the public (i.e., the maximally exposed individual) who would be expected to receive the highest radiation dose from all appropriate pathways. This method tends to overestimate the doses since assumptions are made that would be difficult for a real individual to fulfill.

Individual receptor locations and pathway locations considered for the maximally exposed individual are listed in Table J-3. The estimated dose commitments to the individual who is subject to maximum exposure at selected offsite locations from airborne releases of radioiodine and particulates, and waterborn releases are listed in Tables J-4, J-5, and J-6. The maximum annual beta and gamma air dose and the maximum total body and skin dose to an individual, at the site boundary, also are presented in Tables J-4, J-5, and J-6.

The maximally exposed individual is assumed to consume well above average quantities of the potentially affected foods and to spend more time at potentially affected locations than the average person as indicated in Tables E-4 and E-5 of Regulatory Guide 1.109.[2] With regard to the doses calculated from the nearest farm (ESE 0.6m;) the staff assumed that 20% of the maximum individual's vegetable consumption is obtained from this location.

(b) Cumulative Dose Commitments to the General Population

Annual radiation dose commitments from airborne and waterborne radioactive releases from Waterford 3 are estimated for two populations in the year 2000: (1) all members of the general public within 80 km (50 miles) of the station (Table J-5) and (2) the entire U.S. population (Table J-7). Dose commitments beyond 80 km are based on the assumptions discussed in Appendix H. For perspective, annual background radiation doses are given in the tables for both populations.

REFERENCES FOR APPENDIX J

1. U.S. Nuclear Regulatory Commission, "Calculations of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Pressurized Water Reactors (PWR-GALE Code) NUREG-0017, U.S. Nuclear Regulatory Commission, April 1976.

2. "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," Reg. Guide 1.109, Rev. 1, U.S. Nuclear Regulatory Commission, October 1977.

3. "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Reactors." Reg. Guide 1.111, Rev. 1, U.S. Nuclear Regulatory Commission, July 1977.

Table J-1 Calculated Releases of Radioactive Materials in Gaseous Effluents in Curies per year from Waterford 3

Nuclide	Plant Stack (continuous)	Plant Stack (intermittent)	Turbine Bldg (continuous)
Kr-85m	5.0	2.0	a
Kr-85	330	73	a
Kr-87	2.0	-	a
Kr-88	8.0	2.0	a
Xe-131m	8.0	52	a
Xe-133m	10	42	a
Xe-133	730	6400	a
Xe-135	15	12	a
Xe-138	1.0	a	a
		Total Noble Gases	7692
Mn-54	0.0047	0.000023	b
Fe-59	0.0016	0.0000079	b
Co-58	0.016	0.000079	b
CO-60	0.0073	0.000036	b
Sr-89	0.0034	0.0000018	b
Sr-90	0.00006	0.00000032	b
Cs-134	0.0047	0.000023	
Cs-137	0.0078	0.000049	b
		Total Particulates	0.04
I-131	0.013	0.0027	0.0041
I-133	0.016	0.00096	0.0035
H-3	940	a	a
C-14	7	1	a

a = less than 1.0 Ci/yr for noble gases and carbon-14 less than 10^{-4} Ci/yr for iodine

b = less than 1% of total for this nuclide

Table J-2 Summary of Atmospheric Dispersion Factors (x/Q) and Relative Deposition Values for Maximum Site Boundary and Receptor Locations Near Waterford 3

Location	X/Q (sec/m³)	Relative Deposition (m^{-2})
Site boundary (ESE 0.6 mi)	1.4×10^{-5}	2.3×10^{-8}
Nearest** residence and milk cow (NW 0.9 mi)	7.9×10^{-6}	2.3×10^{-8}
Nearest farm (ESE 0.31 mi)	4.5×10^{-5}	6.5×10^{-8}
Nearest meat animal (NW 0.8 mi)	1.1×10^{-6}	3.2×10^{-8}

*The values presented in this table are corrected for radioactive decay and cloud depletion from deposition, where appropriate, in accordance with Regulatory Guide 1.111, Rev. 1, "Methods for Estimating Atomospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light Water Reactors," July 1977.[3]

**"Nearest" refers to that type of location where the highest radiation dose is expected to occur from all appropriate pathways.

Table J-3 Nearest Pathway Locations Used for Maximum Individual Dose Commitments for Waterford 3

Location	Sector	Distance (mi)
Site boundary*	ESE	0.6
Residence**	NW	0.9
Farm**	ESE	0.31
Milk cow	NW	0.9
Meat animal	NW	0.8

*Beta and gamma air doses, total body doses, and skin doses from noble gases are determined at site boundaries.

**Dose pathways including inhalation of atmospheric radioactivity, exposure to deposited radionuclides, and submersion in gaseous radioactivity are evaluated at residences.

Table J-4 Annual Dose Commitments to a Maximally Exposed Individual Near Waterford 3

Location	Pathway	Doses (mrem/yr per unit)			
		Noble Gases in Gaseous Effluents			
		Total Body	Skin	Gamma Air Dose (mrad/yr per unit)	Beta Air Dose (mrad/yr per unit)
Nearest site boundary[a] (ESE 0.6 km)	Direct radiation from plume	1.6	4.6	2.6	8.1
		Iodine and Particulates in Gaseous Effluents[b]			
		Total Body	Organ		
Nearest[c] site boundary (ESE 0.6 mi)	Ground deposit	0.29 (T)	0.29 (C) (bone)		
	Inhalation	0.04 (T)	0.006 (C) (bone)		
Nearest farm (ESE 0.31 mi)	Vegetable consumption	2.4 (C)	8.2 (C) (bone)		
Nearest milk cow (NW 0.9 mi)	Ground deposit	0.21 (C)	0.21 (C) (bone)		
	Inhalation	0.27 (C)	0.004 (C) (bone)		
	Vegetable consumption	2.10 (C)	7.4 (C) (bone)		
	Cow milk consumption	0.96 (C)	3.6 (C) (bone)		
	Meat consumption	0.25 (C)	1.1 (C) (bone)		
Nearest meat animal (NW 0.8 mi)	Meat consumption	0.40 (C)	1.7 (C) (bone)		
		Liquid Effluents (Adults)			
		Total Body	Organ		
Nearest Drinking Water (St. Charles Parish)	Water Ingestion	<0.01	0.03 (thyroid)		
Nearest fish (Discharge)	Fish ingestion	0.08	0.11 (liver)		

[a] "Nearest" refers to that site boundary location where the highest radiation doses as a result of gaseous effluents have been estimated to occur.

[b] Doses are for the age group that results in the highest dose: T=teen, C=child, I=infant.

[c] "Nearest" refers to the location where the highest radiation dose to an individual from all applicable pathways has been estimated.

Table J-5 Calculated Appendix I Dose Commitments to a Maximally Exposed Individual and to the Population from Operation of Waterford 3

	Annual Dose per Reactor Unit	
	Individual	
	Appendix I Design Objectives[a]	Calculated Doses
Liquid effluents		
Dose to total body from all pathways	3 mrem	0.1 mrem
Dose to any organ from all pathways	10 mrem	0.12 mrem
Noble-gas effluents (at site boundary)		
Gamma dose in air	10 mrad	2.6 mrad
Beta dose in air	20 mrad	8.1 mrad
Dose to total body of an individual	5 mrem	1.6 mrem
Dose to skin of an individual	15 mrem	4.6 mrem
Radioiodines and particulates[b]		
Dose to any organ from all pathways	15 mrem	12 mrem (bone-child)
	Population Within 80 km	
	Total Body	Organ
	(person-rem)	
Natural-background radiation[c]	180,000	
Liquid effluents	6.0	7.1 (thyroid)
Noble-gas effluents	0.23	0.23 (bone)
Radioiodine and particulates	5.5	8.7 (bone)

[a]Design Objectives from Sections II.A, II.B, II.C, and II.D of Appendix I, 10 CFR Part 50 consider doses to maximum individual and population per reactor unit.

[b]Carbon-14 and tritium have been added to this category.

[c]"Natural Radiation Exposure in the United States," U.S. Environmental Protection Agency, ORP-SID-72-1, June 1972; using the average background dose for Louisiana of 84 mrem/yr, and year-2000 projected population of 2,182,000.

Table J-6 Calculated RM-50-2 Dose Commitments to a Maximally Exposed Individual from Operation of Waterford 3[a]

	Annual Dose per Site	
	RM-50-2 Design Objectives[b]	Calculated Doses
Liquid effluents		
Dose to total body or any organ from all pathways	5 mrem	0.1 mrem
Activity-release estimate, excluding tritium (Ci/unit)	5	0.24
Noble-gas effluents (at site boundary)		
Gamma dose in air	10 mrad	2.6 mrad
Beta dose in air	20 mrad	8.1 mrad
Dose to total body of an individual	5 mrem	1.6 mrem
Radioiodine and particulates[c]		
Dose to any organ from all pathways	15 mrem	12 mrem (bone)
I-131 activity release (Ci)	1	0.4

[a]An optional method of demonstrating compliance with the cost-benefit Section (II.D) of Appendix I to 10 CFR Part 50.

[b]Annex to Appendix I to 10 CFR Part 50.

[c]Carbon-14 and tritium have been added to this category.

Table J-7 Annual Total-Body Population Dose Commitments, Year 2000

Category	U.S. Population Dose Commitment, person-rem/yr
Natural background radiation[a]	27,000,000[a]
Waterford Nuclear Station Unit 3 operation	
Plant workers	440
General public:	
Liquid effluents[b]	11.
Gaseous effluents	42
Transportation of fuel and waste	7

[a]Using the average U.S. background dose (100 mrem/yr) and year 2000 projected U.S. population from "Population Estimates and Projections," Series II, U.S. Department of Commerce, Bureau of the Census, Series P-25, No. 541 February 1975.

[b]80-km (50-mile) population dose

Table J-8 Calculated Release of Radioactive Materials in Liquid Effluents from Waterford 3

Nuclide	Ci/yr	Nuclide	Ci/yr
Corrosion & Activation Products			
Cr-51	0.00007	I-130	0.00021
Mn-54	0.001	Te-131m	0.00005
Fe-55	0.00006	I-131	0.092
Fe-59	0.00004	Te-132	0.00072
Co-58	0.0046	I-132	0.0042
Co-60	0.0088	I-133	0.058
Zr-95	0.0014	I-134	0.00002
Nb-95	0.002	Cs-134	0.015
Np-239	0.003	I-135	0.0096
Te-129	0.00003		
Fission Products			
Br-83	0.00004	Cs-136	0.0007
Sr-89	0.00001	Cs-173	0.026
Mo-99	0.0024	Bs-137m	0.0015
Tc-99m	0.0028	Ce-144	0.0052
Ru-103	0.00014	All others[a]	0.00006
Ru-106	0.0024	Total except	
Ag-110m	0.00044	tritium	0.24
Te-127	0.00002		
Te-129m	0.00005	Tritium release	

[a]Nuclides whose release rates are less than 10^{-5} Ci/yr are not listed individually but are included in the category "All others."

Table J-9 Summary of Hydrologic Transport and Dispersion for Liquid Releases from Waterford 3

Location	Transit Time (hours)	Dilution Factor
Nearest drinking water intake (Union Carbide) (-2.6 mi, downstream)	1.0	5
Nearest sport fishing location (plant discharge)	0.01	1
Nearest shoreline (plant discharge)	0.01	1
Nearest irrigated crops (St. Charles)	0.1	5

[a]See Regulatory Guide 1.113, "Estimating Aquatic Dispersion of Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I," April 1977.

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16. ABSTRACT *(200 words or less)*

The Final Environmental Statement related to the operation of Waterford Steam Electric Station, Unit 3 by Louisiana Power & Light Company (Docket No. 50-382), located on the Mississippi River in St. Charles Parish, Louisiana, has been prepared by the Office of Nuclear Reactor Regulation of the Nuclear Regulatory Commission. The statement reports on the staff's review of the impact of operation of the plant. Also included are comments of state and federal government agencies on the Draft Environmental Statement for this project and staff responses to these comments. The NRC staff has concluded, based on a weighing of environmental, technical and other factors, that an operating license could be granted.

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