final

NUREG-0097

environmental statement

related to construction of

MARBLE HILL NUCLEAR GENERATING STATION UNITS 1 and 2

PUBLIC SERVICE COMPANY OF INDIANA, INC., ET AL.

SEPTEMBER 1976

Docket Nos. STN 50-546, STN 50-547

U. S. Nuclear Regulatory Commission • Office of Nuclear Reactor Regulation

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NUREG-0097
September 1976

FINAL ENVIRONMENTAL STATEMENT

by the

U. S. NUCLEAR REGULATORY COMMISSION

OFFICE OF NUCLEAR REACTOR REGULATION

FOR

MARBLE HILL NUCLEAR GENERATING STATION

UNITS 1 AND 2

proposed by

PUBLIC SERVICE COMPANY OF INDIANA, INC.
NORTHERN INDIANA PUBLIC SERVICE COMPANY, INC.
EAST KENTUCKY POWER COOPERATIVES, INC.
WABASH VALLEY POWER ASSOCIATION, INC.

Docket Nos. STN 50-546 and STN 50-547

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SUMMARY AND CONCLUSIONS

This Environmental Statement was prepared by the U. S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation.

1. This action is administrative.

2. The proposed action is the issuance of construction permits to the Public Service Company of Indiana, Inc., Northern Indiana Public Service Company, Inc., East Kentucky Power Cooperative, Inc., and Wabash Valley Power Association, Inc., for the construction of the Marble Hill Nuclear Generating Station, Units 1 and 2 (MH 1&2), Docket Nos. STN 50-546 and STN 50-547.

   The MH 1&2 station, located near the Ohio River in Jefferson County, Indiana, will employ two pressurized water reactors to produce up to 3425 megawatts thermal (MWt) from each unit. Steam turbine generators will use this heat to provide 1130 MWe of electrical power capacity from each unit. The assessments contained in this statement were made on the basis of the above power levels from each unit. The exhaust steam will be cooled by mechanical draft cooling towers with make-up water obtained from and discharged to the Ohio River.

3. Summary of environmental impact an. adverse effects:
   a. The 987-acre site is predominate forest and cropland. Construction-related activities on the site would disturb about 250 acres. The portion of this land not to be used for the plant facilities, parking lots, roads, etc., will be restored by seeding and landscaping. The temporary removal of vegetation will tend to promote erosion. Increased siltation and turbidity can be expected in local streams during construction, but measures will be taken to minimize these effects. (Secs. 4.1, 4.3)

   b. A maximum of 69 cfs of cooling water will be withdrawn from the Ohio River of which 9 cfs will be returned to the river via pipeline with the dissolved solids concentration increased by a factor of about 6. About 60 cfs will be evaporated to the atmosphere by the cooling towers. (Sec. 5.2)

   c. Minor and temporary impacts to the biota of the river and its west bank will result from construction activities. (Sec. 4.3)

   d. The volume of discharge (9 cfs) is very small compared with the river fl (annual mean is about 110,000 cfs) and the thermal effect on the river ecosystem is not expected to be significant. (Sec. 5.3)

   e. Chemical discharges from the plant will be diluted to concentrations below those which might adversely affect aquatic biota. (Sec. 5.5)

   f. The risk associated with accidental radiation exposure will be very low. (Sec. 7)

   g. Transmission lines (about 115 miles) constructed by the applicant will require about 3475 acres of land for the corridors; of this about 85 acres will be occupied by transmission tower bases. About 1110 acres of forest habitat will be replaced by low vegetation and edge habitat. The railroad spur will require about 200 acres of cropland and about 45 acres of forest; however, about half of this area is in a transmission corridor. The 245 acres occupied by the railroad spur will remain cleared for the life of the station. (Sec. 4.1)

   h. Plant construction will involve some community impacts. Hunting, fishing, and other recreational activities on the site will cease. Traffic on local roads will increase substantially due to construction and commuting activities. Influx of workers' families (2200 peak work force) could cause some housing and school problems, although most of the work force is expected to commute from the surrounding area. (Sec. 4.4)

i. No significant environmental impacts are anticipated from normal operational releases of radioactive materials. The calculated dose to the estimated population in the year 2000 which will live within a radius of 50 miles from the plant is 10 man-rems/year. This value is less than the natural fluctuations in the approximately 170,000 man-rems/year dose this population would receive from background radiation. (Sec. 5.4)

j. To assure that construction of the station and auxiliary facilities will not unduly disturb archeological sites of potential value, the staff has recommended additional surveying and other precautions. (Secs. 4.1 and 4.5)

4. Principal alternatives considered:

   a. Alternative sites

   b. Alternative energy sources

   c. Purchase of power

   d. Alternative heat-dissipation methods

   e. Alternative designs of the station water intake and discharge systems.

5. The following Federal, State, and local agencies were asked to comment on the draft environmental statement, which was issued in March 1976:

Advisory Council on Historic Preservation
Department of Agriculture
Department of Army, Corps of Engineers
Department of Commerce
Department of Health, Education and Welfare
Department of Housing and Urban Development
Department of the Interior
Department of Transportation
Energy Research and Development Administration
Environmental Protection Agency
Federal Power Commission
Federal Energy Administration
The Ohio River Basin Commission
Office of the Governor, State of Indiana
Office of the Governor, State of Kentucky
Board of Commissioners of Jefferson County
Plan Commission and Board of Zoning Appeals of Jefferson County
Office of the Mayor, City of Madison, Indiana
Trustee, Saluda Township, Indiana

Comments were received from the above and from the following organizations and individuals:

Louisville Water Company
Save The Valley
Sassafras Audubon Society
Kentucky Audubon Society
Louisville Group Sierra Club
Rosella Schro[illegible]
D. V. Whiteside
J. N. Embry
These comments are duplicated in Appendix A and are responded to in Section 11.

6. This Final Environmental Statement was made available to the public, to the Council on Environmental Quality, and to other specified agencies in September, 1976.

7. On the basis of the analysis and evaluation set forth in this statement, after weighing the environmental, economic, technical, and other benefits of MH 1&2 against environmental and other costs and considering available alternatives, it is concluded that the action called for under the National Environmental Policy Act of 1969 (NEPA) and 10 CFR 51 is the issuance of construction permits for the facility subject to the following conditions for the protection of the environment:

   a. The applicant shall take the necessary mitigating actions, including those summarized in Section 4.5 of this environmental statement, during construction of the station and associated transmission lines to avoid unnecessary adverse environmental impacts from construction activities.

   b. In addition to the preoperational monitoring program described in Section 6.1 of the Environmental Report, with amendments, the staff recommendations in Section 6.1 of this document shall be followed.

   c. The staff requires that the proposed intake structure be redesigned to permit the unimpeded flow of near-shore water. (Sections 5.3.2, 9.3.2 and 11.5.). The design of the travelling screen and debris collector should be adaptable to the incorporation of a fish return device, if its installation is justified by the results of monitoring fish impingement.

   d. The applicant shall establish a control program which shall include written procedures and instructions to control all construction activities as prescribed herein and shall provide for periodic management audits to determine the adequacy of implementation of environmental conditions. The applicant shall maintain sufficient records to furnish evidence of compliance with all the environmental conditions herein.

   e. Before engaging in a construction activity not evaluated by the Commission, the applicant will prepare and record an environmental evaluation of such activity. When the evaluation indicates that such activity may result in a significant adverse environmental impact that was not evaluated, or that is significantly greater than that evaluated in this Environmental Statement, the applicant shall provide a written evaluation of such activities and obtain prior approval of the Director of Nuclear Reactor Regulation for the activities.

   f. If unexpected harmful effects or evidence of irreversible damage are detected during facility construction, the applicant shall provide to the staff an acceptable analysis of the problem and a plan of action to eliminate or significantly reduce the harmful effects or damage.

   g. Within 30 days of the issuance of this statement, the applicant shall submit a plan to mitigate the impacts of increased vehicular traffic during construction for the staff's review and evaluation. (Section 4.4.2.1)

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FOREWORD

This Environmental Statement was prepared by the Division of Site Safety and Environmental Analysis, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission (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 the Federal Government has the continuing responsibility to use all practicable means, consistent with other essential considerations of national policy, to improve and to 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.
- Ensure 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 that supports diversity and variety of individual choice.
- Achieve a balance between population and resource use that 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 the preparation of a detailed statement on:

(i) The environmental impact of the proposed action.

(ii) Any adverse environmental effects that cannot be avoided should the proposal be implemented.

(iii) Alternatives to the proposed action.

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

(v) Any irreversible and irretrievable commitments of resources that 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 for a nuclear power generating station. 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 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 governmental 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. Interested persons are also invited to comment on the draft statement.

After receipt and consideration of comments on the Draft Statement, the staff prepares a Final Environmental Statement, which includes: a discussion of concerns raised by the comments; a benefit-cost analysis, which considers the environmental costs of the plant and the alternatives available for reducing or avoiding them, and balances the adverse effects against the environmental, economic, technical, and other benefits of the plant; and a conclusion as to whether the action called for, with respect to environmental issues, is the issuance of the proposed permit, with appropriate conditioning to protect environmental values, or its denial. 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.

Single copies of this statement may be obtained as indicated on the inside front cover.

Dr. S. Stanley Kirslis is the NRC Environmental Project Manager for this project. Should there be questions regarding the content of this statement, Dr. Kirslis may be contacted at the following address or at 301/443-6980.

Division of Site Safety and Environmental Analysis
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

1. INTRODUCTION

1.1 THE PROPOSED PROJECT

Pursuant to the Atomic Energy Act of 1954, as amended, and the Commission's regulations in Title 10, *Code of Federal Regulations*, an application was filed by the Public Service Company of Indiana, Inc. for construction permits for two pressurized light-water nuclear reactors designated as the Marble Hill Nuclear Generating Station, Units 1 and 2 (Docket Nos. STN 50-546 and STN 50-547), each of which is designed to operate at about 3425 thermal megawatts (MWt) with a gross electrical output of about 1192 megawatts (MWe). PSI will retain 65% of the capacity of the station, 20% of the capacity is committed to ownership by Northern Indiana Public Service Company (NIPSCO), and the remaining capacity will be owned by East Kentucky Power Cooperatives, Inc. (8%) and Wabash Valley Power Association (7%). These four utilities are hereinafter referred to as the applicant, or PSI. The proposed facilities are to be located on the applicant's site in Saluda Township, Jefferson County, Indiana. The site is about 11 miles (18 km) south-southwest of Madison, Indiana, and on the Ohio River. The excess heat will be dissipated by means of mechanical-draft cooling towers, with initial fill and makeup water obtained from the river.

Title 10, Part 51 of the Code of Federal Regulations (10 CFR 51) requires that the Director, Nuclear Reactor Regulation, or his designees, analyze the environmental report that accompanies each application and prepare a detailed statement of environmental considerations. It is within this framework that this Environmental Statement related to the construction of the Marble Hill Nuclear Generating Station has been prepared by the staff of the U. S. Nuclear Regulatory Commission (NRC).

The major documents used to prepare this Statement were the applicant's Preliminary Safety Analysis Report (PSAR),* Environmental Report (ER),** and changes thereto, issued for the Marble Hill Generating Station. Independent calculations and sources of information were also used as a basis for the assessment of the environmental impact. In addition, some of the information was gained from site visits by the staff to the Marble Hill site and surrounding areas in August 1975 and from meetings with State and local officials in September and October 1975.

As part of its safety evaluation leading to the issuance of construction permits and operating licenses, the Commission makes a detailed evaluation of the applicant's plans and facilities for minimizing and controlling the release of radioactive materials under both normal conditions and potential accident conditions, including the effects of natural phenomena on the facility. Inasmuch as these aspects are considered fully in other documents, only the salient features that bear directly on the anticipated environmental effects are repeated in this Environmental Statement.

Copies of this Environmental Statement and of the applicant's Environmental Report (ER) are available for public inspection at the Commission's Public Document Room, 1717 H Street NW, Washington, D. C., and at the Madison-Jefferson County Library, Madison, Indiana.

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*"The Public Service Company of Indiana, Inc., Marble Hill Nuclear Generating Station, Units 1 and 2, Preliminary Safety Analysis Report," Vols. 1-7 and amendments, Docket Nos. STN 50-546 and STN 50-547, September 1975. (Hereinafter this will be cited as the PSAR, with specific section number, page number, etc.)

**"The Public Service Company of Indiana, Inc., Marble Hill Nuclear Generating Station, Units 1 and 2, Environmental Report," as amended, Vols. 1-4, with supplements, Docket Nos. STN 50-546 and STN 50-547, September 1975. (Hereinafter this will be cited as the ER, with specific section number, page number, etc.)

1.2 STATUS OF THE PROJECT

Based on starting construction about July 1976, the applicant planned for Unit 1 to commence operation in January 1982, and Unit 2 in January 1984. The applicant has requested a Limited Work Authorization to permit certain non-safety-related activities to be initiated prior to the issuance of full Construction Permits (Letter of June 25, 1976 from J. Coughlin of PSI to Mr. B. C. Rusche of NRC).

1.3 STATUS OF REVIEWS AND APPROVALS

The applicant has provided a status listing of environmentally related permits, approvals, licenses, etc., required from Federal, regional, State, and local agencies in connection with the proposed project (ER, Table 12.0-1). The staff has reviewed that listing and has consulted with some of the appropriate agencies, and has found no significant environmental impacts of concern to the reviewing agencies.

2. THE SITE AND ENVIRONS

2.1 STATION LOCATION

The proposed nuclear power station is to be located on a 987 acre (400-hectare) site near the Ohio River in Saluda Township, in the southeastern corner of Jefferson County in the State of Indiana. The site is approximately 11 miles (18km) south-southwest of Madison, Indiana, 31 miles (50km) north-northeast of Louisville, and 62 miles (100km) southwest of Cincinnati (see Figure 2.1). The coordinates for the reactor units of the proposed power station are 39° 36' 0"N latitude and 85° 26' 53"W longitude (ER, p. 2.1-1). The site contains portions of Section 17, 18, 19, and 20, Township 2 North, Range 10 East of the 2nd Principal Meridian.

Most of the station structures are to be located on a flat upland area bounded on the east by the valley of the Ohio River and on the north and west by the valley of Little Saluda Creek. The relief from the upland to the valley bottoms varies from about 150 feet (45m) on the west to about 300 feet (90m) on the east (see Figure 2.2). The area within 2200 feet (670m) of Units 1 and 2 will be maintained as an exclusion zone. No public roads or public railroads will traverse the exclusion area.

2.2 REGIONAL POPULATION AND LAND USE

2.2.1 Regional Population

Table 2.1 summarizes the applicant's population estimate for 1974 and projections for the censual years from 1980 to 2020. In 1974, the total estimated population residing within five miles (8km) of the Marble Hill Station was 2,350; by the year 2020, the population in this area will increase to 3,527 persons (See Figure 2.3). Population density averages 30 people per square mile (12/km^2), indicating a sparse pattern of development. Within the five-mile radius of the station site are several small communities (less than 500 people): Bethlehem, 4.5 miles south-southwest of the site; Paynesville, 3 miles west-northwest; Saluda, 4.5 miles northwest; and Wise's Landing, 3.7 miles southeast of the site. With the exception of Wise's Landing, Ky., these communities are located in Indiana. Additional information on population can be found in Sections 2.1 and 2.2 of the ER.

Population estimates and projections for the 0- to 50-mile (0-80km) zone are presented in Figure 2.4. In 1970, the total number of people was 1,242,651; population in this zone is expected to increase 51% to 1,878,313 by the year 2020. Particular attention should be called to the southwest and south-southwest sectors between 30 and 40 miles (48 and 65km) from the station site (See Figure 2.4). Here the population is quite large, reflecting the presence of Louisville, Kentucky (31 miles SSW) which had a 1970 population of 361,470. Table 2.2-1 in the ER lists the populations of all cities and unincorporated areas of over 1,000 people that are located within 50 miles (80km) of the site. After Louisville, the next largest concentrations are in New Albany, Indiana (population 38,400; 29 miles SW) and Pleasure Ridge Park, Kentucky (population 28,600; 38 miles SW). The Cincinnati Standard Metropolitan Statistical Area (SMSA), which is 12 miles beyond the 50-mile radius, had a 1975 estimated population of 1,545,000.

Overall, population density within the 50-mile radius was 158 people per square mile (61/km^2). According to projections supplied by the applicant, this density is expected to increase to an average of 239 people per square mile by 2020. The most densely populated area in 1970 is the ring between 30 and 40 miles from the site with a density of 252 persons per square mile. Projections by other sources were essentially similar (Table 8.13).

2.2.2 Land Use

Within 10 miles of the station site approximately 71% of the land was in farm use in 1969. Of this amount, 55%, or 348,100 acres, was devoted to crop production (ER, Tables 2.2-5 and 2.2-6). Most cropland was planted in soybeans, corn and hay, and the most common livestock were cattle, hogs and chickens (ER, Tables 2.2-8 thru 2.2-11). This area also contains some forested land that is being used for timber production. Although the area in Kentucky is more heavily wooded than the Indiana sectors, the latter have profited more from their forest resources (ER, Table 2.2-7). In 1974, a livestock survey was made of 193 farms within a five-mile (8km) radius of

Fig. 2.1. Site Location. From ER, Fig. 2.1-2.

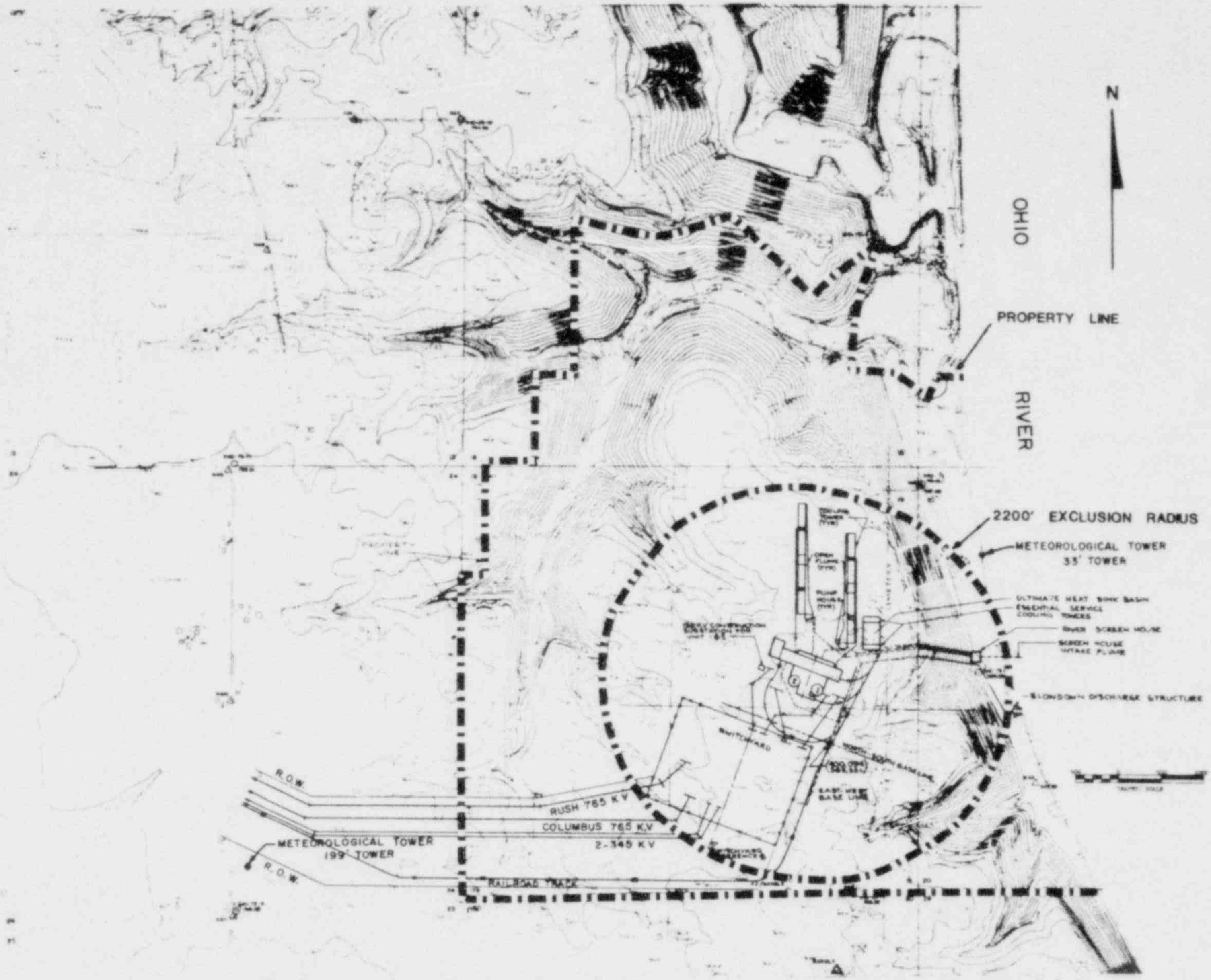

Fig. 2.2. Layout of Station Facilities, Exclusion Area, and Property Line. From ER, Fig. 2.1-4.

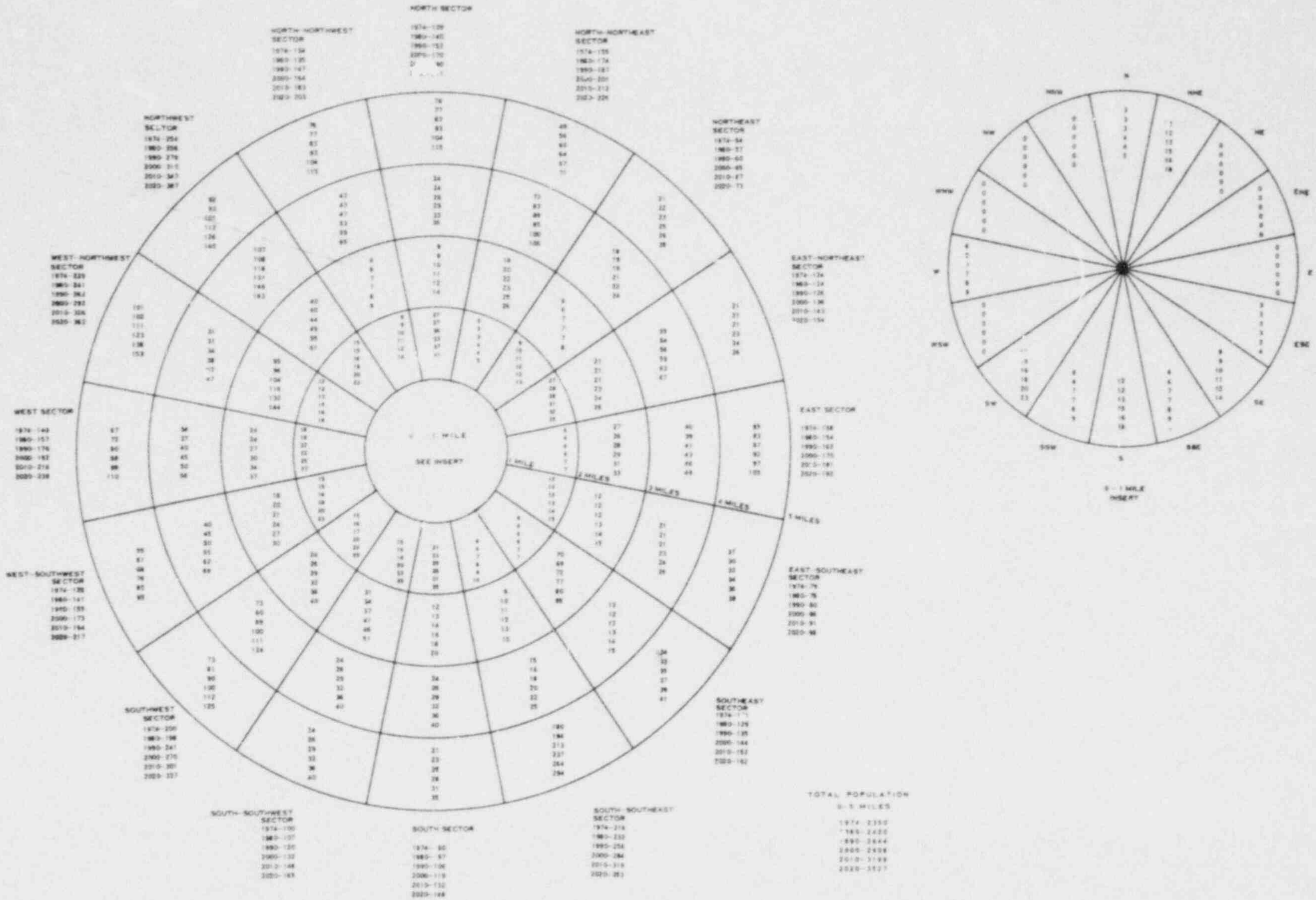

Fig. 2.3. Population Within a 5-Mile Radius of the Site. From ER, Fig. 2.2-1.

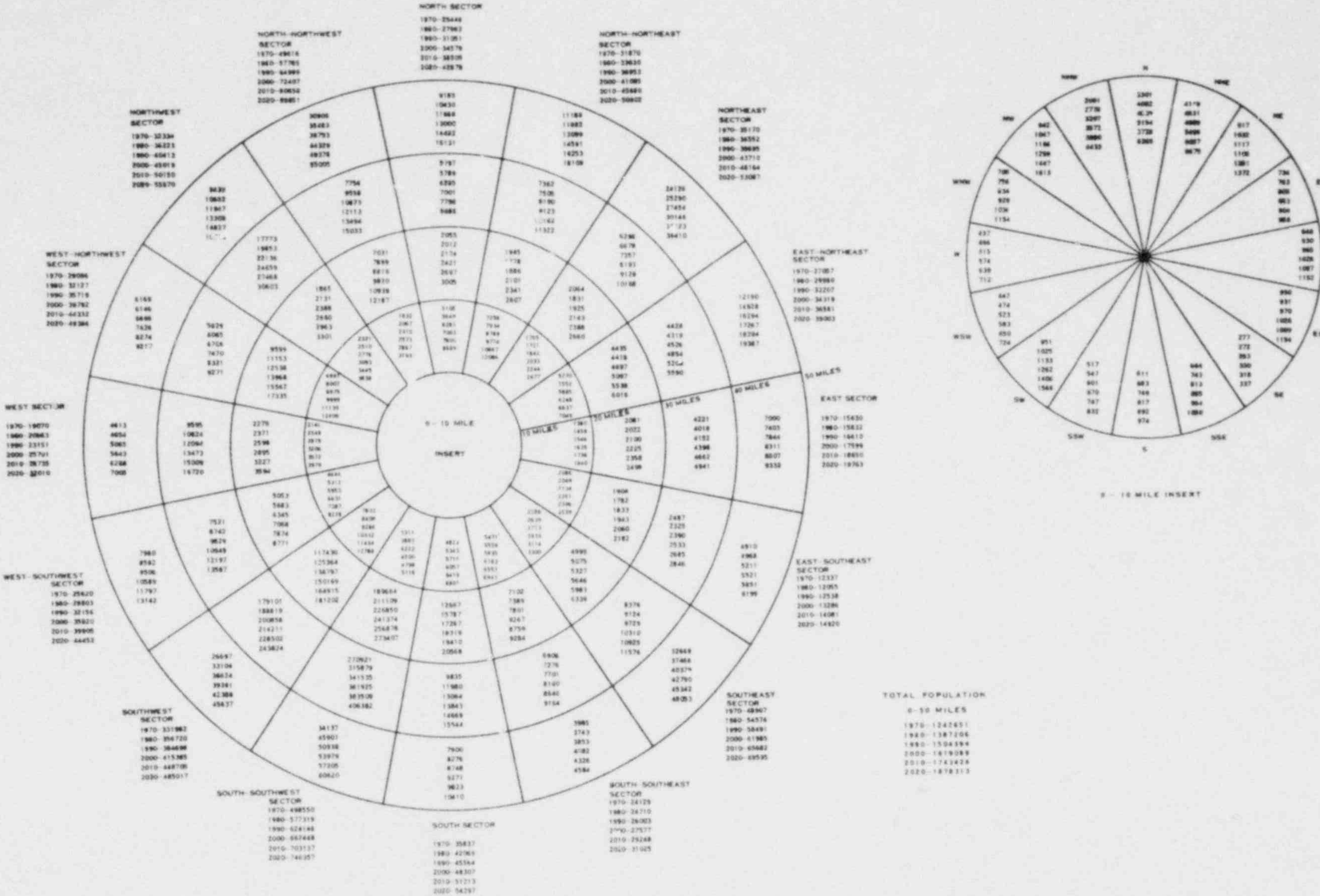

Fig. 2.4. Population Within a 50-Mile Radius of the Site. From ER, Fig. 2.2-4.

TABLE 2.1

PROJECTED POPULATION AROUND THE MARBLE HILL STATION

Radius, Miles	Year 1970*	1980	1990	2000	2010	2020
0-1	72	72	79	87	95	109
0-5	2350	2420	2644	2908	3139	3527
0-10	18609	21060	23312	25643	28225	31075
0-50	1242651	1387206	1504394	1619089	1743426	1878313

SOURCE: ER FIGURES 2.2-1, 2.2-2, AND 2.2-4

*POPULATION DATA WITHIN FIVE-MILE RADIUS BASED ON A 1974 SURVEY.

the station site. Beef cattle, hogs and chickens were the most numerous kinds of livestock in this area of Jefferson County (ER, p. 2.2-9). The location of dairy cows and goats within the five-mile zone is presented in Table 2.2-21A and Figure 2.2-8 of the ER.

The station site itself will comprise 987 acres (400 hectares), which were used for cropland, pasture, woodland, and residences in 1974 (ER p. 2.2-9). Table 2.2 below summarizes the uses on the site.

TABLE 2.2

LAND USE OF THE MARBLE HILL STATION: 1974

USE	ACRES	PERCENT
FOREST	545.7	55.3
Hardwood	528.5	96.8
Riparian	13.1	2.4
Pine	4.1	0.8
AGRICULTURAL	415.8	42.1
Corn	155.5	37.4
Soybeans	67.7	16.3
Wheat	13.8	3.3
Pasture	82.0	19.7
Fallow	96.8	23.3
RESIDENTIAL	8.0	0.8
MISCELLANEOUS	17.9	1.8
Ponds	1.4	7.8
Cemetery	0.4	2.2
Ecotone	16.1	90.0
TOTAL	987.4	100.0

SOURCE: ER, Tables 2.2-20 and 2.2-21.

Other significant land uses within 10 miles of the station include public and private facilities. Eighteen public and private schools with a 1973-1974 total enrollment of 7,850 were located in the general area of the site (See ER, Table 2.2-2). Hanover College, a private institution with a student body of 1,020 and a faculty of 78 is located 7.8 miles from the site. Hospitals in the area include King's Daughter's located in Madison, and Madison State Hospital, a 1,100 bed institution offering long-term psychiatric care. Clifty Falls State Park is one of the principal recreation facilities in the area. The park contains 1,357 acres and is located 10.7 miles north-northeast of the site in Madison. In addition to these institutions, there are 12 churches and 21 cemeteries within five miles of the site (ER, p. 2.2-3).

Six primary State and Federal highways serve Jefferson County, providing access to neighboring counties and metropolitan areas in Kentucky and Indiana as shown in Figures 2.1-3, 9.2-8 and 9.2-10 of the ER.[1]

Rail freight service in Jefferson County is provided by the Penn Central on its Columbus branch which terminates in Madison, and by the Baltimore and Ohio Railroad which has a terminal in Deputy.[2]

Cargo shipments by barge on the Ohio River play a significant but declining role in regional transportation. Madison is served by three barge lines which tie up their vessels at either of the two coal silos or at the cargo dock in the city.[3] There is also a large docking facility at Jeffersonville, about 26 miles from the proposed site.

Regularly scheduled air carrier service is available to the residents of the region at the major airports in Louisville, Cincinnati, and Indianapolis. The Madison Airport, located four miles west of Madison and the only public airport in the county, provides service for small craft.[4]

2.3 WATER USE

2.3.1 Surface Water

The water resources of the Ohio River Valley include both ground and surface supplies. The Ohio River, the primary surface stream in the region, provides an abundant water supply as well as a major transportation route for commercial and recreational navigation. The average river flow measured at the site is about 112,000 cfs (2800 m^3/sec). In the portion of the Ohio River main stem from the confluence of the Kentucky River to the mouth of the Ohio at Cairo, Illinois, there are 86 central water supply systems serving a population of about 1,100,000.[1] The average daily water use of these combined systems is 210 Mgd (7.9×10^5 m^3/d).[1] The Oldham County Water District 1, 12.2 miles (19 km) downstream, is potentially the closest water user for domestic purposes. It has a surface water intake on the Ohio River, but normally buys its water from the Louisville Water Company. Oldham County Water District 3 uses groundwater from an aquifer charged by the Ohio River. The closest surface water intake system (for fulltime domestic use) from the Ohio River belongs to the Louisville Water Company, 30.5 miles (49 kilometers) downstream of the station. This system utilizes approximately 125,000,000 gal/day. (See Appendix page A-37.) Additionally, there are 63 Mgd (2.4×10^5 m^3/d) withdrawn for industrial uses[1] and 3800 Mgd (1.4×10^7 m^3/d) withdrawn as cooling water for power plants.[2] Thus, total water use along this reach of the Ohio River is about 4070 Mgd (1.5×10^7 m^3/d). It should be noted that not all of the water withdrawn is consumptively used; a large portion is returned as treated or untreated discharge. Future projections of water use in this stretch of the Ohio River indicate that by the year 2020 total water use will increase to about 4600 Mgd (1.7×10^7 m^3/d).[1] This would be 45% of the minimum daily low flow. Withdrawals of water for municipal, industrial, and agricultural uses from the McAlpine Pool total about 2400 cfs (68 m^3/sec) of which 2200 cfs (61 m^3/ sec) are used for once-through cooling at the Clifty Creek power plant. The staff makes the conservative assumption, based on the estimated water balance (see Sec. 2.5.1), that the consumptive loss of water in the McAlpine Pool is about 10% of withdrawals. Thus about 240 cfs (6.8 m^3/sec) are assumed to be lost and about 2160 cfs (61.2 m^3/sec) are returned.

There is little recreational use of the Ohio River near the site; some boating, fishing, and sightseeing occur, but there is very little hunting or swimming. There are some game fish in the river, but they are comparatively rare. The other stream adjacent to the site, Little Saluda Creek, provides good habitat for deer, smaller mammals, and quail; thus, hunting is the primary recreational activity along this water course. The fishing is poor because of intermittent flow and lack of game fish. The largest lake in Jefferson County is Hardy Lake, a State impoundment about 15 miles away, near the far western boundary of the county. The lake covers 740 acres (300 hectares), and 1300 acres (530 hectares) of surrounding land are being developed for recreation; swimming, boating, camping, and fishing facilities are already available.

2.3.2 Groundwater

The area surrounding the site relies heavily on the abundant ground water resources, in particular the permeable glaciofluvial aquifer along the Ohio River. Within 10 miles (16 km) of the site, there are six municipal water supply centers utilizing groundwater. Table 2.1 lists these centers and their average and maximum daily use. Maximum daily municipal groundwater use in this area, excluding local domestic or rural wells, is about 12 Mgd (4.5×10^4 m^3/d).

2.4 GEOLOGY AND SEISMICITY

The geology and seismicity of the proposed site will be discussed very briefly. A detailed discussion and evaluation of the geological features will be included in the staff's Safety Evaluation Report.

2.4.1 Geology

2.4.1.1 Physiography

The proposed site is divided into three physiographic areas: the upland, the river bluff, and the Ohio River Valley bottom. The upland is bounded on the east by the valley of the Ohio River and on the north and west by the valley of Little Saluda Creek. The upland is essentially flat with local relief up to 40 feet (12 m). From the upland to the valley bottom, the relief varies from about 150 feet (45 m) on the west to 300 feet (90 m) on the east. The Ohio River Valley bottom is nearly flat and ranges in width from 200 feet (60 m) at the southern site boundary to 1000 feet (300 m) where Little Saluda Creek joins the Ohio River. The valley bottom slopes toward the river from an elevation of 460 feet (140 m) to about 420 feet.

2.4.1.2 Stratigraphy

At the Marble Hill site glacial deposits overlie the sedimentary bedrock of Silurian age dolomites, limestones and shales. The station will be founded upon the Salomonie Dolomite formation which ranges in thickness from 29 to 78 feet (8.8 to 24 m). The base of the containment structure will lie 75 feet below ground level near the top of the Saluda Dolomite formation.

2.4.1.3 Soils

The predominant soils (see Fig. 2.5) on and adjacent to the proposed s   n are loess (windblown silts) on the upland and bluff areas, and alluvial-glaciofluvial deposits on the valley bottoms. Seven major soil types were identified (ER Supp. 1). The Avonburg series (Symbol 572 on Fig. 2.5) occur on the nearly level portions of the uplands, and are developed in poorly drained loess that overlies glacial till. The Rossmoyne series (Symbol 573 on Fig. 2.5) occur on the nearly level to gently sloping portions of the upland, and are developed in moderately well drained loess over glacial till. The Grayford series (Symbol 594 on Fig. 2.5) occur on the nearly level to moderately steep portions of the upland, are developed in a thin mantle of well drained loess over glacial till, and exhibit poor to good stability characteristics. The Crider series (Symbol 844 on Fig. 2.5) are found on the nearly level to strongly sloping portions of the uplands, are developed in well drained loess that overlies material weathered from limestone bedrock, and exhibit poor to fair stability characteristics. The Fairmount series (Symbol 9636 on Fig. 2.5) occur on the strongly sloping to very steep portions of the uplands, are developed in well drained interbedded limestone and soft calcareous shale, and may exhibit possible slope stability problems. The Wilbur series (Symbol 73 on Fig. 2.5) are developed in nearly level alluvial deposits along streams and rivers, are moderately well drained, and exhibit poor stability characteristics. The Huntington series (Symbol 54 on Fig. 2.5) consist of deep, well drained, nearly level floodplain soils developed in recent Ohio River alluvium with fair stability characteristics and a susceptibility to flooding.

The soils along the proposed transmission routes can be identified in only a very general manner from data obtained from the U. S. Soil Conservation Service.

Soil types encountered along the proposed Rush Line (see Sec. 3.7) include the Avonburg, Rossmoyne, Fairmount, and Grayford series found on the site, as well as the Wakeland-Stendal-Haymond-Bartle series (somewhat poorly drained silty soils found on alluvial deposits along the larger streams), the Fincastle-Ragsdale-Brockston series (poorly drained loess founded on glacial till on the uplands), and the Miani-Russell-Fincastle series (somewhat poorly drained loamy loess founded on glacial till on sloping terrain).

Table 2.3. Municipal Wells in the Regional Area

Pumping Center	Population Served	Number of Wells	Average Depth (ft)	Average Daily Use (Mgd)	Maximum Daily Use (Mgd)
Indiana:					
Charlestown	5,700	2	78	1.10	1.40
Hanover College (in Hanover)	1,700	3	65	0.30	0.43
Madison	11,600	6	114	2.50	3.70
East Well Field		2	98	1.10	1.80
West Well Field		2	108	1.40	1.90
Madison State Hospital		2	137	b	b
Washington Township Water Corporation (in New Washington)	1,125	3	63	0.13	0.17
Kentucky:					
Milton	450	2	a	a	0.20
Trimble County Water District No. 1 (in Bedford)	453	2	a	0.12	0.24

From ER, Table 2.2-29.

[a]Not available.

[b]Separate water supply.

Soil types encountered along the proposed Columbus Line (see Sec. 3.7) include the Avonburg, Rossmoyne, and Wakeland-Stendal-Haymond-Bartle series previously mentioned. Other series are Genesee-Shoals-Eel (moderately well-drained loamy soils founded on alluvial deposits near stream beds), Fox-Nineveh-Ockley (well-drained loamy soils on outwash sand and gravel), Martinsville-Whitaker (moderately well-drained loamy soils on outwash or lake-deposited sand and silt found along the hillsides), and Princeton-Ayrshire-Bloomfield (well-drained to somewhat poorly drained loamy loess located on hillsides and uplands).

Soil types encountered along the proposed 345-kV Loop (see Sec. 3.7) include the Avonburg and Rossmoyne series.

2.4.2 Seismicity

The site lies in an area classified as Zone 2 on a Seismic Risk Map of the conterminous United States. Zone 2 is described as one of moderate anticipated damage, corresponding to Modified Mercalli (MM) intensity VII. This is the intensity level at which damage may be widespread, but is considerable only in poorly built or badly designed structures.

Most of the seismic activity in Indiana has occurred in the southwestern part of the State. Events that occurred in several surrounding states have been felt also.

2.5 HYDROLOGY

The station will be located on a moderately undulating upland about 350 feet (105 m) above and about 0.5 mile (0.8 km) west of the Ohio River at River Mile (RM) 570 (miles downstream of Pittsburgh). This stretch of river, designated "Ohio River Main Stem-Louisville," is within the upper reach of the storage and navigation pool between McAlpine Dam (RM 607) and Markland Dam (RM 532).

Fig. 2.5. Soils Map. From PSAR, Fig. 2.5-24.

2.5.1 Surface Water

Surface drainage features in the site vicinity include: the Ohio F...er, Big Saluda Creek, Little Saluda Creek, Squaw Creek, Corn Creek, Hollow Knob Creek, Camp Creek, and Little Camp Creek.

The major surface water stream in the region is the Ohio River as shown in Figure 2.6. The main stem of the river drops 429 feet (131 m) across its 981-mile (1580-km) length and drains an area of about 204,000 square miles (528,000 km^2). It flows generally in a southwesterly direction but in some short reaches turns to all points from south to north. Its valley is rather narrow compared to its drainage area, probably as the result of glacial influences. Within the valley and immediately along the river, alluvial deposits of varying widths occur; some of these have thicknesses of over 100 feet (30 m).[5] In the site vicinity, the river is about 2200 feet (670 m) wide and is flanked by steep banks on the west and a wide floodplain on the east. Normal water depths at the site reach a maximum of 24 feet (7.3 m) at the normal pool elevation (420 ft or 130 m MSL). The water level is higher than 420 ft MSL at least 90% of the time. The average discharge of the river at its mouth is 258,000 cfs (7310 m^3/sec).[5]

Stream gaging station records for the two dams above and below the site indicate river discharge rates as follows: (1) the maximum and minimum recorded flows at the Markland gage (RM 531.5) are 465,000 and 10,500 cfs (13,200 and 300 m^3/sec), respectively; and (2) the maximum, minimum, and average recorded flows at the Louisville gage (RM 607.3) are 1,100,000; 2100; and 113,000 cfs (31,000; 59; and 3200 m^3/sec), respectively. The minimum flow recorded at Louisville predates completion of the lock-and-dam system, thus the more recently recorded low-flow data at the Markland gage (10,500 cfs or 300 m^3/sec) is considered as the minimum regulated flow affecting the site vicinity, because it is lower than the calculated 7-day 10-year low flow (14,200 cfs or 402 m^3/sec).

Inasmuch as the proposed plant will draw its cooling water from the McAlpine Pool of the Ohio River, a study of the water balance for this pool will be discussed. This pool is taken to be the body of water between the Markland and McAlpine Dams. The data given in Table 2.4 are estimates of inflow and outflow for this pool. From this table we find that the small ungaged streams and areas of direct river drainage account for about 316 square miles (818 km^2) of drainage area and contribute about 150 cfs (4.2 m^3/sec) to the pool. The table also shows that the estimated values for inflow and outflow are in good agreement, suggesting relatively little consumptive loss from the pool.

Table 2.4. Estimated Flows into and out of the McAlpine Pool (averaged for last four years of record 1971-1974)[a]

Gaging Station or Stream Name	Drainage Area (sq mi)	Flow Rate (cfs)	Flow Direction
Markland Dam	83,170	126,675	in
Kentucky River	6,970	10,967	in
Eagle Creek	437	811	in
Indian-Kentuck Creek	28	28	in
Harrods Creek	24	45	in
Beargrass Creek (south fork)	17	27	in
Beargrass Creek (middle fork)	19	34	in
Silver Creek	189	209	in
McAlpine Dam	91,170	138,650	out

Sources: "Water Resources Data for Indiana," USGS Documents: 1971 through 1974. "Water Resources Data for Kentucky," USGS Documents: 1971 through 1974.

[a]The last four years of record were used in this comparison because these are the only data available for the Markland Dam gage.

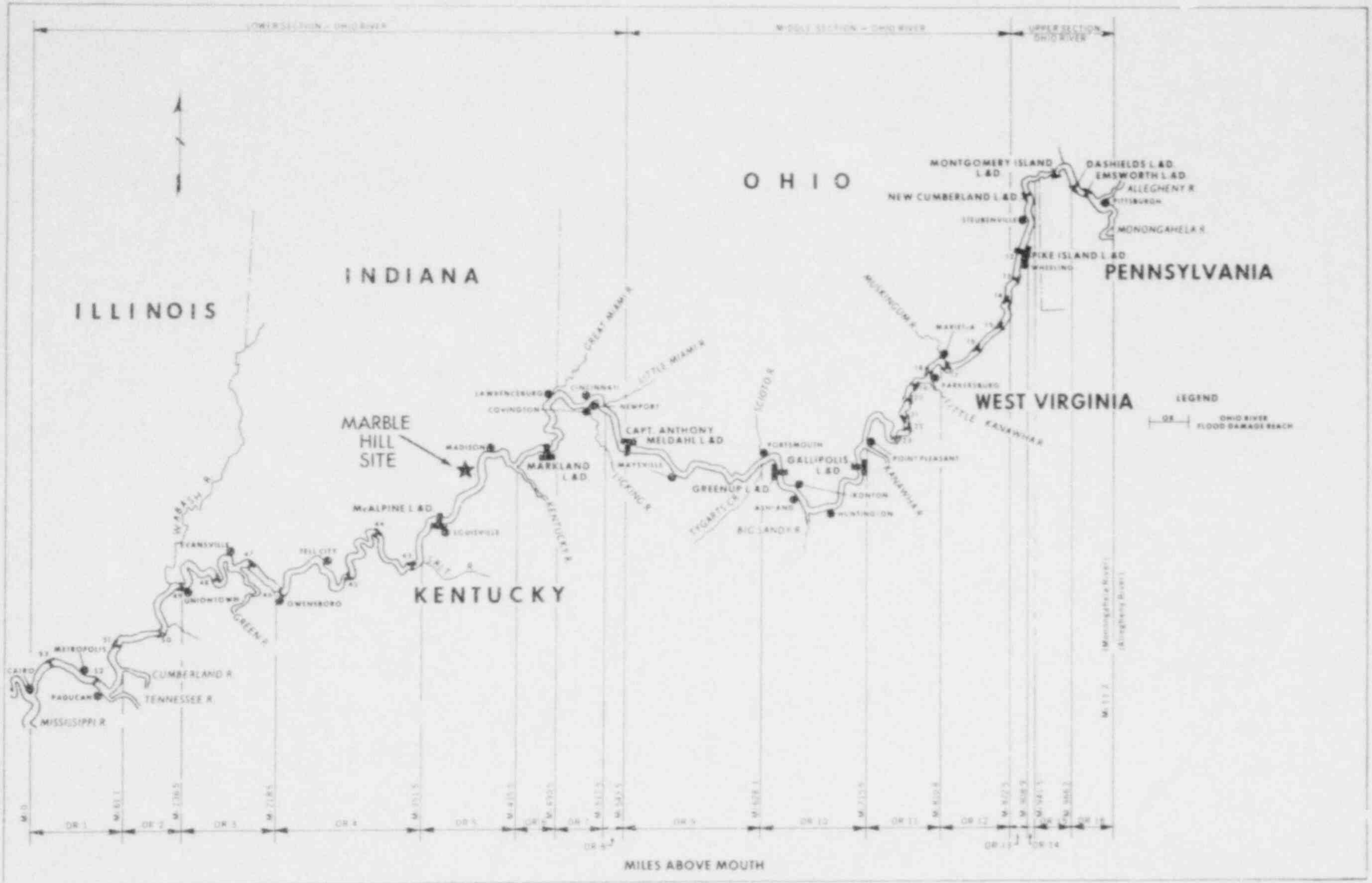

Fig. 2.‿. The Ohio River. From "Ohio River Basin Comprehensive Survey, Appendix N," U. S. Army Engineer Division, Ohio River, Corps of Engineers, December 1967.

2.5.2 Groundwater

Discussion of groundwater hydrology is limited to the area west of the Ohio River in the site region. This is appropriate because the river essentially forms a hydraulic boundary between the Indiana and Kentucky groundwater systems.

The most productive (up to 3.3 cfs or 0.1 m^3/sec) aquifer in the site region is the alluvial-glaciofluvial deposit along the Ohio River. Other aquifers in the region include: sand and gravel lenses in glacial deposits, Louisville Limestone, the Brassfield Limestone and alluvial-glaciofluvial deposits in local stream valleys. Within 10 miles (16 km) of the site, groundwater is utilized as the primary (96% to 100%) water supply. Generally, domestic wells are developed at depths between 80 feet and 140 feet (about 25 m and 40 m). Most municipal supplies in the site vicinity draw water from the alluvial-glaciofluvial aquifer along the Ohio River. The station will draw water needed for construction and potable uses from the same alluvial-glaciofluvial aquifer at the rate of about 1.3 cfs (0.04 m^3/sec). This aquifer is charged by the Ohio River. Therefore, withdrawals by the Station will not affect other groundwater users.

2.5.3 Water Quality

2.5.3.1 Surface Water

Waters of the Ohio River are classified as moderately hard to hard depending on the season of the year. Hardness values (as $CaCO_3$) range from 80 mg/l to 275 mg/l.[5] Water temperatures and chemical analyses of Ohio River water are shown in Tables 2.5, 2.6, and 2.7. It should be noted here that the water quality parameters presented are generally averages or single analyses and that variation can be expected from year to year and season to season. Runoff entering the McAlpine Pool (about 12,200 cfs or 345 m^3/sec) accounts for 10% of the pool's total inflow, and its generally higher water quality compared to the incoming Ohio River water tends to upgrade water quality in the pool.

2.5.3.2 Groundwater

Water from the glaciofluvial aquifer is generally hard (150-600 mg/l) and has a high iron content (up to 3.5 mg/l). The general chemical characteristics of water withdrawn from this aquifer are listed in Table 2.8 and analyses of a groundwater sample taken near the site are listed in Table 2.9.

More detailed information about the chemistry and physical characteristics of the surface and groundwater in the site vicinity is presented in the ER, Section 2.5 and PSAR, Section 2.4.

2.6 METEOROLOGY

2.6.1 Regional Climatology

The climate of the Marble Hill site, located above the Ohio River about 30 miles northeast of Louisville, can be described as continental. The site lies along the principal paths of cyclonic and anticyclonic pressure systems tracking east and northeast through the area during the winter and spring. The contrasting air masses alternating over the area can produce frequent large fluctuations in temperatures.

2.6.2 Local Meteorology

Information from the Climatic Atlas,[8] and data collected at Louisville,[9] Cincinnati[10,11] (about 60 miles northeast of the site), Madison[12] (about ten miles NNE of the site), and onsite have been used to assess the meteorological characteristics of the site.

Mean monthly temperatures may be expected to range from about 33°F in January to about 77°F in July.[8-11] Record maximum and minimum temperatures in the area have been 108°F and -20°F at Madison and 107°F and -20°F at Louisville.[9,12]

Annual average precipitation is about 44 inches at Madison and 43 inches at Louisville.[9,11] Precipitation is well-distributed throughout the year, with the maximum monthly average occurring in March and the minimum monthly average occurring in October.[8,9,12] The maximum 24-hour rainfall reported at Louisville was 6.87 inches in March 1964. Annual average snowfall in the area

Table 2.5. Monthly Average Temperature Data of the Ohio River at Louisville (°F)

	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
Jan			37.5	41.6	39.8	38.0	34.4	34.9	36.3	40.0	42.6	40.8
Feb			40.4	38.9	37.6	41.2	37.5	39.9	39.3	40.0	39.5	40.0
Mar	50.9		44.9	42.0	45.9	46.8	43.4	43.5	44.2	43.9	44.9	49.0
Apr	52.1	58.8	57.5	52.8	52.3	61.6	59.0	56.3	53.6	53.7	54.1	54.0
May	72.3	67.5	70.5	68.9	63.8	64.1	65.1	65.2	70.2	61.9	64.3	60.1
Jun	79.3	77.8	79.0	77.5	76.0	75.7	73.0	76.2	78.5	74.6	73.0	73.1
Jul	79.9	82.5	82.4	81.0	85.0	80.9	81.7	82.8	82.0	80.8	73.5	79.4
Aug		83.3	82.0	81.0	82.2	79.4	82.9	81.3	83.1	78.6	80.0	80.2
Sep	76.2	78.3	77.7	75.9	76.9	73.9	76.9	77.1	80.5	76.5	77.2	79.0
Oct	68.3	71.4	64.6	65.3	63.1	64.1	67.9	67.0	68.0	71.2	65.6	71.0
Nov	59.2	59.9	57.0	55.8	51.5	49.4	55.2	52.8	53.5	59.7	51.9	55.7
Dec		42.7	44.5	45.1	42.0	41.8	41.1	40.3	45.4	48.0	43.0	44.3

Adapted from the ER, Table 2.5-10.

TABLE 2.6. Trace Metal Analysis Results From Two Marble Hill Sampling Stations on the Ohio River During 1974

(All Values as μg/liter)

	Zn	Cu	Fe	Cd[a]	Pb[a]	Total Cr	Hex Cr[a]	Hg	Mn	As
STATION A-1										
March 19	10.9	7.1	116.0	<0.5	<3.0	1.0	<0.7	0.3	10.5	NA
June 20	13.5	2.0	16.7	<0.5	<3.0	0.8	<0.7	0.4	8.9	1.5
September 26	7.0	3.0	380.0	81.0	20.0	10.0	<10.0	0.4	29.0	1.8
December 18	10.4	7.4	17.5	0.2	3.2	0.5	0.5	0.3	8.3	NA
STATION A-4										
March 19	12.5	2.6	133.0	<0.5	<3.0	0.8	<0.7	0.3	10.3	NA
June 20	16.1	2.6	20.8	<0.5	<3.0	0.8	<0.7	0.3	7.0	1.0
September 26	3.0	4.0	350.0	56.0	10.0	10.0	<10.0	<0.1	39.0	<0.5
December 18	10.7	8.2	19.7	0.2	2.6	0.6	0.5	0.4	8.3	NA
Overall Average	10.5	4.6	132.0	17.0	6.0	3.0	3.0	0.3	10.0	1.0

NA - Not Available.

[a] Detection limits vary due to water quality differences.

Source: ER, Table 2.7.5.

Table 2.7. Chemical Data from Marble Hill Sampling Station A-3 on the Ohio River, March 1974 to February 1975 (mg/l except as noted)

Date	DO	Percent Saturation	BOD	COD[a]	pH	Alk. as $CaCO_3$[b]	Cond. (μmho)[b]	SiO_2[b]	Chlorides as Cl	SO_4[b]	Ortho PO_4[b]	Total PO_4[b]	TOC
19 Mar	10.8	92	4.85	< 0.1	7.24	52.0	197	6.8	23.0	47.0	0.53	0.84	9
19 Apr	10.3	96	c	27.5	7.44	57.0	233	7.1	26.2	71.0	0.54	0.72	6
22 May	7.3	79	0.90	19.7	7.33	48.0	252	5.3	34.0	68.4	0.51	0.73	27
20 Jun	7.2	83	3.35	36.6	7.41	64.0	220	4.7	36.1	57.2	0.52	0.78	10
25 Jul	6.1	75	2.65	< 1.0	7.80	64.0	281	6.2	37.8	71.2	0.53	0.83	10
29 Aug	5.5	68	1.55	7.6	7.33	70.8	318	2.1	58.2	67.2	0.51	0.88	21
26 Sep	6.9	78	2.05	20.2	7.24	68.0	307	7.2	40.0	95.0	0.51	0.78	15
23 Oct	8.6	84	1.60	0.2	7.48	75.0	351	4.3	44.5	115.6	0.63	1.02	13
20 Nov	9.6	86	2.85	3.3	7.60	87.6	295	4.0	56.5	134.0	0.64	0.92	24
18 Dec	12.5	95	3.90	22.0	7.59	65.0	236	2.9	33.0	46.8	0.52	1.00	18
22 Jan	13.1	97	4.10	14.0	7.51	64.0	226	6.0	31.0	48.8	0.47	0.67	20
27 Feb	11.4	89	4.20	38.0	7.55	56.0	232	1.3	32.0	45.2	0.48	1.42	24

SEE FOOTNOTES AT END OF TABLE.

Table 2.7. Continued

Date	NH_4 and NH_3 as NH_3	Susp. Solids[b]	Total Dis. Solids	NO_3 as N	Ca	Mg	Na	K	Phenols (μg/l)	MBAS	Hexane Sol.	Chlor-amines	Chlorine Demand
19 Mar	0.12	196	110	0.64	25.8	7.5	7.5	1.8	< 1.0	< 0.025	7.0	< 0.01	4.90
19 Apr	0.34	121	210	2.90	35.6	9.6	10.5	1.9	12.0	< 0.025	5.2	< 0.01	4.52
22 May	0.19	45	138	0.60	29.7	9.0	12.0	2.1	4.0	< 0.025	< 1.0	< 0.01	3.16
20 Jun	0.40	9	157	1.63	31.5	9.0	12.0	1.5	4.0	< 0.025	11.3	< 0.01	7.00
25 Jul	0.60	26	332	2.39	94.5	10.4	13.6	1.9	3000	< 0.025	41.9	< 0.01	1.50
29 Aug	0.66	44	320	9.47	38.3	10.5	21.7	2.1	< 1.0	< 0.025	3.2	< 0.01	5.28
26 Sep	c	12	272	1.45	34.0	10.7	18.9	3.2	< 1.0	< 0.025	7.7	< 0.01	1.50
23 Oct	0.45	7	360	2.02	40.0	12.1	21.6	3.3	2.0	< 0.025	6.8	< 0.01	2.85
20 Nov	0.74	31	420	1.86	54.8	13.6	30.8	9.7	16.0	< 0.025	70.0	< 0.01	2.78
18 Dec	0.22	174	209	0.88	37.3	9.1	12.4	4.3	< 1.0	< 0.025	12.2	< 0.01	1.70
22 Jan	0.20	108	226	0.92	33.9	9.1	12.7	4.0	12.0	< 0.025	85.0	< 0.01	1.20
27 Feb	0.16	618	198	1.07	35.3	8.8	11.5	3.8	10.0	0.025	4.0	< 0.01	3.70

From the ER, Supp. 1, pp. 30-31 and Table 2.7-2.

[a]Detection limits vary due to water-quality differences.

[b]Average of two determinations.

[c]Not available.

Table 2.8. General Hydrologic and Chemical Characteristics of the Alluvial-Glaciofluvial Aquifer
(Numerical ranges represent typical values and do not include unusually high or low values)

Source	Thickness (ft)	Yields of High-Capacity Wells (gpm)	Well Depths (ft)	Depths to Water (ft)	Hardness (mg/l)	Sulfate (mg/l)	Chloride (mg/l)	Iron (mg/l)	Total Dissolved Solids (mg/l)
Glacial and alluvial sand and gravel in the Ohio River Valley	0-120	100-1500	40-120	5-50	150-600	5-50	5-30	0.2-3.5	200-900

Adapted from "Ohio River Basin Comprehensive Survey, Appendix E," U. S. Geological Survey, Water Resources Div., Mid-Continent Area, (Undated) Table 11.

Table 2.9. Water Quality Analyses[a] of the Alluvial-Glaciofluvial Aquifer at the Marble Hill Site, Well Number 36
(ppm except as noted)

pH	7.26	Ca	101.0
Cond, μmho	480	Mg	30.5
NO_3 as N	0.40	Na	3.2
SO_4	36.4	Hardness as $CaCO_3$	378.2
Cl	18.0		
Alkalinity as $CaCO_3$	326	Dissolved solids	450
		Fe	0.1

Adapted from the ER, Table 2.5-18.

[a]Water samples were collected on 10 December 1974 and analyzed in the onsite monitoring program.

varies from about 13 inches at Louisville to about 2^ inches at Cincinnati.[8-11] The maximum 24-hour snowfall reported at Louisville was 15 inches in December 1917.[9]

At Louisville, heavy fog (visibility 1/4 mile or less) occurs about nine days annually, and humidity averages about 68 percent.[9] Annual average humidity at the 199-foot level of the onsite tower for the period January through December 1974 was about 70 percent (ER, Sec. 2.6).

The station is situated about 350 feet above the Ohio River, about one-half mile from the river. Figures 2.7 and 2.9 indicate the onsite wind roses for the 33-foot and 199-foot levels, respectively, for the period January through December 1974. Figure 2.8 indicates the 33-foot level wind rose from a satellite meteorological tower located along the river for the same period. The predominant wind directions at the 33-foot level of the onsite tower are from the SSW (13.7%) and from the southwest (12.1%), with calms occurring 2% of the time. Winds from the SSW are also predominant at the 199-foot level of the onsite tower, occurring about 14% of the time. Data from the satellite tower reflect the expected bimodal river valley airflow, with winds from the south and southeast occurring a total of almost 23% of the time, and winds from the north and northwest occurring a total of about 15% of the time.

2.6.3 Severe Weather

Because of the location of the site with respect to principal storm tracks and contrasting air masses alternating over the area, severe weather is not uncommon.

Thunderstorms can be expected to occur 45 to 50 days each year, with about 60% of these days occurring from May through August.[8-11]

In the period 1955-1967, 12 occurrences of hail greater than 3/4 inch in diameter and 32 occurrences of winds greater than 50 knots were reported in the one-degree latitude-longitude square containing the site.[13] The "fastest mile" wind speed reported at Louisville was 68 mph in May 1915.[9] Also in the period 1955-1967, 17 tornadoes were reported in the one-degree latitude-longitude square containing the site,[13] giving a mean annual frequency of 1.3. The computed recurrence interval for a tornado at the plant site is about 900 years.[14] A tornado passed northwest of the site during the major tornado outbreak of April 3-4, 1974. The maximum wind speed associated with this tornado was estimated by Fujita[15] to be between 207 and 260 mph.

Ice storms accompanied by strong winds are not uncommon, and the applicant has presented information that an ice storm depositing almost three inches of ice can be accompanied by wind speeds about 30 mph (ER, Sec. 2.6).

In the period 1936-1970, there were about 36 atmospheric stagnation cases totalling about 170 days reported in the site area.[16] August has the highest frequency of atmospheric stagnation cases.

2.6.4 Dispersion

PSI has submitted one full year (January through December 1974) of onsite joint frequency distributions of wind speed and direction at the 33-foot level of the 199-foot tower by atmospheric stability (defined by the vertical temperature gradient between 33 feet and 199 feet) in accordance with the recommendations of Regulatory Guide 1.23. Data recovery was 83%. The staff has used these data to provide relative concentration (χ/Q) and deposition (D/Q) values for the site. A "Straight-Line Trajectory Model," as described in Draft Regulatory Guide 1.DD, was used in evaluating atmospheric transport and dispersion characteristics. Partial elevated releases were considered when the exit velocities and building configurations met the criteria established in Draft Regulatory Guide 1.DD. An estimate of maximum increase in calculated relative concentration and deposition due to recirculation of airflow, not considered in the straight-line trajectory model, was included in the calculations.

Because of th 83% data recovery for the first year of onsite data, the staff will use data from the second year (January through December 1975) of onsite monitoring to confirm estimates of atmospheric transport and diffusion.

2.7 ECOLOGY

2.7.1 Terrestrial

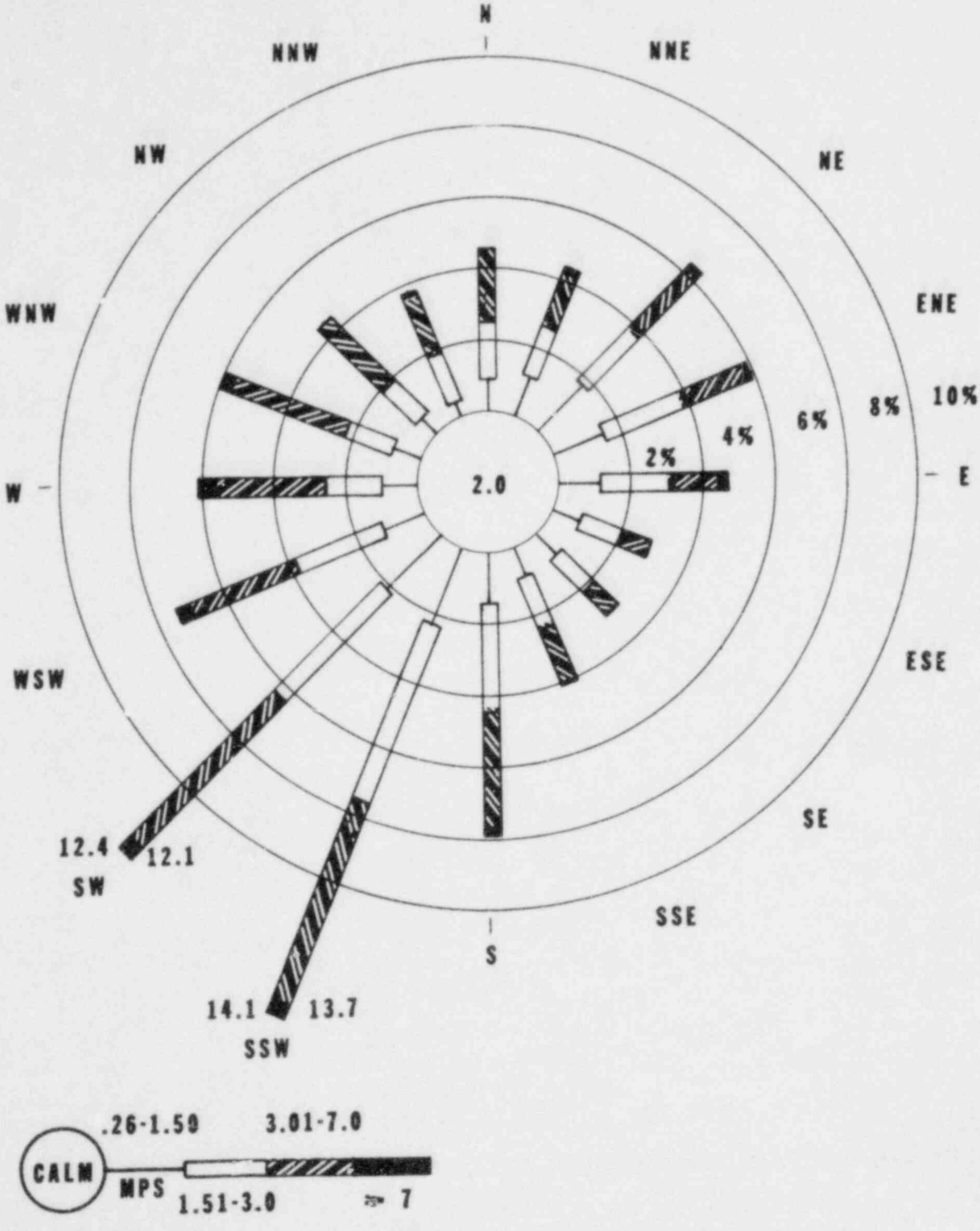

Fig. 2.7. Period of Record Wind Rose, January-December 1974, 33-Foot Level, Onsite Tower #1. From PSAR, Figure 2.3-4.

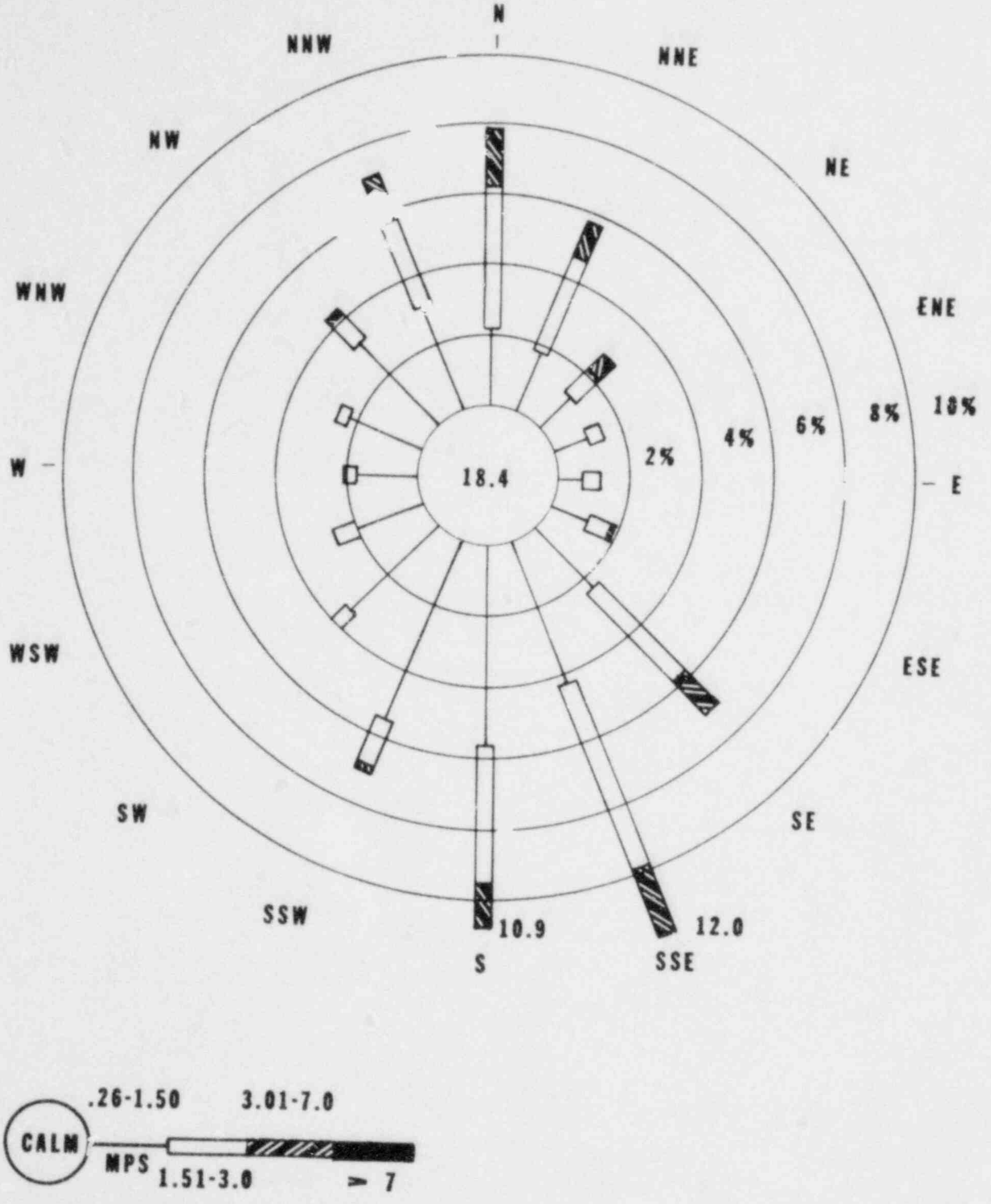

Fig. 2.8. Summary Wind Rose, January-December 1974, 33-Foot Level, Satellite Tower along River. From PSAR, Figure 2.3-18.

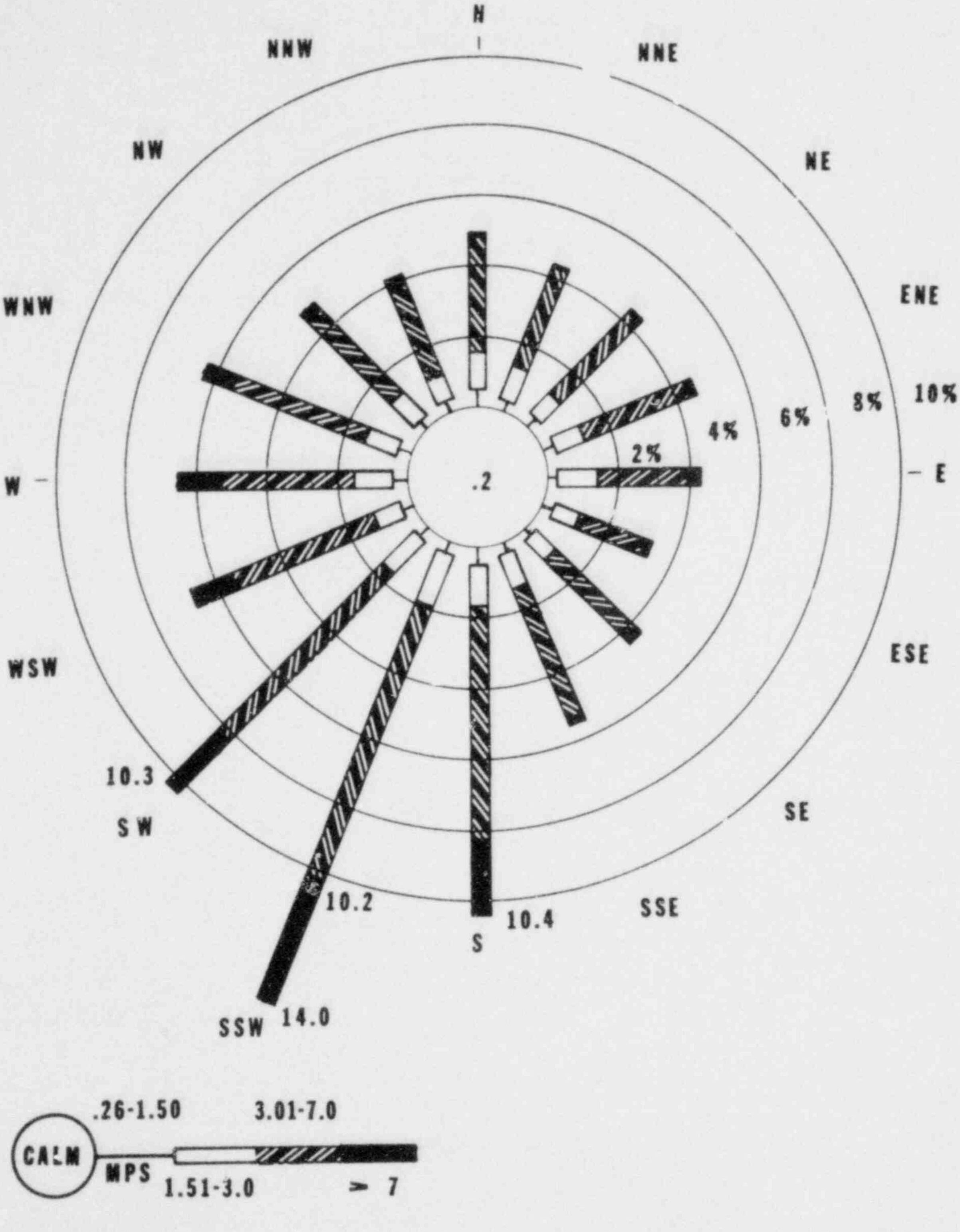

Fig. 2.9. Summary Wind Rose, January-December 1974, 199-Foot Level, Onsite Tower No. 1. From PSAR, Figure 2.3-19.

2.7.1.1 Vegetation

The basic vegetational features of the site are depicted in Figure 2.10. The central portion of the site was cropland, pasture, and fallow field (420 acres or 170 hectares in all) until 1975, when most farming ceased. It is that area upon which most of the station will be built. There is a small area of upland pine forest (4 acres or 1.7 hectares) (stated by the applicant to be unique in the region) and upland grassland (21 acres or 8.5 hectares) dominated by timothy, tall fescue, and Kentucky bluegrass.

The applicant's terrestrial sampling program indicated (see ER, Sec. 6.1.4.3) that there is an ecotone (18 acres or 7.3 hectares) that is abandoned pasture, and was formerly cultivated field. (The applicant uses "ecotone" in the sense of a habitat that is undergoing a rapid change in species composition and that lies adjacent to another habitat.) It is now in an early successional stage with ground cover mainly of Kentucky bluegrass and with some trees dominated by black locust.

The river floodplain (11 acres or 4.6 hectares) is fallow agricultural land now dominated by red clover, yellow sweet clover, and plain plantain. Of trees bordering the Ohio River, silver maple is the most abundant, followed by sycamore, American elm, and cottonwood; however, black locust, honey locust, and yellow poplar are also found. This indicates the area is a second bottom,[17] where less-water-tolerant trees can establish themselves because of infrequent flooding.

The remainder of the site (530 acres or 215 hectares) is hardwood forest. The upland woods is a lowland-depressional-forest type[18] dominated by sassafras and yellow poplar. The east-facing slope is dominated by sugar maple, chinquapin oak, and white ash, and is best characterized as a mixed woods.[18]

None of the plants sampled by the applicant at the Marble Hill site is listed as an endangered species (ER, Table 2.7-117).

2.7.1.2 Animals

Invertebrates

The invertebrates identified in the applicant's sampling are listed in Appendix B (Tables B.1 through B.9).

Amphibians and Reptiles

Lists of amphibians and reptiles known or thought to occur in the areas of Marble Hill or the transmission lines are given in Appendix B (Tables B.10 and B.11).

Birds

It has been estimated that nearly 300 species of birds could inhabit the site area (see Table B.12 of Appendix B). One hundred and ten species were identified on the plant site environs during field observations by the applicant during March, April, May, June, September, and December, 1974 (ER, Table 2.7-124). This species composition is considered to be characteristic of southeastern Indiana. A total of 132 species have been identified as breeding birds of southeastern Indiana.[19,20] Table 2.10 lists these birds according to habitat preference. Some or all of these birds may breed on the site itself.

The Marble Hill area is not part of any heavily traveled waterfowl migration corridor, although the site does lie within the corridor used by 3000-5000 Canada geese in the fall.[21] Ten species of waterfowl are known to breed in the area of the site (see Table 2.8). The waterfront of the Marble Hill site has about 2.2 miles (3.5 km) of suitable wood duck breeding habitat, and it is likely that one to two broods are raised annually in this region. Other species that breed in the area and are frequently hunted include the mallard, black duck, and blue-winged teal.

Three species of upland gamebirds occurring on the site are bobwhite quail, American woodcock, and mourning dove. The average annual harvest of bobwhite quail from 1940 to 1957 in Jefferson County was 16 quail per hunter.[22] Over 50% of the site is good bobwhite habitat. Although woodcocks are not hunted as heavily as quail in the Midwest, hunting pressure has been increasing steadily; the U. S. Department of the Interior has estimated that the woodcock harvest in the U. S. increased by 50% from 1967-1972.[23] The average number of woodcock wings (an index of

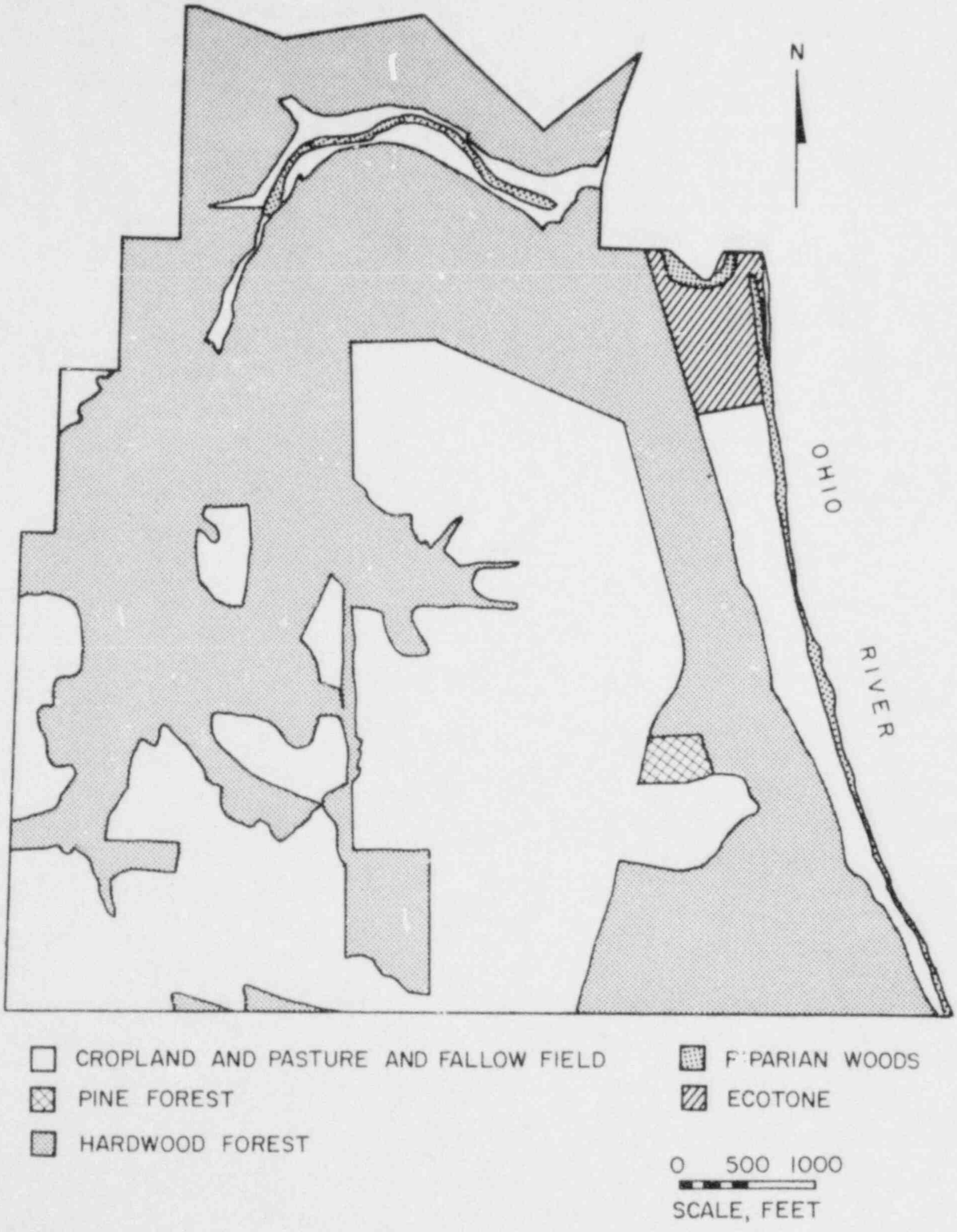

Fig. 2.10. Forest Distribution on the Site.

Table 2.10. Breeding Birds of Southeastern Indiana, Denoting Principal Habitats[a]

Species	Riparian[b]	Forest[c]	Open[d]	Edge (Ecotone)[e]
Pied-billed grebe	X			
Great blue heron	X			
Green heron	X			
Black-crowned night heron[f]	X			
Yellow-crowned night heron	X			
Least bittern	X			
American bittern	X			
Mallard	X			
Black duck	X			
Blue-winged teal	X			
Wood duck	X	X		
Hooded merganser	X			
Turkey vulture		X	X	X
Black vulture		X	X	X
Sharp-shinned hawk		X	X	X
Cooper's hawk[f]		X	X	X
Red-tailed hawk		X	X	X
Red-shouldered hawk[f]		X	X	X
Broad-winged hawk		X	X	X
Marsh hawk[f]	X		X	X
American kestrel[f]			X	X
Bobwhite quail			X	X
Ring-necked pheasant			X	X
King rail	X			
Virginia rail	X			
Sora	X			
Common gallinule	X			
American coot	X			
Killdeer	X		X	
American woodcock	X	X		
Upland plover	X		X	
Spotted sandpiper	X		X	
Rock dove			X	X
Mourning dove			X	X
Yellow-billed cuckoo[f]		X		X
Black-billed cuckoo		X		X
Barn owl[f]		X	X	
Screech owl		X	X	X
Great horned owl		X	X	
Barred owl		X		
Long-eared owl		X	X	
Chuck-will's widow		X	X	
Whip-poor-will		X	X	
Common nighthawk[f]			X	
Chimney swift		X	X	
Ruby-throated hummingbird				X
Belted kingfisher	X			
Common flicker		X	X	X
Pileated woodpecker		X		
Red-bellied woodpecker		X		

SEE FOOTNOTES AT END OF TABLE.

Table 2.10. (Continued)

Species	Riparian[b]	Forest[c]	Open[d]	Edge (Ecotone)[e]
Red-headed woodpecker		X	X	
Hairy woodpecker[f]		X		
Downy woodpecker		X		
Eastern kingbird			X	X
Great crested flycatcher		X		X
Eastern phoebe	X			X
Acadian flycatcher		X		
Willow flycatcher (Traill's)	X			X
Least flycatcher				X
Eastern wood pewee		X		
Horned lark			X	
Bank swallow	X		X	
Rough-winged swallow	X			
Barn swallow			X	
Cliff swallow			X	
Purple martin[f]	X		X	
Blue jay		X		
Common crow		X	X	
Carolina chickadee		X		
Tufted titmouse		X		
White-breasted nuthatch		X		
House wren				X
Bewick's wren[f]				X
Carolina wren				X
Long-billed marsh wren	X			
Short-billed marsh wren	X			
Mockingbird				X
Gray catbird				X
Brown thrasher				X
American robin		X	X	X
Wood thrush		X		
Eastern bluebird			X	X
Blue-gray gnatcatcher		X		
Cedar waxwing				X
Loggerhead shrike[f]				X
Starling			X	X
White-eyed vireo				X
Yellow-throated vireo		X		
Red-eyed vireo		X		
Warbling vireo		X		
Black-and-white warbler		X		
Prothonotary warbler	X			
Worm-eating warbler		X		
Blue-winged warbler				X
Parula warbler		X		
Yellow warbler[f]	X		X	X
Cerulean warbler	X	X		
Yellow-throated warbler		X		
Pine warbler		X		
Prairie warbler				X
Ovenbird		X		
Louisiana waterthrush	X			
Kentucky warbler	X	X		
Common yellowthroat	X			X
Yellow-breasted chat				X

SEE FOOTNOTES AT END OF TABLE.

Table 2.10. (Continued)

Species	Riparian[b]	Forest[c]	Open[d]	Edge (Ecotone)[e]
Hooded warbler	X	X		
American redstart		X		
House sparrow			X	X
Bobolink			X	
Eastern meadowlark			X	
Red-winged blackbird	X		X	
Orchard oriole		X		X
Northern oriole		X		X
Common grackle		X	X	
Brown-headed cowbird			X	X
Scarlet tanager		X		
Summer tanager		X		
Cardinal		X		X
Rose-breasted grosbeak		X		
Indigo bunting				X
Dickcissel			X	X
American goldfinch			X	X
Rufous-sided towhee				X
Savannah sparrow	X			
Grasshopper sparrow[f]			X	
Henslow's sparrow[f]			X	
Lark sparrow			X	X
Bachman's sparrow[f]		X		X
Chipping sparrow				X
Field sparrow			X	X
Swamp sparrow	X			X
Song sparrow			X	X

[a]Species listed in more than one habitat category may be found in either, or require a combination of those habitats.

[b]Along streams, lakes, or rivers; similar to the riparian woods and floodplain habitat on the Marble Hill site.

[c]Mixed forest similar to the upland woods and east-facing slope on the site.

[d]Fields and meadows similar to the upland grassland on the site.

[e]Low, shrubby-type vegetation similar to the ecotone area of the site, or area along the edge of a right-of-way.

[f]On the National Audubon Society's "Blue List" (species considered by some authorties to be suffering abnormal population declines).

success) mailed in by Indiana hunters during this period was seven per year per hunter. The ecotone and floodplain habitat along Little Saluda Creek and the Ohio River are suitable woodcock habitat. Unlike the bobwhite and woodcock, the mourning dove cannot be hunted legally in Indiana; however, it is hunted in Kentucky and surrounding states. Indiana has one of the highest populations of breeding mourning doves in the U. S. Over half of the site represents good mourning dove habitat.

The most common raptors observed on the Marble Hill site during the breeding season were the American kestrel, turkey vulture, red-tailed hawk, broad-winged hawk, screech owl, and sharp-shinned hawk (ER, p. 2.7-51). The kestrel frequented the west and south boundary areas while the vulture, red-tail, and broad-wing hawks hunted the entire site. The screech owls prefer wooded slopes and upland savannahs; the sharp-shinned hawk was observed over the east slope and floodplain. The great horned owl and barred owl are also likely residents of the site. The red-shouldered hawk and the marsh hawk also have been observed on the site. The population of these hawks has declined considerably in Ohio and Michigan since the pesticide era began.[25]

Several non-gamebird species considered by various authorities[19,24] to be rare or uncommon have been observed on the Marble Hill site. At least one pair of pileated woodpeckers was observed frequently on the wooded slopes above the Ohio River. Although the Marble Hill site is within the sharp-shinned hawk's breeding range,[19] Monroe[24] describes the species as being very rare in summer near Louisville, Kentucky, with no breeding record. Uncommon species of warblers breeding on the site include the blue-winged warbler, prairie warbler, hooded warbler, Louisiana waterthrush, prothonotary warbler, and the black and white warbler. All of these warblers were found in the ecotone, floodplain, riparian woods, and/or east-slope woods along the north and east boundaries of the site; the black and white warbler was also found in the upland woods.

Mammals

The mammals sampled by the applicant or considered by the staff on the basis of distribution maps as likely to occur at Marble Hill or in the transmission-line areas are listed in Appendix B (Table B.13); a number of interest to hunters and trappers are discussed below.

The white-tailed deer is the largest game animal in the area. It has a home range of about one mile (1.6 km). It is a browser that eats twigs and shrubs in forest areas and grass, soybeans, and corn in farmed areas. The deer's favored habitat is edge environment of the type prevalent on the Marble Hill site.

The eastern cottontail rabbit is Indiana's number-one game animal. It feeds on a wide range of plants including apple, willow, dogwood, hickory, sumac, clovers, corn, and soybeans. It lives in heavy brush, strips of forest with open areas nearby, and weed patches, so the Marble Hill site furnishes good habitat. Population densities are generally in the range 0.25 to 3 per acre (0.6 to 8 per hectare).

The gray squirrel and fox squirrel do not interbreed, and may exclude each other. Both live in trees and feed on nuts and fruits, but the fox squirrel may also feed on birds' eggs. Of the 1.3 million squirrels bagged by hunters in Indiana each autumn, only 300,000 grays are taken, in part because they are more difficult to hunt.[26] The red squirrel is also found in the area but is generally considered to be too small to be a worthwhile game animal.

Muskrats live along or in rivers, streams, drainage ditches, marshes, lakes, and ponds. They are normally vegetarians eating mainly cattails; however, they will eat fish, frogs, and other muskrats. A quarter-million pelts are taken by trappers in Indiana each winter; most mink are taken in conjunction with trapping efforts for muskrat.

About 170,000 raccoons are taken annually in Indiana. The raccoon is omnivorous, dens up in hollow trees, rock crevices, or ground burrows, and is seldom found in densities greater than one per acre (about 2 per hectare).

Fur bearers hunted or trapped to a lesser extent, or for control purposes, are foxes, woodchuck, coyote, beaver, and opossum.

Protected Species

Five species of animals on the current Federal list[27] of endangered, threatened, or status-undetermined species could exist on the Marble Hill site or along the transmission and railroad rights-of-way.

The Indiana bat (*Myotis sodalis*) is listed as endangered.[27] Large groups of this bat hibernate in caves during the winter; several thousand use the Wyandotte Caves about 50 miles (80 km) southwest of the site.[29] Although there are no caves on the site itself, there are several caves within one mile (1.6 km) of the proposed transmission corridors. During the spring and summer the bats leave the caves and the females form small (20-30 individuals) groups, called nursery colonies, to raise their young, generally under the loose bark of trees. The Indiana bat is best classified as crepuscular (feeds at dusk and dawn) in activity and forages totally on insects, usually in the crowns of tall trees near small streams. The riparian-woods habitat along the north side of the site could contain one or more nursery colonies. Although none were caught during the 24 hours of mist-net sampling on the site, Indiana bats have been recorded frequently in Jefferson County and other counties of southeastern Indiana. Because of the bat's very restricted habitat requirements and its similarity in appearance to the little brown bat, an expert would be required to determine if the bat does indeed inhabit the site. However, there is no critical habitat on the site nor in the proposed transmission corridors, because the critical habitat is in caves (See Section 4.3.1.1).

Both the southern bald eagle (*Haliaeetus leucocephalus leucocephalus*) and the peregrine falcon (*Falco peregrinum anatum*) are listed as endangered species.[27] The peregrine falcon, which is presently being reintroduced in several areas of New England, is strictly a transient of this area and is quite rare. Although southern bald eagles do not breed in southeastern Indiana, juveniles frequently winter along large rivers such as the Mississippi and Ohio.

The osprey (*Pandion haliaetus*) and the eastern pigeon hawk (*Falco columbarius columbarius*) are listed as status-undetermined species,[27] which indicates they could be endangered or threatened but that not enough is known to determine their proper status. The osprey is a transient in southeastern Indiana and one or more ospreys were observed on the site during the ecological survey and listed as a "species repeatedly observed and assumed to be a resident or migrant consistently using the site" (ER, Table 2.7-240). The pigeon hawk is also a transient of this area and is very rare.

On the basis of published literature,[28,29] there are four species of mammals on the Indiana list of rare or endangered mammals that may inhabit the Marble Hill site or the transmission and railroad rights-of-way. They include the Indiana bat, the big-eared bat (*Plecotus rafinesquii*), the badger (*Taxidea taxus*), and the bobcat (*Lynx rufus*).

The big-eared bat is found in the forested regions of the southern U. S., including southern Indiana. In the summer, nursery colonies are most frequently found in badly dilapidated buildings; males are generally solitary and can be found in hollow trees, in crevices behind loose bark, and in buildings. During the winter, the bats generally hibernate in caves or similar shelters. The big-eared bat emerges late in the evening to feed on insects caught in flight.

Badgers live in open country, such as grass lands and open prairies;[30] they may dig out burrows of ground squirrels or woodchucks, or dig their own burrows to live in. Badgers are active at night, and occasionally during daylight hours, feeding mainly on ground squirrels, woodchucks, and meadow mice. No badgers were found on the site during the applicant's field studies.

The bobcat frequents wooded areas along rivers and streams, especially timbered bluffs and slopes.[30] Broken country with open areas provides ideal foraging ground for the bobcat, because mice, rabbits, squirrels, birds, and insects abound there. A bobcat den may be located under a log, within a fallen or standing hollow tree, under a rocky overhang, or sometimes in a dense thicket. Bobcat tracks and scat were found on the site during the ecological studies. The staff considers the site to be excellent habitat for bobcat because of the forested areas on the site and in its vicinity.

2.7.2 Aquatic

2.7.2.1 Aquatic Habitats

Construction and operation of the proposed Marble Hill Station will affect the fauna and flora of the Ohio River, Little Saluda Creek, and 51 offsite streams crossed by proposed new transmission lines and railroad spur. Since the completion of the lock and dam system in 1929, the Ohio River has been changed from a lotic (fast-moving water) to a lentic (slow-moving water) ecosystem through a series of impoundments or pools. The proposed station will be located at River Mile (RM) 570 of the McAlpine Pool, which extends from Markland Dam at RM 532 to McAlpine Dam at RM 607. Because of their reduced flow and impounded nature, these pools are similar to reservoirs and contain aquatic biota typical of this type of lentic ecosystem. The Ohio River will be the source of makeup water and receiver of discharge water for the Marble Hill Station.

Little Saluda Creek is a small intermittent tributary to the Ohio River. It lies in the northern portion of the site and receives drainage from much of the site. It has several riffle and pool areas with fauna and flora more typical of lotic ecosystems.

The 51 offsite streams (see Table 2.11) are quite variable in their characteristics with some being intermittent (Harberts Creek and Brush Creek) and others having a constant flow (Muscatatuck River and Vernon Fork).[31] These 51 streams are located to the west, north and northwest of the site (see Sec. 3.7, Fig. 3.10) and will be crossed by the proposed transmission lines and railroad spur for the Marble Hill Station. The aquatic biota within these 51 streams should be typical of lotic ecosystems.

2.7.2.2 Aquatic Biota

The data on aquatic biota giving species and/or species groups present and their relative abundances limit the staff to a qualitative identification of the dominant communities and important species in the Ohio River and Little Saluda Creek, including those species most likely to be impacted by the proposed station. Data on fish standing crops and relative abundances in the offsite streams crossed by the proposed new transmission lines were not supplied (ER, Supp. 1, pp. 46-47) so that impacts of construction and maintenance of these lines on aquatic biota may not be quantitatively assessed. However, in view of the small aquatic impacts expected in both the onsite and offsite cases, the staff considered that sufficient information was available to assess impacts or to set conditions to protect the biota. (See Section 4.3.2, 5.3.3.6 and 5.5.5)

Phytoplankton

The applicant identified 269 species of phytoplankton (ER, Table 2.7-29) from March 1974 through February 1975, including many identified in previous studies on the Ohio River near the station site.[32-35] In the Ohio River, phytoplankton is comprised predominantly of diatoms with *Cyclatella* spp. (September), *Melosira* spp. (May-August and October-February), and *Navicula* spp. (March and April) being dominant. Seilheimer[36] and Riley[37] indicated that in 1960, 1962, and 1966, respectively, diatoms were the dominant phytoplankters, with *Melosira* spp. being the most abundant species group. In Little Saluda Creek, *Cyclotella* spp. and *Navicula* spp. were the dominant species groups in March, *Gomphonema* spp. in April, *Navicula* spp. and *Stephanodiscus* spp. in May, *Achnanthes* spp. in June and August, and *Navicula* spp. in July.

Phytoplankton standing-crop estimates in Table 2.12 and productivity measurements (C^{14} uptake, ER, Table 2.7-25) indicate that the Ohio River is more productive than Little Saluda Creek. These C^{14} values and those of Seilheimer[36] indicate that productivity values in the Ohio River reach levels typical of eutrophic waters (300-1000 mgC/m^2-day) while those in Little Saluda Creek are typical of oligotrophic waters (30-100 mgC/m^2-day).[38] Peak productivity occurred during August in the Ohio River and during December in Little Saluda Creek (ER, Table 2.7-25).

Only limited phytoplankton data are available for streams to be crossed by the transmission lines and railroad spur. A study[39] by the Indiana State Board of Health in 1972 on the Muscatatuck River near Austin, Indiana, indicated that phytoplankton densities (see Table 2.13) are similar to those observed in Little Saluda Creek (see Table 2.12). Unlike Little Saluda Creek, however, non-diatom orders such as the Chlorophyta (green algae) were at times as abundant as diatoms. *Cyclotella* spp. were the most abundant diatom group and *Chlorella* spp. the most abundant non-diatom group.

Zooplankton (excluding ichthyoplankton)

Studies funded by the applicant identified 77 species of zooplankters in the Ohio River and Little Saluda Creek (ER, Tables 2.7-30 through 2.7-42), including crustaceans, protozoans, and rotifers, typically found in faster flowing rivers and streams. In the Ohio River, protozoans were dominant in January-April, whereas rotifers predominated in May-December (except July) and crustaceans in July. In Little Saluda Creek the most abundant species groups were rotifers (November-January), protozoans (February-March) and crustaceans (April-October). Studies on the Ohio River by WAPORA[32-34] support the applicant's findings with regard to rotifers; however, no aaprotozoans were noted. Seilheimer[36] found that protozoans were dominant in all (except June) of his 1962 Ohio River samples; rotifers were the second most abundant group.

Zooplankton densities observed by the applicant (see Table 2.14) indicate that July and August are the months of peak abundance. Densities in the Ohio River are higher than those in Little Saluda Creek and indicate that this river is fairly productive. These density figures are similar to those in other studies[32-34] completed near the plant site in 1970-1971, 1972, and 1973. No studies regarding zooplankton densities and composition for any of the 51 offsite streams were found.

Table 2.11. Streams that Will Be Crossed by the Transmission Lines and Railroad Spur from the Marble Hill Nuclear Generating Station to the Columbus and Rush Substations, by County

Columbus Line[a]	Rush Line[a]	Railroad Spur[b]
Bartholomew County	Decatur County	Jefferson County
Brush Creek	Creek	West Fork Fourteen Mile Creek
Hill Ditch	Righthand Fork	East Fork Fourteen Mile Creek (Main stem and 4 branches)
	Salt Creek (2 branches)	
Jackson County		Scott County
Sand Creek	Jefferson County	West Fork Fourteen Mile Creek
	Big Creek	
Jefferson County	Big Saluda Creek	
East Fork Fourteen Mile Creek	Camp Creek	
West Fork Fourteen Mile Creek	Chicken Run	
East Fork Muscatatuck Creek	Goose Creek	
Hog Creek	Harberts Creek	
Lewis Creek (main stem and 2 branches)	Hensley Creek	
Little Caney Fork	Middle Fork Creek	
	Ramsey Creek	
Jennings County	Thompson Branch	
Fowler Branch	Turkey Branch	
Mutton Creek		
Six Mile Creek	Jennings County	
Slate Creek	Big Graham Creek	
Storm Creek	Brush Creek	
Tea Creek	Finch Creek	
Vernon Fork Muscatatuck River	Otter Creek	
Scott County	Ripley County	
Woods Fork	Creek	
	Flatrock Creek	
	Honey Creek	
	Leatherwood Creek	
	Sugar Creek	
	Rush County	
	Bull Creek	
	South Fork	

[a] Derived from Tables A and B of the ER, Supplement No. 1, pp. 135-136.

[b] Based on telephone conversation with the applicant.

Table 2.12. Monthly Density and Biomass of Phytoplankton on the Indiana Side of the Ohio River near River Mile 570 and in Little Saluda Creek, March 1974-February 1975

Month	Density (number/l)		Biomass (μg/l)	
	Ohio River[a]	Little Saluda Creek	Ohio River[a]	Little Saluda Creek
Mar	3,387,000	387,000	5.12	0.32
Apr	1,100,000	1,293,000	1.54	1.19
May	1,218,000	116,000	0.85	< 0.01
Jun	2,351,000	237,000	1.49	< 0.01
Jul	255,000	16,000	0.25	< 0.01
Aug	2,148,000	470,000	1.57	0.04
Sep	460,000	0	0.29	0.00
Oct	2,178,000	0	0.92	0.00
Nov	4,175,000	19,000	2.03	< 0.01
Dec	594,000	2,000	0.39	< 0.01
Jan	150,000	0	0.11	0.00
Feb	147,000	4,000	0.14	< 0.01

Derived from Table 2.7-28 of the applicant's ER.

[a]Average values for 5 stations.

Table 2.13. Monthly Densities for Various Phytoplankton Groups in the Muscatatuck River near Austin, Indiana, during 1972

Month	Number/liter					Dominant Genera
	Blue-Greens	Diatoms	Flagellates	Greens	Total	
January	60,000	320,000	40,000	20,000	440,000	*Cyclotella* spp.
February		540,000		320,000	860,000	*Cyclotella* spp.
March		100,000		80,000	180,000	
April	440,000	1,520,000		920,000	2,880,000	*Chlorella* spp.
May		80,000	20,000	60,000	160,000	*Chlorella* spp.
June		140,000		220,000	360,000	*Chlorella* spp.
July		100,000	20,000	40,000	160,000	
August		320,000	20,000	500,000	840,000	*Chlorella* spp.
September		540,000	20,000	300,000	860,000	*Cyclotella* spp.
October		100,000		120,000	220,000	*Chlorella* spp.
November		20,000		40,000	60,000	
December		80,000		60,000	140,000	

From "Indiana Water Quality, 1972," Indiana State Board of Health, Indianapolis, Indiana, 116 pp.

Table 2.14. Monthly Density of Zooplankton on the Indiana Side of the Ohio River near River Mile 570 and in Little Saluda Creek, March 1974-February 1975

	Density (number/l)		
	Ohio River[a]		Little Saluda Creek
Month	Surface	Subsurface	Surface
Mar	3.7	4.2	0.6
Apr	9.3	8 7	8.1
May	52.7	45.0	4.3
Jun	52.6	74.0	25.4
Jul	252.0	291.1	56.9
Aug	199.2	142.1	134.2
Sep	43.3	62.9	11.3
Oct	86.6	124.3	16.1
Nov	65.5	63.9	2.0
Dec	16.8	16.4	2.7
Jan	9.7	13.1	12.1
Feb	17.4	19.9	10.7

Derived from Table 2.7-44 of applicant's ER.

[a]Average values for 5 stations.

Periphyton

Eighty-six species of periphyton, typical of impounded waters, were identified by the applicant in the Ohio River, using artificial substrates (ER, Table 2.7-45). Diatoms always represent more than 86% of the periphyton collected on artificial substrates. The number of periphyton/cm^2 in the discharge area (see Sec. 6.1.5.2, Fig. 6.2, Stations 3 and 4) ranged from 545 x 10^6 in April to 4351 x 10^6 in August (ER, Table 2.7-50). No data were found concerning periphyton in Little Saluda Creek and the 51 offsite streams but the staff made its assessment on the basis of the environmental conditions imposed on the construction of transmission lines across these streams (Sections 4.5.2 and 11.2.17).

Benthos and Macroinvertebrates

Sixty-five species of benthic organisms, typical of riverine ecosystems, and 42 species of macroinvertebrates have been identified by the applicant (ER, Tables 2.7-53 and 2.7-54, respectively), as have 34 benthic and 36 macroinvertebrate species in the Ohio River and 41 benthic and 14 macroinvertebrate species in Little Saluda Creek. Table 2.15 is a summary of the applicant's benthic data from the proposed discharge area of the Ohio River and riffle and pool areas in Little Saluda Creek.

The incomplete Ohio River benthic data only indicate that oligochaetes (*Liminodrilus* spp. and *Branchiura sowerbyi*) are dominant during March and the pelecypod (*Corbicula manilensis*) during October. Insects (0.009 g/m^2 in December--0.448 g/m^2 in August) and amphipods (0.018 g/m^2 in October) were the most abundant macroinvertebrates collected in the discharge area (Stations 3 and 4) of the Ohio River.

A list of freshwater mussels occurring in the discharge area (Station 3) of the Ohio River is given in the ER (Table 2.7-71). Using a crowfoot bar, 6.99 kg of mussels, predominantly *Amblema costata* (6.74 kg), were collected at this station in July and 6.25 kg, predominantly *A. costata* (4.37 kg) and *Proptera alata* (1.85 kg), in October (ER, Table 2.7-72).

In Little Saluda Creek, benthic data were sufficient to indicate seasonal trends in biomass for riffle and pool areas. Insects (*Diptera*, *Plecoptera*, and *Trichoptera*), isopods (*Lirceus* sp.), and gastropods (*Physa gyrina*) were the most abundant groups in all samples. The greatest insect

Table 2.15. Average Biomass Estimates for Benthic Organisms in the Proposed Marble Hill Nuclear Generating Station Discharge Area of the Ohio River and in Little Saluda Creek from March 1974 to February 1975

	Biomass (g/m^2)													
	Ohio River[c]				Little Saluda Creek									
					Mar[f]		Jun[f]		Sep[g]		Oct[g]		Dec[f]	
Taxa	Mar[a]	Oct[b]	Jan[d]	Feb[e]	Pool	Riffle	Pool	Riffle	Pool	Riffle	Pool	Riffle	Pool	Riffle
Oligochaeta	0.822	0.114	0.122	0.153			3.086						0.392	0.058
Hirudinea			0.015											
Turbellaria								2.912	0.229			0.401		
Insecta	0.036	0.095	0.241		0.258	3.668	2.445	0.10				0.515	0.955	0.088
Isopoda	0.038			0.045	2.942	0.764	8.080	4.125	18.775	14.096	7.411	4.183	8.566	8.788
Amphipoda	0.159	0.229	0.531	0.076	0.277		0.612				0.535	0.382	0.335	1.108
Gastropoda		10.696	0.031		0.420		13.284		7.965	19.826	0.936	0.344	0.115	1.675
Pelecypoda	0.331	2499.300	272.840	32.737							0.076		0.067	
Total	1.386	2510.434	273.780	33.011	3.897	4.432	27.507	7.047	26.969	33.922	9.034	5.825	10.430	11.717

Derived from Tables 2.7-55, 2.7-56, 2.7-58, 2.7-59, and 2.7-61 to -64 of the ER.

[a] Average of two samples at Station 3 and one at Station 4.

[b] One sample at Station 3.

[c] No data for June or September.

[d] Average of three samples at Station 3 and two at Station 4.

[e] Average of two samples at Station 3 and one at Station 4.

[f] Average of two pool and two riffle samples.

[g] One sample only.

biomass occurred in the riffle areas during March (3.67 g/m^2) and in the pool areas during June (2.44 g/m^2). The isopod *Lirceus* sp. was most abundant in riffle and pool areas in September (14.10 and 18.78 g/m^2, respectively); and the gastropod *Physa gyrina* in pool areas during June (13.28 g/m^2) and riffle areas during September (19.83 g/m^2). The isopod *Lirceus* sp. also accounted for 85% (0.37 g/m^2) and 98% (0.039 g/m^2) of the average macroinvertebrate biomass in Little Saluda Creek during June and October, respectively (ER, Tables 2.7-67 thru 2.7-69).

Although the benthic and macroinvertebrate data were quite limited (because of vandalism of artificial substrates, ER, p. 2.7-26), it appears that the Ohio River discharge area has more biomass per unit area than Little Saluda Creek, whereas the creek has a greater species diversity. No data on benthos and macroinvertebrates for the 51 offsite streams were located during a literature search by the staff.

Ichthyoplankton

A total of 510 fish eggs and 1213 fish larvae were collected during a 51-hour sampling at five stations located along a transect across the Ohio River in the area of the proposed intake between March and the end of July 1974 (ER, Tables 2.7-94 and 2.7-95). The greatest number of eggs and larvae were found at mid-depth and one meter off the bottom where lower current velocities were recorded. Although the eggs were not identified, the applicant stated that most of those collected during May and June (about 50% of the total) were about the size (0.75 mm) reported for gizzard shad (*Dorosoma cepedianum*). Many of the fish larvae were identified to at least the family level and were predominantly the young of forage and rough fishes; Catostomidae (e.g., white sucker, *Catostomus commersoni*), Cyprinidae (e.g., emerald shiner, *Notropis atherinoides*) and Sciaenidae (e.g., freshwater drum, *Aplodinotus grunniens*) accounted for 92% (1110/1213) of the larvae collected. Of these three families, the Sciaenidae represented 82% (991/1213) of the larvae.

An entrainment study[40] carried out in 1975 at the Robert A. Gallagher Power Plant on the Ohio River just below Louisville, Kentucky, found that 97.8% (about 134,000,000) of fish eggs and larvae entrained were gizzard shad and freshwater drum. Other species included bluegill (*Lepomis macrochirus*) and gar (*Lepisosteus* sp.). This and the applicant's studies concur in that most of the spawning in the Ohio River occurs from early spring to early summer, because eggs and larvae are absent in March and diminish rapidly at the end of July. No ichthyoplankton samples were taken in Little Saluda Creek or the 51 offsite streams.

Fish

Forty-one species of fish were collected by the applicant (see Table 2.16). Thirty-three species (mostly forage and rough fishes) were found in the McAlpine Pool of the Ohio River and eleven (mostly forage fishes) in Little Saluda Creek. Only three species, bluegill, emerald shiner, and green sunfish (*Lepomis cyanellus*), were common to both ecosystems. Emerald shiner (44.7%) and gizzard shad (36%) accounted for 81% of the total Ohio River catch and blacknose dace represented 61% of the fish collected from Little Saluda Creek. Very limited data (a species list) on the fish in streams crossed by the transmission lines are available in the ER, Supplement No. 1, pp. 46-47. A 1971 study by the Indiana Department of Natural Resources[41] identified 61 species in the Muscatatuck Watershed (see Table 2.17). (Several of the streams crossed by the transmission lines are in this watershed.) Four of the 61 species, bluntnose minnow (*Pimephales notatus*), common shiner (*Notropis cornutus*), longear sunfish (*L. megalotis*), and stoneroller (*Campostoma anomalum*), represented about 76% of the total catch in the Indiana study. Additional species (not listed in either the ER or the Indiana study) that may occur in the Ohio River, Little Saluda Creek, and the 51 offsite streams are included in Table C.1 of Appendix C. As many as 77 species may occur in the Ohio River and 137 species may occur in the streams crossed by the transmission and railroad spur corridors.

Historical Changes in the Fish Fauna. There has been a shift in the fish species composition in the Ohio River since the 1800s. Most game species (e.g., lake sturgeon) have decreased markedly in abundance, while less desirable species (e.g., carp) have increased since the turn of the century. In 1894 carp represented only 0.7% of the commercial catch, but currently averages 25%. Collectively, buffalo, carp, and catfishes made up 70%, 80%, and 90% of the commercial catch in 1960, 1962, and 1963, respectively.[42] The decrease in abundance of game fish took place even though commercial fishing has been limited to catfish and rough species.

Table 2.16. Total Numbers and Relative Abundance of Fish Collected from the Indiana Side of the Ohio River near River Mile 570 and from Little Saluda Creek by all Sampling Methods, March 1974-January 1975

Species	Ohio River		Little Saluda Creek		Total	
	Numbers	Rel. Abund.[a] (%)	Numbers	Rel. Abund. (%)	Numbers	Rel. Abund. (%)
Emerald shiner	599	44.7	2	1.3	601	40.4
Gizzard shad	482	36.0			482	32.4
Blacknose dace			91	60.7	91	6.1
Longnose gar	33	2.5			33	2.2
Skipjack herring	29	2.2			29	1.9
River carpsucker	27	2.0			27	1.8
Sauger	22	1.6			22	1.5
Bluegill	7	0.5	14	9.3	21	1.4
Freshwater drum	17	1.3			17	1.1
Bluntnose minnow			14	9.3	14	0.9
White bass	14	1.0			14	0.9
Sand shiner			13	8.7	13	0.9
Channel catfish	11	0.8			11	0.7
Spotted bass	11	0.8			11	0.7
Redhorse (?)	10	0.7			10	0.7
Green sunfish	7	0.5	2	1.3	9	0.6
White crappie	9	0.7			9	0.6
Carp	8	0.6			8	0.5
Goldeye	8	0.6			8	0.5
Largemouth bass	8	0.6			8	0.5
Bullhead minnow			7	4.6	7	0.5
Shiner (?)	7	0.5			7	0.5
Spotted sucker	6	0.4			6	0.4
Smallmouth buffalo	5	0.4			5	0.3
Smallmouth bass	4	0.3			4	0.3
Creek chub			3	2.0	3	0.2
White sucker	3	0.2			3	0.2
Black crappie	2	0.1			2	0.1
Rainbow darter			2	1.3	2	0.1
Bigmouth buffalo	1	0.1			1	0.1
Blue catfish	1	0.1			1	0.1
Common shiner			1	0.7	1	0.1
Flathead catfish	1	0.1			1	0.1
Goldfish	1	0.1			1	0.1
Longear sunfish	1	0.1			1	0.1
Mooneye	1	0.1			1	0.1
Mosquitofish			1	0.7	1	0.1
Pumpkinseed	1	0.1			1	0.1
Rockbass	1	0.1			1	0.1
Walleye	1	0.1			1	0.1
Yellow perch	1	0.1				0.1
Total	1339		150		1489	
Number of species	33		11		41	

Derived from Table 2.7-76 of the applicant's ER, Supplement No. 1. Numbers of fish collected (23) in Squaw Creek are not included.

Relative abundance is equal to the total number collected of a given fish species divided by the total number collected of all fishes.

Table 2.17. Relative Abundance, Average Standing Crop and Frequency of Collection of Fish Collected from Several Stations in the Muscatatuck Watershed, 1971

Species	Relative Abundance %	Average Standing Crop[a] (kg/hectare)	Collection Frequency %
Longear sunfish[b]	9.13	23.47	100.0
Golden redhorse	1.72	13.86	72.2
Bluntnose minnow	49.14	11.89	100.0
Carp	0.10	3.39	27.8
Common shiner	11.68	6.98	83.3
Rock bass[b]	1.31	8.38	66.7
Stoneroller	6.22	5.08	66.7
Smallmouth buffalo	0.03	0.02	16.7
Largemouth bass[b]	0.14	0.83	33.3
Green sunfish[b]	1.29	6.98	72.2
River carpsucker	0.07	0.26	27.8
ellow bullhead[b]	0.44	6.48	77.8
Bluegill[b]	1.22	4.14	72.2
Gizzard shad	0.33	0.28	27.8
Smallmouth bass[b]	0.29	6.66	55.6
Spotted bass[b]	0.36	4.33	77.8
Spotted sucker	0.47	1.48	44.4
White crappie[b]	0.17	0.82	33.3
White sucker	0.25	2.55	44.4
Bigeye chub	3.39	1.29	61.1
Tadpole madtom	0.21	0.27	27.8
Creek chub	0.83	1.36	44.4
Northern hog sucker	0.33	1.08	38.9
Bigeye shiner	3.29	1.02	66.7
Quillback	0.01		5.6
Logperch	0.35	0.73	50.0
Silverjaw minnow	2.32	0.52	44.4
Grass pickerel	0.09	0.89	38.9
Hybrid sunfish[b]	0.06	0.68	33.3
Freshwater drum	0.02	0.52	16.7
Brindled madtom	0.58	0.42	44.4
Black bullhead[b]	0.09	0.97	11.1
Black crappie[b]	0.02	0.13	16.7
Steelcolor shiner	0.42	0.09	11.1
Longnose gar	0.01		5.6
Warmouth[b]	0.04	0.20	33.3
Channel catfish[b]	0.05	0.04	16.7
Creek chubsucker	0.02	0.55	11.1
Silver shiner	0.56	0.16	50.0
Greenside darter	0.37	0.13	66.7
Rainbow darter	0.76	0.15	61.1
Redfin shiner	0.56	0.15	72.2
Pumpkinseed[b]	0.01	0.18	11.1
Blackside darter	0.17	0.04	33.3
Spotfin shiner	0.14		11.1
Brook silverside	0.14	0.06	61.1
Fantail darter	0.22	0.03	27.8
Johnny darter	0.19	0.03	44.4
Orangespotted sunfish	0.01	0.13	5.6
Suckermouth minnow	0.05	0.03	22.2
Flathead catfish[b]	0.04	0.09	11.1
Pirate perch	0.01	0.02	16.7
Slenderhead darter	0.04	< 0.01	5.6
Eastern sand darter	0.04	< 0.01	11.1
Blackstripe topminnow	0.01	0.01	11.1

SEE FOOTNOTES AT END OF TABLE.

Table 2.17. (Continued)

Species	Relative Abundance %	Average Standing Crop[a] (kg/hectare)	Collection Frequency %
rthern studfish	0.01	0.01	5.6
ıgnose minnow	< 0.01	< 0.01	5.6
allid shiner	< 0.01	< 0.01	5.6
rangethroat darter	< 0.01	< 0.01	.6
hestnut lamprey	0.01		5.6
American brook lamprey	< 0.01		5.6
Total	99.85	119.9	
Game species total	14.66	64.40	

From W. J. Zook, "Muscatatuck River Watershed Fisheries Investigations Report, 1971," Indiana Department of Natural Resources, Indianapolis, Indiana, 1972, 52 pp.

[a]Based only on Stations 1-15 of the above report.

[b]Game species.

These changes may be related to at least two major changes in the river system: an increase in turbidity caused by industrialization and farming, and a series of locks and dams completed in 1929. Buffalo, carp, and catfishes adapt well to turbid impounded waters and have increased in numbers. Largemouth bass, sauger, walleye, and other fish mentioned above do not adapt well to turbid impounded waters and their numbers have decreased. The decrease in freshwater drum is difficult to explain, because they normally do well in turbid waters and their preferred habitat is in open-water areas.[43] Except for the catfishes, this change represents a shift from an abundance of game fish to an abundance of "rough" (less desirable) species.

More recent studies done by ORSANCO[35] and EPA[44] indicate that the overall standing crop of fish in the McAlpine Pool of the Ohio River (RM 532-607) has increased (see Table 2.18); gizzard shad (228.7 kg/hectare), freshwater drum (98.5 kg/hectare), carp (36.2 kg/hectare), and channel catfish, *I. punctatus* (33.0 kg/hectare) represented 99% of the noted increase in standing crop between the 1957-1959 and 1968-1970 studies and now represent 92% of the standing crop. Aside from the channel catfish, the bluegill was the only game fish to show an increase (0.04 kg/hectare). Decreases were observed in three forage species: skipjack herring, *Alosa chrysocholoris* (56.7 kg/hectare); emerald shiner (15.4 kg/hectare); and silver chub, *Hybopsis storeriana* (1.5 kg/hectare); and one game fish, flathead catfish, *Pylodictis olivaris* (1.2 kg/ hectare). Overall, the data in Table 2.18 indicate that standing crop increased in six species and decreased in four species. These changes in the Ohio River indicate that the fish fauna have changed from those typical of rivers to those more typical of reservoirs.[45] In summary, sport fishing is poor and commercial fishing is not good enough to be profitable.

Major changes in fish fauna in the 51 offsite streams are not apparent, based on a study of the fish fauna of the Muscatatuck watershed between 1942 and 1971. An additional six species (0.05% of the total number), not present in 1942 or 1954-1959, were noted in 1971 (see Table 2.17). These were the American brook lamprey (*Lampetra lamottei*), blackstripe topminnow (*Fundulus notatus*), chestnut lamprey (*Ichthyomyzon castaneus*), northern studfish (*F. catenatus*), pallid shiner (*N. amnis*), and pumpkinseed (*L. gibbosus*)--all considered nonedible except the pumpkinseed.[37]

General Life-History Features. In the Ohio River, forage and rough fish are the predominant species (see Table 2.18), whereas forage and game species are the most abundant in the offsite streams (see Table 2.17). Forage fish include "minnows" (blacknose dace, *Rhinichthys atratulus*, bluntnose minnow, common shiner, emerald shiner, and stoneroller) and "herring" (gizzard shad and skipjack herring). The emerald shiner, gizzard shad, and skipjack herring are the dominant forage fish in the Ohio River with the other-named species being dominant in the offsite streams. These forage species generally feed on benthic organisms, detritus, periphyton, phytoplankton, and zooplankton.[46] Because forage fishes convert energy from lower trophic levels into energy that can be utilized by higher trophic levels, they are essential to many predaceous species, including game fish that depend heavily on these fish as a food source.

Rough fish are very abundant in the Ohio River and are generally considered undesirable because of poor flesh quality, competition with more desirable species, and destruction of the habitat of more desirable species. Carp and freshwater drum are the dominant rough fish species in the Ohio River (see Table 2.18), and they feed on benthic invertebrates, detritus, plant material, and zooplankton.[46,47] They feed mainly on or near the bottom by touch and taste. In order to get food, the carp is known to disturn sediments, causing local increases in turbidity. This makes the water unsuitable for fish that feed visually, e.g., game species.[48]

Game fish are very abundant in the streams to be crossed by the transmission lines. Bluegill, green sunfish, longear sunfish, rock bass (*Ambloplites rupestris*), smallmouth bass (*M. dolomieui*), spotted bass (*M. punctulatus*), and yellow bullhead (*I. natalis*) are the dominant species in these streams (see Table 2.17). These species are actively sought because of their high quality flesh, size, and/or aggressiveness. Many are visual feeders and feed on benthic organisms, fish, and zooplankton.[46] Greater abundance of game fishes in the offsite streams compared to the Ohio River is probably to be attributed in part to better water quality, abundance of forage fishes, and small populations of rough fish.

Because a shallow underwater terrace, about 50 feet (15 m) wide, exists in the proposed discharge area (ER, Supp. 1, p. 32 and Fig. 2.5-1A), it is likely that fish spawn there.[45] Preferred spawning temperatures of several of the species known to occur in the Ohio River or the 51 offsite streams are listed in Table 2.19 and in the ER, Table 2.7-96.

Life-history features of the various fish families are presented in Appendix 2G of the ER. Specific food categories based on stomach analyses of certain fishes collected are given in Table 2.7-84 of the ER.

Table 2.18. A Comparison of the McAlpine Pool, Ohio River, Fish Fauna in 1957-1959[a] and in 1968-1970[b] (river miles 532-607)

Species	Fish/Acre/Effort		Weight of Fish (kg/hectare/effort)		Relative Abundance		Change in Standing Crop
	1957-1959	1968-1970	1957-1959	1968-1970	1957-1959	1968-1970	
Gizzard shad	1686.5	1275.[illegible]	193.41	422.19	29.2	57.7	+
Freshwater drum	498.9	457.3	26.50	124.99	8.6	20.7	+
Emerald shiner	3148.0	204.5	15.91	0.48	54.5	9.2	-
Channel catfish	74.8	84.3	13.77	46.73	1.3	3.8	+
Skipjack herring	125.1	62.7	60.90	4.20	2.2	2.8	-
Longnose gar	0.7	17.3		29.26	< 0.1	0.8	?
Carp	26.2	16.6	16.02	52.15	0.4	0.8	+
Bluegill	4.2	16.6	0.08	0.12	0.1	0.8	+
Silver chub	100.7	15.8	1.52	0.04	1.7	0.7	-
American eel	0.1	13.0		1.81	< 0.1	0.6	?
White crappie	0.6	13.0		3.22	< 0.1	0.6	?
River carpsucker	2.6	6.5		7.94	< 0.1	0.3	?
Longear sunfish	1.5	4.3		0.13	< 0.1	0.2	?
Sauger	0.4	4.3		1.75	< 0.1	0.2	?
Flathead catfish	5.2	3.6	1.65	0.42	0.1	0.2	-
Redear sunfish		3.6		0.04		0.2	?
Smallmouth buffalo	4.5	2.9	0.64	5.38	0.1	0.1	+
Smallmouth bass	0.1	1.4		0.10	< 0.1	0.1	?
Spotted bass	0.3	1.4		0.16	< 0.1	0.1	?
Black crappie	0.3	0.7		0.01	< 0.1	< 0.1	?
Rock bass	0.2	0.7		0.16	< 0.1	< 0.1	?
Threadfin shad	1.3	0.7		0.03	< 0.1	< 0.1	?
Highfin carpsucker		1.4		1.46		0.1	?
Goldfish		0.7		1.46		< 0.1	?
Walleye		0.7		0.2[illegible]		< 0.1	?
Others	97.2		5.98				
Total	5779.4	2209.5	336.38	704.46			

[a]"Aquatic Resources of the Ohio River," Ohio River Valley Sanitation Commission, Cincinnati, Ohio, 1962, 218 pp.

[b]"Ohio River Fish Study--McAlpine Lock and Dam (M. P. 607.0)," U. S. Environmental Protection Agency, Wheeling, West Virginia, 1968-1970, 1 p.

Table 2.19. Spawning Temperatures of Some of the Fishes Known to Occur in the Southeastern Portion of Indiana, Including the Ohio River

Species	Temperature, °F
Sauger	41.0
Walleye	44.6
Longnose gar	51.4
White bass	53.1
Least darter	53.6
Spotted sucker	55.0
White sucker	53.6-55.4
Silvery minnow	55.4
White crappie	57.2-60.8
Fathead minnow	57.9
Bigmouth buffalo	60.1-64.9
Largemouth bass	60.1
Common shiner	60.1-64.9
Golden shiner	60.1
Green sunfish	60.1
Paddlefish	60.8
Blackside darter	61.7
Gizzard shad	62.1
Spotted bass	64.0
Johnny darter	64.4
Orangespotted sunfish	64.9
Smallmouth bass	65.7
Smallmouth buffalo	66.0
Black buffalo	66.0
Carp	66.2
Bluegill	66.9
Channel catfish	68.0
White catfish	68.0
Pumpkinseed	68.0
Black crappie	68.0
Brook silverside	68.0
Brown bullhead	70.0
Threadfin shad	70.0
Warmouth	70.0
River redhorse	71.1-75.9
Blue catfish	72.0
Flathead catfish	72.0
Freshwater drum	73.4
Redear sunfish	73.4
Longear sunfish	73.9
River carpsucker	75.0

From EPA, "Water Quality Criteria, 1972." Report #EPA-R3-73-033, Washington D. C., 1973, 594 pp.

Commercial and Sport Fisheries. Presently, no important commercial fishery exists in the McAlpine Pool of the Ohio River. Fish populations of potential commercial value are apparently not large enough to warrant commercial operation; therefore, the National Marine Fisheries Service no longer keeps commercial catch statistics on this stretch of the Ohio River (ER, Supp. 1, p. 45).

Sportfishing is the main fishery on both the Ohio River and the streams to be crossed by the transmission lines. More aggressive and edible game species such as sauger and walleye are not very abundant in the Ohio River (see Table 2.18). According to a creel census done by the applicant, carp, catfish, freshwater drum, and "bass" are the species most often caught by Ohio River fishermen (ER, Table 2.7-88). This probably reflects the historic increase in the former species and a decrease in the latter species. In some states, carp and freshwater drum are considered rough fish, and programs have been established to reduce their populations in order to help increase the population sizes of more desirable game species.[50] It is likely that, if species such as sauger and walleye were more abundant, fishermen would prefer them over carp and freshwater drum.

Special-Status Fishes. As indicated in Appendix C (Table C.1) several species that occur or may occur in the Ohio River and the 51 offsite streams deserve special consideration due to their reduced population sizes. Lake sturgeon, which may occur in the Ohio River and its larger tributaries, is protected nationally.[51] Trout-perch (*Percopsis omiscomaycus*) and longhead darter (*Percina macrocephala*), both of which may occur in the Ohio River and its tributaries, are protected by Kentucky law.[52] The Tippecanoe darter (*Etheostoma tippecanoe*) may occur in some of the 51 offsite streams; however, it is protected only by Kentucky.[52] The remaining species, including the sauger and walleye, have been recommended for legal protection in both Indiana and Kentucky waters.[63]

2.7.3 Transmission Corridors and Railroad Spur

The applicant has not sponsored studies to provide data sufficient for an adequate characterization of the ecology of the transmission corridors and railroad spur right-of-way. On the basis of limited data available from other sources the staff can indicate only in a general manner:

(1) terrestrial biota (flora and fauna) of the area through which the transmission lines and railroad spur will pass,

(2) composition of the forest to be cut, and

(3) protected (e.g., endangered) species habitats crossed.

The two 765-kV corridors (conservatively assumed 250 ft or 83 m wide) and the 345-kV corridor (conservatively assumed 150 ft or 45 m wide) will require a total of about 3475 acres (1390 hectares), based on a length of about 115 miles (185 km). Cropland, pasture, roadway, and nonforested idle land represent 2365 acres (947 hectares); typical crops of the area include corn, soybeans, wheat, and hay. The remaining 1110 acres (444 hectares) are deciduous forest, and may include some pastured forest.

The railroad spur right-of-way (conservatively assumed 200 ft or 60 m wide) will require a total of about 250 acres, based on a length of about ten miles. Cropland, pasture, roadway, and non-forested idle land represent 200 acres, with the remaining 50 acres being deciduous forest.

Most of the forested land in southeastern Indiana is a commercial oak-hickory type, with some areas of maple-beech-birch. The ecological characteristics of the community are assumed to be similar to the mixed-woods community of the site, described in Section 2.7.1.1.

Tables B.10 through B.13 in Appendix B list vertebrate species that might be found along the proposed transmission and railroad rights-of-way. All of the protected (e.g., endangered) species recorded by the applicant or indicated by the staff to occur on the site itself may also occur along the transmission and railroad routes.[19,28,29]

2.8 SOCIAL AND ECONOMIC PROFILE

Impact area characteristics are discussed in terms of population, housing, the economy, government structure, and community facilities and services. The focus of this section will be on Jefferson County where, it is expected, the critical impacts of plant construction and operation will occur. Construction-related impacts occurring outside Jefferson County are expected to be slight. However, impacts from the operation of a nuclear facility located at Marble Hill may also be felt in neighboring Floyd and Clark Counties.

2.8.1 Population, Housing and the Economy

2.8.1.1 Population

In 1970, Jefferson County had a population of 27,006 and a density of 73.8 persons per square mile. More than 52% of the County's population is concentrated in two areas: the City of Madison and the town of Hanover. The remaining population is distributed among scattered farms and settlements located at the junctions of county roads.

Planning studies in 1971 and 1973 projected a population growth of 24% by 1990 in Jefferson County, as shown in Table 2.20. The urbanized areas are expected to grow most rapidly, with population increases by 1990 of 39% in Hanover Township and 25% in Madison Township.[54]

TABLE 2.20

POPULATION GROWTH BY TOWNSHIP

TOWNSHIP	1970	1980	1990
Graham	1,262	1,385	1,541
Hanover	3,738	4,395	5,202
Lancaster	1,345	1,483	1,651
Madison	15,628	17,434	19,519
Milton	818	711	678
Monroe	398	430	472
Republican	1,061	1,213	1,337
Saluda	1,236	1,359	1,430
Shelby	705	670	675
Smyrna	815	853	948
TOTAL	27,006	29,993	33,453

SOURCE: Vogt, Sage and Pflum Consultants, Comprehensive Plan Report: Jefferson County, Indiana (n.p., 1973), p. 8.

2.8.1.2 Housing

The 1970 Census indicated 8,554 year-round housing units in Jefferson County, with a median value of $13,000. Nearly 75% of these were owner-occupied. Among those units listed as vacant, almost 2/3 were for rent (see Table 2.21).[55] Between December 1970 and January 1976, permits were issued for 1163 housing units including 270 mobile homes (see Table 2.22).[56] The one-family units had an average value (exclusive of land) of $25,000.

Recent residential development has occurred primarily in Hanover and Madison Townships. These areas are the most likely to experience residential development in the future because they can be provided with sanitary sewers and water supply more easily than the other townships.[57]

2.8.1.3 The Economy

The shift in population from farm to urbanized areas has paralleled a change in the County's employment structure which has shifted from agricultural to nonagricultural industries, particularly since 1950. In 1970, over 30% of Jefferson County's labor force, or 3,090 workers, were employed in manufacturing compared with 430 farmers and agricultural laborers (see Table 2.23). Dominating the occupational distribution are operatives; craftsmen and foremen; clerical workers; and service workers (see Table 2.24). Each of these categories has increased in the past two decades while other categories have remained stable or declined.[58]

TABLE 2.21

HOUSING CHARACTERISTICS IN JEFFERSON COUNTY AND THE STATE OF INDIANA: 1970

	Jefferson County	Indiana
Occupancy, Tenure, Financial Characteristics		
Year-Round Units	8,554	1,711,868
Occupied Units	7,890	1,609,494
% Owner-Occupied	74.9	71.6
Median Value[1]	$13,000	$13,800
Mediam Contract Rent[2]	$ 67	$ 83
Condition		
Substandard Occupied Units[3]	927	87,859
% Substandard	11.7	5.5
Substandard Vacant Units	268	22,822
% Substandard	40.4	22.3
Vacancy Status		
Total	664	102,374
For Sale	98	15,037
For Rent	216	41,176
Other	350	46,161

Source: U. S. Department of Commerce, Bureau of the Census, 1970 Census of Housing, General Housing Characteristics: Advance Report, HC (v1)-16 Indiana (Washington, D.C.: Government Printing Office, 1971), pp. 5 and 15.

1. Limited to one-family homes on less than 10 acres and no business on the property.

2. Excludes one-family homes on 10 acres or more.

3. Substandard is defined as the absence of some or all plumbing facilities.

TABLE 2.22

RESIDENTIAL BUILDING PERMITS ISSUED IN
JEFFERSON COUNTY: 1971-1975

	Structure Type			
Year	1-family	Multi-Family	Mobile	Total Units*
1971	175	4	59	284
1972	138	4	69	217
1973	151	3	37	191
1974	153	3	83	244
1975	170	7	22	227
TOTAL	787	21	270	1,163

Source: "Annual Report of Building Permits Issued for New Residential Construction" for 1971 to 1975 from files of Jefferson County Plan Commission and City of Madison Building Inspector's Office.

* The number of multi-family units was estimated from the value recorded on the building permit.

TABLE 2.23

INDUSTRY OF EMPLOYED PERSONS: 1970

Industry	Number
Agriculture, Forestry, and Fisheries	433
Mining	19
Construction	369
Manufacturing	3,093
Transportation, Communications, Utilities	672
Wholesale Trade	267
Retail Trade	1,600
Business Services	333
Personal and Household Services	1,629
Government and Others	1,487
Total	9,9[illegible]

Source: U. S. Department of Commerce, Bureau of the Census, 1970 Census of Population, General Social and Economic Characteristics, PC (1), Indiana, C-16 (Washington, D.C.: Government Printing Office, 1972), p. 514.

TABLE 2.24

OCCUPATION OF INDIVIUALS IN
LABOR FORCE: 1970

Occupation	Number
Professional, technical and kindred workers	1,218
Managers and administrators, except farm	841
Sales workers	515
Clerical and kindred workers	1,351
Craftsmen, foremen and kindred workers	1,460
Operatives, except transport	1,780
Transport equipment operatives	426
Laborers, except farm	411
Farmers and farm managers	332
Farm laborers and farm foremen	69
Service and private household workers	1,499
Total	9,902

Source: U. S. Department of Commerce, Bureau of the Census, 1970 Census of Population, General Social and Economic Characteristics, PC (1), Indiana, C-16 (Washington, D.C.: Government Printing Office, 1972), p. 506.

All of the 36 manufacturing firms in the County are located in or near the City of Madison. The most recent additions to Madison's manufacturing firms -- Conn Organ, Rex Chainbelt, Reliance Electric, Grote Manufacturing, Madison Plastics -- have located on the plateau above "Old Madison."[59] Other large scale employers in Jefferson Country include the Jefferson Proving Ground, Indiana Kentucky Electric, the Madison State Hospital, and Hanover College. Table 2.2-18 (ER p. 2.2-34) provides a comprehensive list of industry within 10 miles of the Marble Hill site. Future industrial development is expected to locate in North Madison, both within and outside the corporate limits of the city.[60]

The recession has had a particularly harsh effect on Jefferson County. Between June 1975 and January 1976, unemployment rose from 12.1% to 12.7%. Not only is this upward trend contrary to national unemployment patterns, but the level in Jefferson County is considerably higher than the average rate throughout the State (8%).[61]

Madison attracts many tourists because of its historic and architectural resources. It has been estimated that 147,000 annual out-of-state visitors spent $2.3 million in a recent year for food, lodging, recreation and other services.[62]

2.8.2 Government Structure and Community Facilities and Services

2.8.2.1 Government Structure

Jefferson County is composed of 10 townships, 3 towns (Brooks, Dupont, Hanover) and 1 city (Madison). Each of these jurisdictions has tax levying powers. Currently, the tax rate in the County ranges from a low of $6.49/$100 of assessment in Hanover Town to a high of $8.99/$100 in Madison City; Saluda Township, the location of the proposed Marble Hill Station, has a 1976 rate of $6.62/$100.

2.8.2.2 Community Services and Facilities

2.8.2.2.1 Schools

Education is provided by two independent school districts in the County. The Madison Consolidated School System serves the following townships: Graham, Lancaster, Madison, Milton, Monroe and Shelby. Total enrollment in 1975-1976 was 4270, or an 18% underutilization of existing classroom space (see Table 2.25).[63] Southwestern Jefferson Consolidated Schools which serves Smyrna, Hanover, Republican and Saluda Townships had a 1975-1976 enrollment of 1,693 which represents 85% of capacity.[64] In addition to public school facilities, North Madison is the location of an elementary school and a high school operated by the Catholic Church. Enrollment during the 1975-1976 school year was 458, or 28% below planned capacity.[65]

2.8.2.2.2 Water Supply

Residents of Jefferson County receive drinking water from one of three sources: the City of Madison, Hanover College, and private wells. The Madison system supplies water to six distribution systems in widely dispersed areas of the County. During 1975, customers of the Madison System consumed an estimated 2.3 million gallons of water per day at peak which is approximately 62% of effective capacity (see Table 2.26).[66] In addition to providing for its own needs, the wells at Hanover College supply water to more than 500 customers in the Town of Hanover. In 1975, peak daily consumption amounted to an estimated one-half million gallons, or 57% of effective capacity.[67]

Both the Hanover and Madison systems are interconnected to provide additional water in emergency situations.[68] Residents not connected to either of these systems drill deep wells.

2.8.2.2.3 Sewage Treatment Systems

Jefferson County has three sewage treatment systems, serving the towns of Hanover and Dupont and the City of Madison. All other municipalities and areas of the County are served by private septic tanks. The Madison sanitary sewer system has a design capacity of 3.5 million gallons per day. Present treatment averages 2 million gallons per day (see Table 2.27).[69] The Hanover system which serves both the College and the Town of Hanover has a rated capacity of 540,000 gallons per day and is treating 230,000 gallons per day.[70] The Dupont system consists of one pumping unit and serves only part of the town.[71]

Solid waste in the County is disposed of at the sanitary landfill site just outside the City of Madison. Recent estimates indicate that the site has a useful life of 5 to 10 years.[72] Rubbish and garbage collection is provided to all communities in Jefferson County by the City of Madison and several small private operators.[73]

2.8.2.2.4 Police

Police services in Jefferson County are provided by State, county, and municipal agencies. Staffing and equipment of the State and city forces have been judged to be adequate for the present population; county forces may be considered understaffed. The Indiana State Police Post at Versailles, 34 miles from the proposed Marble Hill site, includes 27 troopers, each with a radio equipped patrol car. The County Sheriff's Department staff includes the sheriff, four deputies and one matron, all of whom work fulltime. The City of Madison has a force of 23 full-time men and six radio-equipped patrol cars. Although the City is adequately protected, this force cannot be considered a resource for county-wide protection; the Madison police have no jurisdiction outside the incorporated Madison area. A new Jefferson County jail has been constructed; this facility should meet contemporary standards of size and space allocation.[74]

TABLE 2.25

ENROLLMENT AND CAPACITY IN SCHOOL SYSTEMS

System/School	Grades	1975-1976 Enrollment	Planned Capacity	Surplus (Deficit)
Madison Consolidated				
Canaan	K-6	110	120	10
Central	K-6	279	400	121
Deputy	K-6	167	215	48
Dupont	K-6	172	325	153
Eggleston	K-6	263	350	87
Michigan Road	K-6	232	270	40
Middleton	K-6	251	350	99
Muncie	K-6	662	860	198
Jr. High	7-9	1,168	1,200	32
Sr. High	10-12	966	1,100	134
Sub-Total		4,270	5,190	922
Southwestern				
Elementary	K-6	911	N.A.	N.A.
Jr. High	7-9	425	N.A.	N.A.
Sr. High	10-12	357	N.A.	N.A.
Sub-Total		1,693	1,947*	254
Parochial				
Pope John XXIII	K-8	334	425	91
Shawe Memorial	9-12	124	210	86
Sub-Total		458	635	177
TOTAL		6,421	7,772	1,353

Source: Enrollment and capacity figures were supplied by school system officials; additional capacity information is given in James and Berger Associates, Base Studies: Jefferson County Comprehensive Plan (n.p., 1971), p. PF-45.

N.A. - Data not available.

* Letter from Mr Issac Hogg, Superintendent of Southwestern Jefferson County Consolidated School, to Ms. Sue Ann Curtis, Argonne National Laboratory, 25 August 1975.

TABLE 2.26

WATER SUPPLY SYSTEMS IN JEFFERSON COUNTY: 1975

	Madison	Hanover
Pump Ratings	(2) 1,000 gpm (2) 850 gpm	600 gpm 325 gpm 300 gpm
Design Capacity	5,328,000 gpd	1,764,000 gpd
Estimate Effective Capacity[1]	3,729,600 gpd	1,234,800 gpd
Average Daily Consumption	1,848,200 gpd	425,000 gpd
Estimated Peak Consumption[2]	2,310,250 gpd	531,250 gpd
Excess Capacity	1,419,350 gpd	703,550 gpd

Source: Mr. Charles Keller and Mr. Thomas Champion of the Madison Utilities Office; Mr. Wilbur Heitz of the Hanover College maintenance department; and USNRC staff estimates.

1. Effective capacity is assumed to represent 70% of design capacity.

2. Peak consumption is assumed to be 125% of average daily consumption.

TABLE 2.27

SEWAGE TREATMENT SYSTEMS IN MADISON AND HANOVER: 1975

	Madison	Hanover
Design Capacity	3,500,000 gpd	540,000 gpd
Estimated Effective Capacity*	2,450,000 gpd	378,000 gpd
Treatment	2,000,000 gpd	245,000 gpd
Excess Capacity	450,000 gpd	133,000 gpd

Source. Mr. Charles Keller of the Madison Utilities Office; Mr. James Long of the Hanover Town; and USNRC staff estimate.

*Effective capacity is assumed to represent 70% of design capacity.

2.8.2.2.5 Fire Protection

Nine fire departments serve Jefferson County. Among the eight departments that serve outside the City of Madison, there are 142 men, all serving on a volunteer basis, and 21 fire trucks. The City of Madison Volunteer Fire Department operates six stations and has a membership of over 200 active volunteers. These stations have a working agreement to provide additional protection to the Town of Hanover and all outlying small communities.[75] As discussed in the Base Studies report of 1971, fire fighting resources are substandard due to problems of communication, equipment deficiencies, and service area limitations.[76]

2.8.2.2.6 Hospitals

The principal source of hospital services in Jefferson County is the 130-bed King's Daughter's Hospital, a private non-profit organization located in Madison. During 1975, the hospital provided service to 5,000 patients and achieved an occupancy rate of 74%. Current comparisons of hospital service in Jefferson County with those prevailing throughout the United States and the State of Indiana indicate that county residents presently have adequate hospital facilities and services (see Table 2.28). An application has been approved by State officials for the demolition of the existing non-fireproof south wing and the construction of a three-story 30-bed wing that will also contain laboratories, an emergency room, and other ancillary facilities.[77]

Also, Jefferson County is served by Scott County Memorial Hospital which has 62 beds and an 82% occupancy rate, and Clarke County Memorial Hospital, a 234-bed facility with a 77% occupancy rate (E.R. Supp. 1, p. 2.2-3). Emergency ambulance service is provided by five mortuaries -- three in Madison, and one each in Hanover and Dupont -- which have a total of 10 vehicles. All areas of the County are within the 25-mile maximum running distance standard recommended by the Indiana State Board of Health.[78] Each of the ambulances is available on a 24-hour basis and is equipped with oxygen and first aid equipment.[79]

2.8.2.2.7 Recreation Facilities

Only a small fraction of the land in the area surrounding the proposed site is used for recreation. The major recreational areas of Jefferson County are centered in Clifty Falls State Park, Hardy Lake State Reservoir, Madison, and Hanover. Clifty Falls State Park has 1357 acres of land and offers facilities for camping, fishing, riding and hiking. In 1975, the yearly attendance at the park was 214,400 persons; the addition of new swimming facilities may increase attendance by 1976 or 1977 (ER, Enclosure 1). Hardy Lake Reservoir, which is used for water-related sports, includes 2100 acres (850 hectares) of recreational land. Jefferson County also contains many smaller private recreational facilities. Table 2.29 lists the major recreational facilities in the Madison-Hanover area and their availability to the public. There are no designated hunting areas within 10 miles of the site, although the area provides good habitat for wildlife.

The McAlpine Pool, between Markland and McAlpine Davis on the Ohio River, is an important recreational resource for boating and sport fishing. The quality of sport fishing on the Ohio River has been poor in recent years (see Section 2.7.2.2).

Special events in the Madison area are listed in Table 2.2.2-19 of the ER. In addition, the Hanover College offers a community concert and theatrical season. These activities, particularly those in the Madison area, are an attraction for tourists.

PSI has constructed a public information center in the City of Madison which features displays on the history of Madison and on the Marble Hill Nuclear Generating Station. The facilities of the center are available for use by community groups (ER, p. 8.1-8).

2.8.2.8 Road Systems

Within Jefferson County, the principal access routes are U.S. 421 and State Roads 7, 56, 62, and 107 (see Section 2.2.2). These routes are classified as rural minor arterials and are in good condition.[80] Recent studies by the Indiana State Highway Commission indicate that the Madison-Hanover corridor is heavily-traveled with routes 107 and 62 carrying at least 5000 vehicles during an average day.[81]

2.9 REGIONAL AND LOCAL LANDMARKS

2.9.1 Region

Several sites of historic importance located within 10 miles (16 km) of the Marble Hill Station are listed in Table 2.3-1 of the ER.

TABLE 2.28

SERVICE COMPARISONS FOR SHORT-STAY GENERAL MEDICAL AND SURGICAL HOSPITALS: 1974

	Population* Per Hospital Bed	Population* Per Hospital Personnel	Hospital Personnel Per Bed
Jefferson County	213	123	1.7
Indiana	205	96	2.1
United States	223	91	2.5

Sources: American Hospital Association, Guide to the Health Care Field, 1975 Edition (Chicago: American Hospital Association, 1975), pp. 18, 84-89.

*Population information from U.S. Department of Commerce, Bureau of the Census, Current Population Reports: Population Estimates and Projections, Series P-25, "1973 Population and 1972 Per Capita Income Estimates for Counties, Incorporated Places, and Selected Minor Civil Divisions in Indiana," No. 559 (Washington, D.C.: Government Printing Office, 1975), pp. 1 and 11; and U.S. Department of Commerce, Bureau of the Census, Current Population Reports: Population Characteristics, Series 20, "Household and Family Characteristics: March 1975," No. 291 (Washington, D.C.: Government Printing Office, 1976), p. 1.

TABLE 2.29

RECREATIONAL FACILITIES IN THE MADISON-HANOVER AREA

Name of Facility	Activities	Availability
Madison Country Club	Golf, picnicking, swimming	Private
Madison Golf Area	Golf	Public
Clifty Golf Range	Golf	Public
Kelly's Landing	Boating	Private
Madison Marina	Boating	Private
Bennett's Boating	Boating	Private
Weaver's Dock	Boating	(not known)
Clifty Creek Recreational Area	Boating, swimming, field sports	Private
Hanover Beach	Swimming, summer homes	Private
Hanover Town Park	Field sports, picnicking	Public
Madison City Park	Field sports, picnicking	Public
Madison Playgrounds	17 play areas	Public
Delta Queen	Sightseeing river tours	Public

Source: James & Berger Associates, Base Studies: Jefferson County Comprehensive Plan (n.p., 1971), pp. REC 5-8.

In general, most of these historic sites are near Madison, Indiana, although a few additional sites are listed for the towns of Hanover, Indiana; Milton, Kentucky; and Bedford, Kentucky. This list includes two Madison areas that are also recorded in the National Register of Historic Places and one State museum.[82] In addition, Historic Madison, Incorporated, has preserved several buildings that are open to the public.

Within 10 miles (16 km) of the station site, there is a series of scenic and natural areas so designated by Jefferson County. These locations are shown in Figure 2.3-2 of the ER and include waterfalls, caves, and forests.

The nearest scenic locations in the National Registry of Natural Landmarks[83] are Officer's Woods and the Ohio Coral Reef (Falls of the Ohio). The Woods are about 12 miles and the Falls about 25 miles from the site.

2.9.2 Site

The site of Marble Hill Station has some areas of scenic as well as cultural-historical importance. Esthetically, the northern portion of the site is very attractive, and the white pine forest in this location is unique to the general region (ER, pp. 2.3-2a).

The site also includes an early 19th-century cemetery, two 19th century houses of Federal-style architecture, and evidence of prehistoric settlement. Twelve archeological sites are reported to be within and adjacent to the station property (ER, App. 2A). Several of these sites are recorded as being very early in the archeological sequence of Eastern North America.

The State Preservation Officer has been contacted and his comments are summarized as follows: (1) this project does not affect any sites now listed in the National Register; (2) any archeological sites uncovered by construction activities should be evaluated by an archeologist and salvaged as needed; and (3) the historical and architectural value of two 19th-century buildings on the station site should be investigated (ER, App. 2B).

Since the DES was issued, the buildings on the site have been examined by a consultant of the applicant who concluded that the buildings did not possess significant historical or archeological values. The Indiana Historic Preservation Officer, on reconsideration, concurred with this assessment.[84]

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84. Letter received on June 1, 1976, to Mr. B. J. Youngblood from Mr. J. D. Cloud of the Indiana Department of Natural Resources.

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3. STATION DESCRIPTION

3.1 EXTERNAL APPEARANCE

Most of the Marble Hill facilities will be constructed on a leveled plateau with a base elevation of about 775 feet (236 m) MSL, about 350 feet (105 m) above the normal level of the Ohio River. The principal structures of the station will be:

(1) the turbine building (containing two steam turbine-generators and associated equipment),

(2) two reactor containments (each housing a pressurized-water reactor and associated reactor coolant system),

(3) the solid radioactive waste storage and service building,

(4) the auxiliary building,

(5) the fuel storage and handling building,

(6) two banks of 25-cell mechanical-draft cooling towers,

(7) a conventional electrical switchyard, and

(8) an administration building.

In addition to these structures there will be two mechanical-draft cooling towers for essential service-water cooling located above a concrete reservoir that will store water for the ultimate heat sink. Several water storage tanks for emergency back-up cooling, refueling, and potable water will be located north and south of the central complex along with three biocide (NaOCl) storage tanks and a fuel oil tank. Other facilities will consist of a train washdown shed associated with the fuel storage and handling building, transmission towers and lines, and a river screenhouse and blowdown discharge structure on the Ohio River (PSAR, Fig. 1.2-2). There will also be a 250-space parking area (ER, Fig. 4.1-1). Figure 3.1 shows the site layout. An artist's rendition of the station is given in Figure 3.2, but may not accurately represent the overall appearance of the station when completed.

The station complex will be of a unified architectural design. The turbine building, auxiliary building, and fuel storage building will form a "T" shape with the turbine and fuel storage buildings at the top and the auxiliary building at the base flanked by the two reactor containment buildings. Adjoining the turbine building will be the service and solid radwaste storage building. Housing for each reactor unit will be 150 feet (45 m) in diameter and will extend 200 feet (60 m) above grade elevation. The height of the turbine building will be 125 feet (38 m), with other adjoining buildings slightly lower. The central complex of buildings will be about 880 feet (270 m) long by 680 feet (210 m) wide at the maximum points.

Views of the structures from nearby locations will be obstructed by the existing forest vegetation, most of which will be preserved. The site itself will not be visible from any major transportation route or nearby communities.

3.2 REACTOR AND STEAM-ELECTRIC SYSTEM

The description of the reactor and steam-electric system that follows is brief and general because its purpose is to provide the descriptive basis for the assessment of environmental impacts. More detailed technical descriptions of this system are discussed in the applicant's PSAR, Sections 1.2, 4.0, and 10.0.[1]

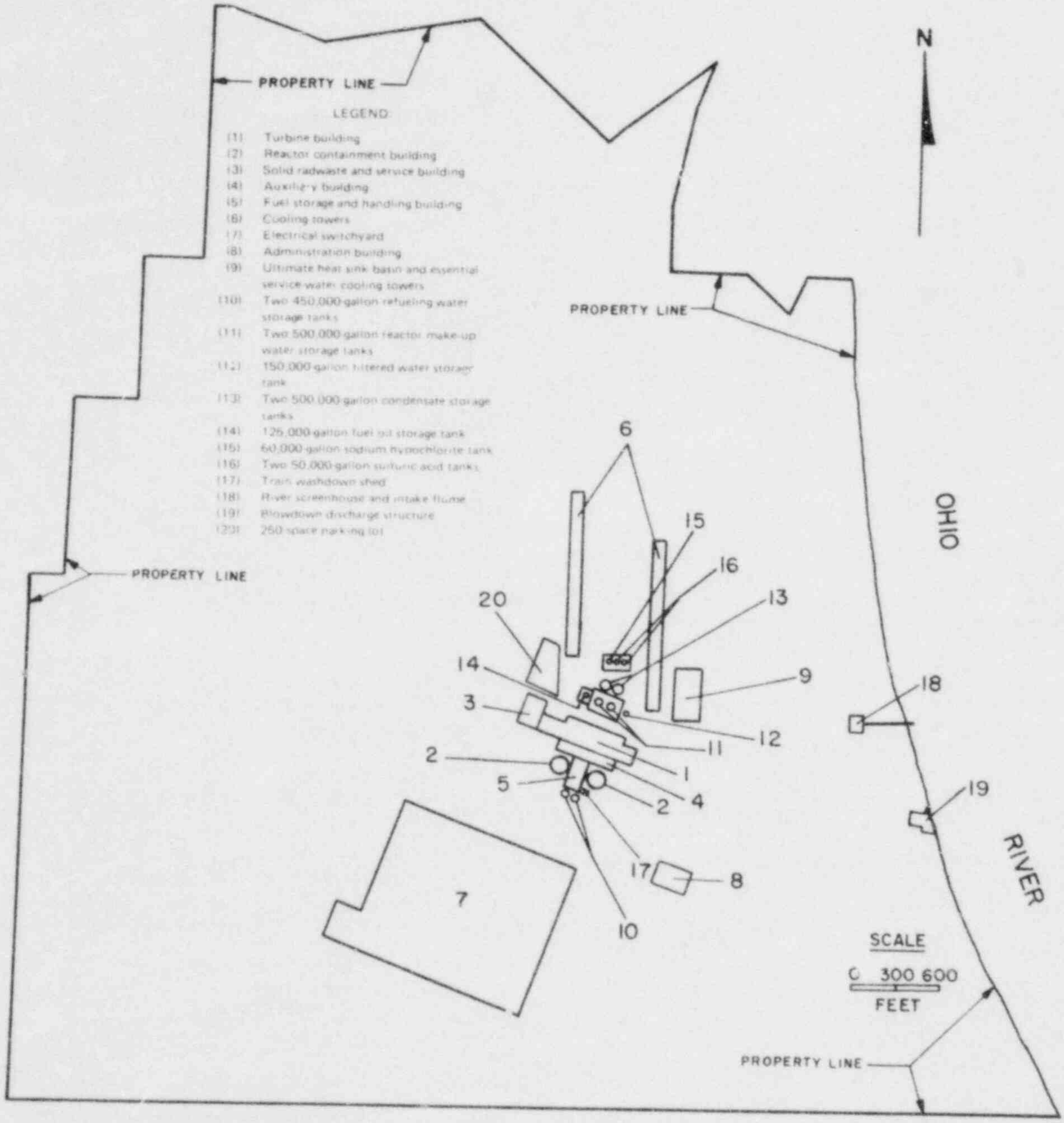

Fig. 3.1. Site Layout. Derived from ER, Fig. 4.1-1.

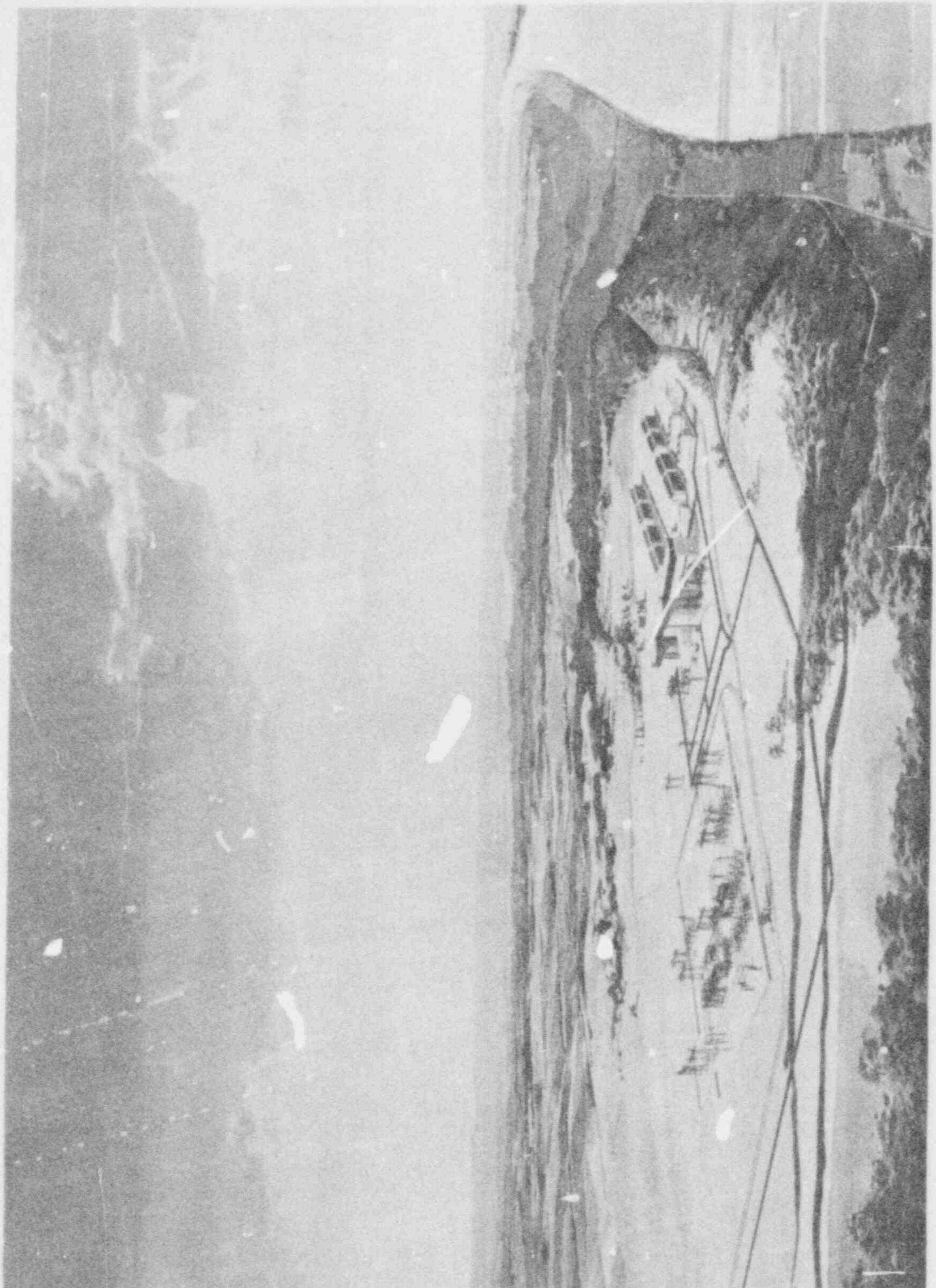

Fig. 3.2. Artist's Rendition of the Station.

3.2.1 Nuclear Reactors

The Marble Hill Nuclear Generating Station (Units 1 & 2) will utilize two Westinghouse Electric Corporation pressurized water reactors (PWRs). The generated steam will drive two tandem-compound 1800-rpm turbines, also of Westinghouse manufacture, each having one high-pressure and three low-pressure stages. Variations in turbine back pressure from winter to summer during normal operation are expected to range from 2.58 to 4.70 inches of mercury, absolute (0.87 to 1.6 newtons per square centimeter).

3.2.2 Fuel Description

Fuel used in the station reactors will consist of uranium dioxide ceramic pellets encapsulated under pressure in Zircaloy-4 fuel rods; U-235 enrichment of fuel rods is expected to vary from 2.1 to 3.1 percent, by weight. There will be 264 fuel rods in each fuel assembly, and each reactor core will consist of 193 fuel assemblies arranged in the shape of a cylinder. During routine operation about one-third of the fuel assemblies will be replaced each year.

3.2.3 Power Output

The gross power output of each unit is estimated at 3425 MWt or 1192 MWe, at rated capacity. Plant-related electrical consumption will be about 60 MWe. Thus, net power output will be about 1130 MWe per unit, 2260 MWe for the station. However, because the containment and engineered safety features are designed for a power rating of 3565 MWt, the analysis of radioactive discharges (see Sec. 3.5) is based on this maximum rating.

3.3 WATER REQUIREMENTS

At the Marble Hill Nuclear Generating Station water will be used in the circulating-water systems, the service-water systems, the steam-cycle makeup, and the potable-water system. A flow chart detailing predicted water usage is depicted in Figure 3.3.

The makeup water required for operation of the proposed generating station will be obtained from the Ohio River near the station site. Because the pool elevation at the site has been maintained at 420 ft (130 m) by the Corps of Engineers, no station outages resulting from lack of water are expected. At this elevation, the pool represents an abundant reservoir for the station's needs. The precise volume of required makeup water will be dependent primarily on the following factors:

(1) the amount of makeup water required to prevent scaling in the condensers and cooling towers, and

(2) the amount of water lost to evaporation and drift.

3.3.1 Circulating-Water System

The circulating water of each unit will flow in a closed-cycle cooling-water system that will dissipate heat from the steam condensers. When flowing through the condensers at a rate of 1263 cfs (35.76 m^3/sec) per unit the circulating water is expected to be warmed about 28°F (16°C). Reduction of the water temperature will be accomplished through evaporation and sensible heat transfer to the atmosphere by means of mechanical-draft cooling towers.

The estimated seasonal average evaporation rates for the mechanical-draft cooling towers have been estimated to range between 52.7 and 57.4 cfs (1.49 and 1.62 m^3/sec), depending on weather conditions. The losses from both banks of cooling towers due to drift will be about 0.53 cfs (0.015 m^3/sec), or 0.02% of the circulating-water flow. The blowdown necessary to maintain the total dissolved solids (TDS) level in the circulating-water system was calculated using these rates of evaporative and drift losses. Blowdown volume will vary between 7.9 and 9.9 cfs (0.22 and 0.28 m^3/sec) from spring to summer depending on the river condition and the evaporation rate. By varying the blowdown volume, the TDS level in the circulating-water systems can be maintained at 1500 mg/liter (a value chosen by the applicant to insure that condenser scaling does not occur). The highest blowdown volume will occur during the summer when evaporation rates are high. To compensate for losses due to evaporation, drift, and blowdown, makeup water at rates varying between 61 and 69 cfs (1.7 and 1.9 m^3/sec) will be withdrawn from the Ohio River. These figures for evaporation, drift, blowdown, and makeup have been calculated by the applicant based on two-unit operation at a 100% capacity factor. Variations in station water consumption are given in Table 3.1 for the following conditions: 100% operation, 50% operation, hot standby, and cold shutdown.

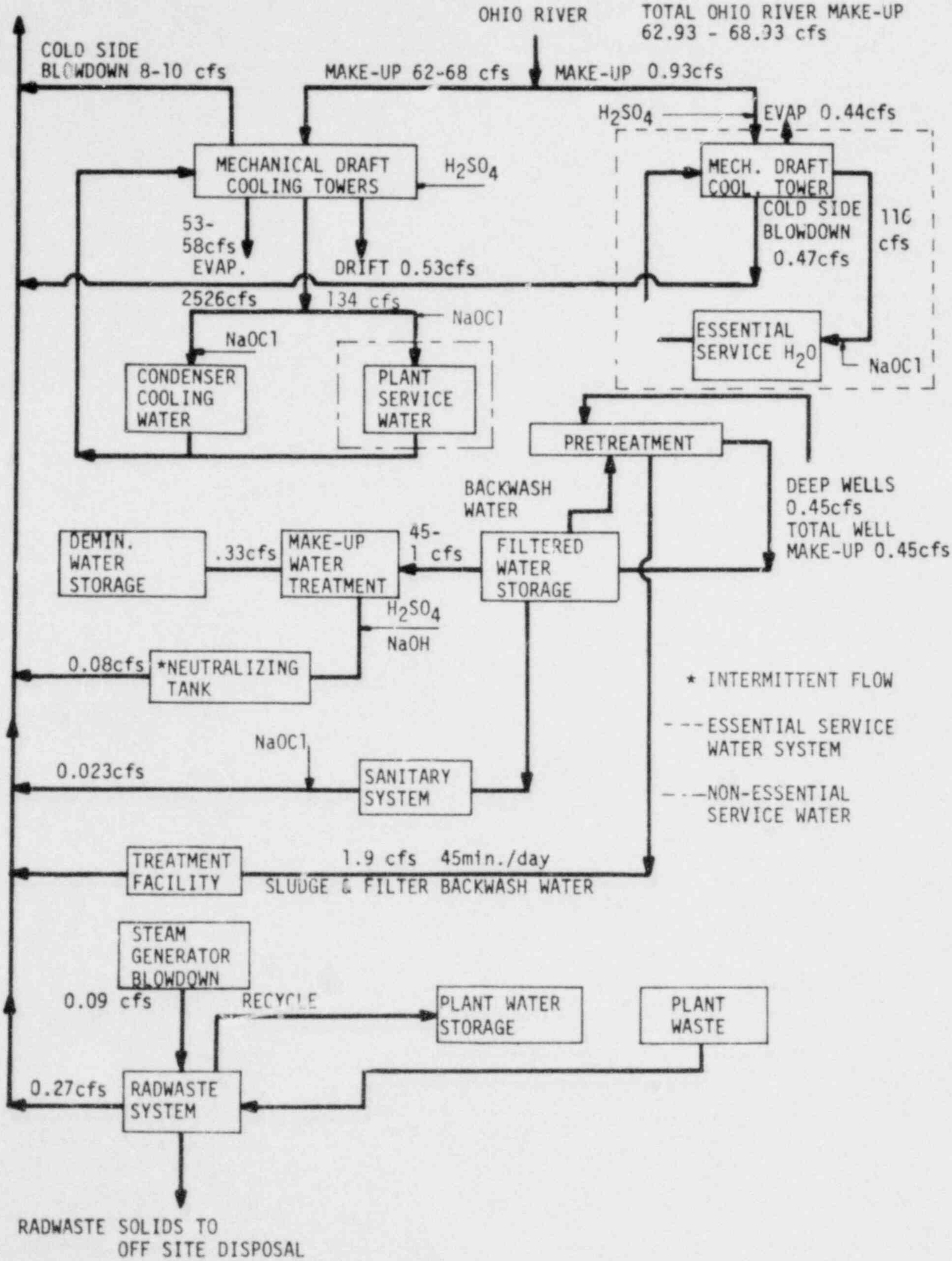

Fig. 3.3. Water Use Flow Diagram. From ER, Fig. 3.3-1.

Table 3.1. Variations in Station Water Use
(cfs, 2-unit operation)

	100% Operation	50% Operation	Hot Standby[a]	Cold Shutdown
Mechanical-Draft Cooling-Tower System				
Makeup	64.5	30.9	4.23	0
Blowdown	8.9	3.7	3.7	0
Evaporation	55.1	26.7	0	0
Drift	0.53	0.53	0.53	0
Sanitary System	0.023	0.023	0.023	0.023
Radwaste System[b]	0.58	0.58	0.58	0.58
Demineralizing System[c]				
Makeup to steam generator	0.33	0.17	0	0
Essential-Service-Water Cooling-Tower System				
Makeup	4[d]	4[d]	2.5	0
Blowdown	2[d]	2[d]	2.0	0
Evaporation	2[d]	2[d]	0.5	0
Drift	0	0	0	0

From ER, Table 3.3-2.

[a]Subject to operating variables.

[b]A major portion of this flow rate will be recycled; 3% will be lost as evaporated concentrates.

[c]The demineralizers will be designed to have a greater capacity to supply demineralized water during start-up conditions.

[d]Peak.

3.3.2 Nonessential-Service-Water System

The nonessential-service-water system cools equipment that is neither safety-related nor essential for safe reactor shutdown, such as the turbine-oil coolers, the sample coolers, and the vacuum-pump-oil cooler. The water, taken from the cold side of the cooling towers, will be supplied by two pumps, one for each unit. A full-capacity standby to serve either unit is also provided. This system requires a total flow of about 134 cfs (3.79 m^3/sec).

3.3.3 Essential-Service-Water System

The essential-service-water system (ESWS) cools safety-related equipment. The design provides for two identical, full-capacity systems for each unit. Each unit will have two full-capacity pumps, each of which will take water from a separate supply line. The equipment includes the diesel-generator coolers, the component-cooling heat exchangers, and other components necessary for safe reactor shutdown. The flow rate through this system will be about 57.9 cfs (1.64 m^3/sec) per unit. Two mechanical-draft cooling towers will cool this water. Makeup water for this cooling system will also come from the Ohio River. Blowdown from the ESWS will be combined with blowdown from the circulating-water-system cooling towers.

3.3.4 Sanitary-Water System

The potable-water system will provide water for sanitary purposes. Water will be obtained from wells on the floodplain. The water will be filtered and pumped into a 150,000-gallon (570-m^3) water storage tank. From this tank, 15,000 gallons (57 m^3) per day will be drawn for final processing through a chlorination and water-softening treatment system. Discussion of sanitary water and its disposal is provided in Section 3.6.3.

3.4 HEAT-DISSIPATION SYSTEM

3.4.1 Cooling System

When operating at full power the station will produce 1.65×10^{10} Btu/hr (4840 MW) of waste heat that will be transferred to the cooling water circulating at 2660 cfs or 75.33 m^3/sec (2526 cfs or 71.54 m^3/sec through the condensers and 134 cfs or 3.79 m^3/sec from the nonessential-cooling-water system). The temperature rise of the cooling water passing through the condensers will be about 28°F (16°C). Most of the waste heat will be dissipated to the atmosphere via mechanical-draft cooling towers.

Each of the two banks of mechanical-draft cooling towers will be about 60 feet (18 m) high, 1200 feet (365 m) long, 50 feet (15 m) wide and will consist of 25 cells. Figure 3.4 shows the important parts of two typical types of mechanical-draft cooling towers that would meet the required performance characteristics (the final design of the towers has not been chosen at this time).

Six circulating-water pumps are used to pump warmed water from the condenser into the top of the tower. The water is allowed to flow by gravity through a fill material; this serves to slow the falling water and to break it into small droplets, greatly increasing the time and area of contact of the water with the air. Most of the cooling results from evaporation of a small portion of the circulating water, but sensible-heat transfer by conduction to air also contributes to the cooling process.

Air is circulated by a fan located at the top of the tower. Drift eliminators placed inside the tower trap water droplets so that the volume of liquid lost from the tower (drift) compared to that of the circulating water is extremely small ($\leq$ 0.02%).

In Table 3.2 are listed the design parameters for each of the mechanical-draft cooling towers. The cooling-tower performance curve used to determine the cold-water temperature as a function of wet-bulb temperature is shown in Figure 3.5. Because the cooling towers have not been purchased at this time, it is possible that this assumed design curve could differ from the final curve; however, deviations are not expected to be large.

3.4.2 Intake

The intake structure shown in Figure 3.6 will consist of a river screen house containing three circulating-water makeup pumps with capacities of 40 cfs (1.1 m^3/sec) each, two essential-service-water makeup pumps, two traveling screens, and a 410-foot (120-m) intake flume (ER, p. 3.4-3a). The operating floor of the screen house will be at 475 feet (145 m) MSL, 5 feet (1.5 m) above flood level. The bottom of the intake flume will be at 405 feet (123 m) MSL, 15 feet (4.6 m) below the 420-foot (128-m) water level maintained by the Army Corps of Engineers. The intake flume will have a depth of 15 feet (4.6 m) and will be divided into two channels, each 11 feet 6 inches (3.5 m) wide. The intake flume will extend about 120 feet (37 m) into the river at a water level of 420 feet (128 m) MSL and has a bar grill (with 3-in or 7.5-cm slits) at the entrance and at the proximal end, just before the traveling screens. The top of the intake flume will be covered by 11,800 ft^2 (1100 m^2) of heavy-gauge grating with hexagonal openings. This will allow water to enter the intake flume from the top when the water elevation exceeds 420 feet (128 m) MSL about 90% of the year (ER, Fig. 2.5-5). There is no fish-diversion mechanism incorporated in the intake-structure design. The intake velocity is expected to be no greater than 0.5 fps (15 cm/sec) at the surface of the traveling screens and 0.01 fps (3 mm/sec) at the grating surface.

The traveling screens will be 11 feet 6 inches (3.5 m) wide and about 70 feet (20 m) high with 3/8-inch (1-cm) square mesh openings. These screens will be used to prevent debris and larger aquatic biota from entering the condenser. This debris will be removed by rotating the screens periodically and will be stored in a pit, sump, or basket until a private contractor removes it for disposal offsite in a manner authorized by the State (ER, p. 3.4-3a; Supp. 1, p. 85; and Supp. 3, p. 21).

3.4.3 Discharge

The blowdown of cooling water with higher concentration of dissolved solids resulting from evaporation and addition of chemicals will be discharged to the Ohio River by means of a single point submerged discharge structure (ER, Suppl. 4, p. 3.4-3), extending about 50 feet offshore, as shown in Fig. 3.7. The average blowdown flow will be 8.9 cfs (0.25 m^3/sec) and the maximum discharge velocity is expected to be 8.0 ft/sec (2.4 m/sec). (See Sections 5.3.3 and 9.3.3.)

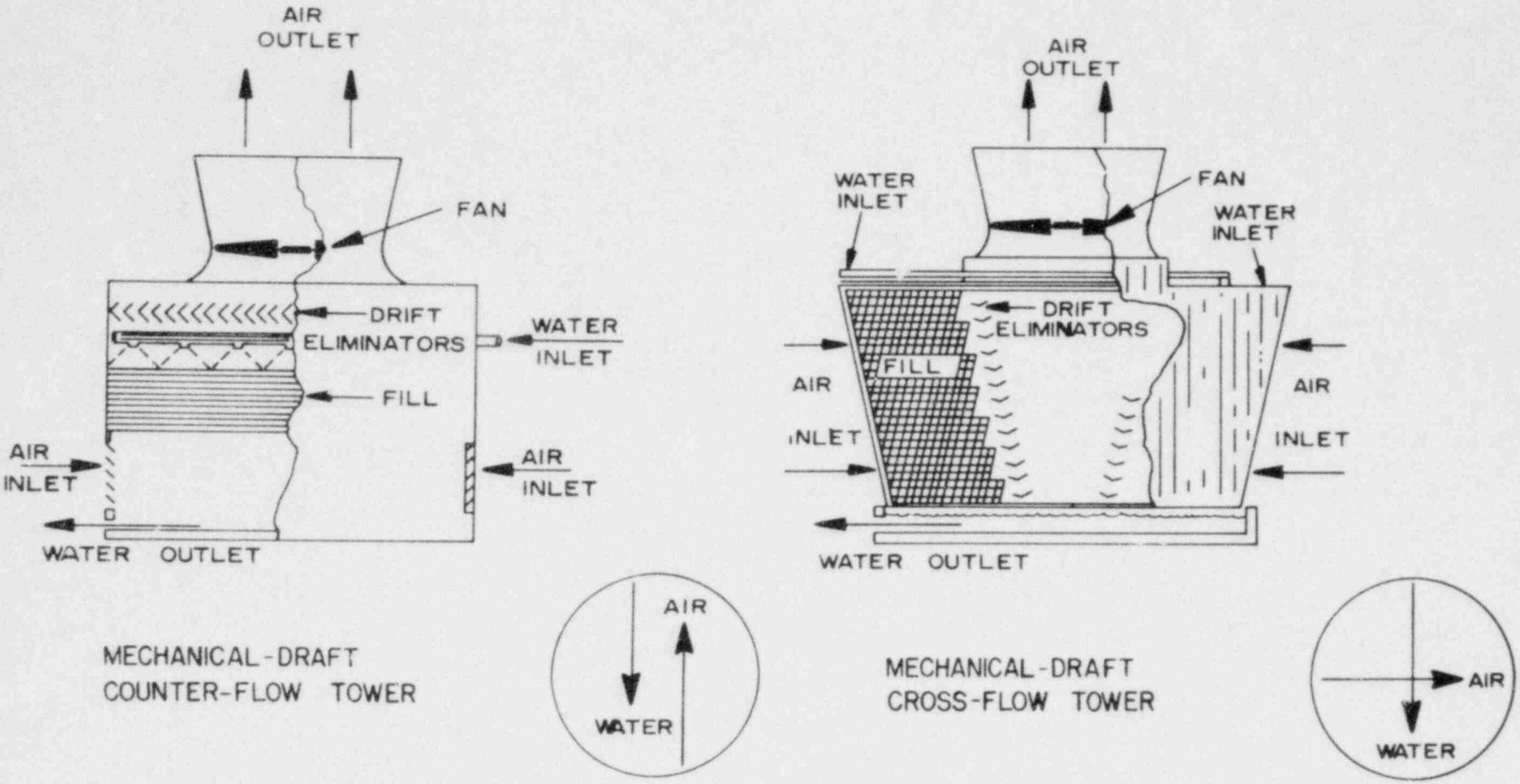

Fig. 3.4. Typical Mechanical-Draft Wet Evaporative Cooling Towers. From "Drift Technology for Cooling Towers," The Marley Company, 1973.

Table 3.2. Design Parameters for Each Mechanical-Draft Cooling Tower

Parameter	Value
Heat dissipation to the atmosphere	8.25×10^9 Btu/hr
Circulating-water flow rate	1330 cfs
Wet-bulb temperature	75°F
Approach	20°F
Range	28°F
Blowdown rate (average)	4.45 cfs
Evaporation rate (maximum)	28.7 cfs
Drift	0.265 cfs
Makeup rate (maximum)	34 cfs

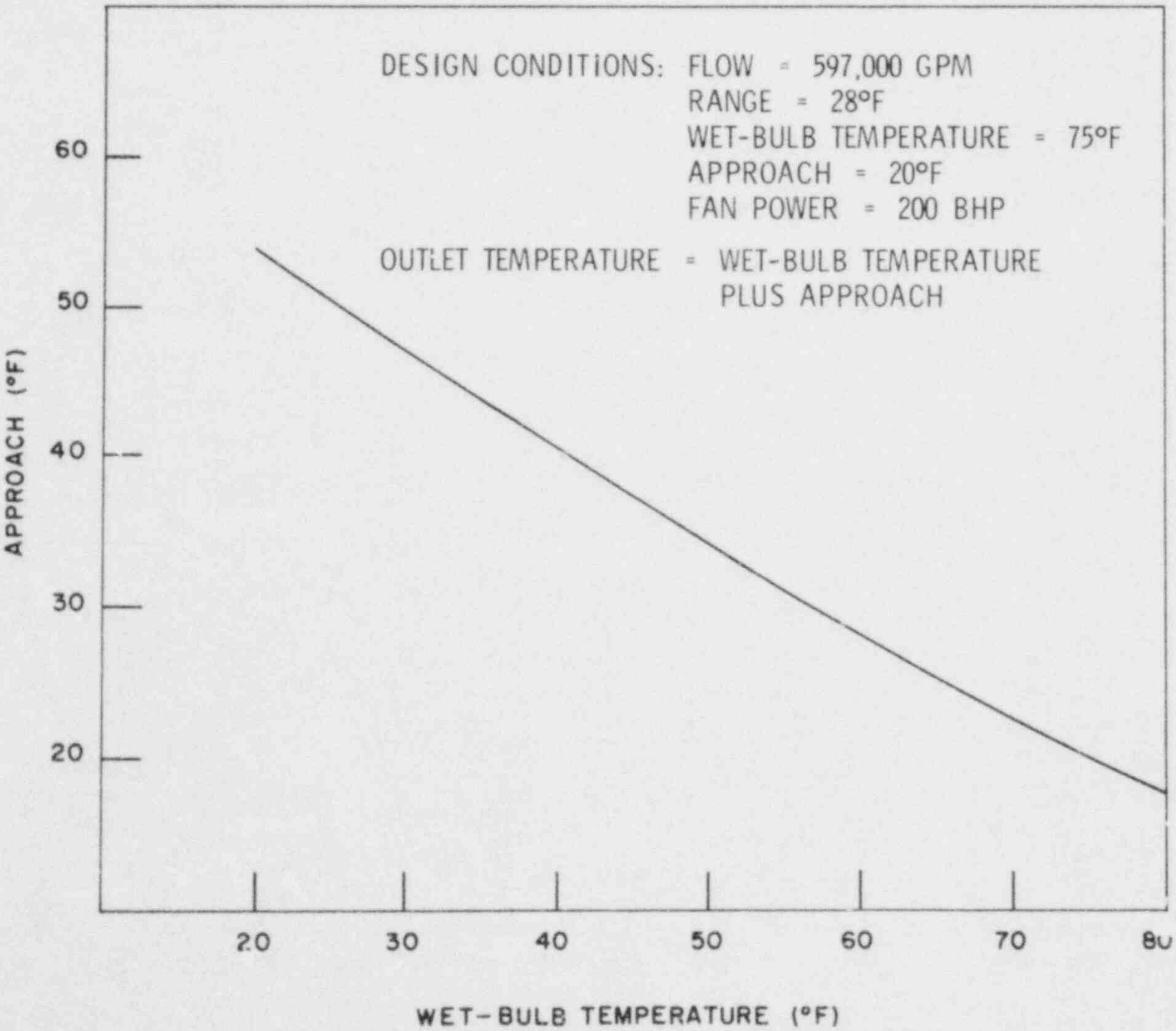

Fig. 3.5. Cooling-Tower Performance Curve.

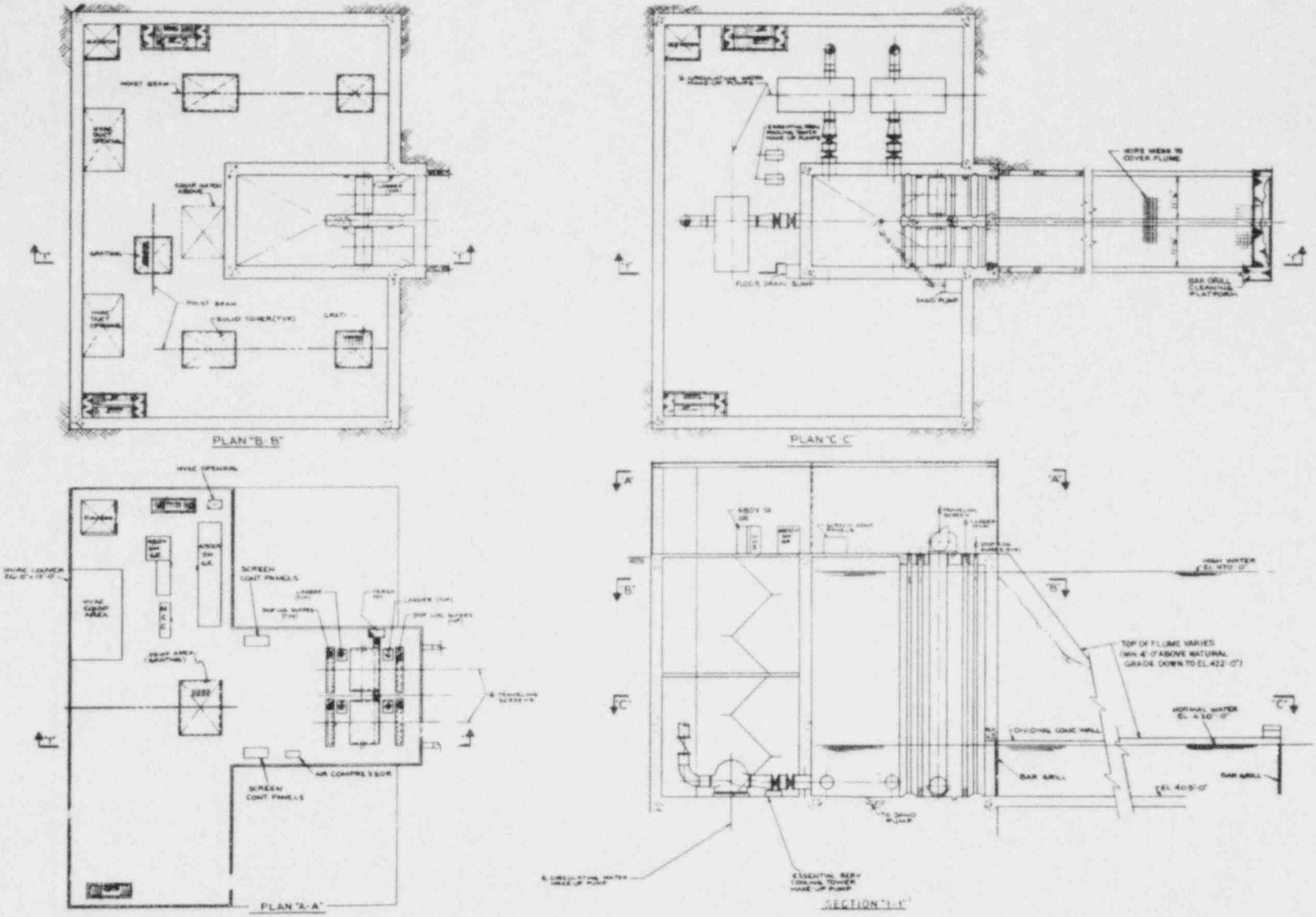

Fig. 3.6. Intake Flume and River Screen House. From ER, Fig. 3.4-2.

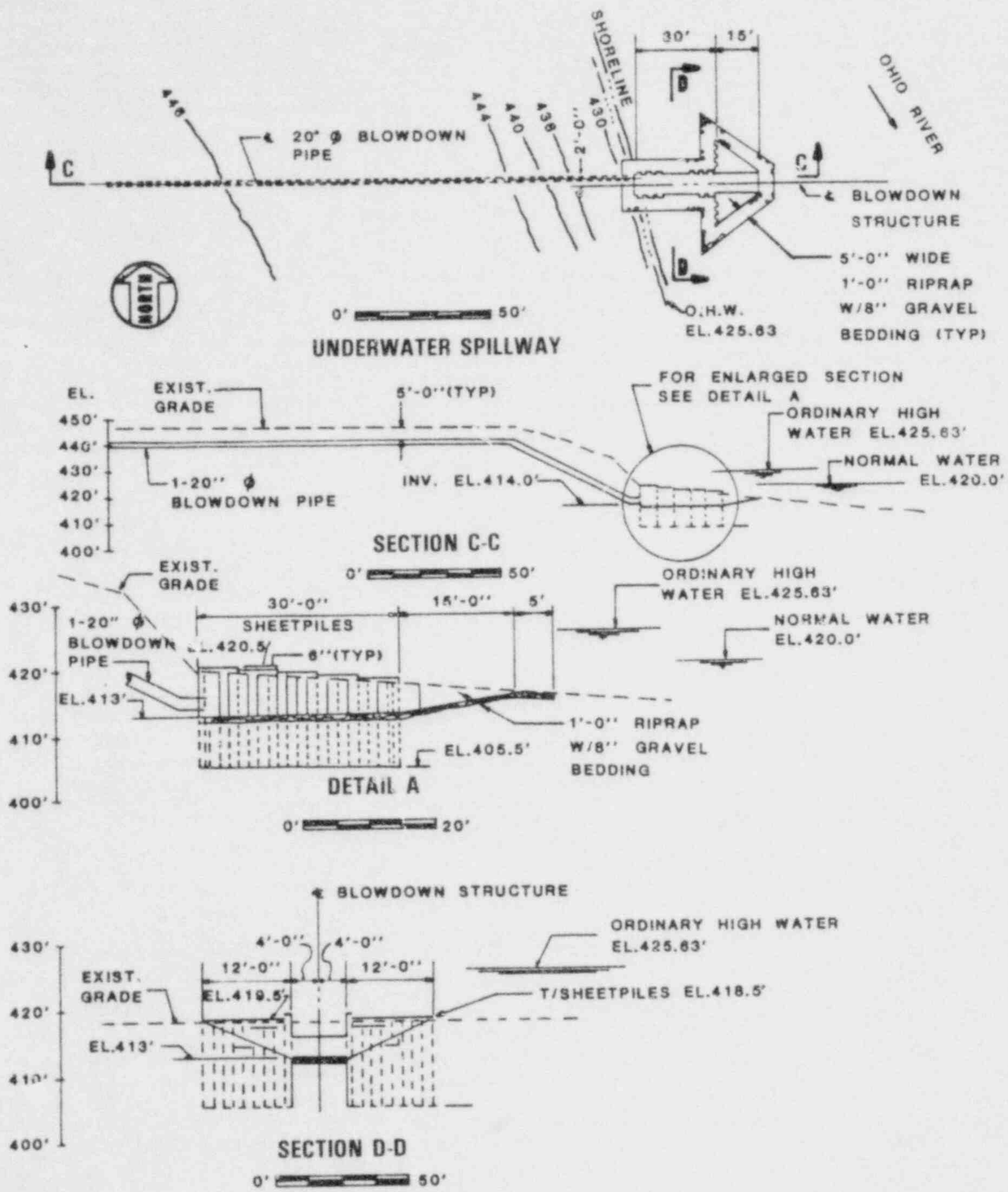

Figure 3.7 Revised Blowdown Discharge
Source: ER Supplement 4, Figure 3.4 -1

3.5 RADIOACTIVE WASTE SYSTEMS

During the operation of Marble Hill Station, Units 1 and 2, radioactive materials will be produced by fission and by neutron activation of corrosion products in the reactor coolant system. From the radioactive material produced, small amounts of gaseous and liquid radioactive wastes will enter the waste streams. These streams will be processed and monitored within the station to reduce the quantity of radionuclides ultimately released to the atmosphere and to the Ohio River.

The waste handling and treatment systems to be installed at the station are described in the applicant's Preliminary Safety Analysis Report dated September 17, 1975 and the Environmental Report dated September 11, 1975. In these documents, the applicant has prepared an analysis of his radwaste treatment systems including estimates of the annual radioactive effluents.

In the following paragraphs, the radwaste treatment systems are described and an analysis is given based on the staff's model of the applicant's systems. The staff's model has been developed from a review of available data from operating nuclear power plants, adjusted to apply over a 30-year operating life. The coolant activities and flows used in this evaluation are based on experience and data from operating reactors. As a result, the parameters used and the subsequent calculated releases vary somewhat from those given in the applicant's evaluation. The liquid and gaseous source terms were calculated by means of the GALE Code as outlined in draft Regulatory Guide 1.BB, "Calculation of Releases of Radioactive Materials in Liquid and Gaseous Effluents from Pressurized Water Reactors (PWRs)," September 9, 1975. The principal parameters used in the source term calculations are given in Table 3.3. The bases for these parameters are given in draft Regulatory Guide 1.BB.

In the Annex to Appendix I to 10 CFR 50 (dated September 4, 1975), the applicant was provided an alternative to Section II.D of Appendix I. The applicant has chosen this alternative (ER, Suppl. 2, p. 2-1). Based on the following evaluation, the staff concludes that the liquid, gaseous and solid radwaste treatment systems are acceptable and that the effluents meet as low as practicable levels in accordance with 10 CFR 50.34a, Sections II.A, II.B and II.C of Appendix I to 10 CFR 50, and the alternative to Section II.D of Appendix I as provided in the Annex to Appendix I.

3.5.1 Liquid

The liquid radioactive waste treatment system will consist of process equipment and instrumentation necessary to collect, process, monitor, and recycle or dispose of potentially radioactive liquid wastes. Prior to releasing liquid waste, samples will be analyzed to determine the type and amounts of radioactivity present. Based on the results of these analyses, the wastes will be released under controlled conditions to the Ohio River after being diluted with cooling tower blowdown or retained for further processing or recycle. A radiation monitor will automatically terminate liquid waste discharge if radiation measurements exceed a predetermined level in the discharge line. A simplified diagram of the liquid radwaste treatment systems is shown in Figure 3.8.

The liquid radioactive waste treatment systems will be divided into three principal systems and will be shared between Units 1 and 2: the Steam Generator Blowdown (SGB), the Radioactive Waste Drains (RWD), and the Radioactive Laundry Waste (RLW) systems. The SGB will be processed continually through the blowdown evaporator and polishing demineralizers. This water will be reused in the plant. The RWD system collects water from floor drains, equipment leakage or chemical operations in individual tanks. After sampling and analysis, RWD water will be processed batchwise with the appropriate combinations of filtration, evaporation and ion exchange. RWD water may be reused in the plant or discharged after treatment. RLW water will be treated by reverse osmosis and may be routed through the radwaste evaporator (if necessary) to remove radionuclides and detergents. The permeate will be analyzed to determine if it is suitable to reuse or will be retreated or discharged.

In addition to the preceding three systems, the Chemical and Volume Control System (CVCS) and the Boron Recycle System (BRS) were considered in the staff's evaluation. The CVCS and BRS process reactor grade water to control boron concentration and reactor coolant purity.

3.5.1.1 Steam Generator Blowdown (SGB)

The SGB system will process steam generator blowdown from both units, and it will have a capacity of 120 gpm. This water will pass through filters, a blowdown evaporator and, as needed, through mixed bed demineralizers. After treatment the blowdown condensate stream will be returned to the condensate storage tank for reuse. The SGB treatment system will have sufficient capacity to allow total recycle of the blowdown stream. The staff assumed the blowdown rate would be approximately 60 gpm at secondary coolant activity and that 1% of this flow will be released to the environment from the condensate storage tank after processing. Based on these assumptions, approximately 0.00027 Ci/yr/unit, excluding tritium, will be released from this source.

Table 3.3. Principal Parameters and Conditions Used in Calculating Releases of Radioactive Material in Liquid and Gaseous Effluents from Marble Hill Station (per unit)

Reactor power level (MWt)	3565
Station capacity factor	0.80
Failed fuels[a]	0.12%
Primary system	
Mass of coolant (lbs)	5.34×10^5
Letdown rate to CVCS (gpm)	75
Shim bleed rate (gpm)	1.9
Leakage rate to secondary system (lbs/day)	100
Leakage rate to containment building (lbs/day)	1%/day of primary coolant noble gas inventory 0.001%/day of primary coolant iodine inventory
Leakage rate to auxiliary building (lbs/day)	160
Frequency of degassing for cold shutdowns (per year)	2
Secondary system	
Steam flow rate (lbs/hr)	1.5×10^7
Mass of steam/steam generator (lbs)	9.1×10^3
Mass of liquid/steam generator (lbs)	1.17×10^4
Secondary coolant mass (lbs)	5.05×10^5
Rate of steam leakage to turbine building (lbs/hr)	1.7×10^3
Steam generator blowdown rate (lbs/hr)	3.0×10^4
Containment building volume (ft^3)	2.93×10^6
Frequency of containment purges (per year)	24
Iodine partition factors (gas/liquid)	
Leakage to auxiliary building	0.0075
Steam leakage to turbine building	1
Steam generator (carryover)	0.01
Main condenser air ejector	0.15

Decontamination Factors (liquids)

	I	Cs, Rb	Others
Boron recycle	1×10^4	2×10^4	1×10^5
Equipment drains	1×10^4	1×10^5	1×10^5
Waste drains	1×10^4	1×10^5	1×10^5

	All Nuclides Except Iodine	Iodine
Waste evaporator DF	10^4	10^3
BRS evaporator DF	10^3	10^2

	Anion	Cs, Rb	Other Nuclides
Mixed bed demineralizer			
Boron recycle feed (H_3BO_3)	10	2	10
Primary coolant letdown	10	2	10
Radwaste	10^2(10)	2(10)	10^2(10)
Evaporator condensate polishing	10	10	10
Cation bed demineralizer	1(1)	10(10)	10(10)
Anion bed demineralizer	10^2(10)	1(1)	1(1)

Containment Building Internal Recirculation System

Flow rate (cfm)	1.6×10^4
Operating period/purge (hours)	16
Mixing efficiency	70%

[a]This value is constant and corresponds to 0.12% of the operating power fission product source term being released to the primary coolant.

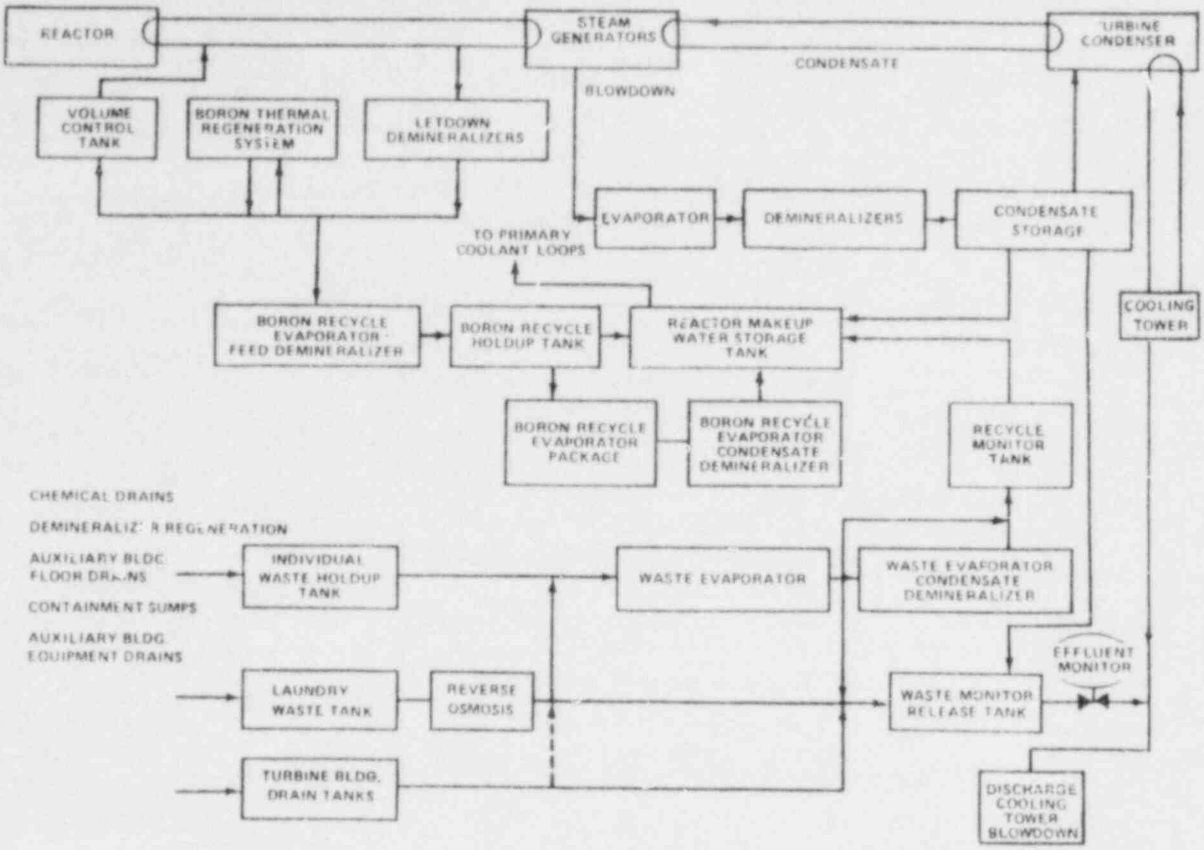

Fig. 3.8. Liquid Waste Treatment Systems.

3.5.1.2 Radioactive Waste Drains (RWD)

The RWD system will collect liquid from the containment sumps, auxiliary building floor drains, turbine building floor drains, auxiliary building equipment drains, turbine building equipment drains, demineralizer regeneration waste drains and chemical drains. Each of these substreams will be collected in its respective drain analysis tanks where its radioactivity level and chemical composition will be ascertained and an appropriate treatment method determined. With the exception of the turbine building drains, liquid radioactive waste will normally pass in batches through a 60 gpm evaporator. The evaporator condensate will be processed through a demineralizer. The treated waste will then be discharged, reprocessed or reused based on its radioactivity content and plant water balance requirements.

In its evaluation, the staff has assumed all of the water from the RWD system will be discharged. This discharge will be approximately 1400 gpd/unit of treated water containing 0.0068 Ci/yr/unit except tritium and noble gas, and 7200 gpd of untreated turbine building water containing an additional 0.018 Ci/yr/unit excluding tritium and noble gas. The staff's release values were calculated using the parameters in Table 3.3.

The applicant estimates a combined release of 0.049 Ci/yr/unit of treated RWD water and untreated turbine building water excluding tritium and noble gases.

3.5.1.3 Laundry Waste Subsystem (LWS)

Laundry wastes will be collected in the 4000 gallon laundry waste tank and processed by reverse osmosis to remove detergents and particulate matter prior to treatment, if necessary, in the waste evaporator. Based on its parameters, the staff assumed a generation rate of 450 gpd/reactor. This entire volume is assumed to be discharged, and will contain 0.002 Ci/yr. The applicant assumes all of the laundry wastes will be discharged, and that there will be no radioactivity released.

3.5.1.4 The Boron Recycle System (BRS)

Primary coolant will be withdrawn from the reactor coolant system at approximately 75 gpm and processed through the Chemical and Volume Control System (CVCS). The letdown stream will be cooled, reduced in pressure, filtered, and processed through one of two mixed-bed demineralizers. Approximately 10 percent of this letdown stream will be passed through an additional cation demineralizer to remove excess lithium and cesium. Radionuclide removal by the CVCS was evaluated by assuming 75 gpm letdown flow at primary coolant activity (PCA) through one mixed-bed demineralizer (Li_3BO_3 form) and 7.5 gpm flow through one cation demineralizer in series with the mixed bed. The CVCS will be used to control the primary coolant boron concentration by passing a portion of the letdown stream through the boron thermal regeneration system. A side stream of approximately 1.9 gpm of the treated letdown stream is diverted to the BRS as shim bleed. In the boron thermal regeneration system, boron will be either absorbed from or desorbed into the letdown stream depending upon the stream temperature. Since the thermal regeneration demineralizer resins will desorb as well as absorb radioactivity, the thermal regeneration system was not considered for radionuclide removal. However, use of the thermal regeneration system will reduce the quantity of liquid waste generated from maintaining boron control.

Shim bleed from the letdown stream will be processed through one of two mixed-bed demineralizers (Li_3BO_3 form) and routed to the recycle holdup tanks. Valve leakoffs and equipment drain wastes in the reactor containment as well as excess spent fuel pit water will be transferred to the recycle holdup tank where it will be combined with the shim bleed. These streams from each unit will form the principal inputs to the BRS and will be processed batchwise from the recycle holdup tanks. The staff calculated the shim bleed input activity by applying the DF for a mixed-bed demineralizer in the LI_3BO_3 form, to the shim bleed stream, assuming 1.9 gpm/reactor flow and CVCS output activity. The reactor coolant drain tank input flow to the BRS was assumed to be 300 gpd/reactor at PCA based on the applicant's assumption which we find to be reasonable.

Radioactive decay experienced during collection in the recycle holdup tank was calculated using the GALE Code. The collection time was calculated to be 16.5 days assuming the 112,000-gallon recycle holdup tanks will be filled to 80 percent capacity using the combined shim bleed and reactor coolant drain tank flow rates from both reactor units. Radionuclide removal was based on the parameters in Table 3.3 for an evaporator and demineralizer in series. Additional credit for radioactive decay time during processing of the contents of the recycle holdup tank through the two recycle evaporators has been given. In its evaluation, the staff assumed that equipment downtime and anticipated operational occurrences will result in approximately 10 percent of the evaporator condensate stream containing 0.001 Ci/yr, excluding tritium and noble gases, being discharged with the cooling tower blowdown to the Ohio River. The applicant assumed that the BRS stream will be recycled and did not specify a discharge fraction in his evaluation.

3.5.1.5 Liquid Waste Summary

Based on the evaluation of the waste treatment systems using the parameters in Table 3.3, the staff calculates the releases of radioactive materials in the liquid wastes to be 0.18 Ci/yr/reactor, excluding noble gases and tritium. The results of these calculations are given in Table 3.4. Based on previous experience at operating reactors, the staff estimates the tritium releases to be 510 Ci/yr/reactor. The applicant has estimated the releases to be 0.05 Ci/yr/reactor, excluding tritium and 660 Ci/yr/reactor of tritium. The difference between the staff's values for releases (excluding tritium) and those calculated by the applicant are due largely to the quantity of BRS waste recycle in the respective models. The staff assumed 10 percent of the BRS stream will be discharged over the life of the plant due to equipment downtime and anticipated operational occurrences whereas the applicant assumed total recycle of this stream.

Based on the staff's evaluation, the radioactivity in liquid effluents from Units 1 and 2 will not result in whole body doses to an individual in an unrestricted area greater than 3 mrem/yr or critical organ doses greater than 10 mrem/yr from either reactor, in accordance with Section II.A of Appendix I to 10 CFR 50. Also, the radioactivity in the liquid effluents from both units, exclusive of tritium and noble gases, will be less than 5 Ci/yr/reactor, and the whole body and critical organ doses will be less than 5 mrem/yr from the site, in accordance with the alternative to Section II.D of Appendix I as provided in the Annex to Appendix I. The staff concludes that the liquid radwaste treatment system will reduce liquid radioactive effluents to as low as practicable levels in accordance with 10 CFR 50.34a, Appendix I to 10 CFR 50, and the Annex to Appendix I to 10 CFR 50 (see Sec. 5.4).

3.5.2 Gaseous

The gaseous waste treatment and ventilation systems will consist of equipment and instrumentation necessary to reduce releases of radioactive gases and airborne particulates from equipment and building vents. The principal source of radioactive gaseous waste will be gases stripped from the primary coolant in the CVCS and BRS. Additional sources of gaseous wastes will be main

Table 3.4. Calculated Releases of Radioactive Materials in Liquid Effluents from Marble Hill Nuclear Generating Station, Units 1 and 2

Nuclide	Ci/Yr/Reactor
Corrosion & Activation Products	
Cr-51	8(-5)[a]
Mn-54	5(-5)
Fe-55	7(-5)
Fe-59	5(-5)
Co-58	8.3(-4)
Co-60	3.8(-4)
Np-239	3(-5)
Fission Products	
Br-83	8(-5)
Rb-88	5(-5)
Sr-89	2(-5)
Y-91	9(-5)
Mo-99	5.1(-3)
Tc-99m	5(-3)
Te-127m	1(-5)
Te-127	2(-5)
Te-129m	6(-5)
Te-129	4(-5)
I-130	1.6(-4)
Te-131m	4(-5)
I-131	1(-1)
Te-132	7.2(-4)
I-132	3.2(-3)
I-133	4.9(-2)
I-134	3(-4)
Cs-134	2.5(-3)
I-135	7(-3)
Cs-136	8.3(-4)
Cs-137	2.2(-3)
Ba-137m	9(-4)
All others	6(-5)
Total Except Tritium	1.8(-1)
Tritium	510

[a]Exponential notation: $8(-5) = 8 \times 10^{-5}$.

condenser vacuum pump offgases, ventilation exhausts from the auxiliary, radwaste, fuel handling and turbine buildings, and gases collected in the reactor containment building. The principal system for treating gaseous wastes will be the gaseous waste processing system (GWPS). The GWPS will collect and store gases stripped from the primary coolant in a continuously recirculating nitrogen loop containing two compressors and six pressurized storage tanks. The GWPS will be shared between Units 1 and 2. The ventilation exhaust from the auxiliary, radwaste, and fuel handling building will normally be processed through HEPA filters before release to the atmosphere. The applicant states that when radioactivity levels are above a predetermined value, the ventilation exhaust will be processed through charcoal adsorbers. The staff evaluation assumes continuous flow through the charcoal adsorbers. Offgases from the main condenser vacuum pump exhausts and the turbine building will be released without treatment. The containment atmosphere will be recirculated through filters and charcoal adsorbers prior to purging through HEPA filters to the atmosphere.

The steam generator blowdown treatment system will provide for cooling the blowdown in heat exchangers to prevent flashing. The blowdown condensate will be collected in the condenser hotwell where degassing will occur due to the relatively low pressure in the condenser. The gaseous waste treatment systems are shown schematically in Figure 3.9.

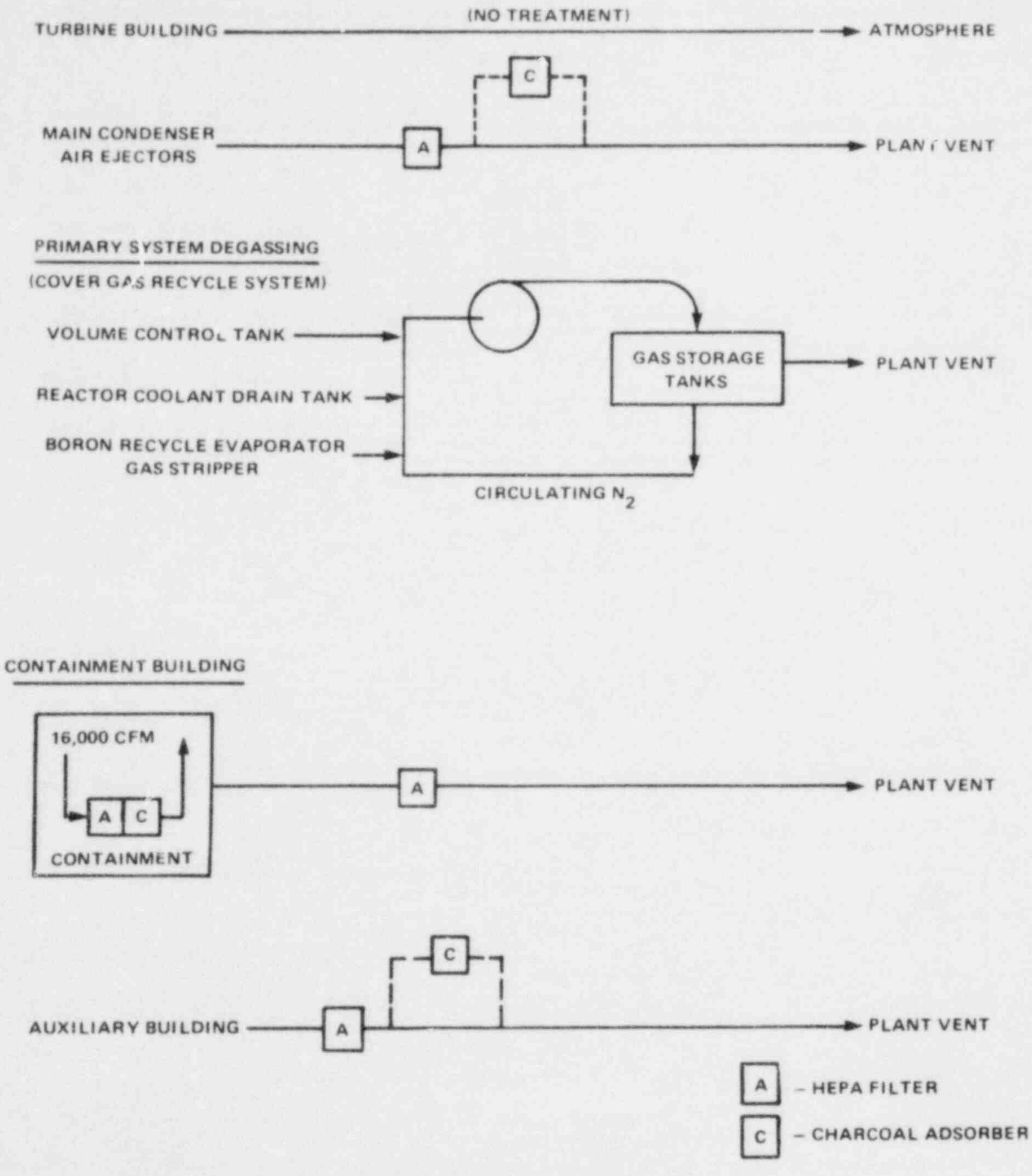

Fig. 3.9. Gaseous Waste Treatment Systems.

3.5.2.1 Gaseous Waste Processing System (GWPS)

The gaseous waste processing system will be designed to collect and process gases stripped from the primary coolant in the CVCS, BRS, and miscellaneous tank cover gases. The GWPS will contain a constant inventory of nitrogen which will be continuously recirculated as a carrier gas to transport radioactive gases removed from the primary coolant. Hydrogen cover gas from the volume control and reactor coolant drain tanks, and gases stripped in the BRS degassifier will enter the nitrogen loop. The nitrogen, hydrogen, and radioactive gases will be collected, compressed, and stored in one of six pressurized storage tanks.

The storage tanks will collect, store, and release gases to the loop in rotation to allow short-lived radionuclide decay. After holdup, the nitrogen, hydrogen, and long-lived nuclides will be reused in the loop or discharged to the environment if sufficient decay has occurred.

The applicant considers the system to be capable of retaining radioactive gases for at least 45 days. The staff has based its calculations on release after approximately 70 days holdup which will leave Kr-85 (10.7-yr half life) and Xe-133 (5.27-day half life) as the predominant radionuclides. The staff's holdup time of 70 days is based on a waste gas input flow rate of 140 cu. ft. per day and a storage tank pressure 70% of the design value. Of the six waste gas decay tanks in the Marble Hill design, one tank is held in reserve for back-to-back shutdowns, one tank is in the process of filling and the remainder are used for storage. Based on the staff's review of the Marble Hill application and experience with similarly designed systems, the staff considers that the operation of the Marble Hill station will result in an expected holdup time of 70 days for gaseous radionuclides in the GWPS. The staff has also analyzed the GWPS assuming only 45 days holdup (the applicant's assumed holdup time), and has determined the system will still meet all applicable codes and regulations, and specifically will still be in conformance with Appendix I to 10 CFR Part 50. The staff calculates the GWPS releases to be 520 Ci/yr/reactor for noble gases, 0.04 Ci/yr/reactor for airborne particulates, 8 Ci/yr/reactor for carbon-14, and negligible for iodine. The applicant estimated 6,000 Ci/yr/reactor of noble gases and negligible amounts of iodine and particulates will be released from the GWPS. The applicant's more conservative estimate is based on operation with 0.25 percent of the operating power fission product source term leaking to the primary coolant while the staff's analysis used 0.12 percent of the operating power fission product source term.

3.5.2.2 Containment Purges

Radioactive gases will be released inside the reactor containment when primary system components are opened or when leaks occur in the primary system. The gaseous activity will be sealed within the containment during normal operation but will be released periodically during containment purges. Prior to purging, the containment atmosphere will be recirculated through HEPA filters and charcoal adsorbers for particulate and iodine removal. Following this recirculation procedure, the containment will be purged to the atmosphere through HEPA filters. The airborne activity was calculated based on the parameters listed in Table 3.3 for primary coolant leakage to the containment. Radionuclide removal was based on 16 hours of recirculation system operation, 70 percent mixing efficiency and a DF of 10 for the recirculation charcoal adsorber. The staff assumed 24 containment purges annually. The staff calculated the containment purge releases to be 6600 Ci/yr/reactor of noble gases, 0.0075 Ci/yr/reactor of iodine-131, 1 Ci/yr/reactor of carbon-14, 25 Ci/yr/reactor of argon-41, and a negligible amount of particulates. The applicant estimated a release of 325 Ci/yr/reactor of noble gases, 0.016 Ci/yr/reactor of iodine-131, and negligible amounts of carbon-14, argon-41, and particulates. The applicant's estimated releases are different from the staff's value due to his assumption of 10 purges per year for each reactor, resulting in more decay time prior to purge, and the use of a different primary coolant radionuclide inventory.

3.5.2.3 Auxiliary and Fuel Handling Building Vent Releases

Radioactive gases will be released to the auxiliary and fuel handling buildings due to leakage from primary system components. These two buildings will share a common ventilation system designed to ensure that airflow will be from areas of low potential to areas having a greater potential for the release of airborne radioactivity. Ventilation air will be exhausted through HEPA filters for particulate removal. The system will have the ability to exhaust through charcoal adsorbers in the event of high airborne radiation; however, the charcoal adsorber must be in operation whenever required to meet the limits of 10 CFR Part 20 and the dose design objectives of Appendix I to 10 CFR Part 50. The staff's calculated releases were based on the auxiliary building leakage rate and iodine partition factor listed in Table 3.3 with credit given for the charcoal adsorber in the operating stream. Based on these parameters, the staff calculates the auxiliary building releases to be 400 Ci/yr/reactor of noble gases, 0.004 Ci/yr/

reactor for iodine-131, 0.003 Ci/yr/reactor for airborne particulates, and 910 Ci/yr/reactor of tritium. The applicant estimated the releases to be 1600 Ci/yr/reactor of noble gases, 0.007 Ci/yr/reactor for iodine-131, 780 Ci/yr/reactor of tritium, and negligible amounts of particulates. The applicant's estimate is based on operation with 0.25 percent of the operating power fission product source term leaking to the primary coolant while the staff's analysis uses 0.12 percent.

3.5.2.4 Turbine Building Vent Releases

Radioactive gases will be released to the turbine building due to secondary system steam leakage. The turbine building ventilation system exhausts will not be treated prior to release. The staff's calculated release values are based on 1700 lbs/hr/reactor of steam leakage to the turbine building assuming all of the noble gases and iodine remain airborne. On this basis, the staff calculated the turbine building vent release to be negligible for noble gases and 0.002 Ci/yr/reactor for iodine-131. The applicant estimated 0.016 Ci/yr/reactor for iodine-131 and a negligible noble gas release. The applicant's more conservative estimate is based on operation with 0.25 percent of the operating power fission product source term while the staff's analysis uses 0.12 percent.

3.5.2.5 Steam Releases to the Atmosphere

The turbine design provides for bypassing 40% of the steam directly to the condensers. The staff's analysis indicates that steam releases to the environs due to turbine trips and low power physics testing will have a negligible effect on the calculated source term.

3.5.2.6 Main Condenser Offgas Releases

Offgas from the main condenser vacuum pump exhausts will contain radioactive gases resulting from primary to secondary system leakage. Iodine will be partitioned between the steam and liquid phases in the steam generators and between the condensing and noncondensable phases in the main condensers and vacuum pumps. The major concentration of iodine present in the vacuum pump exhaust will be released through a charcoal adsorber to the plant vent. Based on the parameters listed in Table 3.3, the staff calculates the main condenser vacuum pump releases to be approximately 250 Ci/yr/reactor for noble gases and 0.003 Ci/yr/reactor for iodine-131. The applicant estimated this release to be 1100 Ci/yr/reactor for noble gases and 0.005 Ci/yr/reactor for iodine-131. The applicant's estimate is based on operating with 0.25 percent of the fission product source term while the staff's analysis used 0.12 percent.

3.5.2.7 Gaseous Waste Summary

Based on the parameters given in Table 3.3, the staff calculates the total radioactive gaseous releases to be approximately 7800 Ci/yr/reactor of noble gases, 0.016 Ci/yr/reactor of iodine-131, 9 Ci/yr/reactor of carbon-14, 910 Ci/yr/reactor of tritium, 25 Ci/yr/reactor of argon-41, and 0.043 Ci/yr/reactor of airborne particulates. The principal sources and isotopic distributions are given in Table 3.5. The applicant has calculated an overall release of approximately 9000 Ci/yr/reactor of noble gases, 0.044 Ci/yr/reactor of iodine-131, 800 Ci/yr/reactor of tritium, and negligible amounts of carbon-14, argon-41 and particulates.

Based on the staff's evaluation, the radioactivity in gaseous effluents from Units 1 and 2 will not result in an air dose to an individual in an unrestricted area greater than 10 mrads/yr for gamma radiation, 20 mrads/yr for beta radiation, or 15 mrem/yr for radioiodine and radioactive particulates from either reactor in accordance with Sections II.B and II.C of Appendix I to 10 CFR 50. Also, the effluents from the site will not result in an annual gamma air dose greater than 10 mrads, a beta air dose greater than 20 mrads, a release of iodine-131 greater than 1 Ci/reactor, or a dose from radioiodine and radioactive particulates released greater than 15 mrem, in accordance with the alternative to Section II.D of Appendix I as provided in the Annex to Appendix I. The staff concludes that the gaseous radwaste treatment system will reduce gaseous radioactive effluents to as low as practicable levels in accordance with 10 CFR 50.34a, Appendix I to 10 CFR 50, and the Annex to Appendix I to 10 CFR 50 (see Sec. 5.4).

3.5.3 Solid Waste Summary

Solid waste containing radioactive materials will be generated during station operations. Solid wastes will be categorized as "wet" and "dry" based upon the need for moisture absorption and solidification during processing. The solid waste system will consist of a waste drumming subsystem for dry solid waste and a separate system for wet solid waste.

Table 3.5. Calculated Releases of Radioactive Materials in Gaseous Effluents from Marble Hill Nuclear Generating Station, Units 1 and 2 (Ci/Yr/Reactor)

Nuclide	Reactor Building Purge System Exhaust	Auxiliary Building Ventilation Systems Exhaust	Turbine Building Vents	Waste Gas Processing System, Miscellaneous Vent Exhaust
Kr-83m	a	a	a	a
Kr-85m	2	2	a	1
Kr-85	110	3	a	510
Kr-87	a	1	a	a
Kr-88	2	4	a	3
Kr-89	a	a	a	a
Xe-131m	56	2	a	6
Xe-133m	41	5	a	3
Xe-133	6400	380	a	240
Xe-135m	a	a	a	a
Xe-135	11	7	a	5
Xe-137	a	a	a	a
Xe-138	a	a	a	a
I-131	0.0075	0.0043	0.002	0.0027
I-133	0.0045	0.006	0.0018	0.0038
Co-60	1.4(-5)[b]	2.7(-4)	c	7.0(-3)
Co-58	3.1(-5)	6.0(-4)	c	1.5(-2)
Fe-59	3.1(-6)	6.0(-5)	c	1.5(-3)
Mn-54	9.0(-6)	1.8(-4)	c	4.5(-3)
Cs-137	1.6(-5)	3.0(-4)	c	7.5(-3)
Cs-134	9.0(-6)	1.8(-4)	c	4.5(-3)
Sr-90	1.2(-7)	2.4(-6)	c	6.0(-5)
Sr-89	7.0(-7)	1.3(-5)	c	3.3(-4)
C-14	1			8
H-3		910		
Ar-41	25			

[a]Less than 1.0 Ci/yr noble gases, less than 10^{-4} Ci/yr for iodine.

[b]Exponential notation: 7.0(-3) = 7.0×10^{-3}.

[c]Less than 1% of total for nuclide.

Wet solid wastes will consist mainly of spent demineralizer resins, filter sludges, evaporator bottoms, reverse osmosis concentrates and chemical drain tank effluents. These wastes will be combined with a cement and vermiculite mixture to form a solid matrix and sealed in 55 gallon steel drums. Since the majority of the radioactivity entering the liquid waste streams will be removed by demineralizers, evaporators, or filters and become wet solid wastes, the staff considers these wastes to be stored for at least 180 days for radioactive decay prior to shipment offsite.

Dry solid wastes will consist of ventilation air filters, contaminated clothing and paper and miscellaneous items such as tools and laboratory glassware. Dry solid wastes will be compressed into 55 gallon drums using a hydraulic press-baling machine. Since dry solid wastes will contain much less activity than wet solid wastes, the staff did not consider the need for onsite storage of dry solid wastes in its evaluation.

Based on the staff's evaluation of similar reactors and operating reactor data, the staff estimates that approximately 11,700 ft^3 of wet solid waste containing approximately 1900 Ci, and 4000 ft^3 of dry solid waste containing less than 5 Ci total will be shipped offsite annually due to the operation of each reactor.

Greater than 90 percent of the radioactivity associated with the solid waste will be long-lived fission and corrosion products, principally Cs-134, Cs-137, Co-58, Co-60 and Fe-55. The applicant estimates that approximately 4000 drums of wet solid wastes ranging from negligible activity to 180 Ci/drum, and 70 drums of dry solid waste ranging from negligible activity to 10 Ci/drum will be shipped offsite annually.

In summary, all containers will be shipped to a licensed burial site in accordance with NRC and DOT regulations. The solid waste system will be similar to systems which the staff has evaluated and found to be acceptable in previous license applications. Based on its similarity to acceptable systems, the staff finds this solid waste system to be acceptable.

3.6 NONRADIOACTIVE WASTE SYSTEMS

3.6.1 Chemical Effluents

About 85% of the makeup water for the condenser cooling systems will be evaporated in the cooling towers. The entire original content of dissolved and suspended solids will be discharged in the remaining 15% of the makeup as blowdown. A very small part (<0.02%) of the dissolved solids also will be lost as spray (drift) from the cooling towers. In addition to the original content of dissolved and suspended solids in the makeup water, a number of additional substances are added in various station systems also, to be discharged with the blowdown. These substances are added for control of corrosion, prevention of inorganic (scale) deposits, prevention or removal of biological growth, and various other purposes in water or steam systems. In addition, discharges occur from systems used to purify and sterilize water. A listing of the common additives, estimated amounts, purposes, and methods of disposal is shown in Table 3.6. The different systems producing the additives are described in the following paragraphs.

3.6.1.1 Circulating System

The major discharge is the blowdown from the condenser cooling system. With the exception of bicarbonate and sulfate ions, the dissolved materials are identical in amount and kind to those in the river but are increased in concentration by a factor of six to eight. Suspended solids may increase by a larger factor if large quantities of dust are in the cooling tower air, or by a smaller factor as a result of settling in sumps or ponds of the system. As a conservative estimate, the suspended solids concentration is considered to increase by the same factor as the dissolved solids. Ammonia or other soluble gases, if present in the air, can dissolve in the cooling water.

Increasing concentrations of dissolved river solids by the factor of six or more causes the solubility limits for calcium carbonate to be exceeded, and, in the absence of control, deposits would form on heat transfer surfaces in the condensers. In order to avoid serious losses of efficiency, prevention of such deposits is necessary. At the Marble Hill Station, the method of prevention to be used is to decrease the concentration of carbonate to a nonprecipitating level by the addition of sulfuric acid. Carbonate, mostly present as bicarbonate ion at the ambient pH, is converted to CO_2 and removed by aeration. Because two bicarbonate ions are replaced by one sulfate ion, the total weight of dissolved salts is decreased slightly.

The applicant expects to use 93% sulfuric acid at a maximum rate of 0.9 gpm (3 liters/min) or 5×10^5 gallons per year (1800 m^3/yr). These quantities correspond to an increase in dissolved sulfate in the blowdown of about 380 ppm and a decrease in dissolved bicarbonate of about 465 ppm. The resulting bicarbonate concentration in the blowdown will be about the same as in the intake. The average composition of the blowdown is shown in Table 3.7. The applicant states that it does not intend to use corrosion inhibitors or other additives in the system.

3.6.1.2 Demineralizer System

The makeup-demineralizer system provides highly purified water for use in the primary- and secondary-coolant systems of the nuclear station. The intake water is filtered, may be softened, and then passed through a series of ion-exchange-type demineralizers. In the exchangers anions are replaced by hydroxyl ions and cations by hydrogen ions in equivalent amounts; these combine to form water. Wastes arise from the necessity of periodically regenerating the ion exchangers with sodium hydroxide and sulfuric acid for anion and cation exchangers, respectively. The applicant expects that daily regeneration of the beds will be necessary, during periods of maximum make-up demands, as during startup. During normal operation, the demineralizers will be regenerated every ten days. For each regeneration, about 2400 lb (1090 kg) of sulfuric acid and 2000 lb (900 kg) of sodium hydroxide are used. Including rinses and backwash, about 60,000 gallons (230 m^3) of wastewater will be produced for each regeneration. After combination and neutralization (if necessary), the waste will be discharged over 24 hours at a rate of 36 gpm (0.14 m^3/min). The average composition of the waste-water is shown in Table 3.7.

In the filtration of the incoming makeup water, it will probably be necessary to use inorganic coagulants, such as aluminum sulfate or organic polyelectrolytes. These materials will be retained as sludges, which will be disposed of in a manner approved by the State, and thus do not appear in the discharge waters.

Table 3.6. Chemicals Used in the Station, per Unit

Chemical	Quantity	Use	Disposal
Sulfuric acid	3.5×10^6 lbs/yr	Scale and pH control	Blowdown
	4.4×10^5 lbs/yr	Demineralizer regeneration	Neutralized before blowdown
Sodium hydroxide	3.5×10^5 lbs/yr	Demineralizer regeneration	Neutralized before blowdown
Sodium hypochlorite	925,000 gal/yr	Condenser cooling system biocide	Blowdown
	40,000 gal/yr	Service water system biocide	
	35,000 gal/yr	Essential water system biocide	
	1,850 gal/yr	Sewage disinfection	
Hydrazine		Oxygen control in steam system	No normal discharge
Morpholine		20-40 ppb in steam system	No normal discharge
Ammonia		pH control in steam system	No normal discharge
Boric acid		Reactivity control in steam system	No normal discharge
Aluminum sulfate soda ash		Filtration aid	Sludge
Organic poly-electrolyte		Filtration aid	Sludge

[a]Staff estimate

TABLE 3.7 MARBLE HILL BLOWDOWN COMPOSITION, PARTS PER MILLION

Component	Ohio River Average	Blowdown (7 cycles)	Regeneration Waste	Combined Average	Combined Maximum[d]	Water Quality Criteria (Drinking Water)[e]
Calcium	40.9[a]	286	280	286	661	
Magnesium	9.9[a]	69	73	69	95	
Sodium	15.4[a]	108	2279	120	236	
Sulfate	72.2[a]	885	4770	920	1353	250
Chloride	37.7[a]	264	456	266	407	250
Alkalinity($CaCO_3$)	64[a]	448	441	448	613	
TDS	246[a]	1500[c]	8299	1560[c]	1560[c]	500
TSS	116[a]	812		812	4326	
SiO_2	4.8[a]	34	39	34	50	
Zinc	0.010[b]	0.07		0.07	0.11	
Copper	0.005[b]	0.035		0.035	0.057	
Iron	0.132[b]	0.92		0.92	2.7	0.3
Cadmium	0.017[b]	0.12		0.12	0.57	0.01
Lead	0.006[b]	0.042		0.042	0.14	0.05
Total Chromium	0.003[b]	0.021		0.021	0.07	0.05
Hexavalent Chromium	0.003[b]	0.021		0.021	< 0.07	0.05
Mercury	0.0003[b]	0.0021		0.0021	0.002	0.002
Manganese	0.010[b]	0.07		0.07	0.27	0.05
Arsenic	0.001[b]	0.007		0.007	0.012	0.01
Discharge Rate (gpm 2 units)		4000	41	4041		

[a]Marble Hill Station 3, 12 samples 1974, ER Table 2.7.2

[b]Stations 1 and 4, 8 samples, 1974, ER Table 2.7.5

[c]Maximum TDS will be limited by operator to 1500 mg/l

[d]Calculated as 7 times maximum observed river value

[e]From ER Table 6.2.2, most stringent of Federal, ORSANCO or Indiana Regulations

3.6.1.3 Miscellaneous

The auxiliary boilers, when they are operated, will normally be blown down for one to two hours per day at a rate of 100 to 200 gpm (0.4 to 0.8 m^3/min). The liquid will contain about 9, 40, and 40 ppm of morpholine, sodium sulfite, and trisodium phosphate, respectively, and a total dissolved solid level of 500 ppm. Discharge will be to the main blowdown system and will not appreciably affect the overall composition because of the small quantities. Blowdown from the primary and secondary cooling systems, which will contain boric acid, hydrazine, and other substances, will be sent to the radwaste system, where organic and inorganic impurities will be removed before any discharge.

In addition to quantities already mentioned, the average river composition near the plant site, final effluent composition, and EPA or Indiana State water quality criteria are listed in Table 3.7. It should be noted that river-water composition is highly variable, but that the applicant plans to operate the system so that the maximum dissolved solid level in the discharge is 1500 ppm regardless of the quality of the intake water.

3.6.2 Biocidal Effluents

Unless prevented, biological growths generally occur on surfaces exposed to ambient water. These growths can impede water flow in pipes, hinder heat transfer through surfaces, and are deleterious to efficient plant operation. In the Marble Hill Station, it is planned to control such growths by injection of 15% solutions of the biocide, sodium hypochlorite (NaOCl), into susceptible station water systems.

For the condenser cooling system, the applicant plans to inject NaOCl solutions in three 30-minute periods per day for each unit. Chlorination periods for the units will be staggered so that blowdown from one unit can be used for diluting and reacting with chlorinated blowdown from the second unit. The applicant expects to add NaOCl to achieve a concentration of 5 ppm of chlorine requiring about 19 gpm (0.07 m^3/min) of the NaOCl solution. The chlorine is to be injected before the condensers, monitored at the condenser outlet, and also before discharging as blowdown, wherein the average concentration is expected to be about 0.05 ppm.

Similar staggered treatments are to be used for the essential and non-essential water systems, but on a correspondingly smaller scale. The applicant expects to consume a per-year total of 18,500,000; 80,000; and 70,000 gallons (70,000, 300; and 250 m^3) of the 15% NaOCl solution for the condenser, non-essential, and essential systems, respectively.

One of the two units of the station is expected to be in operation for two years before completion of the second. During this period chlorine consumption is expected to be about half of that given above. However, unchlorinated flow from one unit will not be available to dilute the flow from the unit being chlorinated. Consequently, chlorine concentrations in the effluent may be double those for two-unit operation.

3.6.3 Sanitary and Other Wastes

3.6.3.1 Sanitary Wastes

Sewage from the station is to be treated in an extended aeration package system with a capacity of 15,000 gpd (55 m^3/d). The capacity is equal to that of the potable water system. The effluent will be given tertiary treatment (filtration and recirculation) and chloripated to a 0.5 ppm residual level before discharge to the blowdown system. The effluent is expected to contain about 12 mg/liter BOD (about six times ambient) and 16 mg/liter of suspended solids. Dilution by the blowdown will reduce these values to meet State standards.

3.6.3.2 Other Waste Systems

The station will maintain four diesel engines for emergency use, which will be normally operated only for testing. Two 75 × 10^6-Btu/hr (22-MW) fired steam boilers will be used for start-up and at other times when the main steam supply is not available. These six units burn low-ash No. 2 diesel fuel oil. Estimated emissions for the two systems and Indiana State Standards are given in Table 3.8.

Table 3.8. Emission Standards and Estimated Emission Rates

	Indiana Emission Standards[a] (lb/10^6 Btu of actual heat input)	Estimated Gaseous Effluents from Steam Boilers[b]		Estimated Gaseous Effluents from Diesel Generators[c] (lb/hr)
		(lb/10^6 Btu)	(lb/hr)	
Carbon monoxide	d	0.03	4.5	78.4
Sulfur	3.2	1.0 (max)	150 (max)	48.0
Nitrogen oxides	d	0.6 (max)	90 (max)	84.0
Particulates	0.6	0.1	15	14.4
Visual scale	40%			

Derived from ER, Table 3.7-1.

[a]From Air Pollution Control Board of Indiana Regulations APC 3, APC 4, APC 13, for new units of heat input less than 250 × 10^6 Btu/hr.

[b]No. 2 oil-fired heating boilers.

[c]From U. S. EPA Publication Ap-42, "Compilation of Air Pollutant Emission Factors," Second Edition, April 1973, p. 1.3-2.

[d]No standard.

3.7 POWER TRANSMISSION SYSTEM

The applicant proposes to construct three new transmission lines to connect the Marble Hill Station to the existing transmission network in southern Indiana. The Marble Hill to Rush Line will be a 765-kV single-circuit transmission line (65.5 mi or 105 km long and 250 feet wide) between the station and a new substation to be located one mile (1.6 km) southeast of New Salem, Indiana. The Marble Hill to Columbus Line will also be a 765-kV single-circuit transmission line (45.7 mi or 73.5 km long and 250 feet wide) and will connect the Marble Hill Station and an existing substation two miles (3.2 km) southeast of Columbus, Indiana. The third proposed line is the 5.6-mile-long (9.0-km-long and 150 feet wide) 345-kV double-circuit Marble Hill to Speed-Madison Line Loop (see Fig. 3.10).

To provide construction and start-up power, a nearby 138-kV transmission line will be tapped. The tap line will run on a single-pole and extend due west of the station switchyard for a distance of 0.5 mile (0.8 km) where it will connect with the existing north-south line.

The following descriptions of the three proposed transmission line corridors are based on data provided by the applicant and additional material collected by the staff. The terrestrial and aquatic ecologies of the transmission corridors are discussed in Section 2.7 and archeological features are discussed in Sections 2.9 and 4.1.1. Ecological, esthetic, and other impacts are discussed in Section 4.3. The applicant has indicated that the design, construction and routing of all transmission facilities will conform to criteria and guidelines prescribed by the U. S. Department of Agriculture, the U. S. Department of the Interior, and the Federal Power Commission.

3.7.1 Marble Hill to Rush Line

The total area required for the right-of-way is 1985 acres (8.033 km^2), including a portion of the 1.2-mile (1.9-km) common corridor near the station. Geographical features are given in Table 3.9.

This 765-kV line will pass within 600 feet (180 m) of the city limits of the town of Volga, 0.2 mile (0.3 km) west of New Point, and 0.25 mile (0.4 km) west of San Jacinto. The applicant's tentative route lies 2300 feet (700 m) west of the Jefferson Proving Ground, 900 feet (270 m) from the Brush Creek State Fish and Wildlife Area, and will be within 800 feet (240 m) of Officer's Woods, designated as a highest-priority natural area by the Division of Nature Preserves, Indiana Department of Natural Resources.[2] The route crosses the South Vernon Fork of the Muscatatuck River and 25 perennial streams of various sizes. Ten major highways, including Interstate 74, and three railroads will be crossed (see Table 3.9).

The single-circuit line will be supported by long-span metal four-legged towers or possibly guyed "V" or guyed "Y" type structures for tangent towers (see Figs. 3.11 and 3.12). The galvanized-steel or aluminum-alloy towers will be of lattice construction. Four-legged self-supporting towers will be used at all points where the segments deviate by more than two degrees. The number of towers will generally vary between four and six per mile, or about three per kilometer, the number increasing in hilly and rugged terrain; the ruling span is expected to average over 1000 feet (300 m). The conductor will be one four-conductor bundle per phase of size 954 KCM ASCR or larger, with a normal load capacity of 3200 MVA and an emergency load capacity of 4000 MVA.

3.7.2 Marble Hill to Columbus Line

The total area required for the right-of-way is 1385 acres (5.605 km^2), including a portion of the 1.2-mile (1.9-km) common corridor near the plant. Geographical features are given in Table 3.9.

This 765-kV line will pass 0.25 mile (0.4 km) north of the town of Deputy, 0.4 mile (0.6 km) southwest of Paynesville, and 0.5 mile (0.8 km) east of Azalia. The applicant's suggested route lies within 4400 feet (134 m) of the Muscatatuck National Wildlife Refuge and 1500 feet (457 m) east of Tribbett's Flatwoods, designated as a second-highest-priority natural area by the Division of Nature Preserves, Indiana Department of Natural Resources.[2] The route crosses two rivers, the Muscatatuck River and the Vernon Fork of the Muscatatuck River, and 19 perennial streams. Eight major highways and four railroads are crossed (see Table 3.9). The towers, span, conductors, and other engineering parameters are the same as those of the Marble Hill to Rush Line.

3.7.3 Marble Hill to Speed-Madison Line Loop

The total area is 102 acres (0.412 km^2), based on a length of 5.6 miles (9.0 km) and a width of 150 feet (45 m). The loop will pass 0.8 mile (1.3 km) southwest of the town of Paynesville, and will cross one major highway, Indiana State Route 62.

This 345-kV double-circuit transmission line will be supported by four to six long-span metal four-legged towers per mile, or about three per kilometer (see Fig. 3.13). The galvanized-steel or aluminum-alloy towers will be of lattice construction with the ruling span averaging over 1000 feet (300 m).

The conductor will be one twin-conductor bundle per phase of size 954 KCM ACSR or larger, with a normal load capacity of 950 MVA and an emergency load capacity of 1200 MVA.

3.7.4 Substations

The Rush Substation will occupy about 100 acres (0.4 km^2) of agricultural land about one mile (1.6 km) east-southeast of New Salem, Indiana. It will be a 765-kV substation for transformation to lower voltages, with an anticipated transformer-bank size of 1500 MVA.

The Columbus Substation will be enlarged by about 100 acres (0.4 km^2), mainly agricultural land. The existing facility is located in Section 33 T9N R9E, about two miles (3.2 km) southeast of Columbus, Indiana. A new 765-kV transformer bank and switchgear will be required for transformation to lower voltages, with an anticipated bank size of 1200 MVA.

3.8 AUXILIARY FACILITIES

The applicant plans to build a railroad spur to connect the Marble Hill Nuclear Generating Station with the Baltimore and Ohio (B&O) Railroad line. The spur will be about ten miles in length and the right-of-way is assumed to be 200 feet wide. The spur will parallel the 345-kV transmission corridor running to the northwest for about five miles, with the remaining five miles running westward to the B&O line at Nabb, Indiana. The right-of-way will occupy about 200 acres of cropland and 45 acres of forest.

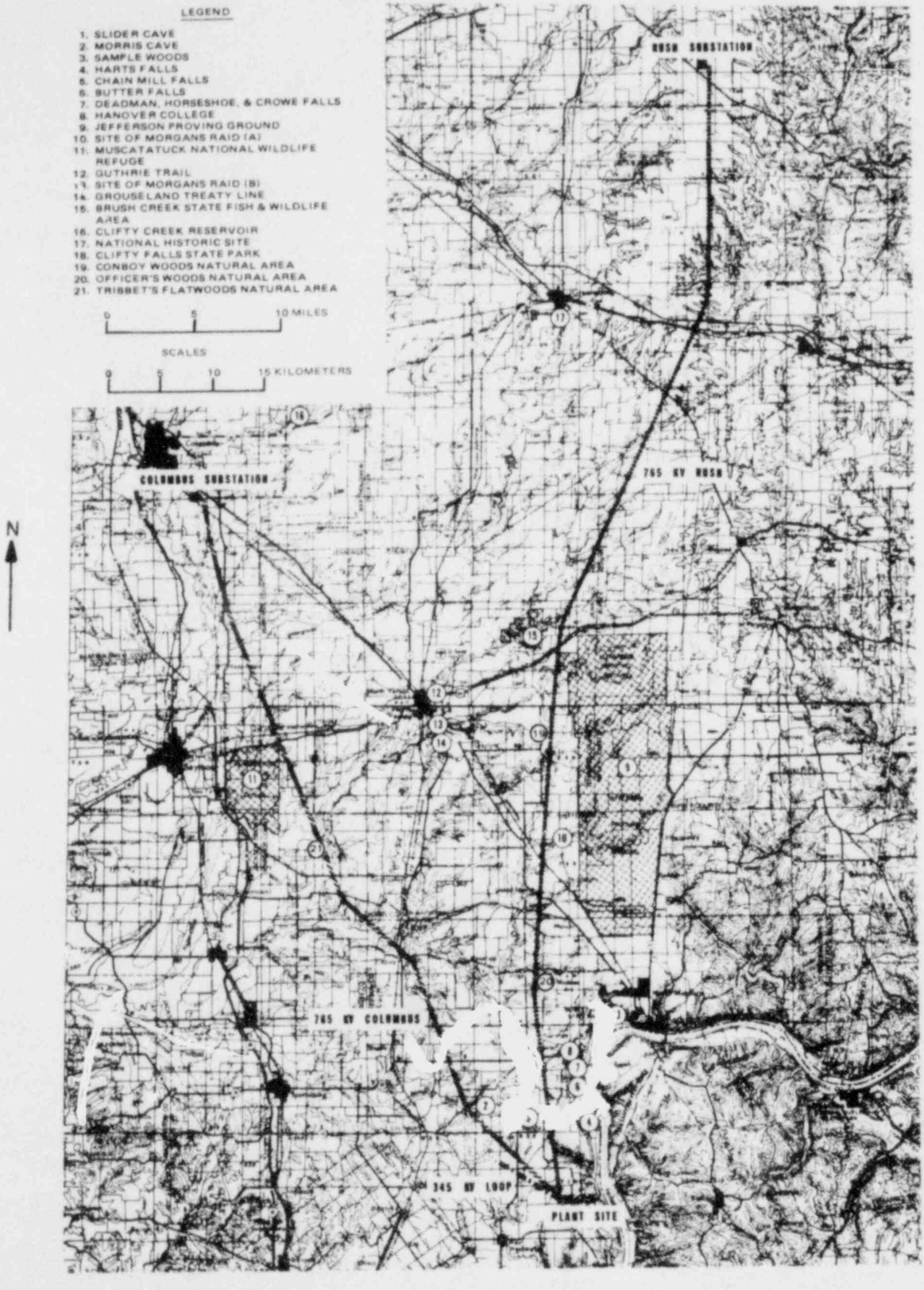

Fig. 3.10. Proposed Primary Transmission-Line Routes. Adapted from ER, Fig. 3.9-1.

Table 3.9. Present Land Use, Terrain, and Cultural Features for the Proposed Primary Transmission Routes

	Rush Line		Columbus Line		345-kV Loop	
Percent length and area in acres	100%	1984.9[a]	100%	1384.9[a]	100%	101.8[b]
Forested[c]	28.9%	573.6	36.5%	505.5	25%	25.4
Open[d]	71.1%	1411.3	63.5%	879.4	75%	76.4
Flat or gently rolling[e]	73.7%	1462.9	47.8%	662.0	96.4%	98.1
Hills or significant topographic change[f]	26.3%	522.0	52.2%	722.9	3.6%	3.7
Rivers crossed	South Vernon Fork of Muscatatuck River		Muscatatuck River Vernon Fork of Muscatatuck River		None	
Number of perennial creeks crossed	25		19		2	
Highways crossed						
Interstate	Int. 74		None		None	
Federal	U.S. 50 U.S. 52 U.S. 421		U.S. 31 U.S. 50		None	
State	Ind. 7 Ind. 46 Ind. 56/62 Ind. 244 Ind. 250 Ind. 256		Ind. 3 Ind. 56 Ind. 62 Ind. 250 Ind. 256 Ind. 356		Ind. 62	
Railroads crossed	Baltimore & Ohio Penn-Central (twice)		Baltimore & Ohio (twice) Chicago & Milwaukee Penn-Central		None	
Nearest town	Volga-0.10 mi W		Deputy-0.25 mi S		Paynesville-0.80 mi NE	
Towns less than 1.0 mile from line	Volga-0.10 mi W New Point-0.20 mi E San Jacinto-0.25 mi E Rossburg-0.30 mi NW Smyrna-0.30 mi NW St. Maurice-0.40 mi W Saluda-0.40 mi E Dupont-0.50 mi W		Deputy-0.25 mi S Paynesville-0.40 mi NE Azalia-0.50 mi W Chelsea-0.90 mi NE		Paynesville-0.80 mi NE	

SEE REFERENCE AND FOOTNOTES AT END OF TABLE.

Table 3.9. Continued

	Rush Line	Columbus Line	345-kV Loop
Number of transmission lines crossed	7	5	1
Number of pipelines crossed	2	2	None
Dedicated land within 1.0 mile			
Wildlife preserves	Brush Creek State Fish & Wildlife Area-0.2 mi NW, 1841 acres	Muscatatuck National Wildlife Refuge-0.2 mi W, 8000 acres	
State parks and reservoirs	Brush Creek Reservoir-1.0 mi W		
Natural areas (private)	Conboy Woods[g]-0.5 mi E, 20 acres	Tribbett's Flatwoods[g]- < 0.01 mi W, 33 acres	
	Officer's Woods[h]-0.15 mi E, 85 acres		
	Slider Cave-1.0 mi E	Morris Cave-0.6 mi W	
Recreational areas	Camp Louis Ernest Boy Scout Camp-1.0 mi E, 160 acres		
Military reservations	Jefferson Proving Ground-0.2 mi E		

Adapted from ER, Table 3.9-1 and Supplement 3, and from information provided by the Indiana Department of Natural Resources.

[a]Acreages based on right-of-way width of 250 feet.

[b]Acreages based on right-of-way width of 150 feet.

[c]Refers to second- and third-growth hardwood, timber, and areas of pastured woodlots.

[d]Refers to agricultural farmland or pastureland cleared of timber except for wooded fence rows.

[e]Refers to prairie-type uplands typical of the region.

[f]Refers to small hills, stream cuts, and changing terrain typical of the dissected southeastern Indiana region.

[g]Terrestrial biological area with second highest priority rating set by the Indiana Nature Preserves Division, DNR.

[h]Terrestrial biological area with top priority rating set by the Indiana Nature Preserves Division, DNR.

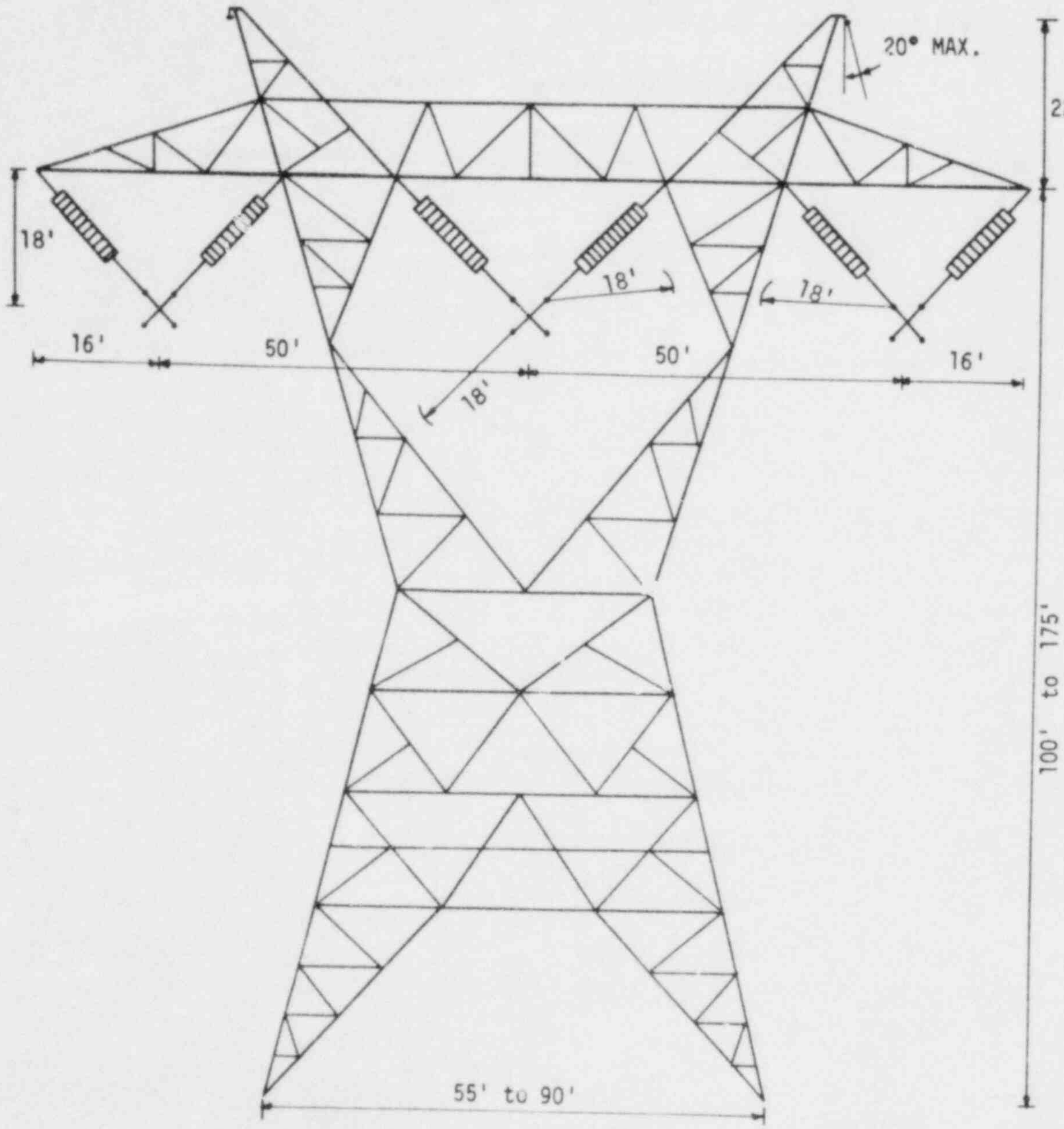

Fig. 3.11. 765-kV Single-Circuit Self-Supporting Tower. From ER, Fig. 3.9-2.

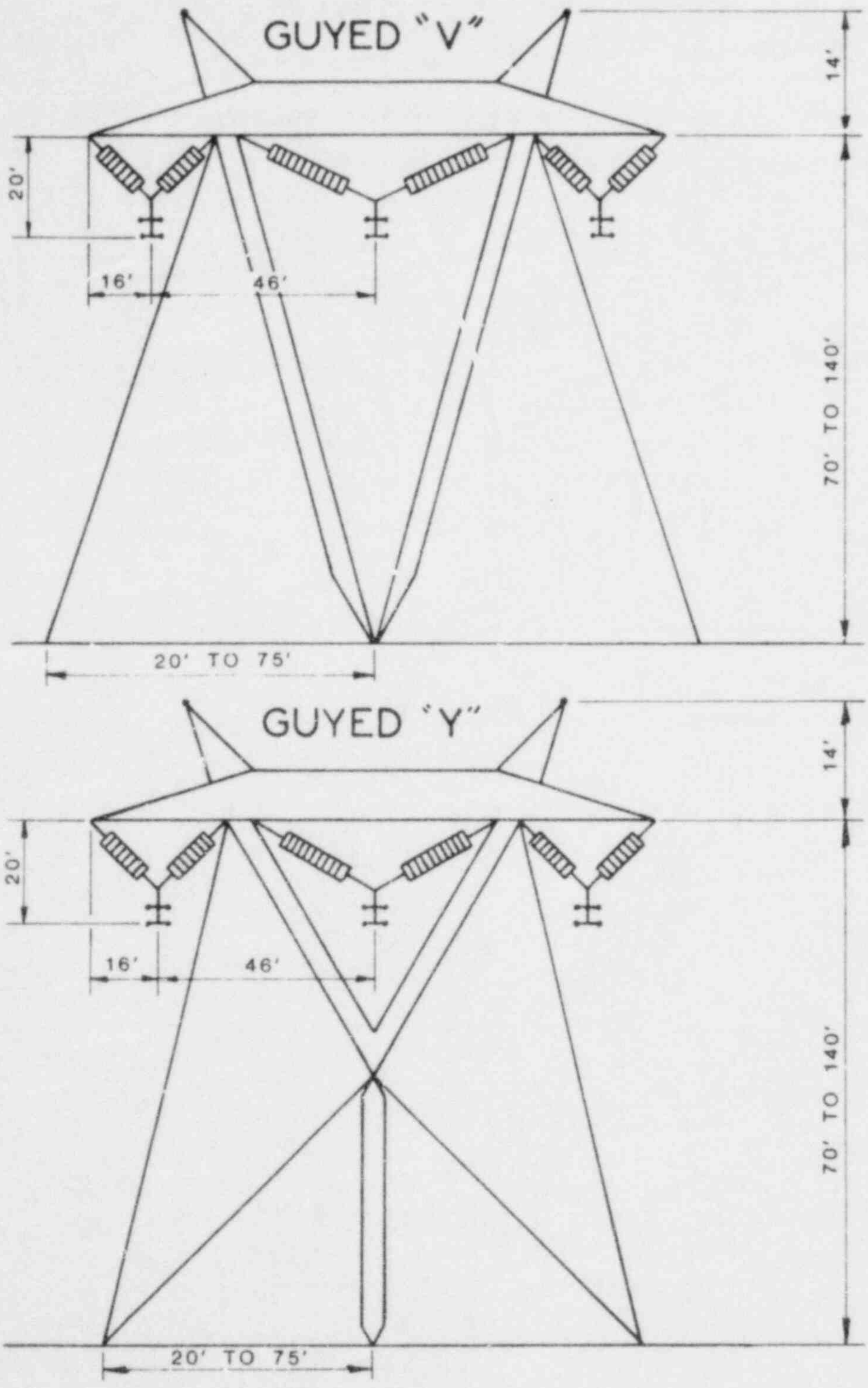

Fig. 3.12. 765-kV Single-Circuit Guyed Towers. From ER, Fig. 3.9-3.

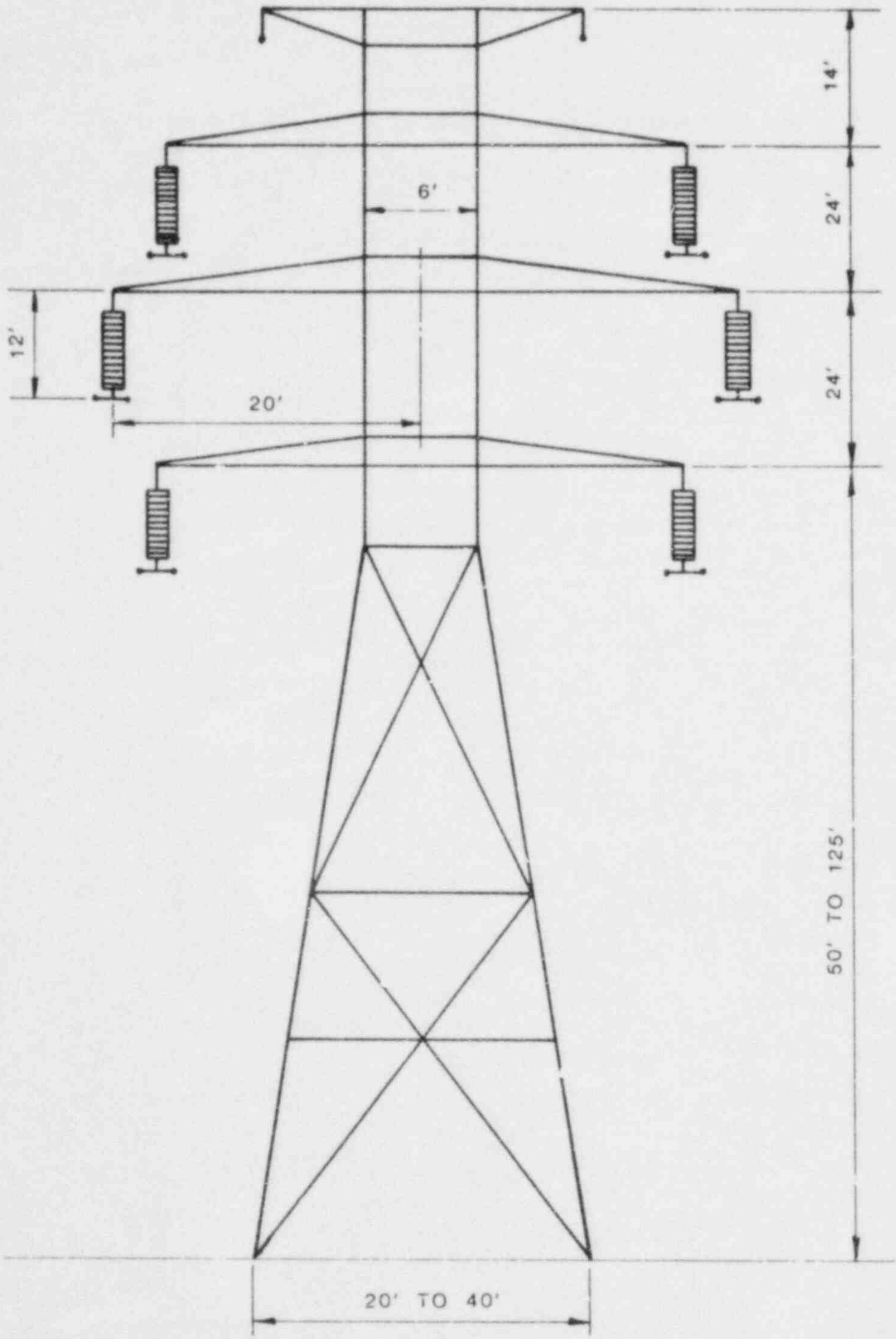

Fig. 3.13. 345-kV Double-Circuit Self-Supporting Tower. From ER, Fig. ?.?-4.

References

1. "Westinghouse Consolidated Reference Safety Analysis Report (RESAR-3)," Filed on 3 December 1973 with the USAEC.

2. "Indiana Natural Areas and Nature Preserves, by County, Map Number, Name of Area and State Division, Ownership, Priority and Type, Acreage and Location," Indiana Dept. of Natural Resources, Div. of Nature Preserves, Rev. 1 August 1975.

4. ENVIRONMENTAL IMPACTS OF CONSTRUCTION

4.1 LAND USE

4.1.1 Onsite

During construction about 250 acres (100 hectares) of the site will be disturbed, and 130 of these acres (53 hectares) will eventually have buildings, roads, transmission corridors, and other constructed facilities on them.

There has been agricultural production on 424 acres (170 hectares) of the 987-acre (400-hectare) site, if pastureland is included. About 45% was corn, 20% soybeans, and the remainder either winter wheat or left fallow. About 35% of the cropland in Jefferson and Clark Counties is used for double cropping of soybeans and winter wheat. In 1975 the worth of those crops that could have been produced onsite was about $16,000; this represents about 2.8% of the equivalent crop revenue for Jefferson County, and about 0.007% of that of the State of Indiana. The applicant calculates that the 1983 present worth of the foregone agricultural revenues at the site for 39 years will be $3,672,253 (ER, Sec. 8.1.3.3). The actual acreages lost will be 333.8 acres (135.1 hectares) of cropland, 82 acres (33 hectares) of pastureland. Twenty-five acres (10 hectares) of woodland will be destroyed, including 23 acres (9 hectares) of upland forest for part of the 765-kV switchyard and one to two acres (0.4-0.8 hectare) of slope forest for the makeup and blowdown lines. Based on a value of $1000/acre ($2500/hectare), this represents a cost of $25,000.

Eleven homes on the site will be razed or moved, and the 17 residents have moved. A number of ponds in the upland area will also be lost. Hunting in the forest area and fishing in Little Saluda Creek will be curtailed. Although 2579 small-game licenses and 753 deer tags were sold in Jefferson County in 1973, it is not possible to tell what proportion was used for hunting at Marble Hill.

Preparation of the site will be carried out in two stages. First, the areas to be occupied by structures will be stripped, excavated, and filled. Supporting facilities such as construction offices, drainage, unloading facilities, and water wells will then be developed (ER, Sec. 4.1.2).

The applicant proposes to control dust, smoke, engine exhaust, and concrete plant operations to minimize air pollution. Construction roads will be of crushed stone and they will be wetted during dry weather to control that source of dust. Trash and chemical wastes, including oil from cleaning, will be collected and will be hauled from the site and disposed of in a legally acceptable manner (ER, Sec. 4.1.2).

The staff believes that noise of construction could disturb local residents despite the low population density and remoteness of the site.

The applicant states that erosion will be controlled in part by the use of a settling pond and in part by revegetation where possible (ER, Sec. 4.1.2). In general, drainage patterns will be little altered and the settling pond will intercept runoff before it is discharged into natural drainages. Oil separators will be installed upstream of the settling pond to extract petroleum contaminants from runoff water. Riprap at the outlet of the pond will be so constructed that the velocity of debouching water will not exceed 2 ft/sec (0.6 m/sec). See Section 11.4.10.

Stabilization of erosion will be by grasses and/or legumes and the area will be permitted to revert to natural vegetation, except that areas around buildings will be planted in grass. There are some plans by the applicant to stockpile and reuse topsoil. Auxiliary facilities such as parking lots, laydown areas, and the switchyard will be graded with fill obtained from onsite excavations. Borrow areas will be revegetated.

The applicant claims that siltation in Little Saluda Creek will be no greater than that caused by agricultural practices in the past; the staff concurs that long-term effects of construction will not be serious although short-term (construction-period) effects might be severe and due precautions must be taken (see Sec. 4.5).

There are several areas of potential cultural-historical importance located on the site, including a 19th-century cemetery, two houses of potential local architectural significance, and 12 prehistoric sites. There are no landmarks in close proximity to the site listed in the National Registry of Natural Landmarks (see Sec. 2.9). The applicant has stated the intent to avoid construction in the cemetery area and to test-excavate the bottomland archeological sites if they are to be disturbed (ER, p. 8.2-6).

The Indiana State Historic Preservation Officer has called attention to the two nineteenth century houses on the site (ER, App. 2B). As discussed in the draft statement, a study was made to determine the architectural and historical importance of these houses. The Indiana State Historical Preservation Officer was satisfied that the two residences were of little value, and could be razed during construction. The staff concurs in this opinion.

In the draft statement the staff expressed the belief that the archeological reconnaissance of the station area was inadequate. A consulting archeologist of the National Park Service, Department of the Interior, concurred in this opinion (see App. E). The State Historic Preservation Officer also called attention to the problem of site recognition and stated that "care should be taken during excavation to report previously unrecorded archeological sites such as those that may have been covered by vegetation" (ER, App. 2B). Since the issuance of the draft statement, further conversations have taken place between the applicant's archeological consultant and the consulting archeologist of the Department of the Interior, regarding additional archeological surveying of the site and of the transmission line and rail spur corridors. A letter is expected from the Department of the Interior in the near future, detailing the understandings reached in these consultations. The applicant shall follow the recommendations of the Department of Interior in consultation with the State Historic Preservation Officer. If, during site preparation and construction activities, any presently known site or any located during the extension of the survey is to be disturbed, all activities in this area shall be suspended pending evaluation by the State Historic Preservation Officer.

4.1.2 Transportation

Transportation of materials to the plant will be by barge, State Route 62, or the Chessie System Railroad line, which comes within 10 miles (16 km) of the site. Use of this railroad would require construction of a spur line. Some of the spur will parallel the transmission corridor, but at least five miles (about 8 km) will be over other land. Road use would require upgrading of the county roads, and transport by barge would require building a barge facility at or near Madison, at the site, or at Jeffersonville (ER, p. 8.2-3C, and Supp. 1, p. 251). Since no barge facility has been proposed by the applicant, the assessments made herein do not include impacts from a barge slip.

4.1.3 Transmission Corridors and Railroad Right-of-Way

The evaluation of transmission line impacts is based on preliminary information from the applicant on corridor-width and routing. The transmission line corridor will require about 3475 acres (1390 hectares); 2365 acres (950 hectares) essentially open farmland, and 1110 acres (444 hectares) forested (ER, Table 3.9-1). The railroad right-of-way occupies 200 acres (80 hectares) of cropland and 45 acres (18 hectares) of wooded land. Construction of transmission lines will remove the farmland from production for one growing season. Applying the monetary yield of \$400/acre/year (see Sec. 4.1.1) found for the site to the lands of the transmission and railroad corridors, the staff calculates that the loss of revenue will be about \$915,000. Production lost during transmission-line operation will be restricted to 85 acres (34 hectares) occupied by tower bases and monetary loss will be about \$1,020,000 over the assumed life of the facility. The production loss from railroad spur operations is about \$2,400,000. If we assume that the forest, mainly oak-hickory,[2] is clear cut, and that the value of the wood that would have been grown is \$100/acre-yr (\$250/hectare-yr), then about \$15,000 worth of timber would be lost. Furthermore, the Rush Substation will require an additional 100 acres (40 hectares), as will upgrading of the

Columbus Substation; as a result, potential agricultural production valued at about $2,400,000 will be lost. The total loss for farm and forest can therefore be estimated as $6,850,000. This estimate may be regarded as being high, based on current prices and evaluations, but escalation of values resulting from inflation forces might well drive the value even higher. However, the staff's estimate is sufficiently conservative to take this into account. In addition, this monetary estimate does not take into account the reduction in the number of extensively wooded areas in Indiana, which is already small. The probability that none of the land will be returned to its present state after use must also be recognized.

During construction, laydown and storage yards will be spaced about every 40 miles (64 km) along the right-of-way. After completion, soil compaction will be ameliorated by discing and seeding the area. Construction field offices may be established at the storage yard areas but the applicant has not yet determined their spacing. It is planned to use oil company service stations as field offices and parking areas for construction workers.

The applicant states that archeological sites located before or during construction of transmission lines will be avoided, or action will be taken to minimize impacts (ER, p. 4.2-5, and Supp. 1, p. 26). The staff requirements on archeological site disturbance presented in Section 4.1.1 are also applicable to any site in the transmission line and rail spur corridors to be disturbed or destroyed. The applicant shall follow the recommendations of the Department of the Interior in consultation with the Indiana State Historic Preservation Officer.

4.1.4 Radiation Exposure to Construction Personnel

During the period between the startup of Unit 1 and the completion of Unit 2, the construction personnel working on Unit 2 will be exposed to sources of radiation from the operation of Unit 1. The applicant has indicated that this radiation exposure will be maintained "as low as practicable" through administrative procedures, physical barriers, locked buildings, and radiation monitoring.

The staff has estimated the integrated dose to construction workers to be about ten man-rem. This estimate is based on 1500 Unit 2 construction personnel being employed during the first nine months of Unit 1 operation and 700 personnel completing the last nine months of construction. Based on the applicant's estimate of numbers of construction personnel the staff concludes that this is a reasonable estimate. Estimates for other LWR's have ranged from 10 to 100 man-rem.

4.2 WATER USE

4.2.1 Surface Water

Construction of the Marble Hill Station will involve clearing of land, grading, pipeline trenching, hauling of soil, and similar activities that will denude areas, accelerate erosion, and increase siltation in adjacent waterways. Although the applicant will take measures to minimize erosion (ER, Sec. 4.1.2), some downstream siltation will be unavoidable.

The major impact of construction activities on surface water resources will result from construction of the intake and discharge structures along the Ohio River. These activities may interfere with commercial and recreational river traffic but such interference will be temporary and end with completion of construction. The applicant has not submitted detailed plans for construction activities along the river edge, but has stated that it "will adhere to the requirements of the U. S. Army Corps of Engineers and the EPA" (ER, p. 4.1-6). Inasmuch as there are no agricultural, domestic, or municipal water withdrawals from the river near the site, the staff considers that, with implementation of proper measures as required by the above-named authorities, there will be no unacceptable impact on the water quality of the Ohio River.

4.2.2 Groundwater

During station construction, sanitary- and construction-water needs will be met by wells to be developed in the Ohio River alluvial deposits just east of the site. An estimated average of 600 gpm (2.3 m^3/min) will be needed during the construction period. Pumped water will be stored in a holding tank (with a capacity of 150,000 gal or 570 m^3) thereby obviating the need for continuous pumping. As the Ohio River Valley aquifer can support pumpages of up to 1500 gpm (5.7 m^3/min), no consequential impacts are expected from the required pumpages during the construction phase.

No offsite water-table fluctuations caused by dewatering at the site are anticipated as it appears that no dewatering will be necessary.

4.3 ECOLOGICAL IMPACTS

4.3.1 Terrestrial

4.3.1.1 Site

The most serious impact of the station construction on terrestrial ecosystems will be the stripping of vegetation from about 250 acres (100 hectares) of former pasture, cropland, and a small section of hardwood forest. About half of this area will be returned to vegetative cover after construction. Upon the completion of site grading, the disturbed land will be reworked and seeded as necessary (ER, Sec. 4.1.2). To help eliminate soil erosion and later problems of reseeding, topsoil should be removed and stockpiled until after the underlying land is reshaped, and then respread over the land; the area should then be maintained in such a manner that revegetation is successful. (See Sections 4.5.2, 11.4.10 and 11.4.25.

Clearing vegetation from the site will cause a loss of habitat for several species of fauna as well as the mortality of some less-mobile fauna, such as soil invertebrates, herpetofauna, and small mammals. Initially much of the abandoned cropland on the station site will be disturbed, and most of those species that depend on this type of habitat for nesting or feeding will be forced to emigrate to similar areas. White-tailed deer, eastern cottontail rabbit, many microtines (mice, voles, shrews), mourning doves, bobwhite, eastern meadow lark, and some swallows and sparrows (see Table 2.8) are among the animals that are likely to be displaced by construction. This in turn may affect the quantity of food available and thus the foraging patterns of those species higher up on the food chain, such as birds of prey and other predators (e.g., red and gray fox, and coyote) dependent on old-field species for food. In addition, the removal of three small ponds will reduce breeding areas for some amphibians.

The noise from construction and other human activities will cause some species not otherwise disturbed by construction to leave the site area. Species such as the uncommon pileated woodpecker (a wary, secretive bird) are likely to leave the east-slope woods because of the noise.

The removal of about 23 acres (9 hectares) of upland mixed woods will reduce the amount of forest habitat available to species dependent on it. Species such as the fox squirrel, woodchuck, raccoon, white-tailed deer, woodcock, some raptors, and several nongame birds may be displaced by construction. Construction of the makeup and blowdown lines and the upgrading of the east-slope road will eliminate one to two acres (4000 to 8000 m^2) of east-slope woods. Because the total of 25 acres (10 hectares) of woodland represents only about 5% of the total wooded area on the site, the impacts to species indicative to those areas are expected to be minor.

About five acres (2 hectares) of ecotone and riparian habitats of the site will be disturbed for construction of the screen house, intake and discharge structures, and potable water lines and wells. Waterfowl (e.g., the wood duck), woodcock, white-tailed deer, and other species attracted to this type of habitat may be displaced by construction.

Birdkills from collision with station structures, transmission towers and lines are expected to be minor, with mortality occurring mainly during construction when floodlights are used. Electrocution of large raptors is not expected since transmission wires will be a minimum of 24 feet apart.

Construction of the station will have only a minor effect on the Federally protected Indiana bat, southern bald eagle, and osprey. Initially all of the species may be disturbed by the noise of construction, but little, if any, loss of habitat will occur, for these species would be expected to inhabit the north and east-slope area, where no construction will take place.

In the draft statement, the applicant was required to confirm the adequacy of the survey for possible impact on the critical habitat of the Federally protected Indiana bat, both on the site and in the transmission line and railway spur corridors. This inquiry resulted in two letters from the Department of Interior (Appendix F and G) which indicated that there was no critical winter habitat (caves) for the Indiana bat either on the site or along the transmission line and rail spur corridors. The staff estimates that a small part of its summer habitat may be slightly affected during the short period of construction at the site and along the corridors.

A protected Indiana species, the bobcat, will be forced to emigrate because of construction noise and loss of foraging habitat. It is possible that this species may find suitable habitat elsewhere, but the staff considers this to be quite unlikely. However, Indiana law protects the bobcat only from hunting, not from loss of habitat. Another protected Indiana species, the big-eared bat, although not observed, may occur on the site. The destruction of old buildings on the site will eliminate preferred habitat for this bat.

Sixteen recreationally or commercially valuable animal species occur on the Marble Hill site: white-tailed deer, cottontail rabbit, coyote, red fox, gray fox, striped skunk, raccoon, long-tailed weasel, gray squirrel, fox squirrel, muskrat, mink, bobwhite, American woodcock, mourning dove, and wood duck. Although station construction will eliminate some habitat of the white-tailed deer and cottontail rabbit, revegetation efforts after construction will restore some of this habitat. Large species such as deer will be kept out of the exclusion area by the exclusion fence. The coyote, red fox, and gray fox may also be disturbed, because these species are unlikely to become habituated to the increase in noise and human activities. All of the other mammals will suffer only minor loss of habitat. About half of the onsite habitat suitable for bobwhite and mourning doves will be disturbed.

Nine species of raptors may breed on the site, including three species presently on the regional Audubon Society's "blue list" (birds not on Federal or State endangered-species lists but that have experienced abnormal population declines in recent years), that will be affected by construction.[3] The loss of feeding habitat will greatly decrease the likelihood that these birds will nest on the site.

Adjacent communities not directly affected by construction activities may be indirectly affected by the displacement of wildlife from construction areas if the carrying capacity of adjacent areas is exceeded. In addition, the ability of an area to support wildlife may be decreased by overexploitation. Thus, the displacement of wildlife from the construction site can result in increased wildlife mortality and habitat damage, depending on the net number of animals displaced.

4.3.1.2 Transmission Corridors and Railroad Spur

The routes of the proposed transmission lines are known by the staff only within about a mile (1.5 km). Thus, the discussion of the ecological impacts of constructing them must be based on general considerations relating to the type of terrain being traversed.

The applicant has indicated that the transmission corridors will be prepared by clear-cutting, tailored clear-cutting, or selective clearing, depending on the terrain. Because selective clearing causes the least ecological damage to plants and wildlife and helps prevent soil erosion, the staff requires that this method should be used to the fullest extent practicable. The applicant will screen some of the corridors by planting dogwood, redbud, autumn olive, and gray willow. Merchantable wood will be stored parallel to the right-of-way until sold by the owner. Wood waste resulting from clearing or trimming will be buried, burned, piled, or hauled from the area in conformance with State and local regulations. To prevent erosion, all disturbed areas will be seeded immediately (weather permitting) with a mixture of perennial grasses or other plants consistent with the recommendations of the property owner and the U. S. Soil Conservation Service. The applicant will keep the number of construction access roads to a minimum.

The applicant plans to use herbicides in the construction and maintenance of the transmission-line rights-of-way (ER, Secs. 4.2 and 5.6). The herbicides, Silvex, 2,4-D, 2,4,5-T, Picloram, and Dicamba will be used to eliminate tall-growing tree species, and to prevent resprouting of stumps. The applicant plans to apply some herbicides by aerial spray. Aerial application will result in nonselective vegetation destruction and may damage some plants outside of the right-of-way; therefore the staff requires that aerial application be strictly limited (see Sec. 4.5.2). The staff recognizes that the use of herbicides is less expensive and may have several advantages over mechanical removal of vegetation, but there are potential environmental hazards associated with the phenoxy herbicides 2,4-D and 2,4,5-T. The EPA permits the use of these herbicides for right-of-way clearing and maintenance; however, both of these compounds have been implicated as possible teratogens (agents capable of causing birth defects or abnormalities).[4] Commercial preparations of 2,4,5-T may contain up to 0.5 ppm of dioxin, a compound that has been reported to be acutely toxic at 0.0006 mg/kg body weight in tests with guinea pigs.[5] The staff expects few adverse effects from moderate use of herbicides for stump or basal application to prevent regrowth of trees on the rights-of-way, but the staff considers application by nonselective spraying methods to be undesirable, even when precautions are taken to prevent drift dispersal outside the rights-of-way. Therefore, the staff requires that aerial spraying be used only in terrain inaccessible to ground transport and where the use of hand sprayers would not be safe or practicable. In addition to the potential hazard to human and other animal health, nonselective spraying removes shrubs and brush that provide habitat and cover for wildlife and do not affect the transmission lines; furthermore, it has been shown that the grassy rights-of-way are more quickly reinvaded by trees than a shrub corridor,[6,7] requiring more frequent application of herbicides.

The applicant should therefore restrict its use of herbicides to selective basal or stump application. The applicant has stated (ER, p. 4.2-5) that herbicides will not be sprayed on brush along streams or ponds and that spraying will be done about every four years. In addition, the staff will require the following precautions:

(1) Use of herbicides should be replaced by hand trimming and cutting in conservation, recreational, and residential areas. (Conservation areas are parks, wildlife refuges, scenic areas, campgrounds and protected woods).

(2) Herbicides should not be applied during or sooner than 4 hours after a heavy rain, nor when heavy rain is predicted within a few hours.

(3) Herbicides should not be applied in areas where contamination of water supplies is likely.

(4) Herbicide applications by broadcast foliar methods should not be made when winds are greater than five mph (8 km/hr).

(5) No formulation should be used whose dioxin (2,3,7,8-tetrachloro-p-dibenzoidioxin) impurity in the undiluted insecticide exceeds 0.1 ppm.

(6) Herbicides should be applied only by a licensed applicator or under his direct supervision.

(7) Herbicides should not be applied within 200 feet (60 m) of water bodies.

These requirements are intended to be consistent with the standards for herbicide usage developed by the EPA and by the State of Indiana.

The greatest ecological impacts of construction of transmission corridors will occur in areas where the lines traverse forest land. About 1110 acres (444 hectares) of forest habitat will be eliminated. To minimize the impacts to forested land, the applicant shall follow the "Recommended Wildlife Practices for Utility Line Rights of Way through Classified Forest Land" set forth by the Division of Forestry, Indiana Department of Natural Resources, where the corridor traverses Classified Forest Land. Even with the use of approved practices, the elimination of this much forest habitat will result in the mortality or displacement of many species of wildlife that depend on this habitat for survival. In addition, the displacement of wildlife can result in increased wildlife mortality and a temporarily reduced carrying capacity (due to overexploitation). The creation of long stretches of open land through forests could lead to an increase of animal and plant diversity in the area, whereas those species requiring unbroken forest in which to live could be displaced.

The ecological impact on Federal and State protected species is unknown. The applicant has committed (ER, p. 4.2-7a, and Supp. 1, pp. 150-151) to avoid important breeding or nesting areas of these species (such an area is defined by the applicant as a single den or nest of a rare species or an unusually high breeding concentration of a more common species). The staff considers the commitments adequate for the protection of these species.

The staff requirements (see Sec. 4.5.2) for the erection of transmission lines are consistent with concerns of the Division of Nature Preserves of Indiana, the Division of State Parks of Indiana, the U. S. Department of the Interior, and the Department of the Army, who made the following requests. The edge of the right-of-way should not be closer than one-half mile (0.8 km) to Officer's Woods and Tribbet's Flatwoods.[8,9] These natural areas have been set aside for scientific research, educational and cultural programs, esthetics, practical benefits such as the protection of rare or endangered species, and for long range socio-economic benefits.[10] The line should not be closer than five miles (8 km) to Clifty Falls State Park to keep the line out of sight of the park visitors.[11] The manager of the Muscatatuck National Wildlife Refuge stated that the tentative location of the transmission corridors "would be detrimental to Refuge Objectives."[12] The staff believes that these objectives could be preserved by routing the right-of-way not closer than one-half mile (0.8 km) to Muscatatuck National Wildlife Refuge to avoid interference with waterfowl flight patterns into the refuge and, in addition, will require that the applicant not use herbicides within the local drainage basin of the refuge. The lines should be a minimum of 0.2 mile (0.3 km) from the perimeter of Jefferson Proving Ground to avoid interfering with the proving ground's chronometers.[13]

In response to these letters and comments, PSI examined the proposed transmission line corridors where they came close to sensitive areas. In Dr. James Coughlin's letter of April 14, 1976 to Mr. H. R. Denton of NRC, PSI indicated that the corridors would approach these areas no closer than 800 feet to the west boundary of Officer's Woods, 1500 feet from Tribbet's Flatwoods, 4.4 miles west of the Clifty Falls State Park, 4400 feet from the Muscatatuck National Wildlife Refuge, and 2300 feet west of the Jefferson Proving Grounds. Three of these distances are shorter than requested, but the staff considered PSI's reasons for not increasing them to be valid. Therefore, the staff has substituted these distances in item 4 of Section 4.5.2.

4.3.2 Aquatic

Impacts on aquatic biota will occur during the construction of buildings onsite, the intake and discharge structures on the Ohio River floodplain, and the transmission and the railroad spur corridors offsite. The main effects of plant construction will be due to increased suspended solids and chemicals in site runoff and elimination of aquatic habitat during construction of the intake and discharge structures and railroad spur. The greatest potential for construction impact on aquatic biota will probably be associated with the transmission and railroad corridors, because 51 offsite streams will be crossed (see Table 2.11).

4.3.2.1 Runoff

According to Cairns,[14] increased concentrations of suspended solids can affect aquatic organisms by (a) mechanical and abrasive actions, (b) increasing sedimentation, (c) reducing light intensity, (d) increasing numbers of microbes by increasing surface area available to them, (e) affecting adsorption and/or absorption of various chemicals, and (f) by their effect on water-temperature fluctuation. These effects could reduce food availability to fishes in Little Saluda Creek and the 51 offsite streams by (a) smothering benthic invertebrates, (b) clogging the feeding apparatus of invertebrates (thus increasing their mortality), and (c) reducing fish visibility sufficiently to prevent them from locating food items. Another important effect could be a decrease in hatching success of fish eggs.[15] If suspended solids settle out and cover the fish eggs, oxygen uptake is decreased and greater egg mortality can be expected. Potentially toxic chemicals, such as oils, may also enter the stream via runoff during construction.

The applicant plans to control runoff by means of a settling pond during site preparation and construction; however, it is likely that some increase in suspended solids in runoff entering Little Saluda Creek will occur, especially during periods of high precipitation. This may also be the situation for streams crossed by the transmission lines, especially if clear-cutting and bank alteration is involved. Long-term impacts from site runoff will be avoided by implementation of runoff control measures outlined in Section 4.5. Inasmuch as Little Saluda Creek is a tributary of the Ohio River, some increases in suspended solids in the river may result; however, because of the small size and intermittent nature of the stream and the chronic high turbidity of the Ohio River, the increases will be relatively insignificant. No runoff is expected to enter the Ohio River directly because the plant site is located on a bluff 350 feet (105 m) above the Ohio River floodplain.

Serious runoff effects where transmission and railroad spur corridors cross offsite streams can be avoided by leaving 100-foot (30-m) wide vegetated buffer zones on each side of the crossing. Also, tower bases shall be located above floodplain levels to the extent practicable. Areas disturbed by railroad spur corridors will be stabilized to minimize erosion.

4.3.2.2 Temperature

In addition to the potential direct impact to runoff from the transmission corridors and railroad spur, clear cutting of vegetation along stream banks can increase the water temperature due to greater insolation.[16] Increased temperatures may inhibit spawning or may make the waters in the affected area of the stream unsuitable for habitation by some species.[17] However, in view of the small area of each stream that is affected (≈ 250 feet) it is highly unlikely that any significant increase in stream temperatures will occur. The staff concludes that optimum spawning temperatures for fishes (Table 2.17) that may spawn in these streams will not be exceeded as a result of construction of the transmission and railroad spur corridors.

4.3.2.3 Habitat Elimination

Some direct loss of benthic habitat, and its associated fauna and flora, will occur when the discharge and intake structures are built. The discharge structure will barely extend into the Ohio River at 420 feet (128 m) MSL. The intake flume is about 23 feet (7 m) wide and will extend 120 feet (37 m) into the river at 420 feet (128 m) MSL (ER, Supp. 3, p. 41). The combined loss of benthic habitat for the two structures should be about 0.1 acre (400 m^2). In view of the size of the Ohio River and the large amount of benthic habitat therein, this loss will be negligible. During construction of the intake and discharge structures precautions will be taken to minimize the amount of siltation during dredging and other construction activities. The dredge spoil will be disposed of offsite (ER, Sec. 4.4.3.7).

Some benthic habitat will be eliminated in the seven streams crossed by the railroad spur if culverts are used. Four of these streams are intermittent and benthic losses therein will be negligible. Use of culverts in the remaining three st ıms should not cause serious losses of benthic habitat.

4.3.2.4 Recreational

Although there will be a temporary interference with recreational activities along offsite streams during construction of transmission and railroad lines across the streams, the staff assesses this impact as moderate and of short duration.

4.3.2.5 Conclusion

With implementation of the required mitigating procedures (see Sec. 4.5.2), it is unlikely that any serious long-term impacts will result to the aquatic biota as a result of construction of the proposed station. The assessments made above and this conclusion are based on general considerations of terrain, soil type, stream characteristics, etc. Should evidence accumulate in the future that construction impacts are more severe than those evaluated herein, the applicant shall submit to the staff a plan to eliminate or materially reduce the excessive impacts, as required in paragraph 7f of the Summary and Conclusions, *supra*.

4.4 SOCIAL AND ECONOMIC EFFECTS

External impacts associated with the construction of the Marble Hill plant will be extensive. The immigration of workers and their families will produce a dislocation in the supply of consumer products and private services. A noticeable strain will be placed on schools, police, sanitary landfill and fire services currently provided to residents of Jefferson County. This section will provide an analysis of the temporary external impacts associated with the construction of the Marble Hill station.

4.4.1 Construction Employment

4.4.1.1 On-site Requirements

A number of potential impacts on Jefferson County can be expected during the construction phase. These impacts are directly related to the commutation of laborers, the in-movement of new households, and changes within the local economy.

The annual schedule for the construction work force is presented in Table 4.1.

Table 4.1. Annual Schedule of Construction Work Force

Year	Number of Workers Per Quarter			
	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec
1976	6	6	9	9
1977	21	36	270	391
1978	685	752	1034	1221
1979	1573	1735	1941	2030
1980	2079	2180	2179	2178
1981	2127	2026	1733	1571
1982	1424	1267	788	614
1983	527	448	-	-

From ER, Table 4.1-1.

This schedule is based on the applicant's estimate that construction would begin on July 1, 1976. The staff estimates a starting date several months later. Table 4.2, which is derived from the applicant's construction work force schedule, indicates that approximately 2,000 workers will be at the Marble Hill site during a 3-year period, 1979 to 1981.

4.4.1.2 Regional Construction Labor Market

The construction of a nuclear power station requires not only a large number of individuals but many with very specialized skills. Most of those who will work on the Marble Hill station will be drawn from a broad labor shed. To determine possible sources of labor and the size of the pool, the staff took into consideration (1) distances travelled by construction labor, (2) the location and availability of local labor pools, and (3) regional access roads. From this analysis, the staff has determined that the potential labor shed for Marble Hill is bounded by Louisville, Lexington (Ky.), Cincinnati (Oh.), and Columbus (Ind.). The farthest city, Lexington, is approximately 90 miles from the site. Within the 28-county area described by these points, 52,402 people were employed in the construction industry in 1970.[18] Moreover, within this regional labor shed, there exists a reservoir of power plant construction experience; currently, fifteen operating power stations are located on the Ohio River between Indiana and Kentucky.[19]

The general unemployment rate for the labor market area in January 1976 was 8.2%. Unemployment in Jefferson County at this time was 12.7%[20] However, conversations with local labor union representatives indicate that employment in the construction trades had been particularly affected by the recession and that unemployment may be closer to 20%[21]

TABLE 4.2

ANNUAL CHANGES IN CONSTRUCTION WORK FORCE

YEAR ENDING	PEAK NUMBER	CHANGES FROM PREVIOUS YEAR	MEAN NUMBER	CHANGES FROM PREVIOUS YEAR
1976	9	9	8	8
1977	391	382	180	172
1978	1,221	830	923	743
1979	2,030	809	1,820	897
1980	2,180	150	2,154	334
1981	2,127	-53	1,864	-290
1982	1,424	-703	1,023	-841
1983	527	-894	488	-535

SOURCE: Derived from E.R., p. 4.1-6.

Because of Marble Hill's proximity to areas of population and the availability of regional highways, the applicant expects that only a small number of workers would move their families into the Madison area (ER, p. 8.2-3). The staff concurs in this opinion. Workers drawn to the project from beyond the regional labor shed, including PSI and contractor supervisory personnel and workers with highly specialized nuclear facility construction skills, may wish to live in the Madison/Hanover area to minimize commuting distance. In addition, some portion of the local population -- experienced members of the labor force and entry level workers -- will be attracted to the Marble Hill project, thus increasing the participation of the local labor force.

4.4.2 Stress on Community Facilities and Services

There will be increased demands on community facilities and services from construction workers and their families who temporarily relocate to Jefferson County. These workers and commuting construction workers will add to local traffic and increase impacts on local roads.

For the purposes of the impact analysis which follows, the staff believes that the number of construction personnel attempting to relocate in response to the Marble Hill project will not be greater than about 200. The staff further believes that most of the inmigrants would be married, with 1.5 children on the average, and would settle in the Madison/Hanover area. In 1980, the year of peak construction employment, 9,550 households with a population of 29,383 would live in Jefferson County (see Table 4.3).

4.4.2.1 Vehicular Traffic

Local roads and the number of cars passing specific points per day are shown in Figure 4.1 (ER, Fig. 2.2-3). Although onsite construction traffic will be managed by the development and regulation of a road system and parking area that will allow for smooth traffic flow (ER, pp. 4.4-1, 4.1-5), roads in Jefferson County will experience an increase in use. This increase will primarily involve commuting workers (2200 maximum) but may also include the movement of some construction vehicles.

Three kinds of impacts are expected from increased traffic. First, an increase in accident frequency may be expected, particularly during periods of heaviest road use. Secondly, county residents will be inconvenienced by heavy traffic on local roads. Traffic congestion on the two-lane Ohio River bridge at Madison is a potential problem. Delays during peak traffic flow and during the tourist season probably can be expected. Residents in the area of the plant site will be inconvenienced by increased traffic on State Road 62, which is the primary access road to the site. Some local roads may be obstructed by plant traffic (ER, p. 8.1-8a) which could increase congestion and inconvenience. Thirdly, increased use of local roads and municipal streets by commuting workers and by construction equipment may cause structural damage to these highway systems. Although precise shipping plans have not been formulated, legal load limits on roads will be met or variances from appropriate government agencies will be obtained. Most of the heavy equipment to be used on the site will be transported by rail on PSI's spur (ER, p. 8.2-3).

Table 4.3

HOUSEHOLD PROJECTIONS WITHOUT MARBLE HILL

	1970	1975	1980	1985	1990
Households	7,890	8,620	9,350	10,275	11,200
Total Persons	27,006	28,470	29,933	33,693	33,453
Household Population	24,798	26,741	28,683	30,318	31,953
Persons/Household	3.14	3.10	3.07	2.95	2.85

Source: Vogt, Sage and Pflum Consultants, Comprehensive Plan Report: Jefferson County, Indiana (n.p., 1973), p. 41; staff estimates for 1975 and 1985.

PSI has stated that heavily traveled roads near the site may be improved to insure local safety and may be provided with turn-around areas where roads are closed to local traffic (ER, p. 8.1-8b).

In response to a staff request in the draft statement, PSI investigated the feasibility of bus service for transporting construction workers.[22] Three bus companies in Indiana and one in Louisville, Kentucky were contacted. They stated willingness to consider additional bus service to the site vicinity if a sufficient market were demonstrated. Special charter service would be more convenient, but would be more expensive. The staff believes that the impacts of plant construction on traffic congestion, and on the potential for accidents, would be mitigated by staggered work shifts and by the provision of incentives by the applicant for car pooling and for bus service to the site. Accordingly, the staff requires that the applicant, within 30 days of the issuance of this statement, submit plans to mitigate these impacts for the staff's review and evaluation.

4.4.2.2 Impact on Housing

The impact on housing during the construction phase will be felt most notably in the rental and mobile home submarkets. Only a marginal number of workers will seek sale housing; such households could be accommodated within the existing and vacant-for-sale stock.

Between 1970 and 1980, it has been estimated that the housing need in Jefferson County is 260 units per year. Housing need is defined as that number of housing units required to accommodate (1) projected household growth in the County, (2) the removal of presently substandard and future substandard units from the inventory, and (3) the in-movement of 200 construction labor households (see Table 4.4). Building permits in recent years have been granted at the rate of approximately 230 units per year (see Table 2.20).

Although current construction activity falls short of projected demand, the staff anticipates that the housing market will be able to accommodate the in-migrating workers. This conclusion is based on three factors.

First, housing need includes the removal of substandard housing units. Many of the substandard units are occupied by households whose incomes are below the level served by private, non-publicly-aided enterprise; without public subsidies these units will remain on the market. Second, the staff expects that construction activity during the latter half of the 1970's will surpass levels of activity recorded during the economically depressed 1971-1975 period. Third, conversations with people familiar with the local housing market indicate that both mortgage money and construction labor are readily available.[23]

The bulk of the relocating construction work force will probably seek mobile home sites in park developments. In 1970, there was a total of 7 mobile home parks with a combined capacity of 105 trailers located in Madison and Hanover.[24] Although the number of current vacancies may not be sufficient to accommodate more than a limited number of workers, the rapid expansion of mobile home sites in park developments is feasible. Madison Mobile Homes has a developable site for over 100 homes adjacent to its existing park; this facility has access to both city water and sewers.[25] Trailer sites are also available on the grounds of Madison State Hospital and the Jefferson Proving Ground.[26]

The staff expects that a small number of the households relocating to the Madison/Hanover area -- perhaps 40 households -- will choose to live in rental apartments. These households should find rental housing in either newly constructed or rehabilitated units, or in hotel and motel rooms.

The small number of workers seeking more temporary rental housing would preclude any shortage of tourist accomodations.

TABLE 4.4

ESTIMATED HOUSING NEED IN JEFFERSON COUNTY:[1]

1970-1980

Household Growth[2]	1,460
Existing Substandard[3]	930
Replacement Due to Obsolescence and Other Causes[4]	310
Construction Worker In-Movement	200
	2,900
Existing Vacant	300
Estimated Need: 1970-1980	2,609
For Sale	1,800
For Rent	800

SOURCE: Staff estimates.

1. This analysis assumes that conversions are not a significant factor in determining the size of the housing stock and that present owner-rental relationships will be maintained in the future.

2. Vogt, Sage and Pflum Consultants, Comprehensive Plan Report: Jefferson County, Indiana (n.p., 1973), p. 41.

3. Occupied housing units lacking some or all plumbing.

4. Deterioration factor used by State of Indiana for Region 12; cited in Indiana Department of Commerce, Division of Planning, Indiana Housing Needs and Resources: A Social Priority (Indianapolis: State of Indiana, n.d.), p. 36.

The total estimated housing stock in the Madison/Hanover area in 1975 was 6,634 units. Projected growth in this area attributable to county residents between 1975 and 1980 is estimated at 476 households, or 7.2% of the base (1.4% compounded annually).[27] The expected increase in demand due to Marble Hill construction workers will not be greater than 200 additional housing units. However, this demand will be made on various sectors of the county's housing stock. For instance, although the bulk of workers will probably live in mobile homes, others will share rooms in hotels and motels or rent apartments and homes. The staff's analysis indicated that obstacles to the provision of adequate new housing, including mobile home sites, and the rehabilitation of existing substandard structures do not exist. The staff concludes that the inflationary effect on rents in the Madison/Hanover area will be negligible (see also ER, p. 8.2-2).

Local residents have expressed a concern that temporary housing developments in rural areas such as Saluda Township would produce undesirable changes in their local life style.[28] The staff believes that housing development attributable to the construction of Marble Hill Station will occur in the urbanized portions of the County, that is, in the Madison/Hanover area, and not in the rural areas of the County. Moreover, it should be emphasized that changes due to construction workers will be temporary.

Finally, through its zoning and enforcement powers, the County is able to control the location of mobile homes, either in park developments or on isolated sites.

4.4.2.3 Schools

As Table 4.5 indicates, the total school-age population of Jefferson County should remain stable over the next 15 years. However, the projected student enrollment in the Southwestern Consolidated School District is expected to increase. Between 1975 and 1980, Southwestern can expect an increase of 247 students, a 14% increase (see Table 4.6). Reference to Table 2.8 indicates that the capacity of existing facilities will scarcely accommodate the increase of students projected for the District by 1980.

Assuming an average of 1.5 school-age children per construction worker household, the staff would expect 300 or fewer additional students in Jefferson County by 1980. These students would represent less than a 5% increase in enrollment. Any portion of these students locating in the Hanover area would represent a burden to the Southwestern District system. On the other hand, 300 additional students could be absorbed in 1980 by the Madison Consolidated District which the staff expects will be more underutilized than at present. The added students would create the need for approximately 14 teachers to preserve current student-teacher ratios and approximately 5 school buses.

According to the State law, there may be a delay of 18 months between tax assessment and full payment. Because of this delay, tax revenues from the Marble Hill Station may not be generated soon enough to meet the initial demands on the Southwestern District by the children of construction workers. Over the long term, the staff assumes that the tax revenues generated by the Marble Hill Station at least will balance those demands on the Southwestern District. The Madison Consolidated School District will not receive tax revenues from the station to defray the cost of service demands arising from students from construction worker households living in this District.

4.4.2.4 Hospitals

Current service relationships in King's Daughter's Hospital (See Table 2.27) in Jefferson County compare favorably with those prevailing throughout the State of Indiana and in the United States. The administrator of this hospital has stated that the anticipated additional demand for hospital services by construction workers could be accommodated. (Summary Report for Site Visit by NRC staff in August, 1975).

In addition to the local facility, PSI's prime contractor will maintain a field medical office, an ambulance, and a nurse onsite during construction for the treatment of emergency cases.

TABLE 4.5

ESTIMATED SCHOOL-AGE POPULATION:

1975-1990

Age Group	1975	1980	1985	1990
5-18	6,455	6,423	6,412	6,401

SOURCE: Adjusted data from Vogt, Sage and Pflum Consultants, Comprehensive Plan Report: Jefferson County, Indiana (n.p., 1973), p. 40.

TABLE 4.6

SOUTHWESTERN JEFFERSON SCHOOL SYSTEM ENROLLMENT PROJECTIONS: 1975-1985

	ACTUAL		PROJECTED		
	1970	1975	1975	1980	1985
K-6	892	911	1,019	1,161	1,323
7-8	247	268	285	325	371
9-12	415	514	473	540	615
TOTAL	1,554	1,693	1,776	2,023	2,304

SOURCE: James and Berger Associates, Base Studies: Jefferson County Comprehensive Plan (n.p.; 1971), p. PF-51. Actual data for 1975 contained in a letter from Mr. Isaac Hogg, Superintendent of Southwestern Jefferson County Consolidated School, to Ms. Sue Ann Curtis, Argonne National Laboratory, August 25, 1975.

The medical demands of 2,200 construction workers at peak ar ıpproximately 500 dependents in the Madison/Hanover area during construction could become a rden on existing medical facilities. This added demand will increase the urgency of the plans to replace and upgrade existing facilities to meet future growth. Other hospital facilities within a 25-mile radius (See Section 2.8.2.4) will also help meet the increased demand on King's Daughter's Hospital during the construction phase.

4.4.2.5 Recreation and Tourism

Public and private recreational facilities are expected to receive an increase in use proportional to the number of persons that may temporarily move into the Madison/Hanover area. However, the County's 1971 consultant study indicated that, although new facilities may be desirable to attract an increase in tourists, "the existing recreation facilities are expected to be generally adequate for county residents throughout the planning period" (that is, until 1990).[29] Tax revenues from the Marble Hill station will offer the county an opportunity to provide those facilities which would be attractive to tourists.

PSI anticipates that the construction and operation of the plant will have no adverse impact on the current recreational use of the Ohio River near the plant (ER, Supp. 1, p. 8.2-8). Similarly, no impact is foreseen on the use of Clifty Falls State Park (ER, Supp. 1, p. 8.2-8). The staff concurs in these assessments. However, as indicated in Subsection 4.3.2.4, the construction of transmission lines for the Marble Hill station will result in a moderate, short-term interference with recreational activities along offsite streams. Finally, the construction activities in the Marble Hill area should not impact the level of tourism in the county, except for the traffic effects indicated in Section 4.4.2.1; in fact, PSI's visitor's center in Madison may serve as a tourist attraction.

4.4.2.6 Public Water, Sewage, and Waste Systems

The discussion of water supply in the Madison/Hanover area (Section 2.8.2.2.2) indicated unused capacity of approximately 2.1 million gallons per day in 1975. By 1980, increased daily demand from 200 construction labor households (700 people) and from the expected 1975-1980 population growth (1,465 people) should equal 324,800 gallons per day, or approximately 15% of existing excess capacity. The staff considers this increase well within the capacity of the water system.

The applicant has also stated that only limited pumping from wells in the site area would occur to supply potable water for construction workers. Since no primary dewatering is planned, the effect of site construction on groundwater is expected to be negligible (ER, p. 4.1-5).

Data presented in Section 2.8.2.2.3 indicated that both the Madison and Hanover sewage systems were operating at far below estimated effective capacity. Using a standard of 100 gallons per person per day, the staff estimates that each system could accommodate normal expected population growth and the construction household in-movement.

During construction, chemical toilet facilities will be used onsite and waste disposal will be accomplished in an environmentally acceptable manner. The applicant states that no adverse effect on water use will occur from this method of sewage treatment and disposal (ER, p. 4.1-5).

Estimates of the useful life of the county's sanitary landfill site vary from 5 to 10 years under current trends. Its use by as many as 200 construction labor households will shorten its useful life.

The staff believes that rubbish and garbage services will not be seriously impacted by the demand from the construction worker households.

4.4.2.7 Police and Fire Services

Although State and City forces are above acceptable standards in terms of manpower and equipment, the County Sheriff's Office is currently understaffed. The in-movement of 200 families and the daily commuting of 2,000 workers will, by 1980, stress the Sheriff's Office, particularly in matters of traffic control and surveillance. At a recommended standard of 1.5 male officers per 1,000 population, the Sheriff's staff should be augmented by 5 full-time deputies and 4 to 6 police-equipped vehicles.[30] Taxes from the Marble Hill station could be used to increase the service capabilities of the Sheriff's Office

Onsite security functions will be performed by guards hired by PSI rather than by local police forces. (ER, p. 8.2-4).

As discussed in Subsection 2.8.2.4, current fire protection services do not meet guidelines established by the national insurance rating organization the American Insurance Association, primarily because of distance from property. New residents associated with the construction of Marble Hill would aggravate this problem, but it is expected that increased taxes from the Station will enable the County to replace aging equipment and to add new equipment as needed.

4.4.3 Other Impacts on Community Life

4.4.3.1 Inflationary Impact on Prices

Personal income and retail trade in Jefferson County are expected to rise by 2.7% and 9.7%, respectively, at the peak of the construction period, compared to their values in 1972.[31] The staff expects these rises to result in moderate local price increases.

4.4.3.2 Shortages of Experienced Labor and Craftsmen

The wage levels paid by PSI and its contractors will probably be higher than those paid by many other employers in Jefferson County. The staff expects that a small fraction of the local skilled labor force, notably plumbers, electricians, and manufacturing workers, may leave their current employment to work at the Marble Hill site. This development will have two principal effects. First, local residents may experience difficulty in hiring craftsmen for home and business repairs. Second, local employers in the manufacturing sector may experience higher than usual levels of turnover as employees leave their current jobs. The extent to which these effects will occ - is impossible to estimate; however, the effects will be felt only during the construction p. iod.

4.4.3.3 Noise and Aesthetic Disturbances

Construction activities during the early stages of site preparation will involve clearing, excavation, trash disposal, land filling, and grading. These operations, in addition to adversely affecting existing terrain features, will produce a variety of pollutants including noise, dust, smoke, and engine exhaust. These temporary disturbances should have minimal impact because of the low population density near the site (ER, p. 8.2-4). Nevertheless, the applicant will undertake a program to control dust, noise, oil and chemical wastes, and other physical impacts of construction (ER, pp. 4.1-5, 4 4-1 to 4.4-3, 6.1-47a, and Supp. 1, p. 233).

4.4.3.4 Relocation

The acquisition of the 987 acres of land for the Marble Hill station required the relocation of 17 residents from the seven permanent residential dwellings located on the site. As of September 1974, all resident families had reached acceptable agreements with the applicant for their properties; some of these families have relocated (ER, p. 8.2-5).

4.4.4 Stimulation of Local and Regional Economies

4.4.4.1 Direct Payroll and Employment

The applicant has estimated that an average of 1,100 workers per year during the 6-1/2-year construction period will result in a total payroll of $358,550,000 (see Table 4.7). Approximately 85% of this total will be for salaries of construction personnel living within the labor shed defined in Section 4.4.2.2 (ER, Supp. 1, p. 8.1-8). The staff views these estimates by PSI as being reasonable.

TABLE 4.7

CONSTRUCTION PHASE EXPENDITURES

Expenditures	1983 Future-Worth Dollars	
Outside of the Region		
Equipment	$554,198,033	
Labor	53,782,734	
Indirect Expenses	196,088,818	
Transmission	16,812,655	
Subtotal		$820,882,240
Within the Region		
Materials	$ 35,374,343	
Labor	304,768,827	
Land	9,200,916	
Transmission	34,025,610	
Subtotal		$383,369,696
TOTAL		$1,204,251,936

SOURCE: ER, Supp. 1, p. 8.1-7.

Semi-and unskilled laborers constitute a large segment of the local unemployed work force in Jefferson County. Their recruitment for station construction may have the desirable effect of reducing the present high unemployment rate. The possibility of several years of employment may attract some workers from their farm, service, and manufacturing jobs into unskilled jobs at the Marble Hill site.[32] However, positions vacated in manufacturing and service firms will more than likely be filled by local residents who are currently unemployed.

4.4.4.2 Local Purchases of Materials and Special Services

PSI anticipates that 3% of the construction cost of the Marble Hill station will be spent on equipment and material purchases in what is broadly described as the "immediate region." Approximately $35,374,000 will be spent on such items as small tools, cement, stone, sand, pre-cast roof slabs, valves, wire, conduit, and fittings (ER, Supp. 1, p. 8.1-8). The average annual expenditure in the local economy due to construction of Marble Hill station would be approximately $5,442,000, or an increase of 9.7% over Jefferson County's retail trade in 1972. Other local businesses, particularly automobile service and repair, restaurants, and general merchandise stores, will benefit from the increased purchases of construction workers.

As construction of the plant moves toward completion, the demand for goods and services in the Madison area will probably decrease. However, the decline will be gradual enough to permit readjustments in inventory and personnel by local businesses. One consequence of this retrenchment will be an increase in local unemployment rates if other employment does not become available locally. A fraction of the personnel required for plant operation may be taken from the local labor pool.

4.4.4.3 Capital Formation Effects

The Marble Hill station will stimulate capital formation in the region. One area that could be of significant magnitude is housing. At the peak of the construction period, approximately 200 workers and their families will have relocated in the general Madison/Hanover area. This demand will generate a need for about 40 new rental housing units. At an average value of approximately $20,000 per housing unit, the staff believes this could amount to a $800,000 increase in the value of Jefferson County's housing supply. In addition, capital formation, in the form of new mobile home parks and improvements to existing dwellings, may also be realized.

4.4.4.4 Multiplier Effects on the Local Economy

A conservative estimate of PSI's expenditures at the peak period for labor, goods, and services is $7.8 million: $5.4 million for goods and services, and $2.4 million for labor (240 workers at $10,000 annual wages). However, for each dollar spent locally by PSI and its local labor force, there will be additional economic activity and personal income generated within Jefferson County. A conservative multiplier of 2 would appear reasonable; therefore, the above $7.8 million per year would become $15.6 million of induced activity.

4.4.4.5 Property Values

Property values for land in the vicinity of the Marble Hill site have, in the past, been based upon its productivity in agricultural use. Average yield for agricultural land in Jefferson County has been about $300 per acre, and land values in the neighborhood of the proposed station range from $400 to $700 per acre, depending upon local conditions.[33] Current and future relative property values in agricultural use should not be significantly influenced by the construction of the Marble Hill nuclear plant on the proposed site. Furthermore, changes in land productivities and property values along the transmission route are not anticipated as a consequence of building the proposed plant. However, it is expected that substantial appreciation in the value of a few selected parcels will probably occur where those sites could be used for commercial and other facilities supplying service to construction labor and, later, operation and maintenance personnel.

4.4.5 Summary of Socioeconomic Effects

The staff believes that the net effect of construction on business and labor will be economically beneficial. However, some local residents object to the disrupting influence of a large construction project in a quiet rural community. The housing market, schools, utilities, and recreational facilities will be able to accommodate both expected county growth and the projected maximum number of in-migrating construction workers. The hospital, sanitary landfill site, police and fire services, and roads, particularly State Road 62 and local access roads, will probably experience increased stress; however, such stresses will be relatively short-lived.

PSI has indicated its intention to work in cooperation with county and city officials to ensure that the improvement and maintenance of roads near the station will be sufficient to meet traffic demands. Early consideration of these impacts by PSI and local government officials may allow mitigating procedures to be more effective. In order for the staff to assess such mitigating measures, the applicant was required to submit a plan by May 1, 1976, that defined the steps to be taken in cooperation with government officials to reduce the impacts discussed above. PSI has made engineering studies and has reached agreement with local officials regarding the improvements needed, but no formal agreement regarding funding had been signed by August, 1976.

In addition to the transportation planning process recommended above, the staff believes that local officials should consider the following:

(1) consolidation of the County's two school districts; under present local tax jurisdictional arrangements, the Madison Consolidated School District would receive a sizeable share of the impact but no revenues directly from the Marble Hill station;

(2) an analysis of the potential for using the Jefferson Proving Ground, Madison State Hospital, or the City's waterfront campgrounds as resources for accommodating mobile homes;

(3) a review of local zoning and health codes in light of past experiences with mobile homes;

(4) placing a high priority on hospital improvements with the view of completing those improvements before the peak construction period;

(5) beginning the search for a new landfill site that will meet the County's needs beginning in 1980;

(6) contracting for a traffic study to evaluate improvements for easing traffic in the area of the bridge at Madison;

(7) a reevaluation of the cooperative arrangements (or lack of such) between city and county police and fire forces in emergency situations; and

(8) negotiating with PSI to obtain tax payments as early as possible during the construction process.

4.5 MEASURES AND CONTROLS TO LIMIT ADVERSE IMPACTS DURING CONSTRUCTION

4.5.1 Applicant's Commitments

To minimize impacts due to construction, the applicant has committed (ER, Sec. 4) to initiate an impact-control program, the main features of which are summarized below.

4.5.1.1 Onsite Practices

1. Existing roads will be upgraded and widened and dust will be kept to a minimum by using crushed stone and petroleum-base surfaces and by watering areas that become dusty (ER, Secs. 4.1 and 4.4).

2. Drainage patterns will be maintained approximately as they are and a settling pond for reducing sediment will intercept runoff water before it is discharged into natural drainageways. The outlet of the settling pond will be designed to ensure that the velocity of the water released to natural drainageways will not exceed 2 fps (60 cm/sec) (ER, Secs. 4.1 and 4.4).

3. Erosion of the graded plant site will be controlled by stabilization with grasses and/or legumes. On erodable surfaces that will support vegetation the soil will be seeded as soon as possible after earthmoving activities have been completed. After initial stabilization in this manner, these areas will be allowed to revert to natural vegetation (ER, Sec. 4.4).

4. All fuels and lubricants will be stored and dispensed in accordance with applicable local laws. Oil separators will be installed in the drainage routes from the switchyard and reactor buildings to extract any petroleum products from the runoff water. Chemicals used for cleaning will be collected in a barge or tank trucks and removed from the area to be disposed of in a legally and environmentally acceptable manner* (ER, Sec. 4.4).

5. Chemical toilet facilities will be used during construction and the waste will be disposed of offsite in an environmentally acceptable manner (ER, Sec. 4).

6. Wherever possible, slash and nonmerchantable timber will be piled in locations near the edges of the wooded areas to provide additional wildlife habitat (ER, Sec. 4.4).

7. Any disruption of floodplain archeological sites will be monitored by an archeologist (ER, Sec. 4.1).

8. Dredge spoils from the construction of intake and discharge structures will be disposed of in onsite spoils areas or loaded into barges or trucks and removed from the site for disposal in an environmentally and legally acceptable manner (ER, Sec. 4.4).

9. Solid trash from site clearing, construction, and cleanup operations will be disposed of in an environmentally and legally acceptable manner (ER, Sec. 4.4).

4.5.1.2 Offsite Practices

1. Borings will be made at selected locations along the transmission corridors to determine foundation suitability for tower bases, and each tower will be sited to avoid as much as possible streams and other water bodies. If areas of archeological or ecological significance are located before or during construction of the transmission lines, appropriate action to either avoid or minimize the impact will be taken (ER, Supp. 1, p. 4.2-5).

2. During construction of the transmission lines, the following practices (see Sec. 4.3.1 and 4.3.2 and the ER, Sec. 4.2) will be followed to mitigate environmental impacts:

   (a) The avoidance of unnecessary clear-cutting.

   (b) The use of selective clearing and vegetative screening.

   (c) Careful cleanup procedures.

   (d) Restoration of soil and seeding of disturbed areas.

   (e) Design of access roads to minimize effects on streams to be crossed.

3. Basal low-pressure herbicide spraying will be selectively used on tall-growing trees and brush. Desirable low-growing ground cover or shrubs and stumps, stubble and brush along streams and pond banks will not be sprayed or treated. Where warranted in specific areas, application of herbicides may be by aerial spray (ER, Sec. 4.2).

4. All important breeding or nesting areas of Federal and State protected species will be avoided (ER, Supp. 1, Response to Question 83; see also Sec. 4.3).

*The phrase "in a legally acceptable manner" is construed by the staff to mean that a responsible representative of the applicant will supervise the activities in accordance with applicable local, State, and Federal laws and maintain a record, suitable for inspection, of the satisfactory accomplishment of such activities.

4.5.2 Staff's Evaluation

Based on a review of the anticipated construction activities and the expected environmental impacts therefrom, the staff concludes that the measures and controls committed to by the applicant are adequate to ensure that adverse environmental effects will be at the minimum practicable level with the following additional precautions.

1. Topsoil shall be removed during the grading of the site and stockpiled for later use in covering and seeding disturbed areas.

2. In preparing transmission corridors the applicant shall utilize selective clearing to the fullest extent possible. The crossing of biologically productive streams by transmission lines shall be carried out to the fullest extent practicable during dry seasons and not during spawning seasons or periods of high water. A 100-ft (30-m) wide vegetated buffer zone on each side of the stream crossed shall be left and tower bases to the extent practicable shall be located above floodplains.

3. In clearing and maintaining the transmission and railspur corridors, the applicant shall use aerial spraying only in terrain inaccessible to ground transport and where the use of hand sprayers would be unsafe or not practicable. No herbicides shall be used within the drainage basin of the Muscatatuck National Wildlife Refuge. In addition, the following precautions shall be observed:

   - Use of herbicides shall be replaced by hand trimming and cutting in conservation, recreational, and residential areas.
   - Herbicides shall not be applied during or sooner than 4 hours after a heavy rain, nor when a heavy rain is predicted within a few hours.
   - Herbicide shall not be applied in areas where contamination of water supplies is likely.
   - Herbicide application by broadcast foliar methods shall not be made when winds are greater than five mph (8 km/hr).
   - No formulation shall be used whose dioxin (2,3,7,8-tetrachloro-p-dibenzoidioxin) impurity in the undiluted insecticide exceeds 0.1 ppm.
   - Herbicides shall be applied only by a licensed applicator or under his direct supervision.
   - Herbicides shall not be applied within 200 feet (60 m) of water bodies. In the case of flood plains broader than 200 feet, herbicides shall be biodegradable and shall be applied between July and December, after the normal flood season.

4. The routing of the transmission lines shall be such as to ensure that the line does not approach closer than:

   (a) 800 feet of Officer's Woods and 1500 feet of Tribbetts Flatwoods
   (b) 4.4 miles of Clifty Falls State Park, and
   (c) 2300 feet of the perimeter of Jefferson Proving Ground

5. The recommendations given by the Department of Interior concerning archeology shall be implemented according to the discussions in Sections 4.1.1 and 4.1.3.

6. If structures of possible historic value may be impacted by the construction or operation of transmission lines, the applicant shall notify the staff and, in consultation with the State Historical Preservation Officer, shall assess these values and take appropriate action.

7. The applicant shall submit detailed plans for staff review and approval prior to the initiation of construction activities associated with the following activities.

   (a) transmission line construction, after detailed routing has been decided,
   (b) railroad spur construction, when detailed route is known, and
   (c) the disposal of dredging spoil from the construction of intake and discharge structures.

4.6 SUMMARY

A summary of the probable environmental effects of construction identified by the staff is given in Table 4.8. The assessments of the impacts range from negligible to moderate. Those assessed as moderate all relate to social stresses induced by construction activities.

Table 4.8. Summary of Environmental Effects Resulting from Construction

Potential Effect	Applicant's Plan for Mitigation (Sec. 4.5.1)	Expected Relative Significance	Available Corrective Actions, Remarks
Dedication of about 1200 acres to industrial use (Sec. 4.1)		Small	
Loss or alteration of about 1300 acres of natural habitat (Secs. 4.1 and 4.3)		Small	Survey for endangered species
Increased siltation in Little Saluda Creek and Ohio River	Use of settling ponds, etc.	Temporary	
Downstream withdrawals (Sec. 4.2)		Negligible	
Biota (Sec. 4.3)		Negligible	May lose some spawning habitat
Increased siltation in fishing streams (Sec. 4.3)	Diversion ditches	Small	Temporary loss of several hundred angler-days
Disturbance of archeological sites (Sec. 4.1)	Floodplain sites to be monitored by archeologist	Small	Conduct more extensive archeological surveys, extend monitoring to upland and transmission-corridor sites.
Increased traffic congestion (Sec. 4.4)	Upgrading and dust control on local roads	Moderate inconvenience to area residents	
Increased stress on housing market (Sec. 4.4)		Small	Careful zoning
Increased stress on public services (Sec. 4.4)		Moderate	
Increased payroll (Sec. 4.4)		\$45 million/year for seven years (1983 dollars)	Beneficial
Induced expenditures (Sec. 4.4)		From \$5 to \$10 million/year for seven years (1983 dollars)	Beneficial
Increased local tax revenues (Sec. 4.4)		Several \$ million over construction period	Beneficial to local area
Radiation exposure to construction workers (Sec. 4.1)		Negligible	

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11. Letter from David L. Herbst, Director, Division of State Parks, State of Indiana, to Michael R. Nathanson, Argonne National Laboratory, 1 October 1975.

12. Letter from Charles E. Scheffe, Refuge Manager, Muscatatuck National Wildlife Refuge, U. S. Dept. of the Interior, to Michael R. Nathanson, Argonne National Laboratory, 24 September 1975.

13. Letter from R. A. Everhart, Dep. Director, Material Testing, Jefferson Proving Ground, Department of the Army, to Michael R. Nathanson, Argonne National Laboratory, 10 September 1975.

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17. P. M. Iwanaga and J. D. Hall, "Effects of Logging on Growth of Juvenile Coho Salmon," U. S. Environmental Protection Agency, EPA-R3-73-006, 1973, 35 pp.

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19. East Central Area Reliability Coordination Agreement, Annual Report, Vol. I: Load Projections and Resource Planning (Canton, Ohio: East Central Area Reliability Coordination Agreement, 1976), Exhibit I-Q.

20. Indiana Employment Security Division, "Indiana Labor Market Labor Force Estimates," (Indianapolis: State of Indiana, 1976); Ohio Bureau of Employment Services, Division of Research and Statistics, telephone conversation on 2 April 1976; and Kentucky Division of Employment Security, Mimeo Report (untitled).

21. Telephone conversation with Vincent Erby, Building and Trades Council of Cincinnati, 1 April 1976 and Delbert Melcher, Louisville Building Trades Council, 2 April 1976.

22. Letter of 30 April 1976 from J. Coughlin of PSI to H. Denton of NRC.

23. Interviews with Mr. Charles Poindexter, Assistant Cashier of the First National Bank, Madison, Indiana, 22 March 1976; and Mr. Robert Hensler of Madison Realty Company, Madison, Indiana, 22 March 1976. See Reference 34.

24. James and Berger Associates, Base Studies; Jefferson County Comprehensive Plan (n. p., 1971), p. HS-11.

25. Interview with Mr. Larry Brogen, Madison Mobile Homes, Madison, Indiana, 22 March 1976. See Reference 34.

26. Interview with Ms. Carolynn Melton, Secretary of the Jefferson County Plan Commission, Madison, Indiana, 22 March 1976. See Reference 34.

27. Vogt, Sage and Pflum Consultants, Comprehensive Plan Report: Jefferson County, Indiana (n.p., 1973), p. 8.

28. Letter from Ms. Marie Horine, President, Save Marble Hill, to Ms. Sue Ann Curtis, Argonne National Laboratory, 14 September 1975; and letter from Mr. Robert Gray to Ms. Sue Ann Curtis, Argonne National Laboratory, 22 August 1975.

29. James and Berger Associates, Base Studies: Jefferson County Comprehensive Plan, p. REC-28.

30. Joshua H. Vogel, Police Stations: Planning and Specifications (Seattle: University of Washington, Bureau of Governmental Research and Services, 1954), as cited in James and Berger Associates, Base Studies: Jefferson County Comprehensive Plan, p. PF-4n.

31. Data on total income and retail sales supplied by the Greater Madison Chamber of Commerce. For 1972, income in Jefferson County was $89,910,111; retail sales for the same year were $55,925,000.

32. Letter from Mr. Lucian Smith, Manager of the Madison Office, Indiana Employment Security Division, to Sue Ann Curtis, Argonne National Laboratory, 6 October 1975.

33. For assumption, see ER, p. 8.2-7. Crop yields and prices were taken from Purdue University Agricultural Experiment Station, Department of Agricultural Statistics, Indiana Crop and Livestock Statistics: Annual Crop and Livestock Summary, 1974 (West Lafayette, In.: Purdue University, 1975), pp. 28-29, 39, 41, and 43. Land values were supplied by Mr. Ben Schnabel, Assessor for Jefferson County, Indiana.

34. Description of Visit to the Marble Hill Site. Letter of April 20, 1975 from Michael Kaltman of NRC to M. L. Ernst of NRC.

5. ENVIRONMENTAL IMPACTS OF STATION OPERATION

5.1 LAND USE

The station is an industrial facility placed in a rural area. Prior to construction, the site was used for cropland, pasture, woodlands, and residential areas (see Sec. 2.2). After the construction phase, the applicant will permit the land around the station to revert to natural vegetation (see Sec. 4.1.1). There will also be an attempt to maintain many of the current areas of scenic beauty at the site, including the northern wooded slopes and portions of the eastern slopes and floodplain (ER, p. 8.1-8a). Currently, PSI has no plans to develop any recreational facilities at the Marble Hill site (ER, p. 8.1-8a).

It should be pointed out that the proposed housing-recreational community described in Section 2.8.3.1 and some local individuals (see Sec. 5.8.4) may place increasing recreational demands on the scenic areas of the site.

Because the station is to be inland on the plateau, it will be partially camouflaged by the existing vegetation (ER, p. 8.2-5). The major material of construction is concrete. The vent stacks of the turbine building will extend 150 feet (45 m), and the containment structures 199 feet (60.7 m), above grade. The containment vessels might be seen, and the plumes will be visible from the plateau, Ohio River, and Kentucky (see Sec. 5.3.1.2). But the containment structures should not be visible from any major transportation route or population center. In part, this is due to the remote setting of the station, but also it is due to the hardwood forest that surrounds the station and partially screens it.

The chemical and thermal blowdowns will not adversely affect land or water use (see Secs. 5.3 and 5.5). An area of 987.4 acres (about 400 hectares), half of which is cropland and the remainder wooded or pasture, will be devoted to the site and unavailable for other uses. Construction will disturb about 250 acres (100 hectares), mostly farmland.

The transmission lines and towers will have an adverse visual impact.

An area of about 3475 acres (1400 hectares) will be used for transmission corridors, and about 1110 acres (440 hectares) of regrowth deciduous forest will be destroyed to make room for the towers and wires. That portion of the forest that is destroyed will be converted from its current use with effects discussed below (see Sec. 5.6). The remaining area, 2365 acres (950 hectares), is cropland, pasture, roadways, streams, and nonforested idle land; except for the tower bases, its land use will not be permanently altered. Operations over the railroad spur require the continued use of about 200 acres of croplands and 45 acres cleared of the original forest.

The cooling towers will produce a plume, ground-level fog, ice, drift, and salt deposition; however, it is not expected that any of these effects will interfere with present land use. Some local people might object to the appearance of the plume and to plant noises that detract from the scenic, natural character of the area.

The applicant has stated that access to the cemetery described in Section 2.9.2 will remain feasible after construction (ER, p. 8.2-5) and that it will be undisturbed (ER, Supp. 3, p. 83); however, prior to the aquisition of the land by the applicant the cemetery had not been maintained and no visitors have been observed in recent years.

5.2 WATER USE

5.2.1 Surface Water

Waste heat generated by the station will be dissipated to the atmosphere by means of an evaporative cooling-tower system utilizing water from the Ohio River. To provide for evaporation and blowdown under normal operating conditions, 62-69 cfs (1.8-2.0 m^3/sec) of makeup water will be required. Of the cooling water utilized by the station, 55-60 cfs (1.6-1.7 m^3/sec) will be lost through evaportion and drift, and 8-10 cfs (about 0.25 m^3/sec) will be returned to the river as blowdown. Withdrawal of 69 cfs (2.0 m^3/sec) from the river corresponds to about 0.06% of the average river flow past the site (112,000 cfs or 3170 m^3/sec) and 0.7% of the minimum regulated low flow (10,500 cfs or 297 m^3/sec).

The projected (2020) water use on the Ohio River main stem from the Louisville reach downstream to its confluence with the Mississippi River is about 7100 cfs (200 m^3/sec). When compared to the average discharge at its mouth (258,000 cfs or 7310 m^3), the projected water use appears to be easily supportable. The additional use of 60 cfs (1.9 m^3/sec) by the proposed station is not expected to adversely impact downstream uses of the Ohio River, nor will it appreciably lower the assimilative capacity of the river for sewage or industrial wastes.

5.2.2 Groundwater

During operation the station will obtain only potable water from wells in the Ohio River Valley alluvial-glaciofluvial aquifers at the rate of 200 gpm (0.013 m^3/sec). The yield of wells in this aquifer ranges to 1500 gpm (5.7 m^3/min) and no deleterious impacts on groundwater use are anticipated.

5.3 HEAT-DISSIPATION SYSTEM

5.3.1 Heat Transfer

5.3.1.1 General Considerations

Two 25-cell mechanical-draft wet cooling towers (MDCT) of conventional design and layout, one for each unit, will be used to discharge most (over 99%) of the waste heat from the condensers directly to the atmosphere. In addition, two 4-cell MDCTs will be used to cool the station's essential service water. In the MDCTs heat and vapor are transferred from the circulating-water system to the air being pulled through the tower by the fans. On the average, about 75% of the heat removal will be by evaporation; the fraction dissipated by evaporation varies from 60% in winter to 90% in summer.

When the effluent leaves the tower, it will mix with cooler, less humid ambient air and more of the water vapor in the discharge will condense in the form of a visible cloud-like plume. Because of its buoyance and momentum, the plume will, under most conditions, continue to rise and carry along evaporated water and a mist of water droplets, called drift, swept from the circulating water in the fill. The drift will contain whatever soluble chemicals are present in the circulating water. Because large amounts of heat and water vapor are added to the atmosphere over a small area, local atmospheric changes will occur. These atmospheric modifications can be separated into four general categories: elevated visible plumes, ground-level fogging and icing, drift effects, and cloud and precipitation formation.

The staff's analysis of possible effects of the MDCTs at the Marble Hill site is given below.

5.3.1.2 Visible Plume

The length of visible plumes created by the MDCTs will depend on plant factors (such as plant load) and cooling-tower-design parameters (such as cooling range and approach), as well as local weather conditions (air temperature, wind speed and direction, saturation deficit, and stability). Because air at low temperatures has a small capacity to hold water vapor, visible plumes will be most pronounced in winter.

Under most meteorological conditions, the water droplets in the visible plume will evaporate within a few hundred feet of the towers. Under other conditions (especially periods with low air temperatures, high humidity, perhaps light rain or drizzle, moderate wind speeds, and a stable atmosphere) the visible plume may extend for several miles.[1,2] Other than the appearance of an extended plume, the main impact of the elevated plume is the reduction of sunshine reaching the shaded area. The decrease in incoming light at ground level is not expected to be significant because of the shifting shadow, the small area affected, and natural cloudiness (long plumes will usually occur during periods of natural cloud cover). Visible plumes will be more frequent and longer in winter than during the other seasons, and the minimum size and the lowest frequency of long plumes will occur in summer. On the daily cycle, plumes will be longest just before and after sunrise, and shortest in midafternoon.

Applicant's Analysis

The applicant has developed and/or used several computer models to estimate the atmospheric effects (such as plume lengths, fogging, icing, and drift effects) of both natural- and mechanical-draft cooling towers at Marble Hill; these models are described in the ER, Appendix 6A. A summary of the output of these models is given in the ER, Sections 5.1.7 and 10.1. One year (1974) of onsite meteorological data, plus cooling tower design parameters, were used in the calculations.

The numerical model used to predict the dimensions (length, height, thickness, and location) employs the plume rise equations of Briggs,[3] the bent-over plume theory as applied to moist plumes by Hanna,[4] and standard atmospheric gaussian dispersion equations at the end of the bent-over plume regime. The MDCT model was calibrated using the field data of Meyer et al.[1] and other, unpublished MDCT plume data (ER, p. 6A-5). The applicant's natural-draft cooling tower (NDCT) model was tuned using data of Slawson et al.[5] for towers in Kentucky. The calculations incorporated the conservative assumptions that (1) both units operate at full capacity at all times and (2) natural cloud cover is ignored.

The MDCT plume-length model is sensitive to the area and configuration of the cooling tower exit. The applicant used two idealized configurations that yield upper and lower bounds for visible plume lengths. In one tower arrangement, the actual tower configuration (see Fig. 3.1) is replaced by a single virtual tower whose radius is 113 feet (34.4 m), located in the center of the actual cooling-tower location. This virtual source would have the same area as the 50 separate cooling-tower exits. A "virtual" source is a single theoretical source with distant consequences much like those of the actual multi-pointsource. Computed plume lengths from such a concentrated source would be longer than those of the actual, more dispersed sources. In the second configuration, the radius of the source is set equal to one-half the length of the towers, or 517 feet (158 m); the calculated plume lengths represent a lower bound. The actual lengths expected would be between these two extremes.

Figure 5.1 shows the upper and lower estimates for elevated plumes. Plumes one km in length are expected to occur between 19% and 32% of the time. Very long plumes (20 km or longer) are expected to occur between 1.3% and 3.0% of the time. For plumes longer than a few kilometers, there is a high probability that low clouds and/or precipitation would also be present. The village of Paynesville would be expected to experience elevated plumes overhead from about 20 to 50 hours per year; Bedford, Kentucky, would have such plumes 5 to 10 hours per year.

Staff Analysis

The staff has concluded that the applicant's model does yield reasonable estimates of plume lengths. Other than the esthetic impact of the visible plume, the staff expects no significant offsite effects from the station's MDCTs, which are about 1250 ft (380 m) from the nearest site boundary.

5.3.1.3 Ground-Level Fogging and Icing

The primary atmospheric effect created by the operation of MDCTs is the formation of surface fog near the towers due to aerodynamic downwash.[2,6-8] Whenever wind flows over an elevated structure, a region of lowered pressure is formed behind the structure, and part of the visible plume is drawn into this region.[9] Observations at operating MDCTs indicate that the plume at ground level travels only a short distance (of the order of 0.5 km) before either evaporating or lifting because of buoyancy.[7,8] Downwash was observed 65% of the time at a large MDCT in Tennessee[7] and occurred whenever the wind speed was in excess of 3 m/sec (except for the cases in which the wind was within ± 10° of the long axis of the tower). The downwash phenomena would be the same in Indiana as in Tennessee.

With air temperatures below 32°F (0°C), the recondensed water in the visible plume will become supercooled water droplets. As a result of their small size, these droplets will be carried around surfaces such as trees, poles, wires, etc. When solid surfaces wet by fog are below 32°F, icing occurs.

There is a second mechanism that, theoretically, could generate fog downwind of cooling towers: the downward dispersion of water vapor (or the lower edge of the visible plume) from the elevated plume. This type of fog is more likely to occur with MDCTs than NDCTs because of the lower height of release of effluents from the former; however, fog from dispersion has never been reported.[6,10,12]

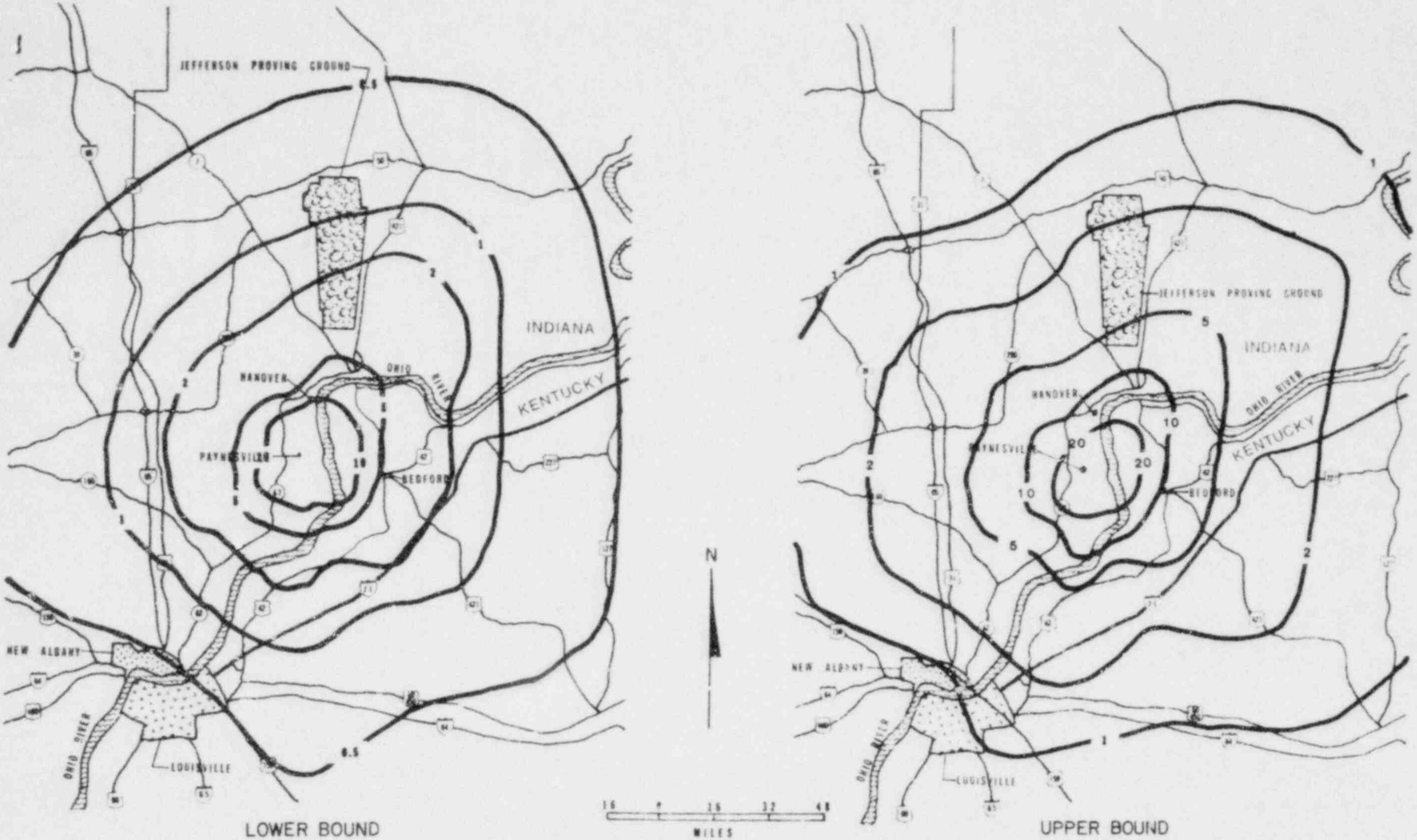

Fig. 5.1. Contours of Elevated Visible Plume--Hours Per Year. From ER, Figs. 5.1-10 and 5.1-11.

Applicant's Analysis

The applicant has used two models to simulate fogging from the station's MDCTs. In one the water vapor increase at ground level is calculated using the models for plume lengths described above. The increase in surface ground-level moisture for the least favorable meteorological condition is only 0.042 gm/m^3, a value in itself too small to cause significant fog, but sufficient to further reduce visibility in an existing fog area.

The second model, described in the ER, Section 6A.2.1, was used to calculate the number of hours of fogging due to downwash. Downwash was assumed to exist whenever winds perpendicular to the long axes of the towers was 5 m/sec or greater. For winds parallel to and diagonal to the long axes, the threshold wind speeds were 10 m/sec and 7 m/sec, respectively. The postulated motion of the plume during downwash conditions is shown in Figure 5.2. The model assumes that plume rise is negligible in the zone in which aerodynamic eddies control plume motion (distance XT_1 in Fig. 5.2). After this stage, the plume will start to rise because of buoyancy, and it is assumed water vapor will disperse along the plume centerline. The analysis indicates that there will be fog from downwash 100 meters from the towers for 2150 hrs/year, or 24.5% of the time. This frequency decreases to 92 hours/year (1.0%) at only 600 meters. The spatial distribution of fog is shown in Figure 5.3.

Staff Analysis

The staff considers the applicant's downwash model to be a significant advance in the art of MDCT plume modeling, inasmuch as it includes downwash conditions. The postulated downwash threshold wind speeds may be somewhat high, considering that Hanna[7] observed downwash at speeds as low as 3 m/sec. In the Oak Ridge studies,[2,7,8] fog from downwash either evaporated, or lifted in the form of a stratus deck, at distances greater than 0.5 km from the tower. The frequency of fog over the Ohio River will be less than that shown in Figure 5.3 as a result of down-slope adiabatic heating.

Based on the Oak Ridge studies and other studies[6] at operating power plants with MDCTs, the staff concludes that ground-level fogging (and icing) will occur frequently, especially during the cooler half of the year. On the other hand, the staff expects no offsite occurrences of icing or fogging. The ice that does form from supercooled droplets will be very light and friable and will not cause structural damage.[13]

5.3.1.4 Cloud and Precipitation Formation

The visible plume from a cooling tower is a cloud. In addition, clouds are sometimes observed to form in the updraft created by a cooling tower after the initial visible plume has evaporated. Hanna[7] reports that cloud development is initiated by plumes from the Oak Ridge cooling towers 10% of the time. There have been a few reported occurrences of very light snow due to cooling tower plumes, but in all cases the amounts were very small.[14,15] Hanna[7] and others have speculated that local precipitation could be increased by natural rain and snow falling through the plumes, but no data with which to appraise this effect are available.

Cooling-tower plumes do create clouds and slightly alter sunshine in the immediate area; however, there is no evidence that they cause significant changes in local weather conditions.

5.3.1.5 Drift

A small fraction (estimated to be 0.02% for this station) of the cooling water is carried into the plume and discharged to the atmosphere as drift. These water droplets will carry with them whatever solids are contained in the circulating water system, and could cause impacts from wetting, icing, and deposition of salts onto the soil, plants, and structures. Under most meteorological conditions, all of the water in the drift droplets will evaporate, and the salts will remain airborne to be dispersed by wind currents. Under conditions of high humidity, the drops may not evaporate completely before impacting surfaces. Studies at operating towers indicate that almost all of the drift that does fall to the ground will do so within 1000 feet (300 m) or so of the towers.[6-8,16-18]

During periods of air temperature below freezing, the drift that falls to the ground can cause icing. The staff does not consider this to be a problem at this station because ice will be deposited onsite at areas very near the towers.[8]

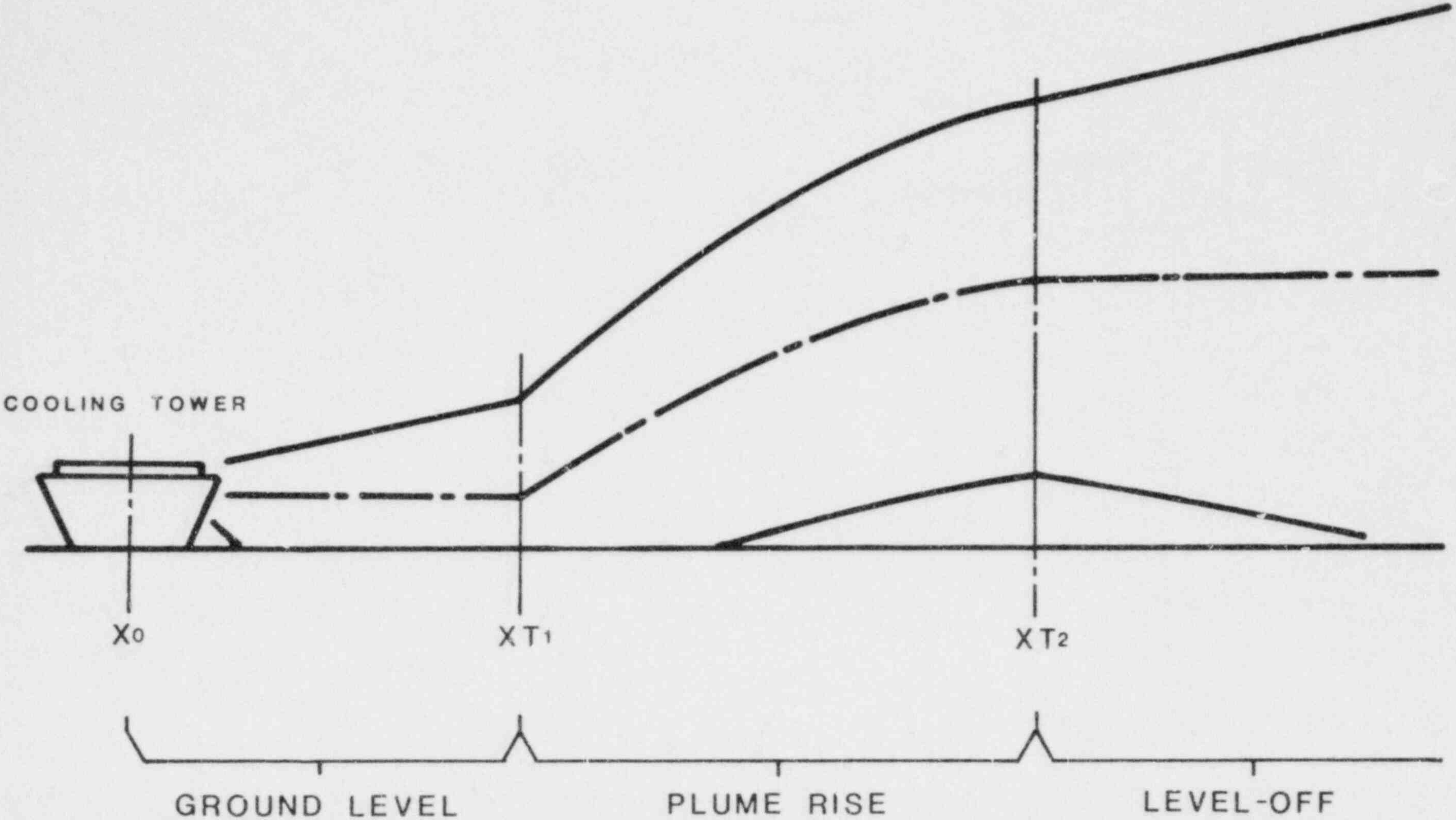

Fig. 5.2. Schematic Diagram of Applicant's Downwash Cooling Tower Plume Model. From ER, Fig. 6A-2.

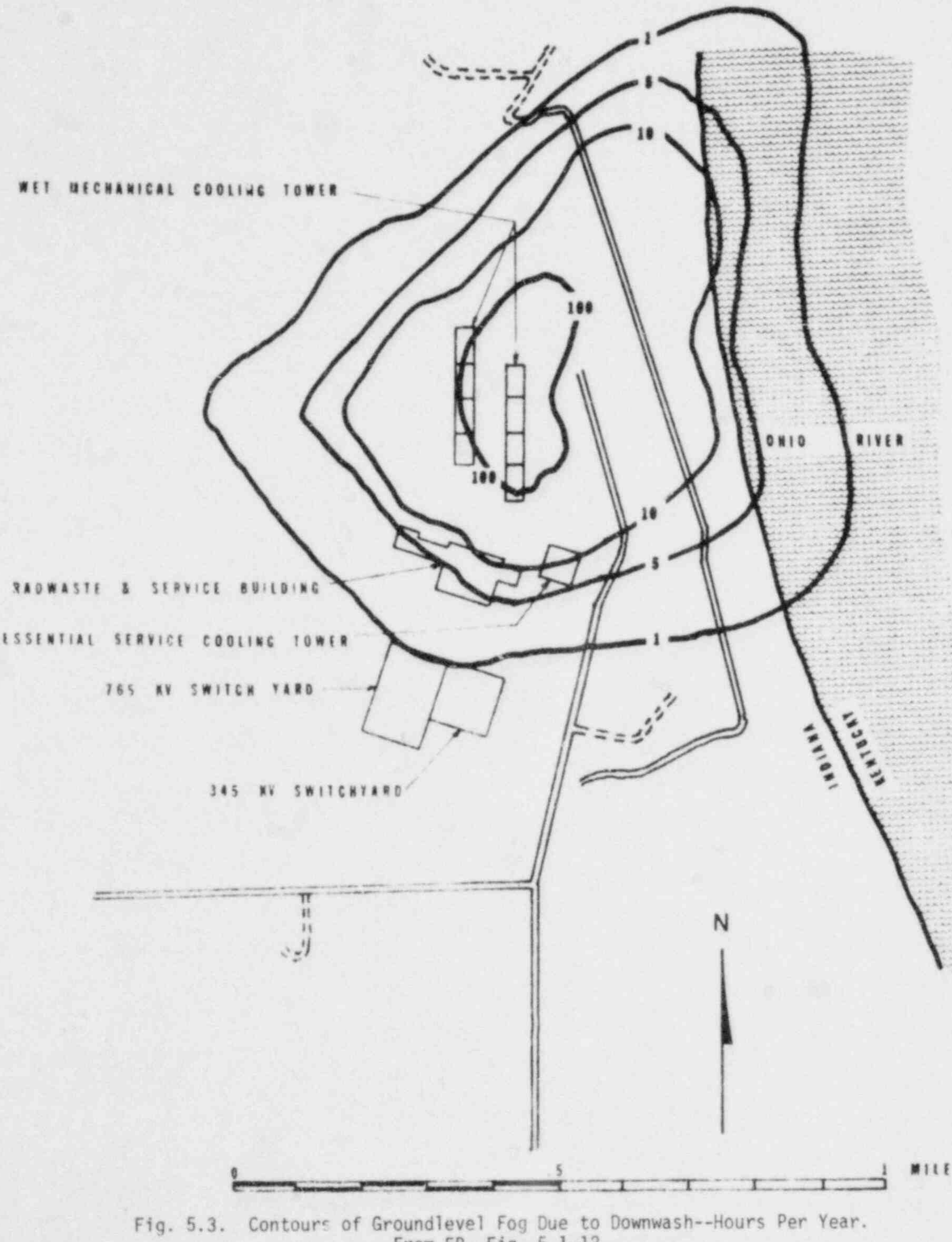

Fig. 5.3. Contours of Groundlevel Fog Due to Downwash--Hours Per Year.
From ER, Fig. 5.1-12.

Applicant's Analysis

The applicant has used a combination of two of the published drift models to predict deposition rates for the Marble Hill Station (ER, Sec. 6A.3). The Hosler et al.[19] droplet trajectory model was used for stable meteorological conditions, while the Schecker et al.[20] tilted gaussian plume method, which incorporates the effect of atmospheric turbulence on drift fallout rates, was used for neutral and unstable conditions. The drift model assumes that all of the drift originates from a single point source instead of two long rows of towers. The model thus overestimates the drift rate at all distances; the overestimation is highest near the source. This procedure also underestimates the area of salt deposition. The calculations are based on a conservatively estimated drift release of 0.02%, a value much higher than those quoted (around 0.005%) for state-of-the-art cooling towers.[16] An additional conservative assumption is that of full (100%) operation of both units.

The calculated maximum deposition rate of salt is 120.5 lb/acre-month (22.12 kg/hectare-month) in the region 200 m north-northeast of the towers (ER, Table 5.1-15). Deposition rates between 10 and 100 lb/ acre-month (1.8 and 18 kg/hectare-month) will occur within one kilometer of the source (that is, onsite) and decrease to the order of one lb/acre-month (200 g/hectare-month) within five kilometers. At the boundaries of the site the calculated maximum offsite deposition will be about 35 lb/acre-month (6.4 kg/hectare-month) north-northeast of the towers, about 20 lb/acre-month (3.6 kg/hectare-month) over the river, and about 10 lb/acre-month (1.8 kg/hectare-month) over the nearest road (south of the plant).

Staff Analysis

The staff is not able to assess empirically the accuracy or validity of the applicant's drift model because of the lack of detailed drift measurements at operating MDCTs with which to test the model.[21] The staff concludes that the calculated values are probably high (conservative) due to the conservative assumptions used by the applicant (high drift rate, 100% load for both towers, and the use of a single point source). General experience at operating MDCTs, however, indicates that drift effects are "observed to be insignificant, except in the area within a few hundred meters of the tower."[8] The staff agrees with the applicant's conclusion that almost all of the drift that does return to the ground will do so inside the station boundary, and that the amounts of salt deposition, even on site, will be too small to cause problems. No appreciable offsite effects from drift are expected.

5.3.1.6 Acid Mist

It has been argued on theoretical grounds that water droplets in a visible cooling tower plume could interact with ambient SO_2 or merge with fossil-fueled stack gases to form sulfuric acid, and that this acid mist would fall to the ground and cause damage to people, vegetation, and structures.

Hundreds of wet cooling towers, both natural-draft and mechanical-draft, have been operating at fossil-fired power plants for decades, both in the United States and Europe, without any reports of significant adverse impacts due to acid mist from cooling tower plumes.[6] Although this lack of reports of damage is certainly not proof that the phenomenon does not occur, (no systematic observations have been made), the problem is probably a minor one at most. This conclusion is in agreement with a recent EPA report,[22,23] which states that the rate of formation of acid mist is very low, and with studies in England.[24]

The statement above does not mean that acid rains and mists due to the use of high-sulfur fuels do not occur or are not problems. The real question is "How does the presence of a cooling tower plume alter the SO_2 cycle in the atmosphere?" The stack gases from a fossil-fueled plant already contain all of the ingredients (SO_2, particulates to act as catalysts, water vapor from the hydrogen in the fuel, and in cold-weather conditions water droplets due to the condensation of this water vapor) needed to cause acid droplets and acid rain. Furthermore, natural weather processes (fog, clouds, drizzle, rain, and snow) provide the liquid water needed to convert SO_2 into H_2SO_4 and to bring the acid to the ground. In other words, the problem of cooling-tower-plume interactions is to isolate the effect of a perturbation on an existing chemical process that goes on near all fossil-fueled plants, with or without cooling towers. Limited data collected in England indicate that acid droplets observed aloft in a NDCT plume were due mostly to ambient SO_2 entrained into the plume, and not due to merging of the plant's stack and tower effluents.[25] Acid drops with pH values between two and three have been observed in the visible plume (but not at the ground) from a NDCT in Pennsylvania.[26]

At the present time, the nearest major source of SO_2 is the Clifty Creek coal plant in Madison, Indiana, located about ten miles (16 km) north of the station. A number of fossil-fueled power plants are reputed to be planned for the area near the station but their exact locations, fuels, SO_2 emission levels, and cooling systems are not known to the staff. One of these power plants (with a closed-cycle cooling system) could be located just across the river in Kentucky, about one mile (1.6 km) from the Marble Hill Station (ER, p. 2.2-7; Supp. 1, p. 41, and Supp. 3, p. 69).

The staff expects no additional a d mist to result from present SO_2 sources interacting with plumes from the station's cooling towers. Should a fossil-fueled plant with a closed-cycle cooling system be built near the station, the primary cause of acid mist (if any) would be the interaction of that plant's stack gases and its own vapor plumes.

5.3.1.7 Summary and Conclusions

The environmental impact of an MDCT is minimal, except for the area within a few hundred feet of the tower. The staff thus expects that the Marble Hill towers will have a very limited effect on offsite areas (an occasional visible plume aloft).

5.3.2 Intake

Operation of the proposed intake system will result in entrainment and impingement of aquatic biota and the displacement and elimination of some benthic habitat and organisms. Organisms small enough to pass through the traveling screens, such as phytoplankton, zooplankton and ichthyoplankton, will be exposed to excessive temperatures, high pressures and high concentrations of biocidals for long periods of time and mortality close to 100% is likely.[27] Fish that enter the intake flume and are entrapped therein will eventually be impinged against the traveling screens and killed. The intake structure itself may disrupt water flow sufficiently to cause silt deposition that may result in the loss of benthos, macroinvertebrates and fish spawning areas upstream and downstream from the structure.

In view of the absence of operational data which will become available only after the station begins to operate, only rough estimates of entrainment losses are possible. Based on the average phytoplankton biomasses observed in the Ohio River by the applicant (see Table 2.11) and a maximum water use of 70 cfs (about 0.06% of average river flow) by the proposed station, entrainment losses (reflected and measured as reductions in primary productivity) could range from 20 kg/day in January to 880 kg/day in March (assuming 100% mortality). Using the same average phytoplankton biomass figures and data on existing water use for the McAlpine Pool (2400 cfs or about 2.2% of average riv r flow: see Sec. 5.2.1), existing levels of entrainment may range from 650 kg/day in January to 30,100 kg/day in March. The latter figures are probably overestimates since 92% of the existing water use is for once-through cooling at the Clifty Creek Power Plant (2200 cfs) and there is little evidence that the reduction in phytoplankton productivity will exceed 25-30% in once-through cooling systems.[27] (100% mortality was assumed for the cooling tower system) Therefore, assuming a 30% reduction, existing entrainment losses may range from 195 kg/day in January to 9000 kg/day in March. The entrainment losses calculated for the proposed plant represent 10% of these possible existing losses. While biomass data are not available for zooplankton and ichthyoplankton, greater existing entrainment losses to these populations are expected. At the J. M. Stuart Power Plant, upriver from the proposed station (RM 405.7), up to 56% of the entrained zooplankton are killed and mortalities to fish eggs and larvae are known to exceed 90% at a number of plants with once-through cooling.[27]

The relative effects of these entrainment losses are greater when computed for the minimum regulated flow (10,500 cfs) in the McAlpine Pool. For the more sensitive ichthyoplankton species, these losses may theoretically exceed the significant level of 20%. Losses of phytoplankton and other zooplankton may reach this level in the immediate vicinity of the Clifty Creek Plant; however, because of the short generation times, especially for phytoplankton, populations may have recovered by the time the Marble Hill intake is reached.

Since most fishes reproduce only once a year, ichthyoplankton losses are potentially more serious. Most fishes spawn in spring and early summer when flows are high (> 50,000 cfs), thereby reducing the potential for serious impacts to these populations. The spawning seasons of some fish species extend into July and August when flows below 24,000 cfs occur (28 times from May 1970 to September 1974). At these times the entrainment of ichthyoplankton at the Clifty Creek Plant could reach significant levels. Therefore, entrainment losses of ichthyoplankton related to the proposed plant must be considered in conjunction with existing levels of ichthyoplankton entrainment by the Clifty Creek Plant.

Some impingement data are available for the McAlpine Pool (see Table 5.1) from an ongoing impingement study[28] at the Clifty Creek Power Plant located about 12 river miles (19 km) upriver (RM 558) from the proposed station. This existing plant has a once-through cooling system (water use-2200 cfs) with intake velocities of 0.4-2.2 fps (12 to 67 cm/sec),[28] while the proposed station will have a closed-cycle cooling system (water use-70 cfs) with intake velocities no greater than 0.5 fps or 15 cm/sec (ER, Suppl. 3, p. 19-20). Because impingement at 0.5 fps (15 cm/sec) has been shown to be substantially less than at 1.0 fps (30 cm/sec),[29] impingement figures for the proposed station should be less per unit intake flow than those in Table 5.1. These data suggest that freshwater drum and gizzard shad young will represent the bulk of the impinged fish; however, it is likely that young channel catfish, bluegill, sauger and white bass will also be impinged.

Table 5.1. Estimated Annual Loss of Fish Species Due to Impingement at the Clifty Creek Power Plant at Ohio River Mile 558.5 from February 1974 through January 1975

Species	Number	Weight (kg)
Gizzard shad	1,872,000	21,440.0
Freshwater drum	224,000	1,024.0
Skipjack herring	62,400	259.0
Sauger	624	93.0
Channel catfish	7,056	68.0
Bluegill	2,568	35.0
Silver chub	2,464	32.0
White bass	8,400	32.0
Emerald shiner	3,776	24.0
Carp	1,736	13.0
Longnose gar	[illegible]	10.0
Quillback	7	1.4
Mooneye	16	1.0
Black crappie	13	0.8
Paddlefish	1	0.2
Golden redhorse	20	0.1
Longear sunfish	1	< 0.1
White crappie	2	< 0.1
Flathead catfish	2	< 0.1
Black bullhead	2	< 0.1
Largemouth bass	4	< 0.1
Darter (?)	1	< 0.1
Green sunfish	1	< 0.1
White sucker	2	< 0.1
Carpsucker (?)	2	< 0.1
Highfin carpsucker	2	< 0.1
Pumpkinseed	1	< 0.1
Total	2,185.110	23,034

From "Fish Entrapment on Cooling Water Intake Screens at Clifty Creek Power Plant," Final Report, Indiana-Kentucky Electric Corp., Piketon, Ohio, 1975, 100 pp.

The design of the proposed intake structure may increase the probability of impingement. With the river at the controlled 420-foot level, the structure may act as a partial dam, diverting water from the upstream inshore areas to flow past the intake opening. Since inshore fish densities are usually high compared to those in the mainstream, the diversion of the inshore waters past the intake opening may increase impingement losses. During the 90% of the time that the river level is expected to be higher than the top of the intake structure, the small fish near shore can be drawn into the intake flume through its covering screen. Therefore, the staff requires that the proposed intake structure be redesigned to permit unimpeded flow of near-shore water and that the covering screen be replaced by a solid cover within 50 feet of the shoreline at the 420 foot level (See Sec. 9.3.2).

Another possible impact of the proposed intake design is that of silt deposition in the vicinity of the structure. These deposits could alter favorable habitat for fish spawning, and benthic macroinvertebrates, such as freshwater mussels.[30] The above requirement to redesign the proposed intake structure would mitigate this problem, also.

The staff makes this requirement in spite of the previous discussion indicating that the biotic impacts of the proposed intake structure would not be large for the present biological conditions of the Ohio River, because (1) the required changes would not be unduly expensive, and (2) biotic impacts would be reduced. However, in the event that the State of Indiana approves the applicant's proposed intake structure design under its authority under Section 316(b) of the Federal Water Pollution Control Act, the staff will withdraw the redesign requirement, in view of its finding above that the impacts of the applicant's proposed design would be acceptable, although larger than necessary.

5.3.2.1 Conclusions

The staff requires that the intake structure be redesigned to reduce silt deposition, entrainment, and impingement. Alternative intake designs that consider these issues are discussed in Section 9.3.2.

5.3.3 Discharge

5.3.3.1 General Discussion

Table 3.2 lists the design parameters for each of the mechanical-draft cooling towers. Figure 3.5 shows the preliminary design curve from which the cold-water temperature as a function of wet-bulb temperature can be obtained.

The blowdown from the towers is to be discharged to the Ohio River by means of the submerged discharge structure shown in Figure 3.7. This type of discharge will fairly rapidly mix the blowdown with the river water, decreasing the size of the surface thermal plume compared to a surface discharge, and decreasing the exposure time of river organisms in the plume. Fewer fish will be attracted to the smaller plume, reducing the potential for cold shock in the event of a two-unit shutdown. Dilution of dissolved solids and chemicals in the blowdown will also be more rapid than with a surface discharge.

The analyses of the thermal effects and biotic effects of the blowdown from the cooling towers were carried out for a shoreline surface discharge design in the draft statement. The applicant converted to the submerged discharge design after issuance of the draft statement, in which the staff suggested that the submerged discharge would be environmentally preferable to the surface discharge. However, the draft statement indicated that the environmental effects of the surface discharge would be acceptable in view of the small discharge flow (9 cfs) and the large average flow of the Ohio River (112,000 cfs). With the submerged discharge design, the blowdown would mix more rapidly with the river water, resulting in a smaller river surface area heated more than 5°F above natural temperature and a smaller volume of heated plume. Accordingly, all of the biotic effects of the heated plume would be reduced. Since the analysis of the surface discharge indicated acceptable biotic effects, the staff felt that a detailed analysis of the effects of the submerged discharge was not required to show that its effects were acceptable. The analysis of the surface discharge is updated in the following and the conclusions are modified to indicate smaller effects from the submerged discharge.

5.3.3.2 Thermal Water Quality Standards

There are three sets of standards promulgated for the Ohio River at the site (ER, App. 2C). They are:

(1) The Indiana Water Quality Standards,

(2) The Kentucky Water Quality Standards, and

(3) The Ohio River Valley Water Sanitation Commission (ORSANCO) Standards.

All three standards state that:

(1) The maximum temperature rise at any time outside the mixing zone (determined on a case-by-case basis) shall not exceed natural temperatures by more than 5°F (2.8°C).

(2) A general guideline for the mixing zone is that its cross section perpendicular to flow should be less than 25% of the cross-sectional area of the river and the plume should extend less than 50% across the width of the stream.

(3) Normal daily and seasonal fluctuations that existed before the addition of heat due to other than natural causes shall be maintained, and

(4) The maximum temperature for the Ohio River outside the mixing zone shall not exceed the values listed in Table 5.2.

5.3.3.3 Applicant's Analysis

Tables 5.3 and 5.4 list the important meteorological and hydrological variables that are required as input for any thermal-plume model. These tables are basically those found in the ER, Tables 6.1-3 and 6.1-4. The maximum wet-bulb temperatures listed are average maxima for the 1949-through-1972 period of record at Louisville, and thus may not represent true extremes at the site. The applicant states (ER, Supp. 3, p. 47) that the minimum river-flow values (see Table 5.4) are absolute minimum values for each month for the period 1960-1973 at the Louisville Gaging Station. However, USGS records list lower values for the months of April, June, July, and August and these are given in parentheses in Table 5.4.

If one were to graph the velocities listed in Table 5.4 as a function of flow, some inconsistencies that the applicant attributes to the combination of regulating effects of the dams and the estimated nature of the tabulated velocities would become apparent.

The applicant has assessed the effect of the blowdown from the cooling towers on the Ohio River using the analytical plume model, LAKFEM (ER, p. 6.1-3), for their original surface discharge. The analysis was applied to three cases of meteorological and hydrological conditions:

(1) Average values of river flow, river temperature, and wet-bulb temperature (data from Table 5.3),

(2) Minimum river flow and temperature and maximum wet-bulb temperature (data from Table 5.4), and

(3) Minimum river flow, maximum river and wet-bulb temperatures.

Table 5.2. Maximum Allowable Temperatures at the Edge of the Mixing Zone

Month	Temperature (°F)
January	50
February	50
March	60
April	70
May	80
June	87
July	89
August	89
September	87
October	78
November	70
December	57

Table 5.3. Applicant's Monthly Average Meteorological and Hydrological Data

Month	Monthly Average River Temperature[a] (°F)	Average Wet-Bulb Temperature[b] (°F)	Blowdown Temperature (°F)	River Flow Rate[c] (cfs)	ΔT[d] (°F)	River Velocity (ft/sec)
Jan	39.2	31.8	77.2	125,090	38.0	1.70
Feb	40.1	33.7	78.4	167,860	38.3	1.80
Mar	46.6	39.3	80.1	271,940	33.5	1.90
Apr	57.4	49.5	84.2	207,860	26.8	1.90
May	66.4	58.9	87.1	152,750	20.7	1.85
Jun	77.7	66.7	90.5	68,710	12.8	1.75
Jul	81.2	69.9	92.9	46,520	11.7	1.70
Aug	70.2	68.4	92.0	36,880	21.8	1.65
Sep	68.8	62.1	88.4	24,500	19.6	1.60
Oct	70.1	52.2	85.5	29,680	15.4	1.60
Nov	53.8	40.6	80.2	63,960	26.4	1.70
Dec	47.6	33.4	77.2	116,400	29.6	1.80

Adapted from the ER, Table 6.1-3.

[a]Data from Aurora Gaging Station.

[b]Data from Louisville Weather Station.

[c]Data from Louisville Gaging Station.

[d]Blowdown temperature minus monthly average river temperature.

Table 5.4. Applicant's Monthly Extreme Meteorological and Hydrological Data

Month	Minimum River Temperature[a] (°F)	Maximum Wet-Bulb Temperature[b] (°F)	Minimum River Flow[c] (cfs)	Blowdown Temperature (°F)	ΔT[d] (°F)	River Velocity (ft/sec)
Jan	33.8	37.6	16,100	78.8	45.0	1.30
Feb	32.0	39.5	20,300	79.9	47.9	1.40
Mar	37.4	45.3	25,600	82.5	45.1	1.50
Apr	48.2	55.5	45,700 (39,900)[e]	86.3	38.1	1.70
May	59.0	63.8	21,700	90.5	31.5	1.30
Jun	68.0	70.9	8,390 (8,370)[e]	93.9	25.9	1.00
Jul	65.2	73.4	8,590 (7,600)[e]	93.4	28.2	1.00
Aug	62.6	72.2	6,640 (5,100)[e]	93.6	31.0	0.90
Sep	68.0	67.2	6,400	91.0	23.0	0.90
Oct	60.8	58.2	6,350	87.4	26.6	0.90
Nov	51.8	46.7	8,690	83.4	31.6	0.96
Dec	38.0	39.9	14,900	80.6	42.6	1.30

Adapted from the ER, Table 6.1-4.

[a]Data from Aurora Gaging Station.

[b]Data from Louisville Weather Station.

[c]Data from Louisville Gaging Station.

[d]Blowdown temperature minus minimum river temperature.

[e]See discussion in text, Section 5.3.3.3.

The results of these calculations can be found in the ER, Tables 5.1-2, 5.1-3, and 5.1-5. Included are the maximum width, maximum length, and total area enclosed by the 3°F and 5°F (1.7°C and 2.8°C) excess isotherms. Plots of several of these plumes are found in the ER, Figures 5.1-1 through 5.1-9.

5.3.3.4 Staff's Analysis

The staff also analyzed the thermal plume for the original surface discharge but used a different set of meteorological and hydrological data as input to its thermal-plume model (see Table 5.5). The wet-bulb temperatures were those obtained from Meteorological Tower No. 1 located on the site. Because only one year of data was available, the maximum observed wet-bulb temperature for each month is used. These values will likely be exceeded occasionally for brief periods during the station's lifetime. It should be noted that these values are much higher than the average maximum values used by the applicant in its calculations and would better represent extreme blowdown temperatures.

The river temperatures used by the staff were those measured at Louisville (ER, Table 2.5-10). These data were chosen rather than those from the Aurora Gaging Station (used by the applicant) because the Louisville data were more recent and appear to be more internally consistent.

Numerous analytical models have been developed to describe the physical characteristics of surface discharges. Many of these models are reviewed by Policastro and Tokar.[31] As a result of the dearth of reliable field data, none of these models has been adequately tested.

The model chosen by the staff was developed by Shirazi and Davis and is generally considered to be among the best available.[32] This model is based on the assumption that the heated effluent is discharged from a rectangular channel into a large, deep body of water that is either at rest or

Table 5.5. Meteorological and Hydrological Data Used by the Staff (°F)

Month	Wet-Bulb Temperature[a]		Blowdown Temperature		River Temperature[b]			ΔT_n[c]	ΔT_e[d]
	Max.	Avg.	Max.	Avg.	Max.	Avg.	Min.		
Jan	60.2	35.2	88.2	78.9	47.9	38.6	32.1	40.3	56.1
Feb	55.6	31.0	86.3	77.5	44.3	39.4	32.4	38.1	53.9
Mar	63.7	42.2	89.7	81.2	56.5	45.4	36.7	35.8	53.0
Apr	67.2	48.8	91.3	83.8	64.5	55.5	46.1	28.3	45.2
May	73.7	57.4	94.4	87.0	79.5	66.2	56.4	20.8	38.0
Jun	77.1	61.6	96.0	88.9	84.9	76.1	63.6	12.8	32.4
Jul	73.8	66.3	94.5	90.8	87.2	81.0	64.7	9.8	29.8
Aug	74.0	67.2	94.7	91.2	86.6	81.3	76.7	9.9	18.0
Sep	72.9	57.9	94.1	87.3	83.9	77.1	67.2	10.2	26.9
Oct	64.8	48.2	90.3	83.5	77.5	67.3	57.7	16.2	32.6
Nov	64.2	41.2	89.9	80.9	68.7	55.1	47.3	25.8	42.6
Dec	56.4	34.9	86.7	78.6	51.6	43.5	35.1	35.1	51.6

[a]From the ER, Table 2.6-7.

[b]From the ER, Table 2.5-10.

[c]Average blowdown temperature minus average river temperature.

[d]Maximum blowdown temperature minus minimum river temperature.

moving at a uniform constant velocity. Although the cross section of the Marble Hill discharge is trapezoidal, the depth of the heated effluent is small enough (about 1 ft or 0.3 m) so that a rectangular approximation is adequate. The velocities used by the staff are half of those given by the applicant (see Tables 5.3 and 5.4). Recent measurements of near shore river velocities agreed with the staff's estimate.

5.3.3.5 Comparison of Results

Figure 5.4 shows a comparison (staff and applicant) of size and configuration of the thermal plume in January for normal meteorological and hydrological conditions. In this case only, the staff used the same values as the applicant for initial ΔT and river velocity, so that a direct comparison can be made with the results of the applicant's model. It is seen that the area enclosed by the applicant's 5°F (2.8°C) isotherm exceeds that of the staff's by a factor of about 10. Comparison of the two models for other months shows that at times the applicant predicts areas only four times those of the staff, whereas for some months the difference can be as high as a factor of 50. In any case, the applicant's model appears to be overly conservative.

Table 5.6 lists the areas (from both staff's and applicant's calculations) contained within the 3°F and 5°F (1.7°C and 2.8°C) excess isotherms for both normal and extreme conditions. The largest predicted areas enclosed by the 5°F (2.8°C) excess isotherm are 5.3 acres or 21,000 m^2 (applicant, October) and 0.27 acres or 1100 m^2 (staff, November). In all cases, both staff and applicant predict that the thermal plume will hug the shore. Inasmuch as the staff's model does not take into account the reduced availability of dilution water from this cause, it is expected that the area listed by the staff might be low by a factor of about two; nevertheless, the area in the most extreme case is less than one acre (4000 m^2).

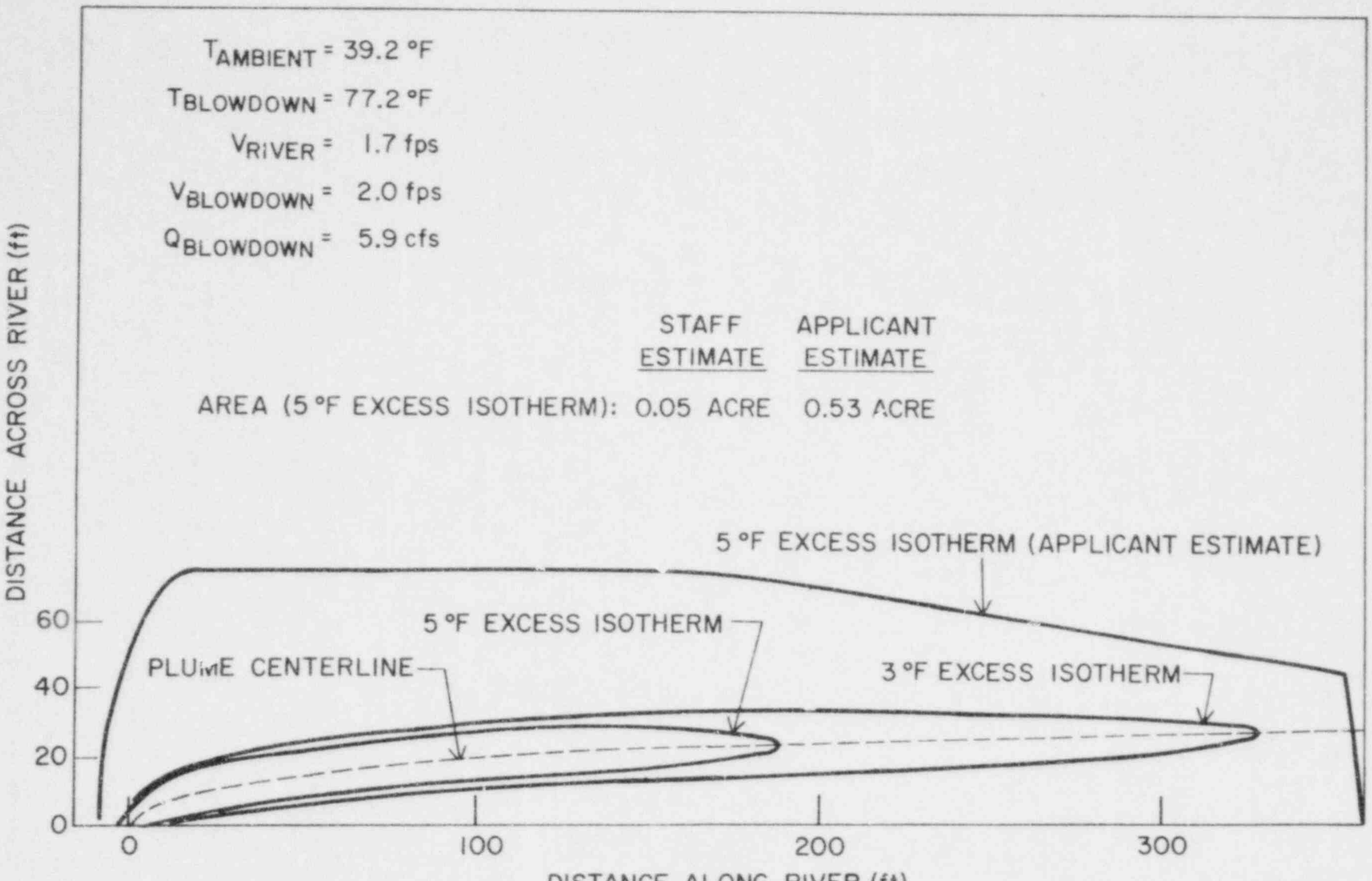

Fig. 5.4. Thermal Plume in January--Normal Meteorological and Hydrological Conditions.

Table 5.6. Comparison of Results for Normal and Extreme Conditions

Month	Staff-Estimated Area (acres)				Applicant-Estimated Area (acres)			
	3°F Excess Isotherm		5°F Excess Isotherm		3°F Excess Isotherm		5°F Excess Isotherm	
	Normal	Extreme	Normal	Extreme	Normal	Extreme	Normal	Extreme
Jan	0.26	0.56	0.12	0.26	1.56	11.9	0.53	3.9
Feb	0.22	0.49	0.098	0.23	0.95	12.1	0.30	3.5
Mar	0.20	0.46	0.088	[illegible]	0.33	9.3	0.09	2.7
Apr	0.22	0.33	0.098	0.15	0.27	4.5	0.06	1.4
May	0.082	0.33	0.031	0.15	0.28	4.2	0.06	1.4
Jun	0.030	0.36	0.009	0.15	0.49	7.0	0.10	2.7
Jul	0.015	0.30	0.004	0.12	0.52	7.3	0.10	3.0
Aug	0.016	0.10	0.004	0.03	2.28	12.4	0.90	5.1
Sep	0.016	0.28	0.004	0.10	1.92	8.0	0.73	3.1
Oct	0.052	0.38	0.017	0.16	1.60	14.6	0.52	5.3
Nov	0.13	0.60	0.050	0.27	1.84	15.6	0.67	4.7
Dec	0.20	0.49	0.088	0.23	1.02	11.1	0.32	3.7

The State standards limit the temperatures at the edge of the mixing zone to those listed in Table 5.2. The ΔTs at the edge of the mixing zone for conditions of simultaneous extreme blowdown temperature and maximum river temperature are listed in Table 5.7. This condition was not treated by the applicant because it investigated only the case for maximum monthly average temperatures and not the absolute maximum recorded. For the months of May and October, the maximum allowable temperature is only 0.5°F (0.3°C) above the river temperature. The staff computes the area contained in this 0.5°F (0.3°C) excess isotherm to be 1.4 acres (5700 m^2).

The staff is not aware of any models that take into account the sinking-plume phenomenon. This phenomenon occurs when the density of the warm effluent is greater than that of the ambient river water (water has a maximum density at about 39°F or 4°C), a condition that would be likely to occur only during the months of December, January, February, and March. It is estimated that the areas within the 3°F and 5°F (1.7°C and 2.8°C) excess isotherms could double as they sink to the bottom of the river.

Since the discharge design was changed from surface discharge to submerged discharge, more rapid mixing of the blowdown with the river is expected, resulting in a surface thermal plume of smaller area. The calculations reported above are of interest only to show that the surface thermal plume was small even for a surface discharge. Consequently, the smaller plume from the submerged discharge will have smaller effects on river temperature and river biota.

In the response to a request in the Draft Environmental Statement for additional information with respect to alternate discharge structures, the applicant has considered three additional alternatives to that originally proposed. ER, Suppl. 4, P. 10.3-1 to 10.3-4. They are:

(1) Single point submerged discharge
(2) Multiport diffuser
(3) Single level spillway

Because of this requirement to look at alternative designs, the applicant has decided to change its discharge structure to that listed under (1) above. This structure will consist of a single, 20-inch pipe discharging the blowdown at 6 feet below minimum water level, 420 feet MSL (see section 2.5).

This method of discharge will result in more rapid dilution of the heated effluent relative to the surface discharge. Thus, the maximum surface temperature will be only a fraction of the initial temperature difference and the 5°F and 3°F isotherms will be smaller than shown in Fig. 5.4 for the surface discharge. (See also Sections 3.4.3 and 9.3.3.)

Table 5.7. Predicted Areas Enclosed by Largest Isotherm Allowed by State Standards for Maximum River Temperature, Maximum Blowdown Temperature, and Minimum River Velocity

Month	ΔT[a] (°F)	Area[b] (Acres)
January	2.1	0.56
February	5.7	c
March	3.5	0.18
April	5.5	c
May	0.5	1.4
June	2.1	0.060
July	1.8	0.025
August	2.4	0.017
September	3.1	0.018
October	0.5	1.4
November	1.3	0.58
December	5.4	c

[a]Maximum allowable temperature at edge of mixing zone minus maximum river temperature.

[b]Area enclosed by allowable excess isotherm to conform to maximum allowable temperature.

[c]Met by 5°F excess isotherm standard.

5.3.3.6 Biological Impacts

Impacts to aquatic organisms that result from thermal discharges usually are due to thermal shock when organisms pass through the plume, inaccessibility to spawning or feeding grounds from thermal blocks, and "cold shock" to fish in the thermal plume as a result of sudden plant shutdowns during winter months. More passive organisms such as ichthyoplankton, phytoplankton, and zooplankton passing through the thermal plume could die if they remain in the plume for extended periods. Because of the small size of the thermal plume, exposure times should not exceed five minutes (river velocity of 1.0 fps or 0.3 m/sec and a plume length of 300 ft or 90 m). This time interval represents the maximum amount of time required to pass through the plume, as defined by the 3°F (1.7°C) excess isotherm, during extreme conditions (January ΔT of 56°F or 31°C). With this short exposure it is unlikely that large numbers of plankton will be lost from thermal shock.

A thermal block (preventing fish from getting to their feeding or spawning grounds) could cause a reduction in growth, recruitment, and survivorship in the affected populations.[33] This is not likely to occur because staff analysis indicates that the maximum width of the thermal plume at the 3°F (1.7°C) excess isotherm should not exceed 200 feet (60 m) or 9% of the river's width. Further, the high temperature regions will be at the surface, with cooler regions below. Fish are known to avoid unsuitable waters[34] and normally will have ample room for avoidance.

Studies by WAPORA, Inc.[35] and Gammon[36] have shown that fish species compositions upstream and downstream of thermal plumes differ and that these differences can be related to preferred temperatures. Species with higher preferred temperatures were more abundant in and downstream of the plume whereas those with lower preferred temperatures were more abundant upstream of the thermal plume. Such distributions may represent losses or changes in local species composition. Therefore, it is possible that local changes in species composition may occur in the discharge area. For Marble Hill, the fractional loss of spawning grounds is likely to be small because of the small size of the thermal plume.

"Cold shock" could occur during winter months when fish congregate in the warmer waters of the thermal plume if the station is shut down rapidly. Such a shutdown results in a relatively rapid return to ambient temperatures and fish may die if they cannot acclimate. Gizzard shad are particularly sensitive to changes in temperature and deceased specimens of this species have been found during winter near thermal discharges on the Ohio River.[37] Such occurrences considered for the Marble Hill Station alone are not expected to result in serious impacts because of the small volume of the thermal plume. In the event of plant shutdown the cooling tower blowdown can be regulated to reduce the "cold shock" effects.

It is possible that thermal impacts of the discharge plume could result in loss of benthic organisms, particularly freshwater mussels, and fish spawning habitat. A shallow (4 to 5 ft or about 1.5 m of water) underwater terrace about 50 feet (15 m) wide at a river level of 420 feet (128 m) MSL is present in the discharge area (ER, Fig. 2.5-1A and Supp. 1, p. 32). This type of underwater terrace is typically excellent spawning habitat for bottom-nesting fishes such as bluegill, channel catfish, and largemouth bass.[38] The limited benthic data collected by the applicant indicates that the discharge area may also be good habitat for freshwater mussels. At times (see Sec. 5.3.3.5) it is likely that the thermal plume will encroach on the bottom and benthic organisms may be eliminated. Temperatures in excess of those stated in Table 2.18 for the species mentioned above could make the area (up to 1 acre or 4000 m^2) unsuitable for spawning.

Inasmuch as most bottom-nesting fish have rather specific nesting requirements, a loss of favorable spawning habitat could reduce recruitment into the adult population, thus reducing the potential for normal population regulation.

All of the biological impacts of thermal discharges discussed in this section are expected to be considerably smaller for the submerged discharge than for the originally planned surface discharge. (See also Sections 3.4.3 and 9.3.3.)

5.3.3.7 Conclusions

As previously mentioned, the staff has used very conservative values in performing thermal-plume calculations for the surface discharge. These were:

(1) Maximum monthly wet-bulb temperatures measured at the site,
(2) Minimum river temperatures,
(3) Half the river velocities quoted by the applicant, and
(4) No heat loss to the atmosphere.

In spite of these conservative assumptions, the heated discharge from the plant is quickly diluted. Except in rare cases when ambient river temperatures might exceed those listed in Table 5.2 (a situation not under the control of the applicant), the staff concludes that the originally proposed surface discharge would have had acceptable effects on water quality and on aquatic biota. With the currently proposed submerged discharge, the environmental impacts will be still smaller.

5.4 RADIOLOGICAL IMPACTS FROM ROUTINE OPERATION

5.4.1 Radiological Impact on Man

The models and considerations for environmental pathways leading to estimates of radiation doses to individuals are discussed in detail in Draft Regulatory Guide 1.AA. Similarly, use of these models and additional assumptions for population dose estimates are described in Appendix D of this Statement.

5.4.1.1 Exposure Pathways

The environmental pathways which were considered in preparing this section are shown in Figure 5.5. Estimates were made of radiation doses to man at and beyond the site boundary based on NRC staff estimates of expected effluents as shown in Tables 3.4 and 3.5, site meteorological and hydrological considerations, and exposure pathways at the Marble Hill Nuclear Generating Station.

Inhalation of air and ingestion of food and water containing tritium, carbon-14 and radiocesium are estimated to account for essentially all of the whole body radiation dose commitments to individuals and the population within 50 miles of the station.

5.4.1.2 Dose from Radioactive Releases to the Atmosphere

Radioactive effluents released to the atmosphere from the Marble Hill facility will result in small radiation doses to the public. NRC staff estimates of the expected gaseous and particulate releases listed in Table 3.5 and the site meteorological considerations discussed in Section 2.6 of this Statement and summarized in Table 5.8 were used to estimate radiation doses to individuals and populations. The results of the calculations are discussed below.

Radiation Doses to Individuals

The predicted doses to (maximum) individuals at selected offsite locations where doses are calculated to be largest are listed in Table 5.9. The maximum individual is assumed to consume well above the average quantities of the foods considered. (See Table A-2 of Regulatory Guide 1.109.) The standard NRC models were used with the following modifications in order to realistically model features of the Marble Hill plant design and the site environs:

1. The fraction of the year milk animals and meat animals are on pasture was assumed to be 0.5 to reflect grazing practices more typical of a midwestern site (value for an unspecified site is 1.0). (Draft Regulatory Guide 1.AA.)
2. The fraction of the leafy vegetables consumed which are grown locally was assumed to be 0.25. This is more typical of midwestern sites (value for an unspecified site is 1.0).

Radiation Dose Commitments to Populations

The radiation dose estimates to the population (within 50 miles) for the Marble Hill Station from gaseous and particulate releases were based on the projected site population distribution for the year 2000. Crop production data for Indiana were also used (1975 World Almanac). Doses beyond the 50-mile radius were based on the average population densities discussed in Appendix D of this statement. The population doses are presented in Table 5.10. Background radiation doses are provided for comparison. The doses from atmospheric releases from the Marble Hill facility during normal operation are extremely small compared to the normal population dose from background radiation sources.

5.4.1.3 Doses from Radioactive Liquid Releases to the Hydrosphere

Radioactive effluents released to the hydrosphere from the Marble Hill Station during normal operation will result in small radiation doses to individuals and populations. NRC staff estimates of the expected liquid releases are listed in Table 3.4, and the site hydrological considerations are discussed in Section 2.5 of this statement. Conservative estimates of the latter are summarized in Table 5.11 and were used to calculate radiation doses to individuals and populations. The results of the calculations are discussed below.

Radiation Doses to Individuals

The estimated exposures to (maximum) individuals at selected offsite locations where doses are expected to be largest are listed in Table 5.12, the closest drinking water intake being that of Oldham County Water District 1. For the Louisville water intake farther downstream, complete mixing of the river can be assured, resulting in a higher d[illegible]ition factor and smaller doses than those given in Table 5.12. The standard NRC models were [illegible] for these analyses (Regulatory Guide 1.109).

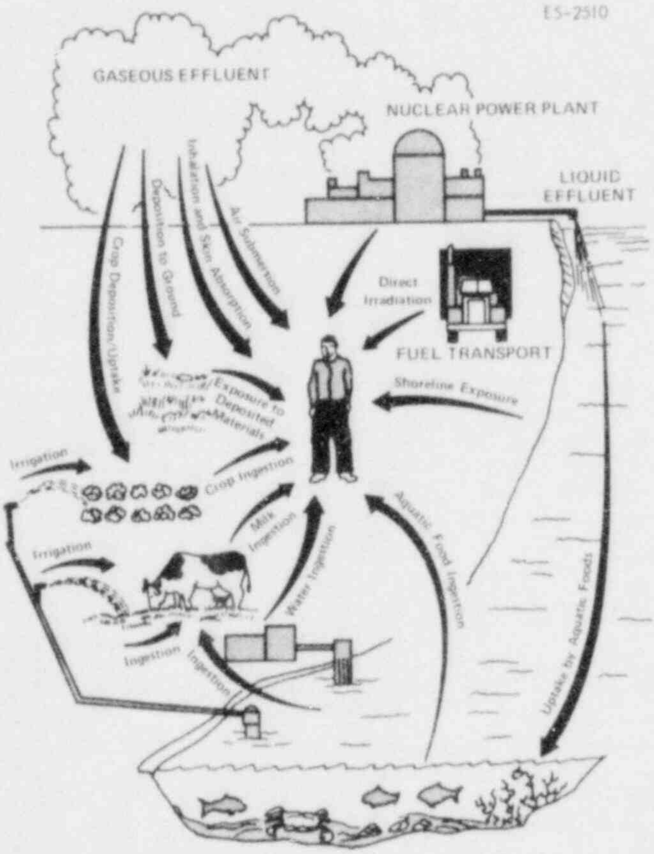

Fig. 5.5. Exposure Pathways to Man.

Table 5.8. Summary of Atmospheric Dispersion Factors and Deposition Va. ~s for Selected Locations near the Marble Hill Nuclear Power Station[a]

Location	Source[b]	χ/Q (sec/m³)	Relative Deposition (m⁻²)
Nearest[c] site land boundary (0.68 mi NNE)	A	2.7E-06	7.1E-08
	B	7.2E-07	3.8E-08
	C	6.2E-06	1.0E-07
	D	1.8E-05	1.0E-07
Nearest[c] residence (0.83 mi NNE)	A	2.3E-06	5.2E-08
	B	6.0E-07	2.6E-08
	C	4.9E-06	7.3E-08
	D	1.2E-05	6.4E-08
Nearest[c] milk animal (1.3 mi ENE)	A	8.0E-07	1.9E-08
	B	1.4E-07	6.1E-09
	C	1.3E-06	1.9E-08
	D	2.2E-06	1.0E-08

[a]See Draft Regulatory Guide 1.DD, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light Water Reactors."

[b]Sources:
Source A is reactor building purge
Source B is auxiliary building vent
Source C is waste gas processing system
Source D is turbine building vent.

[c]"Nearest" in this usage means the location with the highest calculated dose.

Table 5.9. Annual Individual Doses due to Gaseous and Particulate Effluents

Location	Pathway	Dose (mrem/yr)						
		Total Body	Bone	Liver	Thyroid	Lung	Skin	GI-Tract
Nearest[b] residence (0.83 mi NNE)	Plume	0.23	0.23	0.23	0.23	0.24	0.85	0.23
	Ground deposit	1.3	1.3	1.3	1.3	1.3	1.5	1.3
	Inhalation (infant)	0.17	a	0.17	0.24	0.19	0.17	0.17
	Vegetation (child)	3.1	3.1	4.0	3.1	2.9	2.8	2.9
Nearest[b] milk animal (1.3 mi ENE)	Plume	0.09	0.09	0.09	0.09	0.09	0.29	0.09
	Ground deposit	0.33	0.33	0.33	0.33	0.33	0.39	0.33
	Inhalation (infant)	0.04	a	0.05	0.07	0.05	0.04	0.04
	Milk (infant)	0.70	0.98	1.3	4.1	0.73	0.65	0.65
	Vegetation (child)	0.83	0.82	1.1	0.84	0.77	0.74	0.77
	Meat (child)	0.09	0.08	0.10	0.71	0.09	0.09	0.09

[a]Less than 0.01 mrem/yr.

[b]"Nearest" means the location with the highest calculated dose.

Table 5.10. Annual Population Dose Commitments in the Year 2000

Category	Population Dose Commitment (man-rem)	
	50 Miles	U. S. Population
Natural radiation background[a]	170,000[b]	26,000,000[c]
Nuclear plant operation		
Plant work force	d	900
General public		
Gaseous cloud	2.7	6.1
Ground deposition	0.36	0.36
Terrestrial foods	6.5	67.
Drinking water	0.37	0.62
Aquatic food	e	e
Recreation	e	e
Transportation of nuclear fuel and radioactive wastes	d	14

[a]"Natural Radiation Exposure in the United States," U. S. Environmental Protection Agency, ORP-SID 72-1, June 1972.

[b]Using the average Indiana background dose in (a), and year 2000 projected population of 1.62 million.

[c]Using the average U [illegible] background dose in (a), and year 2000 projected U. S. population f[illegible] Population Estimates and Projections," Series II U. S. Dept. of Commerce, Bureau of the Census, Series P-25, February 1975.

[d]Included in U. S. population, since some of the exposures are received by persons residing outside the 50-mile radius.

[e]Less than 1 man-rem/yr.

Table 5.11. Summary of Hydrologic Transport and Dispersion for Liquid Releases from the Marble Hill Nuclear Power Station[a]

Location	Transit Time (hours)	Dilution Factor
Nearest drinking water intake (10 mi downstream)	6.5	1000
Nearest sport fishing location	0	10
Nearest shoreline	0	1.0

[a]See Draft Regulatory Guide 1.EE, "Analytical Models for Estimating Radioisotope Concentrations in Different Water Bodies."

Table 5.12 Annual Doses to Maximum Individual (Adult) due to Liquid Effluents

Location	Pathway	Dose (mrem/yr)						
		Total Body	Bone	Liver	Thyroid	Lung	Skin	GI-Tract
Nearest water use (10 mi downstream)	Drinking water	0.01	a	0.01	0.05	0.01	0.01	0.01
Nearest fish production (0.1 mi downstream)	Fish	0.54	0.36	0.70	1.5	0.11	0.54	0.06
Nearest shoreline (0.5 mi downstream)	Sediments	a	a	a	a	a	a	a

[a]Less than 0.01 mrem/yr.

Radiation Dose Commitment to Populations

The population radiation dose estimates to 50 miles, for the Marble Hill Station, from liquid releases, based on the reported use of water and biota from the Ohio River, are shown in Table 5.10. Doses beyond 50 miles were based on the assumptions discussed in Appendix D.

Background radiation doses are provided for comparison. The doses from liquid releases from the Marble Hill Station represent small increases in the population dose from background radiation sources.

5.4.1.4 Direct Radiation

Radiation from the Facility

Radiation fields are produced in nuclear plant environs as a result of radioactivity contained within the reactor and its associated components. Although these components are shielded, dose rates around the plants have been observed to vary from undetectable levels to values of the order of one rem per year.

Doses from sources within the plant are primarily due to nitrogen-16, a radionuclide produced in the reactor core. Because of variations in equipment layout, exposure rates are strongly dependent upon overall plant design. Since the primary coolant of pressurized water reactors (PWRs) is contained in a heavily shielded area of the plant, dose rates in the vicinity of PWRs are generally undetectable (less than 5 mrem/yr).

Low-level radioactivity storage containers outside the plant are estimated to contribute less than 0.01 mrem per year at the site boundary.

Occupational Radiation Exposure

Based on a review of the applicant's Safety Analysis Report, the staff has determined that individual occupational doses can be maintained within the limits of 10 CFR Part 20. Radiation dose limits of 10 CFR Part 20 are based on a thorough consideration of the biological risk of exposure to ionizing radiation. Maintaining radiation doses of plant personnel within these limits ensures that the risk associated with radiation exposure is no greater than those risks normally accepted by workers in other present-day industries. Using information compiled by the Commission[39] of past experience from operating nuclear reactor plants, it is estimated that the total dose to all onsite personnel at large operating nuclear plants will be, on the average, approximately 450 man-rem per year per unit. The total dose for this plant will be influenced by several factors for which definitive numerical values are not available. These factors are expected to lead to doses to onsite personnel lower than estimated above. On the other hand, improvements to the radioactive waste effluent treatment system to maintain offsite population doses as low as practicable may cause an increase to onsite personnel doses. If all other factors remain unchanged, however, the applicant's implementation of Regulatory Guide 8.8 and other guidance provided through the staff radiation protection review process is expected to result in an overall reduction of total doses from those currently experienced. Because of the uncertainty in the factors modifying the above estimate, a value of 450 man-rem will be used for the occupational radiation exposure for each unit of this station.

Transportation of Radioactive Material

The transportation of cold fuel to each of the Marble Hill reactors, of irradiated fuel from each reactor to a fuel reprocessing plant, and of solid radioactive wastes from each reactor to burial grounds is within the scope of the Commission's Transportation Rulemaking Decision "Environmental Effects of Transportation of Radioactive Materials to and from Nuclear Power Plants" promulgated as 10 CFR Section 51.20(g). Pursuant to the rule, the environmental effects of such transportation are summarized in Table 5.13. For a detailed discussion of the transportation of radioactive material, see the NRC report entitled, *Environmental Survey of Transportation of Radioactive Material to and from Nuclear Power Plants.*[40]

Table 5.13. Environmental Impact of Transportation of Fuel and Waste to and from One Light-Water-Cooled Nuclear Power Reactor[a]

Normal Conditions of Transport			
			Environmental Impact
Heat (per irradiated fuel cask in transit)			250,000 Btu/hr
Weight (governed by Federal or State restrictions)			73,000 lb 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[b] (per reactor year)	Cumulative Dose to Exposed Population (per reactor year)[c]
Transportation workers	200	0.01 to 300 millirem	4 man-rem
General public			
Onlookers	1,100	0.003 to 1.3 millirem	3 man-rem
Along route	600,000	0.0001 to 0.06 millirem	

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

[a]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.I NUREG 75/038, April 1975.

[b]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 5000 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 102 millirem per year.

[c]Man-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 1000 people were to receive a dose of 0.001 rem (1 millirem), or if two people were to receive a dose of 0.5 rem (500 millirem) each, the total man-rem in each case would be 1 man-rem.

[d]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.

5.4.1.5 Evaluation of Radiological Impact

The radiological impact of operating the proposed Marble Hill Nuclear Power Station is presented in terms of individual doses in Tables 5.9 and 5.12, and population doses in Table 5.10. The annual individual doses resulting from routine operation of the plant are a small fraction of the dose limits specified in 10 CFR Part 20. The population doses are small fractions of the dose from natural environmental radioactivity. As a result, the staff concluded that there will be no measurable radiological impact on man from routine operation of the Marble Hill facility.

5.4.1.6 Comparison of Calculated Doses with NRC Design Objectives

Tables 5.14 and 5.15 show a comparison of calculated doses from routine releases of liquid and gaseous effluents from the Marble Hill facility with the design objectives of Appendix I to 10 CFR 50 and with the proposed staff design objectives of RM-50-2.

5.4.2 Radiological Impact on Biota other than Man

The models and considerations for environmental pathways leading to estimates of radiation doses to biota are discussed in detail in Volume 2, "Analytical Models and Calculations" of WASH-1258.[41]

5.4.2.1 Exposure Pathways

The environmental pathways which were considered in preparing this section are shown in Figure 5.6. Dose estimates were made for biota at the nearest land and water boundaries of the site, and in the aquatic environment at the point where the plant's liquid effluents mix with the Ohio River. The estimates were based on estimates of expected effluents as shown in Tables 3.4 and 3.5, site meteorological and hydrological considerations, and the exposure pathways anticipated at the Marble Hill Nuclear Power Station.

5.4.2.2 Doses to Biota from Radioactive Releases to the Biosphere

Depending on the pathway (as discussed in Regulatory Guide 1.109), terrestrial and aquatic biota will receive doses approximately the same or somewhat higher than man receives. Dose estimates for some typical biota at the Marble Hill site are shown in Table 5.16. Doses to a greater number of similar biota in the offsite environs will generally be much lower.

5.4.2.3 Doses to Biota from Direct Radiation

Although many of the terrestrial species may be continuously exposed, and thereby receive higher doses than man, aquatic species and some terrestrial species may receive somewhat lower doses depending on shielding by water or soil (e.g., burrows). As a result of these uncertainties, it was assumed that the direct radiation doses to biota at the site boundary will be about the same as for man. As discussed in Section 5.4.1.4, direct radiation doses are generally less than 5 mrad/yr.

5.4.2.4 Evaluation of the Radiological Impact on Biota[42,43]

Although guidelines have not been established for acceptable limits for radiation exposure to species other than man, it is generally agreed that the limits established for humans are also 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 (e.g., heat, biocides, etc.), 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 Marble Hill Station. The "BEIR" Report concluded

Table 5.14 Comparison of Calculated Doses to a Maximum Individual from Marble Hill Operation with Guides for Design Objectives Proposed by the Staff[a]

Criterion	RM-50-2 Design Objective	Calculated Dose
Liquid effluents		
Dose to total body or any organ from all pathways	5 mrem/yr	1.6 mrem/yr
Noble Gas effluents (at site boundary)		
Gamma dose in air	10 mrad/yr	0.51 mrad/yr
Beta dose in air	20 mrad/yr	1.8 mrad/yr
Dose to total body of an individual	5 mrem/yr	0.30 mrem/yr
Dose to skin of an individual	15 mrem/yr	1.1 mrem/yr
Radioiodine and particulates[b]		
Dose to any organ from all pathways (at nearest residence)	15 mrem/yr	5.4 mrem/yr

[a]Guides on Design Objectives proposed by the NRC staff on February 20, 1974; considers doses to individuals from all units on site. From "Concluding Statement of Position of the Regulatory Staff," Docket No. RM-50-2, Feb. 20, 1974, pp. 25-30, U. S. Atomic Energy Commission, Washington, D. C.

[b]Carbon-14 and tritium have been added to this category.

Table 5.15 Comparison of Calculated Doses to a Maximum Individual from Marble Hill Operation with Appendix I Design Objectives[a]

Criterion	Appendix I Design Objective	Calculated Dose
Liquid effluents		
Dose to total body from all pathways	3 mrem/yr	0.28 mrem/yr
Dose to any organ from all pathways	10 mrem/yr	0.80 mrem/yr
Noble gas effluents		
Gamma dose in air	10 mrad/yr	0.26 mrad/yr
Beta dose in air	20 mrad/yr	0.88 mrad/yr
Dose to total body of an individual	5 mrem/yr	0.15 mrem/yr
Dose to skin of an individual	15 mrem/yr	0.55 mrem/yr
Radioiodines and particulates[b]		
Dose to any organ from all pathways	15 mrem/yr	2.7 mrem/yr

[a]Appendix I Design Objectives from Sections II.A, II.B, II.C of Appendix I, 10 CFR Part 50; considers doses to maximum individual per reactor unit. From Federal Register V. 40, p. 19442, May 5, 1975.

[b]Carbon-14 and tritium have been added to this category.

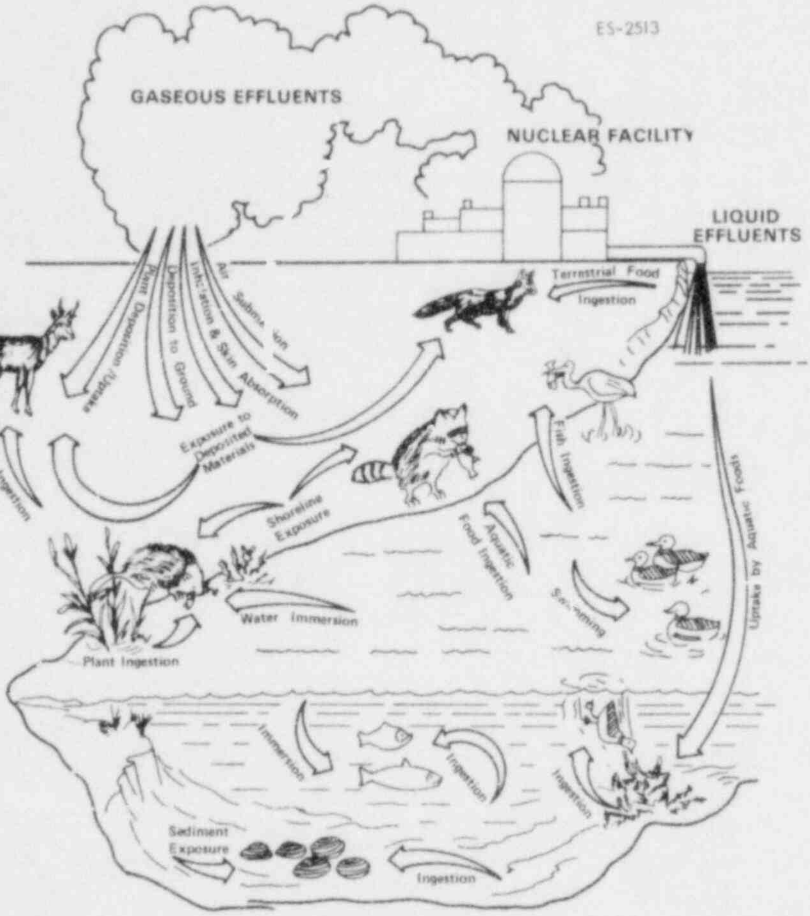

Fig. 5.6. Exposure Pathways to Biota other than Man.

Table 5.16. Dose Estimates for Typical Biota at the Marble Hill Site

Biota	Location	Pathway	Dose (mrad/yr)[a]
Deer	Nearest site land boundary (0.68 mi NNE)	Atmosphere	4.4
Fox	"	"	2.7
Terrestrial flora	"	"	2.1
Raccoon	Nearest site water boundary (0.18 mi N)	Atmosphere Hydrosphere	6.2
Muskrat	"	"	15
Heron	"	"	52
Duck	Plant outfall (0.45 mi SSE)	"	13
Fish	"	Hydrosphere	4.6
Invertebrates	"	"	12
Algae	"	"	3.8

[a]Atmospheric doses include estimates of plume dose, ground deposition dose, inhalation dose, and ingestion doses where appropriate. Hydrospheric doses include estimates of immersion dose, dose from consumption, and sediment dose where appropriate.

that the evidence to date indicates that no other living organisms are very much more radiosensitive than man, therefore, no measurable radiological impact on populations of biota is expected from the radiation and radioactivity released to the biosphere as a result of the routine operation of the Marble Hill Station.

5.5 NONRADIOLOGICAL EFFLUENTS FROM ROUTINE OPERATION

5.5.1 Chemical Effluents

The major change in the blowdown composition from that of the ambient river water is an increase in total dissolved solids concentration from ambient to 1500 ppm. The addition of sulfuric acid to the cooling water causes the displacement of bicarbonate ion by sulfate ion, and the bicarbonate ion dissociates to carbon dioxide, which enters the atmosphere. About 465 mg/l of bicarbonate is replaced by about 380 mg/l of sulfate in the station's cooling water. The liquid is rapidly diluted in the mixing zone, and the staff does not expect untoward chemical effects from sulfuric acid. Several ambient river components (iron, cadmium, and manganese) already are close to, or exceed, the criteria listed in Table 3.7 and will be further concentrated within the blowdown; however, no incremental additions are made in the station and these materials will be rapidly diluted to ambient level in the mixing zone.

The condenser tubing material has not been chosen. Even if a copper alloy is selected, insignificant amounts of copper will be added to the water by erosion and corrosion.

Liquid effluents from the Marble Hill Station are subject to restrictions from a number of agencies. These include the EPA (Federal), the State of Indiana, the State of Kentucky, and the Ohio River Valley Sanitation Commission. The regulations of each of these agencies pertaining to plant effluents are contained in the ER, Appendix 2C. With some qualifications discussed in individual sections (5.5.2, 5.5.5.1) and except when ambient river parameters already exceed criteria, the staff believes the effluents will meet the most restrictive applicable conditions.

5.5.2 Biocidal Effluents

The applicant indicates that each condenser will be treated with chlorine at an average rate sufficient to produce a concentration of five ppm in the condenser water. The observed chlorine demand of Ohio River water has varied between 1.5 and 7.0 ppm and the ammonia content from 0.08 to 0.74 ppm, equivalent to a total uptake of chlorine of about 0.5 to 4.5 ppm. Consequently, an effective and efficient chlorination program will have to allow for wide variations in the level of chlorine additions. The chemistry and kinetics of chlorination are highly complicated, depending strongly on pH, temperature, ammonia, and amine concentration, as well as nonnitrogenous reducing agents. Consequently, even with accurate and continuous monitoring of active chlorine levels after the condenser, it is likely that mismatches of chlorine feed to demand will occur often. Although free active chlorine is highly reactive and may be expected to decay rapidly at neutral and acid pH levels, combined chlorine (with ammonia or substituted amines) is relatively stable and may persist over long periods.

In view of the above considerations the staff believes that free chlorine will very probably (but not certainly) be below the 0.1 ppm level in the discharge. Combined chlorine may normally be below 0.2 ppm but it is likely that periods of relatively high chlorine levels will occur in the discharge to the river. For one-unit operation before the second unit is completed, concentrations may be double these and impacts will be correspondingly more severe. The staff therefore, requires that the cooling system of the plant shall be constructed so that the concentration of total residual chlorine discharged to the river not exceed 0.2 ppm as specified in the State of Indiana Water Quality Certification ("401"), dated Jan. 30, 1976.

5.5.3 Sanitary Wastes

Inasmuch as the sanitary wastes will be treated at a tertiary level and highly diluted in the blowdown, no detectable effects are expected.

5.5.4 Other Wastes

Gaseous effluents from the diesel engines and auxiliary boilers will meet EPA and State standards for such effluents. The effects should be undetectable beyond a very short range of the emitting units.

5.5.5 Biological Impacts

5.5.5.1 Chemical Effects

Expected average and maximum concentrations of metals and other chemical species in the plant discharge are given in Table 3.7. Except for sulfate ion, these concentrations were calculated assuming that the cooling system will concentrate river water by a factor of 7.

Concentrations of metals known to be toxic (see Table 5.17) will occur in the immediate discharge area.[44] Also, metals taken up by lower trophic levels could be concentrated up the food chain with concentrations reaching toxic proportion at the higher trophic levels. Aquatic biota passing through the thermal plume or benthic organisms affected by a sinking plume may be killed or physiologically stressed (e.g., reduced reproductive capability). The possible impacts could be intensified by elevated water temperatures, since studies have shown that a given chemical concentration may be more toxic at higher temperatures.[45] The elevated temperatures of the discharge could attract fish to the thermal plume during winter, which could expose them to toxic levels of various chemicals in the discharge resulting in death or physiological stress. Unlike "cold shock," this exposure, with accompanying possible acute or chronic effects, could occur for several days during winter making the potential impacts more severe. However, because of the rapid dilution of the blowdown with river water, particularly with the submerged discharge, major impacts to aquatic biota from high chemical concentrations are unlikely.

Also, since the applicant will keep the TDS concentration in blowdown below 1500 ppm to avoid scaling, the cooling system will be operated at times with concentrations factors less than 7. At some times of year, the river TDS concentrations reach values such that a concentration factor or 4 would result in a blowdown TDS concentration of 1500 ppm.

5.5.5.2 Biocidal Effects

Sodium hypochlorite will be used as a biocide by the applicant and, because of high ammonia levels in the Ohio River, persistent residual chloramines will be present in the discharge. Total residual chlorine levels in excess of 0.05 ppm are known to be toxic to aquatic biota;[46] this level occasionally will be exceeded in the immediate discharge area and acute and chronic effects could occur to aquatic biota passing through this discharge area or to benthic organisms affected by a sinking thermal plume. The mixing zone has not yet been defined by the State of Indiana. In order to estimate the probable concentration of total residual Cl at the edge of the mixing zone, the staff has taken the 3°F isotherm to represent the boundary of the mixing zone. Table 5.5 indicates the expected dilution factor will vary from 6 to 18; use of the most conservative of these estimates results in an anticipated concentration of 0.03 ppm at the edge of the mixing zone for a discharge concentration of 0.2 ppm. This potential impact was calculated for a surface discharge; it will be reduced several fold by the submerged discharge.

Table 5.17. Lowest Concentration of Various Chemicals that Are Known to Either Cause Mortality or Affect Behavior of Fishes, Insects, and Phytoplankton that Occur in the Ohio River

Chemical	Concentration (ppm)	Effect	Species
Sodium carbonate	250	Minimum lethal concentration in 120 hours	*Notropis atherinoides*
Chloramines	0.154	Death in 3 days	*Pimephales promelas*
Chromic sulfate	0.03	Acute 48-hour TL_m	*D. magna*
Cobalt	0.12	50% loss in reproduction in 3 weeks	*D. magna*
Copper	0.035	50% loss in reproduction in 3 weeks	*D. magna*
Copper sulfate	0.023	96-hour TL_m	*P. promelas*
Copper + zinc	0.025 + 1.0	Death in 8 hours	*P. promelas*
Zinc	0.07	16% loss in reproduction in 3 weeks	*D. magna*
Zinc sulfate	0.024	Killed in hard water	*D. magna*

From C. D. Becker and T. O. Thatcher, "Toxicity of Power Plant Chemicals to Aquatic Life," WASH-1249, Battelle Pacific Northwest Laboratories, Richland, Washington, 1973, 222 pp.

[a]Median tolerance limit.

5.6 OPERATION OF THE POWER TRANSMISSION SYSTEM

Aside from the esthetic impacts of transmission towers and lines from the Marble Hill Station (see Sec. 5.1), operation of these lines may cause the production of ozone, increased electrical fields, shock hazards, radio and TV interference, and acoustical noise. The use of herbicides during right-of-way maintenance also may be of concern.

Ozone and other gaseous pollutants, such as nitrogen oxides, are formed as a result of ionization of air molecules that surround the cylindrical conductors used for transmitting electrical energy at high voltages. This ionization is caused by electrical discharge that is termed corona. The degree of ionization depends on voltage, humidity, conductor diameter, surface roughness, and spacing between conductors. Calculations indicate that ozone production could be 45 times higher in foul than fair weather. Measurements at 345-kV lines show, however, that at ground level beneath the conductors the ozone concentration does not rise above ambient; furthermore, ground concentration of ozone is the same on foul days as fair days, presumably because factors favoring increased production rates also favor increased destruction rates.[47]

Recently, experiments were run over a one-year period in Jefferson County, Indiana, on 765-kV lines running over open, flat cornfields. This is a situation closely duplicating much of the proposed Marble Hill 765-kV lines. When instruments were placed six meters downwind from the 765-kV conductors at conductor height where corona-produced ozone concentration should be greatest ". . . no ozone attributable to the transmission lines was detectable during the test."[48] The natural increase in ozone concentration of two to three ppb for an increase of 30 meters in elevation was observed.

The sensitivity of measuring instruments is about ±2 ppb; hence, increases in ozone concentration above ambient due to corona from 765-kV lines are within the sensitivities of measuring instruments.[49]

The national, primary, air-quality standard for photochemical oxidants prescribes a level of 80 ppb as a maximum one-hour arithmetic mean not to be exceeded more than once per year. Susceptible plant species show damage symptoms from ozone exposure at concentrations as low as 30 ppb,[50,51] but over prolonged periods ozone is not considered injurious to vegetation, animals, or human beings unless concentrations exceed 50 ppb.[52] On the basis of these considerations the staff concludes that ozone from Marble Hill Station's 765-kV lines will be environmentally inconsequential.

There is a possibility that electrical fields set up around transmission lines could affect persons in the field. Studies have been performed by members of the staff of the Johns Hopkins Hospital to determine whether exposure to electrostatic fields such as those existing in transmission line substations result in adverse effects on humans, and were reported by Kouwenhaven et al.[53] The Kouwenhaven study gives the results of physical and medical examinations of eleven linemen over a period of 42 months during the time they were performing live-line maintenance work on a 345-kV transmission system. Measurements of currents induced in a man's body when doing typical work on a 345-kV system such as on transmission towers and in buckets were reported on. In the former case, the man is grounded while in the electric field and in the latter, he is at line potential (barehand work). Body currents of 100 to 400 microamperes for the tower work and from 85 to 210 microamperes for barehand work were measured, depending on degree of bucket shielding used. Field intensities also were determined at various parts of the bodies of men doing barehand work. These ranged from 0.4 kV/in (20 kV/m) to 12 kV/in (470 kV/m) at the top of the head to 0 to 4 kV/in (200 kV/m) at the knees, depending on whether full or partial bucket shields were used.

As a result of this study, the authors reported that

> "Considering the period of observation (3-1/2 years) and the method of study, it can be reported that the health of the eleven observed linemen was unchanged by their exposure to HV lines. Also no evidence of malignancy was found. There was a decrease in the sperm count of two of the 11 subjects. The significance of this is not clear and warrants further study; but no correlation has been found between exposure to HV lines and any effect on the health of individuals in this investigation. Among the 11 men tested, there were four who had had many hours of barehand work during the period of this investigation. Not a single one of these men showed any change in his physical, mental, or emotional characteristics. Their laboratory studies remained entirely normal. No evidence was found that an adequately shielded lineman is endangered in any way by working barehanded in a HV ac electric field, within the limits of this study."

Studies of this nature were also carried on in Russia and their results were reported at the 1972 International Conference on Large High Tension Electric Systems, Paris, France, in a paper by Korobkova et al.[54] In this study, a systematic medical examination of about 250 persons working in 500-kV substations for a long time was undertaken. Measurements were also made of field strengths in various areas where these persons worked in 500-kV substations and similar locations in 750-kV substations. Field potentials up to 26 kV/m were indicated in the 500-kV substations.

The Korobkova report stated that "the examination showed that long-time work at 500-kV substations without protective measures results in shattering the dynamic state of the central nervous system, heart and blood-vessel system and in changing blood structure. Young men complained of reduced sexual potention." It was also concluded that "the depth of these functional diseases or troubles directly depends on the time of stay in the field." Criteria for permissible duration of personnel stay in electric fields were given and ranged from five minutes per day at 25 kV/m to unlimited time at 5 kV/m.

In a follow-on report by the Johns Hopkins staff members,[55] results were given for the continued examination of ten of the previously examined linemen who were still employed by the power companies. The report covers a period of nine years ending June 1973 during which the men were examined completely seven times. There were no significant changes of any kind found in the physical examinations, neither were there any significant abnormalities in any of the laboratory studies. No disease states were found that could be in any way related to the exposure of the men to high-voltage lines.

The investigators were aware of the Russian paper and specifically looked for disorders described in it. In particular, no disorders in the functional states of the nervous and cardiovascular systems of the workers as reported by the Russians were found. The report cautioned, however, that in view of the two diverse populations examined, with entirely different cultures, working conditions and environments, comparison of the two different studies should be "viewed with great caution". The report of the follow-on examinations, therefore, did not change the conclusions reached in the earlier study.

A recent Russian paper, discussed during a US/USSR symposium on high voltage transmission,[67] reiterated that extra high voltage (EHV) substation workers had experienced problems. In this discussion the Russians state, "If the exposure is of brief duration, the effect disappears. If the exposure is on an extended daily basis, the effects appear to be cumulative but ill effects disappeared in one month after removal from exposure." A second Russian paper[68] stressed that present standards apply only to maintenance personnel working on electrical installations. Standards permitting higher voltage gradients for local populations and agricultural workers are currently being considered since these populations will be exposed only infrequently.

These studies did not incorporate controls and are limited in both scope and time. For example, cases are known where adults are unaffected by doses of agents that are teratological or lethal to the fetus or child, and lag times between dose and effect of 20 years or more are known. Since the above studies do not consider children, since children may play beneath the transmission lines, and since controlled studies of long duration have not been carried out, the long-term effect of high voltage transmission lines is currently unknown. However, the staff is not aware of any reported observable effects resulting from exposure to electric fields radiated from high voltage power lines. The physiological effects reported by the Russians were observed on workers in EHV substations, not on individuals below transmission lines.

The applicant's original application did not specify the exact design of the transmission system. But the staff knows[56] that 765-kV systems are being built with the intention that the gradient within the right-of-way at a point of minimum conductor-to-ground clearance is 8 kV/m and at the edge of the right-of-way is 1.8 kV/m. If these gradients were to occur, using the more conservative Russian study, a man could daily spend three hours working beneath the lines with no adverse effects. The general public is not expected to spend significant amounts of time in the transmission line right-of-way corridors.

The applicant has specified in the letter of 30 April 1976 to the NRC that the maximum electrical field gradients at the point of minimum ground clearance will be designed to be 12 kV/m which is below the normal perception level. This will result in a field of 2.4 kV/m at the edge of the right-of-way.

The brief summation of the literature given above includes observations of adverse health effects on switchyard workers, but no such observations were reported from studies on transmission line workers and on individuals outside the switchyard environment exposed to voltage gradients well above 12 kV/m. In the absence of such observations the staff does not believe that there should be changes in the applicant's proposed design. A number of carefully designed studies of the biological effects of electric fields are currently underway and additional studies are planned. The effects of transmission line voltage gradients on the general population will be studied, along with long-term effects. The staff will keep abreast of these studies and of any guidelines resulting from them, and will reconsider the impacts of the transmission line operation prior to or at the time of the Operating License stage review, taking into consideration any new information.

The applicant will minimize induced ground currents by grounding towers, fences, and rail lines where the transmission lines might interfere with railroad communication or signalling devices. Ground resistance tests will be performed for each tower. If the resistance to ground exceeds 10 ohms, the applicant proposes to install additional grounding to keep the value at 10 ohms or less under normal atmospheric conditions (ER, Section 3.9.5).

Induced currents are unlikely to ignite fuel vapors, but currents capable of shocking people could be induced in vehicles without grounding straps. Any stationary structure with metal parts in the right-of-way should be grounded by the applicant, especially such objects as metal fences or rail lines that run parallel to the right-of-way. In such objects that are ungrounded, shock causing involuntary muscle reaction may occur, but no permanent physiological harm is likely.[57] The applicant is committed to ground such fences at intervals of 500 feet (150 m) within the easement strip (ER, Sec. 3.9.5). The staff believes these grounding measures will reduce the likelihood of shock to a level which is of no concern.

A transmission line design guideline pertaining to induced currents which the applicant plans to follow, and which the staff considers prudent, is that ground clearances should be maintained so that a maximum induced current of 5 milli-amperes (rms) is not exceeded under conditions of maximum line sag when the largest anticipated truck, vehicle or equipment under the line is short-circuited to ground. This guideline will effectively reduce the applicant's specified maximum voltage gradient where large vehicles and equipment pass under the lines.

A four-conductor bundle of unspecified configuration, which the applicant intends to use (ER, Sec. 3.9.4), will minimize radio and TV interference from the line and give acceptable fair-weather reception beyond 200 feet (60 m) from the line.[58] AM radio and TV reception will be degraded in any case if the receiving equipment is within 80 feet (25 m) of the right-of-way during foul weather, but there will be no interference with FM reception.

The applicant claims that no complaints about audible noise at the right-of-way edge of operating 765-kV lines have been registered (ER, Sec. 3.9.4). It has been stated that in fair weather audible noise produced at the edge of the right-of-way of a 765-kV line will be 37 dBA, which is too low to be heard.[59] During a heavy rain the noise level can go up to 56 dBA, which can be heard, but the noise of the rain will likely override it. In any case, because the average office or home noise exposure is 75 dBA,[60] the power-line noise would, at most, be a mild irritant.

The applicant plans to use herbicides in the maintenance of the transmission line rights-of-way. For the staff's discussion of the terrestrial impacts of herbicide usage see Sec. 4.3.1.

In forested areas, removal of trees and shrubs along the transmission-line route will create edge habitats that may lead to an increase of animal and plant diversity in the area, whereas those species requiring unbroken forest in which to live will probably be subject to stress.

Impacts on aquatic ecosystems due to operation of the transmission lines will essentially be the same as described in Section 4.3.2, except that the use of herbicides to control the vegetation in the corridors must be considered. Aerial application of these herbicides could result in their entering the streams via runoff. In order to adequately protect the aquatic biota, the applicant shall be required to adhere to conditions set forth in Section 4.5.2.

5.7 URANIUM FUEL CYCLE

The environmental effects of uranium mining and milling, the production of uranium hexafluoride, isotopic enrichment, fuel fabrication, reprocessing of irradiated fuel, transportation of radioactive materials, and management of low- and high-level wastes are within the scope of an AEC (now NRC) report.[61] Table 5.18 summarizes the contributions of such environmental effects.

The NRC Staff may subsequently modify or expand the discussion of environmental effects of the fuel cycle in the light of the Court of Appeals decision in Natural Resources Defense Council v. NRC (CADC Nos. 74-1385 and 74-1586 decided July 21, 1976). That decision is now being analyzed by the Staff.

5.8 IMPACTS ON THE COMMUNITY

5.8.1 Physical Impacts

Because of the remoteness of the station, operational noise should affect very few persons. Moreover, noise emissions that do occur will conform to local, state, and federal guidelines and regulations (ER, p. 8.2-7).

Under certain meteorological conditions, the plumes from cooling towers could increase ground-level fog. The frequency and extent of this physical impact, as well as the information concerning visibility of the plumes, are more fully discussed in Section 5.3.1.

As the plant construction reaches completion, traffic congestion is expected to be considerably less than during the construction peak. The upgrading of roads for the construction phase should be adequate for the operational phase.

5.8.2 Social and Economic Effects

5.8.2.1 Employment

The applicant has estimated that 544 people would relocate to the area within 10 miles of the Marble Hill station as a result of plant operation and maintenance. Within this group are 155 plant employees, 106 induced non-manufacturing employees, 123 school children and 160 other adults (ER, p. 8.1-5). Induced employees are those required to provide services to inmigrating employees. After reviewing the available data, the staff concludes that the applicant's estimate of induced employees relocating to the area has been overstated. An important consideration in arriving at this conclusion is the high local unemployment rate. Some of the locally unemployed and underemployed would benefit from the direct and induced labor demands of the station during both the construction and operation phases.

5.8.2.2 Direct Payroll and Purchases

The applicant estimates that over the operating life of the Marble Hill facility, labor expenditures will amount to more than $216 million (1983 present worth). The applicant also estimates that 90% of the operating payroll will be spent within the region (ER, p. 8.1-6).

Table 5.18. **Summary of environmental considerations for uranium fuel cycle**

Normalized to model LWR annual fuel requirement

Natural resource use	Total	Maximum effect per annual fuel requirement of model 1,000-MWe LWR
Land (acres)		
Temporarily committed	63	
Undisturbed area	45	
Disturbed area	18	Equivalent to 90-MWe coal-fired power plant.
Permanently committed	4.6	
Overburden moved (millions of metric tons)	2.7	Equivalent to 90-MWe coal-fired power plant.
Water (millions of gallons)		
Discharged to air	156	≈2% model 1000 MWe LWR with cooling tower.
Discharged to water bodies	11,040	
Discharged to ground	123	
Total	11,319	<4% of model 1000 MWe LWR with once-through cooling.
Fossil fuel		
Electrical energy (thousands of MW-hour)	317	<5% of model 1000 MWe LWR output.
Equivalent coal (thousands of metric tons)	115	Equivalent to the consumption of a 45-MWe coal-fired power plant.
Natural gas (millions of scf)	92	<0.2% of model 1000-MWe energy output.
Effluents – chemical (metric tons)		
Gases (including entrainment)[a]		
SO_x	4,400	
NO_x[b]	1,177	Equivalent to emissions from 45-MWe coal-fired plant for a year.
Hydrocarbons	13.5	
CO	28.7	
Particulates	1,156	
Other gases		
F^-	0.72	Principally from UF_6 production enrichment and reprocessing. Concentration within range of state standards – below level that has effects on human health.
Liquids		
SO_4^-	10.3	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 constitutents that require dilution and the flow of dilution water are:
NO_3^-	26.7	
Fluoride	12.9	
Ca^{2+}	5.4	
Cl^-	8.6	
Na^+	16.9	NH_3 – 600 cfs.
NH_3	11.5	NO_3 – 20 cfs.
Fe	0.4	Fluoride – 70 cfs.
Tailings solutions (thousands of metric tons)	240	From mills only – no significant effluents to environment.
Solids	91,000	Principally from mills – no significant effluents to environment.
Effluents – radiological (curies)		
Gases (including entrainment)		
Rn-222	75	Principally from mills – maximum annual dose rate <4% of average natural background within 5 miles of mill. Results in 0.06 man-rem per annual fuel requirement.
Ra-226	0.02	
Th-230	0.02	
Uranium	0.032	Principally from fuel reprocessing plants – whole body dose is 6 man-rem per annual fuel requirements for population within 50-mile radius. This is <0.007% of average natural background dose to this population. Release from Federal Waste Repository of 0.005 Ci/year has been included in fission products and transuranics total.
Tritium (thousand)	16.7	
Kr-85 (thousands)	350	
I-129	0.0024	
I-131	0.024	
Fission products and transuranics	1.01	
Liquids		
Uranium and daughters	2.1	Principally from milling – included in tailings liquor and returned to ground – no effluents; therefore, no effect on environment.
Ra-226	0.0034	From UF_6 production – concentration 5% of 10 CFR 20 for total processing of 27.5 model LWR annual fuel requirements.
Th-230	0.0015	
Th-234	0.01	From fuel fabrication plants – concentration 10% of 10 CFR 20 for total processing 26 annual fuel requirements for model LWR.
Ru-106	0.15[c]	From reprocessing plants – maximum concentration 4% of 10 CFR 20 for total reprocessing of 26 annual fuel requirements for model LWR.
Tritium (thousands)	2.5	
Solids (buried)		
Other than high level	601	All except 1 Ci comes from mills – included in tailings returned to ground – no significant effluent to the environment, 1 Ci from conversion and fuel fabrication is buried.
Effluents – thermal (billions of Btu's)	3,360	<7% of model 1000-MWe LWR.
Transportation (man-rem): exposure of workers and general public.	0.334	

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

[b] 1.2% from natural gas use and process.

[c] Cs-137 (0.075 Ci/AFR) and Sr-90 (0.004 Ci/AFR) are also emitted.

Source: Paragraph 51.20(e), 10 CFR 51.

During the operation phase of the station, the applicant estimates that $24 million (1983 present worth) will be spent on the purchase of equipment, 90% of which will be spent locally, (ER, p. 8.1-6).

Some local business will benefit from this increased trade in materials, while other sectors of the local economy should experience increased sales of consumer related products and services to station employees and their families. Capital formation may occur in the modernization and expansion of retail trade facilities.

5.8.2.3 Property Taxes

In Indiana the property tax rate varies with each taxing district according to the formula: amount needed equals tax rate times tax base. The amount of a utility's assets (the utility tax base) that a taxing district can tax is determined by the State Board of Tax Commissioners on the basis of the percent of the utility's assets in each taxing district. The board determines and certifies to the county the amount of distributable property (i.e., total cash value minus the locally assessed value of land and buildings) that the utility owns in the taxing district. Distributable property includes items such as turbo-generators, boilers, transformers, transmission lines, distribution lines, and pipe lines.[65,66]

The State Tax Board determines the total distributable property of the utility as follows: it takes the utility's average yearly profit from a five-year profit-and-loss statement submitted by the utility, and divides that figure by the cost of money to obtain the capitalization of the utility. It also computes the depreciated value of the company by subtracting depreciation from original cost. The arithmetic average of the capitilization and depreciated value is taken to be the cash value of the utility. The assessed value of distributable property is one-third of the cash value. The county treasurer then bills the utility for distributable property, real property, and personal property at the current tax rate; this was $5.90 per $100 assessed value in Saluda Township in 1975.[67] Real and personal property is assessed locally every six years, except that during construction assessment is yearly. After assessment, taxes are payable in 18 months.

The tax levies and rates collectible in Jefferson County, Indiana, in the year 1975, are shown in Table 5.19. The proposed plant is to be located in Saluda Township, so that the applicable county tax rate is $5.90 per $100 assessed valuation which includes the tax levy for the Southwestern Consolidated School District ($2.79). The plant is not included in the tax bases of either the City of Madison or the Madison Consolidated School District.

For purposes of illustration, if the county tax base were tripled by adding the value of the station, and if the budget remained constant, the new tax rate would be one-third of the old tax rate. Similarly, the tax rate for the Southwestern Consolidated School District would be cut even more, since the ratio of new to old tax bases would be greater. Following the same reasoning, the tax rate for residents of Saluda Township would be reduced to a small percentage of the present rate.

The Indiana State Tax Board has the authority to limit the expenditures of individual taxing units to "reasonable" amounts. Also, the State Legislature has the power to change laws on the tax rates, assessments, and the distribution of property tax income among the various taxing units.

These political considerations make it impossible to predict with certainty the total amount and distribution of property taxes from the Marble Hill station during construction and operation some years in the future. The applicant estimated that $4 to $5 million per year of local property taxes would be paid during station operation (ER, p. 8.1-4). Locally prepared estimates range between $2 to $3 million annually.[62]

The impacts of station construction and operation on schools and community services might be partially mitigated by the extra tax monies accruing to some of the local tax units. From these funds, schools in Southwestern Consolidated School District could finance additional staff and facilities to accommodate the influx of students associated with the plant. Such additional funds would not be available to ameliorate impacts in the madison Consolidated School District. However, this district would receive additional property taxes from resident plant workers.

It is also to be expected that the additional demands of in-migrating plant workers on county and community services would be more readily financed through the additional county taxes paid by the station and by tax income from the plant workers. It may be expected that the Jefferson County taxing units will present increased budgets to the State Tax Board to provide for these increased demands.

As the construction, improvement, repair and maintenance of State roads is funded through the Motor Vehicle Fund (from state gasoline and user taxes), which is administered by the State, increased local property tax receipts would not be available for use on State roads.

TABLE 5.19

NOTICE TO TAXPAYERS OF JEFFERSON COUNTY OF TAX RATE CHARGED
FOR 1975

		Graham	Hanover	Lan.	Mad.	Milton	Monroe	Rep.	Saluda	Shelby	Smyrna	Brooks. Town	Dupont Town	Hanover Town	Madison City
STATE	State Forestry	.0065	.0065	.0065	.0065	.0065	.0065	.0065	.0065	.0065	.0065	.0065	.0065	.0065	.0065
	State Fair Board	.0035	.0035	.0035	.0035	.0035	.0035	.0035	.0035	.0035	.0035	.0035	.0035	.0035	.0035
Total State Rate		.01	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01
COUNTY RATE	County General	.618	.618	.618	.618	.618	.618	.618	.618	.618	.618	.618	.618	.618	.618
	County Welfare	.34	.34	.34	.34	.34	.34	.34	.34	.34	.34	.34	.34	.34	.34
	County Health	.052	.052	.052	.052	.052	.052	.052	.052	.052	.052	.052	.052	.052	.052
	Reassessment	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04
	Cum. Bridge Fund	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20
	Elec. & Reg.	.035	.035	.035	.035	.035	.035	.035	.035	.035	.035	.035	.035	.035	.035
TOTAL COUNTY		1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28
TWPS. SCHOOL LIBRARY	Township Tax	.0115	.07	.15	.01	.11	.34	.15	.10	.24	.22	.11	.15	.07	.01
	Township Poor	.0285	.04	.03	.03	.03	.04	.02	.03	.03	.02	.03	.03	.04	.03
	Fire Protection		.06	.05	.01			.07	.04						
	Library Fund	.12	.12	.12	.12	.12	.12	.12	.12	.12	.12	.12	.12	.12	.12
	Library Bond	.03	.03	.03	.03	.03	.03	.03	.03	.03	.03	.03	.03	.03	.03
	General School	4.637	2.79	4.637	4.637	4.637	4.637	2.79	2.79	4.637	2.79	4.637	4.637	2.79	4.637
	Debt Service	.763	.25	.763	.763	.763	.763	.25	.25	.763	.25	.763	.763	.25	.763
	Cum. Bldg.	.05	1.25	.05	.05	.05	.05	1.25	1.25	.05	1.25	.05	.05	1.25	.05
TOTAL TWP., SCHOOL, LIBRARY		5.64	4.61	5.83	5.65	5.74	5.98	4.68	4.61	5.87	4.68	5.74	5.78	4.55	5.64
	Corp. General											.48			1.752
	Park Fund														.22
	Aviation Fund														.023
	Aviation Bond														.012
	Police Pension														.073
TOTAL CORP. RATE												.48			2.08
TOTAL TAX RATE		6.93	5.90	7.12	6.94	7.03	7.27	5.97	5.90	7.16	5.97	7.51	7.07	5.84	9.01
TOTAL CONSERVANCY RATE		.15						.15							.15

NOTE 1. The assessed valuation of property in Jefferson County in 1975 was $75,680,000. For Saluda Township it was $2,500,000. For the taxing units in the Southwestern Consolidated School District it was $11,738,000. For the taxing units in Madison Consolidated School District it was $63,940,000.

NOTE 2. Jefferson County has two separate school corporations - one carries a 2.79 levy and the other 4.637. Any school with the 2.79 levy would benefit from the Marble Hill plant in Saluda Township. The county rate would also benefit but only the township where the property is located would benefit. The state rate would not be affected, nor Madison City's.

5.8.2.4 Housing

Relocating personnel would demand permanent, quality housing suitable for pleasant family living. The staff believes that the bulk of the in-migrants could find such housing in the City of Madison and the Town of Hanover. However, the staff also anticipates that a sizeable percentage of the 155 operating staff households will find housing accommodations in the larger communities to the southwest, notably Jeffersonville and New Albany; both communities are within an acceptable commuting distance of 30 miles.

5.8.2.5 Community Facilities and Services

The availability of community facilities and services and the impact on these facilities and services during the construction period are discussed in Sections 2.8.2.2 and 4.4.

As a result of new residents, there will be an increased demand for local public services including sewage treatment, water supply, education, hospital facilities, and police and fire protection (ER, p. 8.2-8). However, if those services which required upgrading were improved during construction, they should be adequate for meeting the demands of operating worker households. Furthermore, the local school systems are expected to require additional teachers in one or both systems to accommodate an influx of new school children (See Section 4.4.2.3).

5.8.2.6 Recreation and Tourism

The applicant has mentioned the attractiveness of the northern area of the station site (ER, pp. 2.3-2a and 8.8-8a). Some local residents are concerned about preserving the natural beauty of this site, and have pointed out that the land adjacent to the river is particularly well suited for recreational uses including boating, swimming, fishing and camping.[63]

However, the applicant has no plans to develop recreational use of the forests and shoreline of the site (ER, Supp. 1). The applicant does plan to maintain the northern wooded slopes and will attempt to camouflage the river-view of the station with tree cover (ER, 8.1-8a and 8.2-5). Pleasure boating on the Ohio River should therefore not be significantly affected by the station's presence (ER, p. 8.2-8). Because the nearest recreation facilities are more than 5 miles away, the operation of the Marble Hill station should not have a significant impact upon recreational activities (ER, p. 8.2-8). The staff believes that the site areas near the river are suited to recreational activities, but there are many such areas along the River.

Tourist activities are concentrated in and around the City of Madison. The applicant has stated that the operation of the plant should have little or no negative impact on tourism either in terms of activity levels or income loss (ER, p. 8.2-8). It is the staff's belief that PSI's visitor information center may serve as an additional attraction for tourists in Jefferson County.

5.8.2.7 Land Use

The Marble Hill station will occupy approximately 987 acres of which 334 acres were previously used for the production of crops. Using a 5% inflation rate, an annual yield increase of 1%, and a 10% discount rate, the applicant has estimated tha the 1983 present worth of agricultural revenues foregone at the site over 39 years is $3.7 million (ER, p. 8.2-7).

Little impairment of current land uses in the vicinity of the site resulting from adverse environmental, aesthetic, safety impacts, or other considerations are anticipated from the operation of the Marble Hill station (see Section 5.1).

5.8.2.8 Esthetic and Social Effects

In addition to the effects of in-migrating residents discussed above, the operation of an electric generating plant in this area may produce social stress. Some residents resent the placement of another power plant in the Madison area for the benefit of people far away, and feel that the presence of the plant and associated transmission lines is esthetically and psychologically undesirable because it changes the physical environment in which people live and work.[64]

The staff concludes that the placement of a nuclear power station in Saluda Township may, indeed, produce changes in the life style of those who live in that area. An evaluation of the magnitude, extent, and duration of such social changes is difficult to make. It is the staff's opinion that neither the operating personnel nor the physical presence of the plant will result in serious social or psychological damage. However, the staff recognizes that the transmission lines will represent an esthetic intrusion.

5.8.3 Conclusions

The staff concludes that the physcial impacts of station operation, such as noise and traffic, will probably be of little notice to the general public. The transmission lines, and to a lesser extent the visible plumes from the cooling towers, will be considered by many people to be esthetically displeasing.

Negligible impacts from the operation of the Marble Hill station are expected in the following areas: the local housing market, community services and facilities, and existing life styles. Benefits associated with the operation of the plant are the increased local payroll, induced spending, and increased property tax revenues.

5.9 SUMMARY

A summary of the probable environmental effects of operation identified by the staff is given in Table 5.20. The assessments of the impacts vary from negligible to moderate. The moderate impacts on the local community will be offset in part by the monetary benefits of about $9 million/year accruing to the local population.

Table 5.20 Summary of Environmental Effects of Operation

Potential Effect	Applicant's Plan for Mitigation	Relative Significance	Available Corrective Actions, Remarks
Diversion of about 1200 acres to industrial use (Sec. 5.1)		Small	
Consumptive loss of 0.05% of the normal flow (0.6% of the minimum flow) of the Ohio River (Sec. 5.2)		Negligible	
Pumping of 200 gpm from Ohio River Valley aquifer (Sec. 5.2)		Minor	
Increased local temperature of Ohio River water (less than 1 acre increased 5°F) (Sec. 5.3)		Negligible	
Occasional visible plume aloft from MDCTs (Sec. 5.3)		Negligible	
Ground-level fogging and icing (frequent onsite, rare offsite) (Sec. 5.3)		Minor	
Deposition of drift (essentially all onsite) (Sec. 5.3)		Negligible	
Loss of fish by impingement (Sec. 5.3.2)		Minor	
Loss of phytoplankton and zooplankton by entrainment (Sec. 5.3.2)		Minor	
Loss of ichthyoplankton by entrainment (Sec. 5.3.2)		Minor	
Loss of benthic and fish spawning habitat--silt deposition (Sec. 5.3.2)		Small	
Loss of benthic and fish spawning habitat--thermal (Sec. 5.3.3)		Minor	
Loss of aquatic biota passing through thermal plume (Sec. 5.3.3)		Minor	
Loss of fish to "cold shock" (Sec. 5.3.3)		Minor	
Loss of benthic and fish spawning habitat--chemical and biocidal (Sec. 5.5.5)		Small	
Impacts on the community		Small-moderate	
Operation payroll (Sec. 5.8)		About $3 million/ year for 30 years (1983 dollars)	Beneficial
Induced expenditures (Sec. 5.8)		About $2 million/ year for 30 [illegible] (1983 dolla[illegible]	Beneficial
Local taxes (Sec. 5.8)		About [illegible] / year [illegible] s (19[illegible]	Beneficial
Public radiation exposure (80 man-rem/year) (Sec. 5.4)		Negl[illegible]ible	
Workers' radiation exposure (900 man-rem/year) (Sec. 5.4)		Minor	

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68. Y. I. Lyskov, Y. S. Emma, and M. D. Stolyarov, "Electrical Field as a Parameter Considered in Designing Electric Power Transmission of 750-1150 kV; the Measuring Methods, the Design Practices and Direction of Further Research." US-USSR Symposium on EHV AC Power Transmission. Bonneville Power Administration. Washington, D.C. February, 1975.

6. ENVIRONMENTAL MEASUREMENTS AND MONITORING PROGRAMS

6.1 PREOPERATIONAL

6.1.1 Thermal

Temperature measurements in the Ohio River were made at Stations A1, A3, and A5 (see ER, Fig. 6.1.1). The results of these measurements for six days between 19 March 1974 and 27 February 1975 are listed in Tables 2.7-7, 2.7-8, and 2.7-9 of the ER. The temperatures were recorded by a YSI Model 5400 Oxygen Meter with a combination temperature-oxygen probe at the surface, bottom, and water depths of 30% and 60% of maximum.

The results of these measurements all lie within the range of values reported at Louisville. On only one occasion at one of the stations (A1) is there any evidence of stratification, a differential of about 9°F, or 5°C.

Because long-term temperature measurements at Louisville were used for the thermal-plume calculations, the occasional preoperational monitoring can yield useful data only with respect to temperature stratification. The staff concludes that preoperational temperature measurements need be taken only in conjunction with other chemical monitoring programs.

6.1.2 Radiological

Radiological environmental monitoring programs are established to provide data on measurable levels of radiation and radioactive materials in the site environs. The preoperational phase of the monitoring program provides for the measurement of background levels and their variations along the anticipated important pathways of release in the area surrounding the plant, the training of personnel, and the evaluation of 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."

The applicant has proposed a radiological environmental monitoring program to meet these needs. A description of the applicant's proposed preoperationa. program is summarized in Table 6.1, and detailed information on the program is presented in the ER, Section 6.1.

The applicant proposes to initiate parts of the program two years prior to operation of the facility, with the remaining portions beginning either six months or one year prior to operation. The current NRC staff recommendations are outlined below:

Six Months	One Year	Two Years
• airborne iodine	• airborne particulates	• direct radiation
• iodine in milk (whole)	• milk (remaining analyses)	• fish and invertebrates
• animals that are in pasture	• surface water	• fruit and vegetables
• soil (one set of samples)	• drinking water	• meat and poultry
		• sediments and indicator organisms

The staff concludes that the preoperational monitoring program proposed by the applicant is generally acceptable; however, upon finalization of NRC Regulatory Guide 4.8, "Environmental Technical Specifications for Nuclear Power Plants," the applicant should review the guide and assure that the frequency of collection and type of analyses listed in Table 6.1 are consistent with the guide and "sensitivity" values should be converted to the preferred "lower level of detection" (LLD) terminology.

Table 6.1. Proposed Preoperational Radiological Monitoring Program

Sample Type	Collection Site	Frequency of Collection	Type of Analyses
Airborne particulates	1 onsite location 3 locations of highest offsite ground-level concentrations 3 communities within 10 miles of the site 1 offsite location 10 miles away	Weekly	Gross beta weekly gamma scan of monthly samples
Airborne radioiodine	Airborne particulate stations	Weekly	Weekly analysis of I-131
Ion chambers	Airborne particulate stations and 3 highest annual off-site dose locations	Quarterly	Direct reading in field
Thermoluminescent dosimeters (TLDS)	Airborne particulate stations and 3 highest annual off-site dose locations	Quarterly & annually	Readout shortly after collection
Surface water	1 upstream of site 1 approx. 1 mile downstream of site 1 Little Saluda Creek 1 discharge plume	Monthly	Gross beta, gamma scan, both monthly; composite for tritium, Sr-89, Sr-90 quarterly
Groundwater	2 onsite wells in Ohio River alluvial glacio-fluvial aquifer	Quarterly	Gross beta, gamma scan and tritium
Drinking water	1 closest downstream water supply intake and drinking water 1 closest Louisville water intake and Louisville drinking water	Proportional	Gross beta and gamma scan, both monthly; composite for tritium, Sr-89, Sr-90 quarterly
Sediment, benthos, and aquatic plants	1 sample of each from directly downstream of discharge 1 upstream of site 1 pool behind first downstream dam	Semiannually	Gamma scan
Milk	1 nearest offsite dairy farm 1 local dairy representative of area milkshed	Monthly	Gamma scan, I-131
Fish	1 of principle edible type from near discharge 1 from upstream area (not influenced by discharge)	Semiannually	Gamma scan, I-131
Fruits & vegetables	1 fruit from local farm 1 leafy vegetable from local farm 1 of each from a farm 20 miles from site	Annually (at harvest)	Gamma scan of edible parts
Meat & poultry	1 meat from animals fed on crops grown locally 1 poultry from animals fed on crops grown locally 1 egg sample from animals fed on crops grown locally	Annually during grazing season	Gamma scan of edible portions

6.1.3 Hydrological

The preoperational hydrological monitoring program for the station, summarized below, incorporates both physical and chemical measurements of surface water and groundwater in the site vicinity. Quarterly surface-water studies include chemical analysis, with measurements of temperature, depth, current velocities, transparency, and discharge. Groundwater studies include piezometer readings for water-level fluctuations at the site and in the aquifer along the Ohio River Valley, pump tests of the aquifer to determine safe yield, and chemical analyses. This program, detailed in the applicant's ER (Sec. 6.1.1 and 6.1.2), is considered by the staff to be adequate.

6.1.4 Meteorological

The preoperational onsite meteorological measurements program consists of data collection from two meteorological towers--a 199-foot tower at plant elevation, about 6500 feet WSW of the main reactor structures, and a 33-foot satellite tower along the Ohio River, about 300 feet below plant grade. The 200-foot tower provides meteorological measurements representative of the proposed plant area. Both towers became operational in January 1974. On the 200-foot tower wind speed and direction are measured at the 33-foot and 199-foot levels; vertical temperature gradient is measured directly between the 33-foot and 199-foot levels; ambient dry-bulb temperature is measured at the 33-foot and 199-foot levels; and dewpoint temperature is measured at the 199-foot level. Precipitation is measured at ground level. Wind speed and direction, dry-bulb temperature, and dewpoint temperature are measured at the top of the 33-foot satellite tower. Calibrations are performed quarterly on both towers. Magnetic tape is the primary data recording system, supplemented by strip chart recorders. The preoperational onsite meteorological measurements program meets the recommendations and intent of Regulatory Guide 1.23.[1]

6.1.5 Ecological

6.1.5.1 Terrestrial

The applicant's ecological baseline sampling program was carried out during the period March 1974 to February 1975. Sampling areas are depicted in Figure 6.1. Within each sampling area, species of tree, shrub, forb, and grass were documented with respect to frequency, density, and dominance. Biomass was determined for the upland grassland. Trees were sampled using 6-ft by 100-ft (about 2-m by 30-m) belt transects. Shrubs were sampled using 0.01-acre (40-m^2) circular plots. Herbaceous vegetation was sampled using 0.001-acre (4-m^2) circular plots. The line intercept method was used to measure dominance.

The staff finds that the applicant's baseline vegetation sampling program has adequately established the general vegetational characteristics of the site as needed for impact assessment purposes. Therefore, the staff does not recommend that the program be continued as a preoperational monitoring program as suggested by the applicant. Rather, in view of the type of impacts expected (see Sec. 5.3.1, Drift; Sec. 4, Erosion; Sec. 4, Revegetation), the staff will require only that infrared aerial photographs of the site be made once in late spring or early summer each year. The photos should be of a scale and quality to allow the identification of individual plant communities. Infrared aerial photography provides a means of detecting environmental stress to vegetation over a broad area at considerably less cost than ground surveillance. In addition, these photographs will provide a basis for mapping changes in the distribution of the existing plant communities. These photographs will be submitted to NRC along with a written photointerpretation by a competent photointerpreter.

In the applicant's faunal baseline sampling program, direct sightings, road kills, tracks, droppings, auditory indexes, dens, snap-trapping, and mist netting were used to sample for vertebrates. Sweeping and the Berlese funnel were used to sample for invertebrates.

The staff finds that the applicant's baseline study and distributional maps of the fauna of Indiana are adequate to assess the ecological impacts of the station with respect to herpetofauna, invertebrates and mammals. Therefore, the staff will not require the extension of the baseline program into a preoperational monitoring program with respect to the forementioned fauna.

Bird populations were sampled by the applicant on one-acre (4000-m^2) plots in each of five vegetation sampling areas. Observations were made at various times of day, and each plot was sampled for 15 minutes. Ten replications were conducted over a two-to-three-day period in March, April, May, June, September and December. From these observations "bounded count" estimates were made. The staff considers that these observations do not qualify as quantitative ornithology because of

SAMPLING STATIONS:

1 - FLOODPLAIN
2 - ECOTONE
3 - EAST FACING SLOPE
4 - UPLAND WOODS
5 - UPLAND GRASSLAND

1000 0 1000 2000
FEET

Fig. 6.1. Terrestrial Sampling Stations. From ER, Fig. 6.1-2.

extremely small plot sizes and very short periods of surveys; furthermore, four of the six counts were done out of season (March, April, September, and December).

The applicant proposed to extend the baseline sampling study to a preoperational monitoring program. However, the staff has gathered enough outside data to make its assessment of construction impacts. Therefore, a preoperational monitoring program for birds will not be required.

6.1.5.2 Aquatic

The aquatic ecological baseline sampling areas are depicted in Figure 6.2 and the applicant's baseline program is summarized in Table 6.2. More specific details are in the ER, Section 6.1.1 and Tables 6.1-1 and 6.1-2. This program provided information important in the characterization of the Ohio River and Little Saluda Creek, but it did not attempt to characterize any of the 51 offsite streams to be crossed by the transmission lines. Because these impacts are expected to be small and temporary, monitoring is not required.

About two years before the operation of the station, the baseline program for monitoring the aquatic biology of the Ohio River must be resumed, with the omission of sampling at station 7 on Squaw Creek. In addition, water quality must be monitored with increased frequency throughout the construction and preoperational period. The data should be collated and reported in the Operating License-Environmental Report.

6.1.6 Chemical

The applicant began a water monitoring program in March 1974 and data for one year are presently available. Three stations on the Ohio River and a fourth on a small onsite tributary are being monitored. Twenty-five common components or properties are being measured on a monthly basis and ten trace elements on a quarterly basis. Although the staff found some instances of poor material balances in the reported data, the prgoram is regarded as adequate to examine the expected impacts of the station on water quality. Extended tables of water-quality data are in the ER, Sections 2.5, 2.7, 3.3, and 6.1.

6.1.7 Changes in Preoperational Monitoring Programs

As data from the various monitoring programs are accumulated, some objectives of the programs will be realized in whole or in part. When this happens, it will be desirable to modify the existing programs. Proposed modifications will be submitted to the NRC for evaluation.

6.2 OPERATIONAL

The operational radiological, chemical-effluent, thermal-effluent, meteorological, hydrological, and ecological monitoring programs will evolve from the combination of the preoperational monitoring programs described in the applicant's ER and those changes recommended by the staff. For example, monitoring of fish impingement on the travelling screen will be required so that the need for a fish return mechanism can be assessed. Inasmuch as the present action pertains to issuance of a construction permit, detailed staff evaluation of the operational program will be done at the time of application for an operating license, and monitoring requirements will be included in the Environmental Technical Specifications of the Operating License.

6.3 RELATED PROGRAMS AND STUDIES

Currently, a number of related studies are being carried out in the vicinity of the proposed station by, or under the sponsorship of, several State and Federal agencies. In the nonradiological area, these programs include meteorological and hydrological monitoring and ecological and environmental studies. Sponsoring agencies include NOAA, the U. S. Geologic Survey, the U. S. Corps of Engineers, the U. S. EPA, the U. S. FDA, ORSANCO and the Indiana Air Pollution Control Board. A description of these programs and the names of the sponsoring agencies is given in Section 6.3 of the ER.

In addition to the programs noted above, the staff has conducted a general survey of other related programs carried out by other organizations, such as universities, industries, etc. Some of these programs include: Indiana DNR counts of deer at the Jefferson Proving Grounds; censuses of migrating waterfowl at Muscatatuck Wildlife Refuge; Christmas bird counts for Jefferson and Ripley Counties, published by the Audubon Society; sporadic publications on the terrestrial

SAMPLING STATIONS:

1 - UPSTREAM REFERENCE STATION
2 - STATION AT MOUTH OF LITTLE SALUDA CREEK
3 - INTAKE-DISCHARGE ZONE STATION
4 - THERMAL PLUME ZONE STATION
5 - DOWNSTREAM STATION
6 - LITTLE SALUDA CREEK STATION
7 - SQUAW CREEK STATION

Fig. 6.2. Aquatic Sampling Stations. From ER, Fig. 6.1-1.

Table 6.2. Aquatic Parameters and Sampling Frequency for the Marble Hill Nuclear Generating Station

Parameter	Sampling Frequency				Stations
	Monthly	Bi-Monthly	Quarterly	Other	
Chemical					
Total dissolved solids	X				1,3,5,6
Total suspended solids	X				1,3,5,6
Dissolved oxygen	X				1,3,5,6
Oxygen saturation	X				1,3,5,6
Biological oxygen demand (5-day)	X				1,3,5,6
Total organic carbon	X				1,3,5,6
Orthophosphate	X				1,3,5,6
Total phosphate	X				1,3,5,6
Specific conductance	X				1,3,5,6
Phenol	X				1,3,5,6
Ammonia nitrogen	X				1,3,5,6
Nitrate nitrogen	X				1,3,5,6
Calcium	X				1,3,5,6
Potassium	X				1,3,5,6
Arsenic			X		1,4
Cadmium			X		1.4
Copper			X		1,4
Total chromium			X		1,4
Hexavalent chromium			X		1,4
Iron			X		1,4
Lead			X		1,4
Manganese			X		1,4
Mercury			X		1,4
Zinc			X		1,4
Physical					
Current velocity	X				1,3,5,6
River discharge	X				1,3,5,6
Temperature	X				1,3,5,6
Transparency	X				1,3,5,6
Water depth	X				1,3,5,6
Biotic					
Bacteria	X				1,3,5,6
Benthos		X (Oct-Feb)	X (Mar-Sep)		1-6
Fish	X (Mar-Jul)	X (Sep-Jan)			1-7
Ichthyoplankton	X (Apr-Jul)				3
Macroinvertebrates		X (Jun-Feb)			1-6
Macrophytes				X (Jul)	1-5
Periphyton		X			1-5
Phytoplankton	X				1-6
Zooplankton	X				1-6

Modified from ER, Tables 6.1-1 and 6.1-2.

ecology of southern Indiana by the staff and students of the Biology Department of Hanover College, Indiana; estimates of terrestrial populations given in Annual Reports of Indiana Division of Fish and Wildlife; various special reports entitled, "Statewide Wildlife Research" (Indiana); an assessment of the environmental impacts to ecosystems of construction of the proposed Clark Maritime Center on the Ohio River made by the School of Public and Environmental Affairs, Indiana University; aquatic surveys of the Ohio River by the University of Louisville; fish impingement studies at the Clifty Creek Power Plant; and water-quality monitoring of the Ohio River by the Louisville Gas and Electric Company.

References

1. "Regulatory Guide 1.23, Onsite Meteorological Programs," U. S. Atomic Energy Commission, Directorate of Regulatory Standards, 1972.

7. ENVIRONMENTAL IMPACTS OF POSTULATED STATION ACCIDENTS INVOLVING RADIOACTIVE MATERIALS

A high degree of protection against the occurrence of postulated accidents in the Marble Hill Nuclear Station is provided through correct design, manufacture, and operation, and the quality assurance program used to establish the necessary high integrity of the reactor system as will be considered in the Commission's Safety Evaluation. Deviations that may occur are handled by protective systems to place and hold the plant in a safe condition. Notwithstanding this, the conservative postulate is made that serious accidents might occur, even though they may be extremely unlikely; and engineered safety features are installed to mitigate the consequences of those postulated events which are judged credible.

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

The Commission issued guidance to applicants on September 1, 1971 requiring the consideration of a spectrum of accidents with assumptions as realistic as the state of knowledge permits. The applicant's response was contained in the Environmental Report.

The applicant's report has been evaluated, using the standard accident assumptions and guidance issued as a proposed amendment to Appendix D of 10 CFR Part 50 (now 10 CFR Part 51) by the Commission on December 1, 1971. Nine classes of postulated accidents and occurrences ranging in severity from trivial to very serious were identified by the Commission. In general, accidents in the high potential consequence end of the spectrum have a low occurrence rate and those on the low potential consequence end have a higher occurrence rate. The examples selected by the applicant for these cases are shown in Table 7.1. Within each class of accident, the probabilities of the selected examples were of approximately the same magnitude.

Commission estimates of the dose which might be received by an assumed individual standing at the site boundary in the downwind direction, using the assumptions in the proposed Annex to Appendix D, are presented in Table 7.2. Estimates of the integrated exposure that might be delivered to the population within 50 miles of the site are also presented in Table 7.2. The man-rem estimate was based on the projected population (1,851,000) within 50 miles of the site for the year 2020.

To rigorously establish a realistic annual risk, the calculated doses in Table 7.2 would have to be multiplied by estimated probabilities. The events in Classes 1 and 2 represent occurrences which are anticipated during plant operations; and their consequences, which are very small, are considered within the framework of routine effluents from the plant. Except for a limited amount of fuel failures and some steam generator leakage, the events in Classes 3 through 5 are not anticipated during plant operation; but events of this type could occur sometime during the 40 year plant lifetime. Accidents in Classes 6 and 7 and small accidents in Class 8 are of similar or lower probability than accidents in Classes 3 through 5 but are still possible. The probability of occurrence of large Class 8 accidents is very small. Therefore, when the consequences indicated in Table 7.2 are weighted by probabilities, the environmental risk is very low.

The postulated occurrences in Class 9 involve sequences of successive failures more severe than those required to be considered in the design bases of protection systems and engineered safety features. Their consequences could be severe. However, the probability of their occurrence is judged so small that their environmental risk is extremely low. Defense in depth (multiple physical barriers), quality assurance for design, manufacture and operation, continued surveillance and testing, and conservative design are all applied to provide and maintain a high degree of assurance that potential accidents in this class are, and will remain, sufficiently small in probability that the environmental risk is extremely low.

Table 7.1. C'-ssification of Postulated Accidents and Occurrences

Class	NRC Description	Applicant's Examples
1.	Trivial incidents	Included in the evaluation of routine releases.
2.	Small releases outside containment	Included in the evaluation of routine releases.
3.	Radioactive waste system failure	Waste gas and liquid decay tank failures. Equipment leakage or malfunctions.
4.	Fission products to primary system (BWR)	Not applicable.
5.	Fission products to primary and secondary systems (PWR)	Fuel cladding defects and steam generator tube leaks; steam generator tube rupture.
6.	Refueling accident	Fuel bundle and heavy object drop onto fuel in core.
7.	Spent fuel handling accident	Fuel assembly drop in fuel storage pool. Heavy object drop onto fuel rack. Fuel cask drop.
8.	Accident initiation events considered in design-basis evaluation in the Safety Analysis Report	Loss-of-coolant accident, steam line breaks and rod ejection accidents.
9.	Hypothetical sequence of failures more severe than Class 8	Not considered.

The NRC has performed a study to assess more quantitatively these risks. The initial results of these efforts were made available for comment in draft form on August 20, 1974[1] and released in final form on October 30, 1975.[2] This study, called the Reactor Safety Study, is an effort to develop realistic data on the probabilities and consequences of accidents in water-cooled power reactors, in order to improve the quantification of available knowledge related to nuclear reactor accident probabilities. The Commission organized a special group of about 50 spe-ialists under the direction of Professor Norman Rasmussen of MIT to conduct the study. The scope of the study has been discussed with EPA and described in correspondence with EPA which has been placed in the NRC Public Document Room (letter, Doub to Dominick, dated June 5, 1973).

As with all new information developed which might have an effect on the health and safety of the public, the results of these studies will be assessed on a timely basis within the Regulatory process on generic or specific bases as may be warranted.

Table 7.2 indicates that the realistically estimated radiological consequences of the postulated accidents would result in exposures of an assumed individual at the site boundary which are less than or comparable to those which would result from a year's exposure to the Maximum Permissible Concentrations (MPC) of 10 CFR Part 20. The table also shows the estimated integrated exposure of the population within 50 miles of the plant from each postulated accident. Any of these integrated exposures would be much smaller than that from naturally occurring radioactivity. When considered with the probability of occurrence, the annual potential radiation exposure of the population from all the postulated accidents is an even smaller fraction of the exposure from natural background radiation and, in fact, is well within naturally occurring variations in the natural background. It is concluded from the results of the realistic analysis that the environmental risks due to postulated radiological accidents are exceedingly small and need not be considered further.

Table 7.2. Summary of Radiological Consequences of Postulated Accidents[a]

Class	Event	Estimated Fraction of 10 CFR Part 20 Limit at Site Boundary[b]	Estimated Dose to Population in 50-Mile Radius (man-rem)
1.0	Trivial incidents	c	c
2.0	Small releases outside containment	c	c
3.0	Radwaste system failures		
3.1	Equipment leakage or malfunction	0.061	3.5
3.2	Release of waste gas storage tank contents	0.24	14.
3.3	Release of liquid waste storage contents	0.007	0.4
4.0	Fission products to primary system (BWR)	d	d
5.0	Fission products to primary and secondary systems (PWR)		
5.1	Fuel cladding defects and steam generator leaks	c	c
5.2	Off-design transients that induce fuel failure above those expected and steam generator leak	0.001	< 0.1
5.3	Steam generator tube rupture	0.080	4.6
6.0	Refueling accidents		
6.1	Fuel bundle drop	0.013	0.7
6.2	Heavy object drop onto fuel in core	0.22	13.
7.0	Spent fuel handling accident		
7.1	Fuel assembly drop in fuel storage pool	0.008	0.5
7.2	Heavy object drop onto fuel rack	0.032	1.8
7.3	Fuel cask drop	0.19	11.
8.0	Accident initiation events considered in design basis evaluation in the SAR		
8.1	Loss-of-coolant accidents		
	Small break	0.14	14.
	Large break	1.3	430.
8.1(a)	Break in instrument line from primary system that penetrates the containment	d	d
8.2(a)	Rod ejection accident (PWR)	0.13	43.
8.2(b)	Rod drop accident (BWR)	d	d
8.3(a)	Steamline breaks (PWR's outside containment)		
	Small break	< 0.001	< 0.1
	Large break	< 0.001	< 0.1
8.3(b)	Steamline break (BWR)	d	d

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

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

[c]These radionuclide releases are considered in developing the gaseous and liquid source term presented in Section 3 and are included in doses in Section 5.

[d]Not applicable.

References

1. "Reactor Safety Study: An Assessment of Accident Risks in U. S. Commercial Nuclear Power Plants, Draft," WASH-1400, August 1974.

2. "Reactor Safety Study: An Assessment of Accident Risks in U. S. Commercial Nuclear Power Plants," WASH-1400 (NUREG 75/014), October 1975.

8. THE NEED FOR THE STATION

This section discusses the need for the capacity, 2260 MW, of the proposed Marble Hill Station. Public Service of Indiana, Inc. (PSI) and Northern Indiana Public Service Co. of Indiana (NIPSCO) plan to retain 735 MW and 226 MW, respectively, of each unit, and to sell the remaining capacity to East Kentucky Power Cooperative, Inc. (90.4 MW) and Wabash Valley Power Assoc. (79.1 MW). The staff's considerations have been confined to ultimate consumers within the PSI and NIPSCO service areas.

8.1 DESCRIPTION OF THE POWER SYSTEM

8.1.1 Service Areas

The PSI service area is indicated in Figure 8.1. PSI furnishes energy to about 1,589,700 people, 30% of Indiana's population, living within an area of about 22,000 square miles (57,000 km^2), 60% of Indiana's territory. In 1974, 36.2% of the electrical energy produced by PSI was consumed by industrial customers, commercial customers accounted for 18.7% of its generation, and domestic use was 26.7%. In addition, 13.2% was sold to rural co-ops and municipalities for resale to their members. PSI's transmission lines and interconnections with these and all other entities are shown in Figure 8.2.

Also shown in Figure 8.1 is the NIPSCO service area. NIPSCO furnishes energy to about 1,460,000 people, 27% of Indiana's population, living within an area of about 8000 square miles (21,000 km^2), 22% of Indiana's territory. Nonetheless, 85% of the electrical energy generated by NIPSCO is consumed in three heavily industrialized counties, Lake, LaPorte, and Porter, on the southern shore of Lake Michigan. In fact, industrial customers accounted for 72% of NIPSCO's total energy load in 1974. Commercial (5%) and domestic (17%) consumption was 22%, and sales to rural co-ops, municipalities, and other usages amounted to 6%. NIPSCO's transmission lines and interconnections are shown in Figure 8.3.

8.1.2 Regional Relationships

Both PSI and NIPSCO are members of the East Central Area Reliability Agreement (ECAR). ECAR is one of the nine regional reliability councils composing the National Electric Reliability Council that reports annually to the Federal Power Commission (FPC). ECAR is principally concerned with planning for reliable transmission of power among its members, and does not establish reserve requirements.

PSI is a member of the Kentucky-Indiana Pool (KIP).* The other members of KIP are Indianapolis Power and Light Company (IPL), Kentucky Utilities Company, and the East Kentucky Power Co-Op. KIP is principally concerned with coordinating its members' installation of new generating capacity. KIP's load forecasts are made by first collating and then reviewing its members' forecasts. PSI is interconnected with eight investor-owned utilities, five municipal systems with generating capacity, and one rural electric co-op.

NIPSCO is not a member of any power pool. Its only interconnections are with Commonwealth Edison, Indiana and Michigan Company (I&M), and PSI. Commonwealth Edison is bound by a contract, which expires on 30 June 1979, to supply NIPSCO with enough capacity to maintain its reserve at 15% of peak demand. I&M will provide NIPSCO with 200 MW to 400 MW of capacity until 31 December 1987. The exact amount of capacity must be specified by NIPSCO no later than four years in advance of the year in which I&M will provide it. NIPSCO pays for the capacity and pays also for any electrical energy it may draw from it.

The boundaries of ECAR, KIP, and the service areas of IPL, PSI, and NIPSCO are indicated in Figure 8.4.

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*KIP was dissolved in early 1976. Nonetheless, PSI plans to remain in communication with each of its former members and to exchange information on the planned installation of new capacity.

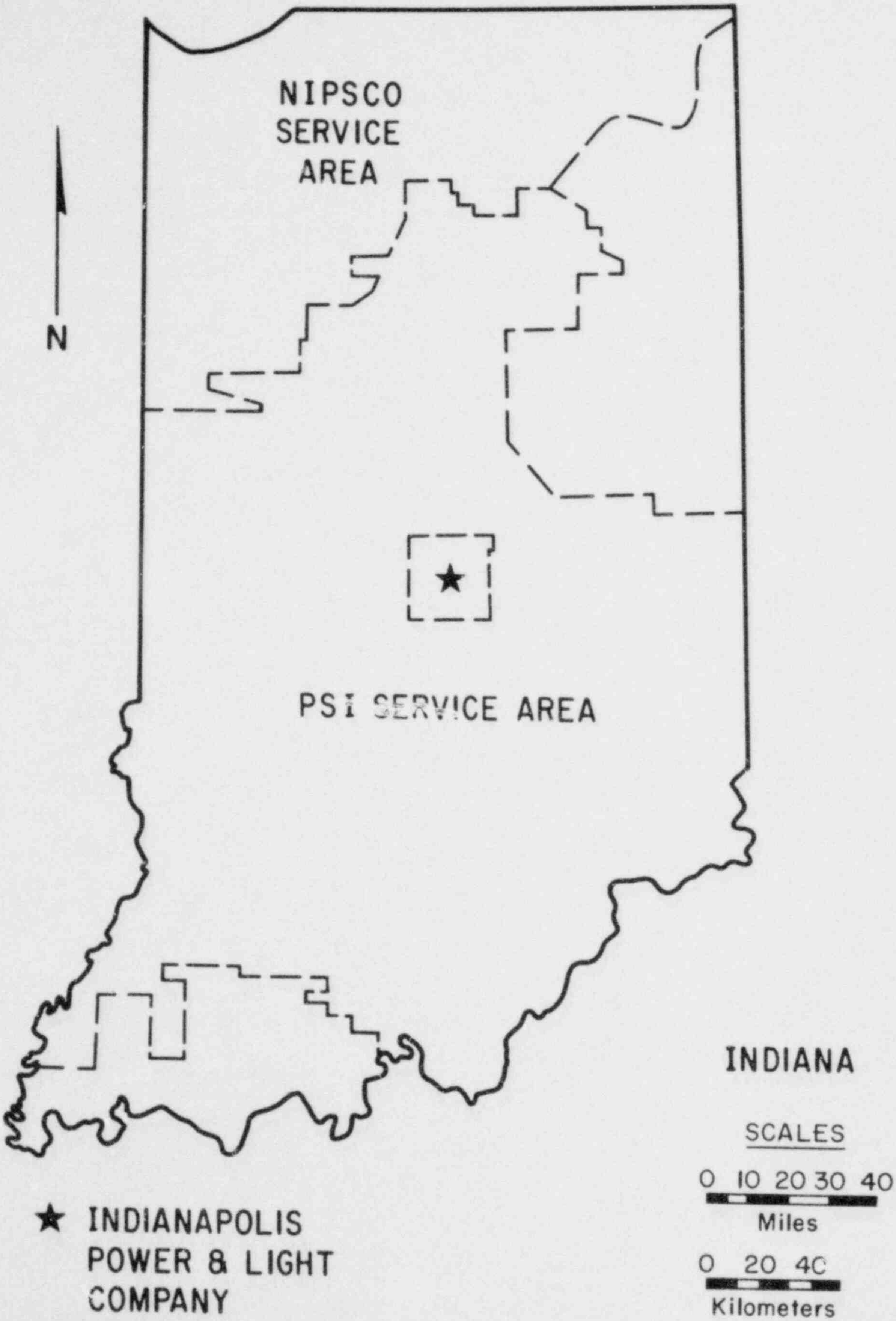

Fig. 8.1. PSI and NIPSCO Service Areas.
Source: ER, Fig. 9.2-9

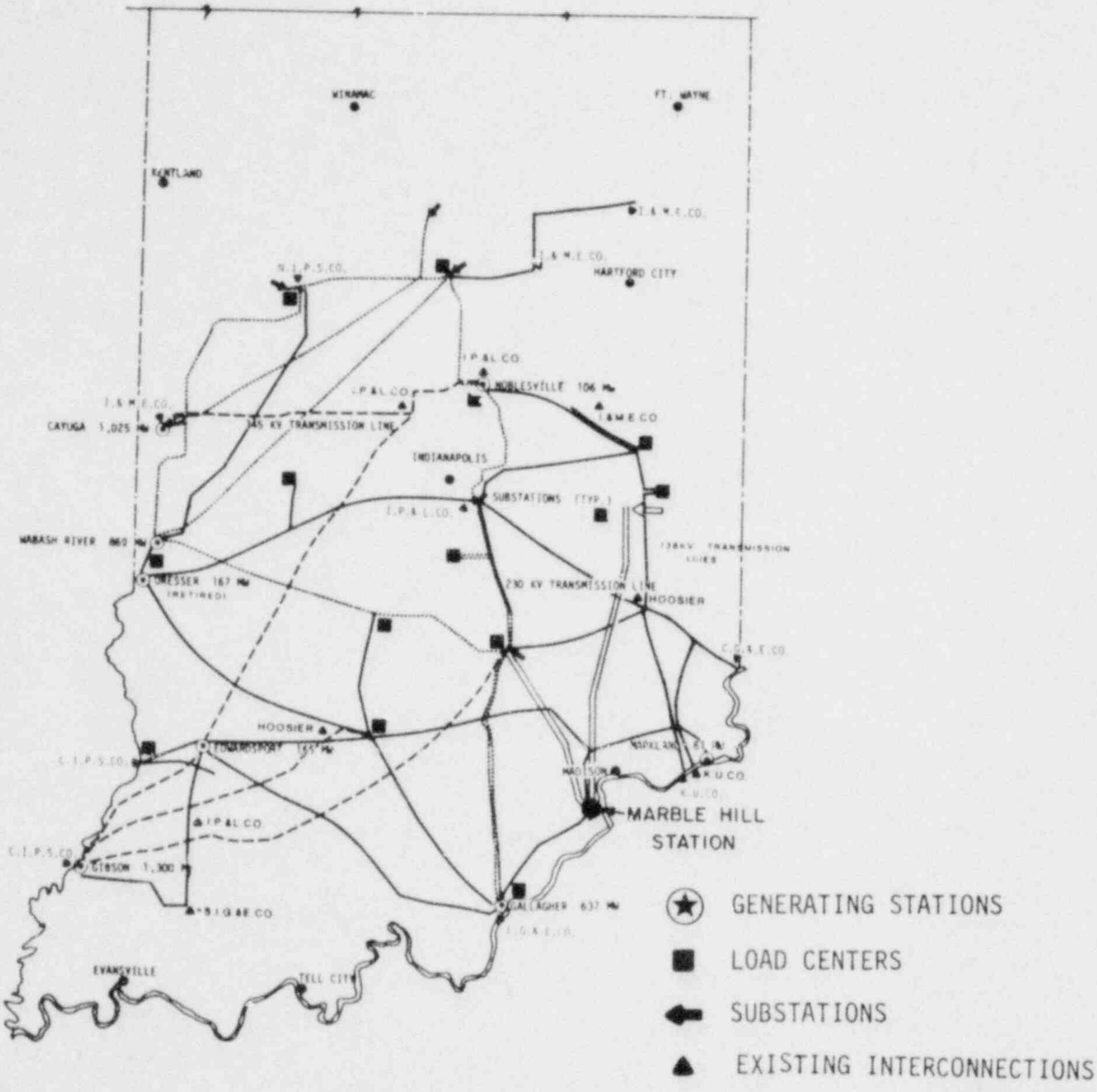

Fig. 8.2. PSI Transmission System. Adapted from ER, Fig. 9.2-6.

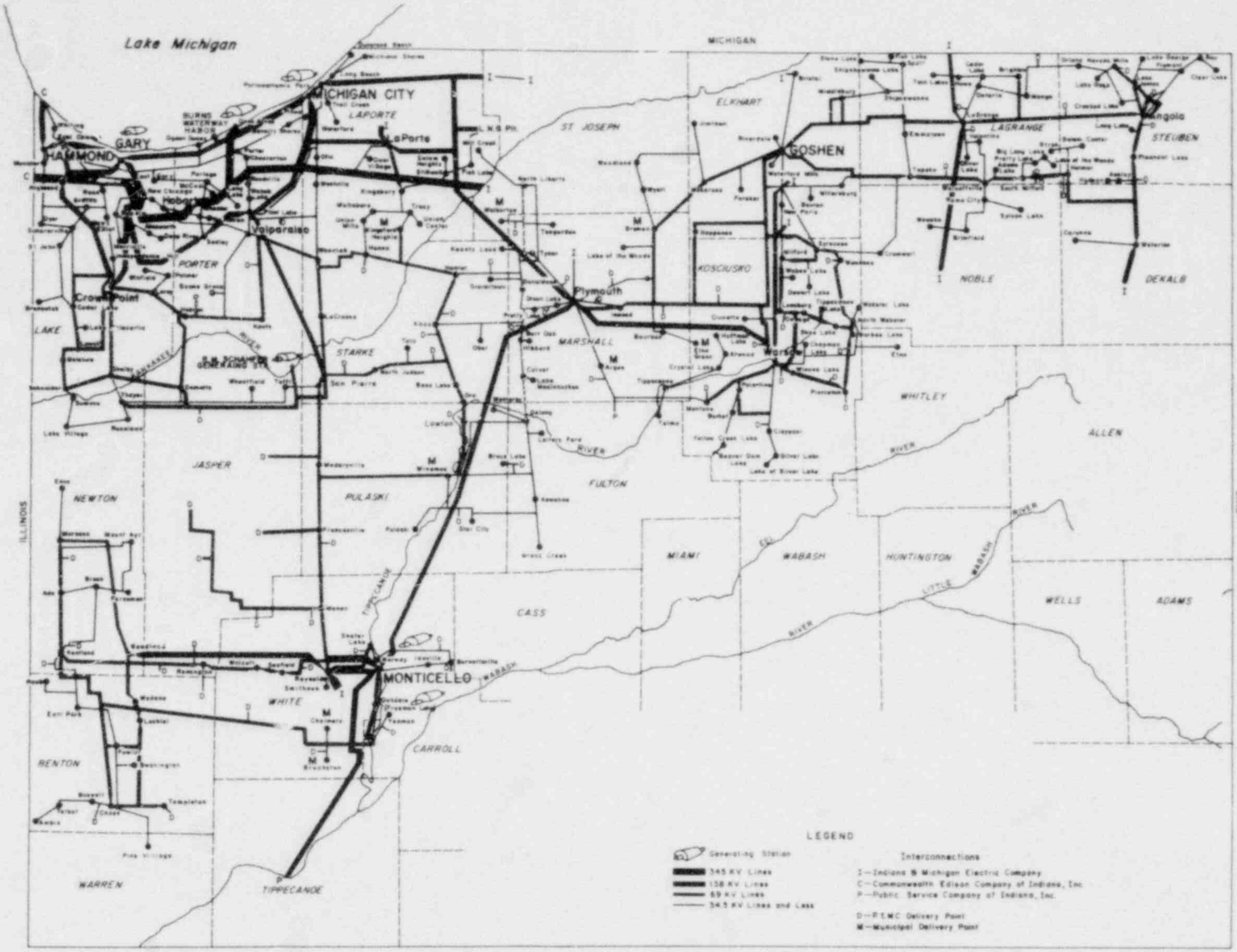

Fig. 8.3. NIPSCO Transmission System.

Source: NIPSCO

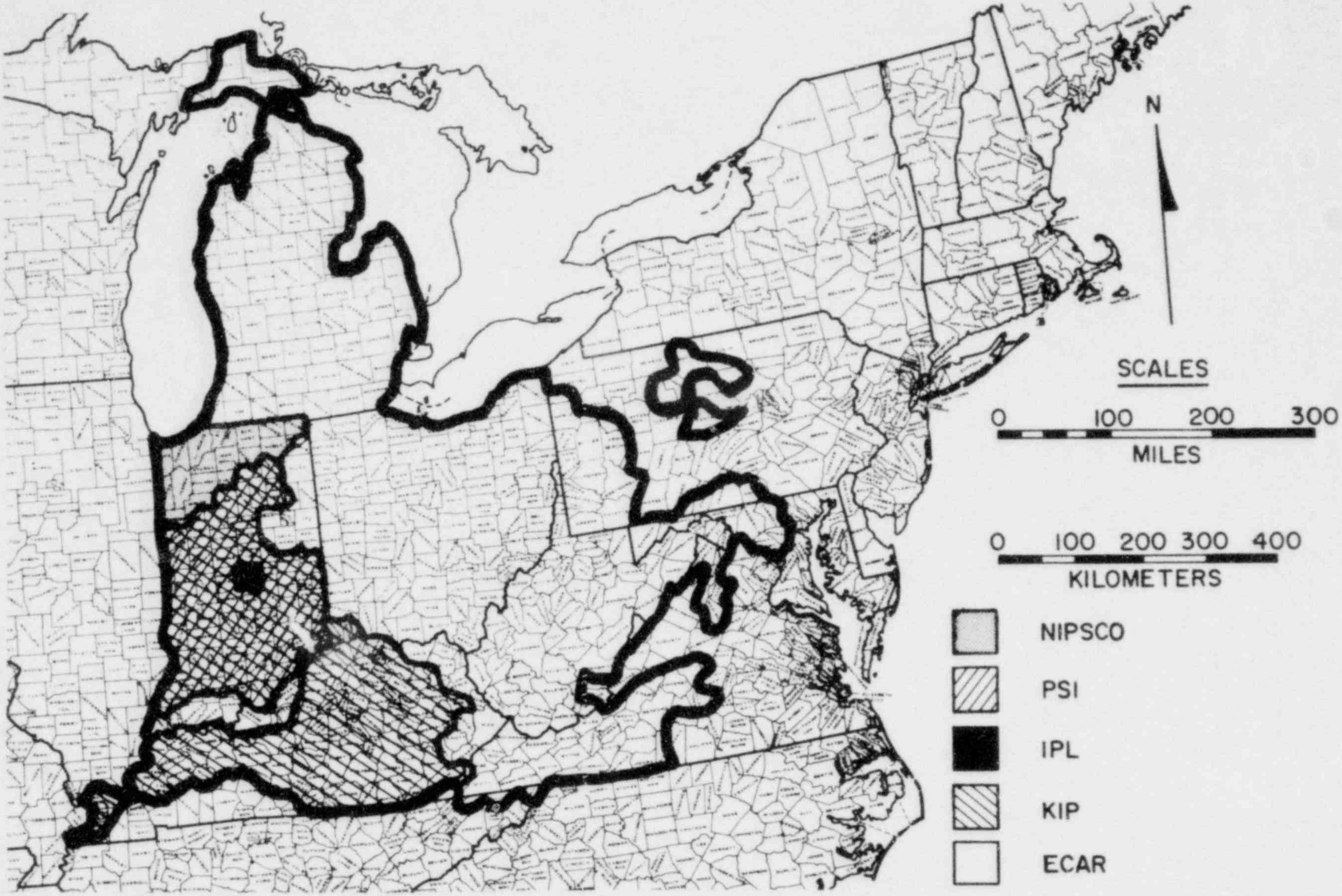

Fig. 8.4. Boundaries of ECAR, KIP, IPL, PSI, and NIPSCO.

Source: PSI

8.2 POWER REQUIREMENTS

8.2.1 Energy Consumption

The consumption of electrical energy by the utilities' customers has increased considerably since 1960. In Tables 8.1 and 8.2[1] the energies generated, bought, and sold each year since 1960 are listed together with the percentage change of the given year's sales from that of the previous year. The data on sales to customers are displayed graphically in Figures 8.5 and 8.6. Among other facts, one sees that 13.8×10^9 kWh of electrical energy were consumed by PSI's customers in 1974 whereas 5.1×10^9 kWh had been consumed by them 14 years earlier. NIPSCO's customers increased their consumption from 3.7×10^9 kWh to 11.5×10^9 kWh during the same period.

Each of the utilities decomposes its total sales in a slightly different manner. The percentage of the total energy that was sold to each sector is listed in Tables 8.3 and 8.4. From these data, it is apparent that each sector has used roughly the same fraction of its utility's output since 1960. Both utilities expect this to be the case in the future.

PSI and NIPSCO differ with respect to the size and variety of their industrial customers. PSI's industrial sector embraces a variety of types of business. This utility's largest single industrial customer accounts for 13% of the industrial sector or 4.8% of the total. Half of NIPSCO's industrial sector, or 36% of the total, is accounted for by four steel companies.

The growth in the domestic consumption of electrical energy has been faster than the growth in the number of customers. Tables 8.5 (PSI) and 8.6 (NIPSCO) display the number of residential customers, their average consumption, their average annual bill, and their adjusted average annual bill. The adjusted average bill represents the average bill in 1974 dollars. It is apparent that from 1960 to 1973 the average consumption by PSI's domestic customers rose from 3.9×10^3 kWh to 8.6×10^3 kWh and that NIPSCO's domestic customers increased their average annual consumption from 3.5×10^3 kWh to 6.4×10^3 kWh during the same period. In both cases the percentage rise of customer consumption was much greater than the percentage rise in the adjusted bill.

PSI records both its system peak load and its spring and fall minimum daily peaks. Past peaks and the utilities' expectations for their system peaks are tabulated in Tables 8.7 and 8.8. The same information is displayed graphically in Figures 8.7 and 8.8.

8.2.2 Applicant's Forecast of Power Requirements

PSI seeks to build the Marble Hill Station because of its conviction that population will continue to grow in its service area and that new commercial and industrial business will be established. Moreover PSI believes that electrical space heating will increasingly displace fossil fuel heating and that growth in air conditioning will continue. Using the methodology described in Section 1.1.1.2 of the ER and in PSI's comments on the DES, PSI forecasts that during the next 12 years the summer and winter peaks will grow at a compound annual rate of 7.1% and 8.2%, respectively, and the system energy requirement will grow at a compound annual rate of 8.6% through 1986.

NIPSCO plans to buy part of the capacity of the Marble Hill Station because it wishes to avoid dependence on renegotiating certain contracts for the firm purchase of electricity, which will expire during a period in which NIPSCO expects an increasing industrial load and population growth. This utility's forecasting methodology is set forth in section 1.1.4 of the ER. NIPSCO expects a growth rate of 6.6% per year in peak load and 6.0% per year in energy requirements through 1985.

Table 8.1. PSI System Energy Data and Expectations

Year	Energy Generated (GWh)	Purchased (Sold) Energy from (to) Peers[a] (GWh)	System Energy[b] (GWh)	Energy Sold to Customers[b] (GWh)	Percentage Change in Sales to Customers
1960	5,718		5,718	5,134	
	6,046		6,046	5,453	6.2
	6,513		6,513	5,901	8.2
	6,951		6,951	6,295	6.7
	7,534		7,534	6,848	8.8
1965	7,955	251	8,206	7,505	9.6
	8,121	908	9,029	8,249	9.9
	8,452	1201	9,653	8,821	6.9
	10,020	817	10,837	9,896	12.2
	11,039	792	11,831	10,839	9.5
1970	11,564	825	12,38[illegible]	11,358	4.8
	12,425	526	12,[illegible]51	11,940	5.1
	14,051	(229)	13,322	12,682	6.2
	14,977	(347)	14,630	13,580	7.1
	14,579	492	15,071	13,855	2.0
1975	16,002	(352)	15,652	14,404	4.0
			17,937		14.6[c]
			19,458		8.5
			21,147		8.7
			23,048		9.0
1980			24,362		5.7
			26,095		7.1
			28,324		8.5
			30,678		8.3
			33,166		8.1
1985			35,751		7.8
			38,535		7.8

Sources: Data for the years 1960 through 1975 are from PSI's Annual Reports to its stockholders. Expectations for the years 1976 through 1986 are from the ER, Section 1.1.1.2.

[a]Other utilities with which PSI interconnects.

[b]The difference between System Energy and Energy Sold to Customers was consumed by PSI.

[c]Projected percentage changes after 1975 were calculated from estimated system energy requirements (Column 4)

Table 8.2. NIPSCO System Energy Data and Expectations

Year	Energy Generated[a] (GWh)	Purchased Energy from Peers[a,b] (GWh)	System Energy[a,c,d] (GWh)	Energy Sold to Customers[d,e] (GWh)	Percentage Change in Sales to Customers
1960	3232	752	3,984	3,728	
	3522	753	4,275	4,019	7.8
	3593	1103	4,696	4,438	10.4
	4158	833	4,991	4,711	6.2
	4269	1020	5,289	4,996	6.1
1965	4630	1112	5,742	5,430	8.7
	4645	1870	6,515	6,154	13.3
	4961	2216	7,177	6,826	10.9
	5220	2805	8,025	7,632	11.8
	6639	2164	8,803	8,377	9.8
1970	7058	1830	8,888	8,437	0.7
	6883	2386	9,269	8,772	4.0
	7074	3191	10,265	9,745	11.1
	7188	4465	11,653	11,070	13.6
	7844	4138	12,000	11,454	3.5
1975			12,880		
			13,500		4.8[f]
			14,300		5.9
			15,200		6.3
			16,100		5.9
1980			17,000		5.6
			18,000		5.9
			19,100		6.1
			20,300		6.3
			21,500		5.9
1985			22,800		12.3
			24,200		6.1

[a]Data through 1974 are from NIPSCO's Annual Power System Statement to the Federal Power Commission, FPC Form No. 12.

[b]Other utilities with which NIPSCO interconnects.

[c]Expectations for the years 1975 through 1986 are from the ER, Section 1.1.3.

[d]The staff assumes that the difference between System Energy and Energy Sold to Customers was consumed by NIPSCO.

[e]From NIPSCO's Annual Reports to its stockholders.

[f]Projected percentage charges after 1974 were calculated from estimated system energy requirements (column 4).

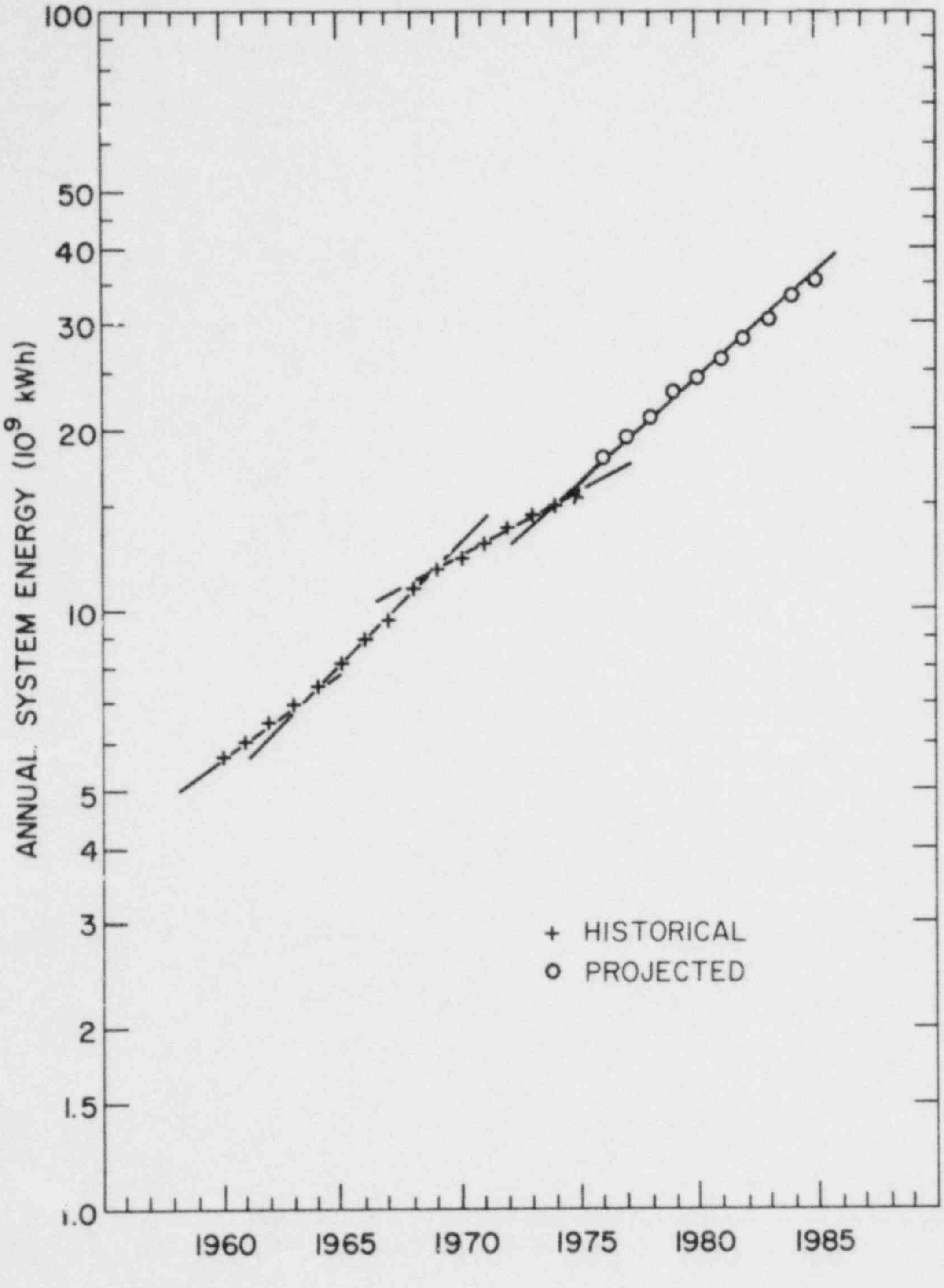

Fig. 8.5. PSI Annual System Energy Requirement

Note: PSI's annual sales are less than its energy requirement because of transmission losses and the company's use of its own energy. The historical values were reported by PSI in its annual reports and the projected values are PSI's expectations as they appear in Table 1.1-1 of the ER. The straight lines that appear on the graph were drawn by the staff primarily to guide the eye. The staff attaches no predictive value to them. On the average, the years 1960-1963 were characterized by 6.7% annual growth, 1963-1969 by 9.3%, and 1969-1974 by 5.0%. PSI expects to need 3.6×10^9 kWh in 1985, which could be reached by an average annual growth beginning from 1974 of 8.2%.

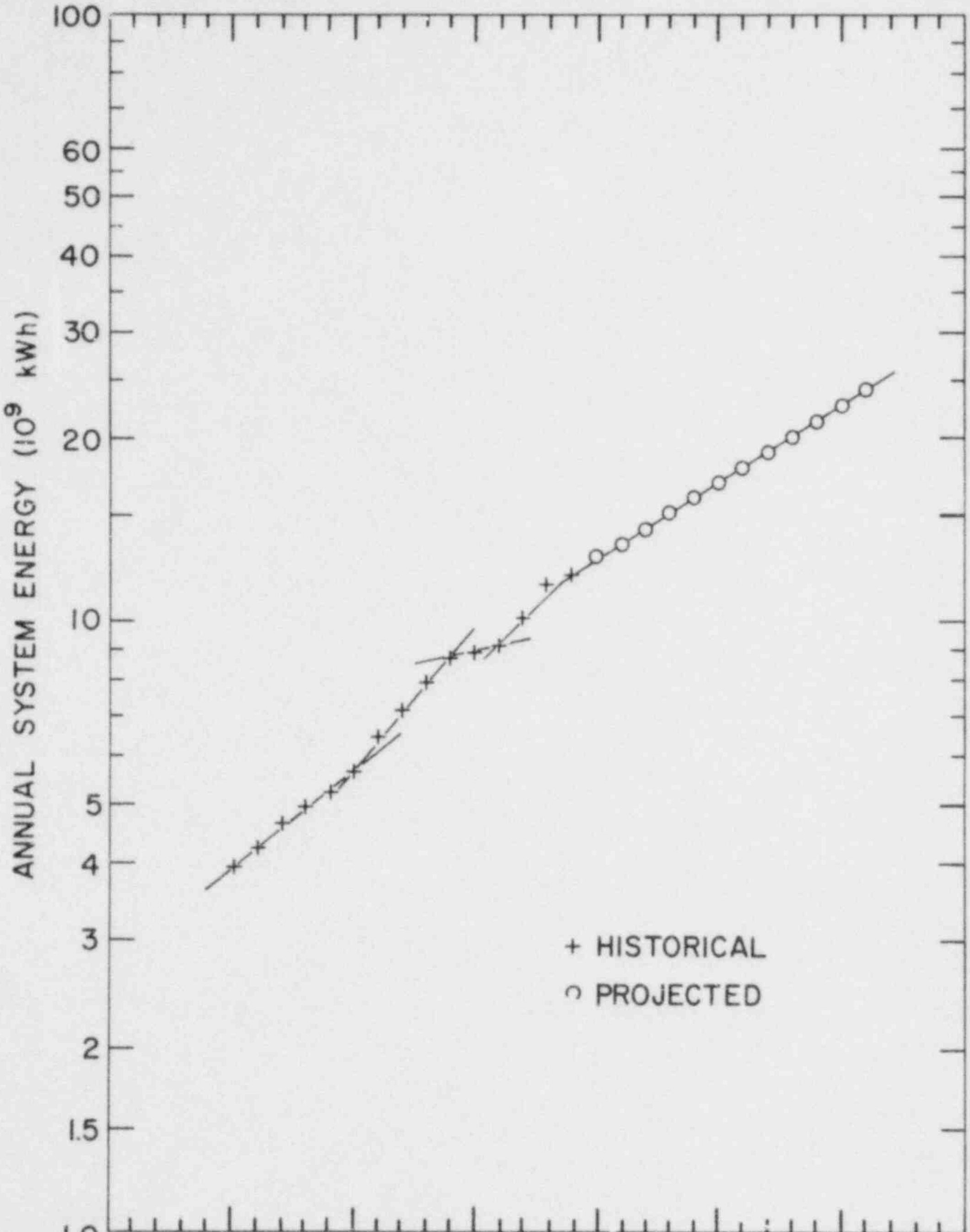

Fig. 8.6. NIPSCO Annual System Energy Requirement

Note: NIPSCO's annual sales are less than its energy requirement because of transmission losses and the company's use of its own energy. The historical values were reported by NIPSCO in Table 1.1-2 of the ER and the projected values, which are NIPSCO's expectations, were reported in the same table. The straight lines that appear on the graph were drawn by the staff primarily to guide the eye. The staff attaches no predictive value to them. On the average, the years 1960-1965 were characterized by 9.6% annual growth, 1965-1969 by 11.3%, 1969-1971 by 2.6%, and 1971-1974 by 9.0%. NIPSCO expects to need 2.3×10^9 kWh in 1985, which could be reached by an average annual growth beginning from 1974 of 6%.

Table 8.3. Percentage of PSI Total Energy Consumed by Sector

Year	Domestic	Commercial	Industrial	REMC[a]	Municipals	Other
1960	25.2	15.6	37.4	14.9	5.9	1.0
	25.1	15.5	37.0	14.9	6.0	1.5
	24.5	15.4	37.2	15.0	6.1	1.8
	24.2	15.7	37.5	15.0	6.1	1.5
	24.0	16.0	38.8	14.7	5.7	0.8
1965	23.9	16.3	38.8	14.5	5.4	1.1
	24.1	16.7	38.3	14.7	5.3	0.9
	24.5	17.1	37.4	15.0	5.3	0.7
	24.4	17.2	37.6	14.9	5.0	0.9
	24.5	17.3	37.2	15.1	5.1	0.8
1970	25.4	18.1	35.9	14.3	5.6	0.7
	25.9	18.7	35.9	12.9	5.9	0.7
	26.2	19.2	37.0	10.7	6.2	0.7
	26.7	19.5	37.8	8.8	6.6	0.6
	26.3	18.8	36.9	11.2	7.1	0.6
1975	28.2	20.3	31.9	11.0	8.0	0.6

From PSI's Annual Reports to its stockholders.

[a]Rural Electric Membership Corporations.

Table 8.4. Percentage of NIPSCO Total Energy Consumed by Sector

Year	Domestic	Commercial	Industrial	Street Lighting	Sales for Resale	Other
1960	21.8	8.4	61.5	1.2	6.0	1.1
	21.7	8.2	62.1	1.2	5.9	1.3
	20.7	8.0	63.5	1.2	5.3	1.2
	20.7	7.7	64.0	1.2	5.3	1.1
	19.5	8.2	64.7	1.2	5.4	1.1
1965	19.0	7.8	65.8	1.1	5.4	1.0
	18.2	7.3	67.6	1.0	5.2	0.8
	17.5	6.8	68.9	0.9	5.1	0.7
	17.3	6.4	69.5	0.8	5.1	0.8
	17.0	6.3	70.3	0.8	5.0	0.6
1970	18.4	6.6	68.2	0.8	5.4	0.6
	19.0	6.6	67.5	0.8	5.6	0.5
	18.2	6.0	68.9	0.7	5.7	0.5
	17.1	5.4	71.2	0.7	5.2	0.5
	16.7	4.8	71.9	0.7	5.4	0.5

From NIPSCO's Annual Reports to its stockholders.

Table 8.5. PSI Domestic Customers

Year	Number of Customers (thousands)	Energy per Customer (kWh)	Average Annual Bill (dollars)	Adjusted Average Annual Bill (1974 dollars)
1960	329.0	3936	105.03	177.37
	332.2	4121	121.98	200.78
	335.2	4314	128.34	208.97
	339.9	4480	131.75	212.00
	345.8	4745	134.40	213.30
1965	352.5	5076	138.79	216.58
	360.4	5520	146.08	221.70
	366.5	5892	152.29	224.62
	375.9	6420	160.84	227.74
	384.5	6907	168.29	226.12
1970	390.2	7395	176.00	223.24
	397.5	7774	182.20	221.43
	406.6	8173	199.69	235.33
	415.8	8736	217.17	240.88
	423.7	8631	221.78	221.78
1975	429.2	9479	258.83	279.44

Source: PSI's Annual Reports to Stockholders.

Table 8.6. NIPSCO Domestic Customers

Year	Number of Customers (thousands)	Energy per Customer (kWh)	Annual Average Bill (dollars)	Adjusted Annual Average Bill (1974 dollars)
1960	234.2	3481	96.81	160.93
	240.8	3574	98.41	161.99
	244.0	3775	102.93	167.60
	247.4	3936	106.61	171.55
	251.2	3881	104.91	166.49
1965	255.2	4052	108.43	169.21
	262.0	4282	111.60	169.38
	266.2	4490	115.49	170.33
	269.9	4884	123.47	174.83
	274.6	5196	129.82	174.43
1970	278.4	5582	137.63	174.58
	283.1	5878	143.50	174.40
	289.3	6137	165.18	194.66
	295.0	6402	178.13	197.57
	298.9	6408	198.80	198.80

Source: NIPSCO's Annual Reports to Stockholders

Table 8.7. PSI Peak Loads

Year	Peak Load (MW)	Spring Base Load (MW)	Fall Base Load (MW)	Firm Sales (Purchases) (MW)
1965	1431[a]	1037	1102	(66)
	1565	1131	1179	
	1671[a]	1220	1288	(145)
	1933	1315	1372	10
	2083	1430	1489	40
1970	2173[a]	1540	1610	(120)
	2372	1608	1689	38
	2514	1706	1830	(79)
	2740	1834	1918	(2)
	2666	1881	1923	31
1975	2873	1901	2018	71
	3150[b]	2013		98
	3405[b]			125
	3675[b]			146
	3960[b]			170
1980	4260[b]			
	4570[b]			
	4895[b]			
	5260[b]			
	5690[b,c]			
1985	6155[b]			
	6635[b,d]			

Source: ER, Suppl. 4, Table 1.1-1, ER, Table 1.2-3:PSI

[a]Winter peak.

[b]PSI's expectation.

[c]1984-1985 winter peak.

[d]1985-1986 winter peak.

Table 8.8. NIPSCO Peak Load

Year	Peak Load (MW)	Firm Purchases (MW)
1965	901[a]	290
	1031[a]	384
	1140[a]	
	1263	
	1402	
1970	1444	400
	1524	400
	1650	600
	1787	690
	1872	690
1975	1884	690
	2120[b]	690
	2250[b]	490
	2385[b]	490
	2525[b]	400
1980	2680[b]	200[c]
	2840[b]	200[c]
	3010[b]	200[c]
	3190[b]	200[c]
	3380[b]	200[c]
1985	3580[b]	400[c]

Source: ER, P 1.1-51

[a]Winter peak.

[b]NIPSCO's expectation.

[c]These numbers represent NIPSCO's current estimates. The binding decision concerning what capacity (between 200 MW and 400 MW) will be purchased from Indiana & Michigan Co. must be made four years in advance.

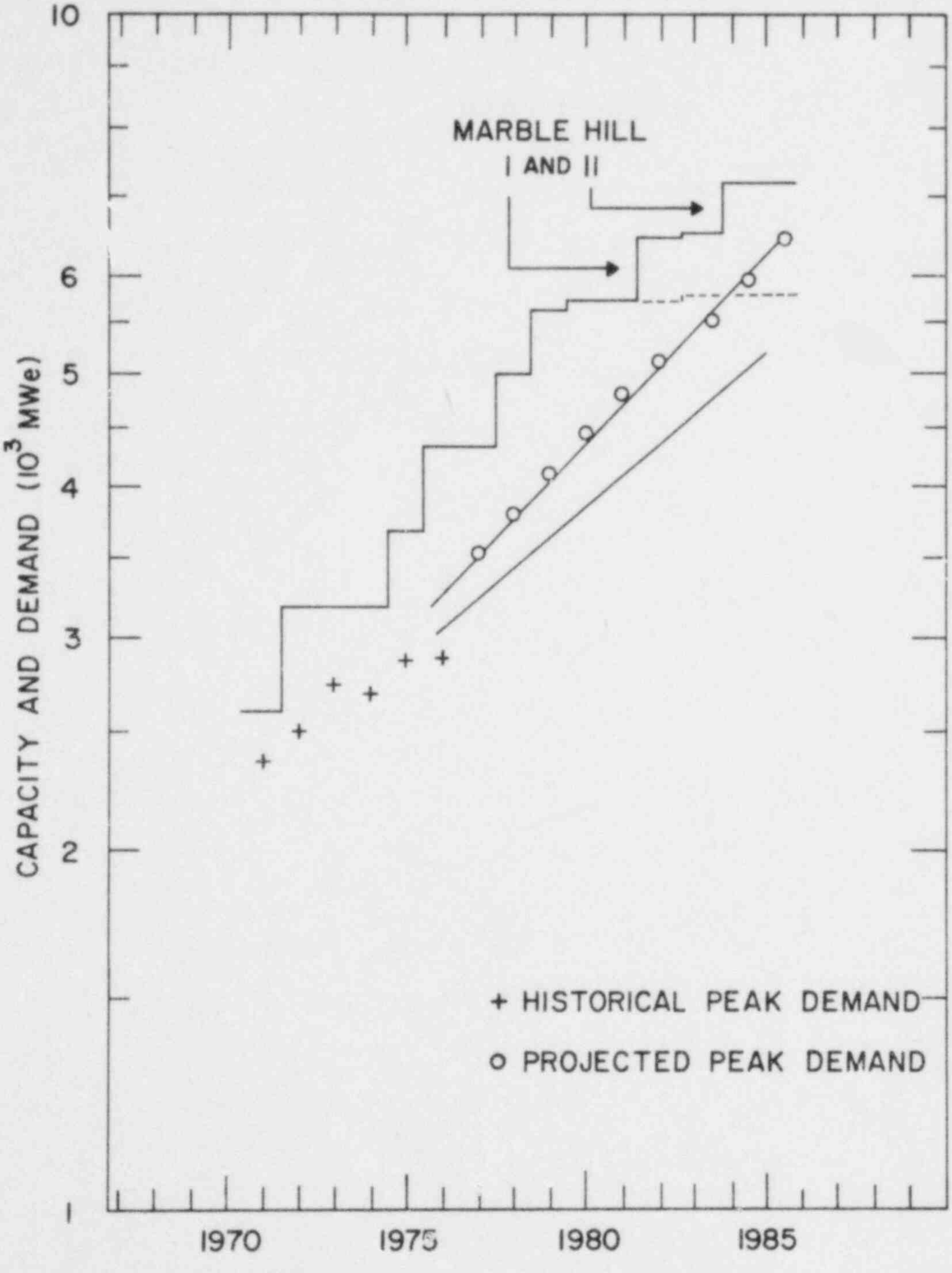

Fig. 8.7. PSI Capacity and Peak Demand

Note: The uppermost solid line represents PSI's past capacity and expectations for the future. The dotted line was obtained by subtracting the capacity (735 MWe per unit) of the Marble Hill Plant. The points represent PSI's past peak demands and its expectations for future peak demands. A line has been drawn through PSI's expectations and for the sake of comparison another line has been drawn below it. This second line represents the staff's opinion of the most probable growth in PSI's peak demand.

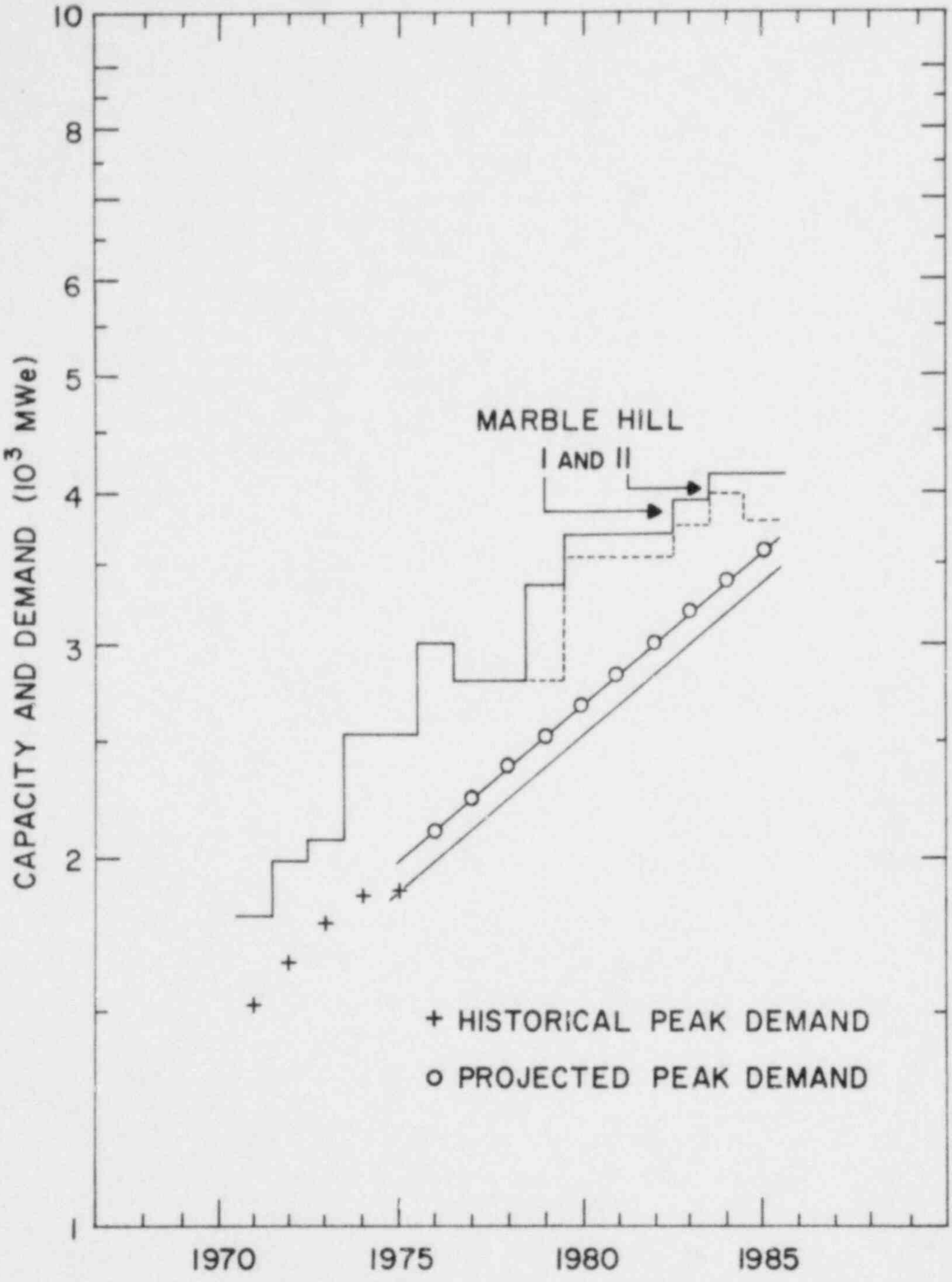

Fig. 8.8. NIPSCO Capacity and Peak Demand

Note: The uppermost solid line represents NIPSCO's past capacity and expectations for the future. The dotted line was obtained by subtracting the capacity (645 MWe) of the Bailly Plant (whose existence is in doubt) and adding 200 MWe (to bring NIPSCO's purchase of capacity from I&M to its maximum) for the years 1980-1984 to NIPSCO's present expectation for future capacity. The points represent NIPSCO's past peak demands and its expectations for future peak demands. A line has been drawn through NIPSCO's expectations and for the sake of comparison another line has been drawn below it. This second line would represent NIPSCO's future peaks if they grow at 6% each year beginning from 1975.

8.2.3 Staff's Forecast of Power Requirements

8.2.3.1 Overview of the Staff's Forecast

In deriving a forecast of the need for the capacity of the Marble Hill Station, the staff has considered various forecasts of growth in national demand for electricity and in business activity, and adjusted them to reflect the differences between national and regional variables significant to the determination of the growth rate in the demand for electricity in the PSI and NIPSCO service areas. Considerable weight has been given to the forecast of national demand for electrical capacity prepared by the U.S. Federal Energy Administration (FEA) and the forecasts of regional growth in population and economic activity prepared by the U.S. Department of Commerce and the U.S. Department of Agriculture (OBERS).

The FEA's forecast appears in the publication "1976, National Energy Outlook" which is the latest published result of Project Independence Evaluation System, the FEA's comprehensive energy model.[2] This report considers how the future demand for electricity would vary under several sets of assumptions regarding fuel supply, conservation, etc. The greatest rate of growth, 6.4%, in the consumption of electrical energy is projected to occur if the nation implements a vigorous program to increase the end use of electricity in place of oil and gas. The least rate of growth, 4.9%, is projected to occur if the nation adopts a full set of conservation policies. If the U.S. energy policy continues as in the recent past and if the price of imported oil remains at $13/bbl, then a growth rate of 5.4% in the consumption of electrical energy results from this "business-as-usual," or "reference" scenario. This is nearly the same as 5.6%, the average of eight other national forecasts.[2]

The 1972 OBERS projections, Series E,[3] provide a point of departure from which to begin a forecast of long-run economic conditions in the service area. These projections are widely used in regional economic planning. A difficulty with using the OBERS projections is that they are made for an area including Marion County which contains the city of Indianapolis but which is not part of PSI's service area. In order to exclude Indianapolis, when using OBERS, one must also exclude the rest of the Indianapolis SMSA which, however, is included in PSI's service area.

The staff also considered two independent county by county population projections. One was prepared by the Water Plan Section of the Indiana State Department of Natural Resources and was published in June, 1974.[4] The other projection has just been completed by the Division of Research of the School of Business of Indiana University for the Indiana State Board of Health.[5]

Starting with the national and regional projections of population and business activity and the national projections of electricity demand, an initial projection was made of regional electricity demand. This initial estiamte was then further considered in terms of the effects of factors such as the price and supply of competing fuels and the impact of energy conservation.

8.2.3.2 Staff Forecast of Energy and Peak Load

Tables 8.9, 8.10, 8.11, and 8.12 show the OBERS Projections for the nation and for most of PSI's service area. Population, total personal income, total earnings and a breakdown of earnings by broad type of business are displayed. In all categories the projected rates of growth during 1971-1980 are less than those of 1962-1969 and the projected rates of growth during 1980-1985 are less than those projected for 1971-1980. The staff believes that the long-run growth in consumption, peak load and base load will be determined by the long-run economic growth of the service area. OBERS projects a regional growth of roughly 4% both in personal income and industry earnings for the period 1975-1985. This rate is equivalent to the national growth rate for the same period. The projected growth of population in the service area (Table 8.13) is 1.1% per year as compared with 0.98% per year for the nation (Table 8.9). The staff's initial estimate, therefore, is that the regional growth rate in demand for electricity will be close to, and perhaps slightly higher than, that of the nation, which is projected to be between 4.9% and 6.4% for the period 1975-1985.

In the following, the staff considers the effects of a number of factors on the demand for electricity in PSI's several customer categories. Table 8.14 was compiled for PSI's industrial sector. The adjusted bills listed in this table were derived from the Wholesale Price Index. PSI's industrial sector embraces a variety of businesses with a variety of concerns. No single customer accounted for more than 13% of PSI's industrial output (4.8% of its total output) in 1974.

Table 8.9. Observed and Projected (OBERS) Population and Percentage Average Annual Growth in Selected Economic Parameters for the United States of America

	1962-1969	1971-1980	1980-1985
Population	186×10^6-201×10^6	206×10^6-224×10^6	224×10^6-235×10^6
Total personal income	5.4%	4.3%	3.6%
Total earnings	5.2%	4.3%	3.5%
Manufacturing	4.9%	4.0%	2.9%
Wholesale and retail trade	4.4%	3.8%	3.0%
Services	6.5%	6.1%	2.3%

From OBERS Projections.

*The staff has used the 1972 OBERS Projections, Series E, in the preparation of this report. These projections are based on the 1972 Series "E" projection of the national population by the Bureau of the Census and were prepared by the U. S. Department of Commerce, Social and Economic Statistics Administration, Bureau of Economic Analysis, Regional Economic Analysis Division, and the U. S. Department of Agriculature, Economic Research Service, National Resources Economics Division, for the U. S. Water Resources Council, 2120 L Street N. W., Washington, D. C. 20037.

Table 8.10. Observed and Projected (OBERS) Population and Percentage Average Annual Growth in Selected Economic Parameters for BEA Economic Area 059[a]

	1962-1969	1971-1980	1980-1985
Population	229,708-248,633	252,600-260,800	260,800-267,700
Total personal income	5.4%	3.7%	3.2%
Total earnings	5.0%	3.6%	3.2%
Manufacturing	5.8%	4.4%	3.2%
Wholesale and retail trade	3.6%	3.4%	2.8%
Services	6.1%	5.7%	4.5%

From OBERS Projections based on Series "E" Projected National Population Bureau.

[a]This economic area is centered near West Lafayette, IN. It contains eight counties and is entirely within the service area of PSI.

Table 8.11. Observed and Projected (OBERS) Population and Percentage Average Annual Growth in Selected Economic Parameters for BEA Economic Area 060[a]

	1962-1969	1971-1980	1980-1985
Population	1,416,365-1,589,681	1,625,800-1,828,400	1,828,400-1,944,400
Total personal income	5.6%	4.6%	3.9%
Total earnings	5.7%	4.6%	3.7%
Manufacturing	5.6%	4.4%	3.3%
Wholesale and retail trade	4.9%	4.2%	3.2%
Services	6.7%	6.6%	5.0%

From OBERS Projections.

[a]This economic area is centered about Indianapolis and contains 22 counties. The only part of this economic area that is not in the PSI service area is the City of Indianapolis. Compare with Table 8.10.

Table 8.12. Observed and Projected (OBERS) Population and Percentage Average Annual Growth in Selected Economic Parameters for the Portion of BEA Economic Area 060 not in Metropolitan Indianapolis[a]

	1962-1969	1971-1980	1980-1985
Population	447,274-497,147	507,500-581,200	581,200-619,600
Total personal income	6.1%	5.0%	4.0%
Total earnings	6.0%	4.9%	3.9%
Manufacturing	b	5.3%	3.8%
Wholesale and retail trade	5.0%	4.4%	3.2%
Services	7.2%	6.5%	4.9%

From OBERS Projections (Vol. 6).

[a]This economic area is entirely within the PSI service area.

[b]This number lies somewhere between 1.7% and 7.5%. It is uncertain because of BEA's uncertainty in the correct partition of 1962 manufacturers' earnings between metropolitan Indianapolis and the rest of BEA Economic Area 060.

Table 8.13. Projected Total Population of 57 Counties in which PSI Sells Electricity[a,b]

	Projected by Indiana Dept. of Natural Resources, State Water Plan Section[c]	Projected by Division of Research School of Business Indiana University[d]
1970	1,916,874	
1975		1,988,917
1980	2.123,400	2,120,535
1985		2,243,504
1990	2,358,300	2,365,678

[a]This tally includes Benton, Fulton, Tippecanoe and Warren Counties each of which is served in part by NIPSCO. The tally also includes Huntington County which is also served by I&M. The tally also excludes Dubois, Gibson and Pike Counties which are also served by I&M. The tally excludes Dubois, Gibson and Pike Counties which are also served by Southern Indiana Gas and Electric Co.

[b]REMCs including many powered by Hoosier Energy also serve in these counties.

[c]This projection appears in "Indiana Population by County, 1900-1970 Actual, 1980-2000 Projected", Research Dept., Indiana State Chamber of Commerce, Board of Trade Building, Indianapolis, Indiana (June, 1974).

[d]This projection appears in "Indiana County Population Projections 1975-2000", Indiana State Board of Health, 1330 W. Michigan Ave., Indianapolis, Indiana (1976).

Table 8.14. PSI Industrial Customers

Year	Number of Customers	Energy per Customer (MWh)	Average Annual Bill (dollars)	Adjusted Average Annual Bill (1974 dollars)
1960	2312	830	11,019	18,524
	2299	879	11,515	19,430
	2256	973	12,421	20,900
	2220	1063	13,293	22,431
	2325	1142	13,969	23,527
1965	2330	1251	14,810	24,447
	2355	1342	15,369	24,561
	2363	1396	16,156	25,767
	2370	1568	17,723	27,588
	2339	1680	18,875	28,268
1970	2413	1691	19,250	27,816
	2424	1767	20,353	28,501
	2440	1923	24,131	32,329
	2437	2108	27,571	32,716
	2438	2045	28,782	28,782
1975	2451	1878	31,463	34,080

Source: PSI's Annual Report to stockholders.

Although industrial consumption of electricity will be influenced by its price, the principal determinant of the long-term consumption of electricity will be the level of business activity or the volume of industrial output, which will be closely related to the projections of earnings and income given in Tables 8.10, 8.11 and 8.12.

A significant further effect on the industrial consumption of electricity is expected, most immediately for new industrial customers, from the substitution of electricity for natural gas and petroleum, which are getting scarce and more expensive. At present, the Indiana Gas Co., Inc. is not accepting new customers. The extent of the potential increase in industrial demand can be inferred from the fact that in 1972, in terms of energy equivalents, about four times more gas than electricity was consumed by industry. However, some of the energy of gas combustion is lost through the smokestack, so that about 50% less electrical energy is required to accomplish heating tasks. As oil and natural gas become less available for industrial use, they must be replaced with coal, coal derivatives, or electricity. On this account, the staff expects an appreciable increase in industrial electrical demand over that anticipated from the level of business activity.

Residential demand for electricity is also expected to increase as the expected shorter supplies and higher prices of oil and natural gas will tend to increase the use of electricity for residential heating.

In 1974 10.6% of PSI's domestic customers used electricity for space heating in 1974 and these customers consumed 21.4% of the energy sold to the domestic sector (ER, p. 1.1-4). Together with the total number of domestic customers and domestic sales (Table 8.5), the figures imply that the average electric space heating customer consumed 17.43 MWh during 1974 while the average non-electric space heating customer consumed 7.589 MWh.* If 4,000 present customers retrofit their dwellings with resistive electrical space heating each year (about 3,700 did so in 1974) and if each new customer uses resistive electrical space heating (18.15 MWh per year) and if the number of customers grows as the staff projects (see Projection B, Table 8.15), then PSI's domestic energy load over that in 1975 (4,068 x 10^3 MWh) will be 1,004 x 10^3 MWh in 1980, 2,026 x 10^3 MWh in 1985, and 3,103 x 10^3 MWh in 1990. It should be re-emphasized that this estimate is based on the assumption that all new customers will heat their homes electrically. These increments could be achieved by annual rates of compound growth of 4.18% from now until 1980, 3.52% from 1980 until 1985 and 3.14% from 1985 until 1990. It is plausible to believe that the Rural Electric Membership Corporations and municipals, that PSI supplies, carry a load that is predominantly residential and thus that this load will grow at the same rate as PSI's domestic load. For the sake of comparison, the staff has also calculated the expected increments in PSI's domestic consumption using the applicant's estimate that customers who use electrical space heating will on the average consume 21.314 MWh per year. The increments are 1.205 x 10^3 MWh in 1980, 2,432 x 10^3 MWh in 1985, and 3,723 x 10^3 MWh, in 1990.

The added load due to domestic space heating above may be estimated by multiplying the number of customers heating electrically by the heating energy used per customer per year. For 1980, this would be (4,000 x 5 years + 43,679) x 10.56, or 672,000 MW hrs per year (see Table 8.15, Projection B). If it is assumed that electrical heating is actually used during one-third of each day during the cold half of the year, the "average" extra capacity needed would be 674,000 x 6 ÷ 8760 hrs/year, or 460 MW. Similarly, average extra capacities needed for 1985 and 1990 would be 930 MW and 142[illegible] MW, respectively.

An estimate of peak extra winter capacity needed for added customers heating their homes electrically may be made by assuming each added customer would require 16.5 kW to maintain a 70°F difference between inside and outside temperatures on a severe winter day.[6] Thus, in 1980, the 63,679 added customers using 16.5 kW each would result in an extra needed winter capacity of 1050 MW. This value would increase in 1985 to 2120 MW above the 1975 value.

These estimates should be regarded as no more than approximate because the staff has assumed there will be no significant improvement in the insulation of the homes of new customers and because we have assumed all new customers will opt for electrical space heating.

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*It must be noted however that 1974 was milder (5247 heating degree days - in Indianapolis) then the average of the past eleven years (5633 heating degree days in Indianapolis). The staff has therefore used 5633/5247 (17.43 - 7.589) MWh/yr = 10.56 MWh/yr as the difference between the consumption of a domestic customer who uses electricity for space heating and one who does not.

Table 8.15. Staff Projection of Number of PSI's Domestic Customers

Year	Projection A	Projection B
1975	429,200[a]	429,200[a]
1980	473,518	472,879
1985		517,553
1990	563,465	565,228

[a]Actual

Method of Projection - The staff assumed that in 1975 there were 3.1 persons per household in the counties served by PSI. PSI furnished domestic service to 66.9% of the population in its service area. Most of the remaining domestic customers are served by REMC's. The staff assumes this will continue to be the case. The staff further assumes that in 1980 there will be 3.0 persons per household, 2.9 persons per household in 1985, and 2.8 persons per household in 1990. Projection A takes its population estimate from the State Water Plan estimate and Projection B takes its population estimate from the School of Business of I.U. Both estimates appear in Table 8.13.

A special factor influencing summer demand is the increasing use of air conditioning. This, combined with the basic factors of increasing population, business activity and per capita use of electrical power, leads the staff to forecast a growth in the summer peak of approximately 6%. The results of this are shown in Table 8.16. Also tabulated for the sake of comparison are rates which the staff regards as implausibly low and high.

Table 8.16. PSI Summer Peak Growth

	Rate of Growth		
Year	4%	6%	8%
1975	2873	2873	2873
	2988	3045	3103
	3107	3228	3351
	3232	3422	3619
	3361	3627	3909
1980	3495	3845	4222
	3635	4076	4559
	3781	4320	4924
	3932	4579	5318
	4089	4854	5743
1985	4253	5145	6202

The staff has not attempted as detailed an analysis for NIPSCO as it has for PSI for three reasons. First NIPSCO wishes to purchase only 20% of the capacity of Marble Hill Station. Second, the regions for which OBERS projects are not small enough to let us distinguish NIPSCO's service area from its environs. Third, NIPSCO sells approximately 36% of its energy to four steel companies. Moreover, in 1972, about a quarter of the electrical energy consumed in the iron and steel industry was generated by that industry and not purchased from utilities. Clearly, the future of the steel business and the undisclosed plans of these companies with respect to their own generation, vis-a-vis purchases from NIPSCO, are the most important factors in anticipating the growth in NIPSCO's sales. In the past, NIPSCO's peak has grown at 6% per year. The staff believes it is reasonable to assume this will continue. NIPSCO's large industrial customers try to avoid consumption during hours of peak system demand in order to take advantage of NIPSCO's peak-shaving rates. The result is a high system load factor and an independence of the system peak from the vagaries of the steel business that is greater than might be expected.

The staff has examined some of the major elements of demand in the PSI-NIPSCO service area. These considerations have led to a staff estimate of compound growth rates of about 6% per year in energy requirement and in peak load. This corresponds to a requirement in 1984 of 4854 MW of peak capacity and of 26,400 GWh in system energy load. These growth rates indicate the need for the capacity of Unit 1 of the Marble Hill Station by 1984 in order for PSI to maintain a reserve margin of 17% (see later discussion). The staff's estimate of needed rate of growth of capacity is consistent with its expectation that PSI's growth rate will be comparable with that of the nation, estimated by the FEA to range from 4.9 to 6.4% per year.

Some of the uncertainties in the factors affecting future demand have been discussed in this section, and further uncertainties will be discussed in the following section on the conservation of energy. In view of these uncertainties, the staff believes that a range of growth rates from 5.0 to 6.5% per year is reasonable to use in projecting electrical demand. The staff generally agrees with PSI that peak load requirements will grow faster than energy requirements and winter peak will grow faster than summer peak. All growth rates however, are expected to fall within the stated range.

8.2.4 Conservation of Energy

Recent energy shortages have focused the nation's attention on the importance of energy conservation, as well as on measures to increase the supply of alternative energy sources. The needs to conserve energy and to promote substitution of other energy sources for oil and gas have been recommended by the Report to the President on the Nation's Energy Future as major needs in regaining national energy self-sufficiency in the future.[7] In the following sections, the staff considers conservation of energy as related to the need for the electricity to be produced by the Marble Hill Station.

8.2.4.1 Recent Experience

Implementation of energy conservation measures by households, business, and government has already contributed to the lack of growth in the consumption of electricity nationally since the third quarter of 1973. Consumption of electricity, in the PSI and NIPSCO service areas, has been less than the forecasted consumption by an average of 6.2% (PSI) and 3.1% (NIPSCO) during the period October 1973 to March 1975. Monthly peak load demand has deviated from forecast by an average of +0.1% (PSI) and -3.6% (NIPSCO) during the same period. The interpretation of the significance of such limited data on energy-conservation impacts on the forecasted need for power in the utilities' general service areas over the next six to ten years is highly uncertain. Much will depend, of course, on future decisions of consumers and governmental agencies in responding to the energy emergency and on potential developments in energy supply and demand factors that might ease the energy shortage or cause it to worsen. However, as time progresses historical information of these kinds and the actual data on power-demand impacts in the utilities' general service areas will provide a more reliable basis for demand projections.

8.2.4.2 Promotional Advertisement and Conservation Information Services

In the past, PSI and NIPSCO have attempted, through advertising, to accelerate the demand for electricity in their service areas. Generally, the major thrust of advertising was to promote demand during off-peak periods, thereby using lower-cost baseload capacity in place of expensive peaking capacity. For example, water heating by electricity has been promoted to make profitable use of what would otherwise be idle generators at off-peak times.

The utilities terminated promotional advertising in October 1973 (ER, pp. 9.1-3a and 9.1-9a, and Supp. 1, pp. 6-7) and, by direct mail and mass media advertising, disseminated information designed to promote efficient residential usage of electricity. On the other hand, promotional advertising by purveyors of electrical appliances and equipment has not been eliminated. For example, throughout the U. S. $4,073,000 was spent on the newspaper advertisement of air conditioners during 1974.[8]

The staff considers that there is no conclusive evidence as to the degree to which the net effect of these programs will impact the projected demand.

8.2.4.3 Change in Utility Rate Structure

The Federal Power Commission regulates the rates for interstate wholesale electric energy,[9] and the Public Service Commission of Indiana regulates the rates utilities charge the ultimate consumer in the utilities' service areas.

Historically, utility rate structures were designed to encourage consumption of electricity by using declining block rates, which reflected the declining average cost of furnishing additional kilowatt-hours of electrical energy to each customer. Until recently the economic logic for declining block rates was never seriously disputed. Today, however, under conditions of increasingly scarce fuel resources, declining block rates tend to encourage greater use of electricity by individual consumers and also to encourage individual consumers to use more electricity instead of other energy resources.

The most commonly mentioned substitutes for declining block rates to dampen demand for electricity are peak-load pricing, flat rates, and increasing block rates.

Statistics such as those in Section 8.2.1 indicate that across the United States, even though the price of electricity has increased during the last few years, the demand is still increasing. The question that statistics such as these do not answer is: at what point will the costs of residential and commercial electricity cause the consumer to significantly decrease his demand? It is obvious that, with sufficient economic incentive, total demand, or at least its rate of growth, could be reduced.

In addition to price, the demand for electricity is influenced by other factors such as: (1) changes in the regional and national economy; (2) the substitution of electricity for scarce fuels; (3) growth in population and households; (4) technological change affecting substitute sources of energy, efficiency in the use of energy resources, and the development of new uses for electrical energy; and (5) market forces affecting the demand for consumer investment in durable goods that require electricity to operate. In the face of such a complexity of causal forces it is exceedingly difficult to factor out the extent to which price changes alone would affect the demand for electricity in the utilities' service areas. This uncertainty exists in analyzing historical data and is even greater in forecasting future developments because of the perturbations of outlook fostered by the energy exigency and decisions yet to be made by consumers, industry, and government agencies in relation to reducing demand for scarce fuels or developing additional reserves or new sources of energy to substitute for scarce fuels.

8.2.4.4 Load Shedding, Load Staggering, and Interruptible Load Contracts to Reduce Peak Demand

Load shedding is an emergency measure taken to prevent system collapse when demand placed upon the system is greater than its capacity. This measure is usually not taken until all others are exhausted. The Federal Power Commission's report on the major load shedding that occurred during the Northeast Power Failure of 9 and 10 November 1965 indicates that reliability of service of electrical distribution systems should be given more emphasis, even at the expense of additional costs.[10] This report identified several areas that were strongly affected by loss of power, such as elevators, traffic lights, subway lighting, prisons, and communication facilities. It is because of such serious impacts that load shedding is used only as a temporary method to overcome a shortage of generating capacity during an emergency.

Load staggering has also been suggested as a possible conservation measure. Basically this alternative involves shifting the work hours of industrial or commercial firms to avoid diurnal or weekday peaks. However, the staff considers the interference with customer and worker preferences as well as with productivity to be of such significant impact that these proposals are of questionable feasibility.

For interruptible load contracts to be efficacious, the load reduction must be large enough to be effective in system-stability planning. Thus, this type of contract is primarily associated with industrial customers. At the present time none of PSI's or NIPSCO's industrial customers is under an interruptible service contract. The acceptability of interruptible load contracts to industrial customers depends upon balancing potential economic losses resulting from unannounced interruptions against savings resulting from the reduced price of electricity. Should the frequency or duration of interruptions increase as a result of insufficient installed capacity, the customer will convert to a normal industrial load contract. Even if the utilities had 1200 MWe of interruptible load, it is doubtful that their customers would continue this contractual relationship if faced with frequent and long periods with no electrical service.

None of the above measures can be considered as a viable alternative for required additional capacity and they do little to solve the energy shortage.

8.2.4.5 Factors Affecting the Efficient Utilization of Electrical Energy

During the past two years, much of industry, the Federal Government, and many State and local governments have made the promotion of energy conservation a priority program. The Department of Commerce has developed a department-wide effort to: (1) encourage business firms to conserve energy in the operation of their processes and buildings, (2) encourage the manufacture and marketing of products more efficient in their use of energy, and (3) encourage businessmen to disseminate information on energy conservation. The National Bureau of Standards has been given a leading role in promoting the development and implementation of energy-saving standards. Programs include: voluntary labeling of household appliances; research, development, and education relative to energy conservation in building; efficient use of energy in industrial processes; and improved energy efficiency in space heating and cooling. Although considerable efficiencies in electricity usage have already been gained, and further efficiencies are likely to be realized, any present estimates of the magnitude of electricity savings to be realized over time must be treated as tentative and subject to continual reassessment.

The need for generating capacity is based on annual peak load demand and not on the volume of consumption over the year. Any conservation measures that reduce baseload but not peak demand will have little or no impact on the need for capacity. PSI's most recent forecasts for total sales and annual peak load demand indicate that total sales are expected to grow at more than 8% while peak demand is expected to grow at 8% annually. The growth in peak demand will continue to be strongly influenced by installation of air conditioning in an increasing percentage of residences and commercial and industrial buildings. Service area projections by PSI indicate that air-conditioning load will grow from 642 MW (fall 1974) to 960 MW (1979).

Considerable efficiency can be achieved in space conditioning by improved insulation as well as by using equipment that transfers or stores heat. For example, the seven-story Federal Office Building to be built in Manchester, NH, illustrates the potential for energy conservation in future commercial buildings using existing technology.[11] For this particular building, energy savings are anticipated to be a minimum of 20% to 25% over a conventionally designed building in the same location. Heat savings alone are expected to be 44% because of better-insulated walls, less window area, use of efficient heating and heat-storage equipment, and the use of solar collectors on the roof.

In 1971, the FHA established new insulation standards intended to reduce average residential heating losses by one-third. Studies have shown that it is possible to realize even greater reductions in heat loss through improved insulation at costs that are economical over a period of years.[12] Improved insulation is advantageous not only in winter but also reduces the air-conditioning burden in the summer.

Lighting, which has accounted for about 24% of all electricity sold nationally, is another area where savings are being realized. Many experts believe recommended lighting levels in typical commercial buildings have been excessive, and it has been estimated that adequate illumination in commercial buildings can be achieved at 50% of current levels of power use through various design and operational changes.[13] Another study indicated that in 1970, if all households had changed to fluorescent from incandescent lighting, the residential use of electricity for lighting would have been reduced about 75% and total electrical sales would have been reduced about 2.5%.[14] However, because the majority of residential lighting occurs in off-peak hours, the reduction of peak demand would have been less than 1%.

The potential for greater energy efficiency in household appliances is well recognized. The National Bureau of Standards is working with an Industrial Task Force from the Association of Home Appliance Manufacturers on a voluntary labeling program that would provide consumers with energy consumption and efficiency values for each appliance and educate them as to how to use this information. Room air conditioners are the first to be labeled. The next categories of household appliances to be labeled are refrigerators, refrigerator/freezers, and hot-water heaters.

The importance of energy-efficiency labeling of appliances is that it will allow the consumer to select the most energy-efficient appliance. A recent study has estimated that an improvement in average efficiency of 60% could save electric utilities almost 60,000 MW in 1980.[15] Air conditioners that are more energy-efficient require a combination of increased heat-exchanger size and higher efficiency compressors resulting in higher initial cost. The consumer must be convinced that in the long run it is profitable for him to purchase the more expensive machine. Today, however, there is a high degree of uncertainty in predicting to what extent consumers will actually purchase these more expensive appliances; selection of central air conditioning by developers and many homeowners has historically been based on minimizing front end costs, consistent with meeting local building codes.

Considerable opportunity for electricity conservation exists in industry in addition to lighting and air-conditioning efficiency already mentioned. Electric motors should be turned off when not in use and motors should be carefully sized according to the work they are to perform. Small savings can be realized by deenergizing transformers whenever possible. Fuel requirements for vacuum furnaces can be reduced by 75% if local direct-combustion low-quality heat is employed rather than high-quality electrical-resistance heating.[16] On the other hand, the National Institute of Occupational Safety and Health has recommended heat-stress standards to the Occupational Safety and Health Administration which, if adopted, would require a significant number of employers to air condition their plants.[17] This possible requirement makes any significant reduction in the future peak demand for electricity from energy-conservation measures in industrial installations highly uncertain at this time.

8.2.4.6 Consumer Substitution of Electricity for Scarce Fuels

While conservation measures are rather quickly adopted in a "crisis" situation, the consumer's substitution of electrical energy for fuels such as oil or gas takes several years to result in a substantial upward impact on the need for power. The staff expects that substitution of electricity for scarce energy sources will likely accelerate in the PSI and NIPSCO service areas because of the uncertainty of oil and gas supplies and the outlook for higher prices relative to the price of electricity produced from coal-fired or nuclear plants. For instance, in the PSI service area, 10.6% of the customers heated their dwellings electrically in 1974 while 21% are expected to do so in 1980. The advent of electric automobiles or other new uses of electricity cannot be discounted, but are not now quantified in projecting need for power because of their high degree of uncertainty. It is the staff's evaluation that substitution effects will to some degree offset savings from energy-conservation techniques.

8.2.4.7 Conclusion of Energy Conservation

In the preceding subsections, the staff has considered the potential reduction of demand for total energy and for peak power by a number of conservation techniques such as terminating promotional advertising, changes in rate structure, load management techniques, and increasing efficiency of utilization. The effect of substitution of electricity for scarce fuels was also considered. The staff believes the net effect will be small. In any case, the FEA projections upon which the staff's forecast of demand was based included these considerations of conservation and substitution.

8.3 POWER SUPPLY

8.3.1 System Capability, Reserve and Base Load Requirements

The reserve requirements of individual power systems and power pools are commonly based on one of the three following standards: (1) a percentage of peak load, (2) the ability to withstand the outage or simultaneous outage of its largest or two largest generating stations, (3) an assessment of the probability of an outage which would force load shedding. Implementation of the third standard is the most complex because it requires an extensive actuarial and engineering effort to calculate the probability needed. These probabilities are themselves an insufficient basis for a decision on whether to seek a reliability compatible with an outage every five years, every ten years or some other level. For this reason, the first and second criteria have been widely used by utilities in the past. At present, industry-wide discussions are taking place and uncertainty exists as to the most efficacious and cost-effective way to set future reliability standards. The staff believes that the proposed minimum installed reserve goals of 17% for PSI and 20% for NIPSCO are reasonable by current industry standards.

At present, PSI generates almost all of its electrical energy by burning coal. Table 8.17 lists characteristic parameters and expected ratings and deratings of PSI's generating stations. As indicated by this table, PSI does not plan to derate a significant amount of capacity in the foreseeable future. It does plan to add Gibson 1, 3, and 4, each of 650-MW capacity. PSI wishes to maintain a reserve capacity of at least 17% of its peak demand, as established by the KIP Planning Committee. PSI's planned capacity and anticipated peak loads are displayed graphically in Section 8.2.2, Figure 8.7. The staff projects that PSI will not need capacity in addition to that now planned before 1984; however, the uncertainties in projections of demand are so large that new capacity may be needed as early as 1982.

Table P.17. Unit Capabilities for PSI

Station	Unit	Unit Type[a]	Service Type[b]	Capacity[c] (MW)	Estimate of Capacity Factor Range (%)	Annual Totals (MW)
Gallagher	1	F	B	160	40-70	
	2	F	B	159	40-70	
	3	F	B	159	40-70	
	4	F	B	159	40-70	
Wabash River	1	F	B	97	40-70	
	2	F	B	98	40-70	
	3	F	B	98	40-70	
	4	F	B	98	40-70	
	5	F	B	120	40-70	
	6	F	B	349	40-70	
Total of fossil units by service type below 100MW size			I	428	20-50	
			P	38	5-10	
Total of hydro units below 100MW size			RR	55[d]		
Total of combustion turbine units below 100MW size			P	92	5-10	
Total of internal combustion units below 100MW size			P	8	5-10	
1970 Summer Tested Capability						2119
Cayuga	1	F	B	500	40-70	
Total of fossil units below 100MW retired			P	-34		
Miscellaneous uprates				12		
1971 Summer Tested Capability						2597
Cayuga	2	F	B	496	40-70	
	3	IC	P	11	5-10	
Connersville	1	CT	P	42	5-10	
	2	CT	P	43	5-10	
Miscellaneous derates				-12		
1972 Summer Tested Capability						3177
Total of fossil units below 100MW retired				-4		
Miscellaneous uprates				4		
1973 Summer Tested Capability						3177
Miscellaneous uprates				8		
1974 Summer Tested Capability						3185
Gibson	2	F	B	650	40-70	
Total of fossil units below 100MW retired			P	-144		
Miscellaneous derates				-10		
1975 Forecasted Summer Capability						3681

SEE KEYS AND FOOTNOTES AT END OF TABLE.

Table 8.17. Continued

Station	Unit	Unit Type[a]	Service Type[b]	Capacity[c] (MW)	Estimate of Capacity Factor Range (%)	Annual Totals (MW)
Gibson	1	F	B	650	40-70	
Miscellaneous derates				-2		
1976 Forecasted Summer Capability						4329
Miscellaneous derates				-2		
1977 Forecasted Summer Capability						4327
Gibson	3	F	B	650	40-70	
Miscellaneous derates				-2		
1978 Forecasted Summer Capability						4975
Gibson	4	F	B	650	40-70	
1979 Forecasted Summer Capability						5625
1980 Forecasted Summer Capability						5625
1981 Forecasted Summer Capability						5625
Marble Hill	1	N	B	735	40-80	
1982 Forecasted Summer Capability						6360
Seasonal upratings				49		
1983-84 Forecasted Winter Capability						6409
Marble Hill	2	N	B	735	40-80	
1984-85 Forecasted Winter Capability						7144
1985-86 Forecasted Winter Capability						7144
Undesignated				845		
1986-87 Forecasted Winter Capability						7989
1987-88 Forecasted Winter Capability						7989
Undesignated				845		
1988-89 Forecasted Winter Capability						8834

From ER, Table 1.1-12:PSI.

[a]Unit-type code: F Fossil; N Nuclear; IC Internal combustion; CT Combustion turbine; H Hydro; GT Gas turbine; CC Combined cycle

[b]Service-type code: B Base; I Intermediate; P Peaking; RR Run-of-the-river

[c]Tested capability.

[d]This is a run-of-the-river hydro plant with an installed capability of 81 MW; however, for capacity planning purposes the firm capability of the plant is taken as 55 MW.

NIPSCO generates almost all of its electrical energy by burning coal. Table 8.18 lists characteristic parameters and expected ratings of NIPSCO's generating stations. Examination of this table is insufficient to understand NIPSCO's capability and reserve situation, because it has negotiated firm purchases of capacity from Commonwealth Edison and I&M. As was mentioned in Section 8.1.2, the contract with Commonwealth Edison guarantees NIPSCO enough capacity to maintain its reserve at 15% of peak load. NIPSCO does not anticipate the continuation of this arrangement after its present expiration date, 30 June 1979. NIPSCO wishes to become more self-sufficient and to increase its reserve capacity to 20% of the peak load. The timely completion of the Bailly plant is necessary for the fulfillment of these wishes. NIPSCO's arrangement with I&M was described in Section 8.1.2. At present NIPSCO plans to avail itself of 200 MW in the years 1980 through 1984.

Table 8.19 reveals that if PSI's peak load grows as the utility now anticipates, then on the basis of reserve margin requirements, Marble Hill Unit 1 would be needed by the summer of 1982 and Unit 2 would be required in 1984. Using the same reserve requirements and the staff's "most likely" forecast of rate of demand growth (6% per year) Unit 1 would not be needed until the February 1984 winter peak, and Unit 2 not until the February 1987 winter peak. The staff's most likely estimate of the time of need for each unit is about two years later than the applicant's. Taking into account the uncertainties involved in forecasting need for power, the staff believes that the range of high probability for the rate of growth of power need for PSI through the mid-1980's extends from 5.0% to 6.5% per year. If the growth rate were 6.5%, Unit 1 would be needed for the winter (February) peak of 1984 and Unit 2 for the winter (February) peak of 1986. With a growth rate of 5.0% per year, Unit 1 would be needed by the summer of 1986 and Unit 2 by the winter of 1989.

Table 8.20 lists NIPSCO's anticipated capacity, demand and reserve. According to the staff's forecast of NIPSCO's peak, the 226 MW share of Unit 1 will not be required until the summer of 1984[5] and Unit 2 will not be needed until the late 1980's, assuming no change in anticipated purchases of power from I&M and addition of generating capacity as scheduled in Table 8.20.

8.3.2 Base-Load Capacity Requirement

Base-load units are added to a system when they are thought to be the least cost alternative to meeting the system's projected need for energy as well as peaking capacity. Although the capital costs for base-load units are higher than for those designed as peaking or load-following, the thermodynamic efficiency of base-load is much greater, resulting in lower fuel costs and lower total cost per unit of output. In the past, it has been the custom both for utilities and for the staff to consider principally peak required capacity in judging the need for a large nuclear power plant. However, a large nuclear plant is clearly designed for providing basel[illegible]ther than peaking capacity. Tables 8.17 and 8.18 indicate that both PSI and NIPSCO have [illegible]ber of small and medium sized power plants that could be used for peaking and intermediate cap[illegible]ity while allowing the Marble Hill unit to provide cheaper baseload power. The load duration curves for PSI and NIPSCO displayed in Figs. 8.9 and 8.10 show the baseload position of the two Marble Hill Station units anticipated by the two utilities for the mid-1980's. Another criterion for judging the adequacy of baseload capacity in a system is that planned baseload capacity operating at a 65% capacity factor should be greater than the average system demand. This corresponds to a requirement that the ratio of planned baseload to average demand should be larger than 1/0.65, or 1.54. This analysis is displayed in Table 8.21. Using PSI's forecast of average energy demand the ratio is 1.58 in 1982 without Marble Hill Unit 1 and 1.54 in 1984 without Unit 2. For the staff's lower bound estimate of 5% growth rate, neither unit would be required before 1987. Using the 6.5% growth rate estimate, the baseload capacity of Unit 1 would be needed in 1984 and that of Unit 2 in 1986. For the "most likely" 6.0% growth rate forecast, the times of need would be 1985 for Unit 1 and 1987 for Unit 2.

8.3.3 Regional Capability and Reserve

As already noted, both PSI and NIPSCO are members of ECAR. On the basis of its members' own forecasts, ECAR submitted its expectation for future regional capacity, demand, and reserve levels in its annual report of April 1975 to the FPC. The pertinent 1975 projections and projections previously made for 1974 are given in Table 8.22. The accuracy of these forecasts is indicated by ECAR's own evaluation:

> "The forecasting of future loads is a most difficult task in light of the present uncertainties which exist with respect to the current trends, energy conservation efforts, the substitution of electric energy in end-use consumption for the increasingly scarce supplies of oil and natural gas, and the lack of a definitive national energy policy. Questions arise as to the relative probability of experiencing the lower load levels reported in this year's response in comparison to those reported in previous responses. The confidence in the 'accuracy' of present load forecasts is undoubtedly lower than it has been in past years because of the great amount of speculation that must be injected in the underlying assumptions that form the basis for the forecasts."

Table 8.18. Unit Capabilities for NIPSCO

Station	Unit	Unit Type[a]	Service Type[b]	Capacity (MW)	Estimate of Capacity Factor Range (%)	Annual Totals (MW)
Michigan City	1	F	I	71	20-40	
	2	F	I	66	20-60	
	3	F	I	66	20-60	
D. H. Mitchell	4	F	B	130	60-80	
	5	F	B	130	60-80	
	6	F	B	130	60-80	
	9	GT	P	52	5-25	
Bailly	7	F	B	183	50-70	
	8	F	B	404	50-70	
	10	GT	P	34	5-25	
Norway		H	RR	4[c]		
Oakdale		H	RR	6[d]		
1970 Summer Tested Capability						1276
D. H. Mitchell	11	F	B	110	60-80	
1971 Summer Tested Capability						1386
1972 Summer Tested Capability						1386
1973 Summer Tested Capability						1386
Michigan City	12	F	B	468	60-80	
1974 Summer Tested Capability						1854
1975 Forecasted Summer Capability						1854
R. M. Schahfer	14	F	B	487	60-80	
1976 Forecasted Summer Capability						2341
1977 Forecasted Summer Capability						2341
1978 Forecasted Summer Capability						2341
Bailly	N-1	N	B	645	65-80	
1979 Forecasted Summer Capability						2986
R. M. Schahfer	15	F	B	528	60-80	
1980 Forecasted Summer Capability						3514
1981 Forecasted Summer Capability						3514
Marble Hill	1	N	B	226	70-80	
1982 Forecasted Summer Capability						3740

SEE KEYS AND FOOTNOTES AT END OF TABLE.

Table 8.18. Continued

Station	Unit	Unit Type[a]	Service Type[b]	Capacity (MW)	Estimate of Capacity Factor Range (%)	Annual Totals (MW)
1983 Forecasted Summer Capability						3740
Marble Hill	2	N	B	226	70-80	
1984 Forecasted Summer Capability						3966
1985 Forecasted Summer Capability						3966
Undesignated				800		
1986 Forecasted Summer Capability						4466
1987 Forecasted Summer Capability						4466
Undesignated				800		
1988 Forecasted Summer Capability						5266
1989 Forecasted Summer Capability						5266

From ER, Table 1.1-5:NIPSCO.

[a]Unit-type code:
F Fossil
N Nuclear
H Hydro
GT Gas turbine

[b]Service-type code:
B Base
I Intermediate
P Peaking
RR Run-of-the-river

[c]This is a run-of-the-river hydro plant with an installed capability of 7 MW; however, for capacity planning purposes the firm capability of the plant is taken as 4 MW.

[d]This is a run-of-the-river hydro plant with an installed capability of 9 MW; however, for capacity planning purposes the firm capability of the plant is taken as 6 MW.

Table 8.19. PSI Capacity, Demand, and Reserve

Year	Peak Capacity MW	Peak Demand, MW: PSI Forecast	Peak Demand, MW: St °f Forecast[e]	Reserve: PSI Forecast MW	Reserve: PSI Forecast %	Reserve: Staff Forecast MW	Reserve: Staff Forecast %
1970	2597	2372		225	9.5		
	3177	2514		663	26.4		
	3177	2750					
	3185	2706					
1975	3681	2873		808	28.1		
	4329	3150	3045	1179	37.4	1284	42.2
	4327	3405	3228	924	27.1	1099	34.0
	4975	3675	3422	1300	35.3	1553	45.4
	5625	3960	3627	1665	42.0	1998	55.1
1980	5625	4260	3845	1365	32.0	1780	46.3
	5625	4570	4075	1055	23.1	1550	38.0
	5625+735[a]+79	4895	4320	730+814	14.9+16.6	1305+814	30.2+18.8
	5625+735[a]+79+49[d]	5260[c]	4579	414+814	7.9+15.5	1095+814	23.9+17.8
	5674+735[a]+735[b]+79+79	5690[c]	4854	-16+814+814	-0.3+14.3+14.3	820+814+814	16.9+16.8+16.8
1985	5674+735[a]+735[b]+158	6155[c]	5145	-481+814+814	-7.8+13.2+13.2	529+814+814	10.3+15.8+15.8

[a] PSI expects to use 735 MW and Wabash Valley 79 MW, for a total of 814 MW of the capacity of Marble Hill I.

[b] PSI expects to use 735 MW and Wabash Valley 79 MW, for a total of 814 MW of the capacity of Marble Hill II.

[c] Winter (February) peak predicted by applicant.

[d] Seasonal uprating was 49 MW.

[e] Summer peak, calculated at 6.0% per year growth from 2873 MW in summer of 1975.

Table 8.20. NIPSCO Capacity, Demand, and Reserve

Year	Peak Capacity, MW	Peak Demand, MW		Reserve			
				NIPSCO Forecast		Staff Forecast	
		NIPSCO Forecast	Staff Forecast	MW	%	MW	%
1970	1786	1524		262	17.2		
	1986	1650		336	20.4		
	2076	1787		289	16.2		
	2544	1872		672	35.9		
1975	2544	1884		660	35.0		
	3031	2120	1997	911	43.0	1034	52
	2831	2250	2117	581	25.8	714	34
	2831	2385	2243	446	18.7	588	21
	3386[a]	2525	2379	861	34.1	1007	42
1980	3714[b]	2680	2521	1034	38.6	1193	47
	3714[b]	2840	2672	874	30.8	1042	39
	3714[b]	3010	2833	704	23.4	831	31
	3714[b]+226[c]	3190	3003	524+226	164+7.1	711+226	24+7.5
	3714[b]+226[c]+226[d]	3380	3183	334+226+226	9.9+6.7+6.7	531+226+226	17+7+7
1985	3914+226[c]+226[d]	3580	3374	334+226+226	9.3+6.3+6.3	540+226+226	16+7+7

[a]Represents Bailly Plant. Completion date depends on pending litigation.

[b]At present NIPSCO plans to buy 200 MW of capacity during this year from I&M. NIPSCO could purchase up to 400 MW. This decision must be made four years in advance.

[c]NIPSCO expects to use 226 MW of the capacity of Marble Hill 1.

[d]NIPSCO expects to use 226 MW of the capacity of Marble Hill 2.

Table 8.21 PSI s Baseload Capacity and Average System Demand

	Baseload[a] Capacity MW	Average System[b] Demand (MWH/H) PSI Fore-cast	Staff's Upper Estimate[h]	Staff's Lower Estimate[i]	Average[c] Purchase (Sale) Demand, MW	Ratio of Capacity to Demand PSI Fore-cast	Staff Upper Estimate[h]	Staff Lower Estimate[i]
1970	1497	1414	1414	1414	94	1.06	1.06	1.06
1971	1997	1478	1478	1478	60	1.35	1.35	1.35
1972	2493	1578	1578	1578	(26)	1.58	1.58	1.58
1973	2493	1670	1670	1670	(40)	1.49	1.49	1.49
1974	2493	1720	1720	1720	56	1.45	1.45	1.45
1975	3143	1847	1847	1847		1.70	1.70	1.70
1976	3793	2048[d]	1967	1939		1.85	1.93	1.96
1977	3793	2221[d]	2095	2036		1.71	1.81	1.86
1978	4443	2414[d]	2231	2138		1.84	1.99	2.08
1979	5093	2631[d]	2376	2245		1.94	2.14	2.27
1980	5093	2781[d]	2530	2357		1.83	2.01	2.16
1981	5093	2979[d]	2695	2475		1.71	1.89	2.06
1982	5093 + 735	3233[d]	2870	2599		1.80 1.58[e]	2.03 1.77[e]	2.24 1.97[e]
1983	5093 + 735	3502[d]	3057	2729		1.66 1.45[e]	1.91 1.67[e]	2.14 1.87[e]
1984	5093 + 735 + 735	3786[d]	3255	2865		1.73 1.54[f] 1.35[g]	2.02 1.79[f] 1.56[g]	2.29 2.03[f] 1.78[g]
1985	5093 + 735 + 735	4081[d]	3467	3009		1.61 1.43[f] 1.25[g]	1.89 1.68[f] 1.47[g]	2.18 1.94[f] 1.69[g]
1986	5093 + 735 + 735	4399[d]	3692	3159		1.49 1.32[f] 1.16[g]	1.78 1.58[f] 1.38[g]	2.08 1.84[f] 1.61[g]

[a]See Table 8.17.

[b]The quantity is obtained by dividing the Annual System Energy (see Table 8.1) by the number of hours in the year.

[c]The quantity is obtained by dividing the Purchased Energy (see Table 8.1) by the number of hours in the year.

[d]PSI's forecast (see Table 8.1).

[e]Without Marble Hill Station 1.

[f]With Marble Hill Station Unit 1 but without Unit 2.

[g]Without either Marble Hill Station Unit 1 or Unit 2.

[h]6.5% growth rate.

[i]5.0% growth rate.

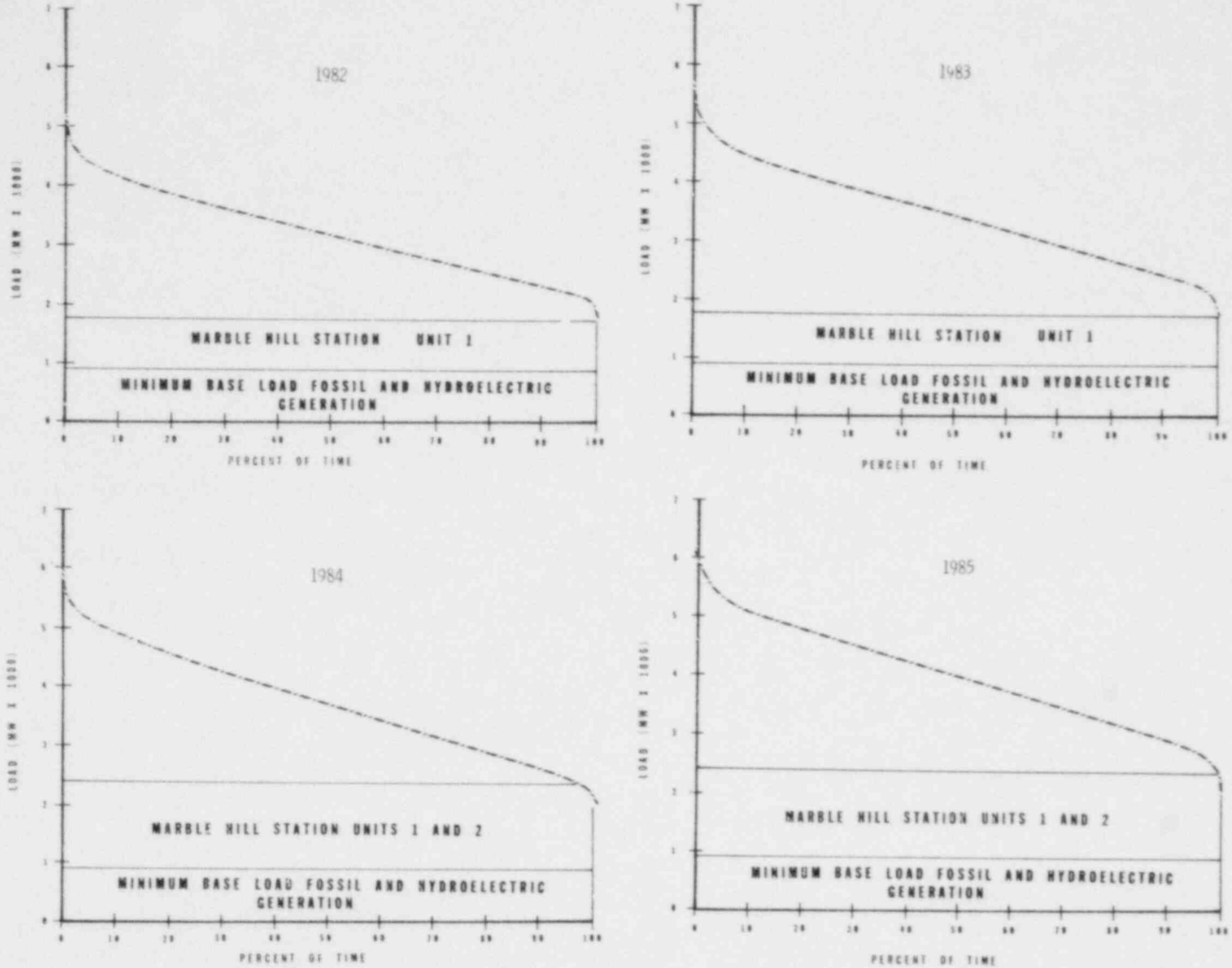

Fig. 8.9. PSI's Projected Load Duration Curves (1982-1985). From ER, Figs. 1.3-1 through -4: PSI.

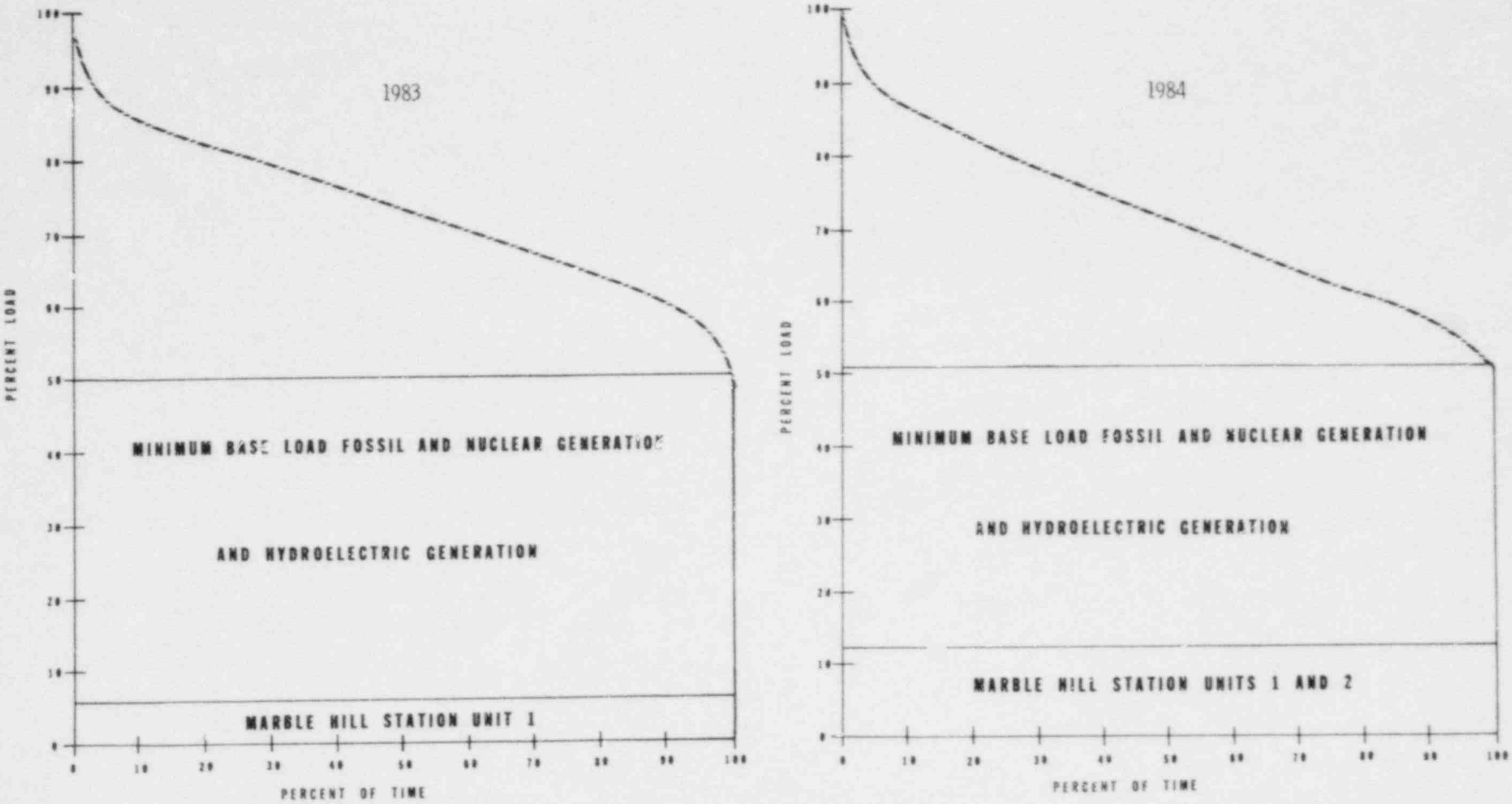

Fig. 8.10. NIPSCO's Projected Load Duration Curves (1983-1984). From ER, Figs. 1.3-1 and -2: NIPSCO

Table 8.22. ECAR Capacity, Load, and Reserve Forecasts

Year	Capacity (MW)		Native Peak Load (MW)		Available Reserve (% of Native Peak)	
	1975	1974	1975	1974	1975	1974
1975	76,641	77,825	55,143	59,392	44.4	36.7
	80,943	84,067	59,782	64,559	27.5	23.9
	83,147	88,753	64,248	68,967	23.9	22.6
	86,650	93,809	68,678	73,575	20.9	22.0
	92,392	103,327	73,117	78,397	20.3	26.1
1980	96,544	108,535	77,774	83,724	20.2	26.5
	102,000	116,066	82,684	89,180	19.6	25.9
	106,334	123,659	87,774	94,936	17.5	26.4
	109,987	132,869	93,063	101,100	14.7	25.7
1985	123,700		105,200			
	132,400		111,500			

The staff regards the 1975 forecast of future capacity as the most reliable column in the table because increases in capacity can only occur as the result of efforts that have begun far in advance of the projected operations date. The data in this column may, of course, overestimate future capacity because of the possibility of unforeseen outages. The staff regards the 1975 forecast for native peak load as reasonable. The available reserve is estimated from expected seasonal capacity, native peak, and sales outside of ECAR. Without the Marble Hill Station, the 1983 reserve is expected to be 13.6% of the ECAR peak. Thus, if the utilities' projections of demand are correct, and if the Marble Hill Station is not in service by 1983, it is still possible that the demand in their service areas could be satisfied by capacity in ECAR.

8.4 CONCLUSION

On the basis of expected growth rates in the range of 5.0 to 6.5% per year in peak and energy demands, the staff expects the capacity of Marble Hill Unit 1 to be needed no sooner than 1984 and that of Unit 2 no sooner than 1986. The times of need would be delayed about another two years if the growth rate were 5.0% per year. PSI's projection, based on growth rates of 7.1% per year for the summer peak and 8.2% per year for the winter peak, resulted in the need for Unit 1 in the summer of 1982 and Unit 2 in 1984. While the staff believes the probability is small that the units will be needed as soon as they are scheduled for completion by the applicant, it recognizes that factors beyond those considered in the foregoing analysis may influence the time of need. For example, NIPSCO could reduce planned purchases of power, thereby increasing the requirement for owned capacity. A local economic boom of greater than estimated proportions would also advance the date of need for new generating capacity. Nevertheless, according to present staff estimates of the growth of population and economic activity in the Indiana service area, it is improbable that Marble Hill Unit 1 will be needed before 1984 and Unit 2 before 1986.

References

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9. ALTERNATIVES

9.1 ENERGY SOURCES

9.1.1 Alternatives Not Requiring New Generating Capacity

In the previous section on need for power, it was shown that projected demand would exceed generating capacity without the Marble Hill station in the mid 1980s in the service areas of PSI and NIPSCO. Strategies such as energy conservation, efficiency increases, substitution of other fuels and peakload pricing would not suffice to meet this demand. The staff's review of the anticipated generating capabilities and projected demands of neighboring utilities indicates that power purchases of the required magnitude for long-term periods cannot be made. Since the companies have no plans to derate a significant amount of existing capacity, no scheme involving delays in derating could help them meet projected demands. Nor do they find it possible to uprate their existing capacity. In short, the staff finds no viable alternative to the construction of new generating capacity to meet the projected demand.

On the basis of the staff's projection, the applicant could delay operations (intended for early 1980's) for a period of several years and/or could increase the time interval between the startup of Units 1 and 2. However, changes in the plans of other utilities or slippage of construction schedules may reduce the projected surplus, whereas the benefit-cost analysis presented below indicates that the net environmental and economic costs of "premature" completion, should that occur, would be small and possibly negative (i.e., a net benefit might result).

The overall environmental costs of construction are somewhat reduced by back-to-back construction as compared to two distinct construction periods separated in time because the total construction period is shortened and because the disruptions associated with the commencement of a large construction project occur once rather than twice. The environmental costs of operation will be virtually nil if the unit is not operated during the assumed period of prematurity. If the unit is operated, it will displace some other generating unit and the reduction in environmental costs of operation for the displaced unit will at least partially compensate for those incurred by the new plant since the latter are relatively small according to the assessment of Section 5. Therefore, the environmental cost is probably small for "premature" construction.

On the economic side, the cost of ownership ("fixed charge rate") is on the order of 15 percent per year for an investor-owned utility. Tending to balance the fixed-charge rate is the price escalation rate. The net economic cost would be further decreased if an export market developed for the plant output.

9.1.2 Alternatives Requiring New Generating Capacity

The staff believes that only nuclear-or coal-fueled power plants are reasonable choices for generating stations being planned at this time. Both types are feasible in Indiana and indeed the applicant has scheduled construction of coal plants for completion prior to that of the proposed Marble Hill Station. Other types of generating plants were considered by the staff but judged to be unsuitable for a commercial plant being undertaken at this time. A brief discussion of the alternatives considered unsuitable is given below.

9.1.2.1 Noncompetitive Sources

Solar and Wind Power

The U. S. Energy Research and Development Administration (ERDA) has initiated a research and development program that may lead to commercialization of several types of generating plants deriving their energy directly from the sun or indirectly from wind or ocean thermal gradients. However, the ERDA plan is expected to achieve a nation-wide level of power production from wind energy by 1985 equivalent to only one or two nuclear units. For the solar alternatives, only small demonstration plants will be achieved prior to 1985.

Solar energy may also be used directly for space heating. In February, 1974, the Indiana Legislature approved a bill that allows owners of real property equipped with a solar energy heating and/or cooling system to exempt up to $2000 of the assessed valuation of their property in computing annual property taxes. However, few solar buildings now appear to be either under construction or in the planning stage, perhaps because alternative fuel sources are still relatively inexpensive and because of the number of heavily overcast days in Indiana.

Natural Gas

Although highly desirable as a fuel from the environmental standpoint, natural gas is now in short supply and will be more so in the future. Accordingly, for reasons of practicality and public interest, new industrial consumption of this valuable fuel should be avoided.

Geothermal

Geothermal resources are classified by the U. S. Geological Survey according to their potential values. Areas are classified as "Known Geothermal Resource Areas" (KGRA's) when " . . . the prospects for extraction of geothermal steam or associated geothermal resources are good enough to warrant expenditures of money for that purpose."[1] The majority of KGRA's in the U. S. are located in 14 western states.[1] None is recognized in Indiana. Studies of heat flow in the Midwest indicate that normal heat flow values generally prevail and no areas of abnormally high heat flow have been documented.

Petroleum Liquids

In view of the uncertain supply of imported oil (over one-third of U. S. consumption), and the importance of petroleum as motor-vehicle fuel and as petrochemical feedstock, it is in the public interest that new industrial uses be avoided.

Advanced Nuclear Sources

Two advanced nuclear energy sources are the breeder reactor and the controlled thermonuclear reactor. Scientific feasibility of the latter has not yet been demonstrated. A demonstration breeder reactor plant is now in the design stage but more than a decade will be required to construct and operate the breeder to demonstrate commercial feasibility. Therefore, a breeder reactor is not a practical source for commercial power needed in the 1980's.

Hydroelectric Power

PSI has a hydroelectric plant, Markland, of 55 MWe firm capacity (81 MWe maximum) on the Ohio River. NIPSCO has two small hydroelectric plants. One, Norway, has a firm capacity of 4 MWe (7 MWe maximum) and the other, Oakdale, has a firm capacity of 6 MWe (9 MWe maximum). An April 1967 FPC survey of the ECAR utilities found about 4600 MWe of potential capacity distributed over 60 sites in the region. Development of most of the sites was deemed uneconomical at the time. The staff believes that, at present, there are ten undeveloped hydro sites along the Ohio whose total potential capacity is about 290 MWe. There does not appear to be sufficient undeveloped hydroelectric capacity near the service areas to merit further study.

Municipal Solid Wastes

The burning of municipal wastes (mixed with coal) as a power-plant fuel has been demonstrated successfully and several utilities are now undertaking programs to exploit this fuel. The staff considers this fuel as a supplement to coal rather than a distinct alternative.

9.1.2.2 Competitive Sources

Staff estimates of the comparative economic costs are presented in Table 9.1. The cost comparison favors the nuclear plant by a small margin.

Capital cost estimates for low sulfur and medium sulfur plants are adjusted from the basic coal cost estimates. For low sulfur coal, costs are increased because the low sulfur coal is generally associated with low BTU content. This characteristic requires a larger boiler, larger coal yards, higher capacity coal handling equipment and other related changes.

Table 9.1. Comparative Economics Costs for 2300 MWe Coal and Nuclear Plants (in millions of 1983 dolla-, except as noted).

	Coal		
	Low Sulfur	Medium Sulfur	Nuclear
Plant Construction			
Total cost at completion[a]	1243	1360	1670
Annualized	131	132.4	162.6
Plant Operation and Maintenance			
Present Value[a]	213	426	213
Annualized	20.7	41.4	20.7
Decommissioning[b]			
Present value[a]	0	0	38
Annualized	0	0	3.7
Total Fixed Costs			
Present valuea	1456	1786	1921
Annualized	141.7	173.8	187
Fixed Costs (mill/KWh) at Capacity Factor			
0.5	14.1	17.3	18.6
0.6	11.7	14.4	15.4
0.7	10.0	12.3	13.2
Fuel Cost[c] (mill/KWh)	15.6	9.7	7.8
Total Generating Cost (mill/KWh) at Capacity Factor			
0.5	29.7	27.0	25.9
0.6	27.3	24.1	23.2
0.7	25.6	22.0	21.0

Construction-cost estimates are based on CONCEPT-IV, a cost account system and computer program (See Appendix I) maintained by Oak Ridge National Laboratory. CONCEPT-IV corrects the orginal estimates for historical and assumed future escalation, and for interest cost during construction. For Marble Hill, a 30-year plant life and a 9% interest rate were assumed.

[a]Calculated for July 1983 idway between the applicant's estimates for commercial operation dates for the two units.

[b]See Section 10.2.4 for a fuller discussion of decommissioning. The table entry ($38 million) is obtained by escalating the $70 million estimate of Section 10.2.4 for Type I (most expensive) decommissioning for 37 years at 5% to estimate the current-dollar cost in the year 2013, followed by discounting for 30 years back to 1983 at 9%.

[c]Coal cost estimates reflect 1975 estimates of 10.6 mill/KWh (low sulfur) and 6.2 mill/KWh (medium sulfur) escalated to 1983 at 5% annually.

Medium sulfur coal requires the installation of flue-gas desulfurization (FGD) equipment. This is a developing technology with uncertainty surrounding the reliability of the technology. Cost estimates are largely based upon engineering estimates rather than actual operating experience.

The medium-sulfur coal cost estimate is based on 1975 costs of 2.7 percent sulfur, 10,405 BTU/lb, Illinois coal used by Indiana utilities, as reported to the Federal Power Commission. The low-sulfur coal estimate is based on the applicant's estimate of the delivered price at which 1 percent sulfur coal could have been purchased in 1975 (none was actually purchased by the applicant). According to FPC data, the prices paid by other Indiana utilities for coal in 1975 varied widely. Substantial purchases were made at 15.83 mill/KWh for 1.0% sulfur coal, 10.19 mill/KWh for 1.4% sulfur coal and 8.70 mill/KWh for 0.4% sulfur coal.

Nuclear fuel costs are developed from ERDA sources on the various components of the fuel cycle. Uranium prices are based upon the consideration of the resource requirements for all lightwater reactors in operation, being built and planned; and on consideration of the cost of supplying the requirements to users. There are now about 237,000 MW of LWR capacity operable, under construction, and planned. Under the "worst case" assumptions used here (that is, no fuel recycle and 0.3 percent U-235 enrichment tails) a total of 1.5 million tons of U_3O_8 will be needed. Of this amount, 1.2 million tons can be supplied at a cost of \$15 or less per pound in 1975 dollars. The remainder would be available at costs somewhat above \$15 per pound. Including a return on investment results in a market cost of approximately \$19.00 per lb. of U_3O_8. To cover the eventuality that market development would not be based strictly on costs of production, the staff added about 25 percent to production costs.

Other fuel costs were developed as follows. Enrichment costs were estimated at \$75 per separative work unit (SWU) in 1975 dollars, even though current charges by ERDA are about \$60 per SWU. The \$75 is considered to approximate full cost recovery for a private operation. Fabrication and conversion costs are estimated by ERDA to be approximately \$100/Kg of uranium, in 1975 dollars. Reprocessing costs are estimated by ERDA to be about \$150/Kg of uranium. Transportation is estimated to cost about \$15/Kg of uranium. Waste management costs are estimated to cost about 0.1 mill per KWh of electricity generated. From these costs is subtracted a credit for plutonium obtained from spent fuel. It is estimated to be valued at \$26/g of plutonium. A carrying charge is added to the above costs based on the value of the prepared but unused fuel carried in inventory.

The staff escalated these figures to 1983 at a rate of slightly less than eight percent per year (eight percent to 1982, and 5 percent thereafter). This results in a fuel cost of 7.8 mill/KWh as shown in Table 9.1.

Since a number of slightly different escalation rates appear in the discussion within this Section and in the CONCEPT assumptions given in Appendix H, clarification may be useful. Interest rates historically have been correlated with the general inflation rate with the nominal interest rate typically 3 to 4% greater than the inflation rate. Thus the 9% discount rate assumed in the present value calculations for Table 9.1 is consistent with an assumed general inflation rate of 5 to 6%. The assumed 5% escalation rate for coal prices is roughly equivalent to the assumption that the price of coal will just keep step with other prices. The staff assumed a somewhat higher near-term escalation rate for uranium as a conservative assumption, in recognition of present uncertainties in the uranium market. The component escalation rates used as CONCEPT inputs are the 15-year regional average rates, based on historical cost indices. The average general inflation rate over the 15 year period was in the range 5 to 6%, so that the CONCEPT input assumptions are consistent with the other assumptions underlying Table 9.1.

The total generating cost is obtained by adding fuel cost to the annualized cost of capital operation and maintenance and decommissioning using a discount-rate of 9%. Estimated environmental costs for the alternative plants are given in Table 9.2. Offsite land use is greater for the coal-fired plant (disturbance of land during mining, fly-ash disposal), but the nuclear plant uses more land at the plant site because of the exclusion area. The freedom from non-radioactive emissions to the atmosphere tends to favor the nuclear plant. The radioactive emissions have been assessed in Section 5.4 as resulting in negligible environmental impact. The greater level of water consumption (as evaporation to the atmosphere) by the nuclear alternative appears of minor consequence in view of the large flow of the Ohio River.

It was previously concluded that the alternatives of no new generating capacity and of using other fuels and energy sources were not feasible choices to provide the required amount of power at the time it would be needed; consequently, the remaining choice was between nuclear and coal fuels. On the basis of the information summarized in Tables 9.1 and 9.2, the staff concludes that the overall economic and environmental costs of the nuclear alternative are no greater than those for the coal-fired alternative. Construction of the proposed nuclear plant is therefore a reasonable choice.

9.2 SITES

9.2.1 Regional Considerations

The PSI service area is divided into northern, southwestern, and southeastern regions (see Fig. 9.1). PSI claims that southwestern Indiana is not as attractive for the siting of a nuclear

Table 9.2. Comparative Environmental Costs for 2260-MWe Coal and Nuclear Plants at Full Output

Impact	Coal	Nuclear
Land Use, acres		
Station proper	∿ 175	∿ 130
Fuel storage	∿ 25	< 1
Waste storage	∿ 500 (offsite)	< 1
Exclusion area	Not required	∿ 350
Release to Air[a]		
Dust, tons/day	25	None
Sulfur dioxide, tons/day	310	None
Nitrogen oxides, tons/day	180	None
Radioactivity, Ci/year	Small	∿ 17,600
Releases to Surface Water		
Chemicals dissolved in blowdown, tons/day	∿ 12	∿ 18
Radioactivity, Ci/year	None	∿ 1,000
Water consumed, millions gal/day	∿ 25	37
Fuel		
Consumed	∿ 28,000 tons/day	∿ 16.5 lb/day[b]
Ash	∿ 2,800 tons/day	∿ 16.5 lb/day[c]
Esthetic	Both require large industrial-type structures and cooling towers. Coal yard, ash pit, tall stack required.	

[a]Coal-fired plant emissions estimated on the basis that the plant just meets applicable EPA standards.

[b]About 8.3 lb/day each of U-235, U-238.

[c]Fission and transmutation products.

power plant as is the southeast; the staff agrees because the seismic risk is less in the southeast than in the southwest, where siting would require increased expenditure to protect against earthquakes.[2] The seismic risk in the northern region is about the same as for the southeastern region; therefore, the southeastern and northern regions are viable alternatives with respect to each other, assuming that adequate makeup water and low population density can be found in the northern region.

The State of Indiana has identified 10 potential sites throughout the state for 2000-MWe fossil-fuel plants.[3] Criteria for selection are that a typical fossil-fuel plant with cooling towers should have a consumptive water use, including blowdown, of about 44 cfs (1.25 m^3/sec) and, together with plants upstream, should not use more than 20% of the 7-day, 10-year low flow, which on this basis would be 220 cfs (6.25 m^3/sec). The staff agrees with these criteria. Because a typical nuclear plant is about 6% less efficient than a typical fossil-fuel plant and all its waste heat is dissipated in cooling water, whereas in a fossil plant one-fifth of the waste heat is dissipated through the stack, a nuclear plant consumes about 1.6 times as much water, or requires a 7-day 10-year low flow of 352 cfs (10.0 m^3/sec). A similar quantity, 322 cfs (9.1 m^3/sec), can be calculated on the basis of the Marble Hill Station's average makeup demand, 64.5 cfs (1.83 m^3/sec) (ER, Table 3.3-2).[4]

In the northern region only the Wabash River starting near Lafayette, where the 7-day, 10-year low flow is 560 cfs (15.9 m^3/sec), has sufficient flow to justify the siting of a nuclear plant.[5,6] The population density near Lafayette is, however, regarded by the applicant as being too high. Midway between Lafayette and Terre Haute the population density differs little from that in Jefferson County, and the 7-day, 10-year low flow is about 700 cfs (20 m^3/sec).[6] A site on this stretch of the Wabash is therefore a possible alternative site. However, there are already 33 coal-fired generating plants on the Wabash and its tributaries, with a total capacity of 5183 MW. The thermal load and consumptive water use therefore, already represent a substantial impact on the river. Because the Ohio River flow is so much larger, the thermal effects and water use impacts would be much less serious. Sites on the Wabash would be more suitable for coal-fired generating plants which volatilize less water and produce less waste heat than a nuclear generating plant, for the same generating capacity. But even for coal-fired plants, the impacts would be more acceptable on a large river like the Ohio.

A further drawback is that the northern location would be close to many of PSI's existing generating plants, and PSI would prefer to disperse more of its generating capacity to the southern part of Indiana. Finally, it may be difficult to find a new site along this stretch of the Wabash that is more than 10 miles from an operating station; the State of Indiana recommends against closer spacing for esthetic reasons.[3] For the reasons given, the staff concludes that a site on the Wabash would not be superior to the proposed Marble Hill site for a large nuclear or coal-fired power generating station.

The staff also considered an alternative site in NIPSCO's service area on the Kankakee River near Dunns in northern Indiana. This site was considered the best alternative for the Bailly Generating Station. The State of Indiana had identified this site as one of several possible sites on the Kankakee River, but also specified that not more than a total of 2,000 MWE of fossil-fueled generating capacity could use the Kankakee River for cooling water. The corresponding limit for a nuclear generating plant, which requires more cooling water, would be about 1,250 MWe. The Kankakee River at this location has an average flow of 1226 cfs and a 10-year 7-day low flow of 250 cfs. At this low flow, the State does not permit any water withdrawal for cooling water. A large reservoir would be required to provide cooling water during dry periods for the maximum allowed generating capacity. The staff believes the State limitations on cooling water use are reasonable.

In any case, this site has been pre-empted by the coal-fired Schahfer generating station. This station has two units of 500 MWe each, one nearly ready for operation and the other under construction. The cooling water limitation would permit only about 600 MWe of additional nuclear capacity on a Kankakee River site. For these reasons, a site on the Kankakee River in Indiana is not a feasible alternative for a nuclear plant generating 2,260 MWe.

9.2.2 Candidate Sites

Twenty-three potential candidate sites in southern Indiana were examined by PSI (ER, Sec. 9.2.5) and ranked in order of attractiveness by means of recommended criteria.[7] The choice was then narrowed to the five top-ranked sites. Three of the five sites are adjacent to the Ohio River and two inland from it. The exact locations of the candidate sites are given in Figure 9.1.

Fig. 9.1. Candidate Regions of the PSI Service Area. Derived from ER, Fig. 9.2-9.

Site B is three miles (5 km) inland from the Ohio River just downstream from Marble Hill, and would require a 3.5-mile (5.6-km) pipeline to supply makeup water. It is situated on flat to gently rolling topography.

Big Graham Creek is 15 miles (24 km) inland from the Ohio River. It would utilize wet mechanical-draft cooling towers, as would Site B, and would require construction of a reservoir that, with a 15-mile (24-km) pipeline from the Ohio River, would supply makeup water.

The Mexico Bottom and Egypt Bottom alternatives are situated on a floodplain on the west bank of the Ohio River. Both would utilize wet mechanical-draft cooling towers. Both are at a low elevation and would require short water lines and minimal pumping.

Marble Hill, the site chosen by the applicant, is described in detail in Section 2. It is located on a bluff about 360 feet (110 m) above the Ohio River on the west bank. A short pipe and moderate pumping would be necessary to supply makeup water. It would utilize wet mechanical-draft cooling towers.

9.2.3 Comparison of Candidate Sites

The costs of cooling water conveyance would be least for the Mexico Bottom and Egypt Bottom sites because they are so close to the river. Marble Hill, because of it- higher elevation above the river, would require more piping and pumping. Site B is somewhat less favorable because it would require a 3.5-mile (5.6-km) water line, and Big Graham Creek would need i 15-mile (24-km) pipeline in addition to the construction of an onsite reservoir. Cost for the pipeline, reservoir-land purchase, and construction of the reservoir raise the cost of Big Graham Creek considerably above that of Marble Hill.

Big Graham Creek, Marble Hill, and Site B have favorable foundation characteristics, because the bedrock is only 5-20 feet (1.5-6 m) below the surface. At Mexico Bottom and Egypt Bottom the bedrock is 150-175 feet (45-53 m) below the surface, and the overlying sandy material has a high potential for liquefaction. Foundation design dictated by seismic characteristics at these two sites would make plant construction costs high compared to Marble Hill.

Mexico Bottom and Egypt Bottom are each accessible by barge or State Route 156. Marble Hill and Site B are accessible by State Route 62 and the Chessie System Railroad. Big Graham Creek is accessible by State Route 7 and the Penn Central. In the latter case, continued railroad operations over the pertinent sections of track are uncertain.

The reasons for some cost differentials have been mentioned above, and they are detailed in Table 9.3. Marble Hill and Site B are the least expensive of the five sites. The additional cost over base for Site B is due to its inland location and the incremental piping and mechanical equipment necessary. Big Graham Creek has the lowest transmission-line cost (see Table 9.3) because it would require the shortest transmission line (see Table 9.4).

Most of the land at the Mexico Bottom and Egypt Bottom sites is agriculturally disturbed and there would be little terrestrial ecological impact (see Table 9.7). The same is true for Marble Hill and Site B except that slope and bluff habitats at Marble Hill that are nonagricultural could be damaged by construction of the pipeline corridor, and 150 acres (0.61 km^2) of hardwood and 40 acres (0.16 km^2) of a mature beech-sweetgum woods would be destroyed at Site B. The impact on aquatic species of all types in the Ohio River would not differ among the above mentioned sites. At Big Graham Creek the bottom lands would be disturbed by the reservoir, and the impoundment would result in a strong shift in the composition of aquatic species.

Although more people would be displaced at Big Graham Creek than at any of the other sites, it is clearly the most favorable in terms of population density within 50 miles (80 km) (see Table 9.5). The densities for the other sites within 50 miles (80 km) include parts or all of Cincinnati or Louisville or both.

Fogging of local roads might cause problems at Mexico Bottom, Egypt Bottom, and Big Graham Creek; otherwise major meteorological problems would not arise at any of the sites.

Table 9.3. Cost Comparison of Alternative Sites (current dollars)

Factors	Sites				
	Marble Hill	Site B	Big Graham Creek	Mexico Bottom	Egypt Bottom
Station differential costs	Base	5,733,000	56,596,000	11,699,000	12,290,000
Transmission-line differential costs	Base	6,720,000	-10,040,000	6,410,000	6,210,000
Other developmental costs (qualitative)	Base	Relatively high due to railroad work and increased mechanical equipment associated with water use	High due to construction of makeup reservoir	High due to foundation problems associated with liquefaction	Same as Mexico Bottom

Summarized from ER, Tables 9.3-1, 9.3-2, 9.3-3.

Mexico Bottom, Egypt Bottom, Marble Hill, and Site B have half or more of their site areas in farmland; the remainder being wooded or pasture. The regional agricultural productivity would not be greatly reduced by locating the station on these sites. Big Graham Creek is the least desirable in terms of land use because the reservoir will use up so much land. Furthermore, Big Graham Creek is a good fishing resource, which would be altered if the station were put there.

All the sites require a survey before their archeological conditions can be compared (see Table 9.5).

In summary, no alternative site has been shown to be superior to Marble Hill. It is 12.5 million dollars less expensive than the next best site (see Table 9.3) and, excluding Big Graham Creek, which is 46.6 million dollars more expensive, Marble Hill requires the minimum transmission-line length of 127 miles (204 km) (see Table 9.4). Mexico Bottom and Egypt Bottom are disadvantageous because of poor foundation characteristics, and Big Graham Creek would use up a great deal of land. Site B, while good, rates second to Marble Hill because 150 acres (60 hectares) of hardwood would be lost, and there would be longer makeup and blowdown lines requiring disturbance of a mature beech-sweetgum forest.

9.3 STATION SYSTEMS

9.3.1 Cooling Systems

The applicant has estimated that heat must be rejected by the plant at a rate of 1.65×10^{10} Btu/hr (4840 MW) when both units are operating at full load. In designing an acceptable method of dissipating heat at this rate, the applicable water quality standards must be considered.

The applicant has considered six heat-dissipation systems in addition to the wet mechanical-draft cooling towers (MDCT) selected. These are: (1) once-through cooling (OTC), (2) natural-draft wet cooling towers (NDCT), (3) wet/dry mechanical-draft cooling towers (W/D), (4) cooling ponds (CP), (5) spray canals (SC), and (6) dry cooling towers (DCT). The applicant has based his selection on the lower costs of MDCTs and the expressed belief that the environmental impacts of this system will be low and acceptable. The staff has considered in addition to the alternatives above, fan-assisted natural-draft (FANDCT) and circular mechanical-draft cooling towers (CMDCT).

The primary process for heat transfer from the circulating water to the atmosphere in wet cooling systems is evaporation. New water must be continuously added to circulating water to replace that lost by evaporation, blowdown, leaks, and drift. The use of evaporative cooling thus does not eliminate the need for a reliable source of water and an intake structure; when compared to OTCs, it reduces but does not eliminate the environmental impacts of water intake and thermal and chemical effects of blowdown. Closed-cycle cooling systems do not eliminate thermal pollution

Table 9.4. Engineering Comparison of Alternative Sites

Factors	Sites				
	Marble Hill	Site B	Big Graham Creek	Mexico Bottom	Egypt Bottom
Transmission-line length (miles)	127	141	86	142	142
Rail access	Baltimore & Ohio, if not abandoned, 11 miles	Baltimore & Ohio, if not abandoned, 7 miles	Penn Central, if not abandoned, 0.5 mile	No railroads nearby	No railroads nearby
Barge access	Not economical because of bluff location	3 miles inland from Ohio River	15 miles inland from Ohio River	Ohio River	Ohio River
Water availability	Good	Acceptable but 3 miles NW of Ohio River	Unfavorable because water would be from impoundment of Big Graham Creek and 15 miles of piped water from Ohio River	Good	Good
Foundation conditions	Good	Good	Good	Liquefaction conditions would necessitate hydroconsolidation to render site usable	Same as Mexico Bottom
Seismic conditions	Good	Good	Good	Good	Good
Road access	Good	Good	Slightly unfavorable	Very good	Very good

Summarized from ER, Table 9.3-3.

Table 9.5. Environmental Comparison of Alternative Sites

Factors	Sites				
	Marble Hill	Site B	Big Graham Creek	Mexico Bottom	Egypt Bottom
Estimated population 1990, 0-50 miles	1,504,394	1,466,589	1,001,741	2,023,006	1,944,000
Land use	987 acres 50% cropland 50% wooded or pasture	940 acres 40% cleared 60% forested	11,000 acres Residential and agricultural	1000 acres Cropland and pasture	1150 acres 90% cropland and pasture
Meteorology	No major fogging problems	Some fogging but none on major highways	Possible fogging on Route 7 and the Penn RR	Fogging on Route 156	Fogging on Route 42/127
Ecology	Ecologically desirable slope and bluff habitats disturbed by construction	Loss of 150 acres of hardwood and 40 acres of beech-sweet gum	Loss of stream fish, lowland and slope vegetation, and masked shrew	Already agriculturally disturbed	Same as Mexico Bottom
Recreational lands	Nearby but not on site	None nearby or on site	Elimination of some fishing, camping, and swimming	Same as Marble Hill	Same as Marble Hill
Historic sites	An old cemetery is on site, but would not be disturbed during construction	None on or near site	Several old churches and cemeteries are on site	None on or near site	An old church and cemetery are on site
Archeology	Archeological areas may be disturbed.	No information-would require surveying.	No information-would require surveying.	No information-would require surveying.	No information-would require surveying.

problems; they transfer the primary impact from the hydrosphere to the atmosphere. Because such systems transfer large amounts of heat and water vapor (except for DCTs) to the atmosphere from small areas, they have a greater theoretical potential to create undesirable atmospheric effects than does a OTC system.

9.3.1.1 Once-Through Cooling

In OTC systems water is drawn from a water body, circulated through the steam condenser where its temperature is raised (about 30°F or 17°C), and discharged directly into the same water body. The applicant estimates that about 1.2×10^6 gpm (4500 m^3/min) of water would be needed to cool the two units, with a resulting temperature rise across the condensers of 28°F (16°C) (ER, Sec. 10.1.1.3). This amount of water is available from the Ohio River, but pumping this quantity of water up 340 feet (about 100 m) to the station site would require considerable power, making this option more expensive than evaporative cooling towers, if the reactors remained on the bluff. If the two power units were moved down to the river (and provided with adequate protection from flooding), OTC would probably be an economically viable cooling system.

The applicant has made an analysis of river cooling (ER, p. 10.1-2 and Fig. 10.1-1); two 553-foot (169-m) long diffusers would be used to distribute heated water to the river. The applicant has rejected this mode of heat transfer for two reasons: the power required to lift the cooling water and problems associated with licensing of OTC. This means of cooling cannot be used unless a variance under Section 316(a) of the Federal Water Pollution Control Act Amendments of 1972 is obtained. The staff does not have sufficient information on the aquatic life in the McAlpine Pool to render a judgment as to whether a 316(a) demonstration can be successfully made. The limited data available, such as the low population density along the riverbanks and lack of commercial fishing in this area, suggest that such a demonstration might be successful. In any event, the monitoring program required to prove lack of damage to the biota of the river would require considerable time.

OTC systems have many advantages over closed-cycle cooling systems, such as lower costs of construction and operation at most sites, higher thermal efficiencies due to lower condenser temperatures, a much smaller visual impact, and negligible atmospheric impacts. Offsetting these are more serious impacts on aquatic biota and a slight increase in the frequency and density of steam fog over the discharge thermal plume. The staff considers that OTC might be a tenable alternative, subject to the results of a detailed cost-benefit comparison, but does not appear environmentally superior.

9.3.1.2 Natural-Draft Cooling Towers

Two large NDCTs, one for each unit, could be used to cool the station; each tower would be about 500 feet (150 m) tall with a base diameter of about 400 feet (120 m). Important advantages of NDCTs when compared with MDCTs are that plant power is not required to move the air and noise levels are relatively low; the discharge height reduces the rate of ground-level drift deposition and eliminates the possibility of fogging and icing.[8-11] Major disadvantages are the relatively high capital cost and the fact that, from an esthetic standpoint, the large structures and their visible plumes tend to dominate the surroundings.

Observations at operating cooling towers in Europe, as well as in the United States, indicate that the primary environmental impacts of NDCTs are the visual impact of the structures and the generation of visible plumes that generally remain aloft.[8,12]

The staff considers the NDCT to be a viable choice for the Marble Hill site, although this type is not preferred to the selected MDCTs because of higher costs (estimated by the applicant to be about $27,500,000 more than that for MDCTs), a greater esthetic impact, and the expected minimal offsite environmental impact of the proposed MDCTs.

9.3.1.3 Wet-Dry Mechanical-Draft Cooling Towers

In this type of tower, a dry-cooling section is added to a conventional MDCT. Various configurations are possible. In a design examined by the applicant, the cooling water passes first through the dry section, then the wet one. Airflow is controlled by louvers, with some of the air passing through the dry section and the rest through the wet one; the two airflows mix inside the tower prior to discharge. The resulting effluent is at a higher temperature and lower humidity than that from a MDCT; hence, the probability of fogging and icing near the plant is reduced but not eliminated. The amount of fog reduction is related to the relative cooling capacity of the dry and wet sections; a large dry section would be required to eliminate fogging potential completely.

Experience with W/Ds is very limited, as only a few cells are now operational. It is expected that such towers would operate as wet-only units in summer, with both the wet and dry sections operating the rest of the year; thus, any savings in water would come in winter. W/Ds would be larger in size and more costly to build and operate than either MDCTs or NDCTs; the applicant's analysis indicates the W/Ds would add about $70,000,000 to the cost of the station. The staff's analysis of fogging from MDCTs does not indicate a fog problem sufficient to justify the higher costs of wet-dry cooling.

9.3.1.4 Fan-Assisted Natural-Draft Cooling Towers

The FANDCT is a relatively new concept. In such towers, fans are used to augment the airflow through the tower and fill. While no FANDCTs are in use or are under construction in this country, a few are in use in Europe. Two such towers, each 268 feet (81.7 m) tall, are used to cool the 1200-MWe Biblis-A nuclear power plant in Germany.[13]

A variety of FANDCT designs exist, including both cross-flow and counter-flow arrangements. In some plants, multiple fans can be turned off on all but the warmest days, and the unit operates as a NDCT. In others, the fans are used at all times for additive cooling capacity for a given-size cooling tower. For example, in a typical English fossil-fired power plant, eight NDCTs (each about 374 ft or 114 m tall with a base diameter of 302 ft or 92.0 m) are used to cool a 2000-MWe power complex.[8] The bulk of these towers and their visible plumes have created an esthetic impact. In an effort to reduce this impact, a single FANDCT is now being built at the 1000-MWe fossil-fired Ince "B" power plant in England;[14,15] this tower will be able to do the cooling of the four NDCTs it will replace. In this design, the fill will be outside the shell in a typical cross-flow arrangement in a circle 564 feet (172 m) across; 35 fans will provide the necessary airflow.

The staff considers the FANDCT to be a viable cooling system from an engineering standpoint, but a less desirable choice than either MDCTs or NDCTs, due to expected higher costs and no environmental advantages.

9.3.1.5 Circular Mechanical-Draft Cooling Towers

A variety of CMDCTs exist. One design uses one very large fan (up to 85 ft or 26 m in diameter) to pull air through fill similar to that in standard MDCTs. A large number of towers of this type are now in use in Europe, with fossil unit sizes of up to 300 MWe per tower. Because of their tall stacks (up to 170 ft or 52 m), some of the force pulling air through the tower results from the natural-draft effect; this type is sometimes called a fan-assisted tower.

Another design concept for a CMDCT is to place the individual cells of the standard MDCT type into a circular array, and to place the fans on the roof above the circular space inside the fill sections. One CMDCT is now in operation in the United States, a 13-fan unit at a 500-MWe fossil-fired plant in Mississippi.[16] This tower became operational in March 1975, so experience with such towers is limited. A drift rate of 0.005% is possible with this unit.

The primary advantage of CMDCTs over the standard MDCT layout is the better aerodynamic characteristics of the rounded structure, which reduces downwash (and thereby fogging and icing) and recirculation.[17] In addition, the concentration of the heated effluents will increase plume rise. Because these towers have better aerodynamic properties and combine the heat output of many cells of a conventional MDCT into one plume, the frequency of ground-level fogging will be somewhat reduced from that of pure MDCTs.

The staff considers the CMDCT to be a technically and economically viable cooling option for the Marble Hill Station, despite the lack of data at operating units to validate computer and wind-tunnel model results.

9.3.1.6 Cooling Ponds

The CP is a proven, effective, and eco. mical heat sink in areas where sufficient level land can be purchased at reasonable (farmland) cc t. Area requirements for dissipation of waste heat via surface effects from a CP are of the ord of 1 to 1.5 acres (4000 to 6000 m^2) per MWe.[18] On this basis an impoundment covering abou. 2300 to 3500 acres (930 to 1400 hectares) would be required. dditional land is required in order to eliminate the effects of steam fogs to offsite roads, buildings, etc.; a buffer zone of 1500 feet (450 m) would be satisfactory.

Because of the lack of sufficient flat land at the site, the staff does not consider a CP to be a viable cooling option for the Marble Hill Station.

9.3.1.7 Spray Canals

The size of a CP can be made much smaller by the use of sprays, by a factor of up to 20.[18] However, as with CPs, a buffer zone of about 1000 to 1500 feet (300 to 450 m) would be needed to confine fogging and drift effects to the site. Heat dissipation to the atmosphere using SCs is effected primarily through evaporation and conduction. In order to maximize cooling by reducing recirculation of air between sprays, the spray modules should be placed in a long, meandering canal;[19] this requires a large and relatively flat area.

A SC cooling system could be placed on the Marble Hill site (ER, p. 10.1-4a and Fig. 10.1-5) with the purchase of 109 extra acres (44 hectares) of land. The applicant estimates that an 82-acre (33 hectare) canal, about 7200 feet (2200 m) long and 260 feet (79 m) wide containing 516 float spray modules, would be required.

The primary atmospheric effects of SCs are fog and drift.[20] Due to the larger area of contact between air and hot water, SC cooling systems have a somewhat lower potential to cause ground-level fog than MDCTs. The drift rate from a SC will depend on several factors such as wind speed and the design of the spray units; inasmuch as there are no drift eliminators, drift rates can be quite high with strong winds. However, the low height of release, low vertical velocity of the drops in the spray, and large drop size would combine to cause most of the drift to fall to the ground within a few hundred feet.[21,22]

In contrast with cooling towers and CPs, both of which have been used for decades, there has been little operating experience with large SC cooling systems, especially in winter, the season of greatest interest. Experience at a power plant with a SC in northern Illinois indicates no serious fogging or other environmental problems after three seasons of operation.[23] Experience with SCs in Michigan[21,22] is similar. As with CPs, the fogging and icing effects decrease rapidly with distance. Hoffman[22] concludes that a distance of 600 feet (180 m) from the SC to public roads and switchyards is sufficient to prevent hazardous conditions. From the limited experience to date, it is reasonable to expect that SC cooling systems will create more severe icing conditions very near the SC during winter than MDCTs and CPs, with drift being the primary cause of the difference.

Quantitative estimates of fog and icing potentials from SCs are not possible, in part because properties of the air (temperature, liquid water content, drop size distribution, etc.) downwind of spray units are unknown functions of ambient weather conditions (wind speed, air temperature, humidity, stability), water temperature, and characteristics of the spray heads (nozzle opening, number of sprays, drop sizes, and their location with respect to the wind direction, etc.). For most wind conditions, the air will be in contact with the water from the spray for a shorter period than it would be in a cooling tower; thus, a larger volume of air will be modified while cooling a given plant load. Sprays are noisier than cooling ponds, because of the pumps, falling water, and lack of baffling.

The staff agrees with the applicant that, though spray cooling could be utilized, the design MDCTs are preferable, both environmentally and economically.

9.3.1.8 Dry Cooling Towers

DCTs remove heat from a circulating fluid through conduction to air being circulated past heat exchanger tubes. Because of poor heat-transfer properties of the metal-to-air interface, the tubes in a DCT are generally finned to increase the heat-transfer area. The theoretically lowest temperature that a DCT system can achieve is the dry-bulb temperature of the air. The dry-bulb temperature is always higher than (or equal to) the wet-bulb temperature, which is the theoretically lowest temperature that a wet-cooling system can achieve. As a result of the use of DCTs, turbine back pressures will be increased, as will the range of back pressures over which the turbines must operate; this, in turn, will result in a reduced station capability for a given reactor size.

The major advantage of a DCT system is its ability to function without large quantities of cooling water. Theoretically, this allows power-plant siting without consideration of water availability, and eliminates thermal/chemical pollution of blowdown. In practice, some makeup water will always be required, so that power-plant siting cannot be completely independent of water availability. From an environmental and cost/benefit standpoint, DCTs can permit optimum siting with respect to environmental, safety, and load distribution criteria without fogging or dependence on a supply of cooling water. When considered as a direct alternative to wet-cooling systems, the advantages of DCTs include elimination of drift, fogging and icing problems, and blowdown disposal.

The principal disadvantage of DCTs is economic: for a given reactor size, plant capacity can be expected to decrease by about 5% to 15%, depending on ambient temperatures and assuming an optimized turbine design.[24] Bus-bar energy costs are expected to be on the order of 20% more than a OTC system and 15% more than a wet-cooling system, assuming 1980 operation.[24] Environmentally, the effects of heat releases from DCTs have not yet been quantified; some air pollution problems may be encountered; noise generation problems for mechanical-draft DCTs will be more severe than those of wet-cooling towers; and the esthetic impact of dry natural-draft towers (which would be much taller than equivalent wet NDCTs) will remain despite the absence of visible plumes. DCTs now being used for European and African fossil-fired plants are limited to those in the 200-MW or smaller category in areas with cool climates and winter peak loads; the use of DCTs to meet the much larger cooling requirements of 1000-MW-size nuclear stations with summer peak loads requires new turbine designs to achieve optimum efficiencies at the higher peak pressure and range required of this system.[24,25]

After weighing the overall advantages and disadvantages of DCTs, and particularly when comparing their greater fuel use and the economic penalty associated with their use with the acceptable environmental impact of the proposed cooling system, the staff has concluded that DCTs are not a preferred alternative for the Marble Hill Station.

9.3.1.9 Conclusions

The staff considers the NDCT, FANDCT, and CMDCT to be viable alternatives to the MDCT. Each has its advantages and disadvantages in costs and environmental impact. If time for a Title 316(a) demonstration is available, the OTC system could possibly be shown to be another viable option. The staff considers that any of the above closed-cycle cooling systems could be used, but concurs that the applicant has made a reasonable choice in selecting conventional MDCTs.

9.3.2 Intake Structures

Three other intake designs, traveling-band screens, Ranney-well collectors, and perforated pipes, could further reduce or even eliminate entrainment and impingement losses.[26] The traveling-band screens operate according to an internal flow system that allows water to pass through the screens from the inside to the outside. The centerflow design features of these screens would further reduce the linear velocities at the screen surface. Other design features of this type of intake system include semicircular screening baskets and a trough to collect fish washed from the baskets and to return them live to the river. Although fish-impingement losses would be reduced, entrainment losses and shoreline shoaling from silt deposition would be about the same as for the proposed intake unless the intake flume was submerged for most of its length. Neither the staff nor the applicant conducted a detailed cost study of this alternative, but general considerations indicate that the cost differential would be insignificant for the proposed Marble Hill Station.

As pointed out by the applicant (ER, Suppl. 1) the Ranney-well collector system would drastically reduce entrainment, eliminate impingement, and problems of silt deposition. In this system a series of concrete caisson wells are built onshore and slotted pipes extended radially into sand and gravel aquifers beneath the riverbed. Filtered water is collected in the wells and pumped out as needed; pumping lowers the water table and induces infiltration of surface water through the riverbed to the wells. It is possible, although unlikely, that drawdown of surface waters may expose fish spawning grounds along the shores; in addition, there would be a visual impact from the number of wells required. The technical feasibility of this alternative depends on such factors as the permeability, capacity, and rechargeability of the aquifier; these would have to be evaluated by a detailed pump-test program. General cost considerations indicate that such a program (and the installation of Ranney collectors, were the tests affirmative) may not be as economically feasible as the other alternatives discussed here.

The perforated pipe intake (comparable to the fixed slotted screen alternative discussed by the applicant in Suppl. 1) is comprised of an inner and outer perforated sleeve and is generally located just off the river bottom parallel to the water flow. The design used by the Washington Public Power Supply System (Units 1 and 4)[27] has an outer sleeve 42 inches in diameter with 3/8-inch slits covering 33% of its area, and an inner sleeve 36 inches in diameter with 3/4-inch slits covering 7% of its area. One 36-inch pipeline, for each station unit, supplies intake water to a pumphouse located onshore. The intake velocities 3/4 of an inch from the surface of the perforated pipe have been estimated to be about 0.4 fps. These low velocities plus location of the intake structure parallel to the water flow help minimize impingement. In the Ohio River the water velocity past the perforated pipe surface will substantially exceed the intake velocity which will further reduce impingement. The two 36-inch pipelines for delivering water to the pumphouse could be buried thus avoiding problems of silt deposition described in Section 5.3.2. A length comparable to that of the proposed intake flume (120 ft from the shoreline at a water level of 420 ft MSL) should also minimize entrainment since the perforated pipe could be located away from the productive underwater terrace and yet would not be far enough offshore to entrain the ichthyoplankton that is concentrated in the deeper offshore waters (ER, Tables 2.7-94 and 2.7-95). The main disadvantage of this type of intake is the filling up of the slits with debris and biological growth. During periods of high water velocities (winter and early spring), when debris concentrations are high, scouring should prevent clogging of the slits. If, at times, filling in does occur, backwashing is possible.

Another possible alternative would be lowering of the proposed intake-flume within 50 or 100 feet of the shoreline to several feet below the 420 foot normal level. The covering screen would be replaced by a solid cover for the lowered section. This would avoid the problem of diverting inshore waters past the intake opening and also avoid problems of silt deposition.

The staff believes that any of the above intake structures, and other offshore intake designs that allow for the unimpeded flow of inshore waters, are biologically more acceptable than the proposed structure and some could be utilized with little or no economic penalty. It is for this reason that the staff recommends that the proposed intake structure be redesigned to permit unimpeded flow of inshore waters (Sec. 5.3.2).

9.3.3 Discharge Structures

The applicant has adopted a submerged single-port discharge in place of the shoreline surface discharge originally proposed (ER, Suppl. 4, P. 10.3-1. See also Sections 3.4.3 and 5.3.3). Two advantages of this type of structure are the greater dilution of heated effluent in the vicinity of the source and the avoidance of plume effects on the biologically productive shoreline areas.

Table 9.6. Design Parameters for Submerged Discharges

Parameter	Typical	Applicant's Design
Number of Ports	1	1
Port Diameter	1 ft	1.7 ft
Depth below Water Surface	20 ft	6
Jet Velocity	11.5 ft/sec	8 ft/sec
Angle of Ports above Horizontal	30°	0°
River Velocity	1.3 ft/sec	1.3 ft/sec
Distance from Shore	250 ft	50 ft

The following analysis is based on a submerged single-port jet discharge, with the typical parameters listed in Table 9.6. For comparison, the parameters for the applicant's proposed design are also given. With the empirical formulae provided by Chasse and Winiarski,[28] a characterization of the resulting thermal plume can be obtained. For the month of January under extreme meteorological conditions (a case with one of the largest surface plumes for the proposed discharge) a dilution of about [illegible]2 is obtained at the surface. Thus, the largest surface temperature due to plant operation will be about 2.5°F (1.4°C) above ambient. Figure 9.2 is an approximate representation of the plume for the above case. This estimate is conservative because the plume in actuality will sink when the effluent density is greater than that of the ambient water (water has a maximum density at 39.2°F or 4°C). As indicated previously in this section, the applicant plans to use a submerged single port discharge structure. The applicant's design will release the discharge at six feet below the normal pool level at a velocity of 8 feet per second.

Because a submerged high-velocity discharge would mix the blowdown more rapidly with the ambient waters and thus reduce the size of the thermal plume, the exposure time for aquatic organisms passing through the mixing zone would be reduced. Also, fewer fish would be attracted to the plume because of its smaller size and high discharge velocities. This, in turn, would minimize the probability of aquatic organisms being exposed to lethal temperatures and chemical levels for long periods of time and reduce the potential numbers of fish to be killed by "cold shock" in the event of a sudden unit shutdown.

By locating the discharge offshore (at a distance comparable to that of the intake) the plume would not impinge on the shoreline and impacts to the shallow underwater terrace in this area would be avoided. The thermal plume would be located off the terrace where productivity is less, but would not impact the high concentrations of ichthyoplankton located in the deeper far-offshore waters. Burying the pipeline for most of its length would also prevent the permanent loss of benthic habitat and any silt deposition.

This type of submerged discharge potentially could stress benthic organisms by exposing them to excessive temperatures and scouring. This undesirable effect can be avoided, however, by elevating the distal end of the discharge pipeline and/or directing it at an angle to the bottom. The model calculation described above addressed the latter case.

In recent years, a majority of the proposed steam-electric plants have chosen submerged discharges. One of the principal reasons for the change is that it is generally easier to meet regulatory standards with submerged discharges. The submerged discharge design proposed by the applicant differs from the typical parameters discussed above in [illegible]t discharge velocity is slower, and the depth and distance offshore of the discharge are less. Although the typical design is environmentally preferable to the applicant's design, the difference in the thermal and biotic effects is small, and the staff considers the proposed design acceptable.

9.3.4 Chemical and Biocidal Systems

9.3.4.1 Chemical

Alternatives to the proposed method of disposing of condenser-cooling-system blowdown include those that reduce the volume of blowdown, with the consequence of higher salt concentrations, or eliminate the blowdown completely. The latter system would entail the disposal of dissolved and suspended materials as an evaporated sludge. In the selected system, about 12% of the total intake water is returned as blowdown; the alternative systems would return less. Consumptive use of water is determined largely by cooling-tower evaporation and would be unchanged, or increased slightly, by the alternatives.

The amount of blowdown from the Marble Hill Station is determined by the need to avoid the formation of scale in the system. Scale formation can be prevented either by complexing precipitant ions in solution to prevent precipitation, or by adding materials that prevent the formation of adherent scale while allowing precipitation. Generally, the complexing agents (chelating organic compounds or phosphoric acid derivatives) must be used in relatively large (stoichiometric) amounts, and are costly as well as having uncertain environmental effects. Scale inhibitors (organic phosphorous compounds or polyelectrolytes, such as polyacrylic acid)[29,30] are used in much smaller quantities and are considered to be a practical means of control. At most, about half of the blowdown could be eliminated, with a concomitant increase in the amount of suspended solids. The suspended solids and dispersants are considered to be innocuous materials[29] but, in view of the relatively small (about 6%) decrease in water use, the staff regards this alternative as one to be based on economic and engineering grounds rather than environmental ones. The use of lime to remove calcium and magnesium would allow a small decrease in water use, but would be at a considerable capital expense and cause the production of waste sludge.

Zero-blowdown systems involve water treatment, such as softening, use of additives, filtration, and final stages, in which water of high solids content is evaporated to dryness. Capital and

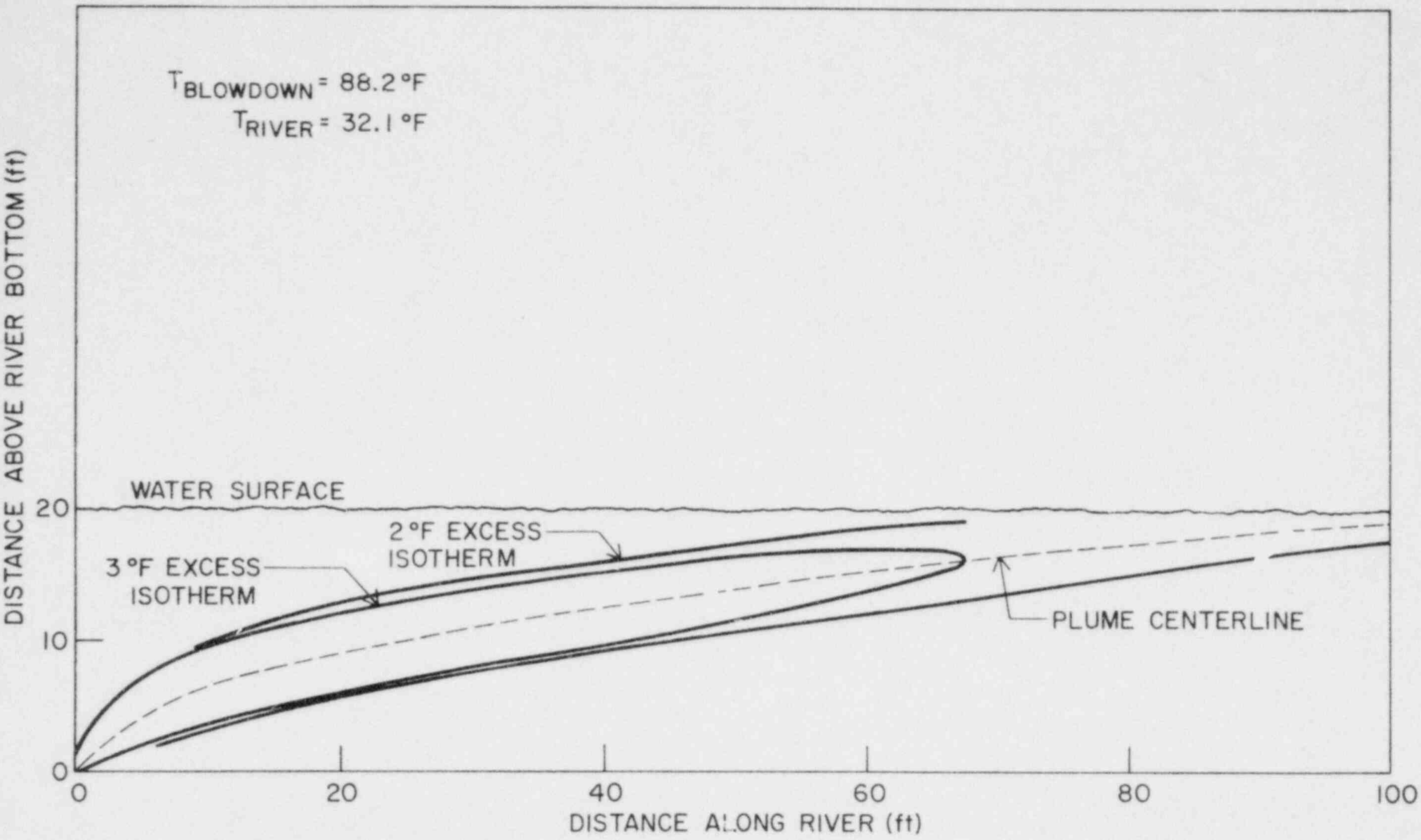

Fig. 9.2. Thermal Plume from a Submerged Single Port for January under Extreme Meteorological and Hydrological Conditions.

operating costs of such systems are high; the staff does not believe that the imposition of such costs is justified in present circumstances. Demineralizer regeneration wastes are similar in composition to blowdown and could be handled by zero-blowdown systems on a much smaller scale. Again the staff does not believe that there are definite environmental benefits, or that the costs are justified by the small gains expected.

In general, the staff believes the selected system is reasonable; there do not appear to be any better alternatives.

9.3.4.2 Biocidal

To control biological growth in heat exchangers and cooling towers, the applicant intends periodically to add sodium hypochlorite solution to these systems. Only one component will be chlorinated at any one time so that its chlorinated discharge will be diluted by the unchlorinated discharges from other components. Blowdown from the treated system will continue during its period of chlorination. The staff believes (see Sec. 5.5) that under this procedure there may be a sufficient number of occasions during which there will be excess chlorine in the discharge, so that the consideration of alternatives is justified. An alternative is to hold up blowdown from the treated system until the chlorine drops to an acceptable level. Other alternatives include additions of agents such as sulphur dioxide or hydrogen peroxide in regulated amounts to react with active chlorine to form harmless products. Dechlorination facilities would require a retention pond, and their annualized costs (about $46,000 per year[32]) would not be justified by the small biotic impact of the chlorine in the small blowdown (9 cfs), which is fairly rapidly mixed with river water by means of the submerged discharge.

Biocides other than sodium hypochlorite, such as elemental chlorine, bromine chloride, and ozone, can be used. Elemental chlorine has essentially the same impacts as sodium hypochlorite, and the choice is largely based on safety, economic and engineering considerations. Bromine chloride is a promising new treatment;[31] however, there is little experience in its use, and it is probably more expensive. At present, the staff regards bromine chloride as a viable option, not necessarily better than sodium hypochlorite.

Ozone is an effective, but very short-lived, biocide that probably would not be effective in the cooling towers or other locations well downstream of the injection point. In view of this defect, and higher costs, the staff currently does not recommend this biocide.

Mechanical methods have been used at a number of plants for condenser cleaning. Such methods, however, cannot be used in cooling towers and some chlorination remains necessary.

The staff concludes that the choice of sodium hypochlorite as a biocide is reasonable.

9.4 TRANSPORTATION

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

9.5 ALTERNATIVE TRANSMISSION LINE ROUTES

The applicant compared seven alternative routings for the Rush transmission line and five routings for the Columbus transmission line (ER, Section 10.9). In addition to cost, the following features were considered: amount and type of land required, rivers and creeks crossed, highways and railroads crossed, and proximity to towns, wildlife preserves, state parks and forests, military reservations, airports and gas fields. The selected routes had the lowest estimated dollar costs. The environmental costs for all the routes were similar.

In response to a request by the staff, PSI investigated the feasibility of routing the transmission lines within the existing rights-of-way of abandoned or little-used railroads. In the letter of April 14, 1976 from J. Coughlin of PSI to H. R. Denton of NRC, PSI described a number of reasons (proximity to towns, narrowness of corridor, etc.) why this alternative was not practical. The staff concurs with this assessment.

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10. EVALUATION OF THE PROPOSED ACTION

10.1 UNAVOIDABLE ADVERSE ENVIRONMENTAL IMPACTS

10.1.1 Physical Impacts

10.1.1.1 Land

Site preparation for and construction of Marble Hill Units 1 and 2 will require about 250 acres of the 987-acre area acquired for the plant. About 30 acres of woodland will be cleared for construction. An area of about 3475 acres will be used for transmission corridors and about 1110 acres of deciduous forest will be cleared. The tower bases will occupy about 85 acres of land that will be removed from production. The rail spur will require an additional 200 acres of cropland and 45 acres of woodland.

Construction of this plant will probably contribute to further industrialization of the area and the consequent esthetic intrusion into the rural setting.

Some archeological sites of scientific value may be disturbed.

10.1.1.2 Water

Dewatering during construction will apparently not be necessary, hence no water-table fluctuations are expected. An estimated 600 gpm will be pumped intermittently from the Ohio River alluvial deposits during construction, but no consequential impacts are expected.

Siltation from digging and filling, and runoff from bare ground, will be detrimental to the water quality of Little Saluda Creek. Temporary changes in stream banks and bottoms will result from construction of the transmission lines.

During operation, warm water will be discharged to the Ohio River, creating a small (less than one acre) thermal plume. Comparatively minute amounts of various chemicals, radioactive substances, and sanitary wastes will be discharged to the river.

The plant will consume about 0.05% of the average total flow (about 0.6% of the regulated low flow) of the river, primarily through cooling tower evaporation.

10.1.1.3 Air

There will be some transient smoke, dust and noise in the air near the site area during construction, creating a slight short-term nuisance to observers and, perhaps, to nearby residents.

During operation, minute amounts of radioactive substances will be released to the atmosphere. There will also be 55 to 60 cfs of water vapor released from the cooling towers. The plume will occasionally be visible for several miles. A very small amount of drift will be dispersed to the atmosphere where it will evaporate.

10.1.2 Biotic Impacts

During construction of the intake and discharge structures the benthic community will be temporarily disrupted by the dredging of the river and riverbank. Speedy recovery is expected once the river bottom is restored to normal.

Planktonic organisms and a small number of fish will be drawn into the plant with the intake water. The loss of these organisms is not expected to have adverse consequences to the downstream ecosystem. An intake structure incorporating the staff's requirements (Sec. 9.3.2) would reduce formation of silt bars upstream and downstream of the structure and result in little loss of spawning habitat.

The proposed submerged discharge will entrain planktonic organisms and some fish, subjecting them to slightly elevated temperatures and somewhat increased chemical concentrations, but no important adverse effects are expected therefrom. These impacts will be smaller than for the originally proposed surface discharge at the riverbank.

During spring and fall songbird migrations, a few birds will be killed by collision with station structures and transmission towers. The numbers will be highest during construction when structures are floodlighted. Major mortalities, such as occur at television towers, are not expected.[1]

10.1.3 Radiological Impacts

The staff does not believe that any adverse radiological effects will occur since the radioactive effluents from the plant will be required to meet the design objectives of Appendix I. The upper-bound dose estimated to be received by the population from operation of Marble Hill Units 1 and 2 would be about 88 man-rem per year, or 0.0004 percent of the population dose (26,000,000 man-rem) that persons living in the United States normally receive from natural background. The total annual dose of 900 man-rem to operating personnel from Units 1 and 2 is also a small percentage (0.4%) of the natural background dose to the regional population. Also the total dose to construction workers is estimated to be 10 man-rem, which is a small percent (0.6%) of the dose which would be received by the construction workers from natural background.

10.2 RELATIONSHIPS BETWEEN LOCAL SHORT-TERM USE OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

10.2.1 Scope

The National Environmental Policy Act (NEPA) requires the staff to consider specifically the long-term consequences to economic productivity of building and operating Marble Hill Station, and of alternative "short-term uses of man's environment." In this context, short-term is taken to mean the period of construction and operation, and long-term to mean the period beyond the service life of the station. In the case of nuclear power plants, there will be strong economic pressures to continue to use the chosen site (or adjacent ones) for power generation for several station lifetimes. In this event, the operational period may also be considered long-term.

The economic productivity of the site while it is used to generate electricity will be extremely large compared with the productivity from agricultural or other likely uses of the site. The resulting boost to the region's economy is expected to result in a corresponding large increase in the long-term productivity, compared with a smaller long-term effect for uses other than power generation. The principal effects of Marble Hill Station inimical to long-term productivity are the consumption of depletable resources and the cost of decommissioning. The overall conclusion of the staff with regard to long-term productivity is that the negative aspects of building and operating Marble Hill Station are overbalanced by the positive long-term effects.

10.2.2 Enhancement of Productivity

The construction and operation of Marble Hill Units 1 and 2 will have a beneficial 30-year effect on the economy of this region of southern Indiana. The availability of substantially more electricity and increased system reliability will tend to allow growth in the different aspects of the economy.

10.2.3 Uses Adverse to Productivity

The local effects of construction and operation of the Marble Hill plant will prohibit the use of the occupied land for agricultural or other purposes.

The use of river water at the Marble Hill Station should have a small impact on the short- or long-term productivity of aquatic life in the river. Dowstream users of Ohio River water will not be adversely affected by water use at Marble Hill.

10.2.4 Decommissioning

No specific plan for the decommissioning of Marble Hill Units 1 and 2 has been developed. This is consistent with the Commission's current regulations, which contemplate detailed consideration of decommissioning near the end of a reactor's useful life. The licensee initiates such consideration by preparing a proposed decommissioning plan which is submitted to the NRC for review.[2] The licensee will be required to comply with Commission regulations then in effect and decommissioning of the facility may not commence without authorization from the NRC.

To date, a total of nine civilian nuclear power facilities have been or are in the process of being decommissioned: Hallam Nuclear Power Facility, Carolina Virginia Tube Reactor (CVTR), Boiling Nuclear Superheater (BONUS) Power Station, Pathfinder Reactor, Piqua Reactor, Elk River Reactor, Fermi I Reactor, Valecitos Boiling Water Reactor and Peach Bottom Unit No. 1.

There are several alternatives that can be and have been used in the decommissioning of reactors: (1) Remove the fuel (possibly followed by decontamination procedures); seal and cap the pipes; and establish an exclusion area around the facility. The Piqua decommissioning operation was typical of this approach. (2) In addition to the steps outlined in (1), remove the superstructure and encase in concrete all radioactive portions which remain above ground. The Hallam decommissioning operation was of this type. (3) Remove the fuel, all superstructure, the reactor vessel and all contaminated equipment and facilities, and finally fill all cavities with clean rubble topped with earth to grade level. This last procedure is being applied in decommissioning the Elk River Reactor. Alternative decommissioning procedures (1) and (2) would require long-term surveillance of the reactor site. After a final check to assure that all reactor-produced radioactivity has been removed, alternative (3) would not require any subsequent surveillance. Possible effects of erosion or flooding will be included in these considerations.

Estimated costs of decommissioning at the lowest level are about $1 million plus an annual maintenance charge on the order of $100,000.[3] Estimates vary from case to case, a large variation arising from differing assumptions as to level of restoration. For example, complete restoration, including regrading, has been estimated to cost $70 million.[4] At present land values, consideration of an economic balance alone likely would not justify a high level of restoration. Therefore, it is to the applicant's advantage not to foreclose any of the several acceptable options[6] on methods of decommissioning until near the end of useful plant life.[5]

The degree of dismantlement will be determined by an economic and environmental study involving factors such as the value of recovered land, the value of salvageable scrap, and the costs of the several levels of decommissioning. In any event, the operation will be controlled by rules and regulations to protect the health and safety of the public which are in effect at the time.[6]

10.3 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

10.3.1 Scope

Irreversible commitments generally concern changes set in motion by the proposed action which at some later time could not be altered so as to restore the present order of environmental resources. Irretrievable commitments are generally the use or consumption of resources that are neither renewable nor recoverable for subsequent utilization.

Commitments inherent in environmental impacts are identified in this section, while the main discussions of the impacts are in Sections 4 and 5. Also, commitments that involve local long-term effects on productivity are discussed in Section 10.2 above.

10.3.2 Commitments Considered

The types of resources of concern in this case can be identified as (1) material resources and (2) nonmaterial resources, including a range of beneficial uses of the environment.

Resources which, generally, may be irreversibly committed by the operation are (1) biological species and their habitat destroyed in the vicinity, (2) construction materials that cannot be recovered and recycled, (3) materials that are rendered radioactive but cannot be decontaminated, (4) materials consumed or reduced to unrecoverable forms of waste, including uranium-235 and -238 consumed, (5) the atmosphere and water bodies used for disposal of heat and certain waste effluents, to the extent that other beneficial uses are curtailed, and (6) land areas rendered unfit for other uses.[5]

10.3.3 Biotic Resources

Development of the two-unit plant and associated offsite construction will commit about 1400 acres of agricultural land and woodland. These land resources, although they could be returned to a similar state in 30 years, are considered irretrievable.

10.3.4 Material Resources

10.3.4.1 Materials of Construction

The construction of the station will require the commitment of the following quantities of materials: 300,000 cubic yards of concrete, 6 million board-feet of lumber, 35,700 tons of steel, and 180 million gallons of water. Numerous other resources (see Table 10.1) are incorporated into the physical station. With the exception of the recoverable materials shown in Table 10.1 and steel, a significant fraction of which could be recovered if the units are eventually decommissioned and dismantled, these commitments must be considered to be irretrievable. In addition, about 100 million kWh of electricity will be required in the construction of the units, as well as a considerable quantity of gasoline for commuting workers, for trucks, and other power equipment onsite.

No commitments have been made on whether these construction materials will be recycled when their present use terminates. Some materials are of such value that economics clearly promotes recycling. Station operation will contaminate only a portion of the equipment to such a degree that radioactive decontamination would be needed in order to reclaim and recycle the constituents. Some parts of the station will become radioactive by neutron activation. Radiation shielding around each reactor and other components inside the dry-well portion of each containment structure constitute the major materials in this category for which it is not feasible to separate the activation products from the base materials. Components that come in contact with reactor coolant or with radioactive wastes will sustain varying degrees of surface contamination, some of which could be removed if recycling is desired.

The estimated quantities of materials used in Marble Hill Units 1 and 2 should be similar to amounts shown in Table 10.1.

Construction materials are generally expected to remain in use for the full life of the station, in contrast to fuel and other replaceable components discussed later. There will be a long period of time before terminal disposition must be decided. At that time, quantities of materials in the categories of precious metals, strategic and critical materials, or resources having small natural reserves must be considered individually, and plans to recover and recycle as much of these valuable depletable resources as is practicable will depend upon need.

10.3.4.2 Replaceable Components and Consumable Materials

Uranium is the principal natural resource material irretrievably consumed in station operation. Other materials consumed, for practical purposes, are fuel cladding materials, reactor control elements, other replaceable reactor core components, chemicals used in processes such as water treatment and ion exchanger regeneration, ion exchange resins, and minor quantities of materials used in maintenance and operation. Except for the uranium isotopes 235 and 238, the consumed resource materials have widespread usage; therefore, their use in the proposed operation must be reasonable with respect to needs in other industries. The major use of the natural isotopes of uranium is for production of useful energy.[7]

10.3.5 Water and Air Resources

The expected releases of chemicals and radioactive materials and their consequences are discussed in Sections 3 and 5. It is necessary in station operation to use both air and water resources to bear these discharges. There is, therefore, a commitment of these resources for this purpose. The more significant commitment of these resources is the consumptive use of about 30,000 acre-feet per year of water from the Ohio River for the life of the station. Such a commitment is, however, neither irreversible nor irretrievable. There are no irreversible or irretrievable commitments of air.

10.3.6 Land Resources

The station site, composed of 987 acres, would be committed to the construction and operation of this power station for the 40 years that the plant would be licensed to operate. Most of the area could be returned to other purposes; however, about 40 acres are considered to be irreversibly committed. The transmission corridors require 3475 acres of land but only the 85 acres occupied by the tower bases would be withdrawn from agricultural production. The railroad spur right-of-way occupies about 250 acres of land, about half of which is also used as a transmission corridor.

Table 10.1. Consumption of Reactor Materials in a 2300-MWe PWR Station (Two Units)

Material	Quantity Used in Plant, kg[a]	
	Consumed	Recoverable
Aluminum	47,568	41,732
Antimony	7.2	
Asbestos	92,534	1,814
Beryllium	2.4	636
Boron	60,844	
Cadmium	324	4.5
Chromium	215,210	
Copper	963,470	2,993,740
Cobalt		0.9
Gold		0.9
Indium	916	
Iron	3,661,738	
Jewel bearings		0.9
Lead		15,340
Manganese	858,399	
Mercury	9	18
Molybdenum	5,847	
Nickel	553,983	
Niobium	1,960	4,536
Platinum		1.8
Silver	5,172	2,314
Tin		136
Titanium	302	0.9
Tungsten		14
Uranium		
Total	97,800	
U-235	53,800	
U-238	44,000	
Zinc	181,439	18,140
Zirconium	282,611	

[a]Pacific Gas and Electric Co., Environmental Report, Units 1 and 2, Diablo Canyon Site, AEC Dockets 50-275 and 50-323, San Francisco, Calif., Supplement No. 2, July 28, 1972, Chap. XIV. Assumes 40-year life of the plant operating at an average of 72.5% capacity.

10.4 BENEFIT-COST BALANCE

10.4.1 Benefit Description of the Proposed Facility

10.4.1.1 Expected Annual-Average Generation

The annual production of Marble Hill Units 1 and 2 at a capacity factor of 70% will be 14 billion kWh.

10.4.1.2 Proportional Distribution of Electrical Energy

The applicant expects the distribution of sales to be the same as it has been in the past. For PSI the distribution has been 26 percent domestic, 19 percent commercial, 36 percent industrial and 19 percent other. For NIPSCO the distribution has been 17 percent domestic, 5 percent commercial, 72 percent industrial and 6.6 percent other.

10.4.1.3 Taxes

Federal and State Income Taxes

The applicant estimates that over the 30-year expected life of the station $123,000,000 will be generated in State corporate tax and $508,000,000 in Federal corporate tax (ER, Sec. 8 1.3).

Local Property Taxes

As discussed in Section 5.8.2.3, several million dollars per year will accrue to the Jefferson County taxing units from the Marble Hill Station. Although taxes can be thought of as transfer payments over a large area, the local tax benefits can be considered as offsetting the local environmental impacts attributable to the Marble Hill Station.

10.4.1.4 Employment

During construction of the Station, employment will be provided over a 6-1/2 year period to a large construction force, peaking at 2,200 workers. Approximately 155 operating and maintenance personnel with an aggregate annual income of $3 million will be employed at the Station.

10.4.2 Cost Description of the Proposed Facility

10.4.2.1 Economic Costs

Estimated economic costs of the Marble Hill Station are given in Table 10.2.

Table 10.2. Economic Costs of Construction and Operation of Marble Hill Units 1 and 2 (in millions of 1975 dollars except as noted)

Basis	Construction and Decommissioning	Operation	Fuel	Total
Present value at time of first operation	1705	213	n.a.	n.a.
Annualized	166	21	94	281
Mills/kWh at capacity factor 0.6	13.7	1.7	7.8[a]	23[a]

Based on Table 9.1.

[a]First year of operation.

10.4.2.2 Environmental Costs

The environmental costs expected from construction and operation of the station are summarized in Table 10.3.

10.4.2.3 Radiological Costs

The Nuclear Regulatory Commission has adopted amendments to Appendix I of 10 CFR Part 50. Appendix I sets forth numerical guides for design objectives and limiting conditions for operation to meet the criterion "as low as practicable" for radioactive material in light-water-cooled nuclear power reactor effluents.

On September 4, 1975, the Commission amended[11] Appendix I of 10 CFR Part 50 to provide persons who have filed applications for construction permits for light-water-cooled nuclear power reactors which were docketed on or after January 2, 1971, and prior to June 4, 1976, the option of dispensing with the cost-benefit analysis required by Paragraph II.D of Appendix I. This option permits an applicant to design his radwaste management systems to satisfy the Guides on Design Objectives for Light-Water-Cooled Nuclear Power Reactors proposed in the Concluding Statement of Position of the Regulatory Staff in Docket RM-50-2, dated February 20, 1974. The applicant has chosen this option, and the staff has concluded that the plant as proposed meets the requirements of RM-50-2. Accordingly, the radiological impact will be negligible.

10.4.2.4 Environmental Costs of the Fuel Cycle

The environmental costs associated with the uranium fuel cycle are summarized in Table 5.18. Their contribution to the overall environmental costs is small enough that the conclusion of the benefit-cost balance is not significantly affected. As noted in Section 5.7, the NRC Staff may subsequently modify or expand the discussion of environmental effects of the fuel cycle in the light of the Court of Appeals decision in Natural Resources Defense Council v. NRC (CADC Nos. 74-1385 and 74-1586 decided July 21, 1976). That decision is now being analyzed by the Staff.

10.4.2.5 Environmental Costs of Transportation

The environmental effects of transportation of fuel and waste to and from the facility are summarized in Section 5.4.1.4. The impact of those effects is sufficiently small so as not to affect significantly the conclusions of the benefit-cost balance.

10.4.3 Benefit-Cost Balance

The primary benefit from the operation and construction of the proposed station will be the production of about 14 billion kWh per year over the life of the station.

The major environmental impacts to be expected from the construction and operation of the proposed units appear to be those typically associated with the creation of large new industrial plants in rural areas. An average of 1100 people will be employed on the site during the seven-year construction period. The mechanical-draft cooling towers will issue visible plumes that will be seen most frequently during the winter.

About 130 acres will be transformed from woodland and pasture to an industrial complex. Although many other environmental impacts are assessed in Sections 4 and 5 and are listed in Table 10.3, none appears to be more than barely perceptible against the normal fluctuations of the environment.

The primary benefit of increased availability of electrical energy in the applicant's service area and in the ECAR region will outweigh the environmental and economic costs of the station.

The staff concludes that the overall environmental impact resulting from the construction and operation of Marble Hill Units 1 and 2 as proposed will be the minimum practicable for a 2260 MWe nuclear electrical generating facility if the conditions in the Summary and Conclusions are implemented. Further, the overall benefit-cost balance would not be significantly improved by an alternative choice of site or by the use of an alternative generating system.

Table 10.3. Summary of Environmental Effects due to Construction and Operation of the Marble Hill Station Units 1 & 2

Effect	Reference Sections	Impact
Land		
Diversion of about 1200 acres to industrial use	4.1, 5.1	Small
Loss or alteration of 1300 acres of natural habitat	4.1, 4.3	Small
Water		
Consumptive loss of 0.05% of the normal flow (0.6% of the minimum flow) of the Ohio River	5.2	Negligible
Pumping of 200 to 600 gpm from Ohio River Valley aquifer	5.2	Minor
Increased local temperature of Ohio River water (less than 1 acre increased 5°F)	5.3	Negligible
Loss of river plankton (< 0.6%) by entrainment	5.3	Minor
Increased siltation in Little Saluda Creek and Ohio River	4.2, 4.3	Temporary
Increased siltation in fishing streams	4.3	Small
Loss of benthic habitat (< 0.1 acre)	5.3	Negligible
Air		
Occasional visible plume aloft from MDCTs	5.3	Negligible
Ground-level fogging and icing (frequent onsite, rare offsite)	5.3	Minor
Deposition of drift (essentially all onsite)	5.3	Negligible
Visual		
Occasional visible plume aloft from MDCTs	5.3	Negligible
Containment structures visible on horizon	5.1	Minor, and only from limited area
Transmission lines and towers	5.1	Minor
Radiation Exposure		
Public radiation exposure (88 man-rem/yr)	5.4	Negligible
Workers' radiation exposure (900 man-rem/yr)	5.4	Minor
Radiation exposure to construction workers (10 man-rem/yr)	4.1	Minor
Social and Economic		
Disturbance of archeological sites	4.1	Small
Increased traffic congestion	4.4	Moderate
Increased stress on housing market	4.4	Small
Increased stress on community services	4.4	Moderate
Payroll	4.4, 5.8	Beneficial
Induced expenditures	4.4, 5.8	Beneficial
Local taxes	5.8	Beneficial

References

1. "Final Environmental Statement, Davis-Besse Nuclear Power Station, Unit 1," USAEC, Directorate of Licensing, Docket No. 50-346, March 1973.

2. Title 10, "Atomic Energy," Code of Federal Regulations, Part 50, "Licensing of Production and Utilization Facilities," Sec. 50.82, "Applications for Termination of Licenses."

3. Atomic Energy Clearing House, Congressional Information Bureau, Inc., Washington, D. C., 17(6):42, 17(10):4, 17(18):7, 16(35):12.

4. "Pacific Gas and Electric Company, Supplement No. 2 to the Environmental Report, Units 1 and 2, Diablo Canyon Site," 28 July 1972.

5. "Draft Environmental Statement, Comanche Peak Steam Electric Station, Units 1 and 2," USAEC, Directorate of Licensing, Docket Nos. 50-445 and 50-446, February 1974.

6. USNRC Regulatory Guide 1.86, Division of Reactor Licensing, August 1974 and January 1975.

7. "Mineral Facts and Problems," U. S. Dept. of Interior, Bureau of Mines, p. 230, 1970.

8. Public Utility Tax Act, Public Law No. 47, State of Indiana.

9. Assessment of Property under the Public Utility Tax Act of 1949, as amended, Regulation No. 19, State Board of Tax Commissioners, State of Indiana, 1968.

10. Notice to taxpayers of Jefferson County of t rate charged for 1974, Rita F. Gosman, Auditor of Jefferson County.

11. Federal Register, Vol. 40, No. 172, September 4, 1975, p. 40816.

11. DISCUSSION OF COMMENTS RECEIVED ON THE DRAFT ENVIRONMENTAL STATEMENT

11.1.1 Introduction

Pursuant to Appendix D of 10 CFR Part 50, the Draft Environmental Statement (DES) was transmitted in March 1976 with a request for comment to the Federal, State and local agencies listed in the summary at the beginning of this final statement. In addition, the AEC requested comments on the Draft Environmental Statement from interested persons by a notice published in the Federal Register on March 11, 1976.

Letters in response to these requests were received from the following:

- Advisory Council on Historic Preservation (ACHP)
- Department of Agriculture (DOA)
- Department of Army, Corps of Engineers (COE)
- Department of Commerce (DOC)
- Department of Health, Education and Welfare (HEW)
- Department of the Interior (DOI)
- Energy Research and Development Administration (ERDA)
- Environmental Protection Agency (EPA)
- Federal Energy Administration (FEA)
- Office of the Governor, State of Indiana (SGI)
- Office of the Governor, Commonwealth of Kentucky (CK)
- Louisville Water Company (LWC)
- Save The Valley (SV)
- Sassafras Audubon Society (SAS)
- Kentucky Audubon Society (KAS)
- Louisville Group Sierra Club (LGSC)
- Rosella Schroeder (RS)
- D. V. Whitesides (DVW)
- J. N. Embry (JNE)

These letters are reproduced in Appendix A of this Statement. The staff's consideration of the issues raised in these letters is reflected in this Section and by changes in the text. The abbreviations and associated Appendix A page numbers refer to the specific comments received from the various agencies, organizations and individuals.

Although the standard 45-day comment period was extended 15 days to May 4, 1976, some comments were received well after this date. The comments were considered by the staff and were included in Appendix A. The staff responded principally to those late comments in areas not discussed in other sections of the statement.

11.1.2 General Comments and Status of Permits, Approvals and Licenses (COE, A-6)

On September 16, 1975, the U.S. Army Engineering District (600 Federal Place, Louisville, Kentucky 40201) was sent a copy of the Applicant's Environmental Report - Construction Permit Stage (ER). Approximately 75 copies of the ER are distributed to the commenting Federal, State and local agencies. Copies are also placed in Public Document Rooms as indicated in FES Section 1.1.

The staff characterizes and summarizes in many areas where there is more information available, such as the status and review of approvals which may be found listed in the ER, Table 12.0-1. The use of this process throughout the entire EIS prevents an inordinate and unnecessary length of the EIS which, as suggested by CEQ, may obscure the intent of NEPA.

11.2.1 Anomalies in Water Quality Data
(EPA, A-20, 21, 22; SV, A-40; COE, A-6)

These questions or comments all relate to the atypical data presented in Tables 2.4 and 2.5. Table 2.4 is a summary of the data collected at Louisville, Kentucky (river mile 61' 6) in 1969-1970 and was extracted from "Water Resources Data for Kentucky", Part 2, 1970. (Reference 2.5-2A in the ER). Analyses by two other organizations also gave occasional high values for cadmium, iron, manganese and phenol. The staff has no explanation for the data, which occasionally indicate that drinking water criteria are exceeded for cadmium, manganese and phenol. However, the Station will not add any of these materials to the blowdown and will therefore have small effect on their concentrations in the Ohio River. Hexane soluble materials are correctly reported in milligrams/liter.

11.2.2 Gasline
(SV, A-39)

Indiana Gas Company and the Petroleum Division of the Indiana Geological Survey are unaware of any pipelines near Saluda.[1]

11.2.3 Topography, Geology and Seismology
(SV, A-39, 40; RS, A-47; CK, A-36; COE, A-6)

The site is in Seismic Zone 2 (Intensity VII-VIII of the Modified Mercalli Scale), and is more than 100 miles from the New Madrid (Zone 3) area. Seismic risks are essentially the same for the alternative sites. This material is also discussed in the Site Suitability Report[2] issued in July 1976. The information on geology, seismology, topography, etc., in the environmental statement is not intended to be sufficient for an independent assessment of the adequacy of the facility design with respect to the geologic environment. Such adequacy is determined by the NRC in its safety evaluation of the proposed station. The Safety Evaluation Report will be published in September 1976 and further information is available in the applicant's ER and PSAR.

11.2.4 Sampling for Herbs and Shrubs
(SV, A-40, 41)

A general reconnaissance[1] of all areas of the site revealed no rare or endangered species.

11.2.5 Soil Characteristics and Stability
(DOI, A-13)

The applicant proposes[1] to maintain the slopes cut around the plant excavations during construction to assure stability. Local instability of the natural slopes along the Ohio River resulting in occasional rock falls was noted[1], as discussed in Sections 2.5.1.2.1 and 2.5.5.1 of the PSAR. The stability of the soil on the bluff will be considered in developing the final design of the intake and discharge pipelines, which will be located[1] in an area of the bluff where the danger of damage to the pipelines from rock falls is minimal.

Soil stability will be considered by the staff in the Safety Evaluation Report.

11.2.6 Groundwater Hydrology
(DOI, A-13)

Piezometric surface maps for the upland portions of the site were presented in the ER, Figs. 2.5-18, -19 and -20. They show the locations of the monitoring wells in relation to the major plant structures. The piezometric levels in the alluvial-glaciofluvial aquifer along the Ohio River floodplain are shown in PSAR, Fig. 321.8-6.

11.2.7 Safe Yields of Onsite Aquifers
(DOI, A-13)

The hydrologic characteristics of the aquifers and aquitards in the site area are reported in ER, Section 2.5.2.3.2.1. The yields of wells in alluvial-glaciofluvial deposits along the Ohio River have ranged as high as 3.3 cfs. Therefore the withdrawal of 600 gpm (about 1.3 cfs) from this aquifer during construction should present no problems. Only 200 gpm will be required during plant operation.

11.2.8 Domestic Water Use from the Ohio River (LWC, A-37; CDE, A-7)

The statistics omitted from the DES concerning LWC are included in Chapter 2, Table 2.2-27, of the ER.

The Oldham County Water District No. 1 does have a surface water intake at river mile 582.2 which may or may not be in service, according to the Louisville Office of the Army Corps of Engineers. District No. 1 is on record as a purchaser of water from the Louisville Water Company (Table 2.2-27 of the ER), but this does not preclude present or future use of their intake. Oldham County Water District No. 3, which is often confused with District No. 1, uses groundwater from a well system.

11.2.9 Aquifer Permeability (DOI, A-13)

The soil and rock formations below the plant site are generally of low permeability. The uppermost carbonate aquifer occurring throughout most of the site is the Laurel dolomite whose permeability ranges from low to practically impermeable when intact (primary permeability). Its permeabilities are reported in the range 0 to 218 ft/yr. Higher values, to 3010 ft/yr, have been observed where the dolomite is jointed and weathered (secondary permeability). The piezometric surface for the Laurel shale marker bed of the Laurel dolomite is shown in Fig. 2.5-18 of the ER.

11.2.10 Officer's Woods (DOI, A-14)

Officer's Woods, about 13 miles north of the site, and within 800 feet of the proposed transmission line route, has recently been added to the National Registry of Natural Landmarks.

11.2.11 Land Suitability (RS, A-48)

The criteria for site suitability are quite different for nuclear power plants and for ordinary industry. For example, a site remote from population, markets and supplies may not be attractive to many industries.

11.2.12 Immediate Vicinity (SV, A-39)

More specifically, there are no industries within 5 miles of the site.

11.2.13 Scenery (SV, A-39, 41, 43)

The scenic wooded bluffs will continue to be visible from the Ohio River and from offsite roads. The station facilities will not be visible from the river nor from the principal local road (Route 62). Some vantage points for viewing will become inaccesible to the public because of Station construction.

11.2.14 Tornadoes (SV, A-40; CK, A-33)

Nuclear plants are built to withstand tornadoes and are evaluated in the Safety Evaluation Report (SER) and in Reference 2.

11.2.15 Birds (SV, A-41)

Corrections to the FES regarding bird populations were made in accordance with the comments of Save the Valley. See Appendix B.

11.2.16 Ohio River Water Quality
(SV, A-40; COE, A-6)

More recent analyses appear in Section 2, Table 2.6. The causes for occasional high concentrations of heavy metals and phenol are not known. See Section 11.2.1.

11.2.17 "More General Ecological Data"
(SV, A-41)

The statement in the draft statement was incorrect. The assessment of effects on periphyton was actually made on the basis of the protective environmental conditions in Sections 4.3.2.5 and 4.2.5.

11.2.18 Historical Changes: Barges
(SV, A-41)

The staff concurs that barge traffic contributed to historical changes in the fish fauna of the Ohio River.

11.3.1 Conboy Woods and Old Growth Forests
(SV, A-42)

The Rush transmission line will pass 0.5 mile east of Conboy Woods.[1] At this distance the transmission line will have small impact on the Woods. Approach to Tribett's Flatwoods, the Muscatatuck National Wildlife Refuge and other conservation areas is described in Section 3.7.

11.3.2 Alternative Transmission Routes
(SV, A-42; DOI, A-15; PSI, A-57)

A more complete discussion of the criteria for choosing among alternative routings is given in Section 9.5 of this statement and Section 10.9 of the ER.[1]

11.3.3 Biotic Effects of Chlorine in Blowdown
(DOI, A-14)

A staggered chlorination procedure will be used in the two Marble Hill units. The chlorine in the blowdown will be rapidly mixed[1] with the large flow of the Ohio River and should not have any measurable impact on aquatic biota.

11.3.4 Storage and Transportation of Radwaste Solids
(LGSC, A-49)

Radwaste solids will be stored on the site and transported to licensed burial facilities in accord with NRC and Department of Transportation regulations. For additional details see Reference 1.

11.3.5 Chlorination Effects and Alternative Biocides
(LGSC, A-49)

With the rapid mixing of the small blowdown with the large flow of the Ohio River, the adverse biotic effects of chlorine and its reaction products will be of small consequence. Therefore the use of other more expensive biocides and of dechlorination methods is not justified. The applicant provides more detail in Reference 1.

11.3.6 Transmission Costs
(DVW, A-56)

The staff concurs with the applicant that the difference in transmission costs is not enough to make power produced at a few large plants more expensive than power produced at many small plants closer to load centers.[1]

11.3.7 Radioactive Effluents
(SV, A-41, 42)

Tritium is considered in Section 3.5.1.5, Liquid Waste Summary. The staff estimates the tritium releases to be 510 Ci/yr/reactor. The staff's calculational model considers that a pressurized water reactor releases approximately 16 times as much tritium as a boiling water reactor of the same power rating.

Anticipated operational occurrences include operator error, component failure, procedural errors, and design errors resulting in unplanned liquid releases. The staff's technique for adjustment of the liquid source term for anticipated operational occurrences reflects 102 reactor-years of operating experience, and is explained in NUREG-0017, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Pressurized Water Reactors (PWR-GASE Code)," April 1976.

The charcoal of the adsorbers through which effluent gases are passed is disposed of as part of the dry solid radioactive waste.

"Sufficient decay" is explained in Section 3.5.2.1 to be 70 days.

The neutron flux is considered in the production of activated corrosion products in the reactor coolant, and has no other effect on the radioactive effluents.

11.3.8 Rate of Release of Radioactive Gaseous Waste
(DOC, A-12)

The reactor building purge is assumed to occur for periods of approximately 2 hours on 24 occasions during a year. The releases from the waste gas processing system are assumed to occur for 8 hours on 15 occasions during a year. All other gaseous releases are assumed to occur on a continuous basis.

Appropriate adjustments were made to the atmospheric dispersion estimates for the short-term releases, as can be seen from the spread of values of X/Q and D/Q in Table 5.8.

11.3.9 Operations of Charcoal Adsorbers
(EPA, A-22)

Section 3.5.2.3 has been revised to clarify the requirements on the use of the charcoal adsorbers in the auxiliary building ventilation system. A similar requirement would be made on the charcoal adsorbers in the main condenser air ejector exhaust. By meeting the design objectives of Appendix I, the systems satisfy the requirements of reducing the effluents to "as low as practicable" levels.

11.3.10 Muscatatuck National Wildlife Refuge
(DOI, A-15)

The nearest approach of the transmission line corridor to the Muscatutuck National Wildlife Refuge will be 4400 feet, close to the minimum of one mile recommended by the Department of the Interior comment.

11.4.1 Concentration of Toxic Materials by Fish
(SV, A-43)

Although the blowdown is several times more concentrated in chemicals than is the river water, the size of the blowdown is small and it is rapidly diluted to ambient chemical concentrations by mixing. Therefore, no measurable effect on fish is expected.

11.4.2 Transmission Line and Railroad Corridor: Aquatic
(SV, A-41; DOI, A-14, A-15; LGSC, A-49; EPA, A-21, COE, A-7)

The staff assesses effects of construction on offsite streams to be small and of short duration. A detailed survey of impacts is not possible since the routes are known only approximately. Approach of corridors to conservation areas is discussed in Section 4.3.1.2 of the FES. The restrictions on herbicide use near streams are discussed in Section 9.5. The crossing of streams during construction is discussed in ER, Section 4.2.1.3. See FES Sections 4.5.2, 11.6.5 and 11.10.2.

11.4.3 Significant Figures
(SV, A-42)

Few numbers in this statement are significant to more than two figures. This accuracy suffices for most purposes of this statement.

11.4.4 Crushed Stone
(SV, A-42)

Crushed stone will be obtained by crushing stone excavated at the site.

11.4.5 Use of Herbicides in the Transmission Corridors
(SV, A-42; SOI, A-30, COE, A-7)

The herbicide 2,4,5-T will be used in accordance with Federal and State regulations. Additional staff restrictions on aeria spraying are described in Section 4.5.2.

11.4.6 Alternative Transmission Line Corridors
(SV, A-42; DOI, A-15)

See FES, Section 4.3.1.2.

11.4.7 Impacts on Schools
(SV, A-42)

See FES, Section 4.4.2.3.

11.4.8 Transmission Corridors: Ecological Edge
(SV, A-42)

Some species of flora and fauna prefer edge habitat, leading to greater diversity. This is discussed further in Reference 1.

11.4.9 Change in Discharge Structure Design
(EPA, A-20; CK, A-32; DOI-14; COE, A-8)

The discharge structure has been modified from the surface discharge with a discharge velocity of 2 feet per second and a structural outfall terminated at elevation 420'0" to a submerged discharge with a discharge velocity of 8 feet per second and the discharge pipe terminated at elevation 414'0". See Section 5.3.3.5 and Reference 1.

11.4.10 Erosion Control Plan
(EPA, A-21; DOA A-3; COE, A-7)

The applicant's system[1] to control site runoff during construction and operation uses a sedimentation basin with a storage volume of about 717,000 cubic feet. This volume exceeds the maximum 24-hour runoff with a recurrence interval of 10 years. The applicant expects the settling pond to result in an effluent containing less than 50 mg/liter of suspended solids during the maximum 10-year 24-hour rainfall.

11.4.11 Construction Impacts on Offsite Streams
(EPA, A-21; SV, A-41; DOI, A-14)

Construction impacts on offsite streams during construction of the transmission lines and rail spur will be small and of short duration, because of the conditions specified in Section 4.5. In particular, herbicides will not be used within 200 feet of water bodies except by tree injection methods, a vegetated border 100 feet wide will be maintained on both sides of the stream, and precautions will be taken to minimize impacts where streams must be crossed by construction equipment.

11.4.12 Pesticide Use (EPA, A-22)

The applicant will follow[1] the appropriate Federal and State regulations.

11.4.13 Storage of Fuels and Lubricants (EPA, A-25)

The applicant states[1] that it will comply with all Federal and State laws concerning oil storage and will develop appropriate SPCC Plans.

11.4.14 Bobcat Habitat (DOI, A-14)

Some bobcat habitat will be lost due to land clearing and noise from construction activities. However, there is suitable habitat[1] for the bobcat near the site. Since the bobcat's range is 6 to 10 square miles, its possible displacement from less than 1 square mile at the site may not be seriously restrictive. The bobcat is protected by Indiana law, but only from hunting.

11.4.15 Herbicide Use in Flood Plains (DOI, A-15; COE, A-7)

The detailed routes of the transmission line and rail spur corridors are not available, so that precise estimates of clearing effects cannot be made. There are few flood plains on small streams wider than 200 feet, within which herbicide use is already prohibited. Further, with the use of a biodegradable herbicide the staff sees small likelihood that herbicide use on flood plains would be damaging to stream biota. However, to minimize the likelihood of herbicides reaching offsite streams during floods, the staff in Section 5.2 has required that the applicant use biodegradable herbicides on flood plains, applying them only between July and December.

11.4.16 Disposal of Spoil from Dredging and Excavation (DOI, A-15)

Plans for disposing of dredge spoils are currently under review by Public Service Company of Indiana, Inc., and it is not possible to describe the exact plans at this time. The possible use of spoil onsite as fill has been mentioned.

The applicant has stated[1] that approximately 410,000 cubic yards of rock will be excavated during construction of the Marble Hill Station. This material will be crushed and used on site for construction of laydown areas and parking lots and offsite for the railroad spur bed. Approximately 600,000 cubic yards of loess and topsoil will also be removed during construction. Topsoil will be stockpiled on site and reused for seeding site area after construction. Loess will be used as fill along the western and southwestern areas of the site.

11.4.17 Historic Structures along Transmission Lines (DOI, A-14)

The staff agrees, if structures of possible historic value may be impacted by the construction or operation of transmission lines, that the applicant, in consultation with the State Historic Preservation Officer, should assess these values and take appropriate action (Section 4.5.2).

11.4.18 Control of Dust during Construction (SOI, A-28)

In Section 4.5.1.1, the applicant indicates methods that will be used to control dust onsite, including sealing. Through Indiana Regulation APC20, dust produced or carried offsite will be regulated.

11.4.19 Transportation by Barge
(RS, A-48; EPA, A-25; COE, A-6)

At the present time, the applicant has not submitted a proposal to the NRC to build a barge facility. Its environmental impact will be assessed if a proposal is submitted.

11.4.20 Archeological Surveying
(RS. A-48)

Additional information on the required archeological surveying of the site is contained in Section 4.1.1.

11.4.21 Visual Impact of Transmission Lines
(LGSC, A-49; CK, A-33)

The staff agrees that the visual impact of 115 miles of transmission lines on the Indiana landscape is undesirable.

11.4.22 Construction Impact on the Southwestern School District
(SV, A-42)

As discussed in Section 4.4.2.3 of the statement, tax revenues in the early years of construction may not be generated soon enough to meet fully the initial demands on the Southwestern District by the children of construction workers. Over the long term, the tax revenues are likely to be sufficient to satisfy the added demands.

11.4.23 Construction Impacts on Schools, Hospitals and other Community Services
(HEW, A-12)

These impacts are considered in Section 4.4 of this statement.

11.4.24 Acidity of Site Subsoil
(DOA, A-4)

There will be no acid reactions of soil with concrete structures since the pH is above 3.5. All Category I structures will be founded either in rock or on structural fill.[1]

11.4.25 Revegetation Plan
(DOA, A-3, 4)

The applicant has developed a revegetation plan[1] for the site which complies with State Highway Specifications and provides for the stockpiling of topsoil and its use for revegetating areas disturbed by construction. The plan specifies the areas to be seeded and some details of seed, fertilizer and mulch to be used.

11.4.26 Site Land Use
(DOA, A-5)

In addition to those permanent plant structures which will occupy 130 acres of land, there will be temporary structures erected during construction. These will include: laydown and material storage areas, construction offices, parking lots, settling ponds for erosion control, access roads, warehouses, unloading facilities, the batch plant, and other miscellaneous facilities. Many of these perform a temporary service and will be dismantled after construction and the land they occupied will be revegetated.

11.4.27 Dioxin Impurity in Insecticide
(RS, A-47)

Current EPA standards require manufacturers to control dioxin impurity in undiluted insecticides to 0.1 ppm.

11.4.28 Use of Herbicides in Transmission Line Corridors
(LGSC, A-49; DVW, A-56)

The applicant states[1] that the herbicides used by PSI are all approved by the EPA and applied under the recommendation of the EPA and the State chemist. Herbicides are used on the right-of-way only by permission of the property owner with provisions established to address any complaints. With the staff's conditions (Section 4.5.2), the impacts will be acceptable and the more expensive alternatives are not justifiable.

11.4.29 Use of Herbicides in the Muscatatuck National Wildlife Refuge
(DVW, A-56)

The staff believes that special consideration should be given to protect the expected higher wildlife populations in wildlife refuges. Extra protection will be afforded to these populations by the conditions in Section 4.5.2.

11.4.30 Disposal of Landscape Waste and Construction Debris
(CK, A-31)

See Section 4.5.1. The applicant will dispose of these wastes in accordance with State of Indiana and local requirements.

11.5.1 Effects of Operating Transmission Lines
(RS, A-48; SV, A-43)

The effects of operating high voltage transmission lines are discussed in Section 5, and are assessed to be small. Only the more important impacts are discussed in Section 10. The ozone experiment referred to was carried out by the American Electric Power Service Corp., with the assistance of Battelle Memorial Institute (Columbus Laboratories).

11.5.2 Transportation of Radioactive Materials
(JNE, A-51; CK, A-34; EPA, A-24)

The transportation of radioactive materials has been generically discussed in the AEC report, "Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants," December, 1972. The staff's evaluation, pursuant to 10 CFR 51.20(g), is given in Section 5.4.1.4.

11.5.3 Life of the Station
(RS, A-47)

The licenses for constructing and operating the station are issued for a total of 40 years from the issuance of the construction permit. However, the economic operating life of the plant is usually considered to be about 30 years.

11.5.4 Bioaccumulation Factors in Ohio River Biota
(LWC, A-37)

Data are not available on the bioaccumulation factors specifically for Asiatic clams and fresh-water sponges. Assuming a factor of 10^5, as large as measured for any organisms, including organisms similar to clams and sponges, an individual would receive a dose less than 1 mrem/year if he ingested a weight of these organisms equal to his intake of water. Accordingly, there is no need to conduct a special study of the bioaccumulation factors for these organisms.

11.5.5 Fogging and Icing
(SOI, A-28; SV, A-43; KAC, A-51)

Fogging and icing effects should be small off site as discussed in Section 5.3.1.3. Unusual weather conditions expected to occur less than once per year would be required for the plume to add to fogging and icing effects several kilometers from the site.

11.5.6 Ultimate Disposal of Radioactive Wastes
(EPA, A-24; DVW; A-56; RS, A-48; CK, A-33; LGSC, A-49; JNE, A-51)

On May 7, 1976, ERDA announced that it was issuing a Technical Alternatives Document (TAD) which presents a comprehensive survey of the current status of technologies for handling and storing commercial radioactive waste. The TAD was prepared by approximately 200 waste management experts at laboratories and universities around the country. It is a complete reference work on the status of technology as of September 1, 1975 for waste generated from the production of electricity in nuclear power reactors. ERDA Administrator, Robert C. Seamans, Jr., said, on the basis of the document, that "ERDA is confident that the technology base does exist to arrive at waste management solutions, and its radioactive waste program is directed to develop this capability to an operating level on a timely and acceptable basis."

The TAD document will provide one basis for a generic environmental statement which ERDA will prepare, with assistance from NRC, on the treatment and storage of the radioactive waste generated by nuclear power reactors. This statement will address in a generic way the particular environmental impacts mentioned in the EPA comments. The information in the TAD was presented in summarized form in testimony before the Joint Committee on Atomic Energy (JCAE) on May 10-12, 1976 by a number of ERDA officials.

Parallel developments have been taking place in the NRC. Responding to a Commission request, the ACRS reviewed the NRC program for regulating fuel cycle activities and suggested in a letter dated April 15, 1976 that the regulatory program in the fuel cycle area be accelerated and expanded, enumerating a number of recommendations for NRC action. The NRC responded in a letter dated May 12, 1976 agreeing in general with the recommendations, and expressing a firm commitment to the establishment of an active and effective regulatory program for the management of nuclear wastes.

This commitment was reaffirmed in NRC testimony before the JCAE on May 12, 1976. It was mentioned that the regulatory framework would have to be supported by a comprehensive environmental impact statement. The extent of NRC contributions to the statement was outlined. The NRC testimony agreed with the ERDA conclusion that the basic technology for waste management is available and that implementation of that technology on a schedule that will meet national needs should be the main direction of future effort. The NRC has firmly established waste management as a high priority effort and has made the commitment to act rapidly and methodically to establish a sound regulatory base for licensing waste management activities.

With regard to social and economic impacts, the NRC task force on goals and objectives of waste management has explicitly considered these factors and has communicated their thinking to the EPA staff on several occasions. Agreement was reached that these issues can best be addressed in a generic manner rather than in individual cases.

On August 13, 1976, in response to the D.C. Circuit Court decision in NRDC v. NRC (July 21, 1976), the Commission had directed the staff to produce a revised environmental survey on the probable contribution to the environmental costs of licensing a nuclear power reactor that is attributable to the reprocessing and waste management stages of the uranium fuel cycle. In addition, the Commission intends to reopen the rulemaking proceeding on the Environmental Effects of the Uranium Fuel Cycle, (Docket RM-50-3) for the limited purpose of (1) Supplementing the record on the reprocessing and waste management issues; and (2) Determining whether or not on the basis of the supplemented record, Table S-3 of 10 CFR 51.20(d) should be amended and, if so, in what respect. The revised environmental survey, together with any amendments to Table S-3 that may be proposed as a consequence of that analysis, will be the basis for these reopened proceedings.

11.5.7 Radiation Doses
(SV, A-40, 41)

Wind direction is considered relative to radioactive effluents. As part of our evaluation, the staff calculates the atmospheric dispersion factor for each of the 16 compass sectors at various distances out to 50 miles. From these, doses are calculated which are used to determine the total population exposure to 50 miles given in Table 5.10.

The effect of the neutron flux is considered in the production of activation products in the reactor coolant. Neutrons are produced only within the reactor core. This is the central, most shielded component of the power plant. Just for the protection of the operators, this shielding consists of several feet of water, several inches of steel, and several feet of concrete. At this point, the neutron flux has been reduced to a point that the dose is acceptable for the plant operators. The public is further protected by the additional feet of concrete in the containment structure which surrounds all the primary plant equipment, and by the shielding and dispersion produced by one-half mile or more of air between the plant and site boundary. At this point the flux and its associated dose are undetectable, and so low as to be of no significance to the public health.

The term "as low as practicable" is defined in 10 CFR Part 50.34a to mean "as low as is practicably achievable taking into account the state of technology, and the economics of improvements in relation to benefits to the public health and safety and in relation to the utilization of atomic energy in the public interest." Numerical guides for design objectives and limiting conditions for operation to meet this criterion are contained in Appendix I to 10 CFR Part 50, issued May 5, 1975, and amended September 4, 1975. Marble Hill Nuclear Generating Station has been determined to be designed in accordance with this regulation.

11.5.8 Extent of Plume
(SV, A-43)

Visible condensed water plumes from cooling towers extending fifteen or more miles downwind will be observed only a small percentage of the time under conditions of high atmospheric stability and small wind shear. Such plumes are most likely to occur when the atmosphere is cloudy or foggy,[1] so that the shadowing and esthetic impacts would be reduced.

11.5.9 Acid Mist
(SV, A-43; SOI, A-28; COE, A-7)

This subject is thoroughly discussed in Section 5.3.1.6. In view of the large amounts of water available in ambient air and in the coal plant plume itself, the staff expects a negligible effect on acid mist formation when plumes from coal plants and nuclear plants mix.

11.5.10 "Case-by-case basis" and "natural"
(SV, A-43)

The phrase "case-by-case" refers to the determination of the permissible size of the mixing zone by the appropriate agency. The "natural" temperature refers to the daily average river temperature upstream from the discharge.

11.5.11 Statistical Correlations
(SV, A-43)

It is entirely possible to correlate variables in a complex system even though they have no causal relationship. We feel sure there are many socio-economic factors which will show an equally close correlation with crime in these areas, and which have a highly probable causal relationship. None of the radiation exposure data collected among workers who received significantly higher levels of exposure have suggested such a causal relationship exists.

11.5.12 Design of Intake Structures
(DOI, A-14; EPA, A-20; PSI, A-64; COE, A-7)

In recommending the redesign of the intake structure to permit unimpeded flow of near-shore water, the staff recognized that the impacts resulting from the impingement of fish would not be great, in view of the moderate number of game fish impinged at the Clifty Creek plant (Table 5.1) where the intake flow was 30 times greater. Nevertheless, it appeared to the staff that modifications of the intake structure design to (1) lower the top of the near-shore section of the intake flume to a few feet below the normal minimum level of McAlpine Pool (420 feet MSL) and (2) cover the intake flume within about 50 feet of the shoreline with a solid cover in place of the wire mesh would be practicable, and probably no more or little more expensive than the original design. With this design, or an equivalent one, fish in near-shore water would not be forced to pass close to the bar grill in migrating up and downstream. Consequently, fewer fish would be impinged than with the current design. Therefore the staff holds to the requirement in the draft statement that the intake structure be redesigned to permit unimpeded flow of near-shore water (Section 4.5.2).

The applicant did not respond to this recommendation in the draft statement with construction and operating cost evaluations supporting the original design.

A continuously operating fish return mechanism is recommended in the comments of both EPA and the Department of the Interior. The staff believes that this requirement should not be imposed until monitoring results show that a significant number of game fish are impinged on the redesigned intake structure. The design of the travelling screen and the debris collector should be such that a fish return device may be incorporated if shown to be necessary by the results of monitoring impingement (Section 4.5.2).

11.5.13 Reactions of Phenol with Chlorinating Agents (SV, A-43)

Both phenol and chlorinating agents are toxic to aquatic organisms at very low concentrations. If they react, the product is likely to be toxic, like most such chlorinated organic compounds. However, the mixing of the small discharge with the large water flow of the Ohio River will rapidly dilute all of these compounds to harmless concentrations.

11.5.14 Effects of 765 kV Transmission Lines (SV, A-43; LGSC, A-49)

The staff has analyzed the possible health effects of transmission line voltage gradients in more detail in Section 5.6. While some adverse health effects have been observed in switchyard workers, none have been observed in individuals exposed to transmission line voltage gradients of 12 kV/m. This is the maximum gradient specified by the applicant.

11.5.15 Effects of Low-Level Radiation (DVW, A-56)

The NRC has held extensive public hearings and considered the testimony of many experts in reaching the conclusions that the low levels of radiation which are expected from this facility will have such a small effect on the population within 50 miles that it will be undetectable. The staff assessment of reactor accidents concludes that the risk is acceptably low. (Section 7)

11.5.16 Bases of Population Dose Commitment (EPA, A-23)

The dose commitment is the 50-year commitment per year of intake. The year 2000 population was projected by the applicant as described in the ER. The projection was verified and used by the staff. The assumptions regarding buildup are described in Appendix D in detail for the four classes of nuclides. The dose contributions of the daughters of strontium, cesium, and other pertinent elements were included in the dose calculations.

11.5.17 Completeness of the Population Dose Commitment (EPA, A-23)

The staff considers its treatment of the impact to the total population of the United States to be an adequate assessment of the impact of an individual nuclear power plant. We have considered population growth during the life of the plant by utilizing the estimated population at the midpoint of the plant life.

11.5.18 Periodic Analysis of Louisville Water (LWC, A-37, A-38)

Only the nearest municipal intake downstream from a facility is usually discussed specifically in NRC statements. Doses from drinking water were calculated for the Oldham County system, 10 miles downstream from the site. Oldham County Water District 3 normally takes its water from wells in an aquifer charged by the Ohio River. Oldham County Water District 1 normally purchases its water from the Louisville Water Company, but it does have a water intake on the Ohio River which can be used. Doses calculated for this intake are conservative compared to those calculated for the Louisville Water Company intake. The Louisville intake was considered in our population dose assessment (Table 5.10).

Because of the very large number of people served by this single system, the staff agrees that the applicant should periodically analyze both the Louisville tap water and intake water during the operational phase of the monitoring program. (Table 6.1).

11.5.19 Frequency of Monitoring of Sediment, Benthos and Aquatic Plants (LWC, A-38)

The guidelines in Regulatory Guide 4.8 recommend these samples be taken semiannually, preferably at times of maximum seasonal activity. In view of the extremely low exposures predicted by these pathways even for the unusual pathway postulated for this location, we feel that this is adequate.

11.5.20 Sulfate Additions to the Ohio River (KAC, A-51)

Approximately 2500 times the amount of sulfates contributed annually by the Marble Hill Station flow by in the Ohio River each year. The figures for sulfate quantities on pages 3-21 of the FES and in Tables 3.6 and 3.7 are correct and consistent with each other.

11.5.21 Weather Effects from Cooling Tower Plumes (KAC, A-51)

Statistically perceptible precipitation increases downwind of large urban heat sources have been observed. The staff is not aware of similar empirical data for weather effects from large cooling towers.

11.5.22 Units in Table 5.18, Environmental Considerations for the Uranium Fuel Cycle (KAC, A-52)

The units in Table 5.18 have been corrected. In four instances, megatons were used in place of metric tons. There is no mistake regarding water use in Table 5.18 as claimed in the comment.

11.5.23 Suspended Solids in Blowdown (EPA, A-20; SOI, A-29; COE, A-8)

A sizable fraction of the suspended solids in the makeup water will settle in the basins of the cooling towers and will be removed periodically. The procedure for cleaning the basins is described by the applicant in Reference 1.

11.5.24 Chemicals in Blowdown (EPA, A-20)

The average free residual chlorine concentration in the blowdown was estimated to be 0.05 mg/l. See Reference 1 for more detailed information.

11.5.25 Interactions between Trophic Levels (EPA, A-21)

Impacts due to interactions between trophic levels are estimated to be small and undetectable,[1] because the original effects on each level are small.

11.5.26 Effect of Drift on Air Quality (SOI, A-28)

The staff expects offsite effects of drift on air quality to be small since almost all of the drift will deposit on the site (Section 5.3.1).

11.5.27 Massive Radioactive Contamination of the Ohio River (CK, A-32)

The probability of massive radioactive contamination of the Ohio River by the Marble Hill Station is so small (see Section 7) that no "self-protective measures" by the Louisville Water Company are needed.

11.5.28 Health Effects on People
(CK, A-33; LGSC, A-49)

Doses to people living near the plant or near waste transportation routes are so small compared to natural background that no danger-to-health thresholds are approached (Section 5.4.1). The NRC evaluation is made on the basis that radiatic from the station will be small compared to the variations in natural background radiation. .refore, effects will be undetectable. Further, individual doses must comply with Appendix I of 10 CFR 50.

11.6.1 Indiana Bat Survey
(SV, A-43)

See detailed discussion in Section 4.3.1.

11.6.2 Use of Ion Exchange in Conjunction with Gamma Scans
(SOI, A-29)

Table 6.1 contains the notation "Gamma scan, I-131." This means that both analyses are to be done, just as the agency has suggested. Nothing specifically states than an ion exchange system is to be used to analyze for I-131, but it is understood that in actual practice this is the only method appropriate for the required level of minimum detectable activity.

11.6.3 Monitoring Programs
(LGSC, A-49)

The pre-operational monitoring programs are described in Section 6.

11.6.4 Methodology of Biological Monitoring
(EPA, A-19)

The aquatic ecological data which appears in the DES has in many instances been generalized or summarized from much more detailed studies appearing in Subsection 2.7 of the ER. In addition, Subsection 6.1 of the ER contains a full treatment of all methodologies used.

11.6.5 Biological Data on Offsite Streams
(EPA, A-21)

The impact of transmission lines on streams over which they pass is expected to be of a temporary nature and should have no long-term effects upon fish standing crops and relative abundance, in light of our protective environmental conditions (Section 4.5.2). These short-term impacts do not justify the time and expense of a stream-by-stream fish study. Likewise, minor short-term impacts of transmission line construction will have no conceivable impact on downstream phytoplankton populations (Section 4.3.1.2).

11.6.6 Reliability of Aquatic Data
(EPA, A-21)

Other references cited in the same paragraph are considerably more recent, dated 1972, 1973 and 1974. The phytoplankton data collected in 1974-1975 are comparable with the earlier data.

It was not possible to sample natural substrates for periphytic algae during the Marble Hill baseline study for several reasons, including (1) suitable natural substrate type was rare in that area of the Ohio River, (2) suitable substrates that were located were highly scoured and did not yield useful data, and (3) fluctuating water levels between samplings further complicated selection of suitable natural substrates. Artificial substrates were used as a practical compromise.

11.6.7 Groundwater Monitoring
(DOI, A-13)

The staff believes that the most dependable early observations of radioactive leaks to groundwater will be obtained from surface water samples from Little Saluda Creek and the Ohio River. However, groundwater radioactivity will also be monitored at the onsite well for potable water (NE corner of the site) and in another onsite well in the Ohio River alluvial-glaciofluvial aquifer southeast of the plant structures.

11.7.1 Safeguards Against Sabotage and Terrorist Attacks
(CK, A-35)

A safeguards program has been in effect for many years to protect against theft, diversion and sabotage in connection with the production, processing, storage and transportation of radioactive and special nuclear materials, such as plutonium. Continuing development programs are being actively pursued by both NRC and ERDA to improve the techniques and cost-effectiveness of existing safeguards systems, as well as to adapt them to the changing requirements of evolving nuclear technology. These developments are described in some detail in the statement of R. G. Page on November 18 75 before a committee of the California legislature (NUREG 75/114), and are summarized in the ERDA Weekly Announcement for the week ending April 30, 1976.

In view of past experience and the increasing emphasis on safeguards research and development, the NRC and ERDA are confident that safeguards problems associated with the expanding nuclear industry will continue to be satisfactorily resolved.

11.7.2 Reactor Safety Study (Rasmussen Report)
(RS, A-48; JNE, A-51; LGSC, A-50)

The Reactor Safety Study (referred to in the comment as the "Rasmussen Report") was originally sponsored by the U. S. Atomic Energy Commission, and was completed under the sponsorship of the U. S. Nuclear Regulatory Commission which came into being on January 19, 1975. The study was conducted by about 60 people under the direction of Professor Norman C. Rasmussen of MIT, and required 70 man-years of effort. This notice is a standard statement routinely placed on all documents prepared by non-NRC individuals or organizations under contract to NRC; the "Reactor Safety Study" was, in large part, prepared by contractors for NRC. All contractors are required by NRC procedures to insert such language, consequently, the inclusion of the notice in the "Reactor Safety Study" should not be construed as reflecting any doubt in its contents by the NRC.

When the final report of the Reactor Safety Study was completed and published in October 1975, the then NRC Chairman William A. Anders said of it,

> "The Commission believes that the Reactor Safety Study report provides an objective and meaningful estimate of the public risks associated with the operation of present-day light water power reactors in the United States. The final report is a soundly based and impressive work. Its overall conclusion is that the risk attached to the operation of nuclear plants is very low compared with other natural and man-made risks. The report reinforces the Commission's belief that a nuclear power plant designed, constructed and operated in accordance with NRC's comprehensive regulatory requirements provides adequate protection to public health and safety and the environment. Of course, such regulatory requirements must be continually reviewed in the light of the knowledge, including that derived from a vigorous regulatory research program."

The staff's analysis of accidents in Section 7 did not rely on the Rasmussen Report as a basis for its evaluations and conclusions.

11.7.3 Adequacy of Accident Analysis
(JNE, A-51; LGSC, A-50; DVW, S-56)

The staff's position on releases of radioactivity to the river is given in footnote "a" to Table 7.2, as follows: "Our evaluation of the accident doses assumes that the applicant's environmental monitoring program and appropriate additional monitoring (which could be initiated subsequent to a liquid release incident detected by in-plant monitoring) would detect the presence of radioactivity in the environment in a timely manner such that remedial action could be taken if necessary to limit exposure from other potential pathways to man. Postulated accidental releases are considered further in the Safety Evaluation Report.

11.7.4 Assumptions Regarding Postulated Accidents
(DVW, A-56)

The staff is not aware of any occurrences at operating nuclear power plants which make the assumptions used to estimate radiological consequences questionable.

11.7.5 Calculations of Accident Doses
(KAC, A-52, DOI, A-15; KAC, A-52)

Table 7.2 includes calculated radiation doses to an assumed individual at the site boundary as a fraction of the 10 CFR Part 20 limit of 500 mrem, not in terms of radioactivity released to the environment as implied by this comment. Table 7.2 also shows estimated integrated radiation exposure to the population within 50 miles. These integrated exposures, as stated in the text, are well within naturally occurring variations in the natural background. The staff's position on Class 9 accidents is stated in Section 7 of the environmental statement. Footnote "a" to Table 7.2 discusses releases of radioactivity to pathways other than airborne transport (see Section 11.7.3).

11.7.6 Health Effects from Radiation
(KAC, A-52)

When absorbed dose is measured in rem, the health effects of different kinds of radiation are the same per rem absorbed.

11.7.7 Need for a Redundant Makeup Water Supply
(LGSC, A-49)

If the makeup pumps all failed because of a river accident or a flood, the nuclear reactors would be shut down and safely cooled by the water contained in the cooling tower basins. This reservoir (Ultimate Heat Sink) will be discussed in the Marble Hill Safety Evaluation Report which is scheduled to be issued in the near future.

11.7.8 Emergency Plans
(CK, A-33,36)

Emergency plans are considered in the safety review and will be specified in the Safety Evaluation Report.

11.8.1 PSI's Efforts on Conservation of Energy
(DVW, A-56)

Measures taken by the applicant to encourage energy conservation are discussed in the response to Question 6 in Supplement 1 of the ER.

11.8.2 Calculations in Table 8.16 of the DES
(SAS, A-54)

The staff's forecast in Table 8.16 used a growth rate of 6% per year in peak demand. In the final statement projections are given for growth rates of 5.0% per year and 6.5% per year. The staff considers that projected growth rates are uncertain to the extent represented by this range.

11.8.3 Need for Power
(SV, A-44)

The staff assessment is described in Section 8. Many sources in addition to those recommended in comments were considered by the staff.

11.8.4 Consequences of No Project
(FEA, A-27)

The principal consequence of no project would be that electrical power judged to be necessary for the PSI service area would not be available when it was needed.

11.8.5 Need for Power Evaluations
(DVW, A-56; ERDA, A-17)

The staff, in its evaluations of the several elements contributing to the need for power in Section 8, discussed the bases for its evaluations and the uncertainties involved in these assessments. The conclusions in Section 8 represent the best estimates of the staff regarding both energy requirement and needed peak load capacity, and the separate factors influencing them. Among the factors considered were conservation measures, peak-load or time-of-day pricing, promotional advertising, dissemination of conservation information, and increasing block rates. The Energy Research and Development Administration is making substantial efforts in the interest of energy conservation, with emphasis on load management techniques, innovative rate structures, and the possible use of advanced technologies, such as solar energy and disaggregated power generation systems.

The range of uncertainty in estimating the combined effect of these factors is indicated in the range of projected demand growth rates from 5.0 to 6.5% per year.

11.8.6 FEA National and Regional Demand Forecasts
(FEA, A-25)

In developing its demand forecast for the PSI and NIPSCO service areas for the final statement, the staff availed itself of the updated 1976 "National Energy Outlook". Both the national and regional forecasts were considered. The national forecast was particularly useful since it provided projections for a variety of assumptions regarding the factors affecting demand.

11.8.7 Evaluation of Population Projections
(FEA, A-26)

Two additional population projections were incorporated in the final statement (Section 8.2.3.2).

11.8.8 Demand Forecast
(LGSC, A-50; DVW, A-56)

Electrical demand may not be reliably predicted from one or two years' data.

11.9.1 Projections of Fuel Costs
(LGSC, A-50)

Sources in several governmental agencies (FPC, FEA, ERDA, EPA) were consulted by the staff in arriving at a method for projecting fuel costs (Section 9.1).

11.9.2 Use of Dry Cooling Towers
(LGSC, A-50)

The staff conclusion remains (Section 9.3.1.8) that dry cooling towers may not be economically or environmentally justified in the PSI service area under present circumstances. Information supporting this conclusion is presented by the applicant.[1]

11.9.3 Average Capacity Factor of Nuclear Power Plants
(LGSC, A-50)

The staff expects that the average capacity factors for large nuclear plants will increase with time as initial operating problems are solved and as operating experience accumulates. The staff considered capacity factors of 50%, 60% and 70% in evaluating the relative costs of power generated from nuclear fuel and coal.

11.9.4 Discussion of Power Cost Calculations
(LGSC, A-50)

The revised version of Section 9.1.2 contains a fuller discussion of the methods of cost calculations.

11.9.5 Uncertainties Regarding Nuclear Power
(DVW, A-56; RS, A-48)

A vast amount of information and basic technology is in existence for solving problems in the areas of uranium supply, waste disposal (See Sections 11.5.7 and 11.10.6), and plant decommissioning. Both NRC and ERDA are confident that demonstrated technologies and satisfactory regulatory procedures will be available in all these fields when they are needed by the nuclear industry.

11.9.6 Effect of Atomic Power Plants on the Coal Industry
(DVW, A-56)

Most forecasts indicate that increasing amounts of coal will be needed for power generation with the nuclear power industry growing as fast as it is able to.

11.9.7 The Coal Alternative
(FEA, A-27)

Table 9.1 comparing economic costs has been revised and provided with supporting discussion.

11.9.8 Natural Draft Cooling Towers
(FEA, A-27)

Overall costs are usually not far apart for natural draft and mechanical draft cooling towers. The applicant's analysis indicated an advantage economically for the mechanical draft alternative.

11.9.9 Solar and Wind Power Alternatives
(RS, A-48)

Additional information on these alternatives was included in Sections 8.2.4 and 9.1.2.1 of this statement.

11.9.10 Premature Plant Completion
(SAS, A-53)

In Section 9.1.1, it was pointed out that premature completion of the Station would have a small economic cost.

11.9.11 The Feasibility of the Coal Alternative
(KAC, A-52)

While Section 9.1.2 showed a small advantage economically and environmentally for the nuclear-fueled plant over the coal-fired plant, the coal plant was considered a viable and competitive alternative.

11.9.12 Power Costs from Plants using Various Fuels
(SAS, A-55)

The portion of the Electrical World article quoted considered only capital costs for constructing power plants. The total operating cost comparison, including fuel costs, in the same article indicates the nuclear alternative provides the cheapest power. The staff analysis given in Table 9.1 reaches the same conclusion.

11.9.13 Comparative Employment Opportunities
(CK, A-33)

For electrical power generation, the entire fuel cycle for coal-fired plants requires about 50% more employees than the fuel cycle for power plants using nuclear fuel.

11.9.14 Alternative Sites farther from Population Centers
(CK, A-33)

There are few sites in Indiana in areas of comparably low population density and as far removed from population centers.

11.10.1 Effect of Power Plants to be Built Nearby
(SV, A-45; JNE, A-51)

The staff foresees no serious environmental impacts from the interactions of the Marble Hill Station with existing or planned power plants.

11.10.2 Impacts of Transmission Lines
(SV, A-45)

In response to the staff's request, the applicant specified distances of lines from important natural areas and explained to the staff's satisfaction why separations could not be greater. Although the precise routing of the remainder of the corridors is not known at this time, the staff assessed biotic effects on the basis of the characteristics of the ecosystems in the vicinity of the proposed route. (See page A-63)

11.10.3 Lead Agency
(RS, A-48)

The NRC is the lead agency for the Marble Hill Station.

11.10.4 Groundwater Consumption
(DOI, A-14)

Table 10.3 indicates the use of 200 gpm from wells for potable water during plant operation and up to 600 gpm during plant construction. This withdrawal will have negligible impact on the aquifer. (See Section 11.2.7)

11.10.5 Decommissioning Costs
(SAS, A-55; RS, A-48)

At the end of its useful life, the Marble Hill plant will be decommissioned according to regulations or guidelines in effect at that time. If the decommissioning procedures will be not greatly different from those used to decommission several nuclear plants recently, the cost will be a small fraction of the construction cost, and will not greatly affect the costs in Table 10.3. Also see footnote "b" to Table 9.1.

11.10.6 Adequacy of Uranium Supply
(CK, A-33)

The ERDA assessment of uranium resources indicates that currently estimated U.S. resources would be adequate to allow fueling of substantially more nuclear power plants than all those now operable, under construction, on order and announced, without recycle of uranium or plutonium. Further expansion of U.S. uranium supplies is possible by discovery of new low-cost resources, utilization of higher cost resources or importation of foreign uranium.

Prices for uranium have increased to levels that make exploration and production economically attractive. Industry exploration and development activities are increasing.

References

1. Letter of June 7, 1976 from James Coughlin of PSI to B. J. Youngblood of NRC, giving PSI responses to comments on the Draft Environmental Statement.

2. Site Suitability Report on the Marble Hill Nuclear Generating Station, Unit Nos. 1 and 2, July 1976.

APPENDIX A

COMMENTS ON THE DRAFT ENVIRONMENTAL STATEMENT

Advisory Council
On Historic Preservation
1522 K Street N.W.
Washington, D.C. 20005

STN-50-546
50-547

March 16, 1976

Mr. B.J. Youngblood
Chief, Environmental Projects Branch 2
Division of Site Safety and Environmental
Analysis
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Youngblood:

Thank you for your request of March 5, 1976, for comments on the environmental statement for the Marble Hill Nuclear Generating Station, Units 1 and 2, Jefferson County, Indiana. Pursuant to our responsibilities under Section 102(2)(C) of the National Environmental Policy Act of 1969 and the Council's "Procedures for the Protection of Historic and Cultural Properties" (36 C.F.R. Part 800), we have determined that your draft environmental statement mentions properties of archeological and historical significance; however, we need more information in order to evaluate the effects of the undertaking on these resources. Please furnish additional information indicating:

Compliance with Executive Order 11593 of May 13, 1971 (16 U.S.C. 470). The environmental statement must demonstrate that either of the following conditions exist:

1. A property eligible for inclusion in the National Register of Historic Places is not located within the area of environmental impact, and the undertaking will not affect any such property. In making this determination, the Council requires evidence of consultation with the appropriate State Historic Preservation Officer and evidence of an effort to ensure the identification of such properties. The Council recommends that comments of the State Historic Preservation Officer be included in the final environmental statement.

2. A property eligible for inclusion in the National Register is located within the area of environmental impact, and the undertaking will or will not affect any such property. In cases where there will be an effect, the final environmental statement should contain evidence of compliance with the Executive Order through the Council's "Procedures for the Protection of Historic and Cultural Properties" (36 C.F.R. Part 800).

2743

The Council is an independent unit of the Executive Branch of the Federal Government charged by the Act of October 15, 1966 to advise the President and Congress in the field of Historic Preservation.

Should you have any questions on these comments or require any additional assistance, please contact Jordan E. Tannenbaum of the Advisory Council staff at (202) 254-3380.

Sincerely yours,

John D. McDermott
Director, Office of Review
and Compliance

AGRICULTURAL RESEARCH SERVICE
WASHINGTON, D.C. 20250

UNITED STATES DEPARTMENT OF AGRICULTURE

OFFICE OF ADMINISTRATOR

4-20-76

April 15, 1976

5+N-50-546
547

Mr. B. J. Youngblood
Division of Site Safety and
Environmental Analysis
Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Youngblood:

In response to your letter of March 5, we have reviewed the Draft Environmental Statement related to the construction of the Marble Hill Nuclear Generating Station, Units 1 and 2, and have no comments.

Sincerely,

H. L. Barrows
Deputy Assistant Administrator

3793

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
NORTHEASTERN AREA, STATE AND PRIVATE FORESTRY
6816 MARKET STREET, UPPER DARBY, PA. 19082
(215) 596-1671

8400
April 16, 1976

Mr. B. J. Youngblood, Chief
Environmental Projects Branch 2
Division of Site Safety and
Environmental Analysis
Nuclear Regulatory Commission
Washington, D.C. 20555

Refer to: 50-546 & 50-547,
Draft Environmental Statement,
Marble Hill Nuclear Station
1, & 2, IN

Dear Mr. Youngblood:

Our Milwaukee Office has forwarded the above statement to us for review as no National Forest lands are involved.

We are concerned chiefly with reestablishment of vegetation on construction sites and transmission line rights-of-way. Though we haven't seen Indiana's guidelines for other States and for the National Forests. No doubt the applicant is following procedures originated by F.E. Egler and others.

Monitoring the seeding and planting program, including replacement of topsoil, at critical points will ensure restoration of stable conditions. Mulching may be necessary to protect newly established vegetation in some cases. We agree with the plans to plant dogwood and other small trees in the area. It appears that the applicant is avoiding the development of square corners which detract from optimum aesthetic values.

RECEIVED APR 20 1976

3964

2.

Thank you for the opportunity to review this Draft Statement.

Sincerely,

DALE O. VANDENBURG
Staff Director
Environmental Quality Evaluation

UNITED STATES DEPARTMENT OF AGRICULTURE 5+N-50-546 547
SOIL CONSERVATION SERVICE
5610 Crawfordsville, Suite 2200, Indianapolis, Indiana 46224

April 16, 1976

Mr. B. J. Youngblood, Chief
Environmental Projects Branch 2
Division of Site Safety and Environmental Analysis
United States Nuclear Regulatory Commission
Washington, D.C. 20555

4-22-76

Dear Mr. Youngblood:

The Soil Conservation Service has reviewed the Draft Environmental Impact Statement for Marble Hill Nuclear Generating Station Units 1 and 2, Jefferson County, Indiana.

Specific comments relating to soil and water resources are as follows:

1. In the first paragraph of section 2.2.1 we feel pasture should be included as a land use. In the same paragraph, we question the word "vegetable" and recommend the word grain in its place.

2. In paragraph four of the same section we believe the remaining 34 percent of agriculture land is primarily pasture and hayland.

3. In paragraph 2.4.1.2, the glacial deposits referred to are of Illinoian Age and have a moderate to strong acid reaction in the subsoil. Any potential impact this may have on the planned subsurface construction materials should be addressed. Also in this paragraph, Silurian is misspelled.

4. The soils section 2.4.1.3, although brief, appears to be adequate for the purpose of this EIS.

5. Proposed erosion control measures are mentioned in 4.3.1.1 Site subsection of 4.3 Ecological Impacts. These measures are mentioned again in section 4.5.1.1 Applicants Commitments for Onsite Practices, but stockpiling of topsoil is omitted. The Final EIS should contain more detailed commitments including specific measures to be taken both during and after construction. These include time of year, consideration of stripping only a portion of the 250 acres at one time if feasible, the use of mulches and nurse crops for quicker stabilization, and fertilization if needed.

3974

Mr. B. J. Youngblood - page 2

6. Further explanation is needed as to why 250 acres will be stripped of vegetation when only 130 acres will be utilized for buildings, roads, transmission corridors, and other constructed facilities as stated in section 4.1.1.

If you have further questions concerning the above comments, please contact:

Bruce L. Stevens, Soil Conservationist
204 East Main Street
Paoli, Indiana 47454

We appreciate the opportunity to comment on this proposed project.

Sincerely,

Acting

Cletus J. Gillman
State Conservationist

cc: CEQ - 5 copies
Administrator, SCS, Washington, D.C.
Dr. Fowden F. Maxwell, Coordinator, EQ Activities, Washington, D.C.
Wm. Reichenbach, A.C., North Vernon, Indiana
David Howell, D.C., Madison, Indiana

DEPARTMENT OF THE ARMY
LOUISVILLE DISTRICT, CORPS OF ENGINEERS
P. O. BOX 59
LOUISVILLE, KENTUCKY 40201

ORLPD-R

STN-50-546
547

3 June 1976

Mr. B. J. Youngblood
Chief
Environmental Projects Branch
Division of Site Safety and
Environmental Analysis
U.S. Nuclear Regulatory Commission
Washington, D. C. 20555

RECEIVED 6-10-76 U.S. NUCLEAR REGULATORY COMMISSION

Dear Mr. Youngblood:

In response to your request, we have reviewed the draft environmental statement for Marble Hill Nuclear Generating Station, Units 1 and 2. We offer the inclosed comments for your consideration.

The opportunity to review and comment on this draft statement is appreciated.

Sincerely yours,

JAMES N. ELLIS
Colonel, Corps of Engineers
District Engineer

1 Incl
As stated

5747

General Comments.

The numerous references to the Applicant's Environmental Report have resulted in omissions of much pertinent information. These omissions would not allow an informed analysis of the draft environmental statement by agencies or individuals not possessing the Applicant's report.

Although this office is not "lead agency" on this action, the intake and discharge structures for the Marble Hill Station will require Department of the Army Permits pursuant to Section 10 of the River and Harbor Act of 1899 and possibly Section 404 of Public Law 92-500. Transmission line crossings of streams will also involve DA Permits. Public interest determinations on these permits will be considered based on the final environmental statement and other pertinent planning and design documents available at that time.

Specific Comments.

Section 1.3 - Status of Reviews and Proposals.

A listing of permits, approvals and licenses required for the proposed project would be helpful. The status of each permit could also be indicated.

Section 2.2.3 - Recreation.

The extent to which the site is presently being used for hunting and fishing could be included.

Section 2.3.1 - Surface Water.

The Ohio River supports much recreation and is a significant recreational feature in the region. The use of the Ohio River as a major transportation route should be included.

Section 2.4.2 - Seismicity.

A graphic representation to indicate regional seismic zones based on Modified Mercalli intensity and any known historical epicenters in regional proximity could be delineated.

Section 2.5 - Hydrology.

This portion of the river should be designated "Ohio River - McAlpine Pool."

Figure 2.4

This figure should be updated to include Cannelton, Newburgh and Uniontown Locks and Dams which have replaced Locks and Dams 43 through 49.

Section 2.5.3.1 - Surface Water.

Much data is presented in this section but it lacks a narrative summary to indicate the relative water quality at the project location. Historical heavy metals analysis presented in Table 2.4 should be updated with STORET information. A copy of a STORET printout, dated 13 March 1975, for various points along the McAlpine Pool is inclosed for your information. *

Section 2.7.2 - Aquatic.

The main thrust of the aquatic section lacks a descriptive summary of species present in the project area waters. The direct comparisons made between the Ohio River and Little Saluda Creek are irrelevant since one would expect wide differences. The use of the Muscatatuck River as an indicator of the other 50 streams involved in stream crossings is very general since it is not likely to be comparable to all other streams involved.

Section 2.7.2.2 - Phytoplankton.

The reference to phytoplankton in the 50 offsite streams would be clearer with the inclusion of sampling data to substantiate the premise.

Zooplankton.

A listing of zooplankton would be helpful, especially indicating species that occurred in only the Ohio River or Little Saluda Creek. A conclusion of the relative importance of the data provided would aid reviewers of this statement.

Benthos and Macroinvertebrates.

The information provided does not give a basis to allow conclusions to be drawn. If a comparison between populations of oligochaetes and pelecypods is to be drawn, differences are likely to be variations of oligochaete populations since populations of Asiatic clams may well be constant. The wide variations in pelecypoda biomass estimates in the Ohio River should be discussed.

Ichthyoplankton.

Table 2.14 could be arranged taxonomically.

Fish.

A discussion could be provided as to method(s) used to provide information of occurrence and abundance.

2

* The copy of the STORET printout is not reproduced herein. Copies are available for inspection in the NRC Public Document Room in Washington, D. C. and the Madison-Jefferson County Public Library in Madison, Indiana.

General Life-History Features

The discussion of the 51 streams to be crossed by transmission lines is over-generalized. The discussion is based on information from the Muscatatuck River which does not necessarily characterize the other streams. Table 2.15 and 2.16 could be arranged in taxonomic order.

A determination should be made of the importance of the underwater terrace as a spawning area. This would be very important in the design and location of the discharge structure.

Special-Status Fishes.

A discussion of "legal protection" would be helpful. Some indication if this relates to total protection or size-season only would be helpful.

Section 2.7.3 - Transmission Corridors and Railroad Spur. This section fails to provide a sufficient word-picture of the quality and diversity of habitats that these facilities will affect. This applies to both acuatic and terrestrial flora and fauna. It does not provide a basis of information to logically discuss potential impacts in following sections.

Table 2.17

It is suggested that this table be arranged in taxonomic order. The spawning temperatures could be presented in ranges rather than specific temperatures.

Table 3.7.

Ohio River data presented could be updated per STORET information.

Section 3.6.1.3 - Miscellaneous.

A discussion of how the applicant intends to restrict discharge TDS levels to 1500 ppm would be helpful.

Section 3.7 - Power Transmission System.

Archeology is not discussed in Section 2.9 as indicated.

Section 4.2.1 - Surface Water.

A further elaboration on the correlation between the lack of water withdrawals and water quality impacts could be included in the FES.

Section 4.3.1.2 - Corridor Impacts - Terrestrial.

Several points involving the use of herbicides should be clarified in the FES.

A. The use of the word "should" in the required staff precautions tends to confuse the reader. As used here, it appears to indicate options.

B. It is confusing to suggest that select basal or stump applications will or can be performed aerially with the degree of preciseness indicated by the requirements. Drift, for example, could well violate distance restrictions from water bodies.

C. It is also suggested that additional requirements be promulgated for wetland areas.

D. The rationale for the specified distance from water bodies indicated for no aerial spraying should be included in the FES.

It is extremely unclear as to how a determination of breeding and/or nesting areas is to be accomplished. The DES does not establish that surveys have been made to a degree necessary so that species will not be located within the rights-of-way.

If alternative route locations are provided by the applicant, it would be helpful to have them included in the FES.

Section 4.3.2.1 - Aquatic-Runoff.

It is agreed that surface runoff may create only minor increases in Ohio River turbidity. The impacts to Little Saluda Creek from the high turbidity levels should, however, be addressed.

Section 5.3.1 - Heat Transfer.

The potential interaction of the cooling tower plume from Marble Hill with the cooling tower plume from Louisville Gas and Electric's planned Wise's Landing Plant could be discussed.

Section 5.3.2 - Intake.

The discussion of impingement should include the impact on fish populations from the loss of individuals listed in the narrative.

Section 5.3.3 - Discharge.

Some confusion exists in this discussion since no statement is made to indicate if the referenced standards will be exceeded and, if so, how often and for what periods of time. For the sake of the lay reader, a summary would be helpful to discuss what may appear to be violations.

Section 5.3.3.6 - Biological Impacts.

The discharge plume may act as a deterrent to normal fish movement by acting as an attractor and "hold" fish during spawning and migration. These thermal effects would not likely be the same as a thermal block and, upon examination, may be significant.

Section 5.4.1.3 - Doses from Radioactive Liquid Releases to the Hydrosphere

This section, and Table 5.11, discusses "Conservative Estimates" of hydrologic transport and dispersion. An indication of whether this is the best case, worst case, most optimistic case, etc. should be included.

Table 5.14

A laymans definition of exposure and tolerance levels would be helpful.

Section 5.5.1 - Chemical Effluents.

The discussion of the chemical effluents meeting applicable criteria indicates qualifications references in other sections. These qualifications could also be listed here for clarity.

Section 5.5.3 - Sanitary Wastes.

The level of tertiary treatment should be defined.

Section 5.5.5.1 - Chemical Effects.

The anticipated concentrations of metals and other parameters of the discharge discussed should reflect updated water quality parameters.

Section 5.5.5.2 - Biocidal Effects.

The referenced Section 5.3.3.7 does not deal with chemotoxicity.

Table 5.17.

An additional column to include the anticipated discharge concentrations would be helpful for comparison.

Section 5.8.4.2 - Onsite Impacts.

Views of the station from the Ohio River will likely be restricted by topography. The station will be visually obvious from the uplands regardless of tree cover.

Section 9.3.2 - Intake.

A discussion of any proposed changes to the intake system should be included in the FES.

Section 9.3.3. - Discharge.

The results of the evaluation of alternative discharge structures should be included in the FES.

Section 9.3.4.2 - Biocidal.

Section 5.5.5.2 discusses potential impacts of residual chlorine in the discharge. Ozone would seem to be a viable alternative with multiple injection points a possible solution to reinoculation of the water by algae. Marble Hill has the capability for the generation of ozone on-site which might make this biocide cost-effective and environmentally more acceptable.

Appendix C - Fish Species.

An indication of those species verified by field studies, along with an indication of project impact for each species, would be desirable.

During the review of this statement, the following observations were made and are supplied for your information.

Section 2.2.1 - Agriculture.

A diagram to describe the existing land use of the project site would be more definitive. Also, an indication of the relative productivity of the land required for the project would be beneficial.

Section 2.6 - Meteorology.

This section could include a discussion of the ambient air quality at the project site. At a minimum, the discussion could include the Southern Indiana Air Quality Control Region, any assigned priority levels and ambient levels of SO_2, NO_x, Co, particulates and photochemical oxidants.

Section 2.7.1.1 - Terrestrial Vegetation.

This discussion does not provide a reasonable characterization of the vegetation present on the project site or its distribution. The discussion could be in terms of plant communities with more detail to canopy, understory and ground cover species. The ecological relationships and habitat quality of the plant communities could also be explored.

The pine forest is indicated to be unique but this could be elaborated to discuss the type(s) of pine, the criteria used in determining it to be unique, its significance and if it will be involved in the station construction.

The term "ecotone" is incorrectly used. The description provided indicates the area is a "sere." The species composition of this area could be included.

"Plain plantain" should be defined. More information could also be provided on the understory species of the flood plain forest.

A more complete discussion of the hardwood forest could be included. The differences between upland and hillside forests are unclear. Figure 2.8 could be revised to reflect these differences.

Floral species identified at the Marble Hill site and along transmission corridors could be compared to the Smithsonian report list of threatened or endangered flora.

Section 2.7.1.2 - Animals.

Invertebrates.

A narrative could be included to, at least, summarize orders found in sampling programs and also include a discussion of vector populations.

Amphibians and Reptiles.

A narrative could be included to provide a representation of species identified on site.

Birds.

Table 2.8 could include references used to compile the list, those species presumed to occur on the site and those actually identified on the site. This could possibly be accomplished by adding an additional column to the list.

Mammals.

More discussion of nongame species would be helpful. Species discussed include those that may be of interest to hunters or trappers but do not provide a representation of project area mammal populations.

Protected Species.

This heading may actually be a misnomer. The heading may more aptly be "Endangered, Threatened or Rare Species." The discussion would be enhanced by the use of the current USDI listing and the Federal and state status of each should be noted.

Section 2.9.1 - Region.

A discussion of the cultural history of the region, prehistoric through historic, could be provided in this section.

Section 2.9.2 - Site.

The cemetery, two houses and 12 archeological sites mentioned could be evaluated in terms of significance and eligibility to the National Register of Historic Places. A copy of the initial archeological survey report would add useful information if it would be appended in the FES; however, exact locations should be withheld to prevent "Pothunting."

The aesthetic portion of the section could be expanded to discuss the scenic characteristics of each portion of the site. The rationale for indicating the northern portion of the site as "attractive" would be helpful.

Section 4.1.1 - Onsite.

The discussion of agricultural production would be enhanced by adding a section on production in terms of bushels/year and typical production of these lands in terms of bushels. The value of $16,000 indicated appears to be low. This discrepancy should be discussed.

A discussion of how many ponds will be affected would be helpful, exactly what "lost" implies and what the impacts will be.

The impacts of construction noise could be elaborated to indicate the decibel increase and probable impact on local residents.

The discussion of "severe" short-term construction impacts to Little Saluda Creek could be expanded.

Section 4.1.2 - Transport‥ion.

The impacts related to the different methods could be discussed.

Section 4.1.3 - Transmission Corridors and Railroad Rights-of-Way.

There appears to be a discrepancy in the annual forestry loss. It seems that the figure should be approximately $110,000 annually. Also, an expanded discussion of the possible loss of productivity of all lands involved in these corridors could be presented to include at least annual production losses.

Section 4.3.1.1 - Site Impacts - Terrestrial.

The amount of hardwood forest to be lost could be expressed in acres, with a distinction between upland and hillside woods.

The clearing of vegetation will remove habitat and likely cause a reduction in species populations. Displacement only will not be the likely end result for some individuals. This elaboration could be included in the FES.

An indication of which reptile species will be affected by pond removal would be helpful.

The impacts likely on secretive species displaced could be discussed.

The osprey may lose habitat if construction of intake and discharge pipelines causes removal of vegetation in the east-slope area. If the Indiana Bat does also occur, it too would likely be impacted. A more thorough investigation to determine if the Indiana Bat is present is necessary.

The three raptors on the Audubon "Blue List" that may be affected by construction would be useful information.

Section 4.4.1.1 - Physical Impacts-Pollutants.

A discussion of the program the applicant intends to use to control dust, noise, smoke, and exhaust would be useful if added in the FES.

Section 4.4.1.2 - Physical Impacts-Vehicular Traffic.

The applicant's plan for mitigating vehicular impacts could be included in the FES.

Table 4.3

A clarification of the terms used to describe "Expected Relative Significance" would be helpful.

Section 5.1 - Land Use.

The containment vessel will be visible in the uplands since most vegetation in the area will not exceed 50 to 75 feet.

The noise levels associated with plant operation could be discussed to indicate expected decibel levels and potential impacts.

Figure 5.5

It is suggested that the word " conceptualized" be added to the figure title.

Table 5.9.

Footnote 1 indicates that this table does not take into account that cows near the Marble Hill Station would likely eat hay and grain grown locally and also consume water. A figure of 1.0 may be more representative of the year fraction to be used.

Figure 5.6

It is suggested that the word "conceptualized" be added to the Figure title.

Table 5.16.

Some of the animals listed will receive radiation from both the atmosphere and the hydrosphere. A revision to indicate this is suggested.

Table 5.19.

A definition of terms used to describe "Relative Significance" should be provided.

Secti‥ ‥.8.2 - Housing and Demography.

This section could include a discussion of land value alterations near the Marble Hill Station.

Section 5.8.3 - Social Organization.

References 64 and 65 are not included in the table of references at the end of Chapter 5.

Section 10.1.2 - Biotic Impacts.

The extirpation of bobcats from the site could be discussed.

Stress on faunal species will likely result from habitat changes and may effect species populations with an adverse impact to present terrestrial fauna.

Table 10.4

The qualitative terms used to denote impact could be clarified.

They could also be replaced simply with the terms "negative" and "positive." The loss or alteration of 1300 acres of habitat is not necessarily "natural habitat". This implies pristine or unaltered.

Appendix B - Terrestrial Vertebrates.

These tables could be arranged in taxonomic order. Those species verified in the field should be noted. An indication of desired habitat and the project impact for each species would be desirable.

UNITED STATES DEPARTMENT OF COMMERCE
The Assistant Secretary for Science and Technology
Washington, D.C. 20230

April 19, 1976

50-546/547

Mr. B. J. Youngblood
Chief, Environmental Projects Branch 2
Division of Site Safety and
Environmental Analysis
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Youngblood:

This is in reference to your draft environmental impact statement entitled, "Marble Hill Nuclear Generating Station Units 1 and 2." The enclosed comments from the National Oceanographic and Atmospheric Administration are forwarded for your consideration.

Thank you for giving us an opportunity to provide these comments, which we hope will be of assistance to you. We would appreciate receiving ten copies of the final statement.

Sincerely,

Sidney R. Galler
Sidney R. Galler
Deputy Assistant Secretary
for Environmental Affairs

Enclosure -- Memo from: NOAA (4-12-76)

RECEIVED APR 2 0 1976 U.S. NUCLEAR REGULATORY COMMISSION

4068

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
ENVIRONMENTAL RESEARCH LABORATORIES
Silver Spring, Maryland 20910

April 9, 1976

APR 12 1976

TO: Director, Office of Ecology and Environmental Conservation

FROM: Isaac Van der Hoven

SUBJECT: Comments on NRC DEIS #7603.10
Marble Hill Nuclear Generating Station, Indiana

In regard to disposal to the atmosphere of radioactive gaseous waste, it would appear that 90 percent of the noble gases and 40 percent of the radioiodines are emitted during containment purges. There is no indication whether these releases are short-period (about an hour) or longer-period (several days). The frequency of such events is assumed to be 24 days per year per reactor by the NRC staff and 10 by the applicant's staff. If the releases are short-period and occur about once a month, the sector-average model used by NRC (see Draft Regulatory Guide 1.111 which replaced 1.DD mentioned in Table 5.8 of this DEIS) is inappropriate. Instead, the centerline model (eq. 3.116, p. 99, Meteorology and Atomic Energy, 1968) should be used with some estimate of the joint probability of any particular wind direction, wind speed and stability. If the releases are not random but, for example, occur at night because of operational procedures, this bias should be taken into account.

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

April 29, 1976

RECEIVED MAY 3 1976 U.S. NUCLEAR REGULATORY COMMISSION

S+N-50-546
547

Dr. S. Stanley Kirslis
Environmental Project Manager
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Dr. Kirslis:

The Draft Environmental Statement for the Marble Hill Nuclear Generating Station Units 1 and 2 (Public Service of Indiana) was reviewed by our Regional Office Facilities Engineering and Construction.

The proposed project is considered to have the potential of adversely affecting future HEW projects. It is requested that the final Environmental Statement include information on what steps will be taken to mitigate potential construction impact on schools, hospitals, housing and other community services.

Thank you for providing us the opportunity of reviewing the Draft Environmental Statement.

Sincerely,

Richard E. Friedman
Regional Director
HEW, Region V

cc: Charles Custard, OEA
Warren Muir, CEQ

United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

RECEIVED MAY 6 1976 U.S. NUCLEAR REGULATORY COMMISSION

ER 76/212

MAY 3 1976

STN-50-546
STN-50-547

Dear Mr. Youngblood:

Thank you for your letter of March 5, 1976, transmitting copies of the draft environmental impact statement for Marble Hill Nuclear Generating Station, Units 1 and 2 (construction stage), Jefferson, Clark and Scott Counties, Indiana; and Carroll, Oldham and Trimble Counties, Kentucky.

Our comments are presented according to the format of the statement or by subject.

General

The Department is pleased to note that several fish and wildlife concerns raised during the review of the applicant's environmental report have been addressed in the draft statement. Also, the attention given in this statement to natural and cultural resources is commended.

Soils

The nearly continuous mantle of loess that covers areas of the proposed construction is described in the draft statement as having only poor to fair stability characteristics. However, the only discussion of resulting instability problems is limited to a very brief mention of proposed control of erosion by grasses and/or legumes. The final statement should discuss potential problems of slumping where surficial deposits are disturbed by construction, particularly in deep cuts or in construction of the intake and discharge pipelines on the steep bluff bordering the Ohio River, where slopes of about 60 percent would be traversed for a distance of about 400 feet. This slope is described as underlain by interbedded limestone and soft calcareous shale. The presence of a strong cap rock of Silurian dolomite beneath the flat upland on which the plant will be situated, overlying the soft shale exposed in the steep Ohio River bluff, creates a situation in which rock falls and slumps may be a significant

hazard. A considerable number of such slumps have occurred historically in the Ohio River valley and vicinity between Cincinnati and the site of Marble Hill Nuclear Generating Station. Consequently, this potential hazard and proposed measures to limit adverse impacts should be discussed in the final statement.

Groundwater Hydrology

In this statement, as in most relating to nuclear plants, water-table contours for the project area should be shown. This should be a standard practice, because the information presented on such a map is essential to any appraisal of the statement's evaluation of impacts of the proposed plant on groundwater. Such contours could, if necessary, simply be superimposed on other mapped data. They would be especially useful if included on a map showing wells, boreholes and monitoring points. Furthermore, in review of virtually every statement, at least average permeabilities or transmissivities and storage coefficients or typical effective porosities are needed and should be included in the summary presented in the statement.

Section 2.5.2 classifies the alluvial-glaciofluvial aquifer with the use of yield figure (e.g., "up to 3.3 cfs"). The meaning of such a reference should be explained; presumably this refers to a concept of "safe yield"; but, if so, the criteria for this categorizing should then be explained.

We note in table 6.1 that the proposed pre-operational radiological monitoring will involve sampling the "two closest wells." The statement should indicate at least the approximate locations and distances to these two wells, as well as the aquifer tapped by each. Furthermore, radiological monitoring should be done in at least one on-site observation well, which should be located down the groundwater hydraulic gradient from the plant site and sufficiently close to the plant to permit early observation of any movement of radioactive material during operation as well as the collection of meaningful pre-operational baseline data. Presumably on-site monitoring during operation will include observation of effects of salt deposition from cooling tower drift, either within the area of heaviest deposition or slightly down-gradient from it (sec. 5.3.1.5).

Table 10.4 indicates that use of 200 gpm of groundwater is an environmental effect of construction and operation of the plant. This apparently will be the consumption rate during operation; however, it seems that 600 gpm will be used during construction. We agree with the conclusion that withdrawal of 600 gpm of groundwater from the alluvium should have negligible impact on the aquifer. Nevertheless, the final statement should indicate these variations in water withdrawal.

Mineral Resources

In the Indiana area, Jefferson County produces sand and gravel, Scott County produces stone, and Clark County produces cement, stone, sand and gravel, and clays. Across the Ohio River in Kentucky, Oldham County produces stone and sand and gravel, and Trimble County produces sand and gravel. The sand and gravel in Jefferson County, Indiana comes from pits near Madison. The proposed project facilities would not conflict with any of the above operations. No other mineral resources that powerplant construction might affect are known.

Aquatic Biota

Because of the high quality sport fishery resource in the Muscatatuck River drainage to be affected by construction and maintenance of the transmission corridors, project impacts on fish and wildlife of all streams crossed by the transmission lines should be assessed in the final EIS.

In addition to clear cutting of vegetation along streambanks, streams intersecting the transmission corridors would presumably be altered by the construction of bridges or culverts to provide a project access road. The impact from alteration of streams and wetlands should also be discussed in the final statement.

The operation of the powerplant could affect fish spawning and nursery grounds in the reaches upstream and downstream from the station. Consistent with improvements of the water quality of the Ohio River, the final statement should assess how operation and/or redesign of the intake and discharge structures and discharges of chlorine would impact on adult, juvenile and larval forms in the fishery of the Ohio River.

Protected Species

We support the staff's requirement that the applicant sponsor a survey by a qualified expert to determine if the Indiana bat inhabits the site as noted on page 6-5. The statement indicates that the Indiana bat has been frequently recorded in Jefferson County, and therefore is likely to be found on the proposed site.

We note it is likely that the bobcat inhabits the site area as "Bobcat tracks and scats were found on the site during the ecological studies," and that the site provides excellent habitat for the bobcat. If construction and operation of the proposed power plant is likely to destroy suitable habitat for this protected Indiana species, it is recommended that this problem be addressed more fully in the final statement and plans be made to mitigate for this loss. Since the bobcat is on Indiana's rare and endangered species list (Discretionary Order W-12 IC 1971, 14-2-3-3), but not on the Federal list, it is suggested that this problem be coordinated with Indiana Department of Natural Resources.

The draft statement indicates that construction noise and loss of habitat are likely to force the bobcat to emigrate from the proposed site. It is considered unlikely that the bobcat would find nearby suitable habitat since we believe there is no adjacent suitable habitat for the bobcat.

Regional and Local Landmarks

To our knowledge, no natural or historic landmarks or sites listed on the National Register of Historic Places will be affected by the proposed powerplant and transmission line construction. The statement in this section concerning the falls of the Ohio is no longer correct as the Officer's Woods Natural Area about 13 miles north of the plant site (identified in Section 3.71, page 3-25, and in Figure 3.10) is now listed on the National Registry of Natural Landmarks (see Federal Register for May 5, 1975).

Intake Structure

It is noted that no fish-diversion mechanism is incorporated in the intake-structure design. Also, it is indicated that aquatic biota will not be replaced into the river after removal by the vertical traveling debris screens. We recommend that the redesigned intake structure provide a fish screen and bypass mechanism that will return aquatic biota to the river with minimal damage. Fish should be screened at the entrance to the water intake mechanism.

Biocidal Effluents

The text suggests that chlorine concentrations in the effluent will increase as operations of the power plant are expanded. Effort should be made to reduce chlorine residual concentrations to levels which are non-toxic to aquatic life.

Power Transmission System

Natural resources along the transmission lines have been carefully considered in this section and the intent to conduct archeological surveys of all areas to be disturbed by plant or transmission line construction is expressed in Sections 4.1.1 and 4.13. However, no statement is made about the presence of historic structures along the transmission lines. We suggest that the State Historic Preservation Officer (SHPO) be consulted for confirmation, and if any such structures are known to be present, that the services of a qualified architectural historian be engaged for a survey of such areas.

Any historic or archeological sites or structures located which may be eligible for addition to the National Register of Historic Places should be evaluated, in consultation with the SHPO, according to the procedures set forth in 36 CFR Part 800.

More specific considerations of clearing operations for the corridors should be given in the final statement, such as: (a) an estimated total number of acres for initial clearing, (b) an estimated acreage to be cleared by each of the clearing methods, (c) an estimated acreage that would be allowed to return to a forest growth unhindered by any kind of control, (d) an estimated acreage that will be allowed to return to shrub control, (e) an estimated acreage vegetated with woody plants, and (f) an estimated acreage converted to herbaceous growth. The draft statement indicates only that approximately 1,100 acres of forest habitat will be eliminated. Obviously, portions of the 1,100 acres will be converted to several of the above categories. The final statement should include a map of the transmission corridors, indicating vegetative types affected by the construction and maintenance of the transmission lines. A rigid limitation of herbicide use in the transmission corridor is commendable. In addition, we suggest, that herbicides not be used within the flood plains of the streams crossed or other areas likely to be flooded.

We understand that alternate routing of transmission corridors will be evaluated as a result of concerns by the Division of Nature Preserves of Indiana, Division of State Parks of Indiana, U.S. Department of the Interior, and the U.S. Department of Defense. The alternate plans would locate the transmission corridor no closer than 0.5 miles to the Muscatatuck National Wildlife Refuge, wh. the previous plan in the applicant's environmental report would locate the corridor 0.2 miles from the refuge. Locating the transmission corridor 0.5 miles from the refuge would not be significantly different than 0.2 miles. It is suggested that the transmission corridor be placed not less than 1 mile and preferable up to 5 miles from the refuge boundary to avoid detrimental effects to the refuge objectives.

Measures and Controls to Limit Adverse Impacts During Construction

It is stated that dredge spoils from construction of intake and discharge structures would be "loaded into barges or trucks and removed from the site for disposal in an environmentally and legally acceptable manner." We believe that a purpose of the draft environmental statement is to describe the proposed manner and place of disposal in order to permit an independent evaluation of its acceptability. In addition, we noted no mention of the required amounts of earthwork involved in construction of the plant, or of the proposed site for placement of spoils from excavation of major structures, which would be founded as much as 75 feet below ground level. These data should be presented in the final statement.

In the staff's evaluation of proposed measures to limit adverse impacts, it might be advisable to include the requirement that alternative transmission line routing within the right-of-way of abandoned or little-used railroads be evaluated by the applicant.

Class 9 Accidents

The consequences of class 9 accidents are not assessed in the environmental statement although it is noted that they "could be severe." Instead, reference is made to the NRC Reactor Safety Study, which was performed to assess accident risks more quantitatively, and it is indicated that "the results of these studies will be assessed on a timely basis within the Regulatory process on generic or specific bases as may be warranted." The draft statement should show that such an assessment has been made for the effects on the Ohio River and the water resources of the area that could result from a class 9 accident at the site. Since the Reactor Safety Study was not site specific and did not specifically assess effects on water resources, it is recommended that such an assessment be made a part of the environmental analysis in the final statement.

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

Sincerely yours,

Stanley D. Doremus

Deputy Assistant Secretary of the Interior

Mr. B. J. Youngblood
Chief, Environmental Projects, Branch 2
Division of Site Safety and Environmental
Analysis
Nuclear Regulatory Commission
Washington, D. C. 20555

UNITED STATES
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
WASHINGTON, D.C. 20545

MAY 3 1976

RECEIVED MAY 7 1976 U.S. NUCLEAR REGULATORY COMMISSION Mail Section

Mr. B. J. Youngblood, Chief
Environmental Projects Branch
Division of Site Safety and Environmental
Analysis
Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Mr. Youngblood:

This is in response to your transmittal dated March 5, 1976, in which you invited the Energy Research and Development Administration (ERDA) to review and comment on the Commission's (NRC) Draft Environmental Statement, NUREG-0048, related to the construction of the Marble Hill Nuclear Generating Station, units 1 and 2 (Docket Numbers STN-50-546 and STN 50-547).

We have reviewed the statement and feel that the proposed action will not interfere with any known ERDA programs. The potential impacts on the environment are reasonably described. No significant radiological impacts from normal plant operation are expected since the year 2000 population dose to the estimated population within 50 miles of the plant is only 10 man-rem/year, a small fraction of the 170,000 man-rem/year dose expected for the same population from natural background radiation.

ERDA staff comments related basically to the Conservation of Energy section of the draft statement are enclosed. We feel that these comments should be considered in the preparation of this final statement as well as in the preparation of future statements on nuclear power plants.

Thank you for the opportunity to review and comment on this statement. In the future, we would appreciate receiving 20 copies of all draft statements for ERDA review.

Sincerely,

W. H. Pennington
Acting Director
Office of NEPA Coordination

Enclosure:
Staff Comments

cc: CEQ (5)

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

ERDA STAFF COMMENTS ON
NRC DRAFT ENVIRONMENTAL STATEMENT
MARBLE HILL NUCLEAR GENERATING STATION UNITS 1 AND 2

(Enclosure)

Section 8.2.4 presents the NRC staff analysis of various energy conservation measures as related to the need for the electricity to be produced by the Marble Hill Station. With respect to the potential effectiveness of load management measures such as peak-load pricing (8.2.4.3) and load staggering and interruptible load contracts (8.2.4.4), the conclusion appears to be generally negative. In particular, section 8.2.4.4 concludes:

> None of the above measures can be considered as a viable alternative for required additional capacity and they can do little to solve the energy shortage.

This kind of conclusion is reached without any stated consideration of the substantial efforts of the Federal Government, in cooperation with state and local regulatory agencies and electric utilities, to encourage and validate load management practices and technologies in the interest of electricity conservation. As examples of these efforts:

- ERDA has lead responsibility for the development of new technologies to expand the suite of load management options available to consumers.

- ERDA is investigating the economic impacts, on electricity suppliers and users, of future application of load management techniques, taking into account the possible existence of advanced technologies, such as solar energy and disaggregated power generation systems.

- The Federal Energy Administration (FEA) is currently in the process of intervening - on an invited basis - in state regulatory hearings, for the purpose of articulating national energy policy as it related to regional and local utilities. One of the purposes of FEA testimony is to advocate the implementation of load management techniques and controls.

- FEA has undertaken a number of cooperative projects to assess consumer response to innovative rate structures, to validate load management practices and technologies, and to promote electricity conservation.

These and other efforts have been initiated in the belief that load management, in its variety of forms, has high potential for controlling the growth of electrical capacity without undue hardships or inequities to suppliers or users of electricity. Thus, we do not agree with the negative conclusions in the draft statement, and recommend that NRC revise it to provide a more balanced treatment of this important subject.

We should like to point out one minor inconsistency. The text on page 2-13, paragraph 8, in referring to Figure 2.7, indicates a 33-foot level wind rose. However, on page 2-17, the Figure 2.7 caption indicates the wind rose is for the 200-foot level.

UNITED STATES
ENVIRONMENTAL PROTECTION AGENCY
REGION V
230 SOUTH DEARBORN ST
CHICAGO ILLINOIS 60604

JUN 18 1976

RE: 76-023-702
D-NRC-F06001-IN

STN-50-546
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RECEIVED
JUN 21 1976
U.S. NUCLEAR REGULATORY COMMISSION
Mail Section

Mr. B. J. Youngblood, Chief
Environmental Projects Branch 2
Division of Site Safety & Environmental Analysis
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Youngblood:

The Environmental Protection Agency has reviewed the Draft Environmental Impact Statement (EIS) issued by the Nuclear Regulatory Commission in conjunction with the application of the Public Service Company of Indiana for a permit to begin construction of the Marble Hill Generating Station Units 1 and 2. Our detailed comments are enclosed.

Although the proposed closed cycle cooling system is in general conformance with requirements of EPA regulations, we believe chemical discharges in the blowdown may adversely affect the aquatic biota of the Ohio River. It should be recognized some of the chemical effluents are toxic to aquatic biota in the concentrations proposed. In addition to the adverse biological effects, dilution of chemical effluents in a mixing zone is not an adequate means of chemical treatment and alternative systems for removal should be considered.

EPA recommends that the applicant collect and evaluate additional biological samples. Furthermore, in order for the data to be evaluated in the proper context, it would be appropriate to list and define methodologies utilized to arrive at the data.

EPA concurs with the staff's request for additional information on alternative transmission line routes. These alternatives should include an evaluation of the major offsite streams to be crossed to determine the location and impacts upon fish spawning areas.

Our review indicates that the proposed gaseous and liquid waste treatment systems are expected to be capable of limiting radionuclide releases and, therefore, the related offsite doses, to levels within the guidance of Appendix I to 10 CFR Part 50. Offsite doses will also be limited to within EPA's proposed generally applicable environmental radiation standard, 40 CFR Part 190.

6262

JUN 18 1976

In light of our review and in accordance with EPA procedures, we have classified the project as ER (Environmental Reservations) and rated the Draft as Category 2 (Insufficient Information). We would be pleased to discuss our rating and comments with you or members of your staff.

Sincerely yours,

George R. Alexander, Jr.
Regional Administrator

Enclosure

ENVIRONMENTAL PROTECTION AGENCY

REGION V

CHICAGO, ILLINOIS 60604

JUNE 1976

ENVIRONMENTAL IMPACT STATEMENT COMMENTS

MARBLE HILL GENERATING STATION UNITS 1 & 2

TABLE OF CONTENTS

INTRODUCTION AND CONCLUSIONS

The Environmental Protection Agency has reviewed the Draft Environmental Impact Statement (EIS) issued in conjunction with the application by the Public Service Company of Indiana for a permit to begin construction of the Marble Hill Generating Station Units 1 and 2. The station is planned for a site in Jefferson County, Indiana approximately 11 miles south - southwest of Madison, Indiana. The following are our major conclusions:

1. The EPA believes chemical discharges from the cooling tower blowdown may adversely affect the aquatic biota of the Ohio River. It should be recognized some of these chemical effluents are toxic to aquatic biota in the concentrations proposed. In addition to the adverse biological effects, dilution of chemical effluents in a mixing zone is not an adequate means of wastewater treatment.

2. EPA recommends that the applicant collect and evaluate additional biological samples. Furthermore, in order for the data to be evaluated in the proper context it would be appropriate to list and define methodologies utilized to arrive at the data.

3. EPA concurs with the staff's request for additional information on alternative transmission line routes. These alternatives should include an evaluation of the major offsite streams to be crossed to determine the location and impacts upon fish spawning areas.

4. Our review indicates that the proposed gaseous and liquid waste treatment systems are expected to be capable of limiting radionuclide releases and, therefore, the related offsite doses, to levels within the guidance of Appendix I to 10 CFR Part 50. Offsite doses will also be limited to within EPA's proposed generally applicable environmental radiation standard, 40 CFR Part 190.

CONDENSER COOLING SYSTEM AND FWPCA REQUIREMENTS

Condenser cooling will be achieved at the Marble Hill Nuclear Generating Station through the use of mechanical draft cooling towers. Under normal operating conditions, makeup water will be obtained from the Ohio River at a rate of between 61 and 69 cubic feet per second. Discharge of cooling water blowdown with higher concentration of dissolved solids will be by means of an open flume. The EPA has delegated to the Indiana Stream Pollution Control Board the responsibility for issuance of a discharge permit for the Marble Hill Facility under the National Pollutant Discharge Elimination System (NPDES), Section 402 of the Federal Water Pollution Control Act Amendments (FWPCA) of 1972. Issuance of the permit will be based upon review and analysis of all relevant information supplied by the applicant.

Marble Hill is an existing source as defined by Section 301 of FWPCA. Section 301 of FWPCA stipulates that effluent limits for point source discharges to navigable waters shall require the application of "Best Practicable Control Technology Currently Available" no later than July 1, 1977 and "Best Available Technology Economically Achievable" no later than July 1, 1983. The levels of technology corresponding to these terms were defined in EPA's "Steam Electric Power Generating Point Source Category Effluent Guidelines and Standards", Federal Register of October 8, 1974. These guidelines call for closed cycle cooling and the proposed Marble Hill cooling tower is in general conformance with these requirements.

In addition, it appears the cooling system as proposed can operate in compliance with Federally approved State water quality standards in regard to most chemical effluents and design technologies. However, EPA is concerned with plant discharges with respect to the concentrations of certain chemicals in the cooling tower blowdown.

CHEMICAL EFFECTS

On page 5-27 of the draft statement, it states that "several ambient river components (iron, cadmium, and manganese) already are close to, or exceed, the criteria and will be further concentrated within the blowdown; however, no incremental additions are made in the station and these materials will be rapidly diluted to ambient level in the mixing zone." In addition to iron, cadmium, and manganese, Table 3.7 also indicates that total dissolved solids, lead, and chloride will exceed water quality standards. The NRC staff believes that there will be "no untoward chemical effects after the liquid (blowdown) is rapidly diluted in the mixing zone." It must be recognized that some of these chemical effluents are toxic to aquatic biota in the proposed concentration.

The discussion regarding suspended solids indicates the level may be increased 6 to 8 times above influent levels. This may result in violations of State of Indiana water quality standards. The Draft statement should discuss possible alternative suspended solids concentrations in

in the blowdown. While there may be a significant increase in suspended solid levels (possibly causing at times a violation of Water Quality Standards aesthetic requirements for color, turbidity, etc.), there will also be significant deposition of sludge in the cooling tower basin. It is standard industrial practice to clean out these basins periodically. The Draft statement does not address how this periodic waste stream will be treated to meet State and Federal effluent requirements.

Due to the potential adverse impacts of chemical concentrations and the apparent violation of WQS, the Final statement should address how the applicant proposes to meet State and Federal standards.

While mixing zones may be established for the thermal component of the discharge, EPA has never recognized dilution of chemicals from a point source discharge in a mixing zone as an adequate means of wastewater treatment. Besides the potential adverse biological effects, dilution of chemical effluents in a mixing zone is not an adequate means of wastewater treatment. Therefore, the applicant should develop alternative water treatment to reduce chemical concentrations in order to comply with Federally approved water quality standards. Furthermore, it is not clear whether or not the average chlorine concentration in the blowdown is expected to be 0.08 mg/l as free or total residual.

INTAKE STRUCTURE

Section 316(b) of the FWPCA requires that "the location, design, construction, and capacity of cooling water intake structures reflect the best technology available to minimize adverse environmental impact." The present design of the intake structure tends to impede the natural flow of the near shore area.

EPA concurs with the NRC staff's recommendation that the proposed intake structure be redesigned to allow for unimpeded flow of inshore waters and that other intake designs such as perforated pipes and Ranney-well collectors be investigated.

The Draft statement on page 3-7 states the travelling screens will be operated periodically and there will be no means of fish return. Regardless of what intake structure is utilized, EPA recommends that the traveling screens be operated in a continuous rather than intermittent manner and that some means of fish return be designed. The above recommendations are referenced from EPA's Development Document for Proposed Best Technology Available for Minimizing Adverse Environmental Impact of Cooling Water Intake Structure of December 1973.

DISCHARGE & RELATED IMPACTS

Fishery data complied by the Ohio River Valley Sanitation Commission (ORSANCO) and U.S. Environmental Protection Agency (Table 2.16) clearly shows a significant increase in three fish species from 1957-59 to 1968-70 that are of particular interest to State fishery groups. These are the sauger, smallmouth bass, and spotted bass. Sauger and smallmouth bass require shallow gravel-rock shoreline habitats for spawning, while spotted bass use small streams a ' gravel bars. In view of this, it is strongly recommended that the discharge structure be submerged and extended beyond the shoreline. In addition, the distal end of the pipe should be directed upward away from the bottom to reduce the impact of heated water on benthic biota and scouring of the river bottom. Another fish which is apparently increasing in the Ohio River, and which is of interest as a game fish, is the paddlefish. They also require shoreline gravel bars for spawning and care should be taken to protect this species.

In terms of providing a more objective view of the Ohio River commercial fish catch, it should be realized that commercial fishing in the Ohio River is legally restricted to catfish and rough fishes. Commercial fishermen are not allowed to take black bass, muskies, sunfish, pike, sauger, walleyes, white bass, or even minnows (in excess of a few hundred for personal bait uses). Thus, the commercial fishery is limited to catfish, drum, carp, buffalo, suckers and carpsuckers, skipjacks, shad, mooneye and goldeye, gar, and paddlefish. The market will seldom buy anything but catfish, paddlefish, and large drum, carp, and buffalo.

The ORSANCO study and the USEPA 1968-70 study lean heavily on lock chamber rotenone samples. This type of sample suffices for an index of the fish population, as long as it is understood that significant segments of the river's fish population are not represented or are disproportionately represented in lock chambers.

CONSTRUCTION EFFECTS

Effluent guideline limitations for point sources of construction runoff are defined in Subpart D of EPA's "Steam Electric Power Generating Point Source Category Effluent Guidelines and Standards," Federal Register, October 8, 1974, as 50 mg/l of total suspended solids and pH values in the range of 6.0 to 9.0. These limitations are applicable to all flows up to that resulting from a 10-year, 24-hour rainfall. The applicant apparently has not provided a detailed erosion control plan to the staff but has proposed to minimize erosion by providing detention ponds. Any point sources of construction runoff from the vicinity of the power plant site are subject to the foregoing limitations. Location of all expected point sources of construction runoff should be provided in the final statement, along with a discussion of proposed treatment facilities and expected effluent concentrations.

Detailed comments on power transmission lines will be withheld pending receipt of supplementary data requested by the NRC staff regarding alternative transmission line routes.

An evaluation of the major offsite streams to be crossed by power lines and railroad corridors should be made to determine if spotted bass spawning areas are being impacted.

WATER QUALITY MONITORING AND BASELINE DATA

The aquatic biology data illustrated and delineated in the statement is too generalized in content and sample frequency for effective biological baseline establishment. In order for the data to be evaluated in the proper context, it would be appropriate to list and define methodologies utilized to arrive at the subject data. There is a need to insure that appropriate sampling techniques and quantifying methodology are utilized. These methodologies should be defined in the Final statement in order to assist in evaluating the biological data.

The use of references dated 1960, 1962, and 1966 for the evaluation of phytoplankton in various locations should be used with caution. A lapse of 10 years does not necessarily indicate that there will be a change in species composition; however, it cannot be assumed that the current situation is the same. The use of artificial substrates without a natural substrate sample certainly biased the data as is pointed out by the absence of many benthic fauna and flora.

The presentation of data of the benthic organisms in units of biomass only (Table 2.13) does not allow for species diversity to be estimated and biases the results to favor the larger organisms. This does not give a true picture of species compositon or community structure.

The evaluation of various aspects of the biota has disregarded the food chain (web). Each group of taxa is evaluated in terms of a possible loss to the ecosystem as an entity i.e., the loss of phytoplankton; the loss of fish; and never the loss of fish due to the loss of phytoplankton, etc. Furthermore, page 5-28, 5.5.5.1, Chemical Effects and 5.5.5.2, Biocidal Effects seem to neglect the cumulative problems of metals buildup in sediments, fauna, and flora. Thus, the statement does not recognize the fact that the amount of uptake of a particular metal via periphyton may eventually affect the clam.

The program for baseline monitoring the aquatic biology of the Ohio River (page 6-3, 6.1.5.2) should not only be resumed but additional representative monitoring of the offsite stations should be established.

The number of chemical parameters under consideration for monitoring in the pre and post-operational modes of the plant are adequate for the intended purpose. However, the chemistry data presented in the statement do not include several parameters which fit the expected mass balance for the Ohio River. NRC projected that either analytical/methodology problems affected the data or that the subject data are atypical. In either case, EPA suggests that the presented chemical data are inadequate for use as the preoperational baseline data. Furthermore, it is difficult to interpret some of the data presented in the EIS. In Table 2.4, the values for the heavy metals (nickel, lead, and cadmium) for the months of June, July, August and September appear to be unusually high. An explanation of this occurrence or resampling should be made. The following numbered comments pertain to Table 2.5:

1. The BOD and COD values in March, July, August, October and November seem inconsistent with other values.

2. Based on the historical data base, the conductivity range seems low.

3. Several of the TOC values, when compared to the BOD and COD values appear questionable or atypical.

4. Based on historical data, the oxidative state of the Ohio River (oxidation and reduction potentional) and the productivity cycle prevalent during the summer and fall months, it is difficult to explain the high ammonia values reported for June, July, August, October and November.

5. The high nitrate value report for August seems atypical when compared to other values and an indication of the cause should be made.

6. The high calcium value reported for July seems atypical. The reasons for this high level should be explained.

7. Phenol values for April, July, November, January and February are atypically high, especially July. The causes of such high values should be explained.

8. Soluable hexane should be reported in micrograms/liter rather than milligrams/liter.

PESTICIDE USE

It is proposed to use herbicides 2,4-D, 2,4,5-T, Silvex, picloram, and dicamba on 3,725 acres of railroad and transmission line rights-of-way. There is no indication that use of these herbicides as outlined in the statement would deviate from accepted practices or pose environmental hazards. The precautions enumerated in the statement should be sufficient to minimize any potential hazard. However, the use of invert emulsions should be encouraged to minimize drift problems. Disposal of all pesticide containers should be in accordance with label instructions, or superseding State or local regulations. Finally, problems relating to the use of the herbicides should be reported to the appropriate Federal or State agencies.

RADIOLOGICAL ASPECTS
RADIOACTIVE WASTE TREATMENT

Based on our evaluation of the draft statement, the proposed gaseous and liquid waste treatment systems represent "state-of-the-art" effluent control technology. However, we agree with the staff comment (Section 3.5.2.3) that the charcoal adsorbers on the Auxiliary, Fuel Handling, and Radwaste Building vent releases should be continually used to process the ventilation exhausts. Similarly, we recommend that the charcoal adsorber on the main condenser air ejector exhaust be used whenever there is radioactivity in the secondary coolant system and that the final statement indicate a commitment to do so. With these conditions, we concur with the NRC staff's conclusion that these systems can reduce effluents to "as low as practicable" levels in accordance with 10 CFR Part 50.

It appears the staff has underestimated the amount of "low-level solid wastes" that will be produced by the proposed plant. Several references are available pertinent to this subject. The Atomic Energy Commission's (now NRC) concluding statement to its rulemaking proceedings on Appendix I to 10 CFR 50 contains improved estimates of low-level solid radwastes produced during nuclear power plant operations. The Oak Ridge National Laboratory (ORNL) has published "A Critical Review of Solid Radioactive Waste Practices at Nuclear Power Plants" (ORNL - 4924), which provides a compilation of operational experience relative to these wastes. The EPA has also conducted extensive research on these wastes and their impacts at selected, licensed, shallow land burial sites.

Based on analysis of the available information, EPA estimates that the annual offsite shipment of "low-level solid wastes" will be comprised of approximately 25,000 ft or 4,000 55-gallon drums, for a 1,000 MWe PWR(1). The draft statement, however, includes the estimate that approximately 600 drums of wet solid waste, and 450 drums of dry solid waste will be shipped offsite annually due to the operation of each reactor. In order to clarify this apparent inconsistency, the final statement should provide the rationale for the lower estimate.

DOSE ASSESSMENT

The calculated doses to individual receptors from radionuclides assumed to be discharged from the Marble Hill Station are within the Regulatory design basis objectives given in 10 CFR Part 50, Appendix I. We commend the NRC for including in the draft statement extensive detailed atmospheric dispersion factors and deposition values. These data greatly assisted us in reviewing the dose estimations for the Marble Hill Station.

(1) Mann, Goldberg, and Hendricks, n.d. "Low Level Solid Radioactive Waste in the Nuclear Fuel Cycle." A paper presented at the November 16-21, 1975, American Nuclear Society meeting, San Francisco, California.

We are pleased to note that the NRC is now including estimates of annual population dose commitments in the environmental statement. This represents a partial evaluation of the total potential environmental dose commitments (EDC) of H-3, Kr-85, C-14, iodines and "particulates," and is a determination which we have urged for several years. Of course, several of these radionuclides, particularly C-14 and Kr-85, will contribute to long-term population dose impacts not just within the continental U.S.A. but on a world-wide basis. From the information presented in the draft statement, it is not clear on what basis the dose commitment has been calculated. For example, there is no indication of (1) the period of time over which the commitment was calculated; (2) what population growth was assumed; (3) what assumptions were used regarding buildup; or (4) whether ingrowth of daughter products was considered. Assessment of the total EDC impact would (1) incorporate the projected release over the lifetime of the facility (rather than just the annual release); (2) extend to several ha[illegible]ves or 100 years beyond the period of release; (3) consider, at least [illegible]litatively or generically, the world-wide impacts; and (4) consider a [illegible]rowing exposed population. As discussed in Appendix D, some of these techniques may have been used, although to what extent is not clear. The EPA suggests that future assessments recognize these influences on the total environmental impact or specify the limitations of the model used.

REACTOR ACCIDENTS

The EPA has examined the NRC analyses of accidents and their potential risks. The analyses were developed by NRC in the course of its engineering evaluation of reactor safety in the design of nuclear plants. Since these issues are common to all nuclear plants of a given type, EPA concurs with NRC's generic approach to accident evaluation. The NRC is expected to continue the efforts initiated by AEC to ensure safety through plant design and accident analyses in the licensing process on a case-by-case basis.

In 1972, AEC initiated an effort to examine reactor safety and the resultant environmental consequences and risks on a more quantitative basis. The EPA continues to support this effort. On August 20, 1974, AEC issued for public comment th[illegible] [illegible]raft Reactor Safety Study (WASH-1400), which was the product of an [illegible]tensive effort to quantify the risks associated with light-water-cooled nuclear power plants. The EPA's review of this document included in-house and contractual efforts, and culminated in the release of final Agency comments on August 15, 1975. Initial comments were issued on November 27, 1974. The EPA concluded that the Reactor Safety Study represents a comprehensive and useful analysis of risks associated with light-water reactors. At present, EPA is reviewing the final Reactor Safety Study, which was released by NRC on November 4, 1975. The current review, which also involves in-house and contractual efforts, is expectd to be completed in May 1976; at that time, EPA will publish final evaluations in public comments.

FUEL CYCLE AND LONG-TERM DOSE ASSESSMENTS

Under the President's Reorganization Plan No. 3 of 1970, EPA is responsible for establishing generally applicable environmental radiation protection standards to limit unnecessary radiation exposures and radioactive materials in the general environment resulting from normal operations of facilities that are part of the uranium fuel cycle. The EPA has concluded that environmental radiation standards for nuclear power industry operations should take into account total radiation dose to the population, maximum individual dose, the risk of health effects attributable to these doses (including the future risks arising from the release of long-lived radionuclides to the environment), and the effectiveness and costs of effluent control technology. The proposed st[illegible]ards are expressed in terms of individual dose limits to membe[illegible] of the general public and limits on quantities of certain long-lived radioactive materials in the general environment.

A document entitled "Environmental Survey of the Uranium Fuel Cycle" (WASH-1248) was issued by AEC in conjunction with a regulation (10 CFR 50, Appendix D) for application in completing the cost-benefit analysis for individual light-water reactor environmental reviews (39 F.R. 14188). This document is used by NRC in draft statements to assess the incremental environmental impacts that can be attributed to fuel cycle components which support nuclear power plants. This approach appears to be adequate for plants currently under consideration, and estimates of the incremental impacts of the Marble Hill Station are reasonable. However, as suggested in our comments on the proposed rulemaking (January 19, 1973), if this approach is to be used for future plants, it is important for NRC to periodically review and update the information and assessment techniques used. The EPA intends to monitor developments in the fuel cycle area that are relevant to continued improvement in assessing environmental impacts.

The summary presentation (Table 5.18) on the environmental effects of the uranium fuel cycle addresses only the incremental environmental impacts expected to result from the operation of a nominal 1000 MWe nuclear reactor. However, there are impacts associated with the ultimate disposal of wastes which, to our knowledge, have not yet been adequately evaluated or are largely unknown. These impacts include:

- Commitment of land and resources for an ultimate disposal site;
- Economic and resource commitments of future generations, including societal and institutional commitments;
- Economic, resource, and energy costs of ultimate waste disposal as balanced against the present benefits realized by energy production.

While EPA recognizes that the individual nuclear power plant environmental statements may not be the proper vehicle for assessing these considerations, the environmental statements can, and should, indicate any pertinent studies (and their expected completion dates) which are being conducted by NRC or other responsible agencies. If no such efforts can be documented, NRC should either include these considerations in an updated version of WASH-1248 or should urge ERDA to consider them in studies directed at developing and ultimate radioactive waste disposal technology.

HIGH-LEVEL WASTE MANAGEMENT

The techniques and procedures used to manage high-level radioactive wastes will have an impact on the environment. To a certain extent, these impacts can be directly related to the individual project because the reprocessing of spent fuel from each new facility will contribute to the total waste problem. However, EPA concurs with NRC's generic approach to waste management impacts. As part of this effort, AEC, on September 10, 1974, issued for comment a draft statement entitled, "The Management of Commercial High-Level and Transuranium-Contaminated Radioactive Waste" (WASH-1539).

Though a comprehensive long-range plan for managing radioactive wastes has not yet been fully demonstrated, acceptance of the continued development of commercial nuclear power is based on the belief that the technology to safely manage wastes can be devised. The EPA is available to assist both NRC and ERDA in their efforts to develop an environmentally acceptable waste management program to meet this critical need. In this regard, EPA provided extensive comments on WASH-1539 on November 21, 1974. Our major criticism was that the Draft statement lacked a program for arriving at a satisfactory method of "ultimate" high-level waste disposal. We believe this is a problem which should be resolved in a timely manner because the United States is comitting an increasingly significant portion of its resources to nuclear power, and waste materials from the operating plants are steadily accumulating. The ERDA now intends to prepare a new draft statement which will discuss waste management and emphasize ultimate disposal in a more comprehensive manner. The EPA concurs with this decision. We will review the new draft statement when it is issued and will provide public comments.

TRANSPORTATION

In its earlier reviews of the environmental impacts of transportation of radioactive material, EPA agreed with AEC that many aspects of this program could best be treated on a generic basis. The NRC has codified this generic approach (40 F.R. 1005) by adding a table to its regulations (10 CFR Part 51) which summarizes the environmental impacts resulting from the transportation of radioactive materials to and from light-water reactors. This regulation permits the use of the impact values listed in the table in lieu of assessing the transportation impact for individual reactor licensing actions if certain conditions are met. Since the Marble Hill Station appears to meet these conditions and since EPA agrees that the transportation impact values in the table are reasonable, the generic approach appears adequate for the Marble Hill Project.

The impact value for routine transportation of radioactive materials has been set at a level which covers 90 percent of the reactors currently operating or under construction. The basis for the impact, or risk, of transportation accidents is not as clearly defined. At present, EPA, ERDA, and NRC are each attempting to more fully assess the radiological impact of transportation accidents. As the quantitative results of these analyses become available, EPA intends to review the acceptability of the potential transportation risks. The EPA will make known its views on any environmentally unacceptable conditions related to transportation. On the basis of present information, EPA believes that there is no undue risk of transportation accidents associated with the Marble Hill Station.

ADDITIONAL COMMENTS

1. The announced intention to locate a new fossil fuel plant one mile downstream and across the river from the Marble Hill site was mentioned in the EIS. It would be appropriate to consider the accumulative effect of these power plants on the environment.

2. It was indicated that construction and operation of a docking facility for barges is being proposed. Since this type of facility can have significant impact on water quality and the surrounding environment, the environmental impacts of this facility should be included in the EIS.

3. It is mentioned that all fuels and lubricants will be stored in accordance with applicable local laws. Attention to applicable Federal and State laws regarding spill prevention planning (SPCC Plans) should also be recognized.

4 A further breakdown of the power distribution from the Marble Hill Station should be provided. At one time, Hoosier Energy was to receive a portion of the electrical power. The distribution provided in the statement does not indicate whether or not Hoosier Energy will receive any power from Marble Hill. If Hoosier Energy is not going to receive a portion of the power produced, a discussion of how Hoosier Energy will meet its demands should be provided.

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FEDERAL ENERGY ADMINISTRATION
WASHINGTON, D.C. 20461

APR 26 1976

OFFICE OF THE ASSISTANT ADMINISTRATOR

FEA 76-72

RECEIVED MAY 6 1976 U.S. NUCLEAR REGULATORY COMMISSION

Mr. B. J. Youngblood
Environmental Projects Branch
Division of Site Safety and
Environmental Analysis
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Youngblood:

This letter is in response to your request for review and comment on the draft environmental impact statement (EIS) on the proposed Marble Hill Nuclear Generating Station, Units 1 and 2, Docket Nos. STN 50-546 and STN 50-547. Our comments are related to electrical energy demand projections, energy conservation and energy development alternatives.

Electrical Energy Demand Projections

1. National Energy Outlook

In deriving its forecast of the need for the capacity of the Marble Hill Station, the NRC staff has noted (page 8-6) that "considerable weight has been given to the forecast of national energy demand for electrical capacity prepared by the U.S. Federal Energy Administration (FEA)." The aforementioned FEA forecasts appeared in the "Project Independence Report," published in late 1974. Due to a number of significant international and domestic events which occurred in 1975, the Nation's energy future has changed somewhat, and FEA published a revised "National Energy Outlook (NEO)" in March 1976. We suggest that NRC consider its electric energy demand projections in light of the updated FEA energy outlook.

The NEO projects a national base case (Reference Scenario) electric energy growth rate of 5.4 percent from 1974 to 1985. For comparison, the Conservation Scenario (full set of conservation actions) results in a national electric energy growth rate of 4.9 percent; the Electrification Scenario (strategy to promote increased electrification of energy end-use) results in a national electrical energy growth rate of 6.4 percent. In terms of peak load demand, NEO projects a range of 3.9 percent to 6.9 percent annual growth. For the Reference Scenario, electric peak load demand is estimated to increase at 4.4 percent annually during this period.

FEA's electric energy growth forecast for the East North Central Census Region, which includes Indiana, was 4.8 percent (Reference Scenario), or less than the national average. By customer sector, growth in this region was forecast as follows: residential, 8.2 percent; commercial, 4.0 percent; and industrial, 2.7 percent.

The applicant's projected combined system peak load growth is 7.4 percent, higher than the NEO projections. According to the draft EIS (page 8-22), "the Public Service Company of Indiana, Inc.'s (PSI's) most recent forecasts for total sales and annual peak load demand indicate that total sales are expected to grow at more than 8 percent while peak demand is expected to grow at 8 percent annually."

The FEA recognizes the limitations of the NEO predictions in that localized demand can vary considerably from regional figures. However, in view of the above differences, it would be useful for the final EIS to include the most recent FEA national and regional forecasts of electrical energy demand, and, where appropriate, the reasons for the expected deviation from the FEA projections in Indiana.

2. <u>Industrial Demand</u>

Industrial customers account for a major portion of the total energy load for both PSI and Northern Indiana Public Service Company (NIPSCO). In 1974, 36.2 percent of the electrical energy produced by PSI was consumed by industrial customers;

during the same period, industrial customers accounted for 72 percent of NIPSCO's total energy load, according to the draft EIS. As noted on page 8-6, PSI "seeks to build the Marble Hill Station because of its conviction that population will continue to grow in its service area and that new commercial and industrial business will be established."

Because the industrial component represents a significant portion of the total energy load, and because FEA forecasts predict only a 2.7 percent growth rate for the industrial sector, the applicant's economic growth assumptions need to be well documented and justified. The EIS notes (page 8-20) that the NRC staff "has compared projections for the economic activity of PSI's service area with that of the Nation and found them to be similar." The final EIS should discuss these economic projections and their compatibility with FEA energy demand projections for the East North Central Census Region.

3. <u>Population Growth</u>

Likewise, since the need for additional electric power is hinged to the anticipated population growth, projections need to be carefully evaluated. Total reliance on OBERS 1972 Series E projections may not be sufficient, particularly in light of recent economic conditions. We suggest that other population projections prepared by state and regional agencies or by universities be reviewed. High and low projections, and their underlying assumptions, should be presented in the final EIS, as appropriate, we well as their implications for energy demand projections.

<u>Energy Conservation</u>

1. <u>Utilities Conservation Action Now Program (UCAN)</u>

Conservation and load management measures, as a means of effecting a reduction in the growth of both energy usage and peak demand, have been addressed in the draft EIS (Section 8.2.4). As noted, both owner systems have initiated consumer education programs on a small scale to advise residential customers of ways to defer energy usage to off-peak periods and reduce overall energy use. However, an effective program of reducing energy consumption will require a major customer conservation program through implementation of FEA's UCAN. Since the writing of the draft EIS, both PSI and NIPSCO have submitted UCAN Action Plans to FEA. They outline in more detail the applicant's energy conservation program at both the end-user and production level, and should either be summarized or referenced in the final EIS.

2. Industrial Conservation

The EIS should describe in greater detail the opportunities for energy conservation in the industrial sector, particularly because of its position as the largest consumer, both in terms of peak-hour and total demand.

Energy Development Alternatives

1. Competitive Sources

The comparative analysis of new generating capacity from coal and nuclear fuels is given in Tables 9.1 and 9.2, without supporting discussion. Based on the tables, the two alternatives are very close economically, and environmentally the differences appear as trade-offs in the type of environmental impacts (e.g., radioactivity vs. air pollution). In view of this and the fact that the coal-fired plant is the major alternative considered, a more detailed comparative evaluation appears warranted. In addition, other factors bearing on the comparison of alternatives should be mentioned. Since the current system generating capacity relies almost exclusively on coal combustion, construction of the proposed nuclear power plants would provide needed fuel diversity for both PSI and NIPSCO.

2. Mechanical vs. Natural Draft Cooling Towers

Selection of Mechanical Draft Cooling Towers (MDCT) over Natural Draft Cooling Towers (NDCT) appears to have been made primarily because of initial costs (page 9.7). Total costs including construction and operation over the plant's lifetime

and associated energy penalties should be considered for each cooling system alternative. The NDCT may be more economical in the long run. Also with regard to the cooling system alternatives, there was no mention of waste heat utilization. At full load, both units can provide 1.65×10^{10} BTU/hr, which is approximately equivalent to 100,000 gallons of #2 oil per hour.

3. No Action Alternative

The consequences of No Project are only briefly alluded to in Section 8. The NRC staff has concluded that a one-year delay in installation of the Marble Hill Station will present no problems (page 8-24). The environmental impact including the socioeconomic impacts to the area of not constructing the two plants or of deferring construction of Unit 2 should be described in greater detail.

We appreciate the opportunity to review the draft EIS and hope that our comments will be useful to you in the preparation of the final environmental impact statement.

Sincerely,

Roger W. Sant
Assistant Administrator
Energy Conservation and Environment

STATE of INDIANA
AIR POLLUTION CONTROL BOARD
1330 WEST MICHIGAN STREET
An Equal Opportunity Employer
INDIANAPOLIS 46206
(317) 633-4420

April 15, 1976

RECEIVED APR 20 1976

U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Attention: Director, Division of Site
Safety and Environmental Analysis
Office of Nuclear Reactor Regulation

Dear Director:

Re: Draft Environmental Statement (Docket Nos. STN 50-546 STN 50-547) Marble Hill Nuclear Generating Station Units 1 & 2, Public Service Indiana, Published March 1976.

This is in response to your request of March 5, 1976, for our comments on the referenced environmental statement. The "Draft Environmental Statement" has been reviewed by my staff and the following comments from this office are limited to the items that significantly affect air quality.

1. Plant Construction

There will be airborne dust generated at various times during the several years of plant construction which could create high, short-term ambient suspended particulate levels. Control of this dust was discussed somewhat under 4.1.1., 4.4.1.1, and 4.5.1.1. This dust must be controlled by the sealing of construction roads with a stone and petroleum-based surface or equivalent, and by the wetting of onsite areas that may become dusty. Fugitive dust, i.e., dust that is air transported beyond the property line of the source, must be controlled in accordance with Indiana regulation APC 20.

2. Mechanical Draft Cooling Towers

Fogging
The analysis by your staff indicates, in item 5.3.1.3, that the fog plume, at ground level, travels only a short distance (on the order of 0.5 km). Our concern is the possibility that the cooling tower could add to fogging several kilometers from the Marble Hill Station

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as a result of aerodynamic down-wash or plume trapping. Fog possibilities are of particular concern at this site because of the high humidities, low wind speeds, and temperature differentials that occur near the surface of the adjacent Ohio River. The occurrence of man-made fogs added to the naturally occurring fogs could conceivably produce an occasional navigational problem for Ohio River traffic.

Icing
It is agreed, as indicated in item 5.3.1.3, that icing may result from the cooling tower emissions and congeal on trees, poles and wires. We think that nearby walkways and roads could become iced but that this would occur only within the plant boundary.

Acid Mist
Although the possibilites of Acid Mist formations have been discussed in quite some detail under 5.3.1.6, we must still have concern because of the particular circumstances and proximity in this instance of another proposed power plant. In addition to the surface shadowing effect of an elevated plume, there is the possibility that the plume from the proposed Louisville Gas and Electric Company (LGEC), Wises Landing, 920 megawatt, fossil-fuel fired generating station might combine with the cooling tower plume and form acid mist. Although the LGEC plant will be located approximately three miles southeast of the Marble Hill site, the wind-channeling effect of the Ohio River Valley makes it possible that the LGEC plume might intersect the Marble Hill cooling tower plume. Estimation of the frequency and extent of this occurrence will depend on extensive modeling and subsequent validation by field data. The latter is not presently available.

Drift
The analysis comprehensively discussed effects of cooling tower drift under item 5.3.1.5, in the referenced statement in which you conclude that almost all of the drift that returns to the ground will do so inside the station's boundary and that even on-site depositions will be too small to

- 3 -

cause problems. W wish to point out that, although the Federal Environmental Protection Agency and the State of Indiana do not specifically regulate emissions from cooling towers nor generally consider them a pollutant emitter, when this plant is running at rated load the cooling towers will emit a total of 780 tons per year of dissolved solids. We realize that this emission is not unique to a nuclear plant since the same type of emission could be expected for a fossil fuel fired power plant which employs a water cooling tower for process cooling. This project will have to address itself to code 40 CFR 52.21 of the Federal Register as it relates to the significant decay of air quality in this area.

Oil-Fir d Steam Boiler
The Indiana Air Pollution Control Board does not anticipate any air pollution problems from the two auxiliary 75x 10^6 BTU/hr (22-MW) fuel oil (No. 2) fired steam boilers, however, these units will require a review of plans and specifications to assure they will meet the Indiana Air Pollution Control Regulations before a construction permit can be issued.

Should you have any questions on the above comments, please contact Mr. Leslie Collet, of my staff, by telephone (317) 633-4512, or by mail at above address.

Very truly yours,

Ralph C. Pickard
Technical Secretary

LGC/imb

STATE of INDIANA

STREAM POLLUTION CONTROL BOARD

INDIANAPOLIS 46206
1330 West Michigan Street
633-5467

April 23, 1976

STN-50-546
50-547

Director
Division of Site Safety and Environmental Analysis
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

RECEIVED 4-27-76

Dear Sir:

Re: Draft Environmental Statement
Marble Hill Nuclear Generating Station
Public Service of Indiana

The staff has reviewed the referenced Draft Environmental Statement prepared by your commission and offers the following comments.

Table 6.1 on Page 6-2, presents the Proposed Preoperational Radiological Monitoring Program. A gamma scan for I-131 is specified for milk and fish samples. The Minimum Detectable Activity (MDA) for a normal gamma scan is limited to 10 pCi/l. The background survey and subsequent operational surveys will most likely yield samples with activity levels below the MDA for a normal gamma scan. Ion exchange systems in combination with the normal gamma scan system (NaI (Th)) permit an MDA below 1 pCi/l of whole milk. In order to provide useful survey data, it is therefore recommended that milk and fish be analyzed for I-131 with an ion exchange system in conjunction with the normal gamma scan.

We are concerned with the level of suspended solids concentrations expected to be in the discharge of the cooling tower blowdown. Table 3.7, Page 3-23 of the Draft Environmental Impact statement indicates that suspended solids in the final discharge are expected to average 408 mg/l with a maximum concentration of 1,554 mg/l.

The discharge of suspended solids of this magnitude presents the probability of settable solids in sufficient amounts to cause deposition of solids in the Ohio River which could violate our water quality standards. We would request that the Nuclear Regulatory Commission and the applicant review this potential problem and solicit comments from other agencies such as ORSANCO, U. S. EPA, and the Army Corps of Engineers for possible alternatives and solutions. We would propose such alternatives as diffusers to provide thorough mixing of the discharge with the Ohio River, settling facilities to remove the settable matter after the blowdown from the towers and prior to discharge, or reduce the recycle rates through the towers thus reducing the concentrating effect of the tower.

4160

Director April 23, 1976

We would be agreeable to meeting with the applicant and the staff of the Commission to discuss these comments. Questions regarding this submittal may be directed to Mr. Michael Esarey at 317/633-5278.

Very truly yours,

Oral H. Hert
Technical Secretary

GASkomp/ds
cc: Dr. J. Coughlin
Public Service Indiana
Vacys Saulys
U. S. EPA, Region V

STATE of INDIANA

DEPARTMENT OF NATURAL RESOURCES
JOSEPH D. CLOUD
DIRECTOR

INDIANAPOLIS, 46204

STN-50-546
547

RECEIVED JUN 1 1976 U.S. NUCLEAR REGULATORY COMMISSION Mail Section

Mr. B. J. Youngblood, Chief
Environmental Projects Branch 2
Division of Site Safety and Environmental Analysis
United States Nuclear Regulatory Commission
Washington, D. C. 20555

RE: DNR #735, Draft Environmental Impact Statement Review, Marble Hill Nuclear Generating Station, Units 1 and 2, Jefferson County, Indiana

Dear Mr. Youngblood:

The Indiana Department of Natural Resources has reviewed the above referenced project in regards to its effects on the environment, including fish and wildlife resources and recreational, historical, architectural and archaeological sites. The following comments are offered for your consideration.

In accord with the Staff Evaluation, Section 4.5.2.3, the Department feels that the use of aerial-sprayed herbicides should be restricted to those areas and conditions which will insure maximum environmental safety.

Due to the construction activities involved with this project, numerous permits will be required from the Natural Resources Commission. We suggest coordination with the Department's Division of Water during all phases of planning to expedite permit applications.

More detailed information is required by the Department in order to assess the impacts of the transmission lines on fish and wildlife resources. We would like to point out, though, that the "wapiti" (Cervus canadensis, table B-13, page B-18) disappeared from this area in the mid-19th Century.

As indicated in our letter of February 4, 1976, care should be taken during any excavation to protect and report any archaeological

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artifacts which are unearthed. The only two 19th Century structures in the area are of little value and would not pose an undue hardship if demolition is required.

We appreciate this opportunity to be of service. If we can be of further assistance, please do not hesitate to contact me.

Sincerely,

Joseph D. Cloud
Director

JDC:JEF:nm

Robert D. Bell
Secretary

Julian M. Carroll
Governor

COMMONWEALTH OF KENTUCKY
DEPARTMENT FOR NATURAL RESOURCES AND ENVIRONMENTAL PROTECTION
OFFICE OF THE SECRETARY
FRANKFORT, KENTUCKY 40601
TELEPHONE (502) 564-3350

50-546/547

May 27, 1976

RECEIVED JUN 1 1976 U.S. NUCLEAR REGULATORY COMMISSION Mail Section

Director, Division of Site Safety
and Environmental Analysis
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D. C. 20555

Attention: Dr. Stanley Kirslis

Re: DES Marble Hill Nuclear
Generating Station

Dear Sir:

The Kentucky Environmental Review Agencies have reviewed the above listed DES and have returned the following comments:

The Division of Solid Waste, Kentucky Department for Natural Resources and Environmental Protection, states: "The draft environmental statement related to construction of Marble Hill Nuclear Generating Station Units 1 and 2 completely ignores the disposition of clearing and grubbing waste and the disposition of construction debris. The draft environmental impact statement makes no comment as to where and how the materials from both of the above would be disposed."

"Certainly if one or the other or both of these wastes were to be disposed of in Kentucky the disposal would have to be a permitted site. . ."

The Division of Sanitary Engineering, Kentucky Department for Natural Resources and Environmental Protection, states: "The complexity of this project precludes a meaningful evaluation as to its environmental implications. There are too many variables and unknowns. Even though control measures may appear adequate including warning systems, etc., the

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possibility of an accident or sabotage would always be present."

"A massive radioactive contamination of the Ohio River would seriously affect Louisville's drinking water supply downst eam within hours. Therefore, unless other liability arrangements are made, the responsibility of instituting prior self-protective measures with the accompanying cost will be imposed on the Louisville Water Company and indirectly on the resident population of that entire metropolitan area."

The Department of Human Resources states: "(1) Thermal and radiation effects to the environment appear to be minimal; (2) The proposed environmental surveillance program appears to be adequate; (3) Radiation exposure to the general population, under normal operating conditions, appears to be minimal."

"It should be noted that a proper review of the proposed Marble Hill program could not be made at this time because the conclusions and recommendation of the HRC staff were the only documents available for review; however, the Department can be more precise in its comments if supplied with the environmental report or the PSAR."

The Development Cabinet states: "In response to the recent request for comments from the Development Cabinet agencies relative to the Marble Hill Nuclear Generating Station, I would like to point out that the Departments of Agriculture and Parks make no comments."

(The following policy statement represents the views of the Office of the Secretary and the Departments of Commerce and Energy, with full consideration having been given to the following statement from the Department of Fish and Wildlife.)

"POLICY STATEMENT OF THE KENTUCKY DEVELOPMENT CABINET ON THE PROPOSED MARBLE HILL NUCLEAR GENERATING STATION DRAFT ENVIRONMENTAL IMPACT STATEMENT"

"Sufficient energy is one of the essential keys to economic growth and job opportunities for any area. Kentucky has been fortunate to have had adequate energy for growth opportunities in the past."

"To maintain this economic growth posture in the future, it is important that we recognize the increasing interdependency of energy systems both within and outside our state borders. We must be vitally concerned with the status of our neighbors, particularly those in the Ohio River Valley. We must recognize that energy deficiency in one area can ultimately impact our own supply situation. It is because of this

concern that we feel compelled to address the Marble Hill nuclear generation proposal by Public Service of Indiana."

"1. There is ample justification that a power plant is needed to meet future projected demands.

2. Due recognition and consideration has been given to all aspects of environmental impact and alternatives. The Development Cabinet does not have the technical expertise to fully analyze the details of this assessment.

3. The question of the economics of nuclear power vs. coal at this site can be argued; but, remaining a matter of judgment which ultimately must be decided by the state of Indiana. The posture of the Kentucky Development Cabinet on this question is as follows:

   a) Nuclear power with full attention to safety and economics, must be developed as rapidly as possible consistent with its competitive position with coal. Both coal and nuclear will be necessary to meet the future growth needs of the nation.

   b) Coal should be used to the maximum extent to meet the nation's energy needs consistent with an acceptable environment for at least the remainder of this century."

The referenced statement by the Department of Fish and Wildlife is as follows: "This Department is in general agreement with the Draft Environmental Statement related to construction of Marble Hill Nuclear Generating Station Units 1 and 2. The Department is especially interested that staff recommendations on monitoring in section 6.1 be followed. It also agrees with staff recommendations on Section 5.3.2 and 9.3.2, to minimize impingement and intrainment be studied and the most feasible alternative be adopted and that after staff recommended studies in Section 5.3.3 and 9.3.3 are completed the most suitable alternative discharge structure be deigned and adopted."

The Kentucky Center for Energy Research states: "The Kentucky Center for Energy Research has reviewed the Draft Environmental S tement for the Marble Hill Nuclear Generating Station. Our questions an comments on the document are as follows:

--How will the ultimate storage of radioactive wastes from the plant be handled?

--What type of assurance can PSI provide that adequate fuel (U308) to operate the facility will be available throughout its expected life at economic cost?

--How do employment opportunities compare between nuclear and coal plant construction and operation?

--What steps are being taken to guard against the potential of radiation release in a situation similar to that which recently occurred at Indianhead #1?

--In the event of a major accident at MH 1 & 2 resulting in the release of radioactivity, major population centers in Kentucky may be affected. Is there now, or will there be an emergency plan developed by PSI which would become operative in the event of such an emergency?

--Have alternative river sites for the facility been investigated which are further away from major population centers? If so, what were the findings of such studies?

--Have safety precautions against tornado damage been updated in view of
--the increased frequency of tornadoes in the Ohio Valley
--new information about the intensity of these tornadoes when satellite vortex speeds are added to the speed of the principal vortex?

--The Commonwealth of Kentucky should be informed of all emissions from the plant and all abnormal operating conditions. A committee should review this data at least twice a year, and more often if abnormal operating conditions warrant. The committee should be composed of state officials, a nuclear engineer, health physicist, hydrologist, meteorologist, and a representative from an environmental quality group."

The Office for Local Government, Department of Finance and Administration states: "Environmental Impact Statements (EISs) must address all significant impacts to the human environment from proposed federal actions. A general criticism of the Marble Hill Impact Statement is that too much emphasis is given to impact on the biotic environment, while the impact on the health and well-being of people is treated in a cavalier and often misleading fashion. It must be remembered that the affects of a proposed action on plants, animals, and the physical environment

are of interest only insofar as they alter human activity or sense of well-being, broadly interpreted. It is in describing this latter relationship, the affect of changes in the biotic and physical environment on people, that the Marble Hill EIS is less than thorough. If the requirements of NEPA mean anything, they mean that all significant affects of a proposed action on people must be thoroughly investigated. The two major impacts to people concern (1) the nuisance of transmission lines, and (2) the dangers of radiation."

Transmission Lines

"New transmission line construction associated with the proposed plant will consume 3475 acres and will run 115 miles in total length. The EIS speculates as to the effect of these lines on vegetation, fauna, and water quality, but there is no study of the social acceptability of these lines, or of new lines in general. We read only that "the transmission lines and towers will have an adverse visual impact." (p.5-1) On page 4-6, the EIS indicates that "tentative" or "suggested" routes for the transmission lines have been chosen. Have affected citizens been consulted? The human impact of these routes will derive from both their location and method of right-of-way acquisition. Just as a conspicuous location means that more people will suffer visual pollution, so a clandestine method of acquisition, in which people are not consulted prior to route selection for their input on siting altenratives, leads to a sense of frustration and resignation to "the larger forces of society". Both affect man's sense of well-being, and are thus within the scope of NEPA. Both location of lines and method of right-of-way acquisition should be more thoroughly described in terms of their effect on the human environment."

Radiation Dangers

"The EIS concludes that "no significant environmental impacts are anticipated from normal operational releases of radioactive material." (p. ii) One may still ask, "Is human health endangered?" The facts used to justify the conclusion are deceiving. They read, "The calculated dose to the estimated population in the year 2000 which will live within a radius of 50 miles from the plant is 10 man-rems/year. This value is less than the natural fluctuations in the approximately 170,000 man-rems/year dose this population would receive from background radiation." Implicit in the statement is a recognition that no additional radiation is 'good' radiation. Any additional radiation increases the risk of cancer, the possibility of congenital disease in children due to parental exposure, and the likelihood of an array of ailments caused by subcellular malfunction. Since no radiation is healthful, the EIS attempts to show that the additional radiation caused by plant operation is so small compared to radiation already received from natural sources that the additional danger is insignificant. But the facts cited to justify this claim are misleading."

DR. STANLEY KIRSLIS
May 27, 1976
Page 6

"Doses in man-rems do not lend themselves to comparison. If for a population of 1000 people, man-rems/year increase from 100 to 105, this could occur by having the dose increase uniformly from 100 to 105 millirems per person, or the dose of 100 millirems per person could remain constant for 999 people with one person making the difference up alone by experiencing 5100 millirems. There is, obviously, a significant qualitative difference in the two situations though man-rem increases are the same. The difference is that the increases are not evenly distributed over the sampled population, which is in fact the case for the population cited in the EIS. The 50-mile radius population will not share the increased dosage uniformly. Those living near the plant and along waste transport lines will absorb the bulk of that increase."

"The EIS must address the radiation hazards to those living in proximity to the nuclear plant and to fuel and waste transport lines. The EIS must address the additional hazards to those living near the waste disposal sites that would result once plant operation commenced. The EIS must address specific health effects of increased radiation, giving close attention to the possibility of danger-to-health thresholds that the radiation addition might cause to be exceeded, though the addition itself be small."

We appreciate the opportunity to review this statement as an Interested State and appreciate the extension of time we were allowed. But since the Clearinghouse was unable to begin the review period at its inception because copies of the Impact Statements were not received until April 19, our review was not as thorough as we would wish. Additionally, some agency comments have not yet been received by the Clearinghouse. Any further comments will be forwarded to you as soon as they are received.

Sincerely,

Frank L. Stanons
for ROBERT D. BELL
Secretary

RDB:sf

Robert D. Bell
XXXXXXXXXXXXX

JULIAN M. CARROLL

COMMONWEALTH OF KENTUCKY
DEPARTMENT FOR NATURAL RESOURCES AND ENVIRONMENTAL PROTECTION
OFFICE OF THE SECRETARY
FRANKFORT, KENTUCKY 40601
TELEPHONE 502 564-3350

RECEIVED JUN 9 1976

OFFICE OF PLANNING AND RESEARCH - (502) 564-7320

June 4, 1976

50-546/547

Dr. Stanley Kirslis
Division of Site Safety and Environmental Analysis
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

RE: Draft Environmental Impact Statement - Marble Hill (76-13)

Dear Sir:

Please acknowledge the enclosed late comment which was received by the State Environmental Impact Statement Clearinghouse on the above Draft Environmental Impact Statement from the Division of Air Pollution.

Sincerely,

Andrew Cammack

Andrew Cammack, Review and
Communications Coordinator
Office of Planning and Research

Enclosure

AC:tlc

5844

MEMORANDUM

May 27, 1976

TO: Frank L. Stanonis, Commissioner, Bureau of Environmental Quality Department for Natural Resources & Environmental Protection

THROUGH: John T. Smither, Director, Division of Air Pollution Control Department for Natural Resources & Environmental Protection

THROUGH: Roger Blair, Deputy Director, Division of Air Pollution Control Department for Natural Resources & Environmental Protection

FROM: Prakash S. Dave

SUBJECT: Draft Environmental Impact Statement - Marble Hill Nuclear Power Station Unit 1 & 2

We have reviewed the draft environmental impact statement related to the construction of Marble Hill nuclear power generating station, units 1 & 2. During the review it was found that problems related to the release of radioactive contaminants to the ambient air have been adequately discussed. The suggested control measures should prove sufficient during the normal operation of the power plant.

However, we would have liked to have seen more discussion on preventive measures taken against possible attacks by terrorists and sabotage.

PSD/jh

RECEIVED
JUN 2 1976
OFFICE OF
PLANNING AND RESEARCH

Robert D. Bell
XXXXXXXXX.XXX

COMMONWEALTH OF KENTUCKY
DEPARTMENT FOR NATURAL RESOURCES AND ENVIRONMENTAL PROTECTION
OFFICE OF THE SECRETARY
FRANKFORT KENTUCKY 40601

OFFICE OF PLANNING AND RESEARCH - (502) 564-7320

RECEIVED JUN 11 1976

June 9, 1976

Dr. Stanley Kirslis
Division of Site Safety and Environmental Analysis
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

STN-50-546
STN-50-5?7

RE: Draft Environmental Impact Statement - Marble Hill (76-13)

Dear Sir:

Please acknowledge the enclosed late comment which was received by the State Environmental Impact Statement Clearinghouse on the above Draft Environmental Impact Statement from the Division of Disaster and Emergency Services.

Sincerely,

Andrew Cammack, Review and
Communications Coordinator
Office of Planning and Research

Enclosure

AC:tlc

6065

COMMONWEALTH OF KENTUCKY
DEPARTMENT OF MILITARY AFFAIRS
DIVISION OF DISASTER AND EMERGENCY SERVICES
FRANKFORT
40601

3 June 1976

RECEIVED
JUN 9 1976
OFFICE OF
PLANNING AND RESEARCH

Mr. Andrew Cammack
Environmental Review
Office of Planning and Research
Department for Natural Resources
and Environmental Protection
6th Floor, Capital Plaza Tower
Frankfort, Kentucky 40601

Dear Mr. Cammack:

This is in response to your request for comments concerning the NRC Draft . mental Statement relating to the Marble Hill, Indiana, nuclear generating s.

The Division of Disaster and Emergency Services (DES) is primarily concerned this case with developing effective preparedness planning activities and emer y response capabilities in order to cope with any disaster occurring in or near e facility. Consequently, the areas covered in the environmental statement are not within the preview of this Division. However, there are some general comments I have on certain sections of the Statement.

The sections of the study that were germane for us seemed to receive little in-depth treatment. Either not enough data was presented to be meaningful, or facts were merely stated with no accompanying analysis or close examination of the subject area.

To illustrate, recent newspaper reports indicate the applicant is considering transporting radioactive materials via barge on the Ohio River. This consideration was omitted from the evaluation (Section 5.4.1.4). Also within the small Seismicity section (2.4.2), no statement or analysis reassures us the facility can withstand earthquake stresses; furthermore, a study calculating earthquake (tremor) probability for the area over the life of the facility would have been useful to us. Other sections that weren't developed fully include Sections 7, 2.6.3, and 10.1.

This means that many of the facts culled from the Statement must now be pursued independently. The report would have been more effective for this organization had all sections received a more in-depth and consistent treatment.

If I can provide any further assistance, please call.

Sincerely,

Robert L. McFerren

ROBERT L. McFERREN
Deputy Director

RLM/CTM/bzb

Robert L. Bell
XXXXXXXXXXXX
Secretary

JULIAN M. CARROLL
Governor

COMMONWEALTH OF KENTUCKY
DEPARTMENT FOR NATURAL RESOURCES AND ENVIRONMENTAL PROTECTION
OFFICE OF THE SECRETARY
FRANKFORT, KENTUCKY 40601
TELEPHONE (502) 564-3350

STN-50-546
547

OFFICE OF PLANNING AND RESEARCH - (502) 564-7320

RECEIVED 6-21-76 U.S. NUCLEAR REGULATORY COMMISSION

June 15, 1976

Dr. Stanley Kirslis
Division of Site Safety and Environmental Analysis
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

RE: Draft Environmental Impact Statement - Marble Hill (76-13)

Dear Sir:

Please acknowledge the enclosed late comment which was received by the State Environmental Impact Statement Clearinghouse on the above Draft Environmental Impact Statement from the Education and the Arts Cabinet.

Sincerely,

Andrew Cammack

Andrew Cammack, Review and
Communications Coordinator
Office of Planning And Research

Enclosure

AC:tlc

COMMONWEALTH OF KENTUCKY
THE EDUCATION AND THE ARTS CABINET
CAPITAL PLAZA TOWERS
FRANKFORT, KY. 40601

Wendell P. Butler
~~XXXXXXXXXX~~
SECRETARY

RECEIVED
JUN 11 1976
OFFICE OF PLANNING AND RESEARCH

June 10, 1976

MEMORANDUM

TO: Andrew Cammack
Review & Communication Coordinator

FROM: Wendell P. Butler WPB

SUBJECT: EIS Review

Upon review of the Draft Environmental-Statement related to construction of Marble Hill Nuclear Generating Station Units 1 and 2 prepared by the U. S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, published March, 1976, this office upon recommendation from the Kentucky Heritage Commission is unable to determine if any adverse effects are likely to occur on historic properties located within our geographic area of concern.

While reference is made to historic sites located ... Milton, Kentucky, and Bedford, Kentucky (see p. 2-42) no documentation relative to a comprehensive survey is available on the referenced county. It is therefore assumed that any potential adverse effects on the historic and/or the archaeological properties located in the project's impact area will be adequately addressed in the Final Environmental Statement.

If further information is needed, please contact me.

WPB/skj

cc: Jacks... ...tee

LOUISVILLE WATER COMPANY
435 SOUTH THIRD STREET · LOUISVILLE, KENTUCKY 40202

FOSTER S. BURBA
PRESIDENT

50-546/547

April 19, 1976

RECEIVED
APR 23 1976

U. S. Nuclear Regulatory Commission
Division of Site Safety and Environment Analysis
Office of Nuclear Reactor Regulation
Washington, D. C. 20555

Attention: Dr. S. Stanley Kirslis

Re: Marble Hill Nuclear Generating Station
Units 1 and 2

Gentlemen:

Louisville Water Company "LWC", by counsel, offers the following comments to the Draft Environmental Statement (DES) related to the construction of Marble Hill Nuclear Generating Station, Units 1 and 2, Public Service of Indiana, Docket Nos. STN 50-546 and STN 50-547, published March, 1976:

1. DES Section 2.3.1 Surface Water. LWC finds the discussion of surface water use inadequate. First, there is no specific mention of the fact that LWC, with intake facilities only 30.5 miles from the proposed Marble Hill Nuclear Generating Station, uses an average of 125 million gallons of river water per day serving a population of 730,000. Second, LWC rather than the Oldham County Water District is the "closest water user for demestic purposes". The Oldham County well system, located 12.2 miles downstream from Marble Hill, utilize groundwater instead of Ohio River water.

2. DES Section 5.4.1.1 Exposure Pathways. LWC finds the discussion of exposure pathways inadequate due to the lack of attention of the possible affects of bio-accumulation of radionuclides on drinking water. The apparent reoccurrence of several species of biota, including Asiatic clams (Corbicula) and fresh water sponges, have presented a problem to LWC in maintaining clear intake facilities. These organisms grow on the interior of piping structures and are periodically subject to rapid disintegration due to changes in environmental conditions. The sudden death of these organisms flushes large volumes of organic material into LWC's treatment facilities.

LWC fears that these organisms may have the capability of bio-accumulating radionuclides, and that these radionuclides might be released in a single large slug directly into the the public drinking water system.

4073

U. S. Nuclear Regulatory Commission
Page Two
April 19, 1976

LWC recommends that the bio-accumulative capability of these and other organisms be investigated to determine the relevance of this exposure pathway.

3. DES Section 6.1.2 Preoperational Radiological Monitoring. LWC recommends five specific changes in the proposed preoperational monitoring as established in this Section of the DES:

(a) Monitoring of drinking water should commence two years prior to operation.

(b) LWC should be identified as the closest downstream water supply intake.

(c) Gross beta and gamma scans should be made at least biweekly and a composite for tritium, Sr-89, and Sr-90 should be made at least monthly.

(d) Applicant should periodically analyze both LWC tap water and LWC intake water to determine the efficiency of LWC's treatment facilities in removing radioactive particles.

(e) In view of the possible exposure pathway from biota, preoperational monitoring of sediment, benthos and aquatic plants should be done at least monthly. Any lesser monitoring would not yield statistically relevant data for assessing the bio-accumulation of radionuclides.

The above comments should not be construed to limit the scope of the contentions LWC intends to present in the Marble Hill proceeding.

Respectfully submitted,

Frank C. Campbell
Vice President-Chief Engineer

FCC/SAH:cr

cc: Mr. Stephen A. Hubbs

LOUISVILLE WATER COMPANY

Route 2, Box 251
Hanover, Indiana 47243

APRIL 30, 1976

RECEIVED MAY 7 1976 U.S. NUCLEAR REGULATORY COMMISSION Mail Section

Director, Division of Site Safety and Environmental Analysis
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Sir:

This letter comprises comments on the Draft Environmental Statement related to construction of Marble Hill Nuclear Generating Station Units 1 and 2; Public Service of Indiana; Docket Numbers STN 50-546 and STN 50-547; March 1976; U. S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation. We refer to this document as DES.

The technical committee of the "Save-The-Valley Corporation," consolidated with the "Save Marble Hill" organization ask that you consider these comments with care and that you incorporate them into the final record.

These comments fall into two categories: A, those related directly to items of reference in DES, and B, those of a more extended nature that deal with matters either omitted from DES or treated in what appears to us as an unacceptably cursory manner in DES.

In conclusion from these comments we make several recommendations that we believe cannot rationally be gainsaid. They gain their right to be said and included here because of NEPA and the statements quoted on p. xii of DES from that Act.

We believe that the U.S. NRC is our only sound bulwark against the assults of unthinking Utility managements. and we pray your best statesmanship in the maintenance of our Earth and our quality of life.

We have placed the Recommendations as a separate section of our Comments, but ask that they be made part of the record.

Very truly yours,

Harold G. Cassidy, Member
Board of Directors
Save The Valley

HGC/db

COMMENTS on the Draft Environmental Statement [DES]

related to construction of

Marble Hill Nuclear Generating Station

Units 1 and 2

Public Service of Indiana

Docket Nos. STN 50-546 and STN 50-547

Published March 1976

U. S. Nuclear Regulatory Commission

Office of Nuclear Reactor Regulation

Also Recommendations

Addressed to:

Director, Division of Site Safety & Environmental Analysis
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

General Comment. The DES appears to be hastily written, and poorly proof-read (c.f. 2.4.1.2 "Siluvian"). The general effect of pressure to rush ahead without adequate time for thoughtful evaluation of the Environmental Report [ER] is repugnant to those citizens who wish to be represented in the critical decisions that are involved.

Specific Comments. All comments identified by JDW were made by Dr. J. Dan Webster, Professor of Biology, Hanover College.

1) 2.2.2. What is meant by "immediate vicinity"? There are numerous industries in North Madison, about 11 miles from the proposed site, and this is downwind from the proposed plant part of the time (see map on p. 2-15). This would seem to qualify as "immediate vicinity".

2) 2.2.2. This section should correct the statement in ER in the last paragraph of 2.2.2.1. There is a gas pipeline closer than the one near Bedford. It crosses Highway Ind. 62 near Saluda and the Ohio River east of that point.

3) 2.2.2. This statement should supplement 2.2.2.1.1. The statements on forested land allow nothing for the scenery value of forested slopes, nor for the long term growth of trees. This applies to both the regional and actual site statements. (J.D.W.)

4) 2.2.3. This paragraph is in error. There are numerous marinas in and near Madison, Indiana, that are used the year round, and to store boats.

5) 2.3.3. is omitted. It should be present, and supplement the statement of ER 2.3.3. and Figure 2.3-2. In the statements and map on scenery, most of the scenery in the area is omitted! (Most of the scenery in the region involves the Ohio River and its fringing bluffs.) On the site is one of the finest views in Jefferson County, if not in the entire Ohio Valley. (J.D.W.)

6) 2.4.2. Seismicity is mentioned too cursorily, especially since in ER 4 lines (p. 2.4-15) are devoted to this important subject. ER says that the "site lies in the zone of low seismicity within Indiana." This is not correct for there are 3 zones of seismicity in Indiana, and the low zone is most of the northern part of the State. DES correctly states that the site area is classified as Zone 2, a zone of moderate anticipated damage, but does not take ER to task.

Further, it is not clear that the plant will be built to withstand an earthquake of 8 on the Richter scale. That such a quake is quite possible here, and perhaps "overdue," may be read in the work of the authority Gordon B. Oakeshott who quotes, also, Professor Nuttli:

"Among the most intriguing earthquakes ever felt in North America was the series of three in the Mississippi Valley centering near New Madrid, Missouri, in 1811 and 1812. 'Unusual' (all earthquakes are unusual) in many respects, these earthquakes serve as an excellent example of the infrequent, large earthquakes of the Mississippi Valley and eastern North America, in contrast to the frequent earthquakes of California and the West.

"Strong earthquakes, centered near New Madrid, occurred on December 16, 1811, January 23, 1812, and February 7, 1812, with magnitudes estimated, respectively, at 7.2, 7.1 and 7.4. Total felt area was about 2.5 million square kilometers. Professor Otto W. Nuttli of St. Louis University, who made a special study of these earthquakes, estimates the total release of energy was equivalent to a magnitude 8.0 earthquake.

"Geologically, the area is at the upper end of the great Mississippi River delta and so is a region of thick alluvium. Layers of water-saturated sand liquefied extensively during the earthquakes, resulting in large surface displacements, sand boils, fissures, and landslides. Land subsidence, uplift or doming, and caving of river banks took place over large areas; Reelfoot Lake was formed in Tennessee. There was no single, well-defined surface fault, but a linear region of 140 kilometers (87 miles) long by a few kilometers wide of 'major subsidence, doming, fissures, sinks, and large sandblows' was developed.

"Most large earthquakes consist of a single major shock followed by a series of much lesser aftershocks; but here were three major earthquakes, rather widely spaced in time. A second anomalous feature was the great area of damage, a felt area about 100 times as great as in an earthquake of similar magnitude in the West.

"However, seismologists are finding that in Mississippi Valley and eastern earthquakes the surface-wave energy seems to diminish outward much more gradually than for earthquakes in the West.

"How, then, do we estimate further earthquake hazards in the United States east of the Rocky Mountains? Professor Nuttli says:

The absence of large-magnitude earthquakes in eastern North America since the Charleston, South Carolina earthquake in 1886 has resulted in complacency, or perhaps unawareness on the part of the general populace of the existence of any earthquake threat to them. When such earthquakes of the size of the 1811-1812 sequence occur, the emotional problems which will result for large numbers of people in the widely affected area will likely be severe, particularly if the earthquake energy is released over a long period of time, in the manner of the 1811 and 1812 earthquakes."

[Gordon B. Oakeshott, Vocanoes and Earthquakes. Geologic Violence. McGraw-Hill, New York, pp. 97 to 98.]

That the 1811 quake was a violent one is certified:

"The first shock occurred the fifteenth of December, and they were repeated at intervals for two or three months. A resident of the valley at that time wrote that the shocks of these earthquakes must have equalled, in their terrible upheavings of the earth, anything of the kind that has been recorded." [J. H. Levering, Historic Indiana. G. P. Putnam's Sons, New York, 1916, p. 133.]

7) 2.5.3.1. No mention is made of the possible causes of the exceptionally out-of-line analyses for heavy metals, August and September, Table 2.4; and July phenols, Table 2.5. These throw some doubt on the reliability of the analyses unless reasonably explained.

8) 2.6.2. From the map, Figure 2.4, it seems clear that Madison is NE of the site, not NNE as given in the first paragraph. Further, the wind roses, e.g. Figure 2.7, indicate that for a significant part of the time Madison, and also Louisville, will be down-wind of the plant. No adequate evaluation of this relative to radioactive effluents is given.

9) 2.6.4. Second paragraph fails to give data or make an evaluation.

10) 2.6.5.5. This category is omitted. It should be noted that in ER the validity of the tornado frequency data is open to question. Omitted is the fact that the nearby town of Hanover was hit by two devastating tornadoes in 137 years.

11) 2.7.1.1. last paragraph. The statement, "None of the plants sampled by the applicant at the Marble Hill site is listed as an endangered species," should have been much qualified. No sampling was done on the north-facing slope, nor in the steep ravine part of the east-facing slope. Also, the endangered species list checked included only trees, not herbs and shrubs, which have more restricted ranges. (J.D.W.)

12) 2.7.1.2. The bird list is essentially correct. However, it should have been noted that all of the scarce or "Blue listed" species mentioned inhabit forests, and the forest area of southern Indiana will be distinctly reduced by the proposed plant and its transmission lines and railroad. For example, these scarce species will be further reduced: Wood Duck, Sharp-shinned Hawk, Broad-winged Hawk, Screech Owl, Great Horned Owl, Barred Owl, Pileated Woodpecker, Red-headed Woodpecker, Parula Warbler, Yellow-throated Warbler, Louisiana Water Thrush, Hooded Warbler. (J.D.W.)

Appendix B-13. Contrary to the statement made, the Red Squirrel does not inhabit the impacted counties of southern Indiana. (J.D.W.)

Appendix B-12. The following errors are in the bird list:

(a) These species don't breed in the impacted counties --Black Duck, Upland Plover, Long-eared Owl, Worm-eating Warbler.

(b) These species are not permanent residents--Long-eared Owl, Black Duck.

(c) This species does breed and should have been so listed--Vesper Sparrow.

In commenting on probable impact on the Indiana Bat, an endangered species, impact of the transmission lines cutting the gallery forests of Big Creek, Vernon Fork of the Muskatatuck River, etc., should have been included. (J.D.W.)

13) 2.7.2.1. The list of endangered flora includes only trees. No list of shrubs and herbs is presented and checked. (J.D.W.)

14) 2.7.2.2. Why was no study of the aquatic biota, including fish and fishing, ordered by the NRC for the creeks and rivers impacted by the transmission lines and railroad? A fairly thorough study was made of the Ohio River, where fishing is poor and pollution bad, but nothing comparable was done for the small rivers and creeks where fishing is better and pollution less! According to table 2.9, there will be no less than 45 creek and-river-crossings by the giant transmission lines and 7 creek-crossings by the railroad. These small rivers and creeks will be severly damaged by timber cutting, bridge building, and herbicide use.

As stated on this page, the Ohio River has changed markedly in the last century as a result of human impact. Why should the power company be allowed similarly to change the Muskatatuck and other streams that are presently in fairly good shape? (J.D.W.)

15) 2.7.2.2. What were the "more general ecological data" used by the Staff in its assessment? (See p. 2-28.)

16) 2.7.2.2. With respect to historical changes in the fish fauna why were not barges considered? They produce enormous, visible turbulence, bringing up visible mud, in their pounding through the water. (See p. 2-32.)

17) 2.73. Why was not the land impacted by the railroad and transmission lines surveyed as carefully as the main site for environmental impact? From my own observations and knowledge, I believe that the creeks, rivers, gallery forests, etc., of these strips have major natural resources that will be damaged by the proposed actions. (J.D.W.)

18) 2.9.2. Scenic views along the Ohio River should have been mentioned, including the magnificent panorama from the site itself. Much of the scenery in the impacted counties consists of the Ohio River and its wooded bluffs, but this was ignored in this publication. (J.D.W.)

19) 3.4.1. No estimate is made of the effect of a 28°F rise of cooling water, the heat of which will, it is said, be largely (5.3.3.1.) dissipated to the atmosphere (about 1.65 x 10^{10} Btu/hr, or 4840 MW) upon the local atmosphere and the normally high humidity of the Valley. This is not adequately addressed in 5.3.1.

20) 3.5. This statement is deficient. It is admitted that "radioactive materials will be produced by fission and by neutron activation of corrosion products in the reactor coolant system." Nowhere, however, as far as is made clear, is the effect of the neutron flux from the reactor, and outside of the site, evaluated. CFR 10-20.4 on units and CFR 10-20.101ff make clear that there is a relation between neutron flux dose and body exposure in terms of mrem.

In the last paragraph of this section what is meant by "as low as practicable levels"? Is this an officially adopted level? What is it?

21) 3.5.1.1. Why is tritium excluded?

Is not a PWR a tritium producer--more so than, say a BWR?

22) 3.5.1.4. The "equipment downtime" and "anticipated operational occurrences" statement is vague, and seems underestimated. What "operational occurrences" are anticipated?

23) 3.5.2. What is the disposition of the charcoal of the adsorbers through which gaseous material is pumped?

24) 3.5.2.1. In paragraph 2 there is no information about what is considered "sufficient decay".

25) 3.5.2.7. No consideration seems to be given to neutron flux.

26) 3.5.3. Radioactive charcoal adsorbers are not mentioned as solid wastes.

27) 3.7.1. In the description of the Rush line transmission corridor, there is no mention of important forests--especially Conboy Woods, near Vernon. In the description of the Columbus Line transmission corridor, there is no mention of one State Nature Preserve, Tribbetts Flatwoods, near Deputy. Tribbetts Flatwoods is bisected by the mapped corridor, and Muskatatuck National Wildlife Refuse is missed by only 900 feet--hardly enough for the migrating flocks of geese, cranes, and ducks to avoid. (Some of these areas are mentioned later in the report, pp. 4-13.) (J.D.W.)

28) 3.9.1. and map 3.9-1. The statement is made [in ER] concerning transmission lines. "All alternative routes were reviewed, and primary routes selected to minimize economic, environmental, and sociocultural impacts." Without supporting details about all the alternative routes and which economic, environmental and sociocultural criteria were used, the statement is meaningless. The map is so small scale as to be almost useless in locating impacts. (J.D.W.)

29) 3.9.2.2. One transmission line is stated to pass .2 mile east of Muskatatuck National Wildlife Refuge. That is much too close for both a mechanical obstruction and navigational electric hazard for flying geese, cranes, and ducks.

The forest land devastated by the transmission lines is called, "Regrowth forests of varied composition, occurring as isolated woodlots." The transmission lines cross, or nearly cross (the map is too small scale to be certain) three of the finest old growth forests in the state of Indiana and the largest forest (one mile square) in Jefferson County.

30) 4.1.1. What is the calculation of agricultural revenue loss that can calculate 39-year loss to 7 significant figures and not be questioned by DES?

31) 4.1.1. Where will the crushed stone be obtained? It would seem that this is important in connection with off-site road conditions.

32) 4.2.1.3.5. In the list in ER of herbicides to be used in the transmission corridors, 2,4,5-T is included. Its use was banned in 1972 and 1974 by E.P.A. for most uses. (J.D.W.)

33) 4.3.1.1. In the description of transmission corridor habitat destruction, there are statements and implications that mammals and birds are "displaced", or moved. This is an ecological lie. The mammal and bird populations are killed or extirpated.

"The staff requires that aerial spraying (of herbicides) be used only in terrain inaccessible to ground transport." Certainly the restriction is better than unrestricted spraying of dangerous herbicides which may be dangerous to animal and human health and certainly will kill many non-target plants. However, the exception allowed is a dangerous one. As inspection of U.S.G.S. topographic sheets shows, the "inaccessible to ground transport" terrain is precisely the area of terrain, in Jefferson and Jennings Counties especially, where forests, wildlife, and natural waters are--ravines and hillsides. If herbicides are necessary (hand cutting with axes would be much less damaging to fish, wildlife, and plants), they should be applied by men on the ground, with hand sprayers or jets. Aerial spraying and spraying of herbicides from vehicles should be prohibited along the transmission corridors and railroad. (J.D.W.)

34) 4.3.1.1. Last paragraph. The NRC wisely required a survey of the possible use of existing railroads (abandoned and almost-abandoned) for transmission lines. A logical additional survey would be the use of existing transmission line corridors, which already cris-cross southern Indiana rather thoroughly; some of them already belong to PSI. (J.D.W.)

35) 4.4.3.1. It is stated that increased tax receipts will balance the increased school expenditures for various county schools. Doubtless this will be true in the long run. In the first four years, however, it appears that there will be sharply-increased school expenses before increased tax receipts begin. In fact, maximum impact on the schools will be during construction, 1977-79, well before increased school tax receipts. Personally, I question the ability of the Southwestern school system to absorb an additional 10% increase in enrollment in one year, despite Superintendent Hogg's letter to the contrary. (J.D.W.)

36) 4.5.1.2. In the description of the environmental impact of transmission line corridors, there is an omission. It should have been noted, here and on page 4.2 above, that the cutting of a corridor through a forest impacts a much wider strip than the actual corridor. On either side of the actual strip of downed trees there is an "ecological edge" created, where

growth of some trees is lessened, brush and honeysuckle increased, and forest ecology, including wildlife, adversely affected. (J.D.W.)

37) 5.3.1.2. It has been observed that the visible plume from the Clifty Creek Plant of IKEC is often visible and traceable as a well-defined body of fly-ash, for fifteen or more miles down-wind. A plume of vapor may extend more than "several miles."

38) 5.3.1.7. The MDCT may well be proven, effective, and economical. However, since plumes may travel considerable distances in well-defined form, and the IKEC plant, producing an average of 286,000 tons per year of sulfur dioxide, is about ten miles away, down-wind some of the time (see map 2.7) it is to be expected that interactions will occur that will subject the people and the buildings of Madison, Indiana, to acid mist or rain.

It has been observed that rain falling through the IKEC plume becomes acid, while rain from the same shower outside of the plume path is neutral to litmus. No such large power stations should be allowed within 25-50 miles of each other.

39) 5.3.3.2. What is meant by a case-by-case basis? The Ohio River Valley Water Sanitation Commission uses the term "aggregate". Does the "natural" temperature become the aggregate temperature after a given pollutant has been allowed?

40) 5.4.1.5. Evaluation of Radiological Impact is inadequate. No account is taken of the work of, for example, Professor G. D. Hanks of Indiana University Northwest, Gary, Indiana, in which he associates intake of radioactive materials above normal background (pre-bomb-testing) and behavioral changes in a population; some members of the population will be susceptible to such behavioral changes.

"The underlying causal effect of internal radiation on some chronic and most infectious diseases is well known but not readily admitted. Hanks (International Genetics Congress, Berkeley CA, August 1973, American Zoologist, 1974) provided very good evidence that internal radiation from atmospheric-atomic tests is a substantial underlying cause of violence. He suggested that emissions from nuclear power plants might be a substantial underlying cause of violent crime (in the laststraw sense). An intensive investigation showed a very strong association of nuclear power plant operation and increased violent crime when the plants were located near sizable populations (e.g. Joliet and Chicago, Illinois; Surry plants in Va.). Other hypotheses were inadequate to explain the result. The possibility of a generalized effect (e.g. Kr-85

buildup--1/2 life about 10 years and much heavier than air) was tested. A statistically significant relationship of violent crime and attitude was found. It is suggested that nuclear power plant gaseous emissions increase crime and other problems involving aggression." [American Zoologist 15, No. 3, Summer, 1975, p. 769.]

There is insufficient recognition in DES of the serious questions that can be raised regarding radiological impacts on man and biota from residence within 50 miles of a nuclear plant. If no questions are raised by NRC, then whose responsibility is it to raise such questions?

41) 5.5.2. What deleterious effects are expected from the extensive chlorination of effluents when, as in table 2.5 there is a high-phenol presence.

42) 5.5.5.1. The known concentrating effect by higher animals in the web-of-life hierarchy, of heavy metals and other toxic materials, raises serious question about the danger to persons who eat these fish. This is in addition to and is probably more serious than, the killing of fish.

43) 5.6. Experiments and data cited don't refer to wild animals, nor to the ecosystem, but only men and caged house mice. Adequate experimental data don't seem to exist on the effects of 765 KV alternating current transmission lines on man, domestic animals, wild animals, and ecosystems. Why should not PSI produce these data before it builds and operates these lines across our land? Probably navigational abilities of birds and other physiological attributes of animals and plants are affected by these intense electrical fields, but it will take a major research effort to find out. (J.D.W.)

44) 6.1.5.1. I commend the NRC staff for requiring an additional survey for the Indiana Bat on the site. The transmission corridors should be added to that Indiana Bat survey. Also, a good ecological survey of the transmission corridors, both terrestrial and aquatic should be added. (J.D.W.)

45) 8.1.3.5. ER, omitted by DES. Here, the aesthetic values of the scenic views on the site are recognized, although they were omitted in Vol. 1. (J.D.W.)

46) 8.1.3.9. ER, omitted by DES. The P.S.I. visitors center in downtown Madison is called "the provision of public education facilities." Is propaganda education? (J.D.W.)

47) 8.2.2.6. ER, omitted by DES. It is stated that local school enrollments are decreasing, and could stand an increase of 15% in one year. The first statement is not true of Southwestern, and I doubt that the second one would be. (J.D.W.)

48) 8.2.3. Staff's forecast is based on data some of it necessarily furnished by the Utilities themselves. Omitted, however, are some recent data, and what seem to be highly important and thoughtful analyses that drastically alter the picture, and the forecasts.

From the Monthly Energy Review [Federal Energy Administration, National Energy Information Center, February, 1976, Part 1, Overview of 1975 cumulated data]. "During 1975 the United States produced 1.8 percent less energy than during 1974 and 3.7 percent less than the level for 1973.... Consumption of energy in the United States also appears to have declined in 1975...a decrease of 2.8 percent from the level for the corresponding period in 1974 and a 5.2 percent decrease from the same months in 1973. These decreases in energy demand are counter to the trend for the 10-year period prior to 1974 when consumption increased at an average rate of 4.3 percent per year.... Production of electricity by public utilities [was] 2.3 percent higher [in 1975] than the total for 1974."

Of the total energy produced in 1975 the portion due to electric utilities increased 2.3 percent over 1974. During the first 10 months of the year 1975 sales of electrical energy increased 6.1 percent to residential; 7.0 percent to commercial; and decreased 5.7 percent to industry customers compared with the same period of 1974. The following table gives the general picture (above reference, p. 31):

Total sales in billions of kilowatt hours to

	Residential	Commercial	Industrial	Other*	Total
1973	579,268	388,137	686,237	59,331	1,712,973
1974	578,500	383,431	688,051	58,084	1,708,066
1975 (10 months)	515,208	343,219	543,921	50,191	1,452,539

*Includes street lighting and trolley cars.

A part of the picture which may have diagnostic value, taken from the same source, Part 4, reads: "Since June 30, 1974, construction delays of between 4 months and 5 years have occurred on 125 units totalling 133,845 megawatts, while 23 units totalling 26,455 megawatts have been cancelled." (nuclear)

A serious omission, it seems to us, is DES's failure to cite the Energy Policy Project of the Ford Foundation, A Time to Choose. America's Energy Future [Ballinger Publ. Co., 1974].

This comprehensive report representing some two years of work by responsible authorities came up with definite conclusions some of which do not agree with those of the DES. Because of their objective source they deserve close attention.

"The major finding from our work is that it is desirable, technically feasible, and economical to reduce the rate of energy growth in the years ahead, at least to the levels of a long term average of about 2 percent annually, as set forth in our Technical Fix scenario. Such a conservation oriented energy policy provides benefits in every major area of concern --avoiding shortages, protecting the environment, avoiding problems with other nations, and keeping real social costs as low as possible...." [pp. 325,326]

"The Project also finds that it appears feasible, after 1985, to sustain growth in the economy without further increases in the annual consumption of energy. Such a Zero Energy Growth scenario can be implemented if needed for reasons of resource scarcity or environmental degradation, or it may occur as a result of policies that reflect changing attitudes and goals...." [p. 326]

"One important conclusion from our work is that the expansion program of the electric power industry now underway is substantially greater than needed to supply the electricity that the Technical Fix scenario requires. Demand for electric power in this scenario would grow faster than 2 percent per year overall growth rate; but it would still amount to only about half the 7 percent which is the electric power industry's historical growth rate. Power plants now on order for completion by 1980 could satisfy the demand for electricity until 1985 under such an energy conservation policy. This would mean that a pause of several years in new power plant starts is possible for the nation as a whole. During this period technical progress could diminish concerns about the safety of nuclear power and about air pollution from burning coal or oil in power plants."

The Nuclear Energy Center Site Survey-1975 (NECSS-75), January 1976, Part V, Resource Availability and Site Screening, pp 6-1ff, considered the power projections of WASH-1139(74) and the ERDA February 1975 report "Total Energy, Electric Energy and Nuclear Power Projections" which "modified these earlier AEC's WASH-1139(74) estimates downward. This ERDA analysis considered four cases. The two of most interest are the next to lowest case which lowered the WASH-1139 Case A nuclear electric generating capacity projections by 29% for 1985, and by 6% for the year 2000; and the lowest case which reduced the Case A nuclear projections by 36% for 1985, and by 26% for the year 2000." [p. 6-1] The estimated nuclear capacity growth was reduced to reflect "recent nuclear construction delays and deferrals." [p. 6-24]

The survey also considered it desirable to include as an option "zero growth in per capita demand for electricity in the period 1985 to the year 2000. This case is included to illustrate minimum future requirements for power plant construction. Neither new uses for electricity, nor the substitution of electricity for other forms of energy use are permitted. [These constraints were absent from the Ford Project Zero Energy Growth scenario.] New generating capacity is needed only to replace obsolete facilities constructed prior to 1970 (this assumes a 30-year life) and to supply electric demands caused by increases in population." [p. 6-24]

49) 10.1ff. In the summary of the environmental impact, these parts of the impact are omitted:

(a) Scenery is not allowed for.

(b) Edge effects of transmission corridors are not allowed for.

(c) No mention is made of other power plants planned for the immediate area, to be built as soon or sooner than Marble Hill. (J.D.W.)

50) 10.9.1. and maps 10.9-1 and 2. in ER. Two transmission line corridor alternate routes are described. The maps are too vague and small scale to be informative. Costs of construction and purchase of land plus a few cultural features, only, are considered. The natural environmental (forests, animals, creeks, soils, etc.) is ignored. Natural areas of major importance are crossed on several routes, apparently. (J.D.W.)

51) General comments with respect to ER and DES and appendices B and C.

A. Material concerning birds scattered through the 3 volumes of ER (J.D.W.):

(1) Three locally common breeding species are omitted--Cerulean Warbler, Kentucky Warbler, Summer Tanager. Omission of numerous other locally scarce species is unimportant.

(2) The "bounded count estimates of non-gamebird populations" are meaningless as quantitative ornithology. Three of them (March, April, September) are out of season for area counts and all six are based on ridiculously small (one acre) plots counted only about three times.

(3) The statement (Vol. II, p. 4.2-7) that "where the (transmission) rights of way pass through wooded regions only minimal impact on wildlife will occur" is a major ecological error. Woodland birds don't live in a 200 ft. wide strip of brush or weeds.

(4) The program for ecological monitoring after operation of the plant begins is badly conceived (Vol. II, p. 6.2-5). Thorough bird censuses along lines or in large plots should be planned for winter or early summer.

B. Material concerning mammals scattered through the 3 volumes of ER (JD.W.):

(1) Lack of Peromyscus maniculatus suggests many specimen misidentifications or little trapping. My trapping in this county has yielded more of this species than any other.

(2) No bat captures or species identifications suggests a lack of mammalogical field work. (Two sight records, unidentified to genus or species, are listed.)

(3) The several statements on transmission line corridors badly understate the impact these will have on animal populations, especially where these corridors impact forest or woodland. The Indiana Bat (Myotis sodalis) inhabits, in summer, only gallery forest along streams; Peromyscus leucopus inhabits only forest, etc. In other words, forest and woodland mammals will be extirpated from extensive strips of southern Indiana by the transmission corridors.

09/20/76

Recommendations

Two recommendations are offered. Basically, they call upon the NRC to exert its decision-making power with respect to: --in NEPA, Section 102(2)(c) terms are quoted on p. xii of DES--"the environmental impact of the proposed action" with regard to "The relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity;" taking account also of "Any irreversible and irretrievable commitments of resources that would be involved in the proposed action should it be implemented;" but especially with respect to the necessity for long term ineluctable changes to start out at the grass-roots level, with the recognition of long induction periods, and with initiation of small incremental guiding acts such as refusal to yield PSI a permit to construct the Marble Hill Nuclear Generating Stations.

We can do no better than to follow the balanced view of the physicist Professor John P. Holdren of the University of California at Berkeley. [Bulletin of the Atomic Scientists, March 1976, pp. 20ff.] He feels that policy-makers (and NRC by every administrative act makes policy) can not wait for concensus on technical matters of the complexity, uncertainty and obscurity of the problems of nuclear power for none is possible, nor will it become possible within the time scale within which major decisions must be made. (And granting a permit to construct and to operate a nuclear facility is clearly a major decision.)

What must be concentrated on, he says, is how to minimize the social costs of such uncertainty.

What are the factual sources of these long-term ineluctable changes? They are: a) The Earth is finite in its materials of all kinds. b) Our industrial society uses up or disperses natural resources. c) The more resources are dispersed the greater the energy cost of recovery and re-use of them. d) The exponential rate of growth of this activity in b) will inevitably bring a point at which much of the energy available to us will be used for recovering dispersed metals, etc., for re-use, and for getting more energy. e) A point of diminishing returns will inevitably arrive.

With these prospects, which cannot be gainsaid, for they are factually correct, we also weigh opinions. 1) It is not prudent, and indeed it is immoral, to use up profligately today our limited resources for short-term gains which will impoverish future generations. 2) It is the function of objective bodies such as the NRC to begin to turn the tide of profligacy towards necessary long-term goals. 3) Such turning of the tide must begin with individual judgments that recognize how essential a slow and minimally disrupting refusal to grant a construction permit is. 4) The time is now, and the occasion is Marble Hill. 5) This could be a landmark case of NRC action in the public interest. We recommend such action.

The problems that would be addressed by such desirable action are many. One of those of most immediate interest arises from the present government tax policy that "encourages utilities to spend billions...for the construction of unnecessary power plants." ["Utility taxes: now you see them, now you don't." Environmental Action, September 27, 1975, p. 7.] This article summarizes a report Phantom Taxes in Your Electric Bill which "explains how the nation's 150 largest private electric utilities overcharged their customers by almost $1 billion in unpaid federal income taxes last year. The EAF study attributed the overcharges to a series of tax loopholes, coupled with sympathetic or lenient state regulation. Last year state regulatory commissions permitted the utilities they oversee to charge customers for $1.4 billion in federal income taxes, despite the fact that the companies actually paid only $505 million to the federal treasury.

"Using Federal Power Commission forms that each utility is required to file, the EAF researchers also discovered that 57 of the 150 largest utilities paid no income taxes to the federal government. Instead these same utilities received credits of $217 million, which the utilities could use to receive refunds of back taxes or could credit toward future taxes....

"Many utilities have convinced regulators to let them keep two sets of books--one using accelerated depreciation for the IRS and another using straight-line depreciation (the practice of depreciating the same amount each year) for the regulatory commission. The commissions allow these utilities to charge their customers for taxes calculated by the straight-line method while paying taxes according to accelerated depreciation.

"Even more important to the utilities than accelerated depreciation is the federal investment tax credit. The investment credit permits a utility to charge a portion of the money it spends on investment towards its income tax. Now that the ITC has been increased from four percent to ten percent, EAF expects that few if any utilities will be paying any federal taxes in the next few years.

"While such tax juggling digs into the pocketbooks of both consumers and taxpayers, the full effect of such tax policy is even more harmful. Accelerated depreciation and the ITC provide utilities with an artificial incentive to grow. This results in a misallocation of our economic resources, funneling capital into industries that can take advantage of tax credits and away from such uses as housing, health, and other public services. Fully 30 percent of all new capital on Wall Street was used by the electric power industry to fuel its growth. Tax policy is one contributing factor to this growth, for the faster a utility grows, the more 'phantom taxes' it can collect from its customers...."

The point that is to be made from this long quotation is that by acting to refuse a construction permit--or to delay one for several years--this Commission has the power to begin to redress the abuses that this article describes. Such an action by NRC would give time for the Congress under pressure from alerted citizens to close some of the loopholes that permit such gross abuses.

A further benefit that would accrue to the Public from action of NRC to delay construction would be that we would be reassured about nuclear waste disposal and the recycling of highly radioactive spent fuel elements. It is becoming more and more widely recognized by the public that a frightening menace of poorly stored rods and wastes, e.g. at the Turkey Point plant in Florida and at the Maxey Flats storage pits in Kentucky, is being tolerated and added to in the fact of governmental inaction.

It is improper to compound these insults to the environment by allowing new plants to be constructed when these exigent problems are not solved. It could be construed as a fraud upon the public and be subject to litigation. The NRC, by courageous action in the Marble Hill case could begin to correct some of these outrageous insults to environment and citizens.

We recommend a) that preferably no permit to begin construction be granted to the Marble Hill Nuclear Generating Station, or if that is not possible at present, b) that the granting of a permit be delayed two years.

04/30/76

Skyline Drive, Box 190, R#3
Floyd Knobs, Indiana 47119
April 13, 1976

Director, Division of Site Safety and Environmental Analysis
Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission
Washington, D. C. 20555

SUBJECT: Draft ENVIRONMENTAL STATEMENT (hereinafter referred to as ES)
MARBLE HILL NUCLEAR GENERATING STATION, Units 1 and 2
PUBLIC SERVICE of INDIANA (PSI), Docket Nos. STN 50-546 and STN 50-547
(Prepared by the U.S. Nuclear Regulatory Commission (NRC), Office of Nuclear Reactor Regulation and published March 1976)

Dear Sir:

Thank you for the opportunity afforded me as an interested citizen of southern Indiana to comment on the above-named document. For quick correlation of subject matter, specific topics in this ES are listed and underscored with my comment and/or question following.

This ES lists 987 acres of predominately forest and cropland will be used as the location of the plant site. An additional 3,475 acres of life-supporting land are yet to be required by PSI for transmission line corridors (eliminating 1,110 acres of forest habitat)--85 acres of which will support the tower bases. A 245 acre track to be occupied by a railroad spur is to remain cleared for the life of the station. QUESTION: What is the expected life--30 years (p. 10-6) or 40 years (p. 10-4)? How is it determined?

2.4.2 Seismicity (p.2-7). An exerpt states: ".....Most of the seismic activity in Indiana has occurred in the southwestern part of the state....". QUESTION: Why are only 6 lines of this ES given to this grave environmental concern? COMMENT: Please list the frequency of earthquakes in the Marble Hill area in the past decade, and magnitude of each quake as measured on the Richter scale. A more realistic assessment appears needed.

4.5.2 Staff's (NRC) Evaluation (p. 4-14). Topic 3 on Herbicide Use by PSI. One criterion listed is: "No formulation should be used whose dioxin impurity in the undiluted insecticide exceeds 0.1 ppm". QUESTION: Who will monitor the dioxin impurity in the undiluted (sic) insecticide? Inasmuch as PSI (p. 4-5) plans to use herbicides Silvex, 2,4-D, 2,4,5-T, Picloram and Dicamba in construction and maintenance of their rights-of-way, have you, NRC, noted PSI's past record of maintaining their transmission corridors by herbicide use and cutting? The picture below, taken from my side yard, shows a 300' wide easement of PSI as it traverses the knobland of Floyd County, Ind. An on-site inspection is welcomed, and affords a view of soil erosion and landslides. To permit any portion of the required 115 miles of new transmission corridors to accommodate the Marble Hill Nuclear Plant to be subjected to such devastation where no reparation has been made would, in my opinion, be exemplary action of "more power at any price".

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Table 4.3 Summary of Environmental Effects Resulting from Construction (p.4-15). COMMENT: It is noted that of the 14 conditions listed under Potential Effect, 8 are described under the corresponding Expected Relative Significance as either small or negligible. Nineteen government agencies (p.ii) are requested to comment on this summation prior to the NRC Final ES, which I understand will not be open to the public for additional comment, but submitted to the Atomic Safety and Licensing Board only. This Summary appears incomplete to this writer, and the following information is submitted at this time for consideration and addition: (1) The U.S. Dept. of the Interior letter (12/31/75) to the NRC (p. E-1) indicates that a substantial amount of the proposed construction area for the Marble Hill Nuclear Plant of PSI has not even been surveyed--in fact, only 30% was considered adequately surveyed. (2) No mention or consideration is made of an Indiana Geological Survey Map and Table entitled "Suitability of geologic areas of Southern Indiana to various types of land use". This recent 1970 Study lists the entire physiographic Marble Hill area in "Area 6", whose Specialized Industrial Use is rated "D - mostly unsuitable; severe limitation in most parts of area". (3) As to the potential effect on streams, including the Ohio River, out of 30 references (pgs. 4-15-16) applicable to Table 4.3, not one is from the U.S. Army Corps of Engineers. The ES (p. 4-2) states that one form of transportation of material will be by barge, but no data on dredging, barge activities or water determinations from the Corps of Engineers accompanies Table 4.3 or this ES.

The desire of the NRC (as listed in the Foreword, p. xii) to conform to the National Environmental Policy Act (NEPA) is commendable, and a number of these considerations are listed in this ES. As a citizen, I too feel the importance of implementing the requirements of NEPA in that Item 6c of Sec. 101 states: "The Congress recognizes that each person should enjoy a healthful environment and that each person has a responsibility to contribute to the preservation and enhancement of the environment". Furthermore, as regards all aspects of the proposed Marble Hill Nuclear Plant, it is requested that an additional portion of NEPA (Sec. 102B) be included in the ES, which is: "Identify and develop methods and procedures in consultation*with the Council on Environmental Quality established by title II of this Act, which will insure that presently unquantified environmental amenities and values may be given appropriate consideration in decision making along with economic and technical considerations". Indiana's own Public Law 98 (enacted Feb. 25, 1972) contains a number of environmental commitments to be adhered to.

5.6 Operation of the Power Transmission System (p. 5-29). An exerpt reads: "Aside from the esthetic impacts of transmission towers and lines from the Marble Hill Station, operation of these lines may (underscored by this writer) cause the production of ozone, increased electrical fields, shock hazards, radio and TV interference, and acoustical noise. The use of herbicides during right-of-way maintenance also may be of concern". QUESTION: Why aren't these issues covered in the final Summary (Table 10.4) of Environmental Effects? Who ran the 1-yr. ozone experiment with 765-kV lines over cornfields in Jeff. Co., Ind?

Fig. 8.5. PSI Annual System Energy Requirement (p. 8-9). COMMENT: PSI's historical and projected values are graphically illustrated in this Fig. and it is stated: "On the average, the years 1960-63 were characterized by 6.7% annual growth, 1963-1969 by 9.3%, and 1969-1974 by 5.0%". The latter appears to be approx. a 50% drop. For the record, PSI's 1972 Annual Report lists a 2% increase in customers at year-end and a 12.1% increase in net income, and 1973 lists a 2.1% customer increase with a corresponding 29.2% increase in net income. QUESTION: How do you equate this data with PSI's projected need of an average annual growth beginning in 1974 of 8.2%? (This writer feels an independent study by the General Accounting Office (GAO) is needed in this matter.)

* Page ii, 6, of this ES states that the ES was made available to the CEQ in Feb. 1976.

9. Alternatives. Solar and Wind Power (p. 9-1). COMMENT: Only 6 lines of the ES relate to this. An exerpt reads: "....for solar alternatives, only small demonstration plants will be achieved prior to 1985". QUESTION: Is this statement in agreement with GAO and Congressional determinations? Won't passage of S. 3227 brighten this gloomy forecast? Isn't solar energy already being utilized in private homes and businesses which prove they are not dependent on power plants for implementation?

10.3.5 Water and Air Resources (p. 10-4). This topic consists of 7 lines in which it is stated: "The more significant commitment of these resources is the consumptive use of about 30,000 acre-feet per year of water from the Ohio River for the life of the station. Such a commitment, is however, neither irreversible nor irretrievable. There are no irreversible or irretrievable commitments of air". COMMENT: It appears that PSI's planned consumptive use of 30,000 acre-feet of water over a period of 30 (or 40?) years from the Ohio River as well as possible dredging and barge facilities did not merit comments of the Corps of Engineers, which is not only the responsible Federal agency but whose management of the Ohio River is under considerable scrutiny at the present time (Courier-Journal & Louisville Times, 12/14/75). It is noted by this writer that NEPA states: "Prior to making any detailed statement, the*responsible Federal official shall consult with and obtain comments of any Federal agency which has jurisdiction by law or special expertise with respect to any environmental impact involved". (*Would NRC as author of this ES apply here?)

Table 10.4. Summary of Environmental Effects due to Construction and Operation of the Marble Hill Station Units 1 & 2, (p. 10-11). COMMENT: This Table is comparable to the previously described Table 4.3 (p. 4-15) which applied to Construction only and not to Operation. For NRC to promise such negligible effect on our land, air and water as stated in this Table 10.4, would indicate to this writer, from a common sense as well as dollars and 'sense' point of view, that something is radically wrong and unjust in the nuclear exclusion coverage in my insurance policies as well as the Price-Anderson Act.

In the ES benefit/cost ratio data, it is noted that the NRC conclusion (p.10-10) is simply: "The primary benefit of increased availability of electrical energy in the applicant's service area and in the ECAR region will outweigh the environmental and economic costs of the station". It is further noted that decommissioning costs are included in Table 10.3 but no plan has ever been devised for that purpose even though six plants have already been shut down or dismantled. No detailed plans are listed in this ES for transportation or burial site of radioactive materials. (As late as April 6, 1976, considerable "handwringing" is reported in Washington on the unresolved problem of Perpetual Care for radioactive waste). The vagueness with which many of these crucial concerns appear to be treated in this ES points to a "wait and see" approach on the feasibility and the safety of the project. A more realistic b/c assessment is requested.

How effective is a system of checks and balance when the NRC must approve or disapprove its own writing, i.e. this ES written by NRC for PSI! PSI, in turn, has moved rapidly ahead on the Marble Hill Nuclear Plant plan while holding up as positive proof of its safety, the Rasmussen Report, sponsored by the Atomic Energy Commission (AEC), prior to being redesignated the NRC. However, the AEC, in a published legal notice inside the cover page of the Rasmussen Summary Report, refused to accept any legal liability or responsibility for the accuracy, completeness or usefulness of any information disclosed in the Rasmussen Report. Who, then, must bear the awesome burden of proof of Nuclear Power Safety?

Respectfully submitted,
Rosella Schroeder
Rosella Schroeder

Twenty copies sent to interested individuals or groups.

STN-50-546
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6407 Regal Road
Louisville, Ky. 40222
April 13, 1976

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APR 29 1976
U.S. NUCLEAR REGULATORY COMMISSION

Director, Division of Site Safety & Environmental Analysis
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington D.C. 20555

Dear Sir:

Evaluation of the Draft Environmental Statement (DES) for the proposed Marble Hill Nuclear Generating Station, Units 1 and 2 by the technical committee for the Marble Hill Nuclear Energy Council and the energy committee for the Louisville Group Sierra Club has produced the following comments. We ask that you consider them carefully and incorporate them into the final record.

1. Ref. p. ii, item 5: Included among the agencies asked to comment on the DES should be the office of the Mayor of Louisville. Comments on the DES by the mayor of the largest population center within 35 miles of the proposed site should be mandatory.

2. Ref. 2.7.3: The transmission corridors are an integral component of the project and involve several times as many acres as the plant site. Before the impact of transmission lines can be adequately assessed, much more detailed information must be made available on the existing environment within and adjacent to the corridors and details of proposed transmission lines must also be made available.

3. Ref. 2.8.3: The DES does not adequately address the recreational value of the Ohio River. Contrary to statements made in the impact statement, we feel that the McAlpine Pool of the Ohio River is the major recreational asset of the region. The air and water impacts associated with the nuclear plant along with safety hazards will have a considerable negative impact on recreational usage of the river.

4. Ref. 3.3 1: We consider the consumptive use of 60 cfs of water by a single user to be a gross waste of water resources. If other water users in the Ohio Valley were as wasteful as this project proposes to be, summer flow in the river would be greatly reduced in volume and the high dissolved solids content of the remaining flow would render it useless to downstream users.

5. Ref. Fig. 3.3: At the bottom of this flow chart there is an arrow indicating flow of Radwaste Solids to off site disposal. At this time no such off site disposal facilities exist, and due to problems such sites may be a long way into the future. In view of this situation we feel that the section on environmental considerations of the uranium fuel cycle should be done on a more realistic basis and in much more detail, and specifically, we want precise clarification of how, where, and when radwaste solids will be disposed. The cost of the disposal and storage facility, that part attributed to the Marble Hill Station, should be factored into the economic justification of the proposed station.

6. Ref. 3.4.2: The intake structure shown in Fig. 3.6 delineates the three makeup water pumps in the same enclosure. This does not provide any redundancy in the event of a structural failure that would flood the pump room. At least one degree of redundancy should be provided for a function as critical as the makeup water supply.

6. Ref. 3.4.2: (continued)

   A duplicate intake flume and river screen house must be located at a reasonable distance from the proposed screen house to prevent a mishap from affecting both pumping systems.

   Are the intake flumes designed to withstand runaway barges and similar unusual shock-loads and debris? Barges have sunk and drifted long distances along the river bottom. Barges containing chlorine or other noxious and harmful chemicals could leak and contaminate the intake water necessitating a second intake flume and river screen house.

7. Ref. 3.6.2: The DES states that the proposed use of chlorine as a biocide in the cooling system will result in chlorine discharge concentrations of 0.2 mg/l. Numerous researchers have found concentrations much below this level to be toxic to aquatic biota. Furthermore, this discharge will increase the level of chlorinated organic compounds in downstream public water supplies. These compounds are known to be carcinogenic. We feel that these adverse impacts justify the additional costs of using ozone as the cooling system biocide. If the Commission does permit the use of chlorine, dechlorination facilities should be provided to remove any measurable chlorine residual from the effluent.

8. Ref. 4.3.1.2: Herbicides are proposed for use in clearing and maintenance of transmission corridors. These chemicals are very hazardous to the human population and environment. Their controlled use is difficult to enforce. Since alternative mechanical means are available, all usage of herbicides should be prohibited.

9. Ref. 5.4.1.4: Medical experts generally agree that most cancer is caused by environmental factors, including radiation from natural and artificial sources. The DES should state the number of additional cancer cases which will be caused by radiation releases during normal operation and accident conditions of this plant and due to the processing of the fuel and wastes associated with the plant.

10. Ref. 5.6: The DES admits that little information is available on the long term effects of exposure to electrical fields near high voltage transmission lines. In view of this lack of information and the large area the proposed transmission lines would involve, we feel that only reduced-voltage lines should be constructed.

11. Ref. 5.8.1: The esthetic impact of the nuclear plant and transmission lines on the rural landscape of southern Indiana is greatly underemphasized. The DES should state from how large an area the transmission lines, plant, and plume will be visible.

12. Ref. 6.1.1: The conclusion of the staff that long term temperature measurements are not necessary either indicates that they have accurate information or data on the downstream thermal plume or are avoiding the issue. The omission of data in the DES indicates the latter.
    Detailed measurements over a long period of time (during the entire time of construction through operation of the plant) should be recorded to determine if significant thermal changes occur in the river after the plant is in operation.

13. Ref. 6.2: Plans should be specified in the Environmental Statement as to monitoring programs which will be utilized. Detailed programs should be spelled out prior to licensing, not afterward.

1219

14. Ref. p. 7-2: The Rasmussen Report is relied upon in this section to conclude that environmental risks due to radiological accidents are small and need not be considered further. At this time the NRC and PSI are well aware that there are at least as many prominent critics as proponents of this report. This report should be shelved, at least until a more acceptable (to the scientific community) study is completed. The DES should study and discuss the consequences and necessary actions that would be realistic in the event of minor and major radiological accidents.

15. Ref. Table 7.2: Population doses due to postulated accidents are tabulated, but all the calculations are based on airborne transport only. This avoids the major problem in the area. The Ohio River, if contaminated due to a radiological accident, is the most predictable and efficient transport system in close proximity with the plant and at a lower elevation. In fact, any released contaminants that reach water or travel on the surface of the ground will find their way into the river. The environmental impact statement should provide an analysis of the possible effects and doses that the entire population exposed to the Ohio drainage system would suffer.

16. Ref. 8.2.3.1: We feel that the impact of energy conservation measures on PSI power requirements has not been adequately assessed and if properly considered makes the need for the Marble Hill station as proposed questionable. Is an electrical demand forecast based on a growth rate of 8.2% per year for PSI realistic in light of their 2.2% growth for 1974? Likewise, is an electrical demand forecast based on a growth rate of 6% per year for NIPSCO realistic in view of their 1974 growth rate of 3.5%?

17. Ref. Table 9.1: The entire economic justification for building a nuclear rather than coal-fired plant at Marble Hill appears to be based on fuel costs. Many utilities have recently cancelled plans for nuclear plants, and among their reasons for doing so are increases in the costs of nuclear fuel. We feel that if the economic analysis for the Marble Hill plant was based on realistic projection for fuel cycle costs, a coal plant would prove to be more economical.

18. Ref. 9.3.1.8: The use of dry cooling towers would greatly reduce the water and air impact of normal plant operation. We feel these reduced impacts would more than justify the additional cost of dry cooling towers. Furthermore, the use of dry cooling towers makes a number of sites nearer the center of the service area feasible alternatives. These other sites, appropriate for a dry cooling tower plant, would result in great reductions in the cost and environmental impact of required transmission lines. Additionally, these plant sites are far removed from the environmentally sensitive Ohio River Valley.

19. Table 9.1: A review of the economic decision made between a coal and nuclear plant is impossible because the information presented in Chapter 9 is very sketchy. This selection (of alternatives), which is of the utmost importance to the consumer, is only addressed in Table 9.1, where nothing but conclusions are listed, with all the considerations and methods of calculation hidden.

What assumption was made for the number of kilowatt hours which will be produced from each ton of uranium oxide ore? What is the concept program? Was reprocessing of fuel considered in the energy yield from the fuel? If so, has an allowance been made for the reprocessing cost, even though an accurate figure is not likely to be known now?

Is it true that the cost of a medium sulfur coal plant includes the SO_2 scrubber sludge handling? This seems to be indicated by the high operation and maintenance costs. If this is the case it would be necessary to allow for disposal of the nuclear wastes and their maintenance for the duration of their hazardous life to make a valid comparison. This cost is also hard to assess since a feasible solution has not been found for permanent disposal.

It seems curious that there is only a 3½% difference between the total cost of a medium sulfur coal plant and a nuclear plant, according to Table 9.1, in view of the fact that last year the average nuclear plant, starting construction, was expected to be 11% more expensive to build than a comparable medium sulfur plant meeting current EPA standards, and that nuclear costs were expected to increase faster than fossil fuel plant costs.

The average capacity factor of nuclear plants of this size in 1975 was 44.5%, which is below the lowest figure the applicants considered. PSI, having no experience in the operation and maintenance of a nuclear power generating station, would be expected to operate at a lower capacity factor than the national average because PSI is at the low end of the learning curve.

CONCLUSIONS:

Our analysis of the DES for the Marble Hill Plant leaves us with some very severe reservations which we feel must be addressed before permission to proceed with construction can be granted. At the very least another more comprehensive DES should be prepared and distributed for comment by interested parties before the final EIS is produced.

On the basis of our analysis, we recommend that the plant not be licensed due to overwhelming environmental impacts which cannot be offset by economic benefits. If the electricity is, indeed, required, a coal-fired plant is the preferred alternative. We suggest that PSI utilize some of the resources they are putting into the promotion of this nuclear plant for the promotion of energy conservation and efficiency. The construction of the station should be monitored by an architectural and engineering firm independent of any ties to the NRC or PSI to insure rigorous compliance with specifications.

A regional environmental impact statement should be prepared which will cover the overall impacts of proposed power plants in the Ohio River Valley, and if the nuclear plant remains as an alternative a decision should not be made on its licensing until this overall EIS has been prepared.

Respectfully submitted,

Gerald J. Kushner, Chairman
MHNBC Technical Committee and
Louisville Group Sierra Club
Energy Committee

50-546/547

1009 King Arthur Lane
Louisville, Kentucky 40220
April 16, 1976

RECEIVED APR 23 1976 U.S. NUCLEAR REGULATORY COMMISSION

Director, Division of Site Safety and Environmental Analysis
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

Reference: Comment on DEIS for Marble Hill Nuclear Generating Station

Dear Sir

My comments on the proposed installation of the Marble Hill Generating Station and the Draft Environmental Impact Statement are as follows:

1. The DEIS does not include the proposed station's Total Impact on the Ohio River Valley when considered with other proposed power plants which are currently being planned. These include Fossil fuel installations.

2. Chapter 7 of the DEIS lacks detail and treats to lightly the possibility of an accident and its effects on the population and the environment.

3. Chapter 7 does not deal adequately with the effects that a serious accident would have on the Ohio River Community in total, considering that the Ohio River is a major source of water supply for far more of the population than lives within 50 miles of Marble Hill, Indiana.

4. The only references utilized in Chapter 7 is WASH-1400 which has been questioned by many authoritative sources as to its validity. I also point out the Disclaimer which appears on the inside cover of the Executive Summary of WASH-1400. I therefore conclude that reference material for Chapter 7 is inadequate or at least questionable as to its validity.

5. The DEIS has failed to address itself to the problem of off site waste disposal and to the transportation of radioactive materials. This is a concern for major environmental impact even though it does not directly effect the immediate site.

My conclusions are that due to the areas which have been outlined above, the Draft Environmental Impact Statement does not satisfy the questions that have been raised about this or any other nuclear installation.

Sincerely

John N. Embry

4674

cc: Mayor Harvey Sloane
County Judge Todd Hollenbach

TELEPHONE (502) 42_-185_

President ...... Mr. Ralph E. Ma_son
Vice President ... Mr. Edward P. French
Secretary ...... Mrs. Mary F. Travis
Treasurer ...... Mr. William R. Bosley
Past President ... Mr. Robert G. Burgess

Kentucky Audubon Council

RECEIVED APR 21 1976 U.S. NUCLEAR REGULATORY COMMISSION

April 17, 1976

United States
Nuclear Regulatory Commission
Washington, D.C. 20555

Subject: Marble Hill Nuclear Station, Units 1 and 2
Docket No. 50-546 and 50-547

Dear Sirs:

We take this opportunity to comment on the Draft Environmental Impact Statement on the above.

First and foremost, we believe the Statement is woefully inadequate. Whether nuclear or fossil-fueled, the approach is extremely narrow and fails to take into account some of the most important pollution effects. It is a well known fact that a multiplicity of power plants are planned for the Ohio River in the vicinity of Madison, Ind. Yet this statement is written as if no other plants are under consideration. This station will dump approximately 8 million pounds of neutralized sulfuric acid per year(page 3-21) into the Ohio River. Multiply this by 6 or 8 or 10 more plants and the amount of sulfate ions will become unbearable to the extent that it will affect water-supply downstream. An extra cost and health burden on municipal drinking water plants is inevitable and this cost should be added to the cost of the subject plants.

Further, the production of 60,000 gallons of waste water in the de-mineralizer is inconsistent with a discharge rate of 36 gpm. This is equivalent to 44,640 gallons and not 60,000 gallons. What happens to the remaining 16,000 gallons? Is it dumped in one large slug or is pumped into the ground?

Still further, the amount of water evaporated and "drifted" into the air in the Madison area will be enormous. Not only would there be an increase in rain, fog and ice, but an increasing number of plants will eventually/result in/a definite change in the weather and health effects. The subject statement does not consider this additive and adverse environmental effect and is clearly in violation of the National Environmental Policy Act.

The items just discussed are but two of many the Statement fails to consider. This colossal disregard for the general well-being of the public and the environment clearly will require the Council on Environmental Quality to reject this Draft Statement as totally inadequate and non-informative.

DATA AND INCONSISTENCIES: For an Agency which tries to create the impression that it is above reproach by the citizenry, this statement is a good example of why the people should

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NATIONAL AUDUBON SOCIETY   KENTUCKY CHAPTER MEMBERS

question all their data, including that on cost and safety. Consider the following: p 3-21, 3.6.1.1 and 3.6.1.2 indicate a yearly use of approximately 7,876,000 pounds of sulfuric acid while Table 3.6 indicates a yearly use of approximately 3,900,000 pounds. While this is a difference by a factor of two, and possibly relates to the number of units, it is not clear in view of Table 3.7 which figure applies. Is the data actually transposed or disconnected?

Table 3.7 should also be read in conjunction with the inadequacies mentioned. In other words, with a multiplicity of plants, the effect on the water from the standpoint of municipal water-supply will definitely be adverse, particularly from the increased amounts of sodium and sulfates.

While consideration for the environmental effect from the entire Uranium Fuel Cycle was not mentioned above under 'Inadequacy', nevertheless Table 5.18 which deals with this subject, is totally confusing and inconsistent. To begin with it is printed in such fine type that one wonders if it was done for the purpose of concealment and confusion. In addition, the comparison bases are variable and difficult to reconcile. Still further the data is questionable, as follows: The table shows that the overburden moved for the basic support of a 1000 MWe-LWR is 2.7 million megatons! This is 2.7 trillion tons just for the support of one LWR plant. This is preposterous.

Further: Table 5.18 shows 11 thousand million gallons of water are used in the Uranium cycle for the support of one 1000 MWe-LWR plant. A notation states that this/is less than 4% of the amount required by a model 1000 MWe-LWR with once-through-cooling. Based on data found in 9.3.1.1 the amount is approximately 17% of the model. This appears to be an error by a factor of at least 4. Does this lend credibility to this Environmental statement?

Still further: Table 5.18 shows an effluent of 4,400 megatons of sulfur dioxide or 4.4 billion tons! to support one 1000 MWe-LWR. It is ridiculous and incredible that a government agency would allow such a misleading document as this Statement to be published. No amount of excuses can remedy the damage to the credibility of the NRC.

SAFETY ANALYSIS: Three pages of the subject Impact Statement are all that are devoted to Environmental Impacts (see Chapter 7). While 'safety' was considered in the previously published so-called "Safety Analysis Report", nevertheless we believe it is incumbent on the NRC to at least relate the effects to the public. Instead, tables are presented showing radiological consequencies in terms of radioactivity released to the environment. Each section in Table 7.2 should show health effects caused by each increase in severity of accident. And above all the conclusion of Professor Rasmussen relating to damage from a Class 9 incident described in Table 7.1 should be included in the EIS statement.

Further, it is widely held by many authorities that small increases in radiation to people are definitely harmful and lead to carcinogenic problems. The subject Statement based on Table 5.10 apparently is intended to show that since the radiation from the

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plant in comparison to background radiation is presumed to be small, that the effect will be negligible. No attempt is made to consider that the background activity has been present for a very long period of time and that body functions have normalized over these same long periods against this background-and that in view of this, even very small additive amounts would require additional long periods for normalization. Further, and probably more important, the types of radiation released are for the most part very different from natural background and very likely could have an effect all out of proportion to the amounts present.

ECONOMICS: A thorough review of the subject Statement reveals that the NRC speaks as if it alone has decided on the need for this plant. Nowhere is there any mention of the fact either the FTC or the PSC of Indiana has issued a certificate of necessity. In view of this it is not difficult to perceive the extreme bias in favor of a nuclear plant. Under Alternatives, no real consideration is given to a fossil-fueled plant. Two tables are presented showing comparative items but no discussion is made. In fact, in 9.1.2 the statement is made that both nuclear and fossil-fueled plants are possible in Indiana. Who made the decision on nuclear and why? We believe this is another glaring inadequacy in the subject Statement.

CONCLUSIONS: We believe this statement is inadequate to satisfy the requirements of the National Environmental Policy Act. Inaccuracies and inconsistencies characterize the presentation and are viewed as a basis for official condemnation. We suggest that the Council on Environmental Quality reject the Statement and convey to the appropriate agencies that an overall ENVIRONMENTAL IMPACT STATEMENT be written for the total effect on the Ohio River valley of a multiplicity of all types of power plants.

Sincerely yours,

Ralph Madison

Ralph Madison

cc:
The White House
Council on Environmental Quality
U.S. Environmental Protection Agency
Energy Research and Development Administration
Federal Power Commission
Ohio River Basin Commission
Governor, State of Kentucky
Governor, State of Indiana
Office of the Mayor, City of Louisville, Ky.
Senator Walter Dee Huddleston, Kentucky
Representative Lee Hamilton, Indiana
Representative Romano Mazzoli, Kentucky

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THE SASSAFRAS AUDUBON SOCIETY
of LAWRENCE · GREENE · MONROE
BROWN · MORGAN AND OWEN COUNTIES

May 2, 1976

Di ector, Division of Site Safety and Environmental Analysis
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Sir,

The Indiana Sassafras Audubon Society, Inc. is honored to be a part of this public environmental analysis process.

Sassafras Audubon has been extremely interested, for some time now, in the national debate concerning nuclear fission power and, more recently, in the proposed Marble Hill Nuclear Generating Station at Madison, Indiana. Hopefully our comments will be benefittal to the Nuclear Regulatory staff and other concerned citizens in evaluating this proposed activity.

Respectfully your,
John A. Brennan, Energy Committee
John A. Brennan

R.R. 4 Box 255-A
Bloomington, Indiana 47401

Indiana Sassafras Audubon Society, Inc. The Energy Committee response to the Marble Hill Nuclear Generating Station, Units 1 and 2, Draft Environmental Statement.

Opening Statement:

The Sassafras Audubon Society wishes to thank the U.S. Nuclear Regulatory Commission (NRC) for the opportunity to review and submit comment on the Draft Statement for the proposed Marble Hill Nuclear Generating Station. Sassafras Audubon approved, at its September 18, 1975 Board of Directors meeting, a three-part energy policy. We believe in: 1) Extreme caution about the rapid development of nuclear fission power and continual, thorough research into all facets of the effects of nuclear fission power, 2) A strong commitment to energy conservation at all levels, and 3) A strong commitment to research in all sources of renewable energy, such as solar power. We also believe that Public Service Indiana (PSI), the principle owner of the proposed Marble Hill Station, must demonstrate to the customers they serve, of which Sassafras members are customers, that Marble Hill is a duly needed generating station. To now commence the construction of the Marble Hill facility and then to later discover its generating capacity as not being essential in satisfying customer electrical demands would economically hurt the customers, not PSI. We, the customers of PSI, are the ones who are going to assume the financial responsibility of Marble Hill. We are going to pay for this facility, through our utilities bills, whether it operates at full capacity or sits idle. Thus in order to protect our environmental and economic interstes, we wish to call your attention to some areas where questions have arisen.

Specific comments are as follows:

Sassafras Audubon focuses its comments on Chapter 8, The Need for the Station, and Chapter 9, Alternatives, and Chapter 10, Evaluation of the Proposed Action.

The NRC staff, in Chapter 8, confines its analysis to the PSI and NIPSCO service areas. Thus the combined service areas, which will eventually receive 1922 MW from the 2260 MW capacity facility, must demonstrate the real need for this additional electrical generating station. Section 8.1.1, Service Areas, provides a review of PSI and NIPSCO service areas and percentages of energy consumed by the different sectors. Sassafras Audubon is surprised that the staff did no further analysis for the entire service area. Since the entire service area has to be shown to genuinely need the electrical energy, we believe the entire service area should be studied as a whole.

Sassafras has worked up additional information to demonstrate how the total service area functions presently, Table 1, and how the elctrical energy from the proposed Marble Hill facility will be used in the future. Table 1 is derived by combining together the 1974 electrical energy produced by both PSI and NIPSCO, for a total of 22423 GWh. From here, it is quite easy to calculate the combined consumption for each sector and the sector's percentage of the total energy produced.

Table 2 provides information on where the produced electrical energy from Marble Hill is to be used. We are only able to identify where 1922 MW, out of a total capacity of 2260MW, will be used, since 338 MW presently remains uncommitted. Sassafras Audubon is confident in its calculations since the staff has stated in Section 8.2.1 "it is apparent that each sector has used roughly the same fraction of its utility since 1960...(and) expect this to be the case in the future." We thus observe that the industrial sector should use approximately 44.6% of all the energy produced by Marble Hill, the commercial sector should use 15.5%, the domestic sector 24.5%, the co-ops 10.1%, and other 5.4%.

Now that Sassafras knows approximately where the energy is to be used, we expect to be positively assured that each sector does in fact require the energy. In Section 8.2, Power Requirement, current consumption patterns are presented and both the applicant and the staff forecast future power requirements.

We believe Section 8.2.2, Applicant's Forecast of Power Requirements, is grossly inadequate in forecasting future energy needs. The applicant, PSI, defends the construction of Marble Hill because "of its conviction" population and industrial business will continue to grow. But PSI presents no demographic data, no economic forecast to substantiate its "conviction." PSI needs to supply much more information in this area before we can accept their "conviction" and their $1.8 billion investment.

Sassafras knows, from reviewing PSI's Environmental Report, that PSI is predicting a 7% annual growth in energy demand. We do not accept this as an accurate projection, especially since the release of a new Federal Power Commission Task Force Study. The study, Electricity Demand: Project Independence and the Clean Air Act, estimates that demand for electrical energy will be 30% less than what the utilities have predicted. The findings indicate the nation can do without nuclear power. We direct the staff's attention to this study and recommend it be used to re-figure PSI's energy need projections.

Section 8.2.3 contains the staff's projection of power requirements. The staff places "considerable weight", in calculating its own forecast, on an U.S. Federal Energy Administration (FEA) forecast presented in the "Project Independence Report", a report, concluded by staff, to be "the most comprehensive energy analysis yet undertaken." It is extremely difficult for Sassafras to accept this FEA forecast, especially since it is well known that the FEA has been and is now a governmental agency promoting nuclear power. In fact, the FEA attempted to establish an Office of Nuclear Affairs (ONA), with a budget of $1 million, a staff of 21, and headed by Paul Dragoumis, a former director of the Nuclear Projects and Supply Group at the Potomac Electric Power Company.

Sassafras must recognize the FEA's forecast for what it is, a strongly biased report in support of nuclear power development. The information generated and the conclusions derived from this report and carried over to this Darft Environmental Statement are thus unacceptable to Sassafras. We recommend the staff to consider other energy projection studies, ones truly independent, free from governmental influence.

The staff, in Section 8.2.41, admits that energy conservation measures have had significant effects in the PSI and NIPSCO service areas. From the period of October 1973 to March 1975, energy consumption was less than what PSI and NIPSCO expected, off 6.2% for PSI and 3.1% for NIPSCO. The staff, then in affect, dismisses this period of decrease energy demand as representing "limited data". Sassafras recommends that 1975 figures be incorporated into the Final Environmental Statement. The 1975 figures have been released and should enable the staff to build up its "limited data".

Sassafras finds it interesting to note that both PSI and NIPSCO terminated promotional advertising in October 1973 and began to provide its customers with conservation and energy efficiency information. October 1973 also began the period of time when " the consumption of electricity, in the PSI and NIPSCO service areas, (was) less than the forecasted consumption by an average of 6.2% (PSI) and 3.1% (NIPSCO)". True, the Arab oil embargo had much to do with the drastic decrease in demand. But the "direct mail and mass media advertising" must have had some positive effect in lowering consumer demand. Yet, the staff presents no analysis to explain the reasons behind the decrease in demand. We suggest that the staff perform follow-up studies to discover the reasons behind the decrease and the effect utility conservation advertising has had on lowering demand.

The lack of analytical effort is also apparent in Section 8.2.4.3, Change in Utility Rate Structure. The staff states their own statistics do not answer the very important question: "at what point will the costs of... electricity cause the consumer to significantly decrease his demand?" We believe much more work is required in this area. A major effort should be advanced in the industrial sector. This sector now consumes 48.7% of all the electrical energy produced by PSI and NIPSCO and will consume 44.6% of all the energy produced at Marble Hill. We need to know how this sector and the other sectors will respond in the face of ever increasing electricity costs.

Sassafras has a few questions on Section 8.3, Power Supply. Referring to Table 8.16, we would like to know how the staff derived the initial figure of 3045 MW, in the column entitled Staff Forecast? Now "applying the staff's forecast of 5.6% rate of growth in peak requirements" to this initial figure of 3045, Sassafras discovered the 1977 peak demand figure should actually be 3215.52 MW, instead of the staff's figure of 3228 MW. It appears, to Sassafras, that the staff used a 6% rate of growth in peak demand in calculating subsequent years instead of their previously announced 5.6%. So in 1985, the difference between the staff's peak demand figure, 5145 MW, and what we calculated, 4972.34 MW, is 172.66 MW. This is a dramatic reduction from what PSI forecasts as the peak demand in 1985. They state the peak demand for 1985 as 6420 MW, or a 1447.66 MW difference from what we have calculated using 5.6%. We recommend the staff to check its own figures in Table 8.16 and to determine how this error will affect PSI's reserve levels.

In Section 9.1.1, Alternatives Not Requiring New Generating Capacity the staff states that "energy conservation, efficiency increases, substitution of other fuels and peakload pricing would not suffice to meet" the energy demands of the 1980's. Sassafras would like to know how short we will fall in meeting the 1980's demands by using the above mentioned strategies. Sassafras believes the staff should investigate additional strategies that would not require additional generating capacity: decentralized energy systems, solar heating and cooling, wind power for localized use, and increasing the block rate pricing structure.

The decentralized energy system (DES), developed by Frederick Varney, could drastically decrease energy demands, while maintaining the same standard of living. This system depends upon three basic technologies; the external combustion engine, the thermal battery, and the heat pump. The DES replaces the usual furance, water heater, air conditioner, and electricity from a power plant. It can provide the needed energy to accomplish the same work as an all-electric home with only 70% of the cost and 10% of the fuel.

Sassafras believes the staff should concentrate much more effort into investigating the real possibilities, potential of the decentralized energy system, of solar heating and cooling, of wind power, and the increasing block rate structure. We believe all the alternative energy strategies should be studied individually and collectively to see if they would meet the energy demands of the 1980's.

The staff provides, in Table 9.1, comparable economic costs for coal-fired plants and nuclear plants. The table shows the nuclear alternative as the best choice at the three different levels of capacity factor. We would like to direct the staff's attention to the Electrical World's 1974 busbar survey. The 19th Electrical World survey, The Steam Station Cost Survey, which appeared in the November 15, 1975 issue of Electrical World, indicates that nuclear power plants do not produce the cheapest electrical power. In fact, Electrical World put nuclear next to last, just slightly ahead of oil. The survey found the coal plants produce the cheapest electrical power, at approximately 14 mill per kilowatt hour. Nuclear is third at about 18 mills per kilowatt hour. Sassafras expects the staff to further investigate the Electrical World survey and include its findings in the Final Statement.

Turning now to Chapter 10, we would first like to know where the staff received its economic data to construct Table 10.3. If this data was obtained from PSI, we highly question its validity. As we discovered in the Environmental Report, PSI completed, on February 14, 1973, a study entitled Nuclear v. Fossil Unit Study. This study shows nuclear power plants costing $440 per kilowatt hour, or a total cost for Marble Hill of $1.2 billion (1973 dollars). The construction costs have drastically risen in the last few years to approximately $1135 per kilowatt hour, or now a minimum construction cost of $1.8 billion (1975 dollars). A number of problems also exist when nuclear fuel costs are figured. The price of uranium has tripled in the past year from $8 per pound to $24. The Nuclear Exchange Corp. of Menlo Park, Ca. projects additional increases to $38 per pound in 1980 and $46 in 1985. A possible reason behind the ever-increasing cost of nuclear fuel is that uranium is becoming a scarce resource. We believe the uncertainities that now exist in the uranium market and the enormous increases in the construction cost should be further analyzed and discussed, in its entirety, in the Final Statement.

Sassafras is surprised to see that a decommissioning cost has been included in Table 10.3. In Section 10.2.4, Decommissioning, the staff states "no specific plan for decommissioning of Marble Hill Units 1 and 2 has been developed." We are interested to learn how the staff was able to calculate a specific figure for decommissioning Marble Hill when "no specific plan" now exists. We are eager to find out how such a computation was made.

This thus concludes Sassafras Audubon's comments to the Draft Environmental Statement on the proposed Marble Hill Nuclear Generating Station.

Table 1
Percentage and Total Energy Consumed by Sector
from PSI and NIPSCO

Total Energy Produced by PSI and NIPSCO in 1974: 22423 GWh

Industrial Sector	48.73%	10926.258 GWh
Commercial Sector	13.91%	3118.473 GWh
Domestic Sector	23.31%	5226.073 GWh
Co-op Sector	8.58%	1924.428 GWh
Other	5.48%	1228.748 GWh

Table 2
Percentage and Total Energy by Sector to be Received
from PSI and NIPSCO

PSI is to receive 1470 MW. Consumption by sector is:

Industrial Sector	36.2%	532.14 MW
Commercial Sector	18.7%	274.89 MW
Domestic Sector	26.7%	392.49 MW
Co-op Sector	13.2%	194.04 MW
Other	5.2%	76.44 MW

NIPSCO is to receive 452 MW. Consumption by sector is:

Industrial Sector	72%	325.44 MW
Commercial Sector	5%	22.60 MW
Domestic Sector	17%	76.84 MW
Other	6%	27.12 MW

Combining PSI and NIPSCO. Consumption by sector is:

Industrial Sector	44.6%	857.58 MW
Commercial Sector	15.5%	297.49 MW
Domestic Sector	24.4%	469.33 MW
Co-op Sector	10.1%	194.04 MW
Other	5.4%	103.56 MW

STN 50-546/547

Rt. 1, Box 296
Lanesville, In. 47136
May 16, 1976

. . Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Washington, D.C. 20555

5222

Gentlemen:

After studing the Draft Environmental Statement (DES) for the proposed Marble Hill Nuclear Generating Station, the following comments are submitted for your consideration and incorporation into the official record.

1. Ref. p. ii, item 5: All local governmental agencies within the 50 mile radius of this facility should have been given the opportunity to comment on the DES. In view of the possible impact this proposed plant may have on the citizens and environment in the entire area, comments from these officials should be mandatory and entered into the official record. Since the water supply for a population of about one million people is taken from the Ohio River, downstream from this proposed plant, it does not seem at all unreasonable for these people tobe involved in this issue.

2. Ref. 3.3: Flow diagram shows radwaste solids to off site disposal. This may not be realistic in view of the recent problems at atomic waste disposal sites. Several sites have been closed due to offsite radioactive contamination and a heavy tax was imposed on all wastes disposed of in another, which in all likelyhood will cause it to close. Cost of waste disposal will increase dramatically in the future and should be considered a major factor in atomic power plant planning.

3. Ref. 3.7: It would seem much more desirable to eliminate the need for the costly and environmentally degrading proposed 765-kV power transmission lines, by building electric generating facilities near where the power is needed. Since there is also a loss of power in the transport through these lines, consideration should be given to requiring that plants be built as near as possible to where the power is to be used.

4. Ref. 4.3.1.2,(1); Use of herbicides should not be allowed on any of proposed power line rights-of-ways. Applicant has for years used very environmentally degrading herbicides and has dismissed all complaints.

5. Ref. 4.5.2, (3): It is very touching that recommendations are made that no herbicides be used within the drainage basin of the Muscatatuck National Wildlife Refuge in the clearing and maintaining the transmission corridors. Why is this area given the benefit of the doubt with regard to herbicides, and the people, domestic animals and wildlife elsewhere are allowed to be subjected to this harsh chemical, whose long term effects are yet to be known?

6. Ref. 5.4.1: Radiological impact on man is one of the most controversial issues in the operation of atomic power plants. The constant low level radiation is bound to have an ill effect on the population, and the very real possibility of high level radiation makes the construction and operation of atomic power plants highly questionable, especially in a heavily populated area such as this, within 50 miles of the proposed plant.

7. Ref. 7.1: Recent accidents and questions relative to these postulated accidents and occurrences at atomic power plants make these assumptions highly questionable.

8. Ref. 7.2: Since this area, because of it's geographic position with relation to atomic power plants, waste disposal sites, atomic fuel enrichment plants and atomic research facilities, has as much or more radio active material transported through as any other area in the country, I feel that the consequences of postulated accidents is grossly under estimated.

9. Ref. 8.2.1: Per capita electric energy consumption for Indiana is well above those in other states in the midwest. Total energy use declined for the second year in the U.S. A. in 1975, therefore it is reasonable to assume that energy use growth will slow down in Indiana.

10. 8.2.2. Applicant's forcast of power requirements are not realistic in view of future energy efficient appliances and buildings, that will require only about onehalf the power that present ones do. Higher costs will also cause less energy use.

NIPSCO should build power generating facilities in it's own area instead of buying interest in a PSI plant hundreds of miles from where the power is to be used. It is very inefficient to transport power loads over long distances that will be required in this case. It is also generally agreed that large power plants are less efficient than small ones, and in this case with two large atomic reactors operating, an accident in either would likely cause both to be shut down. It would be much better to have widely dispersed power plants of smaller size and closer to where the power is to be used. Any savings realized in the construction costs of this proposed atomic plant would be "penny wise and pound foolish". This is a classic example of "bigger is not necessarily better".

11. Ref. 8.2.3.2: Peak load forcast is not realistic, if meaningful conservation measures are considered, along with peakload or time of day pricing.

12. Ref. 8.2.4: Conservation of electric energy will be a fact of life when it becomes more profitable to conserve than to waste. PSI policy has been to encourage waste. This must stop

13. Ref. 8.2.4.2: Promotional advertisement and conservation information services could be far better utilized to encourage energy conservation. The company has not gone out of it's way to make known to their customers that conservation information is available.

14. Ref. 8.2.4.3: A change in utility rate structure is a must if there is to be meaningful energy conservation. Applicant has opposed all efforts to change declining block rates, peak load-time of day pricing or any other measures that would encourage conservation.

15. Ref. 8.4: It is encouraging to see that conclusions are that PSI and NIPSCO's customers will not be enconvenienced if the Marble Hill atomic power plant does not go on line by 1982. This being the case, a construction permit should not be issued pending the results of an area wide study now under way on the impact of the combined proposed power plants in the Ohio River Valley.

16. Ref. 9.1 & Table 9.1: Economic justification for an atomic power plant rather than a coal plant is not realistic in view of the uncertainties with regard to cost of future uranium fuel, waste disposal and plant decommissioning.

There is no shortage of fuel in this area to power electric generating plants. In fact if atomic power plants are built, it will seriously disrupt the coal producing industry and cause unemployment and hardship on coal miners and their families. This is a social cost that has not been considered, but it is a very real one that should be studied very carefully when considering an atomic power plant vs. a coal power plant in a coal rich area such as this is.

My conclusions are that there is not sufficient justification for this proposed facility and the construction permit should not be granted at this time.

Respectfully Submitted,
Douglas V. Whitesides

Douglas V. Whitesides, Citizen
Rt. 1, Box 296
Lanesville, Indiana 47136

0414760009

PUBLIC SERVICE INDIANA

James Coughlin
Vice President - Nuclear

April 14, 1976

Docket Numbers: STN50-546
STN50-547

Harold R. Denton, Director
Division of Site Safety &
Environmental Analysis
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Subject: Comments On Draft Environmental Statement
Marble Hill Nuclear Generating Station Units 1 and 2

Dear Mr. Denton:

Public Service of Indiana has reviewed the Draft Environmental Impact Statement issued in conjunction with the application of the Marble Hill Generating Station. Detailed comments are included in Enclosure 1.

Sincerely yours,

James Coughlin
Vice President-Nuclear

DLO/dea

3857

1000 East Main Street, Plainfield, Indiana 46168 317 ... 0611

ENCLOSURE 1

PUBLIC SERVICE INDIANA COMMENTS ON DRAFT ENVIRONMENTAL STATEMENT

Page	Section	Comment
i	Para. 2	In the second paragraph the electrical power capacity of the station is stated incorrectly as 2360 MWe. It should be 2260 MWe net per ER 3.2.3.
i 2-4 5-1	3.d 2.3.1 5.2.1	The draft environmental statement uses the following values for the average river flow of the Ohio River past the site: a. 110,000 CFS in Summary and Conclusions, Section 3.d. b. 100,000 CFS in Subsection 2.3.1, Line 4. c. 112,000 CFS in Subsection 5.2.1, Line 7. Although these values are fairly close, PSI suggests that a uniform value be used for consistency. The ER Section 2.2.3.1.1 gives the value of 112,000 CFS.
iii	Para. 7d	PSI objects to the requirement that prior approval be obtained for activities that may result in a significant adverse environmental impact. Deletion of this paragraph is requested.
iii	Para. 7e	PSI objects to the requirement that a plan of action be submitted to eliminate or significantly reduce harmful effects or damage. Elimination or significant reduction should be required only where a benefit/cost analysis justifies the change.
iii	Para. 7f	The referenced section 2.8 should be section 2.7 and section 6.1.5.1 should be included among the sections referenced.
iii	Para. 7g & h	PSI will provide the information requested by these paragraphs under protest, based on the fact that NRC jurisdiction over transmission lines currently is subject to a petition for rule making.
1-1	1.1	Letters of intent for the remaining 15% ownership of Marble Hill have recently been signed with interested utilities. PSI requests that the second and third sentence of the first paragraph be revised to read: "PSI will retain 65% of the capacity of this station. The remaining 35% of the capacity is committed to ownership by Northern Indiana Public Service Company (NIPSCO) (20%), East Kentucky Power Cooperatives, Inc. (8%), and Wabash Valley Power Association (7%)."

Page	Section	Comment
1-2	1.2	The date for issuance of the Limited Work Authorization conflicts with the date identified in the Environmental Report (Table 4.1-2). According to PSI's schedule, receipt of the LWA is scheduled for July 1976.
2-1	2.1	In the first paragraph, the sentence relating to the station location should be revised to read "This position is within Section 19 and Section 20, Township 2 North, and portions of Section 18 and 17".
2-1	2.1	In the second paragraph, the last sentence should be clarified as follows "No public roads or public railroads will traverse...".
2-1	2.2.1	The second sentence of the first paragraph implies that the indicated amounts of land are in agricultural production. This sentence should be revised to read as follows: "In 1969, the three Indiana counties had 60% to 68% of the land in farmland while 78 to 91% of the land in the three Kentucky counties was farmland (ER, Tables 2.2-5 and 2.2-6)".
2-1	2.2.1	The last sentence of the third paragraph should read as follows: "The location of the dairy cows and goats within this zone is presented in Table 2.2-21a and Figure 2.2-8 of the ER".
2-4	2.3.1	In the first paragraph, the water users are given at 210 Mgd, 63 Mgd, and 3800 Mgd, which totals 4073 Mgd and not the 4090 Mgd given by the staff.
2-4	2.3.1	This paragraph states that 4,600 Mgd is 35% of the "Minimum Daily Low Flow". This implies that the Minimum Daily Low Flow is approximately 13,140 Mgd. In the ER (Page 2.5-7), the seven day, 10 year Low Flow is 14,200 CFS (9,200 Mgd), the thirty day, 10 year Low Flow is 14,600 CFS (9,450 Mgd), and the recorded minimum flow is 2,100 CFS (1,360 Mgd). Also the DES Section 5.2.1 states that the "minimum regulated low flow" is 10,500 CFS (6,800 Mgd). PSI requests clarification on the value used by the staff for "Minimum Daily Low Flow".
2-5	Table 2.1	The average daily use and maximum daily use columns under Madison are incorrect due to a typing error in the ER. The figure should read as follows:

	Average Daily Use (Mgd)	Maximum Daily Use (Mgd)
Madison	2.50	3.70
East Well Field	1.10	1.80
West Well Field	1.40	1.90
Madison State Hospital	*	*

* Madison State Hospital does not use the Madison municipal water supply.

Page	Section	Comment
2-5	2.4.1.2	At the Marble Hill, glacial deposits overlie the sedimentary bed rock of Silurian and Ordovician (not Siluvian) age dolomites, limestones, and shales, as discussed in ER Section 2.4.2.2.2.
2-9	2.5.2	In the second paragraph, last sentence, the statement that the station will draw water needed for construction and potable uses from the same alluvial-glaciofluvial aquifer as the municipal supplies and other users in the region is inaccurate (See PSAR Section 2.4.13.1.1). The last sentence may be reworded as follows: "The station will draw water needed for construction and potable uses from the same alluvial-glaciofluvial deposits at the rate of about 1.3 CFS (0.04 m^3/sec.). The ground water flow system at the Marble Hill Site, however, is hydraulically separated from the alluvial-glaciofluvial deposits used for the municipal and industrial supplies. The alluvial-glaciofluvial deposits are charged by the Ohio River. Therefore, the effect of onsite wells on other users is negligible."
2-13	2.6.2	In the fifth paragraph, reference to the Figures 2.6 and 2.7 is incorrect and reference to the 200' level should be changed to 199' level in accordance with the ER. PSI requests that the second sentence of this paragraph be revised as follows: "Figures 2.5 and 2.7 indicate the onsite wind roses for the 33-foot and 199-foot levels, respectively for the period of January through December, 1974. Figure 2.6 indicates the 33-foot level...".
2-15 - 2-17	Figures 2.5 through 2.7	To be consistent with the terminology used in the DES text, PSI requests that the captions on these three figures be revised as follows: Figure 2.5 "...33-foot level, onsite Tower #1." Figure 2.6 "...33-foot level, satellite tower along river." Figure 2.7 "...January - December 1974, 199-foot level,...".
2-18	2.6.4	In the first paragraph reference to the 200-foot tower should be changed to the 199-foot tower. Also, the 83% value for data recovery represents the three-way joint frequency distribution. Based on joint frequency data recovery of 83%, the overall data recovery for individual parameters monitored was greater than 90% for the meterological program. (Reference PSAR Section 2.3.3.2). Therefore, the last paragraph in Section 2.6.4 should be deleted.
2-24	2.7.1.2	Under the Section Protected Species, PSI requests that a reference be provided to support the statement that "Indiana bats have been recorded frequently in Jefferson County and other counties in southeastern Indiana."
2-25	2.7.2.2	In the first paragraph under Phytoplankton, the first sentence should be revised to reflect the Supplement 1

Page	Section	Comment
		pages of the ER. PSI suggests the following wording: "The applicant identifies 269 species of Phytoplankton (ER, Table 2.7-29) from March 1974 through February 1975, including many ...".
2-28	2.7.2.2	In the first paragraph of the Section Zooplankton, the referenced tables of the ER should be as follows: "ER, Table 2.7-30 through 2.7-42". (revision underlined)
2-28	2.7.2.2	In the section under Periphyton, PSI requests that the wording be revised to delete the implication that the use of artificial substrates was an inadequate method. As worded, the paragraph indicates a preference by the staff for natural substrates insofar as more "representative" data is obtained and a disproportionate fraction of diatoms "always" appears on artificial substrates. The National Environmental Studies Project (NESP) report, sponsored by the Atomic Industrial Forum, concluded that artificial substrates have several disadvantages. Specifically the substrates "cannot be collected, taken to the laboratory, and held very long without disruption or alteration of the community structure". Similiarly, field measurements of natural substrates are difficult with respect to defining a representative area and measurement technique for varying natural surfaces, and are hindered by being done under field conditions using field equipment. Such techniques are primarily qualitative in nature. According to the NESP, artificial substrates "provide the best means of obtaining quantitative samples of periphyton" because they are "a readily duplicated means of collecting periphyton under a wide range of environmental conditions." Although admittedly not necessarily representative of natural substrates, the artificial substrates were considered superior in that the analyses could be done under laboratory conditions, and the more standardized collection and measurement technique would provide data more suited to comparative evaluation with data obtained at a later time and under presumably different environmental conditions, i.e. post-operational. Also the periphyton concentrations given in the DES have been transposed incorrectly from the ER (Reference ER Table 2.7-50 in which concentrations are given in the units "$X\ 10^3/10cm^2$"). The fourth sentence of this paragraph should read as follows: "...ranged from 544.7×10^6 in April to 4351.44×10^6 in August...".
2-35	Table 2.16	In the heading of the second column, change "ks" to "kg".
2-36	2.7.2.2	In the second paragraph of the section Commercial and Sport Fisheries, PSI suggests that more appropriate wording would be that "Sport Fishing is the main fishery on both the Ohio River and some of the streams to be crossed by the transmission lines." Otherwise, the staff should provide a reference to support the statement that sport fishing is done on (all) the streams crossed by the transmission lines.
2-36	2.7.3	The first sentence of the fourth paragraph implies that most of the forested land in southeastern Indiana is suited for commercial use. PSI requests this sentence be revised to read "Most of the commercial forested land in southeastern Indiana is an oak-hickory type,...".
2-36	2.7.3	In the fifth paragraph the statement that "All of the protected species...may also occur along the transmission routes." is unsupported by reference. PSI suggests that the wording be revised to "It has been assumed that all of the protected...".
2-38	2.8.2	In the last sentence, "quadrants" is misspelled.
2-38	2.8.2.1	The 1970 population of the three small towns of Hanover, Milton, and Bedford, is given in Table 2.2-1 as 780, 3018, and 756, respectively. This total (4554) is about one-fourth (not one-third) of the total population of 18,609 within the ten mile radius as shown in the ER Figure 2.2-2.
2-38	2.8.2.1	In the third paragraph, the staff states that two-thirds of the area residences are occupant-owned. The staff's reference however (Reference 51) indicates that three-fourths are occupant-owned.
2-41	2.8.3.1	In the first paragraph, the unqualified use of 1974 figures to indicate that the attendance at Clifty Falls State Park declined (down 36% from 1973 to 108,756) is misleading because that year the park had a shortened season. Park attendance in 1975 was 214,400.
2-42	2.9.2	In the last sentence of the first paragraph, the fact that several of the archaeological sites are recorded as being very early in the archaeological sequence of Eastern North America may not be significant since the age of archaeological sites is not always related to their value.
2-43	Table 2.18	Provide a footnote identifying the meaning of the column entries under "Source."
3-1	3.1	Item (6) should be revised to the following: "Two banks of 25 cell mechanical-draft cooling towers".

Page	Section	Comment
3-1	3.1	In the second paragraph, the statement that Figure 3.2 "may not accurately represent the overall appearance of the station when completed" is unsupported. PSI requests that this phrase be deleted.
3-4	3.3	Item 1 of the second paragraph should be revised to read as stated in the ER, Page 3.3-1. It should read "The amount of cooling tower blowdown necessary to prevent the total dissolved solids (TDS) content in the circulating water system from increasing to the level where the TDS level and the blowdown is in excess of that permitted by the State of Indiana Water Quality Standards."
3-6	3.3.3	The third sentence should be revised to read: "Each <u>unit</u> will have two full capacity pumps..."
3-7	3.4.2	The 400' intake flume should be changed to 410' as per ER page 3.4-3. Also the staff's conclusion that the water elevation will exceed 420' MSL about 15 weeks per year cannot be ascertained from ER Figure 2.5-5. PSI requests that this statement be deleted or supported by other suitable reference.
3-12	3.5	In the fourth paragraph, PSI requests that reference be made to ER, Supplement 2 following the second sentence.
3-13	Table 3.3	The value for dilution flow should be revised to 2,555 gpm, as per ER, Page 3A-8.
3-13	Table 3.3	In the section describing iodine partition factors (gas/liquid), the values for the main condensor air ejector should be listed as follows: 0.15 (volatile iodine)[b] 0 (non-volatile iodine)[b] and the following footnote added: b The fraction of iodine in volatile form is assumed to be 0.05.
3-19	3.5.2.6	In the first sentence, off-gas from the main condensor vacuum pump exhausts <u>may</u> (not will) contain radioactive gases resulting from primary to secondary system leakage.
3-19	3.5.3	The first paragraph implies that the solid waste system consists only of processing "dry solid waste". It is suggested that the last sentence of this paragraph be revised to read "The solid waste system will consist of a waste drumming sub-system for dry solid wastes and a separate system for wet solid wastes."
3-19	3.5.3	Since a specific wet solid waste drumming system has not yet been finalized, PSI suggests the following rewording of the second sentence of the second paragraph: "These wastes will be combined with a solidification agent such as cement and vermiculite to form a solid matrix within the solidification container".
3-20 3-21	3.6.1	The fraction of dissolved solids lost as drift should be rewritten in terms of the blowdown instead of total circulating water supply to conform with the other discussion. In this case, the amount lost is 0.85% (.53 cfs/62cfs) and not 0.02%.
3-21	3.6.1.2	Wastes arise from the necessity of periodically regenerating (not recharging) the ion exchangers. Recharging implies that new resin beads are installed in the ion column.
3-21	3.6.1.2	The staff states that PSI "expects that daily regeneration of the beds will be necessary". Although the beds have been <u>designed</u> for daily regeneration, normal regeneration is considerably less frequent. Daily regeneration is needed only during periods of maximum make-up demands, e.g. startup. Operating experience at other nuclear generating stations has indicated that during normal operation, the demineralizers are regenerated once approximately every ten days. The expected volume of demineralizer discharge is therefore approximately one-tenth the design volume.
3-21	3.6.1.2	In the last sentence of this paragraph, the frequency and total quantity of the demineralizer discharge cited as high are design frequency, not normal frequency, and the maximum quantity discharged, not the normal quantity.
3-21	3.6.1.3	The auxiliary boilers will be blown down only when they have been in operation. PSI suggests that the first sentence be reworded as follows: "The auxiliary boilers will normally be blown down <u>during operation</u> for one to two hours...". (revision underlined)
3-22	Table 3.6	Under "Sulfuric Acid" the quantity used for demineralizer regeneration should be 4.4×10^5 lbs. per year, per ER page 3.6-5. Also, under sodium hypochlorite the units for service water system and essential water system biocide should be in gallons per year instead of lbs. per year, per ER page 3.6-2. Also, a reference for the pounds per year of sodium hypochlorite used for sewage disinfection should be provided.
3-23	3.6.2	In the second and fourth paragraphs of this section, the unchlorinated blowdown from one unit will not <u>dilute</u> the chlorinated blowdown from the other, but because of the chlorine demand in the unchlorinated blowdown, will <u>dissipate</u> the residual chlorine.

Page	Section	Comment
3-23	3.6.2	In the last sentence of the second paragraph, "expect" should be changed to "expected".
3-24	3.6.2	PSI requests that the first sentence of the fourth paragraph be revised to reflect the scheduled start-up dates. It is requested that this sentence be revised to read: "...in operation for two years before..."
3-25	3.7	In the second paragraph the staff indicates the tap line will be underground. This statement is incorrect. The 138 KV construction power transmission line will be overhead single-pole construction. The 12 KV construction distribution will be underground for the most part.
3-25	3.7.1 through 3.7.3	With respect to the distances shown between the transmission corridors and the various points of interest, it should be indicated that these distances are only approximate, as stated in the first sentence of Section 4.3.1.2. In that Section it states that the location of the proposed lines are known only within about one mile.
4-1	4.1.1	In the 7th paragraph, the statement concerning oil separators should be revised to indicate that oil separators will be installed upstream of the settling pond in accordance with ER Supplement 3, Page 87.
4-2	4.1.1	PSI has completed the architectural study of two houses mentioned in the 10th paragraph. This study was done by an Architectural Historian, Preservationist and Restorationist, who indicated that it would be impracticable to restore the houses because of their deteriorated condition. He recommended them for demolition in view of their minimal architectural merits compared to the other buildings of far greater historical and architectural significance in the Madison area. The conclusions of this study have been supported by the Director of the Indiana Department of Natural Resources who is also the Indiana State Historic Preservation Officer (copy attached).
4-2	4.1.1	PSI objects to the stringent requirements implied in the last sentence of this section requiring the suspension of activities pending evaluation by the State Historic Preservation Officer. As indicated in the final paragraph of the attached letter from the State Historic Preservation Officer, care will be taken during excavations to identify any archeological sites. Any sites that may be destroyed will be evaluated by an archeologist and salvaged as needed.
4-2	4.1.3	In the second sentence, the metric conversion of 2365 acres should be 946 hectares (not 1300 hectares).

0206760003

ER III - 2.3

STATE of INDIANA

INDIANAPOLIS, 46204

DEPARTMENT OF NATURAL RESOURCES
JOSEPH D. CLOUD
DIRECTOR

February 4, 1976

UNCONTROLLED COPY

Mr. David L. Odor, Ph. D.
Supervisor-Engineer Environmental
Public Service Indiana
1000 E. Main Street
Plainfield, Indiana 46168

Dear Mr. Odor:

Our office has reviewed the brief analysis of the historic buildings on the site of the proposed Marble Hill Nuclear Generating Station.

The analysis was well done and gave consideration to all the necessary factors, therefore, we accept the findings of Dr. Hermanson that the two residences are of little value and would not pose an undue hardship if they were demolished during the construction phase of the Marble Hill facility.

As I mentioned in my April 16, 1975 letter, care should be taken during any excavation that archeological sites previously covered by vegetation are reported. Any sites that may be destroyed should be evaluated by an archeologist and salvaged as needed.

Very truly yours,

Joseph D. Cloud,
Director
Department of Natural Resources

JDC:cam

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FEB 5 1975
Public Service Company of Indiana Inc.

Page	Section	Comment
4-2	4.1.3	The staff's assumption that the entire right-of-way is lost from agricultural production for one growing season during transmission line construction is incorrect. Normally, about only 100 feet around the tower locations are lost and approximately 50 feet along the right-of-way are lost to construction traffic. PSI estimates that the dollar value of the lost agricultural land should only be about 25% of the values calculated by the staff.
4-3	4.1.3	In the last paragraph of this section, PSI objects to the requirement that an archaeological survey be made for all areas where tower bases, roads, and transmission line construction will disturb existing soil cover. The construction delay and expense which would result is unjustified.
4-3	4.2.2	In the second paragraph, the statement "No water-table fluctuations caused by dewatering at the site are anticipated as it appears that no dewatering will be necessary." is not completely accurate. There will be some sumping of water into the excavation that will have to be removed. The sentence may be reworded as follows: "No offsite water table fluctuations caused by dewatering at the site are anticipated."
4-4	4.3.1.1	In the second paragraph of this section, the staff's statement that transmission wires will be a minimum of 40' apart is incorrect. As shown in the DES, Figure 3.13, the vertical spacing on 345 kV double circuit towers is approximately 24'.
4-4	4.3.1.1	The wording of the 7th and 8th paragraphs concerning the Indiana bat and bobcat assumes that, in fact, these animals presently inhabit the site. The surveys done for the Indiana bat did not reveal any Indiana bats to be present and only indications that a bobcat may have been present were seen. Furthermore, the implication that the bobcat, if he does inhabit the site, would not be able to find suitable habitat elsewhere does not appear to have any basis. In addition, the discussion of the Indiana bat conflicts with the requirement in the Summary and Conclusions Section to do an additional survey to determine its presence on the site.
4-5	4.3.1.2	In the second paragraph, the staff should provide a reference and basis for the statement that selective clearing causes the <u>least</u> ecological damage to plants and wildlife.
4-5	4.3.1.2	Concerning the next to the last sentence of the second paragraph, PSI has committed (ER Section 4.2.1.3.6) to seed the rights-of-way with seed mixtures that will conform to the existing forage mixture. The staff's position that the U.S. Soil Conservation Service will determine the appropriate grasses and plants to be used eliminates any owner preference for planting on his land. In reality, PSI consults with the U.S. Soil Conservation Service and the property owner on acceptable ground cover on properties other than classified forest lands. PSI requests that this sentence be amended.
4-5	4.3.1.2	In the third paragraph, the staff requires that aerial spraying be used only in terrain inaccessible to ground transport. Practically any area in Indiana is accessible by some type of ground equipment; however in some instances the use of conventional ground spray equipment may cause more erosion problems and damage to property than aerial spraying. PSI requests that this be modified to indicate "terrain not <u>readily</u> accessible".
4-5	4.3.1.2	In the third paragraph, the staff has required that herbicide use be restricted to selective basal or stump application. PSI requests that ground and aerial foliar broadcast treatments be included. There will be situations where species composition dictates that a ground or aerial foliar application is the most desirable method of obtaining initial control of stump sprouting and/or root sucking trees. The staff's position does not consider the feasibility and expense of moving equipment into the right-of-way, and resulting damage to the rights-of-way which will necessitate reseeding or else exposing it to erosion.
4-5	4.3.1.2	With respect to the listing of requirements on herbicide application, PSI requests that these be deleted on the grounds that herbicide usage standards are developed by the EPA and users of herbicides are licensed by the State of Indiana based on EPA standards.
		With respect to item (1), definition of a "conservation area" is requested. PSI has working agreements with the Indiana Department of Natural Resources and the U.S. Forest Service on the use of herbicides in such areas. These organizations in many instances <u>prefer</u> a herbicide treatment in the right-of-way. Furthermore, each county in Indiana is considered a "Soil and Water Conservation District" and under strict interpretation of the requirement as stated by the staff, herbicides would not be able to be used within Indiana.
		Concerning item (2), clarification is needed of the term "immediately" in terms of specific time periods.
		Concerning item (4), PSI considers that selective basal and tree injection applications can be safely made in winds exceeding 5 m.p.h. It is requested that this requirement be reworded to read "herbicide applications by broadcast foliar methods should not be made when winds are greater than 5 m.p.h.".

Page	Section	Comment
		Concerning item (5), PSI adheres to EPA regulations concerning acceptable dioxin impurity levels. It is requested that this requirement be deleted. Concerning item (7), PSI considers that tree injection methods of herbicide application are suitable near water bodies. PSI requests that this requirement be changed to read "herbicides should not be applied within 200' of bodies of water except by use of tree injection method.
4-5	4.3.1.2	In the fourth paragraph, PSI objects to the requirement to use a document pertaining to "<u>Classified</u> Forest Land" as being applicable to all forested land. Furthermore, in working with the Indiana Department of Natural Resources PSI has found that this document does not present a workable solution in some areas of classified forests.
4-6	4.3.1.2	Concerning the sixth paragraph, the following comments are provided with respect to the transmission right-of-way location from various local areas: 1. The staff states that the right-of-way should not be closer than 1/2 mile from Officer's Woods. The Rush line is 800' west of the west boundary of this area. This area is not a recreational or sight-seeing area and the line route traverses open land except for a small area at the Herbert's Creek crossing and will not affect the stand of timber of Officer's Woods. A relocation would necessitate rerouting to the west of the Town of Volga and would put about one mile of the line in Big Creek floodplain necessitating special construction. PSI requests that the right-of-way requirement from Officer's Woods be revised. 2. The staff states that the right-of-way should not be closer than 1/2 mile from Tribbet's Flatwoods. The Columbus line has been relocated and is now 1500' east of the boundary. Any further relocation to the east would put the line in the lowland of Tea Creek with special construction possibly required. The relocated line will have no effect on the stand of timber in the area. PSI requests that the right-of-way restriction from Tribbet's Flatwoods be revised. 3. The staff states that the line should not be closer than 5 miles to Clifty Falls State Park. The line is 4.4 miles west of Clifty Falls in the immediate vicinity of Officer's Woods. The existing 138 kV, 345 kV and 765 kV lines emanating from the Clifty Creek Generating Station at Madison pass near the park and are between our proposed line and the park. Our line should not produce any adverse visual impact on park visitors. PSI requests that the 5-mile restriction from Clifty Falls be revised. 4. The staff states that the right-of-way should be rerouted to not closer than 1/2 mile from Muscatatuck National Wildlife Refuge. A field review of the route in the vicinity of the Refuge was made and the line was relocated further eastward. The closest point to the northeasterly corner of the refuge is now 4400'. 5. The staff states that the right-of-way should be a minimum of 0.2 miles from the perimeter of Jefferson Proving Ground. A field review of the route in the vicinity of the westerly boundary of the Jefferson Proving Grounds was made and our route in the area is now 2300' to the west of the Proving Grounds and also west of the existing Indiana and Michigan Electric Co. 765 kV line.
4-6	4.3.1.2	In the last paragraph, PSI requests clarification of which "abandoned or little-used railways" the staff has considered. Assuming that the railroads referred to are those from Louisville to North Vernon and Madison to North Vernon, these railways are not abandoned and have limited usage. However, as most railroads do, they parallel highways and pass through most of the small communities along their route. Transmission lines would have high visual impact and would require deviations around each of the communities. Railroad right-of-way is generally only 60' wide, insufficient for a transmission corridor. Also the large number of angles required for paralleling the long curves associated with railroads, and the electrical coordination, other than rail grounding, needed to alleviate the communication interferences inherent with lengthy parallel facilities would escalate the monetary and environmental costs significantly. Therefore, PSI requests that alternative routing evaluation be deleted.
4-7	4.3.2.1	In the last paragraph, PSI objects to the requirement that tower bases be located above flood plain levels. Due to Indiana topography much of the land lies below floodplain level. Tower bases located in the flood plain and in the current water flow during flood stages are installed on concrete piers which are deemed necessary to elevate structure bases above water flow and provide the least obstruction to debris or driftwood. Structures in backup water or areas of low flow are not elevated but may have barriers installed to protect structures.
4-7	4.3.2.2	In the first sentence, clear cutting of vegetation along stream banks can increase the water temperature due to greater insolation (not isolation).
4-7	4.3.2.5	In the last sentence, reference is made to Paragraph 7f of the Summary and Conclusions. This should be changed to Paragraph 7d or e.

Page	Section	Comment
4-8	4.4.1.2	In the third paragraph, the reference to "staggered work shifts" is a poor example due to the fact that specific jobs have to be done where all types of crafts need to work together and potential labor requirements may not allow staggered work shifts. Additionally it has been PSI's experience that staggered work shifts lead to a reduction in productivity. PSI requests that this example be deleted.
4-11		All of the references on this page are numbered incorrectly with respect to the Reference section.
4-11	4.4.3.1	In the third paragraph, the staff concludes from the referenced study that construction activities at the site could possibly place a burden on the available facilities for out-patient care and ambulance services. This conflicts with the preceeding statement provided by the hospital administrator. It seems more practical that the current hospital administrator could assess the potential impacts more correctly than a nearly five year old study. A basis for the staff's concluding statement in view of the hospital administrator's statement should be provided. Also as an additional comment on this subject, PSI contractors will provide full time ambulance service at the construction site. This will minimize the impact on any local ambulance services.
4-13	4.5.1.1	In item 8, PSI requests the following wording change be made: "...discharge structures will be <u>disposed of in onsite spoils areas or</u> loaded into barges...".
4-12	4.4.4.4	In the first statement, the page reference in the ER should be page 8.1-7.
4-13	4.5.1.2	Pertaining to item 3, reference PSI's previous comment on Sec. 4.3.1.2 concerning the use of foliar broadcast herbicide treatment along with selective basal or stump application.
4-13	Footnote	PSI objects to the definition of "legally acceptable manner" as worded. PSI (or a representative of PSI) will supervise activities to insure compliance with applicable local, state and federal laws and, if those laws require, will maintain appropriate records suitable for inspection.
4-14	4.5.2	In the next to the last entry under Item 3, "applicator" is misspelled.
4-15	Tables 4.3	This table should provide a concise definition of the staff's interpretation of what is meant by "negligible", "small", "temporary", and "moderate" significance. Additionally, the assessment of "moderate" significance regarding increased stress on public services should be supported with a basis and reference.
4-17		References 26, 27, 29 and 30 should be deleted since they duplicate references 8, 9, 12 and 13, respectively.
5-1	5.1	In the 6th paragraph, two conversions from acres to hectares are incorrect. 3475 acres should be 1400 hectares and 2365 acres should be 950 hectares.
5-10	5.3.2.1	PSI disagrees with the staff that silt deposition, entrainment, and impingement levels of the intake structure are unacceptably high. Silt deposition was not anticipated to inflict a significant adverse impact because of the relatively small benthic area involved and the generally poor quality of Ohio River benthos. Entrainment losses were predicted to be minimal based on the low intake water volume and the staff's statement that the proposed intake (120 feet from the shoreline at a water level of 420 feet MSL) should minimize entrainment since it is "away from the productive underwater terrace and yet would not be far enough offshore to entrain the ichthyoplankton that is concentrated in the deeper offshore water" (ER Section 9.3.2). Impingement losses were not expected to be significant because of the low intake structure, the preponderance of gizzard shad and other rough fish in the Ohio River, and the extremely low volume of intake water compared with nearby Clifty Creek Power Plant (70 CFS verses 2200 CFS). PSI requests that the staff define their "acceptable levels" and provide a basis for requiring redesign of the intake structure.
5-11	5.3.3.3	In the second paragraph, mention is made of some "inconsistencies" that PSI observed with respect to river velocity vs. the flow. The staff should identify what these consistencies were.
5-18	5.3.3.[illegible]	The staff has made conflicting statements with regard to the discharge structure design. In the second paragraph, the staff has concluded that the design and operation of the surface discharge are acceptable and meet appropriate standards. In the third paragraph, the staff has required PSI to consider alternate discharge structure designs. Verification of what is acceptable should be made as a basis for requiring consideration of alternate discharge structures.

Page	Section	Comment
5-20	Table 5.8	Instead of four, only two release points (sources) need be considered. That listed as source D "turbine building vent" is indeed a separate, "ground level", release. Those sources listed as A, B, and C all discharge through the respective Unit 1 or 2 plant vent. These can be combined as a dual source with a single value of X/Q and relative deposition to be calculated using a partial elevated release model.
5-21	Table 5.10	PSI does not understand the staff's basis for consideration of population dose commitment for the U.S. population. This calculation is not required in Appendix I and/or NRC Regulatory Guides. The technical basis for evaluating dos commitments with respect to a political boundary (i.e. the U.S.) is not apparent. Dose commitments are properly evaluated as a function of distance from the plant and not a function of the country in which the plant is located. Also in this Table, the figure given for the US population exposure to natural radiation background (26,000,000 Man-Rem) does not agree with the number given in Section 1.1.8, Page 10-2 (21,000,000).
5-22	5.4.1.3	In the Section, Radiation Doses to Individuals, the staff should reference what standard NRC models were used for these analyses.
5-23	5.4.1.4	In the Section, Occupational Radiation Exposure, "as low as practicable" should be changed to "as low as reasonably achievable" to conform with recent Appendix I and Regulatory Guide revisions.
5-28	5.5.2	In the first paragraph, the staff should provide a basis for the statement that "it is likely that mismatches of chlorine feed to demand will occur often".
5-28	5.5.5.1	In the last sentence of the third paragraph, the wording should be revised to read "...concentration factor of four...".
5-30 5-31	5.6	In the 12th paragraph, the discussion on the voltage gradients achieved in the Greenwood Energy Center project (Ref. 56) is considered inappropriate since the project has not been completed yet; thus their expected gradients have not been confirmed as feasible. PSI requests that reference to the 8 KV/m and 1.8 KV/m values be deleted as well as the comparison with the Russian study in the next sentence since the staff previously stated that this study should be "viewed with great caution".
5-31	5.6	Concerning the staff's grounding requirements in the third paragraph on this page, all structures for the transmission line are grounded. Metal fences are adequately self-grounded if constructed with metal fenceposts. Other structures and wood post fences will also be grounded. Grounding of rail lines parallel to the right-of-way will be done only insofar as possible interference with railroad communication or signalling devices will not result.
5-33	5.8.3	In the first paragraph, the statement that Marble Hill does not benefit the Madison area but "only people far away" is incorrect as the Madison area is a part of the PSI service area. Also, the references 64 and 65 shown in the last sentence of the first paragraph (also in first paragraph of Section 5.8.4.2) do not exist in the list of references and should be revised accordingly. In the first sentence of the second paragraph, PSI presently plans to operate the information center during plant construction and operation.
5-33	5.8.4.1	The statement that improvement to out-patient hospital facilities, etc. conflict with the previous statement of the hospital administrator that the anticipated impact would be minimal. This sentence should be clarified to remove this conflict. Also, in the next paragraph, the wording should be revised to read "...require additional teachers...".
6-1	6.1.1	Several typographical errors were made in the first two sentences of the first paragraph. These sentences should be revised to read: "...Stations A1, A3, and A5 (see ER, Figure 6.1-1). The results of these measurements for six days between 19 March 1974 and 27 February 1975 are listed in Tables 2.7-7, 2.7-8, and 2.7-9 of the ER." (Corrections underlined).
6-1	6.1.4	Reference to the 200-foot tower should be changed to the 199-foot tower.
6-3	6.1.5.1	The first sentence should indicate that the base line sampling program was carried out during the period March 1974 to February 1975.
6-5	6.1.5.1	The requirement in the next to the last paragraph of this section to conduct a survey of Indiana bats (Myotis sodalis) conflicts with the statement in Section 4.3.1.1 that station construction will have minimal effect on the Indiana bat. Additionally, the Office of Endangered Species, Department of Interior, has indicated that further studies are not required based on the fact that there are no caves within a 5-mile radius of the site suitable to the Indiana bat. PSI requests that reference to further studies to determine if the bat inhabits the site be deleted.
6-5	6.1.5.2	In the second paragraph the statement that water quality must be monitored with increased frequency throughout the construction and pre-operational period is unclear. During the base line studies, water quality was monitored monthly and during construction PSI intends to monitor water quality

Page	Section	Comment
		on a quarterly basis. Definition of "increased frequency" is requir.d.
6-5	6.3	The term ORSANCO is misspelled.
7-3	Table 7.2	PSI questions if the values given in the column "Estimated Fraction of the 10CFR Limit" are not in fact percentages. For instance, Class 8.1, Large Break, would result in 6.50 mRem if the "1.3" shown in the column corresponds to 1.3%; the ER indicates 6.5% mRem would be received. Similarly, Class 8.2(a), Rod Ejection Accident, would result in 0.65 mrem if the "0.13" is 0.13%; the ER indicates 0.65 mrem would be received.

Section 8 - The following is a general statement by PS: on the DES, Section 8:

PSI unequivocably ref.tes the staff's conclusions that the Marble Hill Generating Station could be delayed until 1983 without endangering reasonable adequate service to PSI's customers. Based on the following discussions regarding the PSI's load forecast methodology and evaluation of the need for the station, it is evident that the staff's conclusions are inadequate and do not truly represent an assessment.

The PSI service area has grown at a greater rate than the rest of the utility industry over the past 15 years. The following table, a comparison of PSI Native Summer and Winter historical growth rates with ECAR and total electric utility industry growth rates, indicates the relative strength of historical patterns.

Comparison of Utility Growth Rates

	Public Service Indiana	ECAR	Total Electric Utility Industry
Summer			
1960	940 MW	23,313 MW	132,800 MW
	7.7%	5.8%	6.8%
1970	2,061 MW	42,549 MW	274,650 MW
	6.9%	5.0%	5.5%
1975	2,873 MW	54,239 MW	358,200 MW
Winter			
1960-61	986 MW	24,230 MW	133,000 MW
	7.1%	5.3%	5.9%
1969-70	1,965 MW	40,467 MW	236,600 MW
	5.5%	4.3%	4.6%
1974-75	2,562 MW	50,033 MW	296,500 MW

Without exception, as shown in the above table, PSI has exhibited a stronger growth trend than ECAR and the Total Electric Utility Industry. The use of averages can be very misleading. For example, if one compares the average for the Total Electric Utility Industry for the winter periods from 1960 through 1975 and 1969 through 1975, one could come to the conclusion that the growth of the electric industry is declining and that growth above the 5% level would be improbable. The FEA Report states that electric demand, for the business-as-usual case, is projected to grow at a 5.6% rate between 1973 and 1985. This is 1.0% gr..ter than the Winter average for the Electric Utility Industry from 1969 to 1975.

(Sec. 8 comment continued)

The following table dramatizes what can happen if industry averages are used for forecasting when the actual growth rate is greater than the average:

PSI Hypothetical Historical Reserve Analysis

Year	Forecasted Load** using 6.8% Growth Rate*	Load Plus 17% Reserve	PSI Actual Native Peaks**	Calculated Reserve	
1960	986 MW	1154 MW	986 MW	168 MW	17.0 %
1961	1053	1232	1032	200	19.4
1962	1125	1316	1123	193	17.2
1963	1202	1406	1197	209	17.5
1964	1284	1502	1259	243	19.3
1965	1371	1604	1365	239	17.5
1966	1464	1713	1469	244	16.6
1967	1564	1830	1656	174	10.5
1968	1670	1954	1813	141	7.8
1969	1784	2087	1965	122	6.2
1970	1905	2229	2061	168	8.2
1971	2035	2381	2272	109	4.8
1972	2173	2542	2614	28	1.1
1973	2321	2716	2740	(24)	(0.9)
1974	2479	2900	2666	234	8.8
1975	2648	3098	2873	225	7.8

* Total Electric Utility historical growth rate from 1960 through 1975.

** PSI Actual Native Peaks and Forecasted Loads exclude Hoosier Energy Load.

The above tabulation indicates that the PSI load growth followed the 6.8% growth rate the first six years, but starting in 1967 the load growth far exceeded the 6.8% average. It is evident from this Table that had capacity been installed on the basis of this forecast, reserves would have been inadequate.

Conditions that can affect the system peak are temperature, humidity, light intensity, time of day and industrial curtailment. Normalization of the peak is the process of adjusting the actual peak demand because of unusual or abnormal conditions that occurred coincident with the peak. The use of an unnormalized peak as the starting point for a forecast based on a fixed compound growth rate can result in large errors. The normalized PSI 1975 Summer peak is 2976 MW, 103 MW more than the actual Summer peak of 2873 MW.

A factor that makes the forecasting of the PSI load more difficult when using averages is the loss of the Hoosier Energy load in the early 70's, approximately 14% of the PSI Winter Peak. Anyone not aware of this would think that the PSI load was growing at a much smaller rate than it actually is.

In developing the PSI Load Forecast, the Forecast Committee reviewed the factors which normally affect Company load growth, such as, changes in population, number of customers, trends in domestic use, electric heating and air conditioning expansion, commercial and industrial load development and new loads. The following facts pertain to the PSI load and customers:

(Sec. 8 comment continued)

1. The average number of net customer additions from now until 1986 will be 9000 per year, or an increase of 1.6% each year. By the early 1980's at least 80% of all new customers will heat electrically as compared to 50% in 1974.

2. The percent increase in usage for each domestic customer from 1974 to 1975 was 9.8%, 8631 KWH for 1974 to 9479 KWH for 1975. The 9479 KWH compares to an average of 8214 KWH rate for the total electric industry.

3. The number of customers using electricity for space heating is expected to continue to grow from the 6000 total in 1975. It is expected that many of those who heat electrically will use the heat pump. At the time of the winter peak, when temperatures are usually low, the heat pump's demand increases sharply while it loses its advantage in efficiency over the electric furnace.

4. Non-Hoosier Energy REMC demand has increased an average of 11% from 1971 through 1975. The increase in non-coincident demand for January 1975 is 13.6% and for January 1976 is 16.7%.

5. The percent increase in total PSI Winter load was 9.7% and 7.9 percent for 1974-75 and 1975-76, respectively, well above the national average of 2.4% for 1974-75 and ECAR averages of 2.3% for 1974-75 and 2.8% for 1975-76.

6. A special investigation was made to determine what the load growth would be for industrial customers. The result of this study was that the 1976 usage would be comparable to that of 1974 with continued recovery and new loads to be added, and that by 1977, the level of load growth would be slightly above 1973. The 1978-1980 growth is expected to return to the pre-1974 rates. It has also been indicated that PSI will have an edge over Northeastern utilities in attracting energy sensitive load because of the forecasted lower cost of energy produced from coal and nuclear fuels.

After reviewing the pertinent factors which normally have an effect upon system load, it was noted that there were changes in many of these factors which indicated a need to refine the rate of load growth as previously forecasted. (ER Table 1.1-1: PSI) As a result of this refinement, PSI will continue to have a growth rate well above the national average. Over the next 12 years, the growth rate will be 7.1% for Summer peak demands and 8.2% for Winter peak demands. Both Summer and Winter demands have been lowered to reflect:

1. A stronger air conditioning saturation as revealed by the Fall 1975 survey.

2. Adjustment for 1976 housing starts.

3. The continued postponement of gas companies to restrict residential and commercial hook-ups.

4. The rate of economic recovery of the industrial load in 1975 and 1976.

(Sec. 8 comment continued)

Table I is offered to show the comparison of the March 1975 load forecast (ER Table 1.1-1: PSI) with the March 1976 load forecast.

TABLE I

COMPARISON OF PSI NATIVE LOAD MARCH 1975 FORECAST WITH NATIVE LOAD MARCH 1976 FORECAST

	Official March 1975 Forecast (MW)	Official March 1976 Forecast (MW)	March 1976 Over (Under) March 1975
Summer			
1975	3000		
1976	3255	3150	(105)
1977	3530	3405	(125)
1978	3815	3675	(140)
1979	4120	3960	(160)
1980	4440	4260	(180)
1981	4770	4570	(200)
1982	5115	4895	(220)
1983	5480	5235	(245)
1984	5860	5585	(275)
1985	6250	5950	(300)
1986	6660	6325	(335)
1987		6710	
ACGR	7.5%	7.1%	
Winter			
1975-76	2800		
1976-77	3040	3000	(40)
1977-78	3310	3270	(40)
1978-79	3610	3545	(65)
1979-80	3935	3835	(100)
1980-81	4290	4150	(140)
1981-82	4675	4490	(185)
1982-83	5080	4860	(220)
1983-84	5510	5260	(250)
1984-85	5955	5690	(265)
1985-86	6420	6155	(265)
1986-87	6900	6635	(265)
1987-88		7125	
ACGR	8.5%	8.2%	

(Sec. 8 comment continued)

The minimum installed reserve level for Public Service Indiana, Inc. (PSI) has been established as 17% of the adjusted peak load. This level was established by the Planning Committee of Kentucky-Indiana Pool (KIP) of which PSI is a member and is based on their consideration of unit sizes as a percentage of system load and an observation of trends in the occurrences of forced unit outages.

While PSI's most recent system peak load forecast indicates a slightly reduced growth rate from the previous forecast, as shown in the various revised tables, PSI is still convinced that the proposed in-service date of January 1, 1982 for Marble Hill Unit #1 is justified. The forecasted load-capacity situation for PSI during the 1982-1986 period is shown on Table A. The peak loads shown are from the latest PSI load forecast dated March 12, 1976. The forecasted reserve for 1982 without Marble Hill Unit #1 is 730 megawatts or 14.9%, this is 102 megawatts short of the 17% minimum planned company reserve. The forecasted reserve level with Marble Hill Unit #1 in service is shown on Table A as 1465 megawatts or 29.9%.

These forecasted reserve levels do not take into account the potential loss of capacity due to air and water quality regulations and a derating of units due to age. As a result of the potential impact on PSI reserve situations, a second set of figures appears on Table A showing the effect of the retirement of 165 megawatts of capacity at Edwardsport Station. The Edwardsport Station was picked since the age of the units there will be in the 30-40 year group by 1982; however, the 165 megawatt could just as well represent accumulative incremental derates of a number of PSI units due to various environmental reasons. The 165 megawatt reduction and capacity results in 565 megawatts or 11.5% reserves in 1982 without Marble Hill Unit #1 and 1300 megawatts or 26.6% with the unit. This would require purchase of 267 megawatts in 1982 to maintain a minimum installed reserve level of 17%.

Additionally the following reasons also support the proposed in-service date of January 1, 1982 for the Marble Hill Unit #1 facility:

1. The possibility of factors, as yet unknown, that would significantly increase the rate of load growth in a relatively short time span.
2. The projected reserve levels of the ECAR companies for this period of time do not indicate that this would be a dependable source of supply for needed capacity, especially since the influence of present financial conditions may cause many companies to have over reacted in the revised load projections and the resulting reduction in planned capacity installations.
3. If the capacity is needed and is not available, the consequences are very severe both financially with respect to the cost of replacement power, and in the degradation of service reliability due to the reduced reserve levels.
4. If the capacity is available and not required, the cost penalty is very small because of the use of more efficient generation and reduced construction cost escalation will tend to offset the investment carrying cost of the unneeded capacity. Also if a market with the excess capacity exists, which is very likely, the unneeded capacity will result in a cost benefit.

(Sec. 8 comment continued)

One method for meeting a one year deficiency of the magnitude as discussed above would be to contract to purchase firm power to cover the deficiency. However, data published in April, 1976 ECAR response to FPC Order 383-1, Volume 1, indicates low reserve levels and the probability of further delays in construction of new capacity. Table B indicates that without Marble Hill Unit #1 in 1982, the ECAR reserve level will be 15.9%. This figure is well below the 20% recommended in the 1970 Power Survey, Part 1, a report by The Federal Power Commission.

MARBLE HILL ENVIRONMENTAL REPORT

UPDATE OF PSI LOAD - CAPACITY SUMMARY

TABLE A

No Scheduled Retirements

Year	Peak Load(MW)	Capability Without New Capacity(MW)	Reserve MW	Reserve %	Capacity Addition(MW)	Capability With New Capacity(MW)	Reserve MW	Reserve %
1982	4895*	5625*	730	14.9	735	6360	1465	29.9
1983	5260	6409	1149	21.8	-	6409	1149	21.8
1984	5690	6409	719	12.6	735	7144	1454	25.5
1985	6155	7144	989	16.1	-	7144	989	16.1
1986	6635	7144	509	7.7	845	7989	1354	20.4

Effect of Retiring Edwardsport Station (165 MW)

Year	Peak Load(MW)	Capability Without New Capacity(MW)	Reserve MW	Reserve %	Capacity Addition(MW)	Capability With New Capacity(MW)	Reserve MW	Reserve %
1982	4895*	5460*	565	11.5	735	6195	1300	26.6
1983	5260	6244	984	18.7	-	6244	983	18.7
1984	5690	6244	554	9.7	735	6979	1289	22.6
1985	6155	6975	824	13.4	-	6979	824	13.4
1986	6635	6979	344	5.2	845	7824	1189	17.9

*The system peak load for 1982 is forecasted to occur during the summer period, all other years shown are forecasted to be winter peaking. The capacity increase of 49 MW from 1982 to 1963 is due to tested capabilities being higher during the winter period than during the summer period.

Note: No diversity and no Dresser gasifier unit

Reference: MH-ER(CP); Page 1.1-41; Table 1.1-14:PSI

(Sec. 8 comment continued)

Page	Section	Comment
8-1	8	The introductory paragraph has misstated the basis of the need for the Marble Hill Station. The second sentence should be reworded to read "this need is construed to be identical to the market demand of ultimate consumers for additional capacity and the Company's reserve requirements". Also, the remainder of this paragraph should be revised to reflect the ownership of the station by the Wabash Valley Power Association and the East Kentucky Power Cooperative as described in the previous comment on Section 1.1
8-6	8.2.1	In the fourth paragraph, a comma instead of a period following "customers" is required.
8-6	8.3.3.1	In the second paragraph, the words "participation", "toward" and "business" have been misspelled. Also in the paragraph on Page 8-17, "forecasts" is misspelled.
8-6	8.2.2	The staff has not given adequate consideration to the PSI forecasts. Also, the discussion should identify the projected PSI percent growth rates.
8-6	8.2.3	The following section number should be 8.2.3.1 instead of 8.3.3.1. In the second paragraph of Section 8.2.3.1, the staff should justify why they consider the "Project Independence Report" to be the "most comprehensive energy analysis yet undertaken".
8-12	Tables 8.5 thru 8.7	The staff should provide a footnote to these tables indicating the source of data.
8-17	8.2.3.1	In the second paragraph the staff should provide a suitable reference for the "soon to be published" revised forecasts.
8-17	8.2.3.2	In the first sentence, "Table 9.10" should be changed to "Table 8.10".
8-19	8.2.3.2	In the first paragraph on this page "relevant" and, in the second paragraph, "implausibly" have been misspelled.
8-20	8.2.3.2	In the top paragraph, PSI considers that the staff has underestimated the Company's future energy requirements in terms of the new customers per year (4000), their energy usage (17,425 kwh for homes with resistive space heating), and the fraction of new homes with resistive space heating systems (50%). PSI expects to average 13,000 gross new customers (domestic premises never served before) per year for the forecast period. Although this total is modified by the loss of normally older, non-resistive space heated homes due to urban renewal, fires, etc., Table 8.5 of the DES shows that PSI has been averaging about 8400 net new domestic customers (actual number of customer bills) per year since 1970. By the early 1980's, at least 80% of new homes built will employ resistive space heating; the energy consumption of such homes averaged 21,314 kwh in 1974.

MARBLE HILL ENVIRONMENTAL REPORT

UPDATE OF ECAR LOAD - CAPACITY SUMMARY

TABLE B

					One Year Delay in M.H. 1 and 2		
	Peak		Reserve			Reserve	
Year	Load(MW)	Capacity(MW)	MW	%	Capacity(MW)	MW	%
1982	85097	99791	14694	17.3	98661	13564	15.9
1983	90093	103855	13762	15.3	103855	13762	15.3
1984	95340	110684	15344	16.1	109554	14214	14.9
1985	100774	113656	12882	12.8	113656	12882	12.8

Note: 1970 Power Survey, Part 1, as reported by the Federal Power Commission, recommends a 20% reserve level.

(Sec. 8 comment continued)

Page	Section	Comment
		Also the first sentence in the paragraph is grammatically incorrect. The following wording is suggested: "...of natural gas. This will persuade...". In the next to the last sentence the figure 0.09 x 10^5 should be 0.9 x 10^5.
8-20	8.2.3.2	In the next to the last paragraph of this section, it is not clear why the OBERS can distinguish PSI's service area but it is not suitable for distinguishing NIPSCO's area.
8-20	8.2.4.1	In the first paragraph a basis should be provided for the staff's statement that energy conservation has contributed to a lack of growth and consumption of electricity nationally. PSI's experience within its service area has been that energy conservation measures have not significantly affected consumption. Also a reference should be provided to the "forecasted consumption" discussed on Page 8-21.
8-24	8.3.1	In the next to the last paragraph PSI requests clarification of the statement that a one year delay in the installation of Marble Hill Station will "present no problems". The staff's definition of "no problems" is requested. PSI construes this statement to be incorrect if one considers the considerable costs involved with purchase of needed energy if it is not available and consequences of inadequate reserves.
8-34	8.4	In the first paragraph the staff should define what is meant by "reasonably adequate service".

Page	Section	Comment
9-1	9.1.1	In the third sentence of the first paragraph "capabilities" is misspelled.
9-1	9.1.1	In the second paragraph PSI objects to the statement that we "could delay operations (intended for early 1980's) for a period <u>of several years</u>...". The staff's own estimates (Figure 8.7) indicate that we will need additional capacity by 1984 to maintain our reserves greater than 17%.
9-1	9.1.1	In the last paragraph of this section the purpose of the asterisk following "cost of ownership" is questioned. Also a reference should be provided supporting the statement that "cost of ownership is on the order of 15% per year for an investor-owned utility".
9-2	9.1.2.1	In the section <u>Hydroelectric Power</u>, the staff should provide a basis for their statement that there are "ten undeveloped hydro sites along the Ohio...". Furthermore, the discussion should be restricted only to those sites on the Ohio which lie along the Indiana border.
9-3	Table 9.1	PSI questions whether the costs shown in this table are in terms of 1975 dollars or future worth dollars. For instance, in the ER Page 3.1-7, total worth of the plant in terms of 1983 dollars is approximately 1200 million dollars. However in Table 9.1 the staff shows 1290 million dollars for a nuclear plant in terms of 1975 dollars. Also PSI disagrees with the staff's estimate of the cost of low sulfur coal (14.0 mills/KWH, 1975 dollars). Based on currently existing factors for single car freight rates, PSI has estimated that the cost for low sulfur coal is closer to 18.16 mills/KWH (1975 dollars).
9-3	9.1.2.2	In the paragraph beginning with "Note" the staff should identify which CONCEPT computer code was utilized.
9-5	Table 9.2	The values shown for radioactivity releases under the "Nuclear" column correspond with the staff's estimates in Section 3.5 for one reactor only. These values should be doubled to correspond to a 2260-MWe nuclear plant as indicated in the heading. Also in this table beside "<u>Esthetic</u>", PSI considers that "cooling towers" are not necessarily required at coal and/or nuclear plants. As per the DES, Section 9.3.1, once-through-cooling, cooling ponds, and spray canals are also discussed as alternatives to cooling towers.
9-5	9.2.1	In the third paragraph it is not apparent if the discussion on population density implies current population or future population growth values. Population growth should be considered in this discussion.

Page	Section	Comment
9-5	9.2.1	In the third paragraph the staff considers that a stretch on the Wabash would be an adequate alternate site to Marble Hill. PSI's experience with power plants on the Wabash indicates that there are problems with both consumptive water use and transportation of heavy pressure vessel components to these areas of Indiana. These points should be included in the staff's evaluation of the Wabash as a suitable site.
9-6	9.2.3	In the third paragraph "State Route 162" should be "State Route 62".
9-9	Table 9.5	The source of the data for this table should be referenced.
9-16	9.3.4.2	Only one component will be chlorinated at any one time so that the chlorine in its discharge will be dissipated (not diluted) by the chlorine demand in the unchlorinated discharges from other components.
9-16	9.3.4.2	The staff's suggestion that blowdown from a chlorine-treated system be held up until the chlorine concentration has dropped to an acceptable level is not a "simple alternative". A very large retention basin would be required to hold the blowdown flow for two to three days.
9-16	9.3.4.2	In the last sentence of the first paragraph the staff should provide a basis for their statement that products resulting from the addition of sulfur dioxide or hydrogen peroxide would be "harmless".
10-2	10.1.3	There are three comments with respect to the second sentence of this paragraph. First, "population" should be clarified as to whether it is population less than 50 miles or elsewhere. Secondly, the "80 man-Rem per year" disagrees with the sum of the doses to the general public shown in Table 5.10 (approximately 90 man-Rem). Third, the figure of 21 million man-Rem disagrees with the 26 million man-Rem figure given in Table 5.10.
10-3	10.3.3	The first sentence indicates that "development of the two-unit plant and associated off-site construction will commit about 1200 acres of agricultural land and woodland." Section 10.1.1.1 however indicates approximately 1385 acres will be needed (250 acres on the site, 890 acres of forest for transmission corridors, and 245 acres of forest and crop land for the rail spur). This discrepancy should be corrected.
10-4	10.3.4.1	A basis and reference should be provided to support the various quantities of materials committed and the need for about 100 million KWH of electricity for construction.
10-4	10.3.6	In the third paragraph it is stated "transmission corridors require 3475 acres of land...". However, Section 10.1.1.1 indicates that "an area of about 2800 acres will be used for transmission corridors...". This discrepancy should be corrected.
10-9	10.4.2.3	In the third paragraph reference PSI's previous comments concerning the 30 man-Rem/yr total.
10-9	Table 10.3	Reference PSI's previous comments on Table 9.1 as to whether these figures are in terms of 1975 dollars or future worth dollars. The total of nearly 1400 million dollars for construction and decommissioning would imply that they are future worth dollars.
10-11	Table 10.4	Reference PSI's previous comment concerning the 80 man-Rem per year total.
B-17	Table B.12	A reference should be provided identifying the source of this material.

Page	Section	Comment
		The NIPSCO capacity in the Marble Hill Station is expected to approximately equal the load growth, plus reserves. NIPSCO anticipates significant industrial, commercial, and residential load growth during this period."
8-6		Section 8.3.3.1 is misnumbered. It should be 8.2.3.1.
8-20	8.2.3.2	In the fourth sentence of the third paragraph, "36%" should be "38%". Replace the last four sentences of the third paragraph (i.e., beginning with "In the past...might be expected.") with the following: "In the 1965-74 time period, NIPSCO's peak annual growth was 8.4%. The staff agrees that NIPSCO's estimate of 6% load growth is reasonable for the future. NIPSCO's large industrial customers minimize consumption during hours of peak system demand in order to take advantage of NIPSCO's rates which provide peak-shaving benefits. The result is a high system load factor." NIPSCO regards the concluding sentence, "...and an independence of the system peak... might be expected." as a misleading summary. NIPSCO's rates provide incentive for large industrial customers to minimize usage during peaks. As discussed in 8.2.4.4, these customers are not interruptable and thus it is the unilateral decision of these customers to take advantage of the rate incentive.
8-21	8.2.4.2	The staff's characterization of NIPSCO's advertising contained within this section is overly condensed. The staff's attention is drawn to the Marble Hill Environmental Report, Page 9.1-9a, specifically dealing with NIPSCO's advertising. Although NIPSCO's advertising turned to conservation and consumer information in 1971, promotional electrical advertising prior to 1971 and since, has been minimal and confined to the items mentioned in the above referenced Environmental Report se...
8-22	8.2.4.4	In the first sentence of the third paragraph, replace "system-stability planning" with "system planning".
8-22	8.2.4.5	NIPSCO is in general agreement with the conclusions expressed; however some of the data cited appears suspect. For example, we question whether lighting accounts for 24% of national NIPSCO questions whether lighting accounts for 24% of national electric sales. A reference for these statistics should be provided.

Northern Indiana Public Service Company Comments on Draft Environmental Statement, Section 8

The following comments on Section 8 are submitted by Northern Indiana Public Service Company:

Page	Section	Comment
8-1	8.1.?	The second sentence in the second paragraph should read "furnishes electric energy." Also change "27% of Indiana's population" to "28%...". The third sentence in the second paragraph should be "85% of the electrical energy sales" (instead of "generated").
8-1	8.1.2	In the second sentence of the third paragraph, insert "(a subsidiary of American Electric Power Company)" after "(I&M)". Replace the third sentence in the third paragraph with the following: "NIPSCO has a contract which obligates it to purchase Supplemental Capacity from Commonwealth Edison (Indiana) whenever NIPSCO's system reserve margin drops to less than 15%. When NIPSCO's reserves are less than 15%, Commonwealth is obligated to sell capacity up to 175,000 kilowatts Supplemental Capacity to provide 15% reserves. The contract with Commonwealth Edison expires on June 30, 1979. Commonwealth has indicated to NIPSCO that it does not intend to extend the contract in its present form."
8-1	8.1.2	Reword the fifth sentence in the third paragraph as follows: "...in advance of the period (not less than 12 months duration) in which...". Suggest the last sentence in the third paragraph be deleted as it is inappropriate to the preceding discussion.
8-6	8.2.1	In the first sentence of the second paragraph, suggest "classifies" instead of "decomposes".
8-6	8.2.1	With regard to the third paragraph, the four steel companies account for 36% of NIPSCO's system KWH and 38% of NIPSCO's sales KWH. Reference in the second paragraph is to "... total slaes...". Therefore "...36% of the total..." in the third paragraph should read "...38% of total...".
8-6	8.2.2	Replace the second paragraph with the following: "NIPSCO plans to buy a portion of the Marble Hill Station capacity to assure that it can meet the load requirements of its customers. NIPSCO intends to install additional capacity to meet its load growth and intends to utilize purchase capacity in its planning as feasible. However, NIPSCO anticipates an industry-wide shortage of generating capacity by 1980-90 time frame which makes reliance on future purchases dubious.

Page	Section	Comment
8-22	8.2.4.5	NIPSCO is not in agreement with the first sentence of the second paragraph. This statement is not correct for the NIPSCO system which has a high load factor. NIPSCO suggests the following wording be substituted: "The need for generating capacity is dictated by the need to meet the annual peak demand periods and to assure adequate capacity is available to provide reliable service in each and every period of the year. Reliable service requires reserves to provide continuity of service in the event of any one or more of the following: 1. Generation units forced out of service due to equipment malfunctions, and maintenance of the units. 2. Reduction in output due to unforeseen equipment or transmission restrictions. 3. Reduction in capacity due to environmental restrictions and low quality or wet coal. 4. Delays in placing new units in service. 5. The actual demand exceeds the peak demand estimate. (See Page 1.1-47 Marble Hill Environmental Report, Items a. to g.)
8-22	8.2.4.5	NIPSCO suggests rewording the second sentence of the second paragraph as follows: "Conservation measures which reduce consumptions may have little impact on the need for additional capacity."
8-24	8.3.1	In the third paragraph delete the sentence beginning with "As was mentioned..." and subsequent portions of the paragraph. Replace with the following: "As was mentioned in Section 8.1.2, the Commonwealth-NIPSCO contract contains provisions to supply NIPSCO with Supplemental Capacity up to 175,000 KW when the NIPSCO reserve drops below 15%. NIPSCO has been informed that these provisions cannot be renewed; the contract expires in June 1979. As a result of the expiration and the reasons set forth in Section 8.2.4.5, it is the NIPSCO intent to increase its reserve requirement to approximately 20% for planning purposes. These plans are predicated on the timely completion of the Bailly Plant. NIPSCO's arrangement with I&M was described in Section 8.1.2. At present, NIPSCO plans to contract for 200 MW in the years 1980-84."
8-24	8.3.2	In the first sentence, change "thought" to "determined". The intent of the last sentence is not clear. Please revise or delete.
8-34	8.3.3	In the fifth sentence of the second paragraph, change "13.6%" to "13.4%".
8-34	Table 8.18	Table "8.18" should be Table "8.19". (See correction ver'ion attached).
8-2	Figure 8.1	The NIPSCO service area shoul' only indicate the electric service area which would necessitate the removal from the diagram of the South Bend-Elkhart areas that are served by I&M. (See attached Figure 8.1.) In addition, please amend "NIPSCO Service Area" to "NIPSCO Electric Service Area".
8-5	Figure 8.4	Same comment as on Figure 8.1 concerning detection of service area. "NIPSCO" should refer to "NIPSCO Electric Service Area".
8-10	Figur 8.6	Referring to "NOTE" below the figure, the statement "...the years 1960-1965 were characterized by 9.6% annual growth,..." should read "7.6%".
8-16	Figure 8.8	See corrections to attached Figure 8.8. In addition, delete the phrase "whose existance is in doubt".
8-18	Table 8.2	See attached 8.2 for corrections. The percentage change for the future period (1975-1986) is no longer "Percentage Change In Sales To Customers," but is "Percentage Change In System Energy."
8-11	Table 8.4	See attached Table 8.4 for corrections.
8-12	Table 8.6	See attached Table 8.6 for corrections.
8-14	Table 8.8	See attached Table 8.8 for corrections.
8-30	Table 8.17	Data for 1970 was incorrect. Note that peak for 1970 and 1971 is the same. See attachment.
8-31	Table 8.18 - 8.19	Table 8.19 is incorrectly numbered 8.18 and certain data is incorrect. Table is attached, retyped in correct form.

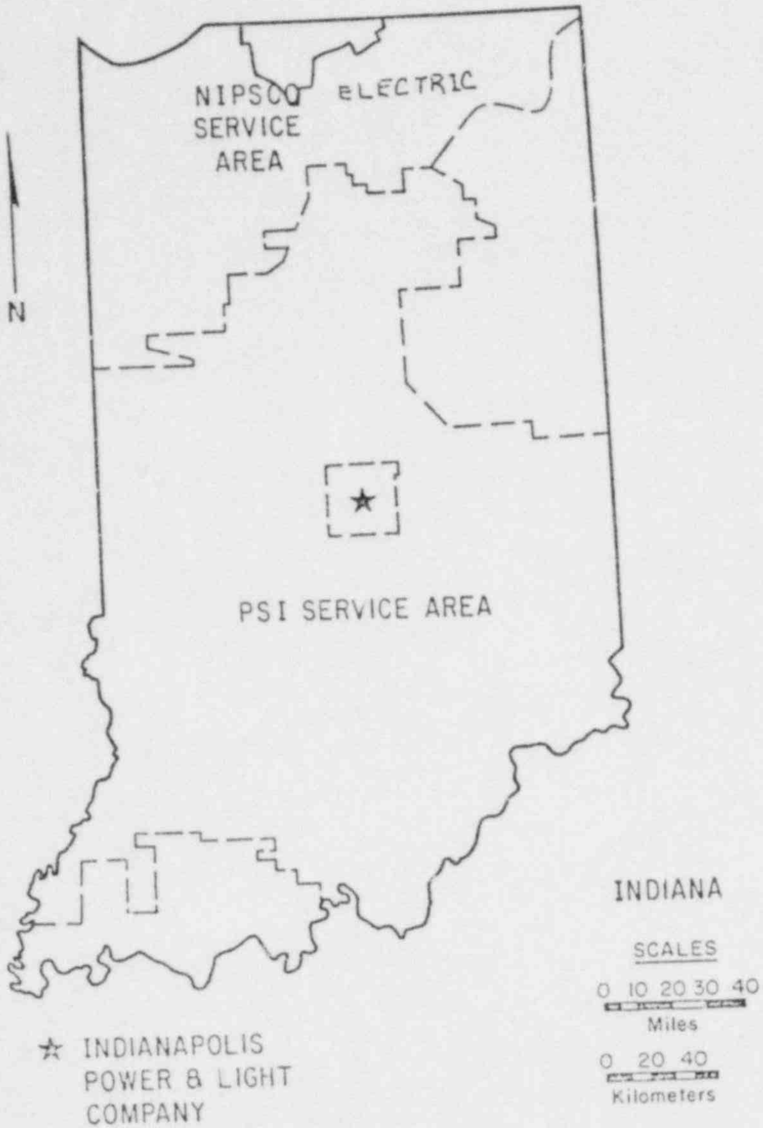

Fig. 8.1. PSI and NIPSCO Service Areas.

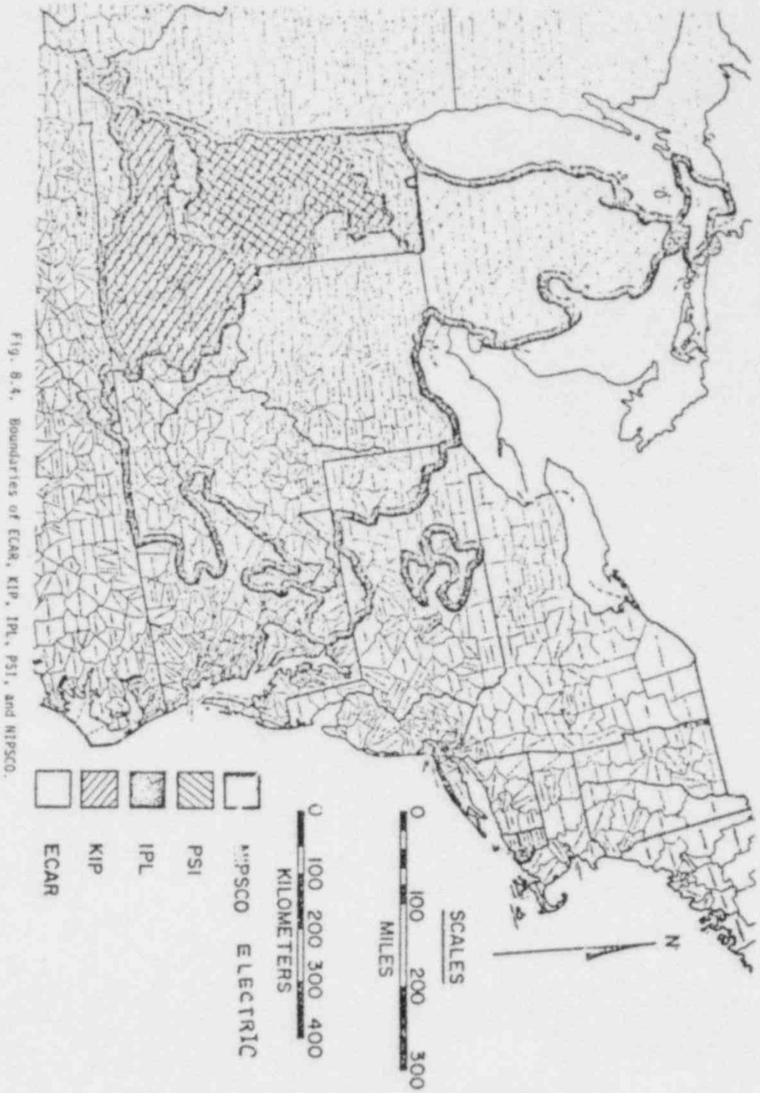

Fig. 8.4. Boundaries of ECAR, KIP, IPL, PSI, and NIPSCO.

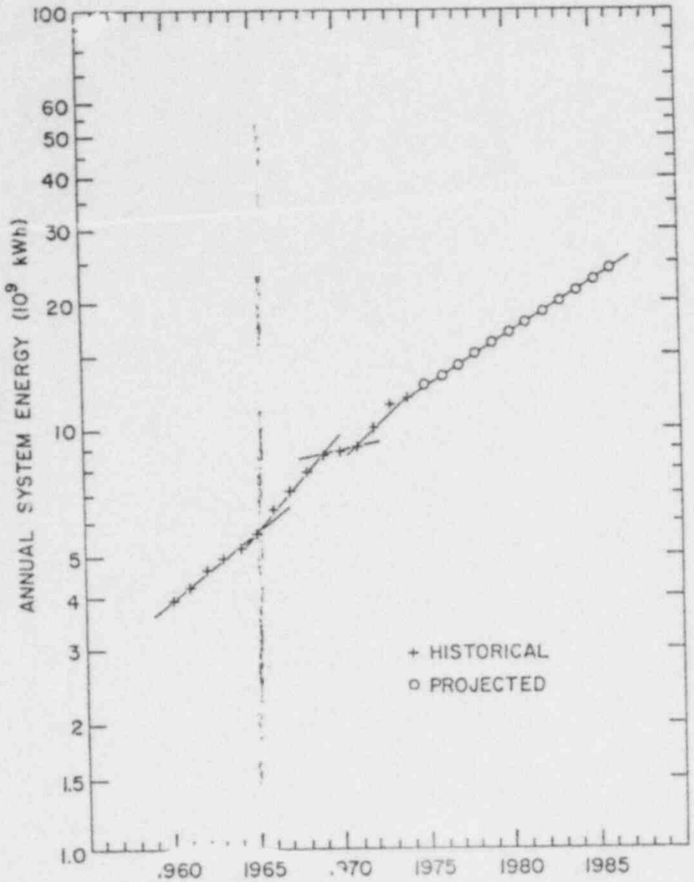

Fig. 8.6. NIPSCO Annual System Energy Requirement

Note: NIPSCO's annual sales are less than its energy requirement because of transmission losses and the company's use of its own energy. The historical values were reported by NIPSCO in Table 1.1-2 of the ER and the projected values, which are NIPSCO's expectations, were reported in the same table. The straight lines that appear on the graph were drawn by the staff primarily to guide the eye. The staff attaches no predictive value to them. On the average, the years 1960-1965 were characterized by ~~4.6~~% annual growth, 1965-1969 by 11.3%, 1969-1971 by 2.6%, and 1971-1974 by 9.0%. NIPSCO expects to need 2.3 × 10⁷ kWh in 1985, which could be reached by an average annual growth beginning from 1974 of 6%

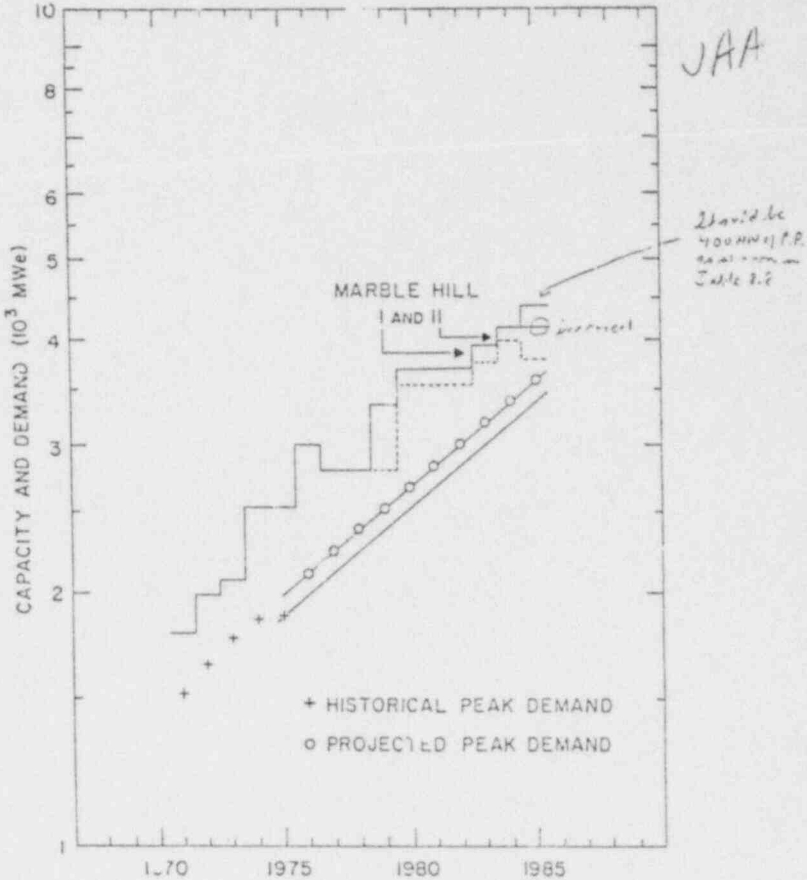

Fig. 8.8. NIPSCO Capacity and Peak Demand

Note: The uppermost solid line represents NIPSCO's past capacity and expectations for the future. The dotted line was obtained by subtracting the capacity ([illegible] MWe) of the [illegible] Plant ([illegible]) and adding 200 MWe (to bring NIPSCO's purchase of capacity from [illegible] to its maximum) for the years 1980-[illegible] to NIPSCO's present expectation for future capacity. The points represent NIPSCO's past peak demands and its expectations for future peak demands. A line has been drawn through NIPSCO's expectations and for the sake of comparison another line has been drawn below it. This second line would represent NIPSCO's future peaks if they grew at 6% each year beginning from 1975.

Table 8.2. NIPSCO System Energy Data and Expectations

Year	Energy Generated[a] (GWh)	Purchased Energy from Peers[a,b] (GWh)	System Energy[a,c,d] (GWh)	Energy Sold to Customers[d,e] (GWh)	Percentage Change in Sales to Customers
1960	3232	752	3,984	3,728	
	3522	[illegible]	4,275	4,019	7.8
	3593	1103	4,696	4,438	10.4
	4158	833	4,991	4,711	6.2
	4269	1020	5,289	4,996	6.1
1965	4630	1112	5,742	5,430	8.7
	4645	1870	6,515	6,154	13.3
	4961	2716	7,177	6,826	10.9
	5220	2805	8,025	7,632	11.8
	6639	2164	8,803	8,377	9.8
1970	7058	1830	8,888	8,437	0.7
	6883	2386	9,269	8,772	4.0
	7074	3191	10,265	9,745	11.1
	7188	4465	11,653	11,070	13.6
	7844	4138	~~12,099~~ 12,022	11,454	3.5
1975			12,880		
			13,500		4.8
			14,300		5.9
			15,200		6.3
			16,100		5.9
1980			17,000		5.6
			18,000		5.9
			19,100		6.1
			20,300		6.3
			21,500		5.9
1985			22,800		~~12.3~~ 6.0
			24,200		6.1

[a]Data through 1974 are from NIPSCO's Annual Power System Statement to the Federal Power Commission, FPC Form No. 12.

[b]Other utilities with which NIPSCO interconnects.

[c]Expectations for the years 1975 through 1986 are from the ER, Section 1.1.3.

[d]The staff assumes that the difference between System Energy and Energy Sold to Customers was consumed by NIPSCO.

[e]From NIPSCO's Annual Reports to its stockholders.

Table 8.3. Percentage of PSI Total Energy Consumed by Sector

Year	Domestic	Commercial	Industrial	REMC[a]	Municipals	Other
1960	25.2	15.6	37.4	14.9	5.9	1.0
	25.1	15.5	37.0	14.9	6.0	1.5
	24.5	15.4	37.2	15.0	6.1	1.8
	24.2	15.7	37.5	15.0	6.1	1.5
	24.0	16.0	38.8	14.7	5.7	0.8
1965	23.9	16.3	38.8	14.5	5.4	1.1
	24.1	16.7	38.3	14.7	5.3	0.9
	24.5	17.1	37.4	15.0	5.3	0.7
	24.4	17.2	37.6	14.9	5.0	0.9
	24.5	17.3	37.2	15.1	5.1	0.8
1970	25.4	18.1	35.9	14.3	5.6	0.7
	25.9	18.7	35.9	12.9	5.9	0.7
	26.2	19.2	37.0	10.7	6.2	0.7
	26.7	19.5	37.8	8.8	6.6	0.6
	26.3	18.8	35.9	11.2	7.1	0.6

From PSI's Annual Reports to its stockholders.

[a]Rural Electric Membership Corporations.

Table 8.4. Percentage of NIPSCO Total Energy Consumed by Sector

Year	Domestic	Commercial	Industrial	Street Lighting	Sales for Resale	Other
1960	21.8	8.4	61.5	1.2	6.0	1.1
	21.7	8.2	62.1	1.2	5.9	1.3
	20.7	8.0	63.5	1.2	5.3	1.2
	20.7	7.7	64.0	1.2	5.3	1.1
	19.5	8.2	64.7	1.2	5.4	1.1
1965	19.0	7.8	65.8	1.1	5.4	1.0
	18.2	7.3	67.6	1.0	5.2	0.8
	17.5	6.8	68.9	0.9	5.1	0.7
	17.3	6.4	69.5	0.8	5.1	0.8
	17.0	6.3	70.3	0.8	5.0	0.6
1970	18.4	6.6	68.2	0.8	5.4	0.6
	19.0	6.6	67.5	0.8	5.6	0.5
	18.2	6.0	68.5	0.7	5.7	0.5
	17.1	5.4	71.2	0.7	5.2	0.5
	16.7	4.8	71.9	0.7	5.4	0.5

From NIPSCO's Annual Reports to its stockholders.

Table 8.5. PSI Domestic Customers

Year	Number of Customers (thousands)	Energy per Customer (kWh)	Average Annual Bill (dollars)	Adjusted Average Annual Bill (1974 dollars)
1960	329.0	3936	105.03	177.37
	332.2	4121	121.98	200.78
	335.2	4314	128.34	208.97
	339.9	4480	131.75	212.00
	345.8	4745	134.40	213.30
1965	352.5	5076	138.79	216.58
	360.4	5520	146.08	221.70
	366.5	5892	152.29	224.62
	375.9	6430	160.84	227.74
	384.5	6907	168.29	226.12
1970	390.2	7395	176.00	223.24
	397.5	7774	182.20	221.43
	406.6	8173	199.69	235.33
	415.8	8736	217.17	240.88
	423.7	8631	221.78	221.78

Table 8.6. NIPSCO Domestic Customers

Year	Number of Customers (thousands)	Energy per Customer (kWh)	Annual Average Bill (dollars)	Adjusted Annual Average Bill (1974 dollars)
1960	234.2	3481	96.81	160.93
	240.8	3571	98.41	161.99
	244.0	3775	102.93	167.60
	247.4	3936	105.61	171.55
	251.2	3881	104.91	166.49
1965	255.2	4052	108.43	169.21
	262.0 [262.4]	4282 [4376]	111.60 [111.43]	169.38 [167.72]
	266.2	4490	115.49	170.33
	269.9	4884	123.47	174.83
	274.6	5196	129.82	174.43
1970	278.4	5562	137.63	174.58
	283.1 [272.2]	5978	143.50	174.40
	289.3	6137	165.18	194.66
	295.9	6402	178.13	197.57
	298.9	6408	198.00	198.00

Table 8.8. NIP[illegible] Peak Load

Year	Peak Load (MW)	Firm Purchases (MW)
1965	901[a]	290
	1031[a]	384
	1140[a]	[506]
	1263	[417]
	1402	[384]
1970	1444	400
	1524	400
	1650	600
	1707	690
	1872	690
1975	1884	690
	2120[b]	690
	2250[b]	490
	2385[b]	490
	2525[b]	400
1980	2680[b]	200[c]
	2840[b]	200[c]
	3010[b]	200[c]
	3190[b]	200[c]
	3380[b]	200[c]
1985	3580[b]	400[c]

[a] Winter peak.

[b] NIPSCO's expectation.

[c] This number represents NIPSCO's current thinking. The binding decision concerning what capacity (between 200 MW and 400 MW) will be purchased from Indiana & Michigan Co. must be made four years in advance.

NORTHERN INDIANA PUBLIC SERVICE COMPANY

CORRECTED TABLE 8.19

Table 8.19 ECAR Capacity, Load, and Reserve Forecasts

Year	Capacity During Native Peak Load (MW)		Native Peak Load (MW)		Available Reserve (% of Native Peak)	
	1975	1974	1975	1974	1975	1974
1975	[illegible]	72,763	55,143	59,392	26.2	22.5
1976	[illegible]	79.957	59,782	64,559	27.5	23.9
1977	[illegible]	84,531	64,248	68,967	23.9	22.6
1978	83,[illegible]	89,769	68,678	73,575	20.9	22.0
1979	87,943	98,857	73,1[illegible]7	78,397	20.3	26.1
1980	93,479	105,922	77,77[illegible]	83,724	20.2	26.5
1981	98,852	112,321	82,684	89,180	19.6	25.9
1982	1[illegible]3,111	119,983	87,774	94,936	17.5	26.4
1983	106,700	127,127	93,063	101,100	14.7	25.7
1984	113,829		98,653		15.4	
1985	123,700		105,200		17.6	
1986	132,400		111,500		18.7	

The Native Peak Load is the Summer Peak and the same as that available from ECAR. However, capacity is that from ECAR data as of December 31 of each year listed. Consequently, the reserve margins are distorted in relation to Native Peak Loads, since the staff did not always use capacity corresponding to these loads.

JAA/MMP
March 24, 1976

Table 8.17. NIPSCO Capacity, Demand, and Reserve

Year	Peak Capacity, MW	Peak Demand, MW		Reserve			
		NIPSCO Forecast	Staff Forecast	NIPSCO Forecast		Staff Forecast	
				MW	%	MW	%
[illegible]	[illegible]	[illegible]		[illegible]	[illegible]		
[illegible]	[illegible]	1534		262	17.2		
[illegible]	[illegible]	1653		336	20.4		
[illegible]	[illegible]	1727		293	16.2		
[illegible]	[illegible]	1872		672	35.9		
1975	[illegible]	1831		560	35.0		
	[illegible]	2120	1997	911	43.0	1034	52
	[illegible]	2250	2117	581	25.8	714	34
	[illegible]	2385	2243	445	18.7	588	21
	3386[a]	2525	2379	861	34.1	1007	42
19[illegible]	3714[b]	2629	2521	1054	38.6	1153	47
	3714[b]	2840	2672	874	30.8	1042	39
	3714[b]	3010	2833	704	23.4	881	31
	3714[b]+226[c]	3190	3003	524+226	16.4+7.1	711+226	24+7.5
	3714[b]+226[c]+226[d]	3380	3183	334+226+226	9.9+6.7+6.7	531+226+226	17+7+7
19[illegible]	3914+226[c]+226[d]	3580	3374	334+226+226	9.3+6.3+6.3	540+226+226	16+7+7

[a] Represents Bailly Plant. Completion date depends on pending litigation.

[b] At present NIPSCO plans to buy 200 MW of capacity during this year from I&M. NIPSCO could purchase up to 400 MW. This decision must be made four years in advan[illegible].

[c] NIPSCO expects to use 226 MW of the capacity of Marble Hill I.

[d] NIPSCO expects to use 226 MW of the capacity of Marble Hill II.

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FEDERAL POWER COMMISSION
WASHINGTON, D.C. 20426

AUG 27 1976

Mr. B. J. Youngblood
Chief, Environmental Projects Branch 2
Division of Site, Safety and
Environmental Analysis
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Youngblood:

This is in reply to your letter of March 5, 1976, requesting comment on the Nuclear Regulatory Commission's (NRC) Draft Environmental Impact Statement (DEIS) related to the proposed issuance of construction permits to the Public Service Company of Indiana, Inc. (PSI) for the construction of the Marble Hill Nuclear Generating Station, Unit Nos. 1 and 2 (Docket Nos. STN 50-546 and STN 50-547).

The Marble Hill units Nos. 1 and 2 are scheduled for commercial operation in January 1982 and January 1984, respectively. PSI has the responsibility for the construction of the two units and will retain 65 percent of station output. The Northern Indiana Public Service Company (NIPSCO) will have a 20 percent ownership in each of the two units with remaining station capability assigned to other electric systems in the area.

Comments presented herein by the Federal Power Commission's Bureau of Power staff (staff) are submitted in compliance with the National Environmental Policy Act of 1969 and the Council on Environmental Quality's, "Preparation of Environmental Impact Statements: Guidelines" dated August 1, 1973. Staff's interest is directed to the thoroughness of the DEIS in assessing the need for the capacity represented by the proposed units as well as related bulk power supply considerations.

In the preparation of these comments, staff has considered PSI and NIPSCO Annual Power System Statements (FPC Form No. 12), the East Central Area Reliability Coordination Agreement's (ECAR) Annual Report on Reliability and Adequacy of Electric Service, 1976-1985 (submitted pursuant to FPC Order No. 383-3, Docket R-362) as well as related information from other FPC reports. The staff bases its evaluation of the need for a specific bulk power facility upon anticipated system load and capacity conditions immediately following the availability of the new facility.

PSI and NIPSCO are members of ECAR, the area Reliability Council which coordinates the planning of bulk power generation and transmission facilities of systems located within the council boundaries (see attached map which delineates council boundaries). PSI is also a member of the Kentucky Indiana Power Pool (KIP), all members of which operate within the ECAR area and are themselves ECAR members. Based on data contained in the ECAR R-362 response, each of the members of KIP will share in the 65 percent PSI share of the Marble Hill station.

The attached tables show the projected capabilities, loads and reserve margins for PSI, NIPSCO, KIP and ECAR during the 1982, 1983, and 1984 summer peak periods and indicate the effects, on generating capacity reserves, of the Marble Hill units. The 1982 summer peak period is the currently scheduled initial service period of unit No. 1, with unit No. 2's in-service date scheduled prior to the 1984 summer peak demand period. The useful life of each unit is anticipated to be 30 years or more; therefore, each unit should offer significant contributions to the reliability of participating systems well beyond the initial service needs discussed in this report.

Reserve margins for PSI and NIPSCO appear more than adequate during the study period, but the significance of the units' capabilities must be considered from a regional viewpoint. The isolation of a system from its electrical environs, for analytical purposes, yields less than accurate results.

Reserve margins for ECAR and KIP are sensitive to the availabilities of the subject units. ECAR has not formulated installed reserve criteria for its member systems; however, the KIP Planning Committee has established a reserve level of 17 percent of peak load to be maintained by signatories to the KIP agreement. The FPC has found that many utilities plan for reserve margins of from 15 to 25 percent of peak load.

Slippage of the Marble Hill Unit No. 1 past the 1982 summer peak period would reduce reserves for the KIP and ECAR groups to 15.8 and 15.9 percent of peak demand, respectively. Although these amounts are below the KIP criterion and only slightly higher than the national planning trend, demands can be met with some degree of reliability provided loads do not exceed projections. Slippage of the No. 1 unit through the 1983 peak would place KIP and ECAR in a critical reserve condition. Likewise, failure to have the plant in operation prior to the 1984 summer peak would cause ECAR and KIP reserves to decline to a level unacceptable from a reliability viewpoint.

The adequacy and reliability of the PSI, NIPSCO, KIP and ECAR bulk power supply capabilities during the 1982-1984 peak periods are not only dependent upon the commercial operation of the Marble Hill station, but also upon the timely installation of several other major generating installations. Delays in the scheduled installation dates of any or all of these units have the potential for causing considerable degradation of electric service.

The staff of the Bureau of Power concludes that electric power equivalent to the output of th Marble Hill station is needed to meet the regional requirement for projected loads and to assure an adequate measure of reliability. The staff further concludes that the capability represented by the Marble Hill units is needed prior to the 1983 summer peak period. Assuming all other anticipated generating capacity will be installed in timely fashion, projected load requirements plus reasonable reserve margin could be maintained during the 1982 summer peak period without Marble Hill No. 1; any further delay in installation of either of the two units would reduce area reliability. The degree of reduction would be contingent upon, among other circumstances, the accuracy of load forecasts and the status of other generating facilities.

Very truly yours,

Alton P. Donnell
for W. Ridgway
Chief, Bureau of Power

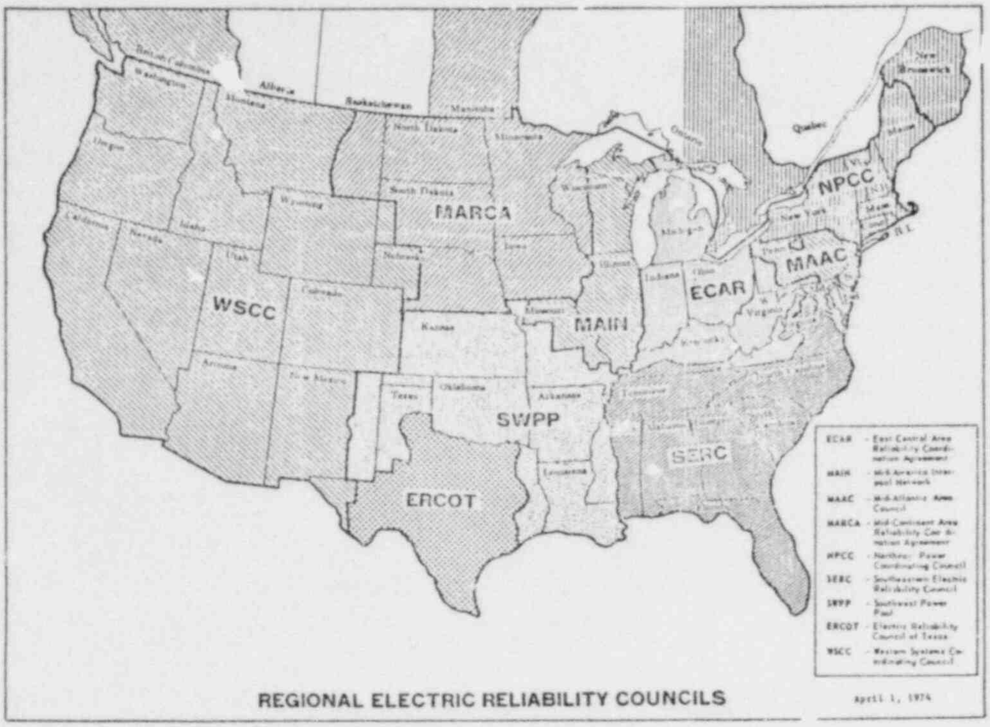
Attachments

Table I - 1982 Summer Peak Load and Supply Conditions

System With Marble Hill No. 1	Seasonal Capacity - MW -	Net of Firm Transfers - MW -	Available Capability - MW -	Anticipated Peak Load - MW -	Reserve - MW -	Reserve - MW -
PSI	6450	---	6450	4076	2374	58.2
NIPSCO	3740	200	3940	2672	1268	47.5
KIP	13626	404	14030	11485	2542	22.2
ECAR	101742	-1951	99791	85097	14694	17.3
System Without Marble Hill No. 1						
PSI	5715	---	5715	4076	1639	40.2
NIPSCO	3514	400 1/	3914	2262	1242	46.5
KIP	12891	404	13294	11485	1809	15.8
ECAR	100612	-1951	98661	85097	13564	15.9

Table II - 1983 Summer Peak Load and Supply Conditions

System With Marble Hill No. 1	Seasonal Capacity - MW -	Net of Firm Transfers - MW -	Available Capability - MW -	Anticipated Peak Load - MW -	Reserve - MW -	Reserve - MW -
PSI	6450	---	6450	4320	2130	49.3
NIPSCO	3740	200	3940	2833	1107	39.1
KIP	14126	391	14517	12385	2132	17.2
ECAR	105892	-2037	103855	90093	13762	15.3
System Without Marble Hill No. 1						
PSI	5715	----	5715	4320	1395	32.3
NIPSCO	3514	400	3914	2833	1081	38.2
KIP	13391	391	13782	12395	1397	11.3
ECAR	104762	-2037	102275	90093	12632	14.0



Attachment A

Table III - 1984 Summer Peak Load and Supply Conditions

System With Marble Hill Nos. 1 and 2	Seasonal Capacity - MW -	Net of Firm Transfers - MW -	Available Capability - MW -	Anticipated Peak Load - MW -	Reserve - MW -	Reserve - MW -
PSI	7235	---	7235	4854	2381	49.1
NIPSCO	4166	200	4366	3183	1183	37.2
KIP	15530	376	1590	13346	2558	19.2
ECAR	112509	-1825	11068	95340	15344	16.1
System Without Marble Hill No. 1						
PSI	6500	---	6500	4854	1646	33.9
NIPSCO	3940	400 1/	4340	3183	1157	36.5
KIP	14795	376	15171	13348	1447	10.8
ECAR	111379	-1825	109554	95340	14214	14.9
Systems Without Marble Hill Nos. 1 and 2						
PSI	5765	---	5765	4854	911	18.8
NIPSCO	3714	400 1/	4114	3183	931	29.2
KIP	14050	376	14436	13348	1088	8.2
ECAR	110249	-1825	108424	95340	13084	13.7

1/ Increase in purchased capability as per contractual arrangement.

APPENDIX B

TERRESTRIAL VERTEBRATES OF MARBLE HILL AND OF THE TRANSMISSION-LINE CORRIDORS, AND TERRESTRIAL INVERTEBRATES OF MARBLE HILL

Table B.1. Relative Abundance for Litter Invertebrates of the Floodplain Sampling Area at Marble Hill Site

Class	Order	Superfamily/Family	Number of Individuals	Relative Abundance[a], %
Nematoda[b]			2	0.50
Oligochaeta	Opisthopora	Lumbricidae	2	0.50
Oligochaeta	Plesiopora	Enchytraedae[c]	2	0.50
Arachnida	Pseudoscorpionida[b]		1	0.25
	Acari	Ceratozetoidea	44	10.89
		Parasitoidea	33	8.17
		Eremaeoidea	5	1.24
		Trombidioidea	2	0.50
		Oribatelloidea	2	0.50
		Uropodoidea	2	0.50
		Phthiracaroidea	1	0.25
		Hermanielloidea	1	0.25
		Raphignathoidea	1	0.25
		Microzetoidea	1	0.25
		Galumnoidea	1	0.25
	Acari	Miscellaneous[d]	136	33.66
	Araneae	Lycosidae[c]	1	0.25
Diplopoda			1	0.25
Symphyla[b]			13	3.22
Insecta	Collembola	Entomobryidae	68	16.83
		Sminthuridae	2	0.50
		Poduridae	1	0.25
	Coleoptera	Staphylinidae	9	2.23
		Carabidae	6	1.49
		Ptiliidae	3	0.74
		Lampyridae	2	0.50
		Cucujidae[c]	2	0.50
		Chrysomelidae	1	0.25
		Pselaphidae[c]	1	0.25
		Miscellaneous[e]	6	1.49
	Thysanoptera	Thripidae[c]	1	0.25
	Hemiptera	Miridae	1	0.25
	Homoptera	Coccidae	9	2.23
		Aphididae	3	0.74
		Cicadellidae	3	0.74
	Lepidoptera	Noctuidae[c]	1	0.25
	Diptera[b]		18	4.46
	Diptera	Chironomidae	6	1.49
		Stratiomyidae	1	0.25
	Hymenoptera	Formicidae	4	0.99
		Pteromalidae	2	0.50
	Diplura	Japygidae	3	0.74
Total			404	100.10

From ER, Table 2.7-144.

[a]Based on five Burlese funnel samples.

[b]Superfamily/Family name not identifiable due to lack of adequate keys or individuals being in too early a life stage.

[c]Uncertain identification due to damaged key characters.

[d]Miscellaneous group consists of the following superfamilies: Oribatelloidea, Microzetoidea, Ceratozetoidea, Galumnoidea, Hermanielloidea, Parasitoidea, Raphignathoidea, Carabodoidea, and Eremaeoidea.

[e]Miscellaneous group consists of the following families: Staphylinidae and Carabidae.

Table B-2. Relative Abundance for Litter Invertebrates of the Ecotone Sampling Area at Marble Hill Site

Class	Order	Superfamily/Family	Number of Individuals	Relative Abundance[a], %
Nematoda[b]			2	0.67
Arachnida	Acari	Ceratozetoidea	59	19.80
		Parasitoidea	33	11.07
		Galumnoidea	22	7.38
		Trombidioidea	4	1.34
		Eupodoidea	2	0.67
		Phthiracaroidea	2	0.67
		Bdelloidea	1	0.33
		Damaeoidea	1	0.33
		Raphignathoidea	1	0.33
	Aranea	Salticidae	8	2.68
		Linyphiidae	7	2.34
		Thomisidae	1	0.33
	Pseudoscorpionida[b]		3	1.00
Symphyla[b]			7	2.34
Chilopoda	Lithobiomorpha[b]		1	0.33
Eucrustacca	Isopoda	(*Cyclistus* sp.)[c]	2	0.67
Insecta	Protura[c]	Acerentomidae[c]	2	0.67
	Collembola	Entomobryidae	76	25.50
	Coleoptera	Staphylinidae	10	3.34
		Carabidae	6	2.01
		Pselaphidae	3	1.00
		Lampyridae[c]	1	0.33
	Thysanoptera	Phloeothripidae	5	1.67
	Hemiptera	Lygaeidae[c]	1	0.33
	Homoptera	Coccidae	7	2.34
		Cicadellidae	5	1.67
		Aphididae	4	1.34
		Cerocopidae[c]	1	0.33
	Lepidoptera[b]		1	0.33
	Orthoptera	Gryllidae	1	0.33
	Diptera[b]		1	0.33
	Hymenoptera	Formicidae	17	5.70
		Pteromalidae	1	0.33
Total			298	100.17

From ER, Table 2.7-145.

[a]Based on four Burlese funnel samples.

[b]Superfamily/Family name not identifiable due to lack of adequate keys or individuals being in too early a life stage.

[c]Uncertain identification due to damaged key characters or early life stage.

Table B.3. Relative Abundance for Litter Invertebrates of the Upland-Woods Sampling Area at Marble Hill Site

Class	Order	Superfamily/Family	Number of Individuals	Relative Abundance[a], %
Arachnida	Acari	Ceratozetoidea	13	18.57
		Galumnoidea	7	10.00
		Nothroidea	1	1.43
		Phthiracaroidea	1	1.43
		Oribatelloidea	1	1.43
Diplopoda[b]			1	1.43
Diplopoda	Julida	Julidae	2	2.86
Insecta	Collembola	Entomobryidae	32	45.71
	Coleoptera	Carabidae	1	1.43
		Staphylinidae	1	1.43
	Thysanoptera	Phloeothripidae	3	4.29
	Diptera	Cecidomyiidae	1	1.43
		Psychodidae	1	1.43
		Scatopsidae[c]	1	1.43
	Hymenoptera	Formicidae	3	4.29
	Diplura	Japygidae	1	1.43
Total			70	100.02

From ER, Table 2.7-146.

[a]Based on four Burlese funnel samples.

[b]Superfamily/Family name not identifiable due to lack of adequate keys or individuals being in too early a life stage.

[c]Uncertain identification due to damaged key characters.

Table B.4. Relative Abundance for Litter Invertebrates of the Upland-Grassland Sampling Area at Marble Hill Site

Class	Order	Superfamily/Family	Number of Individuals	Relative Abundance[a], %
Nematoda[b]			1	0.12
Oligochaeta	Opisthopora	Lumbricidae	3	0.36
Oligochaeta	Plesiopora	Enchytraeidae[c]	6	0.73
Arachnida	Acari	Ceratozetoidea	286	34.79
		Galumnoidea	95	11.56
		Raphignathoidea[c]	49	5.96
		Parasitoidea	14	1.70
		Bdelloidea	6	0.73
		Eremaeoidea	3	0.36
		Hermanielloidea[c]	3	0.36
		Eupodoidea	1	0.12
		Miscellaneous[d]	27	3.28
	Araneae	Salticidae	2	0.24
Insecta	Collembola	Entomobryidae	260	31.63
	Coleoptera	Carabidae	10	1.22
		Lampyridae	2	0.24
		Staphylinidae	1	0.12
		Chrysomelidae	1	0.12
		Pselaphidae	1	0.12
	Thysanoptera	Thripidae	1	0.12
		Phloeothripidae	1	0.12
	Hemiptera	Miridae[c]	3	0.36
	Homoptera	Coccidae	7	0.85
		Aphididae	7	0.85
		Cicadellidae	2	0.24
		Phylloxeridae[c]	1	0.12
	Diptera[b]		7	0.85
	Hymenoptera	Formicidae	18	2.19
	Diplura	Japygidae	4	0.49
Total			822	99.95

From ER, Table 2.7-147.

[a]Based on five Burlese funnel samples.

[b]Superfamily/Family name not identifiable due to lack of adequate keys or individuals being in too early a life stage for family identification.

[c]Uncertain identification due to damaged key characters or early life stage.

[d]Miscellaneous Acari grouping consists of individuals of the following superfamilies: Parasitoidea, Bdelloidea, Eremaeoidea, and Galumnoidea.

Table B-5. Relative Abundance of Foliage Invertebrates of the East-Facing Slope Sampling Area at Marble Hill Site

Class	Order	Family	Number of Individuals	Relative Abundance[a], %
Gastropoda	Stylommatophora	*Paravitrea*[b]	10	8.62
		Triodopsis[b]	1	0.86
		Zonitidae	2	1.72
Arachnida	Araneae	Thomisidae	9	7.76
		Salticidae	1	0.86
	Acari	·rombidiidae	1	0.86
Insecta	Coleoptera	Curculionidae	42	36.21
		Chrysomelidae	7	6.03
		Ptilodactylidae	2	1.72
		Mordellidae	1	0.86
		Elateridae	1	0.86
		Pselaphidae	1	0.86
	Hemiptera	Nabidae	2	1.72
		Tingidae	1	0.86
		Miridae	1	0.86
		Cydnidae	1	0.86
	Homoptera	Aphididae	1	0.86
	Hymenoptera	Formicidae	27	23.28
		Ichneumonidae	3	2.59
		Chalicidoidae	1	0.86
		Pteromalidae	1	0.86
Total			116	99.97

From ER, Table 2.7-148.

[a]Based on two 300-ft sweep net transects (one in June, one in September).

[b]Genus; family not included in key used.

Table B.6. Relative Abundance of Foliage Invertebrates of the Floodplain Sampling Area at Marble Hill Site

Class	Order	Family	Number of Individuals	Relative Abundance[a], %
Arachnida	Araneae	Salticidae	4	1.93
		Thomisidae	4	1.93
	Acari	Oribatelloidae	1	0.48
Insecta	Coleoptera	Cantharidae	39	18.84
		Curculionidae	17	8.21
		Chrysomelidae	4	1.93
		Phalacridae	2	0.97
		Coccinellidae	2	0.97
		Pselaphidae	1	0.48
		Rhipiphoridae	1	0.48
	Hemiptera	Cydnidae	25	12.08
		Miridae	17	8.21
		Pentatomidae	5	2.42
		Coreidae	2	0.97
	Homoptera	Cercopidae	6	2.90
		Aphididae	5	2.42
		Cicadellidae	5	2.42
		Membracidae	2	0.97
	Diptera	Tephritidae	6	2.90
		Chloropidae	1	0.48
	Orthoptera	Acrididae	3	1.45
		Gryllidae	1	0.48
	Hymenoptera	Apidae	47	22.70
		Braconidae	5	2.42
		Collectidae	1	0.48
		Formicidae	1	0.48
Total			207	100.00

From ER, Table 2.7-149.

[a]Based on two 300-ft sweep net transects (one in June, one in September).

Table B.7. Relative Abundance of Foliage Invertebrates of the Ecotone Sampling Area at Marble Hill Site

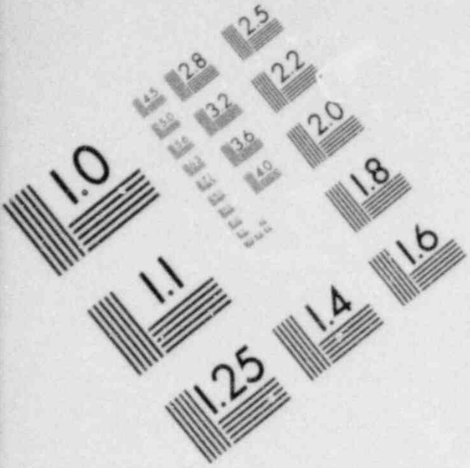
Class	Order	Family	Number of Individuals	Relative Abundance[a], %
Arachnida	Araneae	Salticidae	16	14.68
		Clubionidae	2	1.83
		Thomisidae	2	1.83
	Phalangida	---b	1	0.92
Insecta	Orthoptera	Tettigoniidae	1	0.92
	Coleoptera	Curculionidae	9	8.26
		Chrysomelidae	8	7.34
		Coccinellidae	8	7.34
		Cantharidae	7	6.42
		Lampyridae	3	2.75
		Phalacridae[c]	1	0.92
	Hemiptera	Miridae	4	3.67
		Cydnidae	3	2.75
		Pentatomidae	2	1.83
		Coreidae	1	0.92
	Homoptera	Cicadellidae	14	12.84
		Cercopidae	7	6.42
		Aphididae	1	0.92
	Diptera	Rhagionidae	1	0.92
		Muscidae	1	0.92
	Hymenoptera	Formicidae	7	6.42
		Vespidae	3	2.75
		Apidae	3	2.75
		Braconidae	2	1.83
		Sphecidae	1	0.92
		Proctotrupidae	1	0.92
Total			109	99.99

From ER, Table 2.7-150.

[a]Based on two 300-ft sweep net transects (one in June, one in September).

[b]Unable to be identified to family due to damaged key characters.

[c]Uncertain identification due to damaged key characters.



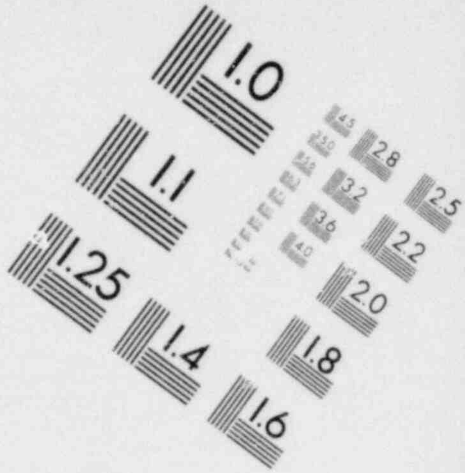
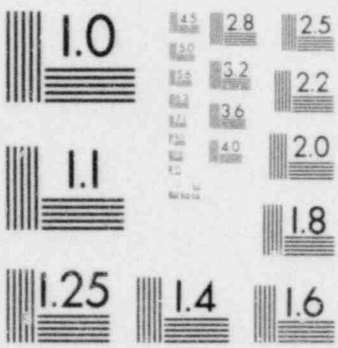


IMAGE EVALUATION TEST TARGET (MT-3)



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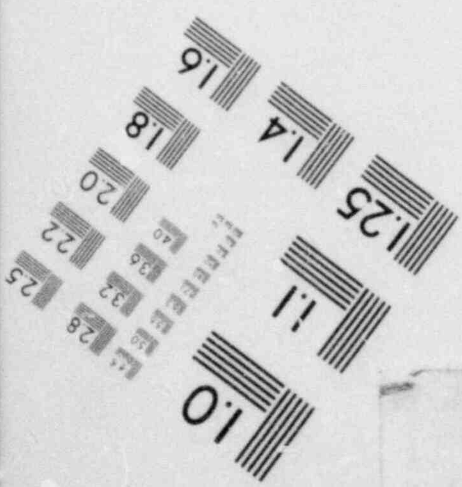
MICROCOPY RESOLUTION TEST CHART



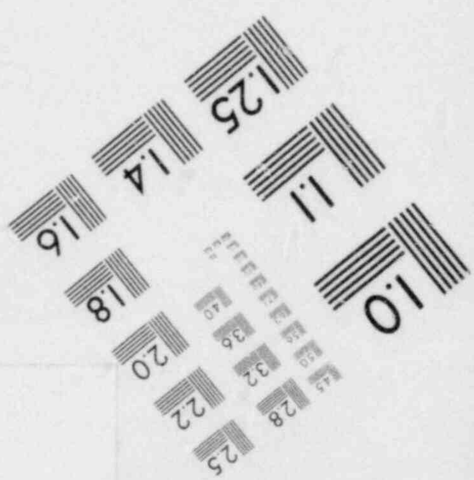
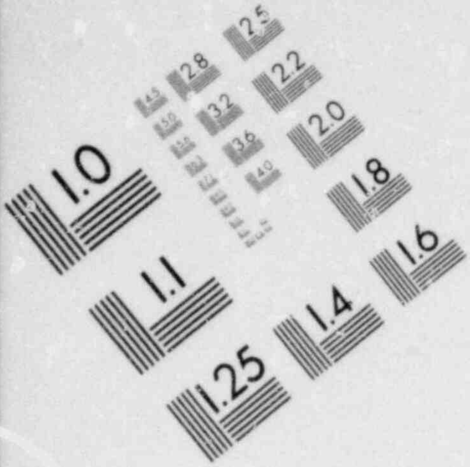
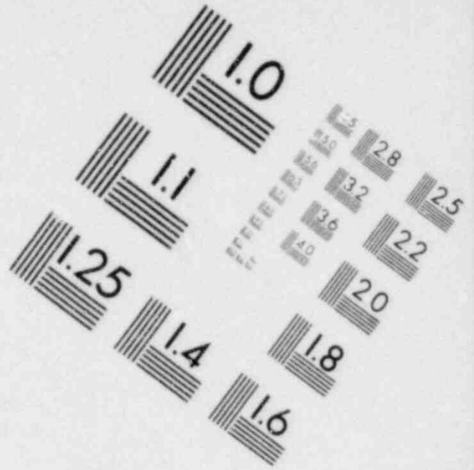
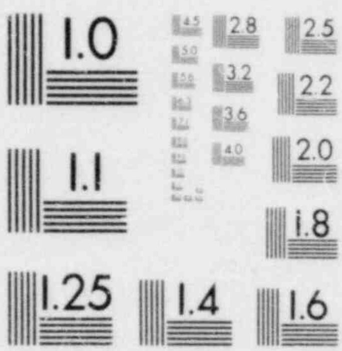


IMAGE EVALUATION TEST TARGET (MT-3)



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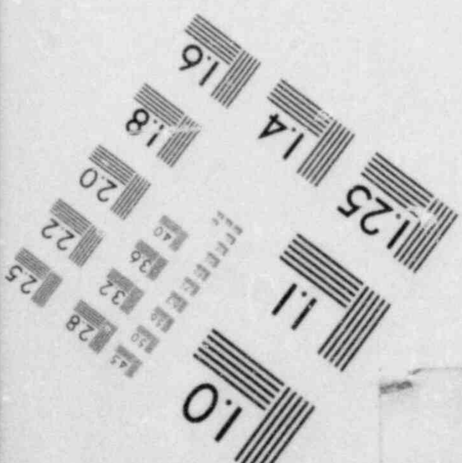
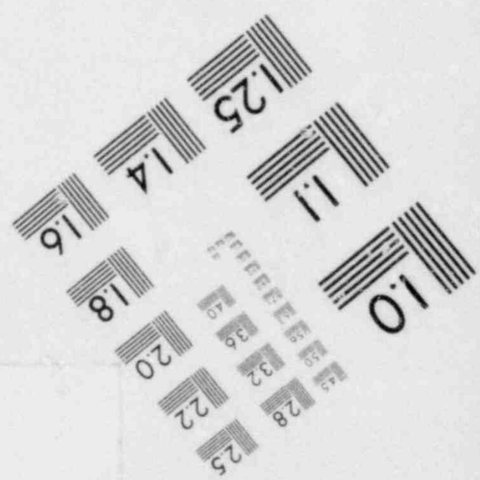

Table B.8. Relative Abundance of Foliage Invertebrates of the Upland-Woods Sampling Area at Marble Hill Site

Class	Order	Family	Number of Individuals	Relative Abundance[a], %
Arachnida	Araneae	Thomisidae	3	3.45
		Salticidae	3	3.45
		Lycosidae	1	1.15
		Clubionidae	1	1.15
		Araneidae[b]	1	1.15
		Agelenidae[c]	1	1.15
Insecta	Orthoptera	Acrididae	1	1.15
	Coleoptera	Chrysomelidae	7	8.05
		Curculionidae	3	3.45
		Anthicidae	2	2.30
		Staphylinidae	1	1.15
		Elateridae	1	1.15
	Hemiptera	Miridae	5	5.75
		Nabidae	2	2.30
		Cydnidae	2	2.30
		Berytidae	2	2.30
	Homoptera	Cercopidae	19	21.84
		Cicadellidae	11	12.64
		Membracidae	2	2.30
	Lepidoptera	Noctuidae[b]	1	1.15
		Geometridae	1	1.15
	Diptera	Muscidae[b]	2	2.30
		Chironomidae	1	1.15
		Syrphidae	1	1.15
		Mycetophilidae	1	1.15
	Hymenoptera	Formicidae	6	6.90
		Pteromalidae	2	2.30
		Proctotrupidae	1	1.15
		Ichneumonidae	1	1.15
		Eurytomidae	1	1.15
		Chalcidoidea	1	1.15
Total			87	100.03

From ER, Table 2.7-151.

[a]Based on two 300-ft sweep net transects (one in June, one in September).

[b]Uncertain identification due to damaged key characters.

[c]Difficult-to-identify spiderling.

Table B.9. Relative Abundance of Foliage Invertebrates of the Upland-Grassland Sampling Area at Marble Hill Site

Class	Order	Family	Number of Individuals	Relative Abundance[a], %
Arachnida	Araneae	Thomisidae	6	6.82
		Araneidae	4	4.55
		Salticidae	3	3.41
Insecta	Orthoptera	Tettigoniidae	10	11.36
		Gryllidae	4	4.55
		Acrididae	2	2.27
	Coleoptera	Chrysomelidae	7	7.95
		Cantharidae	1	1.14
		Elateridae	1	1.14
	Hemiptera	Miridae	7	7.95
		Lygaeidae	6	6.82
		Pentatomidae	3	3.41
		Nabidae	2	2.27
		Reduviidae	1	1.14
		Cydnidae	1	1.14
	Homoptera	Cercopidae	17	19.32
		Cicadellidae	5	5.68
		Aphididae	1	1.14
	Lepidoptera	Noctuidae	1	1.14
	Diptera	Syrphidae	2	2.27
		Chloropidae	1	1.14
		Muscidae	1	1.14
	Hymenoptera	Sphecidae	1	1.14
		Braconidae	1	1.14
Total			88	100.03

From ER, Table 2.7-152.

[a]Based on two 300-ft sweep net transects (one in June, one in September).

Table B.10. Amphibians Known or Thought to Occur in the Area of Marble Hill or the Transmission Lines

Species	
Scientific Name	Common Name
Ambystoma platineum	Silvery salamander
Ambystoma maculatum	Spotted salamander
Ambystomia tigrinum tigrinum	Eastern tiger salamander
Ambystoma opacum	Marbled salamander
Ambystoma texanum	Small-mouth salamander
Notophthalmus viridescens viridescens	Red-spotted newt
Notophthalmus viridescens louisianensis	Central newt
Desmognatus fuscus fuscus	Northern dusky salamander
Plethodon glutinosus glutinosis	Slimy salamander
Cryptobranchus alleganienesis alleganienesis	The hellbender
Necturus maculosus maculosus	The mudpuppy
Ambystomia jeffersonianum	Jefferson salamander
Plethodon cinereus cinereus	Redbacked salamander
Plethodon dorsalis dorsalis	Zigzag salamander
Plethodon richmondi richmondi	Ravine salamander
Eurycea bislineata rivicola	Two-lined salamander
Eurycea longicauda longicauda	Long-tailed salamander
Eurycea lucifuga	Cave salamander
Scaphiopus holbrookii holbrookii	Eastern spadefoot
Bufo americanus	American toad
Bufo woodhausei fowleri	Fowler's toad
Acris crepitans blanchardi	Cricket frog
Pseudacris triseriata triseriata	Western chorus frog
Hyla crucifer crucifer	Spring peeper
Hyla versicolor versicolor	Eastern gray treefrog
Rana clamitans melanota	Green frog
Rana catesbeiana	Bullfrog
Rana pipiens pipiens	Northern leopard frog
Rana pipiens sphenocephala	Southern leopard frog
Rana palustris	Pickeral frog
Rana sylvatica sylvatica	Wood frog

From S. A. Minton, Jr., "Amphibians and Reptiles of Indiana," The Indiana Academy of Science, Monograph No. 3, Indianapolis, Indiana, 1972.

Table B.11. Reptiles Known or Thought to Occur in the Area of Marble Hill or the Transmission Lines

Species	
Scientific Name	Common Name
Chelydra serpentina serpentina	Common snapping turtle
Stenotherus odoratus	Musk turtle
Terrapene ornata ornata[a,b]	Ornate box turtle
Terrapene carolina carolina	Eastern box turtle
Graptemys geographica	Map turtle
Chrysemys picta marginata	Midland painted turtle
Pseudemys scripta elegans	Red-eared turtle
Trionyx spinifer spinifer	Eastern spiny softshell
Trionyx muticus muticus	Midland smooth softshell
Sceloporus undulatus hyacinthinus	Northern fence lizard
Eumeces fasciatus	Five-lined skink
Eumeces laticeps	Broad-headed skink
Natrix sipedon pleuralis	Midland banded watersnake
Natrix erythrogaster neglecta[b]	Northern copperbelly
Regina septemvittata	Queen snake
Clonophis kirtlandii	Kirtland's snake
Storeria dekayi wrightorum	Midland brown snake
Storeria occipitomaculata occipitomaculata	Northern redbellied snake
Virginia valeriae elegans	Western earth snake
Thamnophis sirtalis sirtalis	Eastern garter snake
Thamnophis sirtalis semifaciata	Chicago garter snake
Thamnophis sauritus sauritus	Eastern ribbon snake
Coluber constrictor priapus	Southern black racer
Coluber constrictor flaviventris	Blue racer
Elaphe obsoleta obsoleta	Black rat snake
Lampropeltis getulus niger[b]	Black kingsnake
Lampropeltus triangulum triangulum	Eastern milk snake
Lampropeltus tringulum syspila	Red milk snake
Opheodrys aestivus	Rough green snake
Diadophis punctatus edwardsi	Northern ringneck snake
Carphophis amoenus helenae	Midwest worm snake
Heterodon platyrhinos	Eastern hognose snake
Agkistrodon contortrix mokeson	Northern copperhead
Crotalus horridus horridus	Timber rattlesnake

From S. A. Minton, Jr., "Amphibians and Reptiles of Indiana," The Indiana Academy of Science, Monograph No. 3, Indianapolis, Indiana, 1972.

[a]This species was found in the applicant's survey of Marble Hill, but the species is not normally found there, as the applicant has pointed out (ER, Table 2.7-140).

[b]In the area of the transmission lines only.

Table B.12. Birds of Southeastern Indiana

Species	Breeding Birds	Permanent Residents	Winter Residents	Transients
Common loon			X	X
Red-throated loon				X
Red-necked grebe				X
Horned grebe				X
Pied-billed grebe	X	X	X	X
Double-crested cormorant				X
Great blue heron	X	X	X	X
Green heron	X			X
Common egret				X
Black-crowned night heron	X			X
Yellow-crowned night heron	X			X
Least bittern	X			X
American bittern	X			X
Canada goose			X	X
Snow goose				X
Mallard	X	X	X	X
Black duck				X
Gadwall			X	X
Pintail			X	X
Green-winged teal			X	X
Blue-winged teal	X			X
American widgeon			X	X
Northern shoveler				X
Wood duck	X	X	X	X
Redhead			X	X
Ring-necked duck			X	X
Canvasback			X	X
Greater scaup			X	X
Lesser scaup			X	X
Common goldeneye			X	X
Bufflehead				X
Oldsquaw				X
Ruddy duck			X	X
Hooded merganser	X	X	X	X
Common merganser			X	X
Red-breasted merganser			X	X
Turkey vulture	X	X	X	X
Black vulture	X	X	X	X
Sharp-shinned	X	X	X	X
Cooper's hawk	X	X	X	X
Red-tailed hawk	X	X	X	X
Red-shouldered hawk	X	X	X	X
Broad-winged hawk	X			X
Rough-legged hawk			X	X
Golden eagle				X
Bald eagle				X
Marsh hawk	X	X	X	X
Osprey				X
Peregrine falcon				X
Merlin				X
American kestrel	X	X	X	X
Bobwhite quail	X	X	X	
Ring-necked pheasant	X	X	X	
Sandhill crane				X
King rail	X			X

Table B.12. Continued

Species	Breeding Birds	Permanent Residents	Winter Residents	Transients
Virginia rail	X			X
Sora	X			X
Yellow rail				X
Black rail				X
Common gallinule	X			X
American coot	X	X	X	X
Semipalmated plover				X
Piping plover				X
Killdeer	X	X	X	X
Black-bellied plover				X
Ruddy turnstone				X
American woodcock	X			X
Common snipe			X	X
Upland plover	X			X
Spotted sandpiper	X			X
Solitary sandpiper				X
Greater yellowlegs				X
Lesser yellowlegs				X
Pectoral sandpiper				X
White-rumped sandpiper				X
Baird's sandpiper				X
Least sandpiper				X
Dunlin				X
Short-billed dowitcher				X
Long-billed dowitcher				X
Stilt sandpiper				X
Semipalmated sandpiper				X
Western sandpiper				X
Sanderling				X
Herring gull			X	X
Ring-billed gull			X	X
Bonaparte's gull				X
Common tern				X
Least tern				X
Caspian tern				X
Black tern				X
Rock dove	X	X	X	
Mourning dove	X	X	X	X
Yellow-billed cuckoo	X			X
Black-billed cuckoo	X			X
Barn owl	X	X	X	X
Screech owl	X	X	X	
Great horned owl	X	X	X	
Barred owl	X	X	X	
Long-eared owl	X	X	X	X
Short-eared owl			X	X
Saw-whet owl			X	X
Chuck-will's widow	X			X
Whip-poor-will	X			X
Common nighthawk	X			X
Chimney swift	X			X
Ruby-throated hummingbird	X			X
Belted kingfisher	X	X	X	
Common flicker	X	X	X	
Pileated woodpecker	X	X	X	

Table B.12. Continued

Species	Breeding Birds	Permanent Residents	Winter Residents	Transients
Red-bellied woodpecker	X	X	X	
Red-headed woodpecker	X	X	X	
Yellow-bellied sapsucker			X	X
Hairy woodpecker	X	X	X	
Downy woodpecker	X	X	X	
Eastern kingbird	X			X
Great crested flycatcher	X			X
Eastern phoebe	X			X
Yellow-bellied flycatcher				X
Acadian flycatcher	X			X
Willow flycatcher (Traill's)	X			X
Least flycatcher	X			X
Eastern wood pewee	X			
Olive-sided flycatcher				X
Horned lark	X	X	X	
Tree swallow				X
Bank swallow	X			X
Rough-winged swallow	X			X
Barn swallow	X			X
Cliff swallow	X			X
Purple martin	X			X
Blue jay	X	X	X	
Common crow	X	X	X	
Black-capped chickadee			X	
Carolina chickadee	X	X	X	
Tufted titmouse	X	X	X	
White-breasted nuthatch	X	X	X	
Red-breasted nuthatch			X	X
Brown creeper			X	X
House wren	X			X
Winter wren			X	X
Bewick's wren	X	X	X	X
Carolina wren	X	X	X	
Long-billed marsh wren	X			X
Short-billed marsh wren	X			X
Mockingbird	X	X	X	
Gray catbird	X			X
Brown thrasher	X			X
American robin	X	X	X	X
Wood thrush	X			X
Hermit thrush			X	X
Swainson's thrush				X
Gray-checked thrush				X
Veery				X
Eastern bluebird	X	X	X	
Blue-gray gnatcatcher	X			X
Golden-crowned kinglet			X	X
Ruby-crowned kinglet			X	X
Water pipit			X	X
Cedar waxwing	X	X	X	
Loggerhead shrike	X	X	X	
Starling	X	X	X	
White-eyed vireo	X			X
Yellow-throated vireo	X			X
Solitary vireo				X

Table B.12. Continued

Species	Breeding Birds	Permanent Residents	Winter Residents	Transients
Red-eyed vireo	X			X
Philadelphia vireo				X
Warbling vireo	X			X
Black-and-white warbler	X			X
Prothonotary warbler	X			X
Worm-eating warbler	X			X
Golden-winged warbler				X
Blue-winged warbler	X			X
Tennessee warbler				X
Orange-crowned warbler				X
Nashville warbler				X
Parula warbler	X			X
Yellow warbler	X			X
Magnolia warbler				X
Cape May warbler				X
Black-throated blue warbler				X
Yellow-rumped warbler (Myrtle)			X	X
Black-throated green warbler				X
Cerulean warbler	X			X
Yellow-throated warbler	X			X
Blackburnian warbler				X
Chestnut-sided warbler				X
Bay-breasted warbler				X
Blackpoll warbler				X
Pine warbler	X			X
Prairie warbler	X			X
Palm warbler				X
Ovenbird	X			X
Northern waterthrush				X
Louisiana waterthrush	X			X
Kentucky warbler	X			X
Connecticut warbler				X
Mourning warbler				X
Common yellowthroat	X			X
Yellow-breasted chat	X			X
Hooded warbler	X			X
Wilson's warbler				X
Canada warbler				X
American redstart	X			X
House sparrow	X	X	X	
Bobolink	X			X
Eastern meadowlark	X	X	X	
Red-winged blackbird	X	X	X	X
Orchard oriole	X			X
Northern oriole	X			X
Rusty blackbird			X	X
Common grackle	X	X	X	X
Brown-headed cowbird	X	X	X	X
Scarlet tanager	X			X
Summer tanager	X			X
Cardinal	X	X	X	
Rose-breasted grosbeak	X			X
Indigo bunting	X			X
Dickcissel	X			X
Evening grosbeak			X	X

Table B.12. Continued

Species	Breeding Birds	Permanent Residents	Winter Residents	Transients
Purple finch			X	X
Pine siskin			X	X
American goldfinch	X	X	X	
Rufous-sided towhee	X	X	X	
Savannah sparrow	X		X	X
Grasshopper sparrow	X			X
LeConte's sparrow			X	X
Henslow's sparrow	X			X
Sharp-tailed sparrow				X
Vesper sparrow	X			X
Lark sparrow	X			X
Bachman's sparrow	X			X
Dark-eyed junco			X	X
Tree sparrow			X	X
Chipping sparrow	X			
Field sparrow	X	X	X	X
White-crowned sparrow			X	X
White-throated sparrow			X	X
Fox sparrow			X	X
Lincoln's sparrow			X	X
Swamp sparrow	X	X	X	X
Song sparrow	X	X	X	X
Lapland longspur			X	X

Table B.13. Mammals Known or Thought to Occur in the Area of Marble Hill or the Transmission Lines

Species	
Scientific Name	Common Name
Didelphis marsupialis	Common opossum
Sorex cinereus	Masked shrew
Sorex longirostris	Southeastern shrew
Blarina brevicauda	Short-tailed shrew
Cryptolis parva	Least shrew
Scalopus aquaticus	Eastern mole
Myotis lucifugus	Little brown myotis
Myotis keenii	Keen's myotis
Myotis sodalis	Indiana myotis
Lasionycteris noctivagans	Silver-haired bat
Pipistrellus subflavus	Eastern pipistrelle
Eptesicus fuscus	Big brown bat
Nycticeius humeralis	Evening bat
Lasiurus borealis	Red bat
Lasiurus cinereus[a]	Hoary bat
Plecotus rafinesquii	Rafinesque's big-eared bat
Sylvilagus floridanus	Eastern cottontail rabbit
Sciurus carolinensis	Gray squirrel
Sciurus niger	Fox squirrel
Marmota monax	Woodchuck
Spermophilus tridecemlineatus[b]	Thirteen-lined ground squirrel
Tamias striatus	Eastern chipmunk
Glaucomys volans	Southern flying squirrel
Castor canadensis[a]	Beaver
Peromyscus maniculatus	Deer mouse
Peromyscus leucopus	White-footed mouse
Synaptomys cooperi	Lemming mouse
Ondatra zibethicus	Muskrat
Microtus pinetorum	Pine vole
Microtus pennsylvanicus	Meadow vole
Microtus ochrogaster	Prairie vole
Rattus rattus[a]	Black rat
Rattus norvegicus	Norway rat
Mus musculus	House mouse
Zapus hudsonius	Meadow jumping mouse
Canis latrans[a]	Coyote
Vulpes fulva	Red fox
Urocyon cinereoargenteus	Gray fox
Procyon lotor	Raccoon
Mustela frenata	Long-tailed weasel
Mustela vison	Mink
Taxidea taxus[a]	Badger
Mephitus mephitus	Striped skunk
Lynx rufus	Bobcat
Odocoilus virginianus	White-tailed deer

From R. E. Mumford, "Distribution of the Mammals of Indiana," The Indiana Academy of Science, Monograph No. 1, Indianapolis, Indiana, 1969.

[a]Occurrence questionable.

[b]In the area of the transmission lines only.

APPENDIX C

FISH SPECIES THAT MAY OCCUR IN THE OHIO RIVER AND IN STREAMS CROSSED BY THE TRANSMISSION LINES

Table C.1. A Composite List of Fish Species that May Occur in the McAlpine Pool of the Ohio River and in the Indiana Streams Crossed by the Transmission Lines

Species		Status	Present in Ohio River[a]	Present in Counties[b]
Petromyzontidae				
Ohio lamprey	*Ichthyomyzon bdellium*		X	All
Chestnut lamprey	*I. castaneus*			B,JA,R
Silver lamprey	*I. unicuspis*			All
Least brook lamprey	*Lampetra aepytera*			All
American brook lamprey	*L. lamottei*			All
Acipenseridae				
Lake sturgeon	*Acipenser fulvescens*	NT[c]		All
Shovelnose sturgeon	*Scaphirhynchus platorynchus*	KE[d]		All
Polydontidae				
Paddlefish	*Polydon spathula*		X	All
Lepisosteidae				
Spotted gar	*Lepisosteus oculatus*		X	None
Longnose gar[e]	*L. osseus*		X	All
Shortnose gar	*L. platostomus*		X	All
Alligator gar	*L. spatula*		X	J,JA,JN,RY,S
Amiidae				
Bowfin	*Amia calva*			All
Anguillidae				
American eel[e]	*Anguilla rostrata*		X	All
Clupeidae				
Alabama shad	*Alosa alabamae*			J,JA,JN,RY,S
Skipjack herring[e]	*A. chrysocholoris*		X	J,JA,JN,RY,S
Gizzard shad[e]	*Dorosoma cepedianum*		X	All
Threadfin shad	*D. pretense*		X	JN,S
Hiodontidae				
Goldeye[e]	*Hiodon alosoides*		X	All
Mooneye[e]	*H. tergisus*		X	All
Umbridae				
Central mudminnow	*Umbra limi*			JN
Esocidae				
Redfin pickerel	*Esox americanus americanus*			All
Grass pickerel	*E. a. vermiculatus*			All
Muskellunge	*E. masquinongy*	KE,IE[d]		All
Cyprinidae				
Stoneroller[e]	*Campostoma anomalum*		X	All
Goldfish[e]	*Carassius auratus*		X	None
Carp[e]	*Cyprinus carpio*		X	All
Ozark minnow	*Dionda nubila*			None
Silverjaw minnow[e]	*Ericymba buccata*		X	All
Cypress minnow	*Hybognathus hayi*		X	None
Silvery minnow	*H. nuchalis*		X	All
Speckled chub	*Hybopsis aestivalis*			J,JA,JN,S
Bigeye chub	*H. amblops*			All
Streamline chub	*H. dissimilis*			All

SEE KEY AND FOOTNOTES AT END OF TABLE.

Table C.1. Continued

Species		Status	Present in Ohio River[a]	Present in Counties[b]
Cyprinidae (cont.)				
Silver chub[e]	*H. storeriana*		X	All
Gravel chub	*H. x-punctata*			All
Hornyhead chub	*Nocomis biguttatus*	KRE[f]		All
River chub	*N. micropogon*			All
Golden shiner[e]	*Notemigonus crysoleucas*		X	All
Pallid shiner	*Notropis amnis*			B,D,J,JA,JN,RY,S
Rosefin shiner	*N. ardens*			J,JN,RY,S
Emerald shiner[e]	*N. atherinoides*		X	All
River shiner	*N. blennius*		X	J,JA,JN,RY,S
Bigeye shiner	*N. boops*			All
Ghost shiner[e]	*N. buchanani*		X	All
Striped shiner[e]	*N. chrysocephalus*		X	All
Common shiner	*N. cornutus*		X	J,JA,JN,R,S
Pugnose minnow	*N. emiliae*			All
Blacknose shiner	*N. heterolepis*			R
Silver shiner	*N. photogenis*		X	All
Rosyface shiner	*N. rubellus*			All
Silverband shiner	*N. shumardi*			J,JN,RY,S
Spotfin shiner[e]	*N. spilopterus*		X	B,D,J,JA,R,RY,S
Sand shiner[e]	*N. stramineus*		X	B,D,J,JA,R,RY,S
Redfin shiner	*N. umbratilis*			B,D,JA,R,S
Mimic shiner	*N. volucellus*		X	All
Steelcolor shiner	*N. whipplei*			B,J,JA,RY,S
Suckermouth minnow	*Phenacobius mirabilis*			All
Southern redbelly dace	*Phoxinus erythrogaster*			All
Bluntnose minnow[e]	*Pimephales notatus*		X	All
Fathead minnow	*P. promelas*			D,J,JA,JN,R,RY,S
Bullhead minnow	*P. vigilax*		X	None
Blacknose dace[e]	*Rhinichthys atratulus*		X	All
Longnose dace[e]	*R. cataractae*		X	JN
Creek chub[e]	*Semotilus atromaculatus*			All
Catostomidae				
River carpsucker[e]	*Carpiodes carpio*		X	All
Quillback[e]	*C. cyprinus*		X	All
Highfin carpsucker	*C. velifer*			All
White sucker	*Catostomus commersoni*		X	All
Blue sucker	*Cycleptus elongatus*	IR[d]	X	J,JA,JN,RY,S
Creek chubsucker	*Erimyzon oblongus*			All
Lake chubsucker	*E. sucetta*			All
Northern hogsucker	*Hypentelium nigricans*			All
Smallmouth buffalo[e]	*Ictiobus bubalus*		X	All
Bigmouth buffalo[e]	*I. cyprinellus*		X	All
Black buffalo	*I. niger*			All
Spotted sucker[e]	*Minytrema melanops*		X	All
Silver redhorse	*Moxostoma anisurum*			All
River redhorse	*M. carinatum*			All
Black redhorse	*M. duquesnei*			B,D,J,JA,JN,RY,S
Golden redhorse[e]	*M. erythrurum*		X	All
Shorthead redhorse	*M. macrolepidotum*			B,D,J,JA,R,RY
Ictaluridae				
White catfish	*Ictalurus catus*		X	None
Blue catfish	*I. furcatus*		X	J,JA,RY,S
Black bullhead[e]	*I. melas*		X	All
Yellow bullhead[e]	*I. natalis*		X	All
Brown bullhead	*I. nebulosus*		X	All
Channel catfish	*I. punctatus*		X	All
Mountain madtom	*Noturus eleutherus*			All
Stonecat	*N. flavus*			All

SEE KEY AND FOOTNOTES AT END OF TABLE.

Table C.1. Continued

Species		Status	Present in Ohio River[a]	Present in Counties[b]
Ictaluridae (cont.)				
Carolina madtom	*N. furiosus*			All
Tadpole madtom	*N. gyrinus*		X	All
Brindled madtom	*N. miurus*			All
Freckled madtom	*N. nocturnus*			All
Flathead catfish[e]	*Pylodictis olivaris*		X	All
Amblyopsidae				
Northern cavefish	*Amblyopsis spelaea*	IE[d]		All
Spring cavefish	*Chologaster agassizi*			B,D,J,JA,JN,RY,S
Southern cavefish	*Typhlichthus subterraneus*	IE[d]		J,JA,JN,S
Aphredoderidae				
Pirate-perch	*Aphredoderus sayanus*			All
Percopsidae				
Trout-perch[e]	*Percopsis omiscomaycus*	KE[d,f,g]	X	All
Gadidae				
Burbot	*Lota lota*		X	None
Cyprinodontidae				
Northern studfish	*Fundulus catenatus*			B,D,J,JA,R,RY
Banded killifish	*F. diaphanus*		X	None
Blackstripe topminnow	*F. notatus*			All
Atherinidae				
Brook silverside	*Labidesthes sicculus*			All
Gasterosteidae				
Brook stickleback	*Culaea inconstans*			B,D,J,R,RY
Percichthyidae				
White bass[e]	*Morone chrysops*		X	All
Centrarchidae				
Rock bass[e]	*Ambloplites rupestris*		X	All
Flier	*Centrarchus macropterus*		X	B,J,JA,S
Green sunfish[e]	*Lepomis cyanellus*		X	All
Pumpkinseed[e]	*L. gibbosus*		X	R
Warmouth[e]	*L. gulosus*			All
Orangespotted sunfish[e]	*L. humilis*		X	All
Bluegill[e]	*L. macrochirus*		X	All
Longear sunfish[e]	*L. megalotis*		X	All
Redear sunfish[e]	*L. microlophus*		X	None
Smallmouth bass[e]	*Micropterus dolomieui*		X	All
Spotted bass[e]	*M. punctulatus*		X	All
Largemouth bass[e]	*M. salmoides*		X	All
White crappie[e]	*Pomoxis annularis*		X	All
Black crappie[e]	*P. nigromaculatus*		X	All
Percidae				
Crystal darter	*Ammocrypta asprella*			D,J,JA,JN,RY,S
Eastern sand darter	*A. pellucida*			All
Greenside darter	*E. blennoides*			B,D,J,JA,JN,R,RY
Rainbow darter[e]	*E. caeruleum*		X	All
Bluebreast darter	*E. camurum*			All

SEE KEY AND FOOTNOTES AT END OF TABLE.

Table C.1. Continued

Species		Status	Present in Ohio River[a]	Present in Counties[b]
Percidae (cont.)				
Fantail darter[e]	*E. flabellare*		X	All
Stripetail darter	*E. kennicotti*		X	None
Least darter	*E. microperca*			All
Johnny darter	*E. nigrum*			All
Orangethroat darter	*E. spectabile*			All
Tippecanoe darter	*E. tippecanoe*	KE[d,f,g]		B,D,JA,R
Variegate darter	*E. variatum*			All
Banded darter	*E. zonale*			All
Yellow perch[e]	*Perca flavescens*		X	R
Logperch	*Percina carpodes*		X	B,J,JA,JN,R,RY,S
Channel darter	*P. copelandi*	KR[d,f]		All
Gilt darter	*P. evides*	KR[d,f]		All
Longhead darter	*P. macrocephala*	KE[d,f,g]	X	None
Blackside darter	*P. maculata*			All
Slenderhead darter	*P. phoxocephala*	KR[d,f]		All
Dusky darter	*P. sciera*		X	All
River darter	*P. shumardi*	KR[d,f]		B,D,J,JA,R,RY,S
Sauger[e]	*Stizostedion canadense*	KD[d]	X	All
Walleye[e]	*S. vitreum vitreum*	KD[d]	X	All
Sciaenidae				
Freshwater drum[e]	*Aplodinotus grunniens*		X	All
Cottidae				
Mottled sculpin[e]	*Cottus bairdi*		X	All
Banded sculpin	*C. carolinae*			B,J,JA,JN,RY,S

KEY

Counties:

B Bartholomew
D Decatur
JA Jackson
JN Jefferson
J Jennings
R Rush
RY Ripley
S Scott

Status:

IE Indiana endangered
IR Indiana rare
KE Kentucky endangered
KD Kentucky depleted
KR Kentucky rare
KRE Kentucky rare and endangered
NT National threatened
(Blank indicates not on any list)

[a]Based on the following references:

"Aquatic Resources of the Ohio River," Ohio River Valley Sanitation Commission, Cincinnati, Ohio, 1962, 218 pp.

"Continuing Ecological Studies of the Ohio River, 1973," WAPORA, Inc., Chevy Chase, Maryland, 1974, 98 pp.

[b]"Environmental Resource and Inventory Analysis System (ERIAS), Bio-Information Sub-System," Army Corps of Engineers, Louisville, Kentucky, 1975, computer printouts.

[c]"Threatened Wildlife of the United States," U. S. Department of the Interior, Resource Pub. 114, 1973.

[d]R. M. Miller, "Threatened Freshwater Fishes of the United States," Trans. Amer. Fish. Soc. 101:239-252, 1972.

[e]Reported in applicant's ER.

[f]"A Preliminary List of Rare and/or Endangered Species in Kentucky," Kentucky Academy of Science.

[g]"Kentucky Rare and Endangered Fish and Wildlife," Kentucky Department of Fish and Wildlife Resources, KFWR-H&F-7, Frankfort, Kentucky.

APPENDIX D: NEPA POPULATION DOSE ASSESSMENT

Population dose commitments are calculated for all individuals living within 50 miles of the facility employing the same models used for individual doses (see Draft Regulatory Guide 1.AA in preparation). In addition, population doses associated with the export of food crops produced within the 50-mile region and the atmospheric and hydrospheric transport of the more mobile effluent species such as noble gases, tritium, and carbon-14 have been considered.

Noble Gas Effluents

For locations within 50 miles of the reactor facility, exposures to these effluents are calculated using the atmospheric dispersion models in Draft Regulatory Guide 1.DD (in preparation) and the dose models described in Regulatory Guide 1.AA. Beyond the 50 miles, and until the effluent reaches the northeastern corner of the United States, it is assumed that all the noble gases are dispersed uniformly in the lowest 1000 meters of the atmosphere. Decay in transit was also considered. Beyond this point, noble gases having a half-life greater than one year (e.g., Kr-85) were assumed to completely mix in the troposphere of the world with no removal mechanisms operating. Transfer of tropospheric air between the northern and southern hemispheres, although inhibited by wind patterns in the equatorial region, is considered to yield a hemisphere average tropospheric residence time of about two years with respect to hemisphere mixing. Since this time constant is quite short with respect to the expected midpoint of plant life (15 years), mixing in both hemispheres can be assumed for evaluations over the life of the nuclear facility. This additional population dose commitment to the U. S. population was also evaluated.

Iodines and Particulates Released to the Atmosphere

Effluent nuclides in this category deposit onto the ground as the effluent moves downwind, which continuously reduces the concentration remaining in the plume. Within 50 miles of the facility, the deposition model in Draft Regulatory Guide 1.DD was used in conjunction with the dose models in Draft Regulatory Guide 1.AA. Site-specific data concerning production, transport, and consumption of foods within 50 miles of the reactor were used. Beyond 50 miles, the deposition model was extended until no effluent remained in the plume. Excess food not consumed within the 50-mile distance was accounted for, and additional food production and consumption representative of the eastern half of the country was assumed. Doses obtained in this manner were then assumed to be received by the number of individuals living within the direction sector and distance described above. The population density in this sector is taken to be representative of the Eastern United States, which is 160 people per square mile.

Carbon-14 and Tritium Released to the Atmosphere

Carbon-14 and tritium were assumed to disperse without deposition in the same manner as krypton-85 over land. However, they do interact with the oceans. This causes the carbon-14 to be removed with an atmospheric residence time of four to six years, with the oceans being the major sink. From this, the equilibrium ratio of the carbon-14 to natural carbon in the atmosphere was determined. This same ratio was then assumed to exist in man so that the dose received by the entire population of the U. S. could be estimated. Tritium was assumed to mix uniformly in the world's hydrosphere, which was assumed to include all the water in the atmosphere and in the upper 70 meters of the oceans. With this model, the equilibrium ratio of tritium to hydrogen in the environment could be calculated. The same ratio was assumed to exist in man, and was used to calculate the population dose, in the same manner as with carbon-14.

Liquid Effluents

Concentrations of effluents in the receiving water within 50 miles of the facility were calculated in the same manner as described above for the Appendix I calculations. No depletion of the nuclides by deposition on the bottom of the stream was assumed. It was also assumed that aquatic biota concentrate radioactivity in the same manner as was assumed for the Appendix I evaluation. However, food consumption values appropriate for the average individual, rather than the maximum, were used. It was assumed that all the sport and commercial fish caught within the 50-mile area were eaten by the U. S. population.

Beyond 50 miles, it was assumed that all the liquid effluent nuclides except tritium have deposited on the sediments so they make no further contribution to population exposures. The tritium was assumed to mix uniformly in the world's hydrosphere and to result in an exposure to the U. S. population in the same manner as discussed for tritium in gaseous effluents.

APPENDIX E.

United States Department of the Interior

NATIONAL PARK SERVICE
WASHINGTON, D.C. 20240

IN REPLY REFER TO:
H22-PT

DEC 31 1975

Mr. B. J. Youngblood
Chief, Environmental Projects
Branch #3
Division of Reactor Licensing
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Youngblood:

This is in response to your request of October 6 for this office's evaluation, comments and recommendations of an archeological assessment conducted by Indiana University of the proposed Marble Hill Nuclear Generating Plant; Jefferson County, Indiana.

The subject environmental report has been subjected to intensive staff analysis and the following comments and recommendations are offered at this time:

Comments

According to Dr. Keller's report, a substantial amount of the proposed construction area for plant facilities and attendant features was not surveyed. In addition, the survey methodology utilized does not directly relate the level or intensity of survey on those portions of the project area which were subjected to professional examination. Accordingly, the reader of this report not only cannot ascertain the intensity of survey, but also receives no indication of the surveyed as opposed to unsurveyed sectors. Further, p. 4 (map 2.3-1) should indicate exact survey coverage. The investigator states that only 30% of the area is "considered to have been adequately surveyed." The presence of medium to heavy vegetational growth is not considered an acceptable reason for permanently excluding a major portion of the project area from the survey. The exact nature of the 30% sample should be defined. If it were derived in a rigorous and valid statistical fashion it might be quite acceptable as a means of generalizing for the entire area. However, if it were derived haphazardly or in a biased manner no generalizations of statistically valid nature can be derived from it.

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Although three test excavations were conducted it is difficult to identify which sites were subjected to testing. A reconstruction of the data available appears to indicate that sites 12JE108 and 12JE109 were tested, but the third test occurred in a completely unidentified area.

Indiana University's general recommendations concerning further data collection in the uplands and bottomlands of the project area are duly noted, however, no mitigating measures are proposed by the investigator for site 12JE103 in the uplands, for sites 12JE108 and 12JE109 in the bottomlands,nor is any mention made concerning acquisition of an adequate data sample in the bottomlands.

On p. 4.1-4 it is stated that three of the six upland sites are to be destroyed during construction and the affects of construction upon the lowlands sites are not yet known. On p. 4.4-1 construction impact control measures are not discussed under the category of archeological and historical resources. Subsequently, no mitigating measures are proposed indicating the low-level of attention afforded cultural resources at Marble Hill to date.

Recommendations

Obviously, certain sectors previously unsurveyed at this point in time should be subjected to professional examination in the very near future. We suggest that in the early spring of 1976 an additional survey be conducted in those heavily vegetated areas heretofore excluded. Subsequently, or at the same time, a mitigation plan should be developed and executed to alleviate the loss of cultural resources in the floodplain sector and where plant facilities and transmission lines are proposed. The Public Service Company of Indiana should be responsible for all costs incurred.

The two Federal style homes should be subjected to professional examination by an historical architect in the near future. For information concerning the availability of such professionals in the Marble Hill area, we suggest contacting Dr. Brown Morton, Chief, Interagency Architectural Services/Office of Archeology and Historic Preservation, 523-5891.

The documents available for review indicate no attempt to afford the President's Advisory Council on Historic Preservation an opportunity to comment on this undertaking. Accordingly, we suggest your office establish contact with the Advisory Council and maintain compliance with 36CFR800.

If we may be of further assistance, please feel free to contact this office on any occasion.

Sincerely yours,

Charles M. McKinney
Acting
Departmental Consulting
Archeologist

APPENDIX F

ADDRESS ONLY THE DIRECTOR, FISH AND WILDLIFE SERVICE

United States Department of the Interior

FISH AND WILDLIFE SERVICE
WASHINGTON, D.C. 20240

In Reply Refer To:
FWS/SE Sp

APR 2 7 1976

Dr. David L. Odor
Supervising Engineer-Environmental
Public Service Indiana
1000 East Main Street
Plainfield, Indiana 46168

Dear Dr. Odor:

Thank you for your March 18, 1976, letter to John L. Paradiso of this Office concerning a proposed construction of a nuclear generating facility at Marble Hill in southeastern Indiana and its possible impact on the "Endangered" Indiana Bat (Myotis sodalis). This letter will confirm that additional surveys for the Environmental Report seem to us to be unnecessary. The Indiana Bat is dependent on caves for hibernation and since there are no caves in the area of concern, it is improbable that winter habitat for the species is present. In summer the bats disperse over a large area, and it is highly unlikely that any significant concentration would occur in the area.

Sincerely yours,

Ronald O. Skoog

Ronald O. Skoog, Chief
Office of Endangered Species
and International Activities

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Federal Building, Fort Snelling
Twin Cities, Minnesota 55111

IN REPLY REFER TO:
AFA-SE

JUN 1 0 1976

50-546/547

Dr. S. Stanley Kirslis
Environmental Project Manager
Marble Hill Nuclear Facility
Office of Nuclear Reactor Regulation
Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Dr. Kirslis:

In a telephone conversation with James Engel on June 3, you requested the location of caves inhabited by the Indiana bat that might affect location of transmission lines from the Marble Hill Nuclear Facility. I am enclosing a copy of the December 16 Federal Register in which the critical habitat for the Indiana bat was proposed. A final determination has not been made but we expect a decision within three months.

In addition to the thirteen caves listed in the proposed rules, I know of two others that have been recommended for inclusion -- Twin Domes Cave located within the boundaries of the Harrison-Crawford State Forest in Harrison County and Cave 031 in Missouri. Though none of the caves are in the area of the proposed transmission lines illustrated in Figure 3.9-1 of the draft environmental statement, you will note the Federal Register mentions riparian habitat may be essential to the bat for feeding and reproduction.

The U. S. Fish and Wildlife Service is currently reviewing the status of several hundred animals and approximately 1,700 plants will be proposed in the near future as threatened or endangered. It is suggested therefore, that all parties continue communications as construction of the proposed facility progresses.

For your information, I am also enclosing a set of Guidelines that were * developed to assist Federal Agencies in complying with Section 7 of the Endangered Species Act. If we can be of further assistance, please let us know.

Sincerely yours,

D.K. [signature]

Assistant Regional Director
Federal Assistance

Attachments

cc: Area Ofc, USFWS
Lebanon, Ohio

RECEIVED 6-15-76 U.S. NUCLEAR REGULATORY COMMISSION

* The Guidelines are available in the Public Document Room, 1717 H Street, N. W., Washington, D. C. and the Madison-Jefferson County Library, 420 West Main Street, Madison, Indiana.

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APPENDIX H

COST ESTIMATES FOR ALTERNATIVE BASE-LOAD GENERATION SYSTEMS

COST ESTIMATES FOR ALTERNATIVE BASE-LOAD
GENERATION SYSTEMS

A recently developed computer program was used to rough check the applicant's capital cost estimate for the proposed nuclear power station and to estimate the costs for fossil-fired alternative generation systems.

This computer program, called CONCEPT[1-4] was developed as part of the nuclear assessment activities of the ERDA Division of Nuclear Research and Applications (formerly Division of Reactor Research and Development), and the work was performed in the Reactor Division at the Oak Ridge National Laboratory. The code was designed primarily for use in examining average trends in costs, determining sensitivity to technical and economic factors, and providing reasonable long-range projections of costs. Although cost estimates produced by the CONCEPT code are not intended as substitutes for detailed engineering cost estimates for specific projects, the code has been organized to facilitate modifications to the cost models so that costs can be tailored to a particular project. Use of the computer provides a rapid means of estimating future capital costs of a project with various assumed sets of economic and technical ground rules.

DESCRIPTION OF THE CONCEPT CODE

The procedures used in the CONCEPT code are based on the premise that any central station power plant involves approximately the same major cost components regardless of location or date of initial operation. Therefore, if the trends of these major cost components can be established as a function of plant type, size, location, and interest and escalation rates, then a cost estimate for a reference case can be adjusted to fit the case of interest. The application of this approach requires a detailed cost model for each plant type at a reference condition and the determination of the cost trend relationships. The generation of these data has comprised a large effort in the development of the CONCEPT code. Detailed investment cost studies by an architect-engineering firm have provided basic cost model data for light water reactor nuclear plants, fossil-fired plants, and high-temperature gas-cooled reactor nuclear plants.[5,6] These cost data have been modified to reflect multiple-unit plant designs and to reflect plant design changes occurring since the reference date of the initial investment cost studies.[7-10] Cost models for flue gas desulfurization (FGD) equipment for fossil-fired plants are based on a study of limestone-slurry scrubbing performed by Oak Ridge National Laboratory.[11]

Each cost model is based on a detailed cost estimate for a reference plant at a designated location and a specified date. This estimate includes a breakdown of each cost account into costs for factory equipment, site labor, and site materials. A typical cost model consists of over a hundred individual cost accounts, each of which can be altered by input at the user's option. The ERDA (formerly AEC) system of cost accounts[12] is used in CONCEPT.

To generate a cost estimate under specific conditions, the user specifies the following input: plant type, location, net capacity, beginning date for design, beginning date for construction, beginning date for commercial operation, and rate of interest during construction. If the specified plant size is different from the reference plant size, the direct cost for each account is adjusted by scaling functions which define the cost as a function of plant size. This initial step gives an estimate of the direct costs for a plant of the specified type and size at the reference date and location.

The code has access to cost index data files for 20 major cities in the United States. These files contain data on wage rates for 16 construction crafts and unit costs for 7 site-related materials as reported by a trade publication over the past 15 years.[13] These data are used to determine historical trends in costs of site labor and materials, providing a basis for projecting future costs. These cost data can be overridden by user input if data for the particular project are available. Cost indexes and escalation rates for manufactured equipment must be specified by the user.

This technique of separating the plant cost into individual components, applying appropriate scaling functions and location-dependent cost adjustments, and escalating to different dates is the heart of the computerized approach used in CONCEPT. The procedure is illustrated schematically in Fig. 1.

ESTIMATED CAPITAL COSTS

The assumptions used in the CONCEPT calculations for this project are listed in Table 1. The plant capital investment estimate for the proposed nuclear station is summarized in Table 2, and estimated costs for alternative coal-fired plants are presented in Table 3. Total estimated capital costs showing sensitivity to interest rates, labor content, labor rates, and escalation rates, are presented in Table 4.

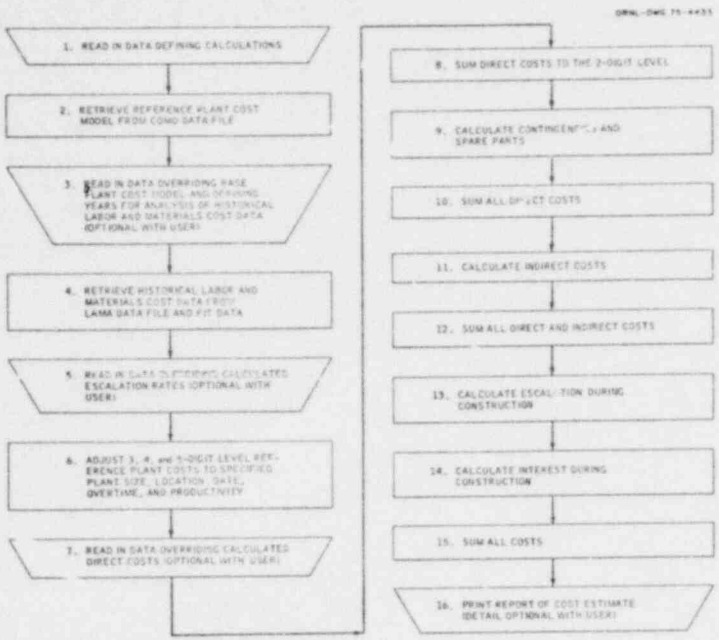

Fig. 1. Use of the CONCEPT program for estimating capital costs.

Table 1. Assumptions used in CONCEPT calculations for the Marble Hill Generating Station

(Revised July 1, 1976)

Plant type	PWR with mechanical draft cooling towers
Alternate plant types	Coal
Unit size	1150 MWe-net, each unit
Plant location	
Actual	Near Madison, Indiana
CONCEPT calculations	Cincinnati, Ohio
Site labor requirements	10 mh/kWe - nuclear 8 mh/kWe - coal with FGD 6.5 mh/kWe - coal without FGD
Escalation during construction	
Purchased equipment	6%/year
Site labor	8.6%/year
Site materials	5.5%/year - nuclear; 5.8%/year - coal
Interest during construction	9%/year, compound
Start of design date	
NSSS ordered	September 1974
Fossil alternatives	January 1976
Start of construction date	
Nuclear plant	January 1977
Fossil alternatives	January 1978
Start of commercial operation date	
Unit 1	January 1982
Unit 2	January 1984

Table 2. Plant capital investment summary for a pressurized water reactor nuclear power plant utilizing mechanical draft cooling towers

(Revised July 1, 1976)

(Public Service Company of Indiana, Marble Hill Generating Station)

	Unit 1	Unit 2	Total
Net capability, MWe	1150	1150	2300
Direct costs (millions of dollars)*			
Land and land rights	1	0	1
Structures and site facilities	76	71	147
Reactor/boiler plant equipment	127	128	255
Turbine plant equipment	127	127	254
Electric plant equipment	46	43	89
Miscellaneous plant equipment	9	5	14
Subtotal	386	374	760
Spare parts allowance	5	4	9
Contingency allowance	38	38	76
Subtotal (direct costs)	429	416	845
Indirect costs (millions of dollars)*			
Construction facilities, equipment, and services	25	13	38
Engineering and construction management services	62	27	89
Other costs	20	17	37
Subtotal (indirect costs)	107	57	164
Total costs (millions of dollars)			
Total direct and indirect costs*	536	473	1009
Allowance for escalation	97	118	215
Allowance for interest	189	257	446
Plant capital cost at commercial operation			
Millions of dollars	822	848	670
Dollars per kilowatt	715	737	26

*In 1976 dollars

Table 3. Plant capital investment summary for a 2300-MWe coal-fired plant utilizing mechanical draft cooling towers as an alternative to the Marble Hill Station

(Revised July 1, 1976)

	With FGD	Without FGD
Direct costs (millions of dollars)*		
Land and land rights	1	1
Structures and site facilities	92	81
Reactor/boiler plant equipment	299	287
Turbine plant equipment	192	185
Electric plant equipment	59	45
Miscellaneous plant equipment	10	10
Subtotal	653	609
Spare parts allowance	8	8
Contingency allowance	65	61
Subtotal (direct costs)	726	678
Indirect costs (millions of dollars)*		
Construction facilities, equipment, and services	38	3
Engineering and construction management services	42	35
Other costs	24	21
Subtotal (indirect costs)	104	84
Total costs (millions of dollars)		
Total direct and indirect costs*	830	762
Allowance for escalation	204	183
Allowance for interest	326	298
Plant capital cost at commercial operation		
Millions of dollars	1360	1243
Dollars per kilowatt	591	540

*In 1976 dollars

Table 4. Sensitivity of total estimated capital costs to interest rates, labor content, labor rates, and escalation rates for the Marble Hill Generating Station

(Revised July 1, 1976)

	Base	Labor Content	Labor Content	Low Interest and Escalation	High Interest and Escalation
Interest rate, %/year	9	9	9	8	10
Site labor requirements, mh/kWe					
Nuclear plant	10	8	12	10	10
Coal plant with FGD	8	6.4	9.6	8	8
Coal plant without FGD	6.5	5.2	7.8	6.5	6.5
Site labor rate in June 1976, $/hour					
Nuclear plant	12.04	12.04	12.04	12.04	13.24
Coal plants	12.22	12.22	12.22	12.22	13.44
Escalation rates, %/year					
Equipment	6.0	6.0	6.0	4.0	8.0
Site labor (nuclear plant)	8.6	8.6	8.6	6.6	10.6
Site labor (coal plants)	8.6	8.6	8.6	6.6	10.6
Site materials (nuclear plant)	5.5	5.5	5.5	3.5	7.5
Site materials (coal plants)	5.8	5.8	5.8	3.8	7.8
Total estimated capital cost, millions of dollars					
Nuclear plant	1670	1536	1805	1531	1891
Coal plant with FGD	1360	1254	1467	1243	1532
Coal plant without FGD	1243	1158	1325	1135	1393
Total estimated capit-' cost, $/kWe					
Nuclear plant	726	668	785	666	822
Coal plant with FGD	591	545	638	540	666
Coal plant without FGD	540	503	576	493	606

REFERENCES

1. U.S. Atomic Energy Commission, *CONCEPT — A Computer Code for Conceptual Cost Estimates of Steam-Electric Power Plants — Status Report*, WASH-1180, April 1971.

2. R. C. DeLozier, L. D. Reynolds, and H. I. Bowers, *CONCEPT — Computerized Conceptual Cost Estimates for Steam-Electric Power Plants — Phase I User's Manual*, ORNL-TM-3276, Oak Ridge National Laboratory, October 1971.

3. H. I. Bowers, R. C. DeLozier, L. D. Reynolds, and B. E. Srite, *CONCEPT — Computerized Conceptual Cost Estimates for Steam-Electric Power Plants — Phase II User's Manual*, ORNL-4809, Oak Ridge National Laboratory, April 1973.

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5. United Engineers & Constructors Inc., *1000-MWE Central Station Power Plants — Investment Cost Study*, USAEC Report WASH-1230 (Vols. I-IV), June 1972.

6. United Engineers & Constructors Inc., *770-MWE Central Station Power Plants — Investment Cost Study*, USAEC Report WASH-1230 (Vol. V), December 1973.

7. H. I. Bowers and I. T. Dudley, *Multi-Unit Power Plant Cost Models for the CONCEPT Code*, ORNL-TM-4300, Oak Ridge National Laboratory, March 1974.

8. United Engineers & Constructors Inc., *Review of Multi-Unit Power Plant Cost Models for the CONCEPT Code*, UEC-AEC-740715, July 1974.

9. U.S. Atomic Energy Commission, *Power Plant Capital Costs — Current Trends and Sensitivity to Economic Parameters*, WASH-1345, October 1974.

10. H. I. Bowers, *Cost-Model Modifications for the CONCEPT-IV Computer Code*, ORNL-TM-4891, Oak Ridge National Laboratory, October 1975.

11. M. L. Myers, *Cost Estimate for the Limestone—Wet Scrubbing Sulfur Oxide Control Process*, ORNL-TM-4142, Oak Ridge National Laboratory, July 1973.

12. NUS Corporation, *Guide for Economic Evaluation of Nuclear Reactor Plant Designs*, USAEC Report NUS-531, January 1969.

13. *Engineering News-Record*, McGraw-Hill, New York, published weekly.