final

NUREG-75/088

environmental statement

related to construction of

PERKINS NUCLEAR STATION, UNITS 1, 2, and 3

DUKE POWER COMPANY

OCTOBER 1975

1724 024

Docket Nos. STN 50-488, STN 50-489, and STN 50-490

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

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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 a construction permit to the Duke Power Company for the construction of the Perkins Nuclear Station (PNS) Units 1, 2, and 3 located in Davie County, North Carolina (Docket Nos. STN 50-488, 50-489, and 50-490).

   The station will employ three identical pressurized water reactors to produce a warranted output of 3817 MWt each. A steam turbine generator will use this heat to provide 1280 MWe (net) of electrical power capacity per unit. The exhaust steam will be cooled by a flow of water in a closed-cycle system incorporating circular mechanical-draft wet cooling towers using makeup water from the Yadkin River. Blowdown from the circulating water system will be discharged into the Yadkin River.

3. Summary of environmental impact and adverse effects:

   a. A total of 2402 acres will be used for the PNS site; another 1401 acres will be used for the Carter Creek Impoundment. Construction-related activities on the primary site will disturb about 617 acres. Approximately 631 acres of land will be required for transmission line right-of-way, and a railroad spur will affect 77 acres. This constitutes a minor local impact. (Sect. 4.1)

   b. Station construction will involve some community impacts. Twenty-six families will be displaced from the site proper while an additional 16 families will be affected (10 houses and 3 mobile homes will be removed) in the Carter Creek area. Traffic on local roads will increase due to construction and commuting activities. The influx of construction workers' families (an average work force of 1500) is expected to cause no major housing or school problems. (Sects. 3.10, 4.4.1)

   c. The heat dissipation system will require a maximum water makeup of 55,816 gpm, of which 50,514 gpm will be consumed due to drift and evaporative losses. This amount represents 4% of the mean monthly flow of the Yadkin River. The cooling tower blowdown and chemical effluents from the station will increase the dissolved solids concentration in the Yadkin River by a maximum of 18 ppm. The thermal alterations and increases in total dissolved solids concentration will not significantly affect the aquatic productivity of the Yadkin River. (Sect. 3.4.1)

   d. It is assumed that aquatic organisms entrained in the service water system will be killed due to thermal and mechanical shock. The applicant will not consumptively use water to cause river flows to be less than 880 cfs. Therefore, the maximum impact, based on the $7Q_{10}$ flow of 625 cfs, will be the destruction of approximately 16% of the entrainable organisms present in the Yadkin River. This is not expected to constitute a significant impact during periods of low river flow; however additional data on important species must be collected before the impact can be quantified. (Sect. 5.5.2.1)

   e. Although there is a potential for impingement of aquatic organisms at the intake structure, the staff does not consider that serious impingement losses will occur. (Sect. 5.5.2.1)

   f. There exists no serious potential for ground-level fogging and icing due to operation of the cooling towers. Drift effects on terrestrial ecosystems are considered to be minimal. (Sect. 5.1.1.1)

   g. The risk associated with accidental radiation exposure is very low. (Sect. 7.1)

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h. No significant environmental impacts are anticipated from normal operational releases of radioactive materials. The total annual dose to the U.S. population (total body plus thyroid) from operation is 210 man-rems, which is less than the normal fluctuations in the background dose this population would receive. The occupational dose is approximately 1400 man-rems/year (Sect. 5.4.2.5).

4. Principal alternatives considered were:

   a. Purchase of power
   b. Alternative energy systems
   c. Alternative sites
   d. Alternative heat dissipation methods

5. The following Federal, State, and local agencies were asked to comment on the Draft Environmental Statement issued in May, 1975:

   - Advisory Council on Historic Preservation
   - Department of Agriculture
   - Department of the Army, Corps of Engineers
   - Department of Commerce
   - Department of Health, Education, and Welfare
   - Department of Housing and Urban Development
   - Department of the Interior
   - Department of Transportation
   - Energy Research and Development Administration
   - Environmental Protection Agency
   - Federal Energy Administration
   - Federal Power Commission
   - Office of Intergovernmental Relations, State of North Carolina
   - Piedmont Triad Council of Governments, Greensboro, North Carolina
   - County Manager, Davie County, Mocksville, North Carolina

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

   - Department of Agriculture, Forest Service
   - Department of Agriculture, Agricultural Research Service
   - Department of Agriculture, Soil Conservation Service
   - Department of Commerce
   - Department of Transportation, U.S. Coast Guard
   - Duke Power Company
   - Department of Health Education and Welfare
   - Energy Research and Development Administration
   - Environmental Protection Agency
   - North Carolina Department of Administration
     Department of Natural and Economic Resources
     Department of Human Resources
   - Federal Power Commission
   - Department of Interior
   - David Springer, The Point Farm, Mocksville, North Carolina

   Copies of these comments are appended to this Final Environmental Statement as Appendix A. The staff has considered these comments, and the responses are located in Section 11.

6. This Environmental Statement was made available to the public, to the Council on Environmental Quality and to other specified agencies in October, 1975.

7. On the basis of the analysis and evaluation set forth in the statement, after weighing the environmental, economic, technical, and other benefits of Perkins Nuclear Station, Units 1, 2, and 3, 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 Part 51 is the issuance of a construction permit 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 Sect. 4.5 of this Environmental Statement, during construction of the station, associated transmission lines, and the railroad spur to avoid unnecessary adverse environmental impacts from construction activities.

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b. The applicant will be required to submit a detailed erosion control plan prior to initiation of construction activities. The plan must identify those areas where serious erosion could occur as a result of clearing and construction, and it must describe in detail, for each of these areas separately, actions that will be taken to impede the erosion. (Sect. 4.3.1)

c. 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 Reactor Licensing for the activities.

d. The applicant shall establish a control program that 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. If unexpected harmful effects or evidence of serious 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.

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FOREWORD

This environmental statement was prepared by the U.S. Nuclear Regulatory Commission (NRC), Office of Nuclear Reactor Regulation (staff) in accordance with the Commission's regulation, 10 CFR Part 51, which implements the requirements of the National Environmental Policy Act of 1969 (NEPA).

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

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

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

(i) the environmental impact of the proposed action,

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

(iii) alternatives to the proposed action,

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

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

Pursuant to 10 CFR 51, the NRC Office of Nuclear Reactor Regulation prepares a detailed statement on the foregoing considerations with respect to each application for a construction permit or full-power operating license for a nuclear power reactor.

When application is made for a construction permit or a full-power operating license, the applicant submits an environmental report to the NRC. 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 questions and objections raised by the comments and their disposition thereof; a final benefit-cost analysis, which considers and balances the environmental effects of the facility and the alternatives available for reducing or avoiding adverse environmental effects with the environmental, economic, technical, and other benefits of the facility; and a conclusion as to whether--after the environmental, economic, technical, and other benefits are weighed against environmental costs and after available alternatives have been considered--the action called for, with respect to environmental issues, is the issuance or denial of the proposed permit or license, or its appropriate conditioning to protect environmental values.

Single copies may be obtained as indicated on the inside front cover. Dr. Robert A. Gilbert is the NRC Environmental Project Manager for this statement. Should there be questions regarding the contents of this statement, Dr. Gilbert may be contacted at the following address:

Division of Reactor Licensing
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555
(301) 443-6990

Effective January 19, 1975, activities under the U.S. Atomic Energy Commission regulatory program were assumed by the U.S. Nuclear Regulatory Commission in accordance with the Energy Reorganization Act of 1974. Any references to the Atomic Energy Commission (AEC) contained herein should be interpreted as Nuclear Regulatory Commission (NRC).

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1. INTRODUCTION

1.1 THE PROPOSED PROJECT

Pursuant to the Atomic Energy Act, as amended, and the U.S. Atomic Energy Commission's regulations in Title 10, Code of Federal Regulations, an application with an accompanying Environmental Report was filed on March 29, 1974, by Duke Power Company (hereinafter referred to as the applicant) for construction permits for three generating units designated as the Perkins Nuclear Station (PNS), Units 1, 2, and 3 (Docket Nos. STN 50-488, 50-489, and 50-490), each of which is powered by a pressurized water reactor (PWR) and is designated for initial operation at approximately 3817 MWt with a net electrical output of 1280 MWe. Condenser cooling will be accomplished through the use of circular mechanical-draft cooling towers. Makeup water for the cooling towers will be obtained from the Yadkin River and the tower discharge (blowdown) will be returned to the Yadkin River. The proposed facilities will be located on the applicant's 2402-acre primary site in Davie County, North Carolina, about 12 miles N of Salisbury and about 7 miles SE of Mocksville. The applicant also proposes a 1401-acre water impoundment facility in Carter Creek, which enters the Yadkin River about 9 miles upstream of the primary site.

Integration of the power from PNS will be accomplished by two double-circuit 230-kV lines and one single-circuit 525-kV line folded into the Perkins switchyard. This will require the construction of approximately 16 miles of transmission lines into existing electrical systems. Two switching stations (one 230 kV, one 525 kV) will be located on the Perkins site in proximity to the generating units and will constitute the terminus of the circuits over which the output of the station will be delivered to the load centers.

1.2 BACKGROUND

10 CFR Part 51 requires that the NRC analyze the applicant's Environmental Report and prepare a detailed statement of environmental considerations. It is within this framework that this Environmental Statement related to the construction of the Perkins Nuclear Station Units 1, 2, and 3 has been prepared by the Office of Nuclear Reactor Regulation (staff) of the Nuclear Regulatory Commission.

Major documents used in the preparation of this statement were the applicant's Environmental Report (ER), and supplements thereto, and the applicant's Preliminary Safety Analysis Report (PSAR). In this Environmental Statement, the ER[1] is cited extensively and the PSAR[2] is cited a number of times; however, their full titles and documentation are given only in the list of references for Sect. 1. Elsewhere in this statement, references to these two documents will appear as the abbreviations ER and PSAR, respectively, followed by the number(s) of specific sections, pages, tables, figures, and appendices.

Independent calculations and other sources of information were also used by the staff as a basis for the assessment of environmental impact. In addition, information was gained from visits by the staff to the site, the Town of Mocksville, and the surrounding areas. Members of the staff also had discussions with representatives of the North Carolina Department of Natural and Economic Resources (NCDNER), local officials of the Town of Mocksville and Davie County, North Carolina, and local conservation officers.

As a part of the Commission's safety evaluation leading to the issuance of construction permits and operating licenses, this statement makes a detailed evaluation of the applicant's plans and facilities for minimizing and controlling the release of radioactive materials under both normal and potential accident conditions, including the effects of natural phenomena on the facility. Because 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 the applicant's Environmental Report are available for public inspection at the Commission's Public Document Room, 1717 H Street, NW, Washington, D.C., and at the local Public Document Room, Mocksville Library, Mocksville, North Carolina.

1.3 STATUS OF REVIEWS AND APPROVALS

The applicant has provided a status listing of environmentally related permits, approvals, and licenses required from Federal, State, regional, and local agencies in connection with the proposed project (ER, Sect. 12). The staff has reviewed this listing and has consulted with appropriate agencies in an effort to identify any significant environmental issues of concern to these agencies. As a result of this effort, a potential non-NRC licensing problem has been identified. The North Carolina Department of Natural and Economic Resources (NCDNER) issued a technical report on October 11, 1974 (TR No. IV-21-C) recommending that the Perkins Nuclear Station not be allowed to directly withdraw water from the Yadkin River for cooling purposes if such consumptive use would cause the flow downstream of the station to drop below 880 cfs. The report, on the other hand, also recommended that Duke Power Company construct an upstream storage reservoir from which releases could be made to maintain the flow downstream at 880 cfs if consumptive use at the station would lower the flow below that figure. However, the upstream releases were not required to exceed the consumptive use by the station. This means that river flows below the station could drop below 880 cfs for reasons other than consumptive use at the station. Duke and the state tentatively agreed to these recommendations.

On July 17, 1975, the North Carolina Environmental Management Commission (NCEMC) directed a study to be made to determine whether the Yadkin River Basin should be declared a capacity use area. If, at the conclusion of that study, the NCEMC declares the basin a capacity use area, it would have the power to regulate withdrawal or use of Yadkin River water in excess of 100,000 gpd and could thereby establish a minimum low flow restriction in the river different than the 880 cfs recommended by the technical report of the NCDNER. The staff has taken into consideration the potential environmental effects of such limitations in Sections 4 and 5.

REFERENCES FOR SECTION 1

1. Duke Power Company, *Environmental Report, Perkins Nuclear Station, Units 1, 2, and 3*, Docket Nos. STN 50-488, 50-489, 50-490, March 29, 1974; Amendment No. 1, July 8, 1974; Amendment No. 2, January 31, 1975.

2. Duke Power Company, *Preliminary Safety Analysis Report, Perkins Nuclear Station*, Docket Nos. STN-50-488, 50-489, and 50-490, March 29, 1974.

2. THE SITE

2.1 PLANT LOCATION

The proposed construction site of the Perkins Nuclear Station (PNS) lies on the Yadkin River in southeastern Davie County, North Carolina, approximately 7 miles ESE of Mocksville, the county seat. The geographical coordinates of the proposed site are longitude 80°27'10"W and latitude 35°50'53"N. The site layout is shown in Fig. 2.1.

Details of present site area usage and site development plans are given in the applicant's Environmental Report (ER, Sect. 2.1).

2.2 REGIONAL DEMOGRAPHY AND LAND AND WATER USE

2.2.1 Regional demography

The proposed site is in an area of low population density, approximately 47 people/sq mile within a 3-mile radius. The 1970 populations within 1, 2, 5, and 10 miles were 195, 544, 4517, and 34,369 respectively (ER, Table 2.2.1-2). Within a 50-mile radius the 1970 population was estimated to be 1,506,152 (ER, Table 2.2.1-2). The nearest towns of any size are Lexington (17,205), Mocksville (2529), Salisbury (22,515), and Cooleemee (1115). Population centers within the 50-mile radius are Charlotte (241,178), Kannapolis (54,095), High Point (63,204), Greensboro (144,076), and Winston-Salem (132,913). Figure 2.2 shows the 1970 population distribution within the 50-mile radius. The 1970 population distribution extrapolated to the year 2023 is shown in Fig. 2.3. All population data are based upon the 1970 census except for the population within the 5-mile radius. This data was determined for Davie County from an actual house count and for Davidson County from the Davidson County Tax Assessor's records for 1973. The applicant has projected the 1970 population to the year 2023 on the basis of extrapolations made by Region IV, Environmental Protection Agency (ER, Sect. 2.2). The staff's review and assessment of census data are in agreement with the applicant's census data.

There are 13 schools located within a 10-mile radius of the proposed site: 6 in Davie County, 1 in Rowan County, and 6 in Davidson County. The nearest hospital is located in Mocksville, approximately 8 miles W of the site. Although there are no major industries within 5 miles of the site, there are a number of industries ranging in size from 2 to 750 employees within 20 miles. Mocksville, the industrial center for Davie County, is an important center for highway transportation and has a number of diversified industries.

Major highways in the area are U.S. Highways 64, 601, 70, Interstates 40 and 85, and North Carolina Highway 801. There is rail service provided by Southern Railway, and commercial air service exists in the Winston-Salem, Greensboro-High Point area. There are three general aviation airfields within 10 miles of the site: Twin Lakes Airport is located approximately 5 miles N of the site; Strawberry Hill Airport 9 miles N; and the Lexington Airport about 8 miles ESE. Major features of the area within a 50-mile radius of the site are given in Fig. 2.4. Additional details of the local and regional demography may be fo. ' in the applicant's Environmental Report (ER, Sect. 2.2).

2.2.2 Land use

The area in the immediate vicinity of the site (5-mile radius) is rural and sparsely populated. The predominant land use is agricultural. There is substantial cultivation of tobacco and truck crops, but most emphasis is on small grain crops. There are two privately owned campgrounds within 5 miles of the site, and Boone's Memorial Park, a state park, is located approximately 2.5 miles S of the site. The North Carolina Wildlife Resources Commission manages and maintains the Cooleemee Plantation Game Land located on the Yadkin River 1.3 miles ENE of the site. The latter area is used for seasonal hunting purposes. For details of land use, see the applicant's Environmental Report (ER, Sect. 2.2.2).

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POOR ORIGINAL

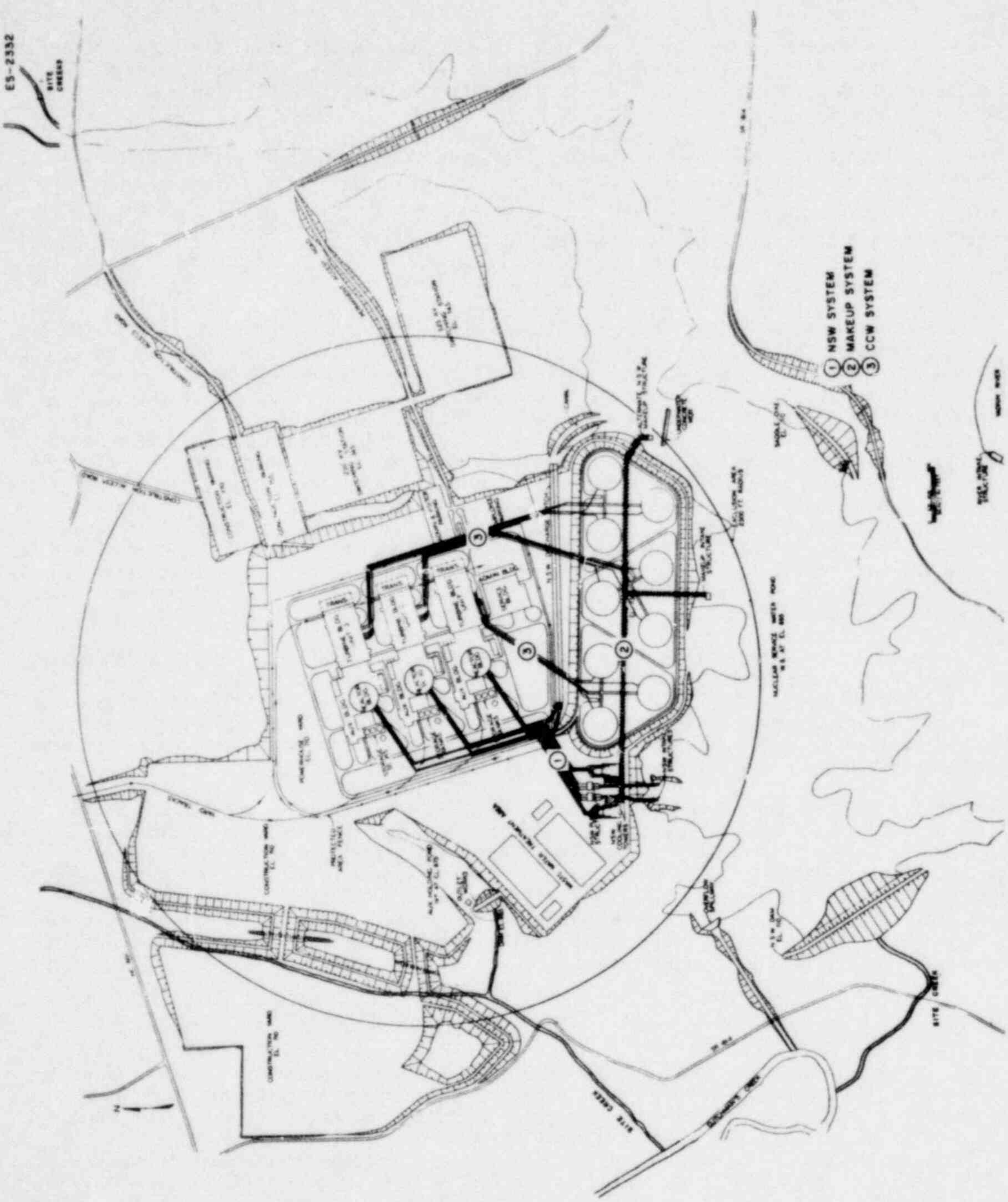

Fig. 2.1. Site layout — Perkins Nuclear Station. Source: ER, Fig. 3.4.0-1, Amend. 3.

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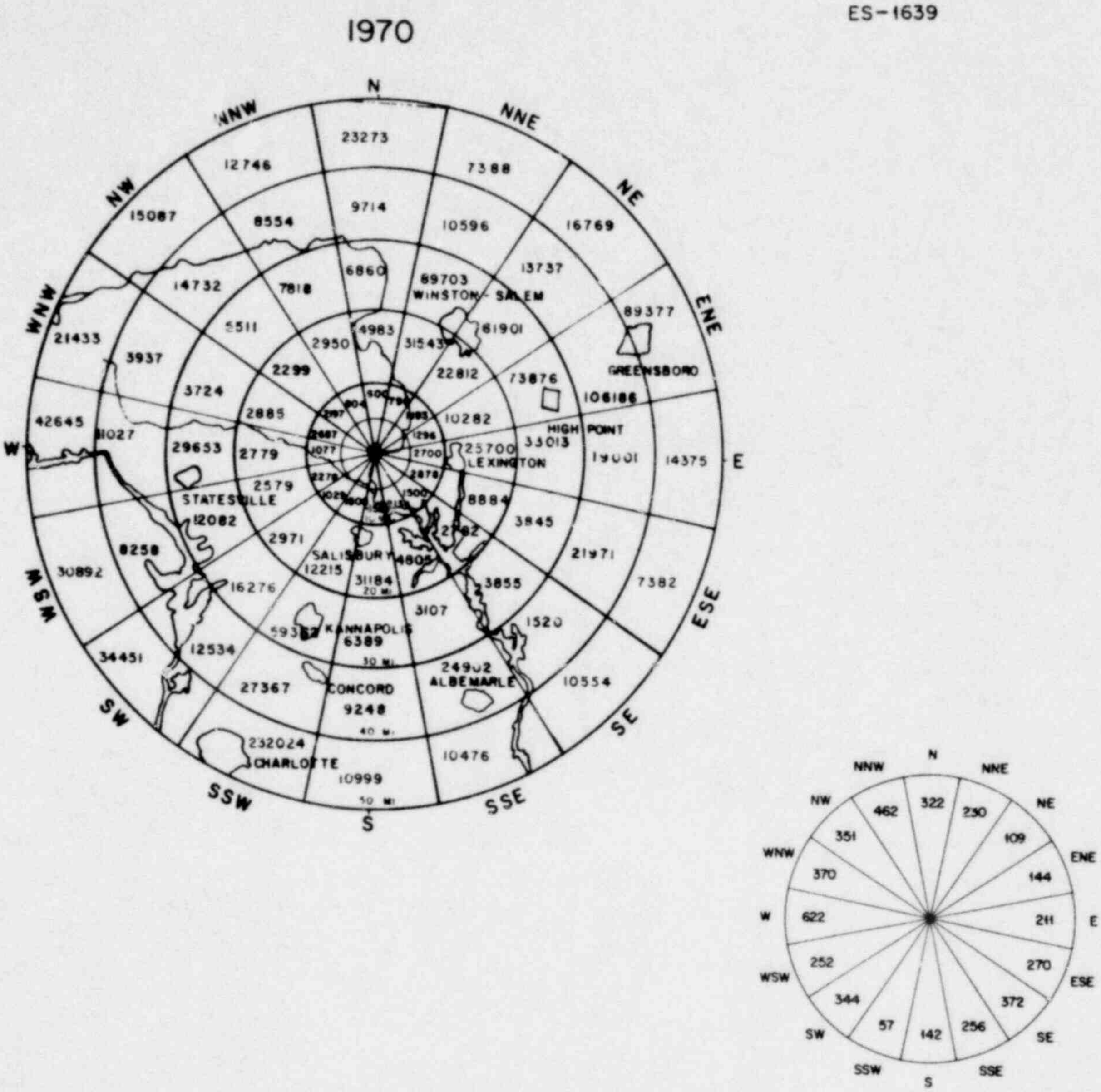

Fig. 2.2. Population within a 50-mile radius of Perkins Nuclear Station — 1970. Source: ER, Fig. 2.2.1-5, Amend. 2.

2023

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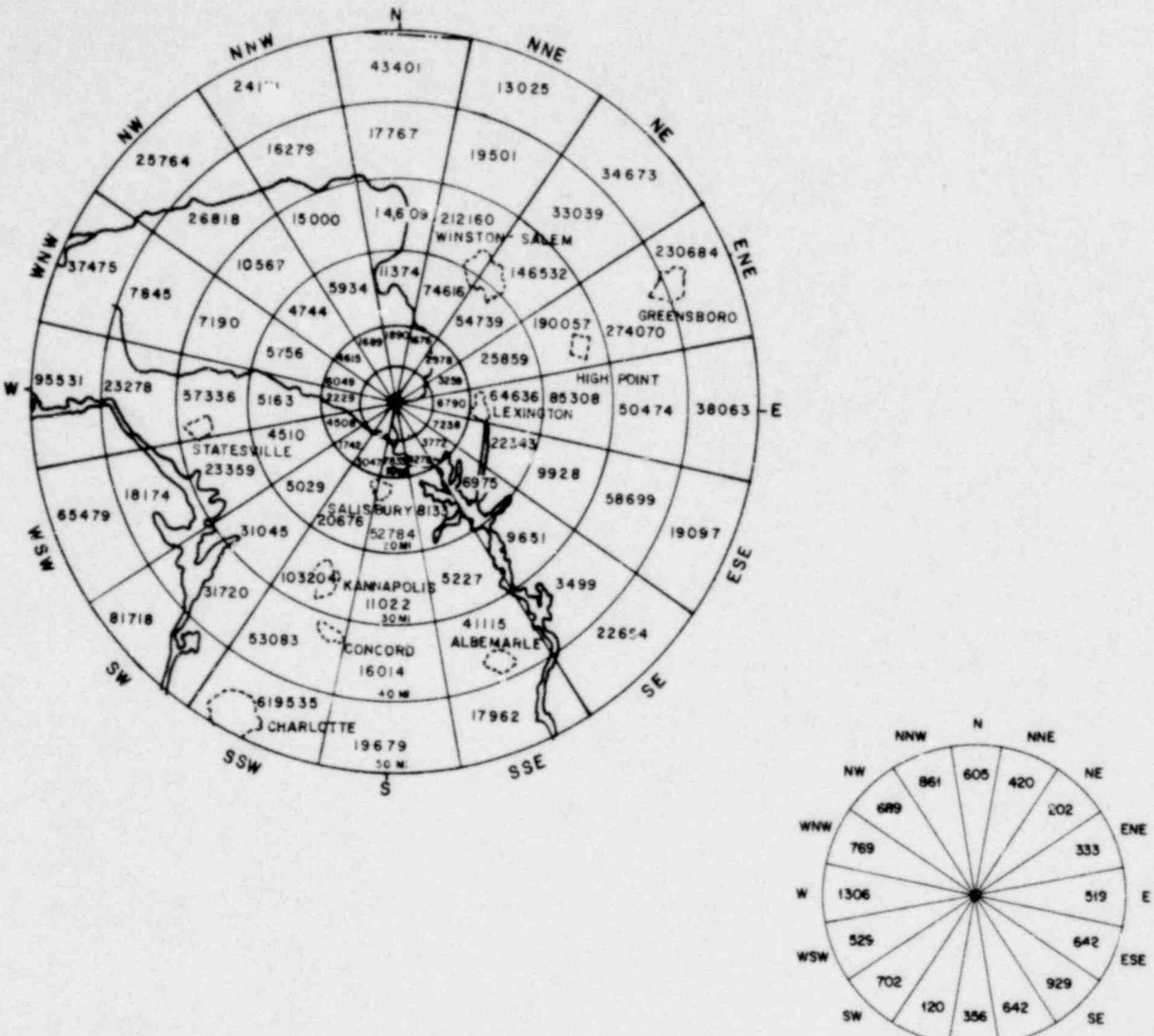

Fig. 2.3. Projected population within a 50-mile radius of Perkins Nuclear Station — 2023. Source: ER, Fig. 2.2.1-7, Amend. 2.

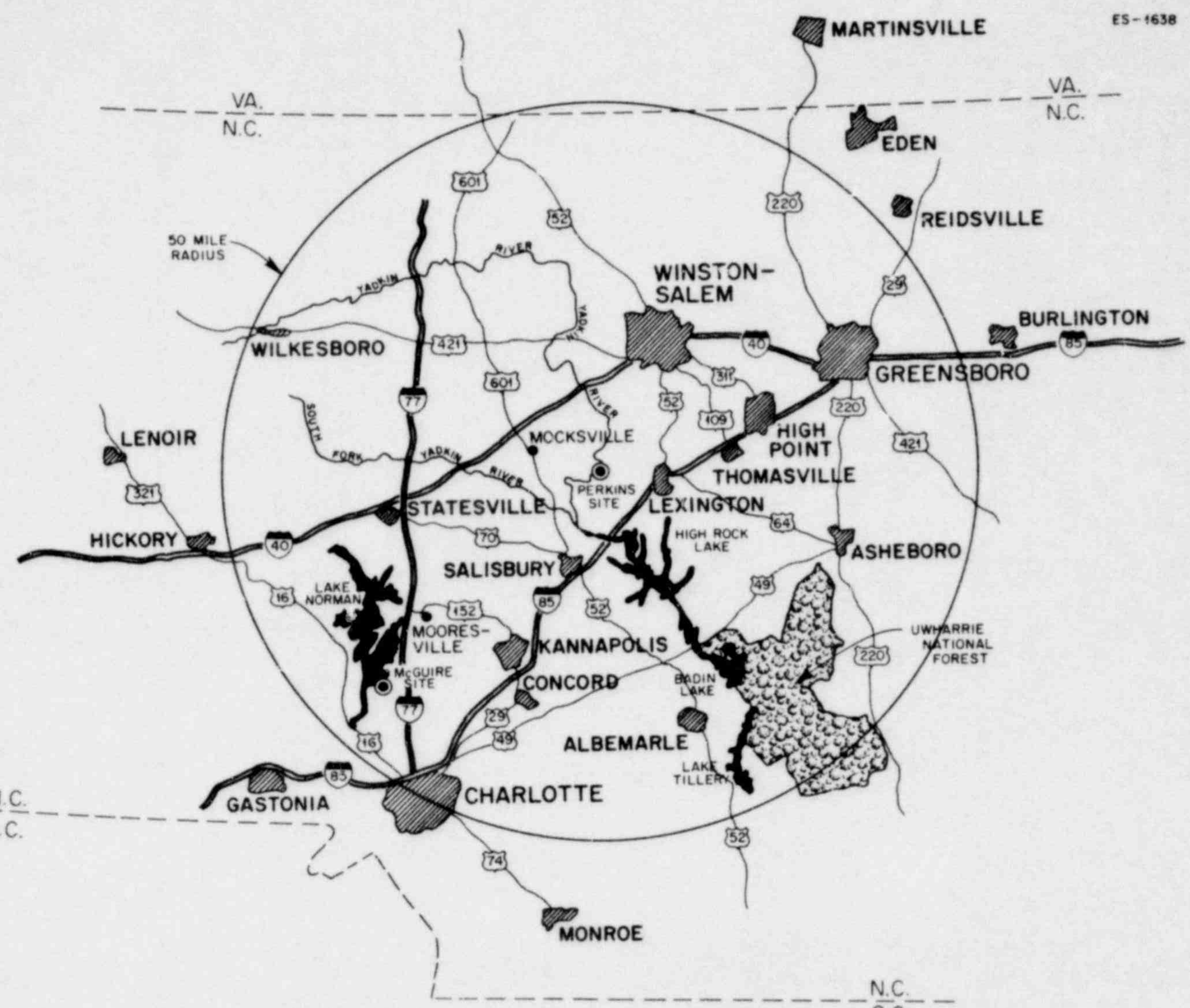

Fig. 2.4. Major features of the area within a 50-mile radius of the proposed Perkins Nuclear Station.

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2.2.3 Water use

2.2.3.1 Surface water

The Yadkin River is the major source of water supply within the vicinity of the site. The nearest downstream municipal intake is about 11 miles from the site and has a capacity of 12 Mgd. There are 14 other water intakes on the Yadkin River or its tributaries within a 50-mile radius of the site. These are largely municipal intakes and have a combined capacity of approximately 61 Mgd (ER, Figure 2.2.2-7, Table 2.2.2-3). No data is available relative to their total consumptive use of water.

2.2.3.2 Groundwater

There are approximately 58 wells or groups of wells serving industrial and public uses within a 20-mile radius of the site. The well located nearest to the site is a single well at Tyro School about 5 miles ESE. The applicant's Environmental Report covers this subject in greater detail (ER, Sect. 2.2.2.5).

2.3 HISTORIC AND ARCHAEOLOGICAL SITES AND NATURAL LANDMARKS

2.3.1 Historic sites

The applicant has made contact with the Division of Archives and History of the State of North Carolina. Evaluation by this agency showed that plant construction would have no adverse impact on any historic structures (ER, Amend. 2, Attach. 2).

The National Register of Historic Places lists four historic sites within approximately 10 miles of the site:

(1) The Old Davidson County Courthouse, Davidson County, in Lexington,

(2) Davie County Jail, Davie County, in Mocksville,

(3) Cooleemee Plantation, Davie County, and

(4) Trading Ford, Davidson County.

2.3.2 Archaeological sites

The applicant has contacted the North Carolina Division of Archives and History about possible archaeological sites within the plant area, and an appraisal of the effect of the proposed plant on such sites was carried out by the Division. Their evaluation showed that, although there are over twenty archaeological sites within the area, none of the sites, with possibly one exception still being evaluated, are important enough to be included in the National Register of Historic Places (ER, Attach. 2.0). The staff agrees with this evaluation.

2.3.3 Natural landmarks

The National Register of Natural Landmarks lists no natural landmarks within 10 miles of the proposed site.

2.4 GEOLOGY

The geology of the proposed site will be discussed here very briefly and only to the extent needed to describe potential environmental impact. A detailed discussion of the geological features will be made in the staff's Safety Evaluation Report. The applicant also covers the site geology in more detail (ER, Sect. 2.4; PSAR 2.5).

The proposed site is located in the Charlotte Belt in the Piedmont Geologic Province. The topography is characterized by low, rounded hills and gentle slopes. Elevations range from 780 ft above sea level on the north side of the site to approximately 640 ft on the south. On the site there are several ridges tending approximately north-south. These ridges are divided by small streams that flow south into the Yadkin River. The larger streams of the area flow in beds of alluvial material; however, there are some streams that have bedrock as a base. There are few rock outcrops on the site.

River terrace material has been deposited on the site and can be found on hills and ridges where it has not been eroded by surface runoff, streams, or gravity. This terrace material lies at elevations generally above 700 ft.

The residual soils of the Piedmont Physiographic Province are derived from in-place weathering of the underlying igneous and metamorphic bedrock. The rock weathers at different rates, depending upon the type, the variations in composition, and the presence of joints in the bedrock, thus resulting in a characteristically knobby and uneven rock surface.

The soils at the proposed site are derived from the weathering in place of adamellite rock, which has produced tan, gray, and white saprolites that are classified as sandy silts. Limited alluvial deposits are also present. The surface soils consist of an organically stained topsoil zone, 0.3 to 1 ft thick. Underlying this is a zone of brown to red clayey silts ranging up to 3 ft thick. With increasing depth through the intermediate weathering zone, there occurs a transition zone between soil and rock. This zone consists of lenses of hard soils and moderately to severely weathered bedrock. The adamellite bedrock is found at varying depths throughout the proposed site.

2.5 HYDROLOGY

2.5.1 Surface water

The river intake structure for the proposed Perkins Nuclear Station is located on the west bank of the Yadkin River at river mile 289.

The Yadkin River drains approximately 2527 sq miles above the proposed site. This area includes 130 sq miles drained by Dutchman's Creek, which enters the Yadkin about 2 miles downstream from the intake structure. The Yadkin rises in the foothills of the Blue Ridge Mountains and flows generally east for a distance of 84 miles. The river then turns south and flows about 43 miles before passing the proposed site. About 16 miles downstream from the site, the river flows into the impoundment, High Rock Lake. The Yadkin River later becomes the Pee Dee River below Badin Lake near Albemarle, North Carolina.

There has been a U.S. Geological Survey (USGS) gauging station on the Yadkin River near Yadkin College at river mile 295, about 6 miles upstream of the proposed plant intake structure, since July 1928. The maximum recorded flow is 80,200 cfs, which occurred August 15, 1940. The maximum water surface elevation known is 674.95 MSL, which occurred in July 1916. The estimated flow for that elevation is 94,300 cfs. The minimum instantaneous flow at the gauge was 177 cfs on October 12, 1954.

The nearest upstream hydroelectric station and river control facility is Duke Power's Idol's Hydroelectric Station, located approximately 19 river miles above the proposed site. The dam is a "run-of-the-river" one with a 10-ft net head, and the reservoir has a net surface area of 35 acres at full pond. The Corps of Engineers' W. Kerr Scott Reservoir, near Wilkesboro, North Carolina, is effective in the control of the Yadkin River flow.

The High Rock Dam and Hydroelectric Station is the nearest downstream river control structure. It is located 31 river miles below the proposed site. The High Rock facility is owned and operated by the Aluminum Company of America. The dam impounds an area of 15,180 acres at full pond. Total storage includes 234,866 acre-ft at 30-ft drawdown.

The applicant has had a water sampling and analysis program in force for about 2 years. A summary of water quality data for the Yadkin River is given in Table 3.7. Seasonal variations occur in the concentrations of both dissolved and suspended solids.

2.5.2 Groundwater

Groundwater in the proposed site area is derived entirely from precipitation. This precipitation is held in pores that occur in the residual soils and fractures in igneous and metamorphic rock. In many locations, the earth's surface is relatively impermeable with the result that only 10 to 15 in. of the average 47 in. of precipitation percolate to the water table. In the site region the distance from the surface to the water table depends primarily on topography and rock weathering. The water table varies from ground-surface elevation in valleys to more than 100 ft below the surface on sharply rising hills. The groundwater level normally declines during late spring, summer, and early fall when rainfall is low. At the proposed site, measured depths from ground surface to the water table on the ridges vary from 10 to 55 ft.

Because of these stratigraphic characteristics, the movement of groundwater is limited. This is borne out by the observation that the radius of influence of a well extends to only a few hundred feet from the well. The median yield of wells in the area of the site is about 15 gpm for domestic wells and 35 gpm for industrial wells. The groundwater in the site vicinity is suitable without treatment for domestic use.

2.6 METEOROLOGY

2.6.1 Regional climatology

The climate of the Perkins site, located about 25 miles SSW of Winston-Salem, is typical of continental climates in southern areas and is characterized by cool winters and relatively long, warm summers. Cold air moving southward into the area is modified somewhat by crossing the Appalachian Mountains.

2.6.2 Local meteorology

Climatological data from Winston-Salem and Greensboro airports (about 35 miles NE of the site) and available onsite data have been used to assess local meteorological characteristics of the site.

Mean monthly temperatures at the site may be expected to range from about 39°F in January to about 78°F in July.[1,2] Record extreme temperatures in the site area have been 104°F and -10°F.[1]

Annual average precipitation[2] in the site area is about 42 in. The maximum mean monthly precipitation of about 4.8 in. occurs in July, while the minimum mean monthly precipitation of about 2.7 in. occurs in October and November.[2] Annual average snowfall[2] is about 9 in.

Wind data[3] from the 30-ft level at the Perkins site for the period October 11, 1973 through October 10, 1974, indicate prevailing wind directions from the SW (12%) and the NE (10%). These predominant wind directions evidently reflect drainage flow patterns under certain synoptic conditions. Winds from the SSE and S occurred least frequently at about 3.4%. Calms occurred about 3.8% of the time. The average wind speed at the 30-ft level for this time period was 4.3 mph. The onsite wind rose for the 30-ft level for the period October 11, 1973 through October 10, 1974, is presented in Fig. 2.5.

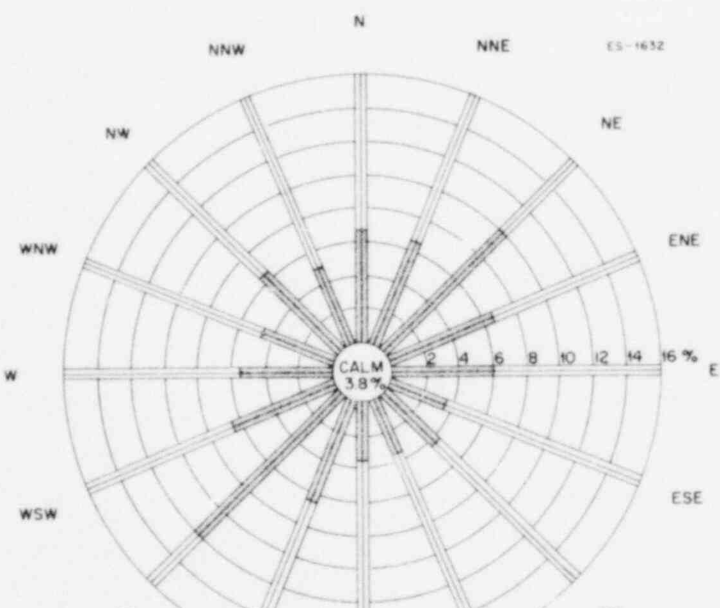

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Fig. 2.5. Perkins onsite wind rose at 30 ft above ground level, October 11, 1973 through October 10, 1974.

2.6.3 Severe weather

The PNS site may be affected by thunderstorms, tornadoes, tropical storms, and hurricanes. Thunderstorms can be expected to occur on about 47 days per year, with the period May through August having 36 thunderstorm days.[2]

During the period 1955-1967, 17 tornadoes were reported in the one-degree latitude-longitude square containing the site, giving a mean annual frequency of 1.3.[4] The computed recurrence interval for a tornado at the plant site is 1000 years.[5]

In the period 1871-1971, 27 tropical storms, hurricanes, and depressions passed within 50 miles of the site.[6] The "fastest-mile" wind speed,[2] recorded at Greensboro, was 63 mph.

In the period 1936-1970, there were about 69 atmospheric stagnation cases, totaling about 284 days, reported in the site area.[7] The maximum monthly frequency occurs in October.

2.7 ECOLOGY

2.7.1 Terrestrial ecology

2.7.1.1 Physical characteristics

The primary site is located near the center of the Piedmont physiographic province and is sited on the northwest bank of the Yadkin River. The topography of the site consists mostly of gentle slopes. The center of the exclusion area is located on a high point of land (elev 760 ft), surrounded for the most part by creek valleys with gentle slopes. All of these creeks eventually lead into Dutchman's Creek, a tributary of the Yadkin River. Soils on both uplands and valley slopes belong to the Hopludults (Red-Yellow Podzolic) great soil group and are identified by the Soil Conservation Service as the Cecil, Lockhart, and Wickham series. All three are moderately deep to deep sandy loam over clay or clay loam, are well drained, and have moderate dimensional stability and moderate erodibility (ER, Sect. 2.4.1.2). Both upland and valley slope soils have similar nutrient concentrations (ER, Sect. 2.4.1.3). The terrestrial ecology and impacts of the 1400-acre Carter Creek Impoundment are considered in Sect. 4.

2.7.1.2 Vegetation

The combined effects of topographic variations and soil drainage characteristics, past land use practices, and dynamics of the Yadkin River have led to the establishment of several vegetation types. The site within the boundary fence (931 acres, staff estimate from ER, Fig. 4.1.1-2) is 59.5% forested (554 acres) and 40.5% tilled or abandoned fields and pastures (377 acres); these statistics indicate that the site is similar to most of the surrounding land within 5 miles (ER, Fig. 3.9.1-2). The site and the surrounding area are highly diverse as to land use and vegetation patches, consisting of small patches of forests of various types, pastures, and tilled and abandoned fields.

The forest vegetation data that the applicant has provided to date (ER, Tables 2.7.1 through 2.7.12) indicate that the forests are similar to widespread forests that would be expected to occur in the Piedmont area of North Carolina.[8,9] The forest types, their dominant species, their general locations on the site, and their acreages within the fenced area are given in Table 2.1. There appear to be no unique or unusual forest types located on the site or on applicant-owned property.

The nonforested areas consist of abandoned upland fields (80 acres) and fields and pastures (297 acres). Observations made during site visits by the staff seem to confirm the applicant's general description of the area.

Succession in aquatic areas, leading to the establishment of terrestrial communities, occurs in the following sequence: floating aquatics, cattails, black willow, cottonwood, and boxelder—river birch—water oak. Successional stages on sand bars are forbs, willows, and cottonwoods. Abandoned croplands and pastures on floodplains are quickly invaded by such plants as alder and species of rose and blackberry, followed by sycamore, winged elm, river birch, and other wet-site hardwoods. Abandoned fields on uplands are invaded first by pioneer plants such as wild aster (*Aster pilosus*) and broom sedge (*Andropogon virginicus*), followed by pitch pine and juniper, then shortleaf pine followed by hardwoods. Other successional relationships of forest vegetation are depicted in ER, Fig. 2.7.1-1.

Table 2.1. Forest types of the Perkins Nuclear Station site

Type[a]	Dominant species[b]	Location	Acres[c]
Alluvial forest (6,163)	Boxelder, green ash, river birch	Floodplains	21
Alluvial thicket	Sweet gum, green ash, and rose and blackberry species	River islands or abandoned floodplain	6
Upland thicket	No data	No data	33
Mixed mesophytic hardwood (7, 690)	American beech, shortleaf pine	Lower slopes and valley sides, on well drained soils	180
Mesic pine forest (75)	Shortleaf pine, scrub pine	Low-fertility soils on timbered, burned, and abandoned sites	182
Oak-hickory forest (41, 52)	White oak, mockernut hickory	Upland slopes and ridgetops, on thin, well-drained soils	90
Pine plantations	Loblolly pine	Old fields	44

[a]Numbers in parentheses are forest type numbers of the American Society of Foresters[9] that the given forest types most closely resemble.

[b]Determined with dominance ratings (ER, Table 6.1.4-1).

[c]Acreage of vegetation types in the 931-acre area surrounded by the PNS site fence shown in ER, Fig. 4.1.1-2, as determined from ER, Fig. 5.1.5-2, Amend. 2.

Almost all of the site has been, at one time or another, disturbed by man's activities. Because of clearing during early days of settlement and subsequent activities, virgin forests are completely absent from the site as well as from the entire Piedmont region.[10] The clear-abandon process has been repeated on many lands, resulting in forests of different ages and different stages of succession.

Nonextensive logging, involving mostly selective harvesting of pine, is being conducted by local landowners on the proposed site (ER, Sect. 2.7.1.1.5). Pines are logged from pine plantations, mixed forests, and mesic pine woodlands, which tend to favor and accelerate the establishment of hardwood species.

Because most of the land is sloping, existing vegetation plays an important role in preventing rapid runoff with resultant erosion, loss of soil, siltation of nearby aquatic habitats, flooding, and lowered replacement rates of groundwaters.

2.7.1.3 Fauna

The variety of plant species and vegetation types present provides suitable habitat for numerous vertebrate and invertebrate species. Invertebrate species have not been surveyed but would include such forms as earthworms, slugs, arachnids, and numerous insects.

As determined from a report of probable mammalian species compiled for the PNS site (ER, Table 2.7.1-20) and census data for the site (ER, Tables 2.7.1-21 through 2.7.1-24), 21 mammalian species are known to occur and have been observed on the site, and 42 species are known to occur in the vicinity of the site.

The only endangered mammalian species that could occur on the site is the eastern cougar, but its occurrence in such an agricultural area is so rare that the site can be judged insignificant to the status of the cougar.

Of 241 bird species that could potentially occur on the PNS site, 106 have been observed there by the applicant's consultants. Three endangered avian species that could potentially occur on the site are the bald eagle, peregrine falcon, and the red-cockaded woodpecker. The latter species is the only one that might reside on the site, but to date no individuals have been observed, and none would be expected to occur in the small, dense patches of immature pine woods found on the site. The other two species might occur along the Yadkin River during nonbreeding seasons, but the site should be of no particular importance to them. Use of the Yadkin River by waterfowl is light, and the site is of no particular importance to any given population.

Reptiles and amphibians include 65 species that could potentially occur on the site and 32 species that have been observed on the site. One rare species, the bog turtle, could occur on the site but has not been observed.

2.7.2 Aquatic ecology

The applicant initiated an aquatic ecological monitoring program in September 1973. The Yadkin River has received the major sampling emphasis, because it will be the source of cooling tower makeup water as well as the receiving stream for most liquid effluents released by the plant. Several other environments are being studied in the program: the two onsite creeks that are to be impounded to form the Nuclear Service Water Pond and the auxiliary holding basin; Dutchman's Creek immediately to the west of the site; Carter Creek, which will be impounded to form an 860-acre supplementary storage impoundment; and High Rock Lake, a 15,180-acre Yadkin River impoundment located from 16 (upper end) to 32 miles (dam) below the proposed site (Fig. 6.2). Data collected from October 1973 through October 1974 are presented in the applicant's Environmental Report (ER, Sect. 2.7.2). Specific communities of the aquatic environment are briefly discussed in the following sections.

2.7.2.1 The Yadkin River

The Yadkin River is one of the major rivers draining the North Carolina Piedmont (Fig. 2.4). As it passes the PNS site, the Yadkin River averages about 200 ft in width and 7 ft in depth. The gradient is low (1.56 ft/mile), with current velocities averaging 2.5 fps and ranging from 0.5 to 5.5 fps, depending on river flows. Below the site the river gradually slows as it approaches the High Rock Lake Impoundment. The mean annual river flow measured at the USGS Yadkin College gauge, 5 miles above the site boundary, is 2853 cfs. The historical maximum and minimum daily average flows are 64,100 cfs and 330 cfs, respectively. Highest flows generally occur from February through April while low flows most often occur from July through November (Fig. 5.6).

The Yadkin River is normally quite turbid. During 1973-1974 the total suspended solids content of the Yadkin River averaged 180 mg/liter, equaling about 4000 tons of sediment per day (ER, Table 2.5.0-1).

The predominant bottom substrate of the river is coarse sand and is characteristic of the flat stretches of river. The sand substrates are interspersed occasionally with rocky shoals formed where the river flows over bedrock upcroppings (ER, Fig. 2.5.1-4).

Average monthly water temperatures range from lows of 38 to 40°F in December and January to highs of 75 to 84°F in July and August (ER, Table 2.5.0-1).

2.7.2.2 Primary producers

Primary producers utilize sunlight, carbon dioxide, and water in the process of photosynthesis to produce chemical energy in the form of carbohydrates. Three types of primary producers may be present in a river: rooted aquatic macrophytes, attached algae (periphyton), and algae suspended in the water currents (phytoplankton). In addition, large quantities of terrestrially produced primary production can enter a river in the form of leaf litter, dissolved organics, or sewage wastes.

Aquatic macrophytes

In the course of sampling, the applicant did not report any aquatic macrophytes in the Yadkin River. Their presence would be considered highly unlikely, because the swift currents, high turbidity, high sediment load, unfavorable substrate, and the wide annual fluctuations in water levels would greatly inhibit their establishment.

Periphyton

The predominant sandy substrate of the Yadkin River and the high turbidity of the water are not favorable to the establishment of periphyton communities.[11] Some favorable substrates are present, however, such as the rocky shoals and the numerous fallen logs and stumps along the River's edge. The applicant, using artificial substrate sampling, revealed that the periphyton of the Yadkin River were dominated throughout the year by diatoms. *Nitzschia*, *Melosira*, *Achnanthes*, and *Navicula* were the dominant taxa recognized. Neither the species composition nor the production of periphyton followed any recognizable seasonal trends. Periphyton colonization, survival, and production in the Yadkin River is probably limited by scouring caused by the large sediment load and fluctuating water flows and velocities of the river. Additional data on the periphyton of the Yadkin River is presented in the ER, Sect. 2.7.2.3.

Phytoplankton

The phytoplankton populations present in the Yadkin River probably should not be considered as true phytoplankton. The planktonic flora recognized in the collections probably are not self-sustaining river populations but emigrants from populations present in quiet backwaters and upstream reservoirs and from benthic, periphytic populations that have been washed into the river currents.

A total of 310 phytoplankton taxa were recognized in the first full year of collections from the Yadkin River. Diatoms (Bacillariophyceae) numerically dominated the phytoplankton. The diatoms were followed in abundance by the green algae (Chlorophyceae), blue-green algae (Cyanophyceae), euglenoids (Euglenophyceae), dinoflagellates (Dinophyceae), and cryptomonads (Cryptophyceae), the latter two classes being only rarely encountered.

The densities of phytoplankton were highest in the late spring and early summer and again in the late fall (ER, Table 2.7.2-3). The dominant taxa encountered were diatoms, including *Achnanthes*, *Melosira*, *Navicula*, and *Nitzschia*. The green and blue-green algae did not show as definable seasonal trends as did the diatoms; however, they tended to be present in low numbers in the spring and attained their highest densities in the summer and fall. The most abundant taxa included *Crucigenia*, *Closterium*, and *Selenastrum* among the green algae and *Phaphediopsis* and *Oscillatoria* among the blue-green algae. Generally, the phytoplankton populations in the Yadkin River were quite low in density compared with densities recorded in other rivers.[11] A complete list of the phytoplankton taxa collected is presented in the ER, Tables 2.7.2-1 and 2.7.2-26; additional data is presented in the ER, Sect. 2.7.2.1.

Consumers

In a freshwater ecosystem two groups of consumers are of primary importance in accomplishing the transfer of energy available from phytoplankton and detritus to higher-level consumers such as fish. These organisms are the zooplankton and the benthic invertebrates.

Zooplankton

A large zooplankton community can develop only in still or very slow-moving waters and are inhibited in developing, or are even reduced in size, in turbulent, highly turbid waters such as are characteristic of the Yadkin River.[11] The zooplankton present in a river are generally emigrants from nonplanktonic benthic populations or from planktonic populations present in the backwaters of the river or in upstream reservoirs that have been washed into the river.[11]

The zooplankton community of rivers is often numerically dominated by rotifers.[11] Sampling in the Yadkin River indicated that, numerically, 62% of the zooplankton collected during 1973-1974 were rotifers. The dominant taxa recognized were of littoral origin and included *Euchlanis*, *Brachionus*, *Cephalodella*, *Keratella*, and *Kellicottia*. Other important components of the zooplankton were nauplii, copepods, and cladocerans, comprising 14, 8, and 6%, respectively, of the collections. Though relatively few in number, the copepods and cladocerans, due to their large individual size, often represented over 90% of the total biomass of the zooplankton. Common taxa recognized were *Cyclops*, *Bosmina*, *Eubosmina*, and *Daphnia* (ER, Tables 2.7.2-5 and 2.7.2-31). Two periods of peak zooplankton abundances were noted, the first occurring in November when a maximum of 565/m^3 were collected and the second occurring in May when 538/m^3 were collected. Even these maximum densities are relatively low when compared with average zooplankton abundances recorded in other rivers.[11] A list of the zooplankton species collected in the Yadkin River is presented in the ER, Tables 2.7.2-4 and 2.7.2-29. Additional information on the zooplankton is presented in the ER, Sect. 2.7.2.2.

Benthos

In a river where the zooplankton community is poorly developed (such as the Yadkin), the benthos should be the principal primary consumers in the trophic structure of the river.

Two bottom substrates are present in the Yadkin River, each with a more or less characteristic benthos. The first and principal substrate, sand, is characteristic of the vast majority of the river in the PNS area. Because sand is not a favorable habitat for benthos,[11] the variety and density of benthos found in this substrate were low. Over 98% of the benthos were comprised of Diptera (mostly Chironomidae), Oligochaeta, and Trichoptera. Chironomidae, the dominant taxon, represented over 67% of the total benthos collected. Common taxa recognized were *Polypedilum*, *Rheotanytarsus*, nr. *Demicryptochironomus*, *Orthocladius*, and *Cricotopus*. Other important Diptera included *Culicoides* and *Chaoborus punctipennis*. Chironomid densities in the samples varied from 0 to 4281/m^2 with an average of 377/m^2. Maximum chironomid densities were encountered in late spring and early summer and thereafter decreased, probably due to the emergence of adults (ER, Table 2.7.2-15).

Oligochaete densities followed no definable trends. The average density of oligochaetes in the benthos sample was 107/m^2, with the most frequently recognized taxon being *Nais simplex*.

Maximum densities of Trichoptera were found in late spring and early summer. The densities decreased in later samples, probably due to the emergence of adults. Trichoptera averaged 52/m^2 with the two predominant taxa being *Cheumatopsyche* and *Hydropsyche*.

The rocky shoal areas of the Yadkin River are the second most common substrate type. These rocky areas appeared to support only one benthic taxon in large numbers. This was the trichopteran, *Hydropsyche*, which was found at densities averaging 436/m^2. Sufficient data were not available to establish seasonal trends.

Benthic invertebrate drift

Benthic invertebrate drift was studied by the applicant in September and October 1974. The majority of the drifting organisms collected were Diptera, including chironomid pupae and larvae (71%) and *Chaoborus punctipennis* (8%). The only other abundant taxon was *Hydropsyche* (8%). Terrestrial insects were at times collected in relatively large numbers. The average number of drifting organisms collected was 203 per 100 m^3 (ER, Sect. 2.7.2.5.5). Analyses of the stomach contents of several Yadkin River fishes indicated that the most abundant drifting invertebrates, Diptera and Trichoptera, were also the principal taxa being eaten by the fishes examined (ER, Table 2.7.2-23).

Fish

A total of 40 fish species were collected from the Yadkin River watershed (See Figure 6.1 for sampling sets). In addition, another 22 species are thought to be present in the watershed although they have not been collected by the applicant (ER, Tables 2.7.2-16 and 2.7.2-18).[12] Twenty-five species, comprising seven families, were collected from the mainstream of the Yadkin River (Table 2.2). The cyprinidae (minnows), which include the common carp, dominated the catch both in numbers (31.0%) and biomass (68.8%). Centrarchidae (sunfishes) were second in abundance numerically (28.6%), followed by the Ictaluridae (catfishes, 20.1%) and the Clupeidae (shads, 17.7%) (Table 2.2). The single most abundant species was the bluegill (21.6%) followed by the common carp (18.2%). This section of the river is considered by the State of North Carolina to provide fair fishing; however, locally fishing is popular and productive for white and channel catfish.[13] White bass (*Morone chrysops*) migrate up the Yadkin River out of High Rock Lake and pass the PNS site in the early spring to spawn. Further upstream, migrations are blocked at Idol's Hydroelectric Dam, 19 river miles above the PNS site. As a result, large numbers of fish congregate below the Dam. These fish attract large numbers of fishermen for a brief but very productive fishery.[14] Other species that probably migrate up the Yadkin River to spawn include redhorse (*Moxostoma* spp.), white perch, channel and white catfish, and gizzard and threadfin shad.[14]

Several large fish kills have occurred in the Yadkin River during the last several years. The principal species killed have been gizzard shad, though numerous game and food species have been included at times. The causes of the kills were thought to be influxes of large quantities of untreated sewage wastes from the city of Winston-Salem and toxic effluents from an industry located 16 miles below the PNS site.[15-17]

A larval fish sampling program was initiated by the applicant in August 1974. Preliminary data have been submitted to the staff on day and night sampling conducted through July 8, 1975. Fish larvae were first collected in the Yadkin River on April 21, 1975, and were continuously collected through July 8. The highest densities of larvae, averaging 124 per 1000 m^3, were collected at night during the month of May. Generally, night samples were more productive than day samples; for the entire period from April 21 through July 8, night samples averaged about 62 fish larvae per 1000 m^3 whereas day samples averaged 43 per 1000 m^3. The principal taxa recognized in samples were Catostomidae (suckers), accounting for 82 and 78% respectively, of day and night samples. Ictaluridae (catfish) were second in abundance. Other taxa collected in small numbers included the Clupeidae (shads), Cyprinidae (minnows), Centrarchidae (sunfishes), and Percidae (perches).

Table 2.2. Occurrence and relative abundance of the fish species collected from the Yadkin River, Dutchman's Creek, and the site creeks at the Perkins Nuclear Station, October 1973 through October 1974

Species	Yadkin River		Dutchman's Creek		Site creeks	
	Number	% of total number	Number	% of total number	Number	% of total number
Clupeidae						
Dorosoma cepedianum	116	17.1	37	14.1		
Dorosoma petenense	4	0.6	11	4.2		
Cyprinidae						
Cyprinus carpio	123	18.2	24	9.2		
Hybognathus nuchalis			16	6.1		
Nocomis leptocephalus	1	0.1			18	9.6
Notemigonus crysoleucas	4	0.6	2	0.8	6	3.2
Notropis analostanus	1	0.1	2	0.8		
Notropis niveus	81	12.0	2	0.8		
Semotilus atromaculatus			1	0.4	71	38.2
Catostomidae						
Moxostoma anisurum	11	1.6	7	2.7	1	0.5
Moxostoma papillosum	2	0.3				
Ictaluridae						
Ictalurus brunneus	1	0.1				
Ictalurus catus	87	12.9	10	3.8	1	0.5
Ictalurus melas	1	0.1			2	1.1
Ictalurus nebulosus	3	0.4	4	1.5	2	1.1
Ictalurus platycephalus			1	0.4		
Ictalurus punctatus	44	6.5	2	0.8		
Pylodictis olivaris	1	0.1				
Poeciliidae						
Gambusia affinis	2	0.3	6	2.3	5	2.7
Percichthyidae						
Morone americana			2	0.8		
Morone chrysops			4	1.5		
Centrarchidae						
Lepomis auritus	11	1.6			13	7.0
Lepomis cyanellus	4	0.6	2	0.8	33	17.7
Lepomis gibbosus	3	0.4	9	3.4		
Lepomis macrochirus	146	21.6	80	30.5	20	10.8
Lepomis microlophus	4	0.6	20	7.6		
Micropterus salmoides	21	3.1	7	2.7	14	7.5
Pomoxis annularis	3	0.4	7	2.7		
Pomoxis nigromaculatus	2	0.3	5	1.9		
Percidae						
Perca flavescens	1	0.1	1	0.4		
Total	677		262		186	

Source: ER, Tables 2.7.2-17 and 2.7.2-19.

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Additional data on the fish populations of the Yadkin River, including information on life histories, stomach content analyses, and the length-frequency distributions of several species, are presented in the ER, Sect. 2.7.2.6. The applicant will be required to continue sampling and monitoring programs to provide additional data concerning fish densities and seasonal changes in abundance.

High Rock Lake

High Rock Lake is a 15,000-acre, mainstream, Yadkin River impoundment, the upper reaches of which first become evident about 16 miles below the PNS site. Because the lake is essentially a lentic or nonflowing environment, its aquatic biota differ substantially from that of the Yadkin River. The lake provides good fishing, particularly for crappie, sunfishes, and white catfish.[13] The applicant has extensively studied the biota of the lake, and the data that have been collected are presented in the ER, Sect. 2.7.2.

Dutchman's Creek

Dutchman's Creek is a medium-sized tributary of the Yadkin River which flows past the western edge of the PNS site. The water of the Creek is normally quite turbid (although less turbid than the Yadkin), and the bottom substrate of the Creek is sand. The biota of Dutchman's Creek resembles that of the Yadkin River in most respects. Diatoms were the most abundant component of the phytoplankton throughout the year. The zooplankton community was represented mostly by rotifers although copepods, present in lower numbers, often comprised a larger proportion of the total zooplankton biomass. The benthic community was primarily represented by chironomids and oligochaetes. Fish abundances appeared to be quite high in Dutchman's Creek as catches were often higher than in the Yadkin River; however, this may be a result of the Creek being more easily sampled than the River proper. Common species encountered were bluegill, carp, and catfish. Several white bass were collected in March and April, which may indicate that this Creek is also used for spawning by white bass on their spawning runs out of High Rock Lake. Additional data on the biota of Dutchman's Creek is presented in the ER, Sect. 2.7.2.

Site creeks

The two small creeks that flow through the PNS site are quite similar in nature. Their gradient of flow is small, and the bottom substrate is mostly sand with some gravel riffles present.

The phytoplankton populations of the creeks were quite low in abundance and were all probably periphytic in origin. The dominant taxa are diatoms, except that occasionally relatively high numbers of euglenoids (*Trachelomonas* sp.) and some green algae were encountered. The zooplankton of the creeks were also probably nonplanktonic in origin and were characterized by a high proportion of rotifers, but the relatively fewer numbers of copepods and cladocerans often comprised over 90% of the biomass. The benthos communities of the creeks were much more varied than those of Dutchman's Creek or the Yadkin River. Substantial numbers of mayfly, stonefly, and dragonfly naiads were encountered, often comprising over 50% of the benthic biomass. Numerically, the chironomids and oligochaetes predominated.

The number of fish species encountered in these streams was high (Table 2.2), considering their small flows. Several game and food species were collected, including largemouth bass, green sunfish, redbreast sunfish, bluegill, and black bullheads. Additional information on the biota of the two site creeks is presented in the ER, Sect. 2.7.2.

Carter Creek

The applicant initiated sampling of Carter Creek in January 1975, and some preliminary results are available. The Creek is small (flow 20 to 25 cfs) with a sandy substrate. The biota of Carter Creek appears to be similar to that found in the two site creeks. Fish species collected to date include *Nocomis leptocephalus* (bluehead chub), *Semotilus atromaculatus* (creek chub), and *Lepomis macrochirus* (bluegill) (ER, Carter Creek Questions).

Rare or endangered species

Only one endangered species, the Carolina darter, *Etheostoma collis*, is known to occur in the Yadkin River system. *E. collis* has not been collected by the applicant to date, but is found in some lower Piedmont tributaries of the Yadkin River located well below the site.[12]

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16. North Carolina Department of Natural and Economic Resources, *Report of Fish Kill Investigation, Upper High Rock Lake, Yadkin River at I-85*, Raleigh, North Carolina, 1973.

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3. FACILITY DESCRIPTION

3.1 EXTERNAL APPEARANCE

The Perkins Nuclear Station will be located in rolling terrain on the north side of the Yadkin River about 10 miles due north of Salisbury, North Carolina. The main structures for the power station will be located on elevated portions of the site and will be visible from several vantage points in the surrounding countryside.

One of the noticeable features of the station will be the three domed reactor buildings, each about 220 ft in diam and standing about 160 ft above the finished grade elevation of 710 ft. The centerline distance between the reactor buildings is about 400 ft. Each of the three units will also have a separate turbine-generator building, about 300 x 400 ft and reaching 110 ft above the finished grade level. The nine cooling towers will be located on an 800 x 2200 ft graded site just south of the reactor buildings and have a finished grade level of 730 ft. The 74-ft-high cooling towers will not in themselves be a dominant feature, but the white plumes of water vapor, which may at times rise above the towers and drift for relatively long distances downwind, will be visible for many miles, particularly on clear, cold days in the winter months.

In addition to the reactor and turbine-generator building, each unit will be provided with an auxiliary building. An equipment building and administration building will be shared by the three units at the station.

The applicant states that the architectural style of the station will be contemporary (ER, Sect. 3.1). The reactor buildings will have a concrete exterior surface, and the turbine-generator buildings will have a masonry wainscot topped with colored siding. The station is to be landscaped after construction is complete, using materials that are generally native to the area. The staff finds no reason to doubt that the PNS will have a neat, functional, and generally pleasing appearance.

3.2 REACTOR AND STEAM-ELECTRIC SYSTEMS

The three units at the PNS are identical, with pressurized-water reactors manufactured by Combustion Engineering, Incorporated, and turbine-generators manufactured by the General Electric Company. The reactor fuel is zircaloy-clad uranium dioxide, with a maximum enrichment of 2.9%. Each unit of the nuclear steam supply system has a guaranteed main steam flow of 17,185,000 lb/hr, a warranted output of 3817 MWt and a design output of 4018 MWt. The turbine-generators have a gross rated electrical output of 1345 MWe and a "valve-wide-open" rated capacity of 1387 MWe. The cycle net heat rate is given as 9683 Btu/kWhr, which is equivalent to a thermal efficiency of about 35.3%. The net electrical output for the station (total of three units) is 3840 MWe.

3.3 STATION WATER REQUIREMENTS

The PNS will use water from the Yadkin River to provide makeup for the cooling towers, to provide water for the fire protection system, and to supply water to the filtered water system. The latter provides potable water and supplies the demineralized water system, which furnishes water for steam generator feedwater makeup, the reactor coolant system, etc. An average of about 40,287 gpm (90 cfs), and a maximum of about 54,800 gpm (122 cfs), will be pumped from the river into a Nuclear Service Water Pond,* which will have an area of about 190 acres. The applicant estimates that rainfall and runoff into the pond will exceed the evaporation and seepage losses

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*Based on tentative agreement reached between the applicant and the NCDNER on January 20, 1975, the PNS will not be allowed to contribute, through its consumptive water use, to lessening the Yadkin River flow below 880 cfs. When such consumptive use would cause the flow to fall below 880 cfs, the applicant will be required to release an amount of water equal to its consumptive use from the proposed Carter Creek Impoundment. The pumping rate into the Carter Creek Impoundment is limited to the excess river flow above 880 cfs plus consumptive withdrawal being made at the PNS intake. In addition, the consumptive withdrawal at PNS plus the withdrawal from the Carter Creek Impoundment will not exceed 25% of the total river flow.

by an amount equivalent to about 1240 gpm. This is about 3% of the total water requirement of the PNS. The largest consumptive use of water from the pond is for the cooling tower makeup, which is estimated to average about 40,887 gpm and to have a maximum value of 55,816 gpm. About 5300 gpm will be returned to the river as blowdown from the cooling tower basins. During most periods, the level of water in the pond can be maintained by withdrawal of water from the river, but there may be some short periods of drawdown when tower makeup exceeds the pump-up rate from the river.

A schematic diagram and a listing of the PNS water use, as proposed by the applicant, are shown in Fig. 3.1 and Table 3.1 respectively. More detailed estimates of the flow quantities, including average and maximum values, are given in the ER, Table 3.3.0-1, Amend. 3. Descriptions of the various water systems and the quality of the effluents appear in Sects. 3.5, 3.6, and 3.7.

3.4 HEAT DISSIPATION SYSTEM

3.4.1 Cooling towers

Combined operation of the three units at PNS at rated capacity will result in the discharge of about 26.1 x 10^9 Btu of heat per hour to the environment. This heat will primarily be dissipated to the atmosphere through evaporation of water in wet, mechanical-draft type cooling towers. As indicated in the diagram of the heat dissipation system (Fig. 3.2), makeup water for the cooling towers will be pumped from the Nuclear Service Water Pond, which is supplied with water from the Yadkin River. The blowdown from the cooling towers will be discharged into the Yadkin River about 250 ft downstream of the intake water structure. Average and maximum flow rates and temperatures at design conditions are shown in Fig. 3.2.

Each of the three units at PNS will be provided with three cooling towers. The nine towers will be located on a slightly elevated portion of the site on an 800 x 2200 ft area to be leveled immediately south of the reactor buildings. The towers will be arranged in two rows on about 435-ft centers (ER, Fig. 3.4.0-1, Amend. 3). The towers will be of a new circular mechanical-draft (CMD) type developed by The Marley Company. The design offers the promise of the lower costs and lower visibility (low height) usually associated with mechanical-draft towers, while at the same time providing plume buoyancy forces approaching those attained by the large-diameter plumes discharged from natural-draft cooling towers. A sketch of the CMD towers is shown in Fig. 3.3. The towers for PNS will be about 270 ft in diameter at the base and about 74 ft high overall, and each will have thirteen 28-ft-diam fans arranged within a 170-ft-diam circle. At summer design conditions, about 93% of the heat dissipated by the towers is by evaporation of about 46,000 gpm (102.5 cfs) of water; the remainder is absorbed by heating the air flow through the towers to an exit temperature of about 102°F. At winter design conditions, about 75% of the heat is absorbed by evaporation of about 37,000 gpm (82.4 cfs) of water, and the exit temperature of the air is about 85°F. These and other cooling tower data are given in Table 3.2.

An improved design for the drift eliminators is said by the applicant to limit the drift loss from the towers to less than 0.005% of the condensing water circulation rate. The drop-size distribution of the drift particles, as furnished by the applicant, is given in Table 3.2. The first large-scale CMD tower went into operation in Gulfport, Mississippi, in the spring of 1975. Drift and other performance data are being collected but are not yet generally available. However, preliminary indications are that the performance will be essentially as predicted and that the values shown in Table 3.2 are representative.

Chlorination of the circulating water is expected to control algae and slime-forming microorganisms in the cooling tower system. A free residual chlorine content of 0.5 ppm will periodically be maintained in each circuit for about 1 hr during cold weather; in warmer months the chlorine residual will periodically be maintained at 1 ppm for about 1 hr. The three units at PNS may use a total of 1600 to 3200 lb chlorine per day in the form of sodium hypochlorite fed into the system on the suction side of the circulating pumps. The cooling tower blowdown is expected to have an average total residual chlorine concentration of 0.14 ppm.

3.4.2 Intake structure

A maximum of about 54,800 gpm (122 cfs) of water for cooling tower makeup will be pumped from the Yadkin River. The water will first pass through an intake screen and pumphouse structure and then be held in the Nuclear Service Water Pond where about 60 to 70% of the suspended solids will settle out. The settling basin, or pond, will be impounded by construction of an earth-fill dam about 1400 ft long, as shown in the site plan (Fig. 2.1). The water surface elevation in the river is roughly 650 ft, the pool elevation in the pond is about 695 ft, and the elevation of the cooling tower site is about 730 ft.

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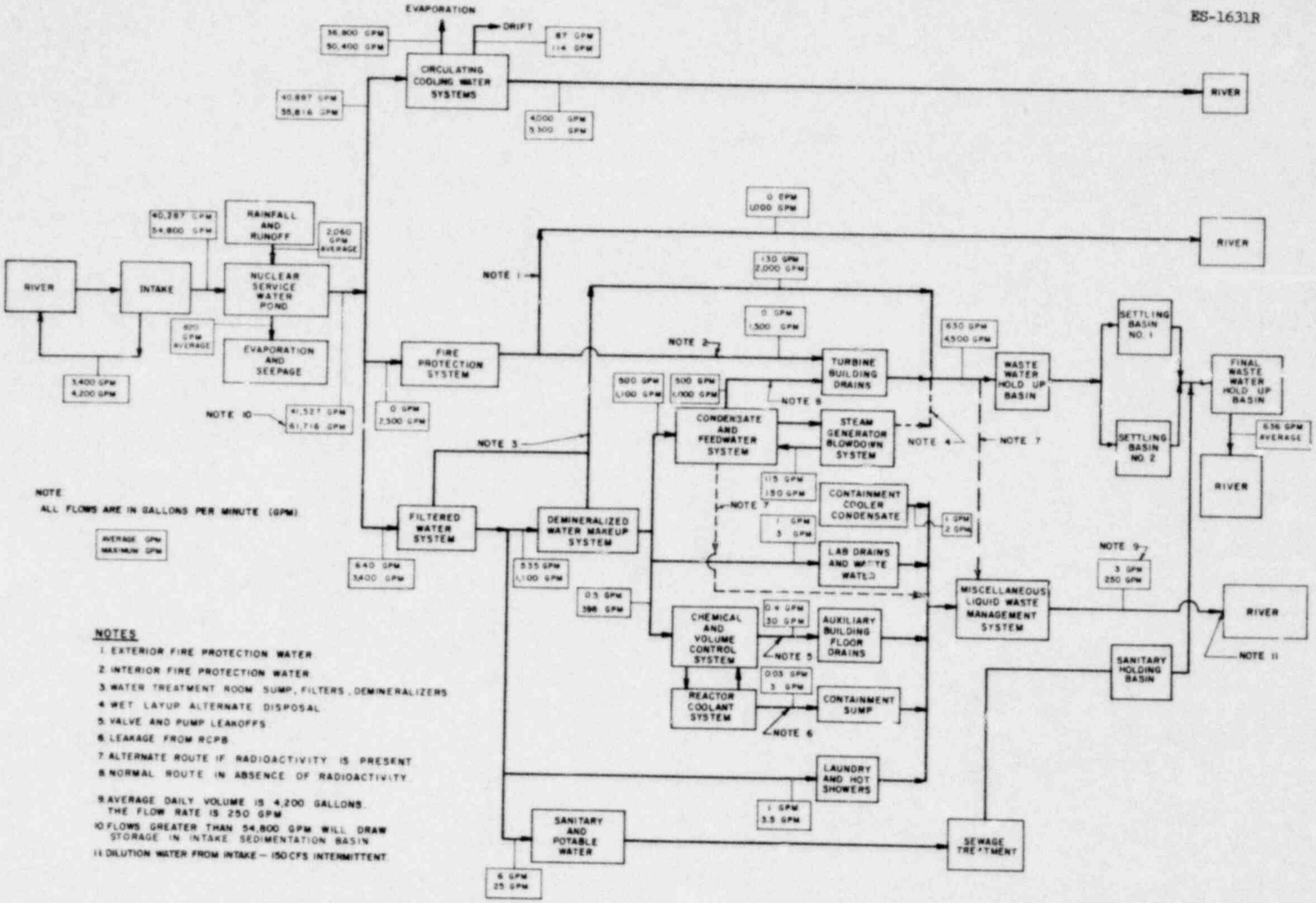

Fig. 3.1. Perkins Nuclear Station water use. Source: ER, Fig. 3.3.0-1, Amend. 3.

Table 3.1. Perkins Nuclear Station water use

Flow	Average gpm	Maximum gpm
River water makeup	40,287	54,800
Plant makeup	41,527	61,716
Rainfall and runoff to Carter Creek storage	4,310	
Evaporation and seepage from Carter Creek storage	2,133	
Cooling tower makeup	40,887	55,816
Cooling tower evaporation	36,800	50,400
Cooling tower drift loss	87	114
Cooling tower blowdown	4,000	5,300
Intake screen backwash	3,400	4,200
Exterior fire protection	~0	1,000
Interior fire protection	~0	1,500
Filtered water makeup	640	3,400
Filtered water waste	20	50
Demineralized water makeup	535	1,100
Demineralizer regenerant waste	33	100
Secondary coolant makeup	509	1,000
Secondary system pump seals and leakage	500	1,000
Turbine building and water treatment drains	553	2,650
Steam generator blowdown (after flashing)	9	30
Containment cooler condensate	1	2
Lab drains and wastewater	1	3
Chemical and volume control system makeup	0.5	396
Primary coolant leakage[a]	0.4	30
Primary coolant leakage[b]	0.03	3
Laundry and shower	1.0	3.5
Sanitary and potable water	6	25
Miscellaneous liquid waste management system discharge	3	250
Miscellaneous liquid waste management dilution system, intermittent	67,320	67,570
Wastewater treatment system discharge	636	

[a]Using alternative route if blowdown is radioactive.

[b]Leakage from Reactor Coolant Pressure Boundary.

Source: ER, Table 3.3.0-1, Amend. 3.

In addition to the water pumped from the Yadkin River for cooling tower makeup, about 150 cfs will occasionally be pumped from the river to dilute the radioactive waste system effluent before it is discharged into the river. The pumps and intake screens for this intake flow will be housed in the same intake structure that houses the cooling tower makeup pumps (ER, Fig. 3.4.1-1, Amend. 3). The dilution water is pumped directly to the river and does not pass through the Nuclear Service Water Pond. It is discharged into the river through the same headwall structure that is used for the blowdown water, as described in Sect. 3.4.3.

The water intake structure on the Yadkin River will be located almost due south of the cooling tower yard, as indicated in Fig. 2.1. The 39 x 98 ft structure will be located at the shoreline and will house four makeup water pumps, each with an 8-ft-wide vertical traveling screen, and three radioactive wastewater dilution pumps, each with a 10-ft-wide traveling screen. A cross-sectional sketch of the intake structure is shown in Fig. 3.4. A concrete apron extends about 20 ft in front of the screens. The apron slopes downward to the screens, with its outer lip a minimum of about 4 ft below the minimum water surface elevation, as shown in the ER, Fig. 3.4.4-2, Amend. 3.

Trash racks, probably consisting of vertical steel bars set on 3- or 4-in. centers, will be located near the face of the intake structure and will extend vertically from the bottom of the structure to above the 645-ft elevation. A skimmer wall will extend downward from the top of the structure to an elevation of about 645 ft to prevent floating trash that passes through the trash racks from impinging on the traveling screens when the pool elevation is higher than normal. Assuming a 122-cfs makeup water flow rate and a 150-cfs radioactive waste dilution flow rate and assuming that the traveling screens are the commonly used 3/8-in. mesh type with 60% free area for flow based on outside dimensions, the staff concurs with the applicant that the face velocity at both sets of screens would be about 0.5 fps.

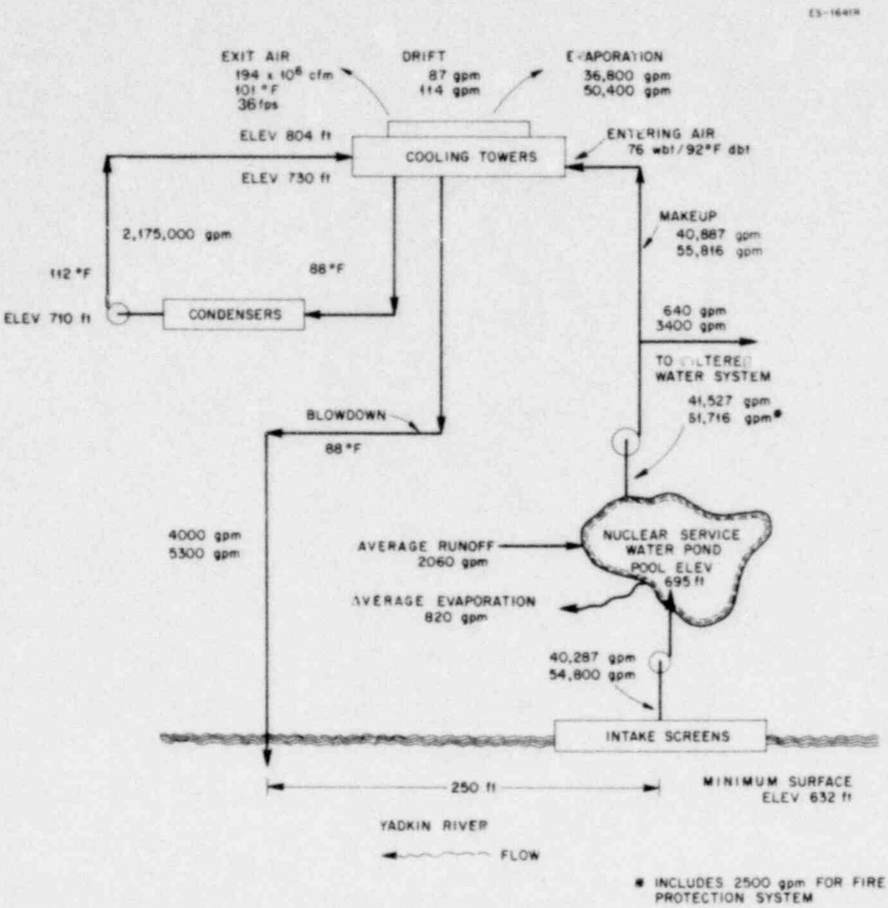

Fig. 3.2. Heat dissipation system for Perkins Nuclear Station. All quantities are total for three units at station; total Q = 26 x 10^9 Btu/hr; average (based on 76% load) and maximum flow rates are shown where applicable; temperatures are at summer design conditions.

3.4.3 Discharge structure

Approximately 5300 gpm (12 cfs) of cooling tower blowdown water at temperatures in excess of the river ambient temperature (by about 10 to 15°F in the summer and 20 to 30°F in the winter) will be discharged into the Yadkin River at a point on the shoreline about 250 ft downstream from the intake structure (ER, Fig. 3.4.1-1). The discharge structure is a simple concrete headwall that serves as a terminus for the 21-in.-diam blowdown water pipe, as indicated in ER, Fig. 3.4.1-2. When the River water surface elevation is at its minimum value of about 632 ft MSL, the submergence of the centerline of the outfall pipe will be about 2 ft. The discharge can be characterized as a single-port, surface-type arrangement, discharging horizontally and perpendicularly to the stream flow at a velocity of 4 to 5 fps.

The same headwall structure will also accommodate the radioactive waste discharge of about 150 cfs (ER, Fig. 3.4.1-2). The applicant plans for the radioactive wastewater to be discharged from three ports, one discharging straight across the stream, the second at a 20° angle with the shoreline, and the third at a 50° angle with the shoreline. The discharge velocity from these ports is given as 7 fps. The frequency of the radioactive discharge will vary from once every day to once every 30 days, as need dictates. Because the temperature of the radioactive waste dilution water is essentially the same as the river ambient temperature, this discharge will have no thermal impact on the river.

The applicant states, and the staff agrees, that the rocky character of the river bed in the vicinity of the discharge structure eliminates any concern for bottom scouring in front of the discharge ports.

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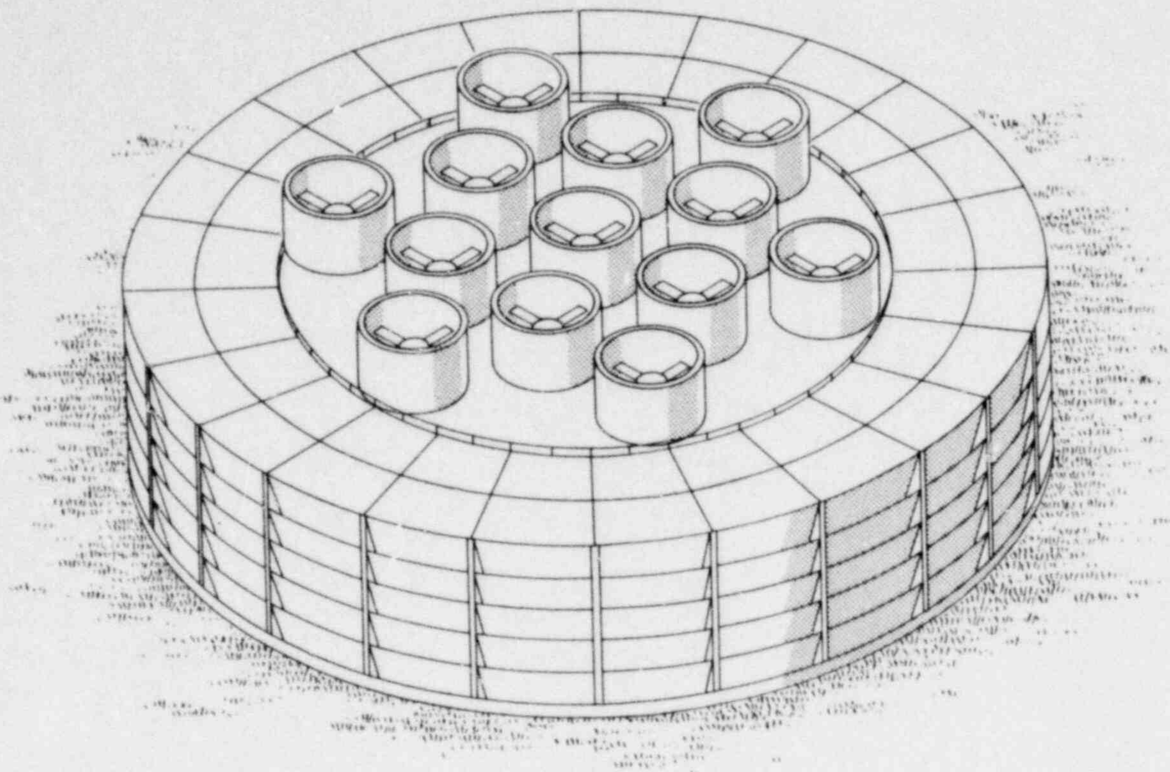

Fig. 3.3. Conceptual sketch of circular mechanical-draft cooling tower proposed for Perkins Nuclear Station. The tower is about 270 ft in diam and 74 ft high.

3.5 RADIOACTIVE WASTE SYSTEMS

During the operation of the Perkins Nuclear Station Units 1, 2, and 3, radioactive material 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 minimize the quantity of radioactive nuclides ultimately released to the atmosphere and to the Yadkin River. The liquid, gaseous, and solid radioactive waste systems will be separate for each unit with no subsystems or components shared with other units.

The waste handling and treatment systems to be installed at the station are discussed in the applicant's Preliminary Safety Analysis Report and Environmental Report, both dated May 24, 1974. In these documents, the applicant has prepared an analysis of the treatment systems and has estimated the annual radioactive effluents.

In the following paragraphs, the waste treatment systems are described, and an analysis based on the staff's model of the applicant's radioactive waste systems is given. The model has been developed from a review of available data from operating nuclear power plants that have been adjusted to apply over a 40-year operating life. The coolant activities and flows used in the evaluation are based on experience and data from operating reactors. As a result, the parameters used in the staff model and the calculated releases vary from those given in the applicant's evaluation. The resulting differences do not lead to adverse effects in the evaluation. The staff's evaluation was based on the parameters in USAEC Report WASH-1258 and the "Concluding Statement of Position of the Regulatory Staff, ALAP LWR Effluents" (with Attachment, "Draft Regulatory Guides for Implementation"), Docket No. RM-50-2, February 20, 1974. The staff's liquid and gaseous source terms were calculated by the PWR-GALE Code as described in "Draft Regulatory Guide 1.BB," which is a revised version of the ORIGEN and STEFFEG codes given in WASH-1258. The principal parameters used in the staff's source term calculations are given in Table 3.3.

On April 30, 1975, the Nuclear Regulatory Commission announced its decision in the rule-making proceeding (RM-50-2) concerning numerical guides for design objectives and limiting conditions for operation to meet the criterion "as low as practicable" for radioactive material in light-

Table 3.2. Cooling tower data – Perkins Nuclear Station[a]

Type of tower		Circular mechanical-draft
Total number of towers		Nine
Number of towers per cluster[b]		Three
Distance between towers in cluster		138 m (453 ft) [450]
Tower height		22.6 m (74 ft)
Base diameter		77 m (254 ft) [270 ft]
Equivalent radius of top		17.2 m (56.4 ft)
Approach temperature	12°F summer	29.5°F winter
Range	24°F summer	24°F winter
Design wet-bulb temperature	76°F summer	40°F winter
Design dry-bulb temperature	92°F summer	48°F winter
Design exit air temperature	101.2°F summer	85°F winter
Heat dissipated by towers[c]	1829.2 mg-cal/sec	(26.12×10^9 Btu/hr)
Air flow rate[c]	191.5×10^6 cfm	(815.81×10^6 lb/hr)
Air exit speed	11.0 m/sec	(36 fps)
Circulating water flow rate[c]	2,175,000 gpm	(4846.3 cfs)
Water/air ratio	1.74 lb/lb [1.63]	
Evaporation rate, design[c]	48,021 gpm summer [47,800 gpm]	
Blowdown rate[c]	5,300 gpm summer	5,300 gpm winter
Drift rate[c]	0.0052% of circulating water flow	(114 gpm)
Makeup rate, max[c]	55,816 gpm	
Concentration factor for solids	10	
Dissolved solids in makeup	53 ppm (av)	98 ppm (max)
Drop-size mass distribution in drift:		
0–60 μ, 50%	225–325 μ, 8%	
60–125 μ, 22%	325–425 μ, 6%	
125–180 μ, 5%	425–525 μ, 5%	
180–225 μ, 4%		

[a]When different values were used in staff's analysis, data are given in brackets.
[b]For calculating multiple-plume effect.
[c]Total for all towers (nine) at Station.

water-cooled nuclear power reactor effluents. This decision is implemented in the form of a new Appendix I to 10 CFR 50. To effectively implement the requirements of Appendix I, the NRC staff is currently reassessing the parameters and mathematical models used in calculating releases of radioactive materials in effluents to comply with the Commission's guidance. In the interim, until such reassessment is completed and can be applied to the Perkins Station, the staff has prepared upper bound estimates of the potential effect on the estimated radiological environmental impact set forth in the FES. The dose estimates discussed in Sect. 5.4 used revised estimates of expected annual releases of radioactive materials in effluents from the Perkins Station. The applicant has stated (Appendix B) that he does not intend to remove any currently proposed equipment or systems and will provide such additional equipment determined to be necessary to meet the requirements of Appendix I as a result of a detailed evaluation.

On the basis of information currently available on the technology to reduce radioactive effluent releases, the Perkins Station can be designed to meet the requirements of Appendix I.

3.5.1 Liquid waste

Liquid radioactive wastes will be processed on a batch basis to permit optimum control of releases. Prior to being released, samples will be analyzed to determine the types and amounts of radioactive materials present. Based on the results of the analysis, the wastes will either be retained, recycled, or reprocessed, or they will be released under controlled conditions to the Yadkin River. A signal from a radiation monitor will automatically terminate liquid waste discharges if radiation measurements exceed a predetermined level in the discharge line. A simplified diagram of the liquid radioactive waste treatment systems is shown in Fig. 3.5.

The liquid waste management systems will be divided into two principal systems: the boron recovery system (BRS) and the miscellaneous liquid waste management system (MLWMS). The BRS will process high-grade water from the reactor coolant system, which will normally be recycled for

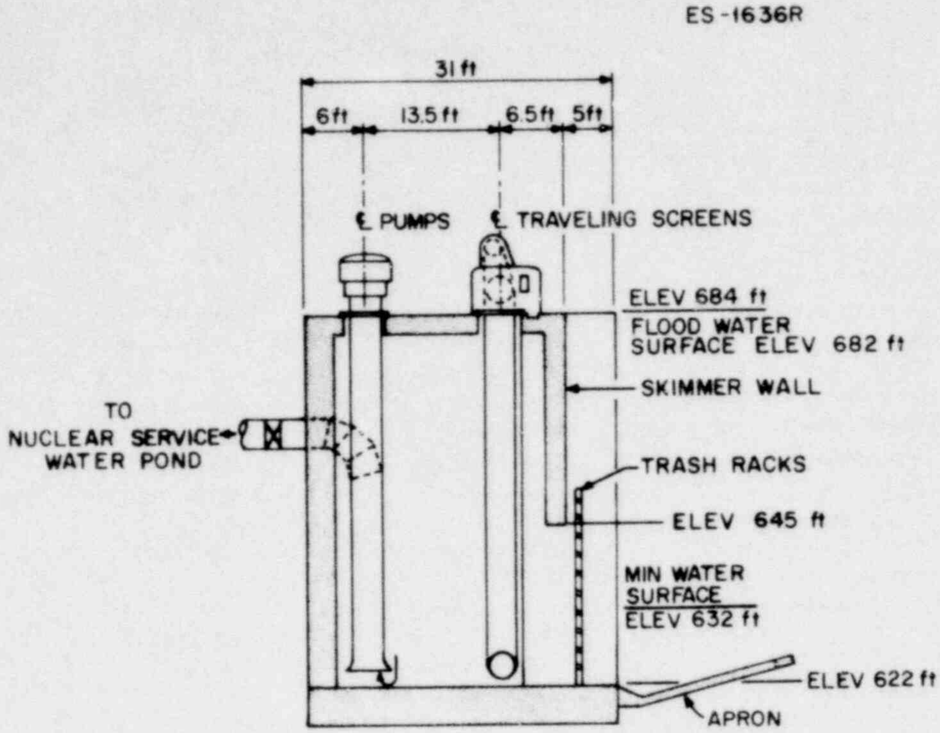

Fig. 3.4. Sketch of cross section through intake water structure on Yadkin River.

reuse in the plant after treatment. The BRS consists of holdup tanks, mixed-bed demineralizers, a gas stripper, an evaporator, and a distillate demineralizer for processing. The MLWMS will process water from equipment drains, building sumps, and laundry wastes. Some of these wastes will be discharged after treatment, and some will be reused. The MLWMS will consist of holdup tanks, an evaporator, and a distillate mixed-bed demineralizer for processing.

In addition to the preceding systems, the chemical and volume control system (CVCS) is considered in the evaluation. The CVCS will process reactor grade water through mixed-bed and anion demineralizers to maintain boron control and reactor coolant purity and will be the principal input to the BRS. Liquid leakage to the turbine building will be collected in the turbine building floor drain system and will be released without treatment.

The boron recycle system (BRS)

Primary coolant will be withdrawn from the reactor coolant system at approximately 84 gpm and processed through the CVCS. The letdown stream will be cooled and reduced in pressure, then filtered and processed through one of two mixed-bed demineralizers, and finally sent to the volume control tank. The second mixed-bed demineralizer will be used intermittently for lithium and cesium control. Boron concentration will be controlled during core life by feed and bleed operation to the BRS, and at the end of core life, it will be controlled by an anion de-borating demineralizer in the CVCS. Radionuclide removal by the CVCS was evaluated by assuming 84-gpm letdown flow at primary coolant activity (PCA) through one mixed-bed demineralizer. Deaerated hydrogenated equipment drain wastes in the reactor containment will be collected in the 2850-gal reactor drain tank. High-purity liquid wastes outside the reactor containment will be collected in the 10,500-gal equipment drain tank. The drain wastes from these tanks will be combined with the shim bleed from the CVCS letdown stream and routed to a mixed-bed demineralizer and a gas stripper, where fission product gases and hydrogen will be removed. The stripped liquid will then be collected in the 450,000-gal holdup tank for decay and will be processed through a 20-gpm evaporator and a mixed-bed demineralizer. The staff calculated the shim bleed input activity by applying the decontamination factor (DF) for the mixed-bed demineralizers to the shim bleed stream, assuming a 30-gpm shim bleed flow and CVCS output activity. The combined reactor drain tank and equipment drain tank input flow to the BRS was assumed to be 240 gpd at PCA. Radioactive decay during collection in the holdup tanks was calculated in the PWR-GALE code. The collection time was calculated to be 38 days assuming the 450,000-gal holdup tank will be filled to 80% capacity using the combined shim bleed and reactor equipment drain flow rate of 4720 gpd.

Table 3.3. Principal parameters and conditions used in calculating releases of radioactive material in liquid and gaseous effluent from Perkins Nuclear Station Units 1, 2, and 3

Reactor power level (MWt)	3990
Plant capacity factor	0.80
Operating power fission product source term	0.25%
Primary system	
Mass of coolant (lb)	5.71×10^5
Letdown rate of CVCS (gpm)	84
Shim bleed rate (gpm)	3.1
Leakage rate to secondary system (lb/day)	110
Leakage rate to auxiliary building (lb/day)	160
Leakage rate to containment building (lb/day)	240
Frequency of degassing for cold shutdowns (per year)	2
Secondary system	
Steam flow rate (lb/hr)	1.72×10^7
Mass of steam/steam generator (lb)	1.81×10^4
Mass of liquid/steam generator (lb)	1.63×10^5
Secondary coolant mass (lb)	2.81×10^6
Rate of steam leakage to turbine building (lb/hr)	1.7×10^3
Dilution flow (gpm)	4.0×10^3
Containment building volume (ft^3)	3.3×10^6
Frequency of containment purges (per year)	4
Iodine partition factors (gas/liquid)	
Leakage to containment building	0.1
Leakage to auxiliary building	0.005
Steam leakage to turbine building	1
Steam generator (carryover)	0.01
Main condenser air ejector	0.0005

Decontamination factors (liquids)

	Boron recycle	MLWMS	SGB/VCC (condensate treatment)
I	1×10^5	1×10^4	1×10^2
Cs, Rb	2×10^4	1×10^5	1×10^1
Mo, Tc	1×10^5	1×10^6	1×10^4
Y	1×10^4	1×10^5	1×10^3
Others	1×10^6	1×10^5	1×10^2

	All nuclides except iodine	Iodine
Waste evaporator DF	10^4	10^3
BRS evaporator DF	10^3	10^2

	Cation[a]	Anion[a]	Cs, Rb
Mixed bed demineralizer (Li_3BO_3)DF	10	10	2
Mixed bed demineralizer (H^+OH^-)DF	10^2(10)	10^2(10)	2(10)
Cation demineralizer DF	10^2(10)	1(1)	10(10)
Anion demineralizer DF	1(1)	10^2(10)	1(1)
Powdex DF	10(10)	10(10)	1(10)

(Note: for two demineralizers in series, the DF for the second demineralizer is given in parentheses.)

Removal by plateout	Removal factor
Mo, Tc	10^2
Y	10

Containment building	Recirculation system
Flow rate	1.8×10^4 cfm
Operating period/purge	16 hr
Mixing efficiency	70%

[a] Does not include Cs, Mo, Y, Rb, Tc.

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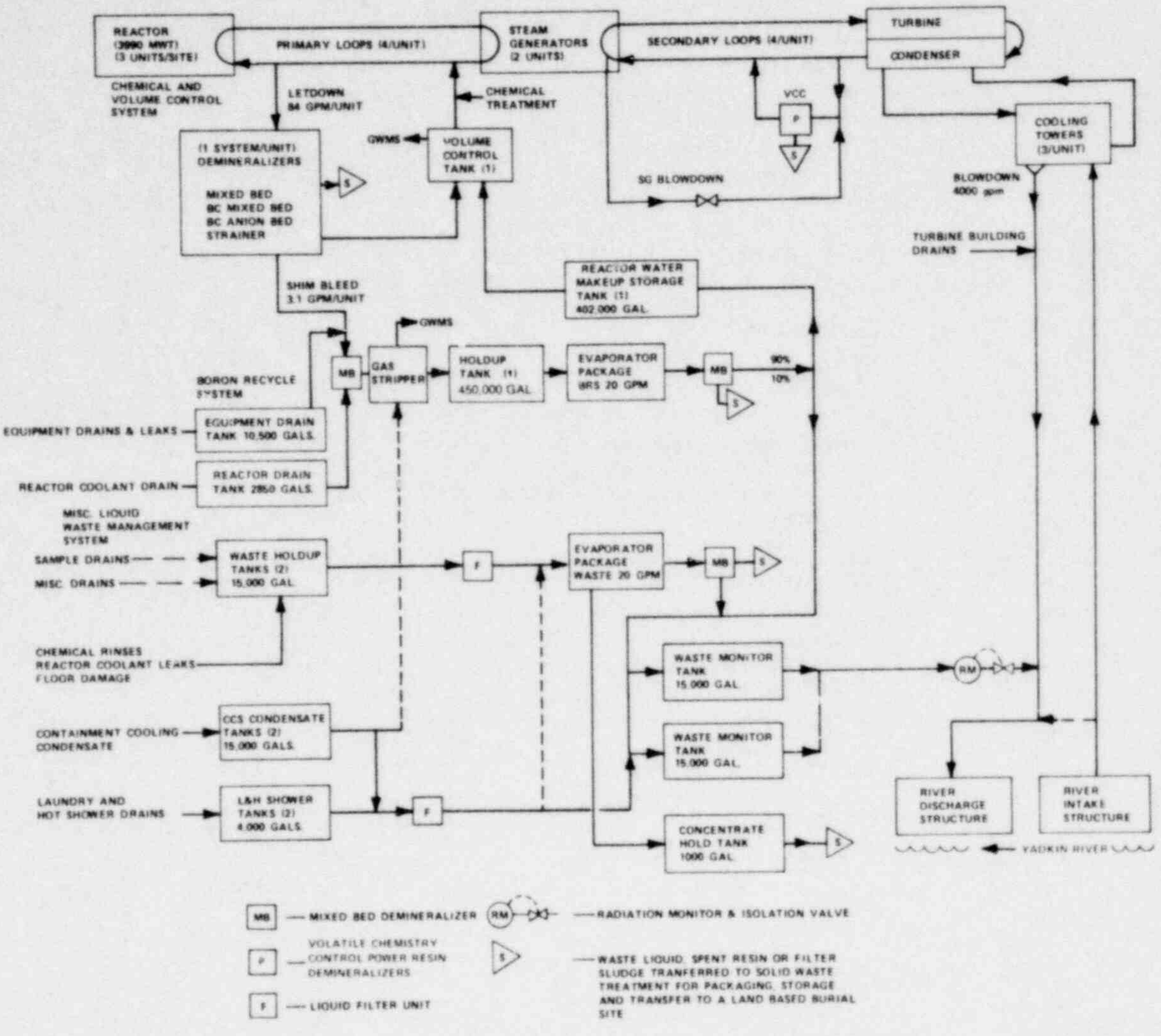

Fig. 3.5. Liquid radioactive waste system, Perkins Nuclear Station Units 1, 2, and 3.

Radionuclide removal by the BRS was based on the parameters in Table 3.3 for an evaporator and the mixed-bed demineralizers in series. Additional credit for radioactive decay during processing was based on transferring the holdup tank liquid at the evaporator flow capacity (20 gpm). In its evaluation, the staff assumed that equipment downtime, anticipated operational occurrences, and tritium control will result in approximately 10% (138,000 gal/year) of the evaporator condensate stream being discharged to the Yadkin River. The applicant also assumed that a portion of the BRS stream will be discharged for primary coolant tritium control.

Miscellaneous liquid waste management system (MLWMS)

Aerated radioactive wastes will be collected in one of two equipment and floor drain waste tanks, one of two laundry drain tanks, and one of two containment cooler condensate tanks. Liquid wastes from these tanks will be processed through an evaporator and a mixed-bed demineralizer. Based on staff parameters and information supplied by the applicant, the staff calculated the liquid waste flow to be approximately 1375 gpd at 0.08 PCA.

By assuming that one of the two 15,000-gal waste tanks will be filled to 80% capacity, the staff calculates the collection time to be nine days. Radionuclide removal by the liquid waste system was based on the parameters in Table 3.3 for an evaporator and a mixed-bed demineralizer. Additional credit for radioactive decay during processing was based on transferring the tank liquid at the evaporator flow capacity (20 gpm) and holdup in one of the two 15,000-gal waste condensate tanks. The staff's evaluation, like the applicant's, assumes that all of the processed waste liquid will be discharged to the environment.

Wastes from laundry and contaminated showers will be collected in one of two 4000-gal laundry drain tanks for analysis. Normally, these wastes will be of low activity and will be filtered and discharged to the environment. They may be processed by the evaporator-demineralizer in the liquid waste system if the activity is above a predetermined value. Based on its parameters, the staff assumed that the laundry and shower tank activity will be approximately 10^{-4} $\mu Ci/cm^3$ and the release rate will be 450 gpd.

Two 4000-gal containment cooler condensate tanks will be provided to collect condensation from humidity in the containment ventilation system. Because this liquid will normally be of low activity, it will be filtered and discharged to the environment. If the activity is above a predetermined level, liquid will be processed by the liquid waste system. Based on staff parameters and information supplied by the applicant, the containment cooler condensate tank input stream flow was calculated to be approximately 315 gpd at 0.005 PCA.

Blowdown from the steam generators will be treated and recycled through the secondary loop condensate polishing demineralizers. Four of these five nonregenerated, powdered resin demineralizers will provide volatile chemistry control for the U-tube steam generators and filtration for the blowdown stream. The staff's evaluation, like the applicant's, assumed that the blowdown rate will be approximately 10% of the main steam rate with no blowdown waste release and that the condensate polishing demineralizers will process 65% of the secondary loop flow rate. Spent resins from these demineralizers will be transferred to the solid waste system.

Turbine building floor drains

Waste collected by the turbine building floor drain system will contain radioactive materials from secondary system leakage as well as leakage from nonradioactive cooling systems. The applicant has indicated that these wastes will not be treated prior to discharge. The staff assumes that the activity discharged through the turbine building floor drain system will be due to secondary system condensate leakage at a rate of 5 gpm. The quantity of activity released through this path will be approximately 0.04 Ci/year. The staff concludes that the release of the turbine building floor drain wastes without treatment is acceptable.

Liquid waste management system summary

Based on the staff's evaluation of the waste treatment systems using the parameters in Table 3.3, the release of radioactive materials in the liquid wastes discharged to the Yadkin River was calculated to be 0.4 Ci/year per reactor, excluding dissolved gases and tritium (see Table 3.4). Based on previous experience at operating reactors, the staff estimates the tritium releases to be 350 Ci/year. The applicant has estimated the normal releases to be approximately 0.1 Ci/year per reactor, excluding dissolved gases and tritium, and 77 Ci/year per reactor of tritium, based on an operating fission product source term of 0.1% as compared with the staff's value of 0.25%.

The radioactivity in liquid effluents from Units 1, 2, and 3, exclusive of tritium and dissolved noble gases, will be less than 5 Ci/year per reactor. The whole body and critical organ doses will be less than a total of 5 millirems/year from the three units at the site.

3.5.2 Gaseous waste

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 condenser air ejector exhausts, ventilation exhausts from the auxiliary and turbine buildings, and gases collected in the reactor containment building. The principal system for treating gaseous wastes will be the gaseous waste management system (GWMS). The GWMS will collect and store gases stripped from the primary coolant in a cover gas nitrogen loop containing a recombiner, compressors, and three pressurized storage tanks. Each reactor will have its own GWMS.

The auxiliary building ventilation exhausts, fuel handling area, and containment purge exhausts will be processed through HEPA filters and charcoal adsorbers prior to release. In addition, the containment atmosphere will be recirculated through HEPA filters and charcoal adsorbers prior to purging. The main condenser air ejector exhausts will be processed through charcoal adsorbers. Noncondensible substances from the steam generator blowdown will be vented to the main condenser. Ventilation exhausts from the turbine building will be released without treatment. The gaseous waste treatment system is shown in Fig. 3.6.

Table 3.4. Liquid radioactive source term (Ci/year/unit) for Perkins Nuclear Station Units 1, 2, and 3

Radionuclide	Ci/year	Radionuclide	Ci/year
Br-82	0.00009	Ba-139	0.00005
Br-83	0.0001	Ba-140	0.0002
Rb-86	0.00005	La-140	0.0001
Sr-89	0.0002	Ce-141	0.00003
Sr-91	0.00008	Ce-143	0.00001
Y-91*m*	0.00003	Pr-143	0.00003
Y-91	0.0001	Ce-144	0.00007
Zr-95	0.00003	Pr-144	0.00002
Nb-95	0.00003	Nd-147	0.00001
Mo-99	0.0004	Na-24	0.0001
Tc-99*m*	0.0004	P-32	0.00003
Ru-103	0.00002	P-33	0.0001
Rh-103*m*	0.00002	Cr-51	0.0004
Te-125*m*	0.00001	Mn-54	0.00008
Te-127*m*	0.0001	Mn-56	0.001
Te-127	0.0002	Fe-55	0.0004
Te-129*m*	0.0006	Fe-59	0.0002
Te-129	0.0004	Co-58	0.004
I-130	0.0005	Co-60	0.0005
Te-131*m*	0.0007	Ni-65	0.00003
Te-131	0.0001	Nb-92	0.00008
I-131	0.18	Sn-117*m*	0.00003
Te-132	0.01	W-185	0.00002
I-132	0.01	W-187	0.0006
I-133	0.1	Np-239	0.0002
I-134	0.00009		
Cs-134*m*	0.00004		
Cs-134	0.01	All others	0.0001
I-135	0.02	Total (except tritium)	0.4
Cs-136	0.007		
Cs-137	0.01		
Ba-137*m*	0.01	H-3	350
Cs-138	0.00003		

Note: Isotopes with discharges less than 10^{-5} Ci/year/unit are not identified but are included in the "All others" term.

Gaseous waste management system (GWMS)

The GWMS will collect and process gases stripped from the primary coolant. The system will contain an initial inventory of nitrogen that will be continuously replaced by nitrogen as a cover gas transporting radioactive gases removed from the primary coolant. Hydrogen cover gas from the volume control tank and reactor coolant drain tank, gases stripped in the BRS stripper and evaporator, and gases purged from the sample system will enter the GWMS 20-ft^3 gas surge tank. The cover gas will carry with it small amounts of hydrogen gas removed from the primary coolant. The hydrogen will be combined with oxygen in the recombiner and will be removed as water vapor. The remaining radioactive gases will have a negligible effect on the overall gaseous inventory. The nitrogen and radioactive gases will be alternately collected and stored in one of three 700-ft^3 (design pressure of 380 psig) pressurized storage tanks. The storage tanks will collect, store, and release gases in rotation to allow short-lived radionuclide decay. After holdup, the nitrogen, containing long-lived radionuclides, may be reused as cover gas in the primary loop. In this manner, short-lived radionuclides will decay during storage, and long-lived radionuclides will accumulate in the system. The system is designed to hold up gases for long-term storage. However, the applicant has estimated periodic releases to avoid buildup of long-lived isotopes and has estimated releases based on a one-year holdup. The staff based its calculations on release after a 90-day holdup, which will leave Kr-85 (10.7-y half-life) as the predominant radionuclide. The staff assumed gas stripping of the BRS to be 3 gpm on the basis of information provided by the applicant. The staff calculated the GWMS releases to be 456 Ci/year per reactor for noble gases and negligible for iodine. Waste gases displaced from aerated tanks, demineralizers, the BRS, and waste evaporators will exhaust to the gas collection header and will be directed to the plant vent for monitoring and release without treatment. The staff considered these waste gases as infrequent exhausts and included the releases in the auxiliary building

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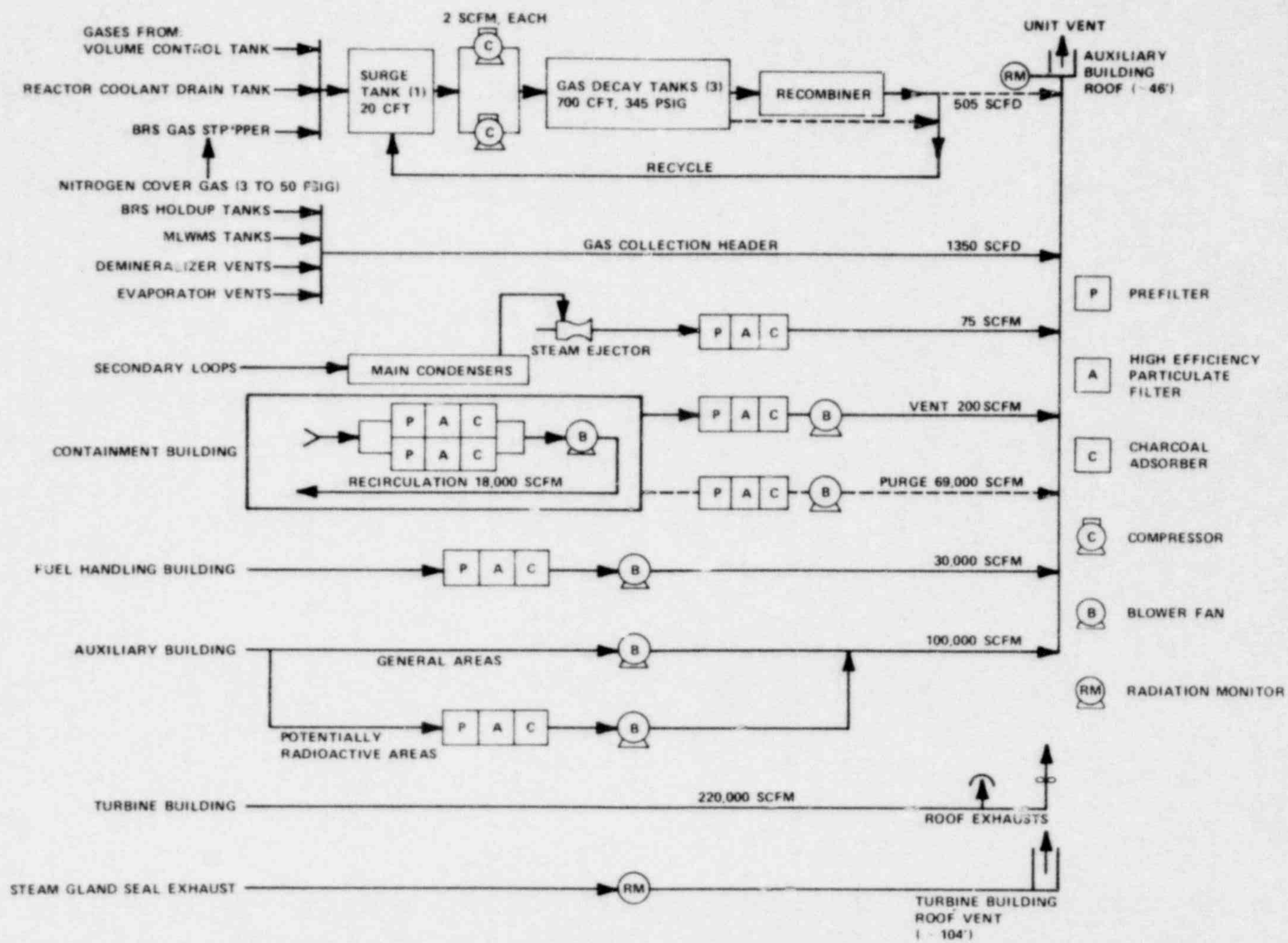

Fig. 3.6. Gaseous radioactive waste system, Perkins Nuclear Station Units 1, 2, and 3.

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releases. The applicant calculated gas releases from the plant based on a higher gas stripping rate (up to 140 gpm) and estimated the combined GWMS and waste gas release to be 3300 Ci/year per reactor of noble gases and negligible amounts of iodine.

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 during containment purges. Prior to purging, the containment atmosphere will be recirculated through HEPA filters and charcoal adsorbers (18,000 scfm) for particulate and iodine removal. Following recirculation, the containment will be purged through HEPA filters and charcoal adsorbers to the atmosphere. The airborne activity was calculated on the basis of the parameters for primary coolant leakage to the containment in Table 3.3. Radionuclide removal was based on 16 hr of recirculation system operation, 70% mixing efficiency, and a DF of 10 for the recirculation charcoal adsorber. The staff assumed four containment purges annually and calculated the containment purge releases to be approximately 9200 Ci/year of noble gases per reactor and 0.017 Ci/year of I-131 per reactor. The applicant did not provide a separate estimate of these releases.

Auxiliary, turbine, waste gas, and fuel handling area releases

Radioactive gases will be released to the auxiliary building due to leakage from primary system components. The ventilation systems will be designed to ensure that air flow will be from areas of low potential to areas having a greater potential for the release of airborne radioactive material. Ventilation air from the fuel handling area and potentially radioactive areas will be passed through HEPA filters and charcoal adsorbers. Ventilation air from other auxiliary building areas will be monitored and discharged to the environment through the plant vent without treatment. The staff's calculated releases were based on the auxiliary building leakage rate and iodine partition factor listed in Table 3.3. On the basis of these parameters, the staff calculates the auxiliary building, waste gas, and fuel handling area releases to be 335 Ci of noble gases per reactor and 0.042 Ci of I-131 per reactor annually. The applicant estimated the auxiliary building releases alone per reactor to be 320 Ci of noble gases and 0.001 Ci of I-131 per year.

Radioactive gases will be released to the turbine building due to secondary system steam leakage. The turbine building releases are not filtered and will go directly to the atmosphere. The staff's calculated release values are based on 1700 lb/hr per reactor of steam leakage to the turbine area, assuming that all of the noble gases and iodine remain airborne as specified in the parameters. On this basis, the turbine area releases were calculated to be less than 1 Ci/year per reactor for noble gases and 0.006 Ci/year per reactor for I-131. The applicant estimated the turbine building releases to be 7.7 Ci/year per reactor for noble gases and 0.002 Ci/year per reactor for I-131.

Steam releases to the atmosphere

The turbine bypass capacity to the condenser will be 55%. The staff 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.

Main condenser air ejector exhausts

The main condenser air ejector 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 noncondensibles phases in the main condensers and air ejectors. Air ejector exhausts will be passed through charcoal adsorbers to the plant vent. Based on the parameters listed in Table 3.3, the staff considered 110 lb/day per reactor of primary to secondary leakage and partition factors of 0.01 and 0.0005 for iodine in the steam generators and main condenser air ejectors, respectively. The staff considered a DF of 10 for the charcoal adsorbers in our evaluation. The staff calculates the main condenser air ejector releases to be approximately 218 Ci/year per reactor for noble gases and 0.003 Ci/year per reactor for I-131. Based on the higher gas stripping rate of the primary coolant, the applicant estimated this release to be 300 Ci/year per reactor for noble gases and 0.002 Ci/year per reactor for I-131.

Gaseous waste summary

Based on the parameters given in Table 3.3, the staff calculates the total radioactive gaseous releases to the environment through the plant vent on top of the containment building to be approximately 10,200 Ci/year of noble gases per reactor and 0.068 Ci/year of I-131 per reactor. The principal sources and isotopic distribution are given in Table 3.5. The applicant has calculated an overall release of approximately 3950 Ci/year of noble gases per reactor and 0.004 Ci/year of I-131 per reactor. The applicant has assumed a DF of 100 vs the staff's DF of 10 for charcoal adsorbers in the auxiliary building, containment purge, and containment recirculation system releases, resulting in a lower I-131 release estimate.

Table 3.5. Gaseous radioactive source term (Ci/year/unit) for Perkins Nuclear Station, Units 1, 2, and 3

Radionuclide	Reactor building	Auxiliary building	Turbine building	Air ejector	Decay tanks	Total
Kr-83m	a	a	a	a	a	a
Kr-85m	9	3	a	2	a	14
Kr-85	40	1	a	a	453	494
Kr-87	2	1	a	a	a	3
Kr-88	11	5	a	3	a	19
Kr-89	a	a	a	a	a	a
Xe-131m	51	2	a	1	3	57
Xe-133m	95	4	a	3	a	102
Xe-133	8910	310	a	200	a	9420
Xe-135m	a	a	a	a	a	a
Xe-135	56	8	a	5	a	69
Xe-137	a	a	a	a	a	a
Xe-138	a	1	a	a	a	1
I-131	0.017	0.042	0.006	0.003	a	0.068
I-133	0.011	0.061	0.004	0.004	a	0.080
H-3						760
C-14						8
Particulates						0.06

[a] Less than 1 Ci/year/unit noble gases, less than 10^{-4} Ci/year/unit iodine.

3.5.3 Solid waste

Solid wastes containing radioactive materials will be generated during station operation. Wet solid wastes will consist mainly of demineralizer resins collected in the 5000-gal spent resin storage tank, evaporator concentrates collected in the 5000-gal evaporator bottoms holdup tank, and miscellaneous chemical reagent wastes. These wastes will be mixed with a solidifying agent, transferred to a shipping container for onsite storage, and then shipped to an NRC burial ground. The staff considers these wastes to be stored for 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-gal drums by using a baling machine. Noncompressible solid wastes will be packaged for offsite shipment. Because 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 the evaluation.

The staff's estimates that approximately 600 drums of wet solid waste containing approximately 10 Ci/drum and 450 drums of dry solid waste containing a total of less than 5 Ci will be shipped offsite annually per reactor. Greater than 90% of the radioactive materials 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 4440 ft^3 of solidified evaporator bottoms totaling approximately 380 Ci, 324 ft^3 of demineralized resins with a total of 8800 Ci, 1500 ft^3 of compressible dry solid wastes, 120 ft^3 of chemical reagent wastes, and 70 filter cartridges will be shipped offsite annually per reactor.

Solid waste summary

All containers will be shipped to licensed burial sites in accordance with NRC and DOT regulations. The solid waste system will be similar to systems that have been evaluated and found to be acceptable in previous license applications. Therefore, the staff finds this solid waste system to be acceptable.

3.6 CHEMICAL AND BIOCIDAL EFFLUENTS

Operation of PNS will result in the discharge of chemical wastes into the Yadkin River. The chemical wastes result from (1) the concentrating effect on the dissolved solids in the intake water due to cooling tower evaporation and subsequent blowdown and (2) the addition of chemicals to the various systems during reactor operation, which eventually are dumped into the effluent stream.

A summary of chemicals discharged to the environment is given in Table 3.6. A partial water analysis of the Yadkin River (intake water) and the results of the concentration effected by the cooling towers are given in Table 3.7. The relative magnitude of the chemicals discharged from the station may be judged by using these tables.

All nonradioactive wastewater from the station, except the cooling tower blowdown, will be discharged to the wastewater treatment system (WWTS). This system (total surface area about 6.2 acres) will consist of a hold-up basin, two settling basins, and a final hold-up basin. The discharges to the Yadkin River from this system will average 636 gpm (for further details, see ER, Sect. 3.6.2).

Table 3.6. Chemicals added to liquid effluent during station operation

Parameter	Maximum total added (lb/day)	Maximum concentration[a] in effluent (mg/l) (blowdown or WWTS discharge)	Incremental increase in Yadkin River (mg/l)[b]
Sodium hydroxide (NaOH)	3,742	283 (Na^+)	0.6
Sulfuric acid (H_2SO_4)	4,584	582 (SO_4^{3-})	1.3
Cyclohexylamine ($C_6H_{11}NH_2$)	99[c]		
Morpholine (C_4H_9NO) (alternative)	493[c]		
Hydrazine (N_2H_4)	49[c]	3.9[d]	0.01
Lithium hydroxide (LiOH)	0.1		
Boric acid (H_3BO_3)	165		
Sodium triphosphate (Na_3PO_4)	12,946[e]	15 (PO_4^{3-})	0.03
Polyacrylate polymer	192	3	0.03
Aminomethylene phosphonate, AMP (as PO_4^{3-})	165	2.6	0.02
Chlorine (Cl_2)	3,390		
Free residual		0.3	0.004
Chlorine reaction products		50	0.14
Dodecylguanidine Hydrochloride (alternative)	617	10	0.09
Polyelectrolyte	100	13	0.03
Ammonia	10	0.3	0.001
Liquid detergent	1,145[e]	2.3	0.007

[a] Based on 636-gpm flow from WWTS and 5300-gpm blowdown from cooling towers.
[b] Based on river flow of 470 cfs.
[c] Yearly total divided by 365.
[d] Based on layup maximum discharge only.
[e] Total used per unit prior to startup only.

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Table 3.7. Maximum increase in chemical effluent concentration due to cooling tower blowdown

Parameter	Maximum intake concentration mg/liter[a]	Cooling tower blowdown concentration, mg/liter[b]	Incremental increase in Yadkin River mg/liter
pH	8.1		
BOD_5	16	160	2.7
Hardness ($CaCO_3$)	26	260	4.4
Calcium (Ca)	5.5	55	0.9
Magnesium (Mg)	1.8	18	0.3
Sodium (Na)	7	70	1.5[c]
Potassium (K)	3.5	35	0.6
Iron (Fe)	0.14	1.4	0.02
Manganese (Mn)	0.1	1.0	0.02
Ammonia (NH_3)	0.4	4	0.07
Nitrate (NO_3)	3.5	35	0.6
Phosphate (PO_4)	2	20	0.3[c]
Chloride (Cl)	8	80	1.5
Fluoride (F)	0.3	3	0.05
Silica (SiO_2)	18	180	3.1
Sulfate (SO_4)	7	70	1.8[c]
Zinc	0.26	2.6	0.04
Aninomethylene phosphonate (as PO_4)		2.6	0.02
Polyacrylate polymer		3	0.03
Dodecylquanidine			
Hydrochloride (alternative)		10	0.09
Chlorine			
Free residual		0.3	0.004
Chlorine reaction products		50	0.14
Total dissolved solids (TDS)	108[d]	1080	18

[a]Source: ER, Table 3.6.2-1.
[b]Assuming ten cycles of concentration.
[c]Include added chemicals from WWTS.
[d]Source: North Carolina Department of Natural and Economic Resources

The operation of this waste facility must be conducted in compliance with all State of North Carolina regulations on the discharge of chemicals, oil, and other wastes. The staff concludes that the system, as proposed, can comply with these regulations.

3.6.1 Condenser cooling system

Makeup water for the cooling towers will be supplied from the sedimentation basin (Nuclear Service Water Pond) (see Fig. 3.1), at a maximum rate of about 55,816 gpm. Evaporation and drift will consume about 50,514 gpm of this amount, and the blowdown will be about 5300 gpm. Because of the concentrating effect of the evaporation, the cooling tower water, and consequently the blowdown, will have a dissolved solids concentration about ten times that of the intake water. Because of the high sediment burden of the Yadkin River, the makeup water will be processed through the Nuclear Service Water Pond, where 60 to 70% of the suspended solids are removed. The remaining solids and precipitates will be stabilized as sols by use of organic corrosion and deposit inhibitor mixtures of a short chain polyacrylate polymer and aminomethylenephosphonate. This inhibitor will be used at a 30-ppm concentration to permit system operation at a pH of 7.8 to 8.25.

Organic growth and chemical scaling in the condenser tubing will be partly controlled by use of a mechanical system of cleaning. Sponge rubber balls, slightly larger in diameter than the condenser tubing, will be recirculated through the condenser tubing to control fouling of condenser heat-transfer surface. The condenser cooling tubes will be stainless steel, which is highly resistant to water corrosion. Therefore, no significant amounts of corrosion products are expected to be released to the Yadkin River.

Various other chemicals will be added to the cooling tower circulating water system. For control of biological growth, a biocide will be added once a day near the cooling tower basin outlet. The applicant proposes the application of 533 to 1066 lb of chlorine (as sodium hypochlorite) daily per unit (1600 to 3200 lb/day total) over a period of 1 hr or more to obtain a free chlorine residual of 1 ppm during warm months and 0.5 ppm in cold weather, the higher concentration being necessary because of more biological growth during the warm months. The units are to be chlorinated sequentially. The free residual chlorine in the cooling tower water will decay to essentially zero in a matter of hours, but because of the large ratio between the volume of water being chlorinated and the volume of water being blown down, the concentration of the added chlorine and its reaction products (chloride ion, chloramines, organic chloramines, and chlorophenols, etc.) will build up in the circulating water to an essentially steady state of approximately 50 ppm. Although the exact composition of this steady state cannot be accurately estimated, the staff agrees that a large fraction of it will be chloride ion. Blowdown will not materially decrease this concentration between chlorinations; therefore, the blowdown from each unit will contain this average concentration at all times. For each chlorination, the resultant concentration in the circulating water effluent (blowdown to river) will initially consist of up to a maximum of 0.3 ppm free residual chlorine and 50 ppm of the reaction products of chlorine which amounts largely of chloride ion with minor amounts of chlorophenols and chloramines, etc. After several hours, the free residual chlorine in the circulating water will decay, leaving only the chlorine reaction products. The applicant states that the cooling tower blowdown is expected to have an average total residual chlorine concentration of 0.14 ppm.

If chlorine-resistant organisms require control, the applicant proposes the use of an organic biocide, such as dodecylguanidine hydrochloride. This biocide will be applied in the 10 to 30 ppm concentration range twice a week, resulting in a 3 to 10 ppm concentration in the effluent.

3.6.2 Filtered water treatment

Water for station use, other than the condenser cooling system, will be obtained from the sedimentation basin (NSW pond). Because this water will contain clay-type colloidal materials, a 2100-gpm water treatment unit, combining usage of a polyelectrolyte coagulant, approved for use in potable water, prechlorination, and three deep-bed upflow type filters, will be used to treat the water taken from the Nuclear Service Water Pond. The applicant estimates that use of 38 to 190 lb of chlorine and 25 to 100 lb of polyelectrolyte will be required daily in this process. The wastes from this system will be routed to the WWTS.

3.6.3 Demineralizer regeneration

To provide the necessary reactor makeup water, a system composed of granulated activated carbon filters just ahead of two mixed-bed demineralizers, with a capacity of 700 gpm each, will be used. These beds will be periodically regenerated with sodium hydroxide and sulfuric acid. The elutant will be routed to the WWTS and neutralized to a pH not exceeding 9. The applicant estimates that the demineralizer process will result in the daily maximum use of 3742 lb of sodium hydroxide and 4584 lb of sulfuric acid.

3.6.4 Reactor coolant chemicals

The chemicals added to the reactor primary coolant system will be present in any effluent only as the result of leakage or letdown for processing. Because the primary coolant will contain radioactive material, any leakage will be processed through the liquid radioactive waste system (Sect. 3.5). Daily use is estimated to be 0.1 lb of lithium hydroxide and 165 lb of boric acid.

3.6.5 Secondary coolant feedwater

The applicant will use hydrazine as an oxygen scavenger and amines for control of pH in the secondary system. The annual use of these substances will amount to 18,000 lb of hydrazine and 36,000 lb of cyclohexylamine (or 180,000 lb of morpholine). Little release is expected from this source, since hydrazine reacts chemically to form nitrogen and water. The other amines follow the same waste routes as the hydrazine. During shutdown, the secondary side of the units will be blanketed with nitrogen and/or filled with condensate quality water containing 200 ppm hydrazine and 10 to 15 ppm ammonia.

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3.6.6 Miscellaneous

Prior to station startup, about 850 gal of liquid detergent will be used during the construction period for degreasing and spray cleaning of pipe assemblies. This waste will be processed through the temporary sewage system (Sect. 3.7.1). Also, prior to startup, hot trisodium phosphate solution will be used for degreasing and cleaning of condensers. The applicant estimates that about 30,000 lb of trisodium phosphate ($Na_3PO_4 \cdot 12H_2O$) and 138 gal of liquid detergent per unit will be used for this purpose. About 720,000 gal of water containing this waste will flow to the WWTS and will be discharged to the river after dilution and neutralization.

3.7 SANITARY WASTES AND OTHER EFFLUENTS

3.7.1 Temporary sewage

During the period of plant construction, the applicant will treat sewage waste in prefabricated extended aeration-type sewage treatment plants that have a combined capacity of 36,000 gpd and use up to 6 lb of chlorine (as hypochlorite) per day in chlorine contact chambers. Sewage solids will be digested by extended-aeration treatment, leaving a chlorinated liquid with a minimum of 0.5 to 1.0 ppm free residual chlorine. This liquid will be pumped to a holding pond, where waste stabilization will be completed during the normal retention period, and ultimately to the river.

3.7.2 Permanent sewage

Domestic sewage from the plant, estimated at 8000 gpd, will be collected in a septic tank and a sand filter with tertiary treatment. The effluent from the underdrains of the filter will be treated in a chlorine contact chamber using up to 2 lb of chlorine (as hypochlorite) per day. The effluent from the chamber, which has a minimum residual free chlorine concentration of 0.5 to 1.0 ppm, will be pumped to the WWTS, and after stabilization, it will ultimately be pumped to the Yadkin River.

Both the temporary and permanent sewage treatment systems will meet all applicable standards of the State of North Carolina.

3.7.3 Auxiliary heating systems

The plant heating boiler, used prior to unit startup, will be electrically fired, and consequently, there will be no gaseous emissions.

The diesel generators, used for emergency power only, will be started and tested for an hour at least once every two weeks. The exhaust gases will pass through a silencer before being discharged. The fuel to be used is fuel oil that has a cetane rating of 37 to 47, 0.6% sulfur, 0.01% ash, and 0.15% carbon residue. The staff concludes that the emissions from this source would be within the limits set in North Carolina State regulations.

3.8 TRANSMISSION SYSTEMS

3.8.1 Switching stations

Two switching stations (SS) will be required for Perkins — a 17-acre 230-kV SS about 800 ft east of the powerhouse and a 19-acre 525-kV SS adjacent to the 230-kV SS on the east. Power from each unit will be transmitted via two separate overhead transmission lines connecting to the 230-kV SS. The switching stations at Perkins will interconnect with the Duke Power Transmission Network by two double-circuit 230-kV overhead transmission lines and one single-circuit 525-kV overhead transmission lines (Fig. 3.7). Provisions for four additional double-circuit 230-kV lines and six additional single-circuit 525-kV lines are included in the design for Perkins.

3.8.2 Transmission lines and routes

Transmission lines proposed for connection of Perkins with the existing distribution system are illustrated in Fig. 3.7. To connect Perkins with Duke Power Company's existing transmission system, two double-circuit 230-kV lines and one single-circuit 525-kV line will be folded into the Perkins switchyard.

Marshall to Beckerdite 230-kV fold-in

One double-circuit 230-kV line will be constructed over a 270-ft-wide, 2.7-mile-long corridor (87.4 acres) that leads from Perkins to a juncture with the Marshall-Beckerdite 230-kV line. Towers are spaced approximately 1100 ft apart and are 110 to 175 ft high. Minimum wire clearance to the ground at any point is 35 ft. Of the total 87.4 acres of right-of-way, about 51.7% is forest, 11.9% is pasture, and 36.4% is active and inactive agricultural land.

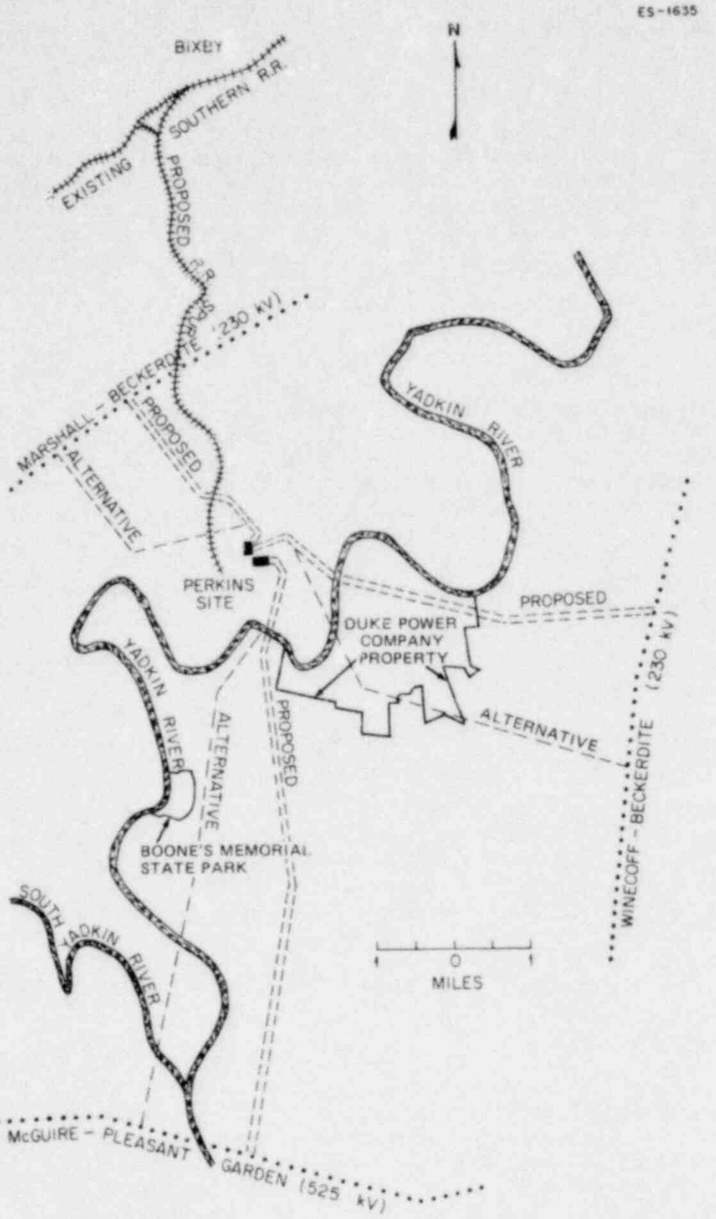

Fig. 3.7. Proposed and alternative transmission line right-of-way routes and proposed railroad spur.

Winecoff to Beckerdite 230-kV fold-in

One double-circuit 230-kV line will be constructed over a 270-ft-wide, 5.5-mile-long corridor (181.3 acres) that leads from Perkins to a juncture with the Winecoff-Beckerdite 230-kV line. Tower specifications and wire clearance are the same as above. Of the total 181.3 acres of right-of-way, about 56.6% is forest, 19.6% is pasture, and 23.1% is active and inactive agricultural land.

McGuire to Pleasant Garden 525-kV fold-in

One single-circuit 525-kV line will be constructed over a 380-ft-wide, 7.9-mile-long corridor (362.0 acres) that leads from Perkins to a juncture with the McGuire-Pleasant Garden 525-kV line. Towers are usually 120 ft high and spaced about 1300 ft apart. Minimum wire clearance to the ground is 45 ft. Of the total 362 acres of right-of-way, 73.9% is forest, 1.0% is pasture, and 24.4% is active and inactive agricultural land.

For all three fold-ins identified above, all forested land will be cleared. None of the proposed lines cross any existing railroads, none require removal of any man-made structures, and none interfere directly with any public facilities. The Winecoff-Beckerdite and McGuire-Pleasant Garden fold-ins each cross the Yadkin River once, involving a total of 3 acres of water surface. The alternative routes are discussed in Sect. 9.2.3.

Existing lines will be modified to accommodate voltage output from the Perkins Nuclear Station. This involves upgrading or replacing towers, as well as replacing or rebuilding conductors, along a total of 47.4 miles of existing lines.

3.9 TRANSPORTATION CONNECTIONS

The applicant will cooperate with the North Carolina Department of Transportation and the Southern Railway Company to alleviate any transportation and traffic problems caused by construction of the Perkins Nuclear Station and to upgrade transportation facilities as necessary.[1]

3.9.1 Railroad spur

The applicant has proposed construction of a railroad spur for use in transporting fuel, radioactive waste materials, and construction materials. A minimum 100-ft-wide corridor, including a total of 77 acres, is required over the approximately 6.5-mile spur that connects with an existing railroad near Bixby, North Carolina (Fig. 3.7). Land use along the proposed route is 20% cropland, 41% pasture, and 39% forest.

3.9.2 Access roads

Two construction access roads, one of which will become a permanent access road (ER, Fig. 4.1.1-2), are proposed by the applicant for accommodating truck and automobile traffic. Both will connect with the existing service road SR 1814, which then connects with North Carolina highway 801. A temporary access road will be constructed on the right-of-way of each of the three fold-ins, requiring a total of about 16.1 miles of temporary access roads.

3.10 CONSTRUCTION DURATION AND MANPOWER REQUIREMENTS

The proposed construction calls for site preparation to begin in March 1976. The scheduled dates for principal activities for Unit 1 are listed below:

Activity	Start date
Site clearing and excavation	March 1976
Intake and discharge structures	January 1977
Plant structures	July-October 1977
Cooling towers	March 1979
Set reactor vessel	December 1979
Preoperational testing	March 1982
Fuel loading	May 1982
Commercial operation, Unit 1	January 1983

The estimated yearly averages of the number of construction personnel needed to maintain construction schedules for Perkins Nuclear Station Units 1, 2, and 3 are as follows:

Year	Number
1976	162
1977	542
1978	1184
1979	1835
1980	2477
1981	2593
1982	2554
1983	2291
1984	1935
1985	1378
1986	746
1987	90

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REFERENCE FOR SECTION 3

1. W. H. Owen, Duke Power Company, letter to W. H. Regan, Jr., Nuclear Regulatory Commission, Aug. 11, 1975.

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4. ENVIRONMENTAL IMPACTS OF CONSTRUCTION

4.1 IMPACTS ON LAND USE

The total land area to be subjected to construction (both temporary and permanent facilities) of PNS and related facilities will include 2185 acres as follows (all acreages given below are approximations):

Land use	Acres
Station and facilities (including two access roads, spillway, intake and discharge structures, and NSW Pond)	617 (staff estimate from ER, Fig. 4.1.1-2, Amend. 2)
Rights-of-way	
Transmission lines (including access roads)	631
Railroad spur	77
Carter Creek Impoundment	860 (staff estimate from ER, Table Q6-1)[1]

The area included within the site boundary fence is 931 acres (staff estimate from ER, Fig. 4.1.1-2), while the primary site owned by the applicant is 2402 acres, including 266 acres still to be purchased (staff estimate from ER, Fig. 2.1-4). The total land to be owned for the Carter Creek Impoundment is 1401 acres, and the total acreage involved in property and right-of-way acquisition is 4511 acres. Land irretrievably lost from agricultural production can be assumed to be the 617 primary site acres cleared during construction and the 77 acres of railroad spur corridor. Although the area covered by ponds could be reclaimed in the future, the remainder of the 617 acres will probably be rendered unsuitable for future agricultural production because of grading, removal of topsoil, and other construction activities.

Acreages of land use types to be affected by Perkins Nuclear Station and related facilities are given in Table 4.1. Agricultural productivity of Davie County is indicated in Table 4.2. These data are discussed in appropriate paragraphs below.

4.1.1 Station site

A diagrammatic land use plan for Perkins is shown in Fig. 2.1 (ER, Fig. 3.1.0-2, Amend. 2). Of the total 617 acres to be directly affected by PNS construction, 59.5% is forested and 40.5% is pasture or farmland, including buildings (staff estimate from ER, Fig. 5.1.5-2). Thus, approximately 367 acres of forest within the site boundary fence will be cleared. This includes 145 acres of forest to be cleared before flooding by the Nuclear Service Water (NSW) Pond, which will also flood 45 acres of abandoned and cultivated fields and pasture. Forest on the remaining DPC-owned land and land to be purchased may be cut, because the applicant has given timber rights to previous landowners (ER, Sect. 2.7.1.1.5). The applicant has not stated the disposal procedure for the cleared timber and slash.

Excavations for building foundations and installations of intake and discharge structures will provide substantial amounts of fill material. Excavation will be confined almost entirely to cleared areas (i.e., most of the area within the exclusion boundary and the acreage covered by the NSW Pond). Grading and site excavation will involve the following estimated quantities of earthwork and dredging:

Wastewater collection basin dam	105,000 yd^3 fill
Nuclear Service Water Pond dam	290,000 yd^3 fill
Nuclear Service Water Pond dike	40,000 yd^3 fill
Station yard (including plant yard, cooling tower yard, and switchyards)	5,000,000 yd^3 fill 7,600,000 yd^3 excavation

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Table 4.1. Acreages of land use types affected by property acquisition by the applicant and by construction of the Perkins Nuclear Station

	Primary station site	Transmission line corridors	Railroad spur	Carter Creek site
Forest				
Cleared	367	416	30	572
Not affected	187	0	0	311
Total	554	416	30	883
Fields[a]				
Cleared	250	<5[c]	47	285
Not affected[b]	127	≈207	0	205
Total	377	212	47	490
Ponds				
Destroyed	0	0	0	3
Not affected[b]	0	0	0	5
Total	0	0	0	8

[a]Includes cropland, pasture, and abandoned fields.
[b]Not affected by construction itself.
[c]Less than 5 acres of land is expected to be covered by towers.

Table 4.2. Agricultural production in Davie County, North Carolina 1974

	Acres	Yield per acre	Total dollar value (thousands)	Dollar value per acre
Corn for grain, bu	7000	80	1400	200
Wheat, bu	3000	50	495	165
Oats, bu	1000	60	90	90
Barley, bu	2000	80	320	160
Sorghum, bu	1000	70	210	210
Soybeans, bu	4000	20	600	150
Silage corn, tons	5000	15	1000	200
Tobacco, lb	805	1630	1312	1630
Cotton, lb	51	300	4.9	96
Hay, tons	6000	3	900	150

Source: Unpublished data obtained from Davie County agricultural extension agents.

The total fill required amounts to 5,435,000 yd^3 compared with the 7,600,000-yd^3 excavation. The applicant did not state where the excess excavated material would be placed, but it may be used as compacted fill in adjacent low areas to serve as construction yard space and as a base equipment storage. Excavation to depths below the existing water table will require dewatering for placement of foundations and substructures. No quantitative estimate of effluent volume is yet available from the applicant; however, all effluents will be detained in temporary holding facilities to reduce turbidity prior to release from the site into the Yadkin River (ER, Sect. 4.1.4.1).

A total of 33 homes and 8 barns will be removed as a result of land acquisition and plant construction (ER, Fig. 2.1-3).

All 2402 acres of the applicant's site property can be considered as removed from productive status. The applicant has indicated that there will be no public recreational uses allowed for the area outside the security fence.

The establishment of the Perkins site (2402 acres) will remove approximately 766 acres of active fields and pastures from possible use. In addition, approximately 207 acres of abandoned fields will be removed from future agricultural use. In itself, this removal of agricultural production should not have a serious impact on production in the surrounding region or in Davie County.

Construction noise is not expected to have any serious impact on surrounding land use because of the large area of applicant-owned property surrounding the exclusion area and because of the sparse human population around the site.

4.1.2 Carter Creek Impoundment

The applicant, after consultation with NCDNER personnel, has tentatively agreed to develop an impoundment on Carter Creek for supplying supplementary water to the Yadkin River during periods of low water flow. The applicant would acquire approximately 1401 acres of land while the impoundment, at 723-ft elevation, would flood about 860 acres. The following acreages of forest types would be flooded, with the total acreage of each to be owned by the applicant in parentheses: hardwood forest, 440 acres (653); mixed pine-hardwood forest, 40 acres (95); pine forest or plantations, 88 acres (137); and pine scrub, 4 acres (11). Also, 285 acres of pastures, cropland, and other cleared lands would be inundated. The remaining few acres to be inundated consist of ponds. (The acreage values above are staff estimates from ER, Table Q6-1 and Fig. Q4-2.)

Creation of the reservoir will affect 13 houses, 3 mobile homes, and 2 farm buildings (ER, Q15). Ten houses and 3 mobile homes will be removed. One tower of an existing 230-kV transmission line would be placed on concrete piers in the reservoir. One 44-kV line would be built from Mocksville to the reservoir, involving a distance of about 8 miles, but its route and other specifications have not been designated by the applicant (ER, Q16).

Merchantable timber and pulp will be sold if a market exists, or it will be burned according to local burning ordinances or removed to approved fill areas (ER, Q7). The earth-filled dam for the impoundment will require about 1.1 million cubic yards of fill, which is expected to be obtained from suitable borrow areas within the proposed reservoir area (ER, Q11). East-west traffic on two rural roads (Davie County roads 1617 and 1618) would be permanently blocked, which would probably cause slight but insignificant increases in traffic through the Town of Advance. Alternative roads are available for persons in the immediate vicinity of the proposed reservoir, so that blocking of the two roads should cause no appreciable hardships to the local residents.

4.1.3 Transmission lines

The applicant has outlined a proposed routing and an alternative routing for each of the three fold-ins that connect with other lines of the applicant's existing system (Fig. 3.7). Comparisons of alternative and proposed routings are given in Sect. 9. With the exception of the Winecoff-Beckerdite tie-in, none of the transmission line routes cross any marshes, wildlife refuges, scenic, historic, or recreational areas, national forests, or wilderness areas. The Winecoff-Beckerdite tie-in crosses Duke-owned game land which had been leased to the state (ER, p. 3.9-2, Figure 3.9.3-1). The only land that will be permanently removed from productive agricultural use is that land immediately under the transmission towers; land use on other areas is not expected to change.

Visual impact of the three fold-ins is expected to be minimal, because they cross strictly rural areas. None of the lines cross any major highways. There should be little, if any, visual impact on persons visiting Cooleemee Plantation 1.3 miles NNE of the site or Boone's Memorial Park about 3.7 miles S of the site center.

In terms of actual construction of the lines proposed for PNS, the principal impact on present land use will be the conversion of 416 acres of forested land to low-growing grass, herbs, and brush. These acreages are approximate values, because the final routes for the transmission lines may shift up to 0.5 miles to either side of the proposed route (ER, Sect. 3.9). Impact on remaining lands (212 acres, not including 3 acres of river surface), active and inactive croplands and pasture, will be limited to impacts from grading and other actions associated with tower siting and stringing of high-tension lines. Except for areas occupied by tower bases and access roads, these lands will be allowed to revert to their former uses following construction. The temporary construction roads on each right-of-way will eventually be seeded to impede erosion.

4.1.4 Railroad spur line

The principal impact associated with construction of the railroad spur described in Sect. 3.9 (Fig. 3.7) will be the permanent removal of about 77 acres of land from other uses, including 15 acres of harvest cropland, 32 acres of pasture, and 30 acres of forest. Details concerning amounts of cut and fill required have not been supplied by the applicant. These activities should be restricted to a 100-ft-wide corridor over the length of the spur.

4.1.5 Access roads

About 0.3 mile of a new road will be constructed on the applicant's property outside the site fence (ER, Fig. 4.1.1-2). This road will traverse primarily cleared land and will have little impact. A second access road will lie within the fenced area. Construction traffic will approach the two access roads from NC 801 and SR 1814.

4.1.6 Makeup and blowdown pipelines and structures

Between 2 and 4 acres of sparse forest on steep slopes adjacent to the Yadkin River will need to be cleared for the proposed intake and discharge structures. Such clearing could result in serious erosion on these slopes. The staff is requiring the applicant to present an erosion control plan that will state the methods to be used to minimize such erosion. Less than 4 acres of forest on less steeply sloping land will need to be cleared for intake and discharge pipelines (staff estimates from ER, Figs. 4.1.1-2 and 3.4.1-1).

4.1.7 Conclusion and summary

A total of 1385 acres of forest — the primary site (367 acres), transmission line rights-of-way (416 acres), railroad right-of-way (30 acres), and Carter Creek Impoundment (572 acres) — will be cleared during construction and these removed from productive forest status. Additional forested acreage near the site may be cleared for the construction of mobile home parks and other living accommodations for personnel involved in PNS site preparation and construction. The staff considers this potential impact to be minor relative to statewide changes in forest acreage.

A total of 1517 acres of cropland and pasture (including abandoned fields) will be lost from active use as a result of property acquisition for the primary site (973 acres of cropland and pasture), railroad right-of-way (47 acres), and Carter Creek Impoundment (497 acres). The acreage under transmission lines is not included here, because present land uses would be allowed to continue under those lines.

Using data on crop acreages and crop dollar value obtained from Davie County officials, the staff estimates that the present dollar value of annual crop production on the 1517 acres of cropland and pasture to be lost from active use is approximately $293,000 (about $193/acre/growing season). This is to be compared with a statewide figure for 1972 crops (*1972 United States Statistical Yearbook*) calculated to be $227/acre/growing season.

The relative impact of the above changes in land use may be compared with land use changes in Davie County for the period 1958-1967 (Table 4.3).[2] For illustrative purposes it is assumed that all land use impacts will occur in Davie County, although some of the impacts will in reality occur in Davidson County.

The clearing or conversion of 1385 acres of forest to other uses will reduce the 1967 inventoried forest acreage of Davie County by 1.9%. This percentage loss may decrease slightly as forests develop on abandoned cropland and pasture on the site. Assuming that all of the applicant's forest and right-of-way forest (2771 acres) is lost from inventoried status, the staff calculated that the inventoried forest acreage in Davie County would be reduced by 3.7% (0.015% statewide).

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The loss of 1517 acres of cropland and pasture would reduce 1967 inventoried cropland and pasture in Davie County by 2.2% (0.02% statewide). Crop production in Davie County (Table 4.2) will probably be reduced also by about 2.2% because of this acreage loss. The staff does not expect that this loss will have serious impacts on the local economy. The acreage not drastically modified by construction and that acreage to be covered by ponds could be reclaimed in the future for agricultural purposes, if necessary.

Land use changes in Davie County (Table 4.3) from 1958-1967[2] involved relatively large losses of cropland (-24.9%, including open land formerly cropped), which were apparently absorbed mostly by urban and built-up areas but partly by pasture. Construction of PNS would cause continuation of this trend and might increase the rate of these changes if industry is attracted to the area.

Table 4.3. Land use inventory for Davie County, North Carolina, as compared with land use for all counties, 1958–1967[a]

Land use	Acres		Change (1958–1967)	
	1958	1967	Acres	Percent
Total inventory	166,650 (28,580,634)	151,780 (27,850,688)	−14,870 (−729,946)	−8.9 (−2.6)
Cropland	64,316 (7,657,791)	48,333 (6,543,769)	−15,983 (−1,114,022)	−24.9 (−14.5)
Pasture	16,427 (1,556,513)	20,176 (1,653,978)	+3,749 (+97,465)	+22.8 (+6.3)
Forest	76,713 (18,055,720)	74,244 (18,355,495)	−2,469 (+299,775)	−3.2 (+1.7)
Other land	9,194 (1,310,610)	9,027 (1,297,446)	−167 (−13,164)	−1.8 (−1.0)
Noninventory[b]	2,350 (2,817,996)	17,180 (3,480,658)	+14,830 (+662,662)	+631.1 (+23.5)
Federal noncropland	0 (1,879,654)	0 (1,877,967)	0 (−1,687)	0 (−0.1)
Urban and built-up areas	1,800 (799,689)	16,600 (1,461,711)	+14,800 (+662,022)	+822.2 (+82.8)
Small water areas[c]	550 (138,553)	580 (140,980)	+30 (+2,427)	+5.5 (+1.8)

[a]Totals for all counties are shown in parentheses.

[b]Noninventory land is the land excluded from farming purposes.

[c]Small water area includes ponds and lakes less than 40 acres and streams less than ⅛ mile wide; acreages attributable to larger bodies of water have been subtracted from total land areas.

Source: North Carolina Soil and Water Conservation Needs Committee, *North Carolina Conservation Needs Inventory*, Raleigh, North Carolina, 1971.

4.2 IMPACTS ON WATER USE

4.2.1 Surface water

The major potential impact on water use will be the increased turbidity in the Yadkin River that will result from activities associated with construction of the river intake and discharge structures at both the plant site and the Carter Creek Impoundment. During site preparation, there will also be some increase in turbidity due to runoff during rainstorms. River uses that could be affected by an increase in turbidity are fishing and other water-related forms of recreation downstream. There are no agricultural, domestic, or metropolitan water withdrawals from the Yadkin River near the Perkins site. The staff considers that if the applicant implements proper erosion controls in the site area, there will be no appreciable impact on the water quality of the Yadkin River.

4.2.2 Groundwater

The groundwater environment at the site will be substantially changed by the proposed construction. During construction dewatering of the various excavations will cause the groundwater table to be lowered (ER, Sect. 4.1.4.2). The applicant also states (PSAR, Sect. 2.4.13.2) that the groundwater in the area moves from the site to the S, SW, and W, flowing towards the Yadkin River, which acts as a groundwater sink for the site and the surrounding area. Because the nearest well is outside the effective zone of influence of such dewatering, the staff considers that construction will have no effect on adjacent wells. However, the staff recommends that the applicant monitor the nearest well (Sect. 2.5.2) and, if any effect is noted, take remedial steps.

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4.3 EFFECTS ON ECOLOGICAL SYSTEMS

4.3.1 Terrestrial

In general, all mitigative activities of the applicant should focus on maintaining the productivity of natural systems, which is especially critical as human demands for foodstuffs, renewable natural resources, and recreational opportunities increase. A major key to maintaining maximal productivity of terrestrial systems is to maintain soil fertility. Therefore, operational procedures that maximize and maintain a productive topsoil should be used. Such procedures will include restriction of grading, leveling, and bulldozing operations, saving and replacing topsoil where such operations must occur, and preventing erosion through rapid and efficient revegetation programs.

4.3.1.1 The primary site

Vegetation

Clearing for construction and site development constitutes an unavoidable disturbance to the immediate environs. The bulk of forest clearing will involve mesic pine forest, mixed mesophytic hardwood forest, and oak-hickory forest, which comprise 48% of the area within the site fence. Fields and pastures comprise another 40% of this area. About 66.3% of the 931 acres within the site fence is expected to be directly involved in construction and subject to clearing (staff estimate from ER, Fig. 4.1.1-2). Assuming that 66.3% of each forest type within the fence will be cleared, the staff estimates that the following acreages of forest types will be lost: mesic pine forest, 119 acres; mixed mesophytic hardwood, 119 acres; oak-hickory forest, 60 acres; upland thicket, 22 acres; pine plantation, 29 acres; alluvial forest, 14 acres; and alluvial thicket, 4 acres. The total forest to be cleared is 367 acres. Impacts resulting from this clearing include elimination of the plant and animal communities in the area to be cleared and increased turbidity in the Yadkin River because of increased erosion. The applicant should minimize these impacts by quickly replacing and stabilizing topsoils, carrying out appropriate landscaping, and restoring vegetation.

Some areas cleared during construction will be allowed to undergo natural succession, thus reverting, after many years, to some semblance of their original condition. For succession to proceed rapidly, however, the topsoil on cleared and graded or eroded areas must be replaced and quickly stabilized with vegetation; otherwise, the re-establishment of vegetative cover will be slow, the soil will further erode rapidly, and wildlife populations will receive minimal benefit from the areas.

Fauna

Impacts upon local fauna include killing and displacement of numerous animals, which will result in a reduction of the populations of the species involved. Numerous forms that are less mobile, including invertebrates, amphibians, reptiles, small and medium-sized mammals, and juvenile birds (during spring and summer) will be killed during clearing, excavation, grading, and filling. Larger mammals and adult birds will disperse from the site as dictated by construction activities. In predicting population reductions of forest-inhabiting wildlife, the staff assumes that wildlife population numbers are directly proportional to the amount of suitable habitat available. The reduction of suitable habitat is thus equivalent to reduction of the animal populations involved. For example, the clearing of 367 acres of pine and hardwood forests on the site can be expected to reduce total bird populations on this acreage and in the region by 1116 individuals, or 152 pairs per 100 acres (staff estimate using data from ref. 3). Rare and endangered species (Sect. 2.7.1) are not expected to be affected seriously by PNS construction.

Species that can exist in lawns and shrubbery and around buildings will move back into the area after construction subsides and revegetation of the area begins. Such animals include many invertebrates, a few species of lizards and small snakes, certain amphibians if ponds and streams are available, and several species of birds and mammals. Other species that require woodlands for existence may, with time, disperse back into areas that are allowed to undergo natural succession and revert to their original forested condition, although this process would take several to many decades. Successional stages of vegetation, however, are important to several species, including game species that inhabit ground-level strata of vegetation (e.g., white-tailed deer, bobwhite quail, cottontail rabbit). An area of lawns, shrubbery, and scattered groves of trees can support fairly dense populations of certain species, such as mockingbirds, robins, brown thrashers, cottontail rabbits, and squirrels, and it can be an attractive area for migrating species of birds. However, an area of cut grass with few trees and shrubs will have sparse wildlife populations of few species.

The Nuclear Service Water Pond is expected to receive little use by waterfowl during any particular season.

Increased traffic can be expected to cause an increase in road kills of mammals, birds, reptiles, and amphibians, but the increase is expected to be insignificant relative to that caused by other than PNS-related traffic.

4.3.1.2 Transmission facilities

Perkins transmission facilities are described in Sect. 3.8, and proposed and alternative routes and their impacts are compared in Sect. 9.2.6.

Vegetation

Clearing for the construction of transmission facilities constitutes an unavoidable disturbance to the immediate environs as a result of the establishment of an electrical power plant. The three fold-in transmission lines of the PNS project will cover 631 acres, consisting of 65.9% forest, 7.9% pasture, and 25.6% active and inactive agricultural land. Approximately 416 acres of forest will be cleared and permanently lost; they will be replaced by earlier successional stages of vegetation, such as grasses, herbs, shrubs, and small trees. Most of the forested vegetation to be cleared will probably be pine and oak-hickory forests. Assuming that relative acreages of forest types are similar to that in the site area, the staff estimates that the following acreages of forest will be cleared: mesic pine forests, 136 acres; mixed mesophytic hardwood forest, 135 acres; oak-hickory forest, 68 acres; and miscellaneous, 77 acres. The removal of these acreages of forests is not expected to seriously affect the commercial production of forest products or the population of any plant species.

Plant species that require open areas with abundant sunlight will benefit from clearing of the forests, because they will be able to invade the right-of-way as allowed by maintenance activities after initial construction operations. The clearing of corridors through forests for rights-of-way may function in a way similar to that of extensive forest fires in the past (i.e., in causing a diversity or mosaic of successional stages to exist within large regions),[4] and it may also increase the diversity of plant and animal life in the area while successional stages exist on the rights-of-way. In any case, the impacts will be detrimental to some species and beneficial to others.

Erosion problems

Erosion is not expected to be a serious problem on transmission-line rights-of-way, because the corridors will pass through country largely composed of gently rolling topography. The lines will cross streams in several places, and the applicant has stated that low-growing vegetation will not be disturbed along the banks so that soil stability can be maintained and aquatic life will not be seriously affected (ER, Sect. 3.9.3). Provided that towers are set back from the edges of the river and disturbances to vegetation along the banks are minimal, no significant environmental damage is anticipated from the one proposed Yadkin River crossing.

The applicant's plans for clearing and reclamation operations are as follows: (1) initial clearing of rights-of-way will involve hand labor and such equipment as necessary; (2) no herbicides, growth retardants, or sprays will be used in the clearing operations; and (3) all slash and unmerchantable timber will be removed, buried, or otherwise disposed of in accordance with local regulations. After clearing, the rights-of-way will be planted with 50 lb of Fescue #31 per acre, and Sericea lespedeza will be used in rough areas such as steep slopes. In other places, German millet will be planted along with the fescue to provide cover and protection until the grass becomes established. Access roads are ultimately to be seeded and maintained in the same manner as the rest of the right-of-way (ER, Sect. 4.2.1).

The staff suggests that the applicant consider breaking up any compacted road surface before seeding to accelerate the growth of vegetation that would impede erosion. On slopes, much care should be taken to prevent erosion; the road should be broken up at a time of year when rains are not sudden and heavy, and structures should be provided to impede erosion.

The staff emphasizes that, to prevent erosion, all bare areas including access roads should be given immediate attention. If erosion occurs initially, revegetation without replacement of topsoil will be very slow, and increased erosion could be a serious problem for the life of the transmission lines. For a long period of time, increased erosion would cause reduced levels of plant production, reduced levels of terrestrial wildlife via reduction in food and cover, and reduced levels of aquatic life via siltation of streams.

The staff recommends that bulldozing be limited to the extent necessary for preparation of the access roads and placement of towers.

Fauna

The impact of the preparation of rights-of-way and the construction of transmission lines on the fauna will result mostly from the clearing of forest communities. The impact on fauna will thus involve mainly a permanent reduction of certain woodland species and a concomitant increase in other species that utilize woodland edges and successional stages of vegetation. Conversion of forest to forb-grass-shrub habitats is expected to reduce the bird population from a density of 152 pairs to 66 pairs per 100 acres (staff estimate using data from ref. 3). About 416 acres of this conversion might reduce the bird population by as many as 715 individuals. No reliable predictions can be made, however, because at present, sufficient data is not available on the impacts of clearing narrow corridors and creating more edge through forests. The successional stages of vegetation on the rights-of-way may provide more food for deer, quail, and rabbits than would be provided in solid woodland.

The clearing of 416 acres of forested land in narrow belts (270 to 380 ft wide) is not expected to seriously reduce or affect the regional populations of any animal species. In the areas surrounding the proposed transmission-line corridors, much forest of the same types will remain uncleared, so that the effect of clearing 550 acres is not serious to any of the populations requiring these forest types.

4.3.1.3 Carter Creek Impoundment

A total of about 572 acres of forest will be cleared for the proposed Carter Creek Impoundment (Sect. 4.1.2). Forest types and their associated fauna, including rare and endangered species, are similar to those found on the site (Sect. 2.7.1). Because of forest clearing and loss of shrubbery habitats that provide food and cover for wildlife, total terrestrial plant and animal populations are expected to be reduced in the immediate and surrounding region in proportion to the number of acres cleared. Although this involves large numbers of individual plants and animals, the losses should not seriously affect the regional populations of any species. The reservoir is expected to be used very little by waterfowl and other vertebrates. Siltation of the Yadkin River is not expected to be serious if the applicant follows appropriate erosion control procedures.

4.3.1.4 Conclusions

In view of the potential for serious erosion on the PNS site, as described in preceding sections, the staff requires that the applicant formalize its procedures for control of drainage effluents and submit a detailed erosion control plan for staff review prior to undertaking construction activities that have potential for serious soil erosion. The plan must consider both the Station site proper and transmission-line rights-of-way. The plan must identify all areas where serious erosion could occur as a result of clearing and construction and must describe in detail actions that will be taken to impede the erosion for each of these areas separately. The staff recommends that the plan include a procedure by which the applicant can proceed initially with construction of the two site ponds and then use these ponds as sedimentation ponds for site runoff. As most of the site is included in watersheds of the two creeks, runoff of highly turbid water to Dutchman's Creek and to the Yadkin River could thereby be held to a minimum. If properly implemented, such procedures should substantially reduce inputs of suspended solids. All drainage effluents must conform to EPA regulations on turbidity.

The staff also recommends that the applicant consult with appropriate State agencies to develop and submit a plan for maximizing the productivity of vegetation and wildlife on all areas subjected to clearing or other modifications.

4.3.2 Aquatic

The potential adverse impacts of large construction activities on aquatic environs generally result from: (1) dredging and filling in aquatic environments; (2) altering aquatic habitats by the damming of streams; (3) construction site runoff; and (4) releases of chemical wastes.

Construction activities at PNS that could produce potentially adverse environmental impacts are associated with: (1) construction of the intake and discharge structures; (2) construction of the Nuclear Service Water Pond and auxiliary holding pond; (3) the clearing of land at the site; (4) releases of chemical effluents; and (5) construction of the proposed Carter Creek Impoundment.

4.3.2.1 Construction of the intake and discharge structure

The makeup water intake structure will be constructed on the inside of a bend of the Yadkin River, due east of the site of the reactor and turbine buildings (Fig. 2.1). The blowdown and radioactive waste discharge structure will be located about 300 ft downstream from the intake structure.

Both structures will be bankside structures and will be constructed within cofferdams. The area enclosed by the cofferdams (approximately 0.4 acres) will be pumped dry during construction. This practice will result in the destruction of the enclosed benthos populations but will exert little influence on other ecosystem components. Insofar as benthic productivity is concerned, the area selected for construction is characterized by a sandy, unproductive substrate and is in no way unique to the river (Sect. 2.7.2.4). Thus, considering that upon removal of the cofferdams much of the area formerly enclosed will be recolonized by benthos, the staff does not consider the overall impact to be significant.

The location of the intake and discharge structures will be on a section of the riverbank characterized by a steep slope (Fig. 2.1). An area of from 2 to 4 acres on the riverbank will be cleared of vegetative cover during construction. This will create a potential for severe bank erosion and transport of substantial quantities of soil into the River, thereby increasing turbidity of the water. The effects of increased turbidity on aquatic biota are discussed in Sect. 4.3.2.3. Inasmuch as the consequences of uncontrolled erosion are deemed unacceptable by the staff, the applicant will be required to implement appropriate erosion control measures, including the revegetation of the slopes, as quickly as practicable after construction commences to reduce this impact to an acceptable minimum.

Dewatering effluents pumped from within the two cofferdams will be discharged into the River. The flow rates and turbidities of the effluents cannot be predicted; however, as the turbidities of the effluents should not be much greater than those existing in the Yadkin River and considering that flow rates of the effluents will be small compared with the river flow, no lasting impacts are anticipated.

4.3.2.2 Construction of the Nuclear Service Water Pond and the auxiliary holding pond

A small creek that flows immediately south of the site of the reactor buildings will be impounded to form the 190-acre NSW Pond (Fig. 2.1). Another creek, which flows northwest of the site of the reactor buildings, will be impounded to form 2.6-acre auxiliary holding pond (Fig. 2.1). The damming of these streams will result in three types of impacts: (1) migrations of fish into and out of the creeks will be blocked; (2) biota in about 2.5 miles of the first stream and about 0.3 mile of the second will be transformed from running-water (lotic) community types to still-water (lentic) types; and (3) stream flow below the dams will be substantially reduced.

The staff considers that these impacts will be locally significant to the indigenous biota of the two site creeks as the physical characteristics of large portions of the creeks will be completely altered from their present state; however, these impacts will be insignificant when applied to the broader scale that includes Dutchman's Creek and the Yadkin River.

4.3.2.3 The clearing of land on the site

Increased surface runoff results when the protective vegetative cover of the soil is removed. The runoff can contribute to increasing erosion and thus carry off large quantities of soil into the streams of the area. For the construction of PNS, the clearing of 617 acres of land on the site will be required. Applying the "Universal Soil Loss Equation," the applicant estimates that erosion of bare soil at the site after clearing would equal 120 tons/acre-year as compared with 4.5 tons/acre-year under existing soil conditions (ER, Sect. 4.1.3.1). Assuming that all 617 acres will be bare of vegetation at the same time, a conservative estimate, an additional 71,260 tons of soil per year would erode from the site if protective measures are not taken. To reduce erosion the applicant plans to construct berms and dikes as necessary, to build interceptor ditches to protect side hill cuts, to use sheet piling and sandbagging, and to seed all cleared, cut, and filled areas as soon as practical (ER, Sect. 4.1.3.1).

Uncontrolled erosion would result in about a 14% annual increase in the sediment load of the Yadkin River. Most erosion and runoff would occur during periods of precipitation; thus, the total suspended solids (TSS) load of the river could be increased substantially during periods of heavy rainfall. The principle point sources of construction runoff to the Yadkin River will be the inputs of the two site creeks into Dutchman's Creek.

The effects of turbidity on aquatic life are well documented and include reduction of light penetration and photosynthesis;[6-8] impairment of respiratory and feeding functions; the clogging of bottom substrates; smothering of benthos, spawning sites, and demersal fish eggs;[6,7,9] alterations in species composition; and the lowering of fish production.[10]

The average TSS level now present in the Yadkin River, 180 mg/liter, is already sufficiently high to stress turbidity-intolerant biota.[6] Any substantial increase in TSS could render the river intolerable for these species and should be avoided. Therefore, to prevent further degradation of Yadkin River water quality, the applicant, as stated earlier (Sect. 4.3.1.4), will be required to submit a plan for control of erosion and runoff for staff approval. All runoff from the construction site, up to flows resulting from a 10-year 24-hr rainfall, will be limited to an average TSS content of 50 mg/liter. Compliance with this limitation will provide adequate protection to the biota of the river.

Domestic sewage

Chemical effluents that will be discharged during the construction of PNS will consist primarily of sewage effluents. Sewage waste (up to a maximum of 35,000 gpd) will be treated in a prefabricated extended aeration-type sewage treatment plant. The effluent will have a minimum concentration of free residual chlorine of 0.5 to 1.0 mg/liter. The effluent will be pumped to the auxiliary holding pond and then ultimately released to Dutchman's Creek. Total residual chlorine in the discharge to Dutchman's Creek will be present at levels well below those toxic to aquatic biota (Tables 3.6 and 3.7). In addition to chlorine, the effluent will contain a maximum of 27 lb of ammonia, 36 lb of nitrate, and 245 lb of phosphate per day (ER, Table 3.6.2-1). After dilution, maximum concentrations of 0.03 mg ammonia per liter, 0.04 mg nitrate per liter, and 0.3 mg phosphate per liter will be encountered in Dutchman's Creek. These concentrations are below the average concentrations of these compounds encountered in the Yadkin River and therefore should produce no adverse impacts on the biota of the river.

Spillage of harmful liquids

Spillages of environmentally injurious liquids (e.g., gasoline and oil) are a possibility. Apart from the intake and discharge structures, however, all construction areas are a substantial distance from the Yadkin River. After completion of the two site impoundment dams, most spills occurring on the sites would enter the ponds. The probability of any injurious liquids entering Dutchman's Creek or the Yadkin River would be remote and will have little, if any, impact.

Carter Creek Impoundment

The impacts associated with the construction of the Carter Creek Impoundment will be similar to those associated with the construction of the NSW Pond. The biota in 6 to 7 miles of Carter Creek and its tributaries will change from lotic to lentic community types, fish migrations into and out of the creek will be blocked, and stream flow below the dam will be substantially reduced. Eroded sediments originating from the site should not enter the Yadkin River, because the impoundment will hold all runoff. Some temporary increases in turbidity and local destruction of benthos will result during construction of the combined intake and discharge structures. Carter Creek is not considered to be a significant tributary of the Yadkin River;[5] therefore, the staff considers that the above impacts, although significantly altering Carter Creek, will not have a significant impact on the Yadkin River ecosystem.

4.3.2.5 Summary

Construction of PNS could adversely affect the aquatic environment through destruction of benthic habitat, alterations in the environment of three creeks, an increase in the turbidity of adjacent waters, and the release of deleterious effluents.

The destruction of some benthic habitat will occur during the construction of the intake and discharge structures; however, due to the small area involved, 0.4 acre, the impact will be insignificant. Damming of three creeks will have a significant impact on 8 to 10 miles of the creeks. Further use of the streams as spawning or nursery areas for Yadkin River and Dutchman's Creek fishes will be prevented; however, due to the small sizes of the creeks and their relative insignificance in the Yadkin River system, this loss is considered minor.

Increases in erosion and runoff from cleared land on the site could significantly increase the TSS content of the Yadkin River. The applicant will be required to submit to the staff a plan to control erosion and runoff and thereby minimize this potential adverse impact.

The concentrations of total residual chlorine, ammonia, nitrates, and phosphates in the effluent from the auxiliary holding pond will be below levels that would produce adverse impacts on the biota of Dutchman's Creek or the Yadkin River.

The probability of spillages of deleterious liquids reaching open water is considered by the staff to be remote, and the impact therefore insignificant.

The impacts of PNS construction on the aquatic environment are summarized in Table 4.4

Table 4.4. Summary of environmental impacts due to construction of Perkins Nuclear Station

Potential impact	Applicant's plans to mitigate	Expected relative significance	Corrective actions available and remarks
Construction of intake and discharge structures	None	Some minor, temporary increases in turbidity and losses of benthos will occur. There is a potential for substantial riverbank erosion.	Applicant must institute measures to control riverbank erosion.
Construction of three proposed ponds	Some erosion and runoff control procedures are proposed.	Significant local impact on the three site creeks but an insignificant impact on the Yadkin River.	Applicant must submit an erosion and runoff control plan for staff approval and must limit the TSS content of construction runoff to 50 mg/liter.
Clearing of land on the site	Some erosion and runoff control procedures are proposed.	A potential exists for increasing annual sediment load of Yadkin River by 14%. Increased stress on turbidity-intolerant biota would result.	Applicant must submit an erosion and runoff control plan for staff approval and must limit the TSS content of construction runoff to 50 mg/liter.
Discharge of chemical effluents	Sewage will be treated and chlorinated in a prefabricated unit and discharged into a waste collection basin.	Insignificant	Effluent composition must meet all applicable standards.
Spillages of harmful liquids	Proper handling procedures will be followed.	Insignificant	None

4.4 IMPACT ON PEOPLE

4.4.1 Physical impacts

The noise and dust from construction activities will not be a major impact to the human environment, because the site is quite remote and rather sparsely settled. The applicant will comply with all Office of Safety and Health Administration (OSHA) requirements for noise and dust levels.

A total of 26 families will be removed as a result of land acquisition and plant construction on the site proper while an additional 16 families will be affected by creation of the Carter Creek Impoundment.

The construction will result in an increase in vehicular traffic on local roads. The applicant has addressed this problem to some extent in his Environmental Report (ER, App. III), giving the traffic density, intersections affected, etc., on those arteries expected to be impacted. The applicant has also stated that the North Carolina Highway Department will be consulted as to recommendations for needed improvements on those highways and intersections. The staff, during the site visit, made a visual inspection of the road systems surrounding the site. With the exception of North Carolina Highway 801, the roads appear more than adequate to handle the increased burden. The staff estimates that use of these roads by an additional several thousand cars and trucks per day will result from construction at the proposed site. The staff considers that such an added traffic burden will not cause undue inconvenience to the local traffic except at peak usage hours. The staff recommends that the applicant consult with local authorities to explore methods for minimizing such inconvenience.

4.4.2 Population growth and construction worker income

The applicant has indicated (ER, Sect. 4.12 and App. III) that based on its prior construction experience, only about 12% of the construction work force is expected to move into the vicinity of the site as new residents. This would result in the influx of approximately 300 new families into the area with a concomitant increase in population. The applicant has carried out a study on available housing in the area (ER, App. III), and as of November 1974, there would appear to be adequate rental units available to accommodate the influx of construction workers' families. The staff met with local authorities[11] and discussed the problem of temporary housing (i.e., trailer parks). The staff was informed that Davie County has a relatively new zoning ordinance that will cover trailer parks insofar as all sanitation and other requirements must be met before a permit is issued. The staff does not consider that the influx of construction workers will have a severe impact on local housing.

The total construction payroll for this project is expected to be over $335 million (ER, Sect. 8.1.2.3), of which a large fraction is expected to be spent within the area. The staff expects that some localized economic letdown will result as construction activities phase out, but because this process will occur gradually, the effects of such a letdown should be fairly minor.

4.4.3 Impact on community services

The applicant has addressed this issue in some detail (ER, App. III). Since the Perkins installation will provide its own potable water, sanitary sewage disposal, and security personnel, its impact on existing community services will be negligible except for the impact of those workers who move into the area. The applicant's study indicates that in the areas of schools, hospitals, police and fire protection, utilities, and recreation, this impact can easily be accommodated. The staff agrees with this analysis in general. In consulting with local authorities,[11] the staff was informed that one area of concern was overcrowding of schools. This was felt to be a problem in distribution rather than in total numbers. However, the authorities indicated that this was a transitory rather than a permanent problem.

4.4.4 Impact on recreation capacity of the area

While the construction activity involved in erecting the intake and discharge structures will undoubtedly affect fishing in close proximity to these structures adversely, the staff does not consider that construction of PNS will have a major impact on the normal recreational capacity of the area.

4.4.5 Radiation exposure to construction workers

During the period between the startup of Unit 1 and the completion of Units 2 and 3, the construction personnel working on Units 2 and 3 will be exposed to the radioactive effluents from operation of Unit 1 initially and from Unit 2 when it goes into operation.

The applicant has estimated that 1056 man-years will be expended in the two years between the startup of Unit 1 and the startup of Unit 2, and 344 additional man-years will be expended between the startup of Unit 2 and the completion two years later of Unit 3. The dose rates from Unit 1 are estimated to be 9.0×10^{-3} and 1.2×10^{-3} millirem/hr at Units 2 and 3. The dose rate at Unit 3 resulting from operation of Units 1 and 2 is 1.02×10^{-2} millirem/hr. The total exposure to construction personnel is estimated to be 80 man-rems. Estimated values for other LWRs have ranged from 10 to 100 man-rems. Thus, the staff concludes that the estimate of 80 man-rems is reasonable.

4.5 MEASURES AND CONTROLS TO LIMIT ADVERSE EFFECTS DURING CONSTRUCTION

4.5.1 Applicant's commitments

(1) A major portion of the skilled labor force at PNS will be drawn from the unskilled laborers hired locally and will be trained under the applicant's in-house training program.

(2) Two construction access roads are planned for truck and automobile traffic; both roads are designed to meet North Carolina State Highway Standards.

(3) Onsite parking will be provided for construction workers and visitors.

(4) The location of the access railroad will not require any families to relocate their present residences.

(5) Efforts will be made during construction to control erosion, sedimentation, dust, smoke, noise, unsightly landscape, and waste. These will be controlled to meet practical levels and permissible limits where such limits are specified by regulatory authorities.

(6) Only the minimum amount of clearing will be done for construction preparation. Clearing will be staged to provide minimum space requirements for earthwork and excavation.

(7) To help control erosion on cleared areas, the applicant will follow the best available practices, as determined by the specific situation.

(8) Detention ponds and berms will be provided as necessary to detain sediment-laden water and to provide settling of sediment before discharge into the receiving streams.

(9) A permanent drainage system will be installed as soon as practical in the immediate plant yard area to prevent excessive erosion from surface runoff.

(10) All areas not paved will be seeded. All paved areas will be sloped and drained in a manner to prevent erosion of unpaved areas. Seeding, restoration planting, and landscaping will be done as soon after construction as practical and possible.

(11) Good drainage, dry-weather wetting, and paving of the most heavily traveled construction roads will be used to reduce dust generated by vehicular traffic.

(12) Excessive and objectionable construction noises will be reduced to acceptable levels.

(13) Tree-lined fringes will be left around construction areas to help reduce noise and visual pollution.

(14) The applicant will adhere to the air pollution control measures applicable to Davie County and the State of North Carolina. All reasonable precautions will be taken to prevent accidental fires on the construction site and brush or forest fires on adjacent lands.

(15) Wastes, such as chemicals, fuels, lubricants, bitumens, and raw sewage, will not be deposited into the natural watershed where these materials can be transported into the Yadkin River.

(16) Wastes will be handled in accordance with State and local laws.

(17) A sewage treatment facility that will meet State and local laws will be installed.

(18) Bitumens, waste chemicals, and fuels will not be disposed of on the site.

(19) Solid waste will be disposed of in a Construction Department sanitary landfill or transported offsite to an approved landfill.

(20) Combustible material from station construction will be burned under provision of permits issued by State and local authorities. If permits are not made available, materials will be buried in a spoil fill area.

(21) Construction yards and substations, employee and office parking areas, and construction offices are temporary and will be removed upon completion of construction. These areas will be restored by suitable landscaping.

(22) A permanent fire protection system will be installed as soon as backfill operations permit. This system will be maintained during the remainder of the construction program.

(23) The final construction activities will be the removal of construction facilities and grading and landscaping.

4.5.2 Staff evaluation

Based on a review of the anticipated construction activities and the expected environmental effects, the staff concludes that the measures and controls committed to be the applicant when supplemented by those identified below are adequate to ensure that adverse environmental effects will be at the minimum practicable level.

(1) The applicant will monitor the nearest well while dewatering is in process to ensure that no adverse effect on either the quality or quantity of the well water results from the dewatering.

(2) A control program shall be established by the applicant to provide for a periodic review of all construction activities to assure that these activities conform to the environmental conditions set forth in the construction permit.

REFERENCES FOR SECTION 4

1. W. H. Owen, Vice-President, Design Engineering, Duke Power Company, letter of March 7, 1975, to W. H. Regan, Division of Reactor Licensing, NRC, Table Q6-1.

2. North Carolina Soil and Water Conservation Needs Committee, *North Carolina Conservation Needs Inventory*, Raleigh, North Carolina, 1971.

3. D. W. Johnston and E. P. Odum, "Breeding Bird Populations in Relation to Plant Succession on the Piedmont of Georgia," *Ecology* 37: 50-62 (1956).

4. H. E. Wright, Jr., and M. L. Heinselman, "Introduction: the Ecological Role of Fire," *Quaternary Research* 3: 319-328 (1973).

5. F. F. Fish, *A Catalog of the Inland Fishing Waters in North Carolina*, North Carolina Wildlife Resources Commission, Raleigh, North Carolina, 1968.

6. E. H. Hollis, J. G. Boone, C. R. DeRose, and G. J. Murphy, *A Literature Review of the Effects of Turbidity and Siltation of Aquatic Life*, Staff Report, Department of Chesapeake Bay Affairs, Annapolis, Maryland, 1964.

7. A. J. Cordone and D. W. Kelley, "The Influence of Inorganic Sediment on the Aquatic Life of Streams," *Calif. Fish and Game* 47(2): 189-228 (1961).

8. J. Cairns, "Suspended Solids Standards for the Protection of Aquatic Organisms," pp. 16-27 in *Proc. 22nd Indust. Waste Conf.*, Part 1, Purdue University Engr. Ext. Sir. No. 129, May 1957.

9. J. C. Ritchie, "Sediment, Fish and Fish Habitat," *J. Soil Water Conserv.* 27(3): 124-125 (1972).

10. D. H. Buck, "Effects of Turbidity on Fish and Fishing," pp. 249-261 in *Trans. 21st N. A. Wildl. Conf.*, 1956.

11. H. E. Zittel, letter of August 12, 1974, to R. A. Gilbert, re: Perkins Site Visit.

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5. ENVIRONMENTAL IMPACTS OF FACILITY OPERATION

5.1 IMPACTS ON LAND USE

Changes in land use resulting from acquisition of property and construction of PNS, such as loss of cropland and forest, were discussed in Sect. 4.1. Discussion in this section will consider only land that will not be lost, that is, land that is not covered by permanent facilities and is capable of supporting terrestrial plant and animal communities or land that could be subjected to future development.

Of the total 2402 acres that the applicant will own at the site (Sect. 4.1), approximately 1785 acres will be left as is (after any logging by previous landowners), 289 acres will be covered by permanent facilities, and 328 acres will be used for temporary facilities, later to be landscaped or allowed to undergo natural succession. Cropland that is not affected by construction will probably undergo natural succession (see Sect. 2.7).

Associated with the operation of PNS will be the maintenance of about 744 acres of potentially forested land in various other land cover types, consisting of lawns and shrubbery at the station site (328 acres, assuming no natural succession is allowed) and permanently maintained successional stages of vegetation on the transmission-line rights-of-way (416 acres). The railroad corridor and the Carter Creek Impoundment are not included, because this acreage is assumed to be lost because of construction. The total acreage maintained in artificial biotic conditions (744 acres) is 1.0% of the 1967 inventoried forest acreage in Davie County (see Table 4.1). Additional potential forest acreage may continue to be covered by mobile home parks and other living accommodations built for personnel originally involved in PNS site preparation and construction (Sect. 4.1.7).

5.1.1 Station operation

5.1.1.1 Cooling tower plumes

The plumes of moist air resulting from cooling tower operation (described in Sect. 5.3.2) are not expected to have any serious effects on land use. Negative impact on the use of North Carolina Highway 801, located 3600 ft from the cooling tower yard should be slight. The staff estimates that less than 15 additional hours of fog per year for North Carolina Highway 801 will result as a consequence of operation of PNS (Sect. 5.3.2.2). The plumes should result in no significant visual impacts on persons visiting Boone's Cave State Park; plumes are expected to occur over Boone's Cave only during times of natural cloud cover, from which the plumes would be indistinguishable. Therefore, cooling tower operation is not expected to increase cloud cover or shading at Boone's Cave.

When temperatures are sufficiently low, cooling tower plumes can cause icing, that is, liquid droplets in the plume may freeze and fall to the ground, or condensation with subsequent freezing may cause icing of surrounding obstacles and surfaces, such as trees and roads. Few qualitative or quantitative observations of such icing have been reported for cooling tower operations. Because of the above low estimates of additional hours of fog per year on Highway 801, the potential for dangerous driving conditions resulting from either icing or fogging would appear to be low.

Of seven small airports located within 20 miles of the site center, four lie outside the 1% isopleth for visible plume length frequency, two lie within the 1% isopleth, and one lies within the 3% isopleth (ER, Fig. 5.1.5-1). Therefore, decreased visibility because of cooling tower plumes is not expected to be a serious problem at these airports.

5.1.2 Transmission lines and railroad spur

Operation of the transmission lines will cause fewer negative impacts than does the construction phase. The presence of transmission lines across agricultural land will not permanently alter the use of that land, except for the land immediately under the towers. The three fold-ins for PNS will require that 416 acres of potential forest be maintained in early successional stages, which is not expected to seriously alter overall land use in this region. Properly maintained

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rights-of-way with successional vegetation stages may produce food and cover needed by certain wildlife species. The extension of transmission lines over land zoned "rural-residential" will restrict development in the rights-of-way proper.

Aesthetic impacts associated with transmission lines are difficult to quantify but are present in the form of constant visual effects persistent over the lifetimes of the installations. Visual impacts associated with PNS lines are primarily linked with crossings of rural roads and two crossings of the Yadkin River.

Based on personal observations, the staff expects that sound produced by the 525-kV lines during very moist weather will extend 50 yards from the rights-of-way, but the impact on the local population should be insignificant.

With regard to present and future development along the proposed transmission lines, the applicant has contacted officials from Davie and Davidson Counties, who, according to the applicant, stated that no historic sites listed or nominated to be listed in the National Register of Historic Places are located in or near the line routes and that no plans exist for any recreational or industrial sites along the planned corridors. The effect on land use adjacent to the railroad right-of-way is also expected to be minimal, barring any unforeseen accidents or maintenance problems.

5.2 IMPACTS ON WATER USE

5.2.1 Surface water

During operation a maximum of 122 cfs of makeup water will be withdrawn from the Yadkin River. Two cfs additional water enters the NSW pond because runoff exceeds evaporation by that amount. About 12 cfs will be returned to the river as blowdown, resulting in a maximum consumptive loss of about 112 cfs. The amount of consumptive loss may vary, depending on meteorological conditions and the percentages of load capacity in operation, between 76 and 112 cfs (ER, Table 3.3.0.2). The average monthly loss of water as a percentage of upstream average river water flow at 100% load capacity would range from 2.6% in March to 6.2% in September. These reductions may cause adverse impacts on some downstream users of Yadkin River water.

Only tentative plans for the withdrawal of water during periods of critical low flows have been set forth by the applicant. Negotiations are under way with the State of North Carolina to arrive at a definite minimum river flow at which proposed pumping rates will still be allowed. The applicant is presently proposing an impoundment on Carter Creek to supply sufficient supplemental storage of water to permit operation when flows drop below the eventual State-established maximum requirements. Until more definitive plans are presented, the staff will base its analysis on a flow of 880 cfs, a figure recently proposed by the applicant after discussion with state personnel. Under this mode of operating, pumping of water into the NSW Pond from the Yadkin River without compensating releases from Carter Creek Impoundment would only be permitted when river flows exceeded 880 cfs plus the amount being consumed by PNS. This means that when the plant is operating at the maximum consumptive use (112 cfs) and the flow in the river starts to drop below 992 cfs (880 + 112) as measured at the Yadkin College gauge, which lies between Carter Creek and the intake for PNS, the applicant must start to release water from Carter Creek in order to maintain the flow at 992 cfs at Yadkin College. This will maintain flow downstream of PNS at 880 cfs. If the river flow continues to decrease, the applicant must increase his release rate until it reaches 112 cfs (the consumptive use at PNS). At that point the tentative agreement requires only that the Carter Creek release continue to equal the PNS use. The river flow downstream, therefore, may start to drop below 880 cfs but this would occur only as a result of natural and/or other manmade conditions and not be due to operation of the station. The direct impact of the consumptive use of river water by PNS would be to increase the frequency and duration of lower river flows. A flow of 880 cfs is exceeded in the river about 98% of the time. A flow of 880 plus 112 cfs, or 992 cfs, is exceeded about 95.4% of the time; therefore, a loss of 112 cfs would increase the frequency of a flow of 880 cfs occurring at the PNS site by 2 to 3% (PSAR, Fig. 2.4.8-5).

The operation of PNS could effect downstream water use by: (1) decreasing water quality; (2) decreasing the waste assimilative capacity of the river; (3) decreasing the amount of water available for industrial and municipal users; and (4) decreasing the availability of water for generation of hydroelectric power.

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5.2.1.1 Water quality

The cooling tower blowdown will contain about 10 times the concentration of the dissolved substances present in the ambient river water. As a result, the 12 cfs of blowdown will increase the total dissolved solids (TDS) of the river by a maximum of about 18 mg/liter and the BOD of the river by about 2.7 mg/liter (Sect. 3.6). These minor increases would not adversely affect the quality of the wat-- for municipal or industrial users downstream. Except as noted for releases of zinc, phosphorous, and chlorine, all effluents from PNS should meet all pertinent State and Federal water quality standards (Sect. 5.3.3).

5.2.1.2 Waste assimilative capacity

The waste assimilative capacity of a stream is largely determined by the flow of water, the temperature, and the re-aeration rate of oxygen back into the water.[1] The consumptive loss of 112 cfs by PNS will affect the waste assimilative capacity of the river primarily by reducing the flow of water past the site by a maximum of 11%.

A reduction in the flow of water by 112 cfs will correspondingly reduce the dilution of wastes downstream. Several industrial and municipal waste discharges enter the Yadkin River between the PNS site and High Rock Lake (ER, Table 2.2.2-7). Less dilution of these wastes will result in a higher rate of consumption of the available dissolved oxygen (DO). This impact would be significant only during periods of prolonged, lower than normal summer flows. Although the reduction in water flow would affect only a short stretch of the river above High Rock Lake, it may also contribute to increasing hypolimnetic oxygen depletion in High Rock Lake. Because the occurrence of flows sufficiently low to create a substantial reduction in DO would be rare, the staff does not consider this impact to be significant.

The addition of heat to the Yadkin River by PNS operation will be small and will produce less than a 0.5°F increase in temperature during low flows (Sect. 5.3.1.1). A reduction in flow by 112 cfs at a river flow of 1000 cfs would create only an insignificant reduction in the river velocity (0.05 fps) and would not significantly reduce its re-aeration rate. Neither of these effects would significantly reduce the waste assimilative capacity of the Yadkin River.

There is one major source of industrial waste discharge into the Yadkin River between the PNS site and High Rock Lake (ER, Table 2.5.3-11). Discharges from this industry have been responsible for several recent fish kills.[2-4] The causative agents responsible for the kills were thought to be a high biochemical oxygen demand (BOD) load, which reduced DO to critical levels, and substances toxic to fish present in the effluent (ER, Q.2.7.12).[2-4]

Buck Steam Plant, located about 16 miles downstream from the PNS site, is the largest user of Yadkin River water located between the site and High Rock Lake. The plant uses a once-through cooling system with an average intake of 576 cfs for condenser cooling purposes. The thermal effluent from the plant has a maximum summer temperature of from 91 to 101°F (ER, Table 2.5.3-1). At downstream river flows of 1200 cfs (predicted minimum), about 51% of the water flowing past the Buck Steam Plant would be withdrawn.

The mixing of industrial wastes with the thermal discharges from Buck Steam Plant may synergistically increase the potential for fish kills. The thermal discharge, by increasing the rate of biological oxygenation of the organic wastes, would reduce the DO content of the water. Many fish are more susceptible to toxicants when stressed by low DO levels.[5] In addition, the toxicity of many substances increases with increased temperatures.[6] These two factors working together would tend to increase the probability of fish kills occurring. Any reduction in flows by PNS would further increase this probability. As fishing is a water use of the Yadkin River and High Rock Lake, an increase in the frequency and severity of fish kills could have an adverse impact on this use.

The applicant has plans to retire several units of Buck Steam Plant by the time PNS begins operation (see Table 8.4). If followed, this schedule would reduce the impacts mentioned above.

5.2.1.3 Water available for industrial and municipal use

The consumptive use of 112 cfs of water by PNS will increase the frequency of a flow of 880 cfs occurring by about 2.5%. This flow will still be exceeded 95.4% of the time (PSAR, Fig. 2.4.8-5). A flow of 880 cfs should be adequate to fulfill the needs of all present downstream users of this water; however, if the future water needs for the river grow significantly, critical water shortages could develop.

Impact on High Rock Lake

The dam that forms High Rock Lake is operated to maintain as high a lake level as possible during the summer recreational period. Under an amendment to the project's FPC license, the average weekly flow of water released from the lake cannot be less than 1610 cfs during the period from May 15 to July 1, and cannot be less than 1400 cfs during the period from July 1 to September 15.

The object of this operating schedule is to continue some water flow to downstream users while reducing the summer drawdown to a maximum of five ft. Before this operating schedule was initiated, higher releases were allowed and summer drawdowns of up to 12 ft had been experienced; however, the effect of the schedule has been to reduce the summer drawdown to 4 ft through mid-August, 96% of the time.

The full pond storage volume of the lake is about 250,000 acre-ft (Fig. 5.1). The consumptive use of 112 cfs by PNS during the period from May 15 to September 15 would be equal to a total of about 27,100 acre-ft. Referring to Fig. 5.1, a loss of 27,100 acre-ft of water would lower the lake level about 2 ft below normal by September 15 if it is assumed that all other releases of water by the dam were the same as in the past. The only means available to mitigate this effect, besides reducing the consumptive loss of water by PNS, would be to correspondingly reduce the releases of water from High Rock Lake dam; however, the restrictions of the project's FPC operating license limit this option.

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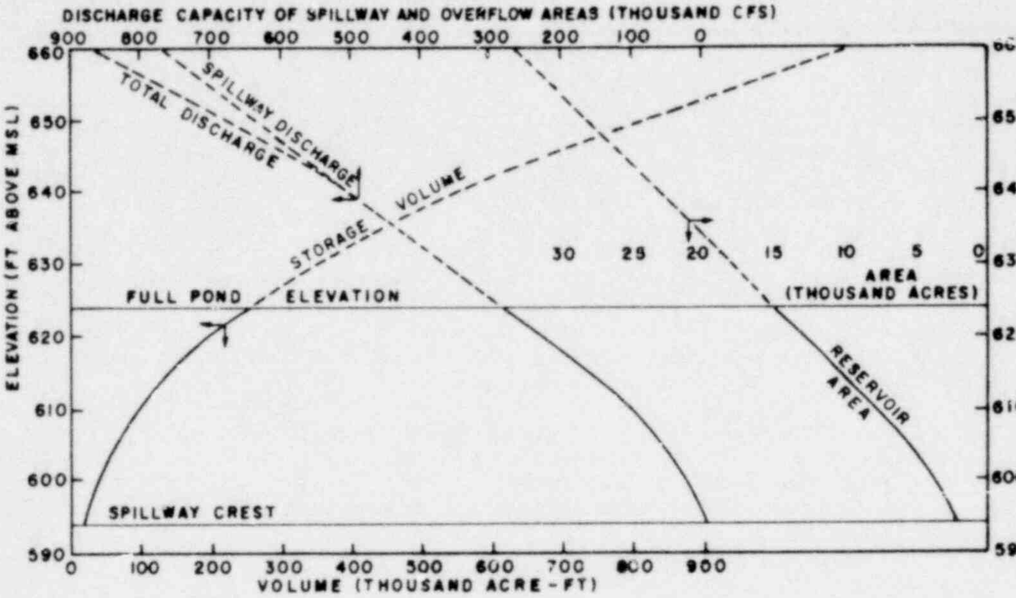

Fig. 5.1. High Rock Reservoir: area capacity and spillway curves.
Source: ER, Fig. 2.5.2-19, Amend. 2.

The impacts of a 2-ft below normal reduction in summer lake level on High Rock Lake would be to: (1) decrease the area of the reservoir by about a maximum of 1000 acres by September 15 (see Fig. 5.1), (2) decrease the desirability of the lake for swimming by increasing the exposure of mud flats and swimming hazards such as stumps and rocks, and (3) increase the boating hazards of the lake. High Rock Lake is an uncleared lake and is considered one of the most hazardous lakes in the High Rock chain. Any increased drawdown of the lake would be expected to increase this hazard.

Several factors must be considered to put the potential increased drawdown into perspective. A full 2-ft drop in lake level by September 15 would only occur if all three units of PNS were operating at 100% capacity throughout the summer. If less than three units were operating and/or if any of the units was operating at less than 100% capacity, the resultant reduction in lake level would be proportionally less. It should be reiterated that the full 2-ft drop below normal would only be reached by about September 15 and would be proportionally less earlier in the summer. Figure 5.2 demonstrates the fluctuations in the level of High Rock Lake during the past several years. From this figure it can be ascertained that an additional 2-ft drop by September 15 would still keep the total drawdown to less than 5 ft during most of the summer. The staff concludes that the lake level will probably drop to the 5 ft-below-full-pond level by September 15 nearly every year the station operates at full power throughout the summer.

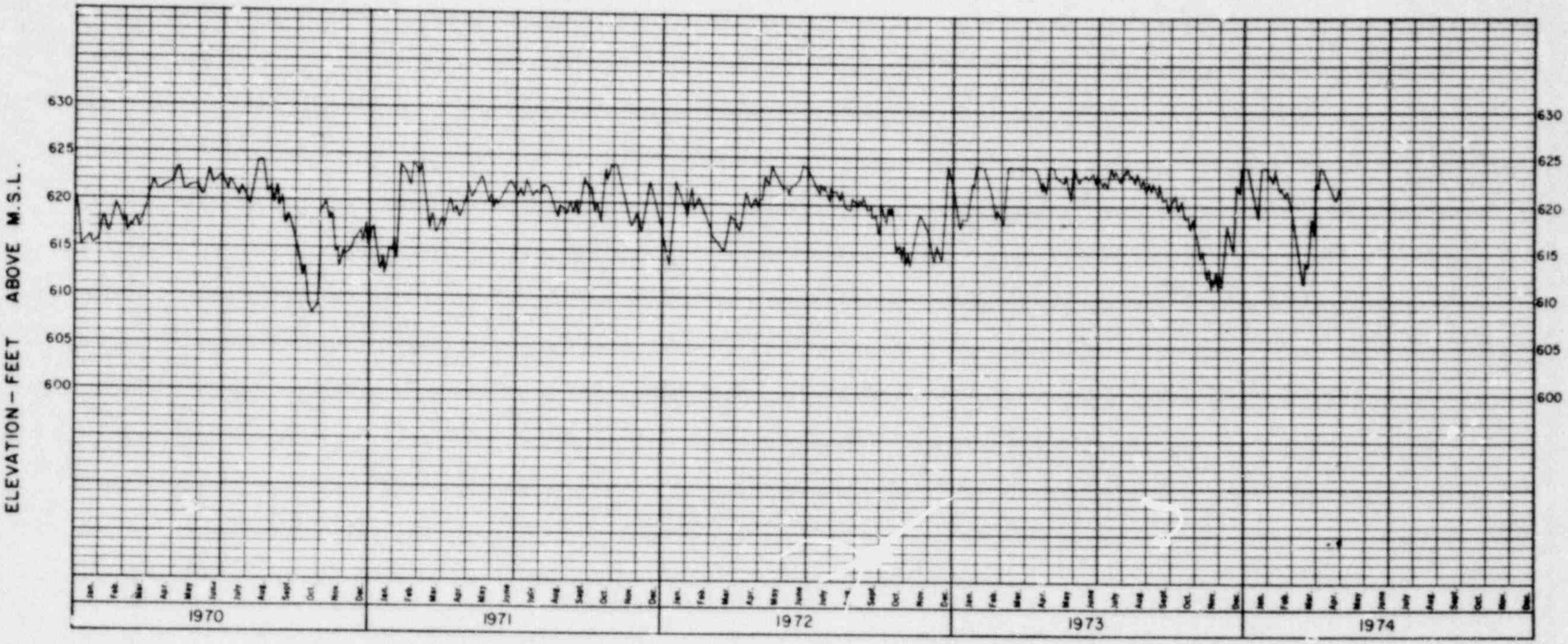

Fig. 5.2. High Rock Lake water surface. Source: ER, Fig. 2.5.2-20, Amend. 2.

5.2.1.4 Downstream hydroelectric generation

The consumptive loss of an average of 83.3 cfs of Yadkin River water would correspondingly reduce the hydroelectric generating capacity of every downstream hydroelectric generating facility. This loss has been calculated to be equal to an average of 24.4 million kWhr annually and to have a value of $133,000, based on the applicant's 1973 average generating costs of 5.45 mills/kWhr (ER, Sect. 3.3.1). If the downstream hydroelectric facilities primarily generate peak power then the replacement cost of the lost hydroelectric generating capacity would average about $483,000 annually, based on the applicant's recent generating costs of 19.79 mills/kWhr for combustion turbine units (ER, Sect. 9.1.3).

5.2.2 Groundwater

The filling of the Nuclear Service Water Pond and the Auxiliary Holding Pond will raise the groundwater table near these ponds. However, the relatively low permeability of the in situ materials will cause the area of significant rise in groundwater levels to be limited to the immediate vicinity of these ponds (ER, Sect. 5.1.3). Because bottom elevations of the proposed structures at the site are below the present water table, a permanent underdrain system will be installed in some locations to lower the water table below these elevations. The underdrain system will maintain the water level at an elevation about 10 ft above the bottom of the various structures (PSAR, Sect. 2.4.13 and PSAR, Appendix 2B). Changes in elevation of the groundwater table (depression of it as a result of the underdrain system and elevation of it as a result of on-site pond water levels) will produce local redirections in the flow of groundwater, but these redirections will be limited in extent and will not represent a diversion of groundwater away from the Yadkin River. The main effect on the groundwater environment at the site will be to, in general, decrease the slope of the water table towards the river. This effect will be observed only within a few hundred feet of the structures and ponds, and since under normal conditions the flow from the underdrain system will be discharged via the surface water drainage system, the staff considers the overall effect on the groundwater table outside the site area to be negligible.

5.2.3 Summary

The operation of PNS may adversely affect water use by: (1) decreasing water quality; (2) decreasing the waste assimilative capacity of the Yadkin River; (3) decreasing the quantity of water available for industrial and municipal use; and (4) decreasing the availability of water for the generation of hydroelectric power.

The staff considers the impacts of PNS operation on water quality to be minor.

The waste assimilative capacity of the Yadkin River will be slightly reduced by the consumptive loss of 112 cfs of water. This will result in a maximum reduction in river flows of about 11%. An increase in the frequency and severity of fish kills may occur as a result of the interaction of decreased river flow with downstream industrial waste discharges and the thermal discharges from Buck Steam Plant (however, see Sect. 5.2.1.2). This would result in an increase in the rate of biochemical oxidation, a decrease in DO levels, and an increase in the toxicity of the wastes.

A loss of 112 cfs of water will probably not adversely reduce the supply of water available for present downstream users; however, it may make it more difficult to maintain desired lake levels in High Rock Lake during prolonged periods of below normal river flows. A greater than normal decrease in the lake levels of High Rock Lake during periods of lower than average flows may occur and may adversely affect recreational uses of the lake.

A reduction in downstream hydroelectric generation of 24.4 million kWhr annually would result from an average loss of 83.3 cfs of water. No significant impacts on groundwater are expected.

5.3 PERFORMANCE OF THE HEAT DISSIPATION SYSTEM

5.3.1 Heated water discharge into the Yadkin River

5.3.1.1 Far-field, or well-mixed, thermal effect on the Yadkin River

The temperature of the blowdown water is primarily a function of the wet-bulb temperature of the air drawn into the cooling towers. Monthly average blowdown temperatures are estimated by the applicant to range from about 70°F in the winter months to about 86°F in July (ER, p. 3.4-2). However, on the basis of the applicant's data of 76°F design wet-bulb temperature and 11.3°F approach temperature, the blowdown temperature could be 87.3°F. Ambient river temperatures range from about 40°F in the winter months to a maximum of about 84°F in the summer (ER, Table 2.5.0-1). During the summer, the temperature of the blowdown could be 4 to 15°F above the ambient river temperature, and in the winter months could be up to 30°F in excess of the river temperature. After becoming well mixed with the river water, this excess temperature will be diluted approximately in proportion to the ratio of the flow rate in the river to the blowdown flow rate (about 12 cfs). The flow in the Yadkin River varies over a wide range, typically between about 2000 cfs and 17,000 cfs, with the lowest flows in the late summer and fall months. The minimum flow on record is 330 cfs,* and the seven-day average lowest flow with a ten-year recurrence interval (7Q10) is 625 cfs. On the basis of this latter value, the staff estimated that after the blowdown is well mixed with the river water, the resulting temperature rise of the river would be about 0.6°F. If the flow in the Yadkin River were not allowed to fall below 880 cfs, the maximum temperature rise would be less than 0.5°F. At more typical flow rates, the residual excess temperature would be substantially less, probably on the order of 0.1°F.

5.3.1.2 Near-field thermal effect on the Yadkin River

Both the applicant and the staff made predictive calculations of the local temperatures in the immediate vicinity of the PNS discharge port to obtain information that could be used as a guide by the State of North Carolina Board of Water and Air Resources in judging whether the extent of the mixing zone would be acceptable. Several mathematical models are available for predicting near-field temperatures; the applicant chose the Sill and Schetz model[7] whereas the staff selected the Motz and Benedict model[8] as being adequately representative.

The Sill and Schetz model[7] used by the applicant assumes that a surface discharge is injected into a bounded, co-flowing mainstream, and includes both near- and far-field mixing and heat transfer to the atmosphere. The model has been experimentally verified by Sill and Schetz[7] and by the applicant (ER, Sect. 5.1.2.1). The results of the applicant's analysis are shown in the ER, Figs. 5.1.2-1 and 5.1.2-2. During winter time conditions, when the discharge water temperature is assumed to be 70°F and the river ambient temperature is 40°F, the 5°F isotherm was calculated to extend about 78 ft across the stream. The study was based on the seven-day, ten-year average low flow in the Yadkin River of 625 cfs; at this condition the river's width is estimated to be about 150 ft. The 5°F isotherm would thus extend about one-half of the way across the stream. The staff considers the assumed conditions to be somewhat overly conservative, because historically, the extreme low flow conditions occur between June and November (ER, Fig. 2.5.1-6) whereas the lowest river ambient temperatures occur between about November and March (ER, Fig. 2.5.1-7). During wintertime conditions when the temperature differential between the discharge and the ambient river temperature is high, average flow rates in excess of 2000 cfs would historically exist.

The staff made predictive calculations of the behavior of the heated water discharge in the near field to survey the effects at less stringent wintertime conditions than those used by the applicant and also to quantitatively evaluate the thermal shock potential for fish during the winter months. The two-dimensional Motz and Benedict model[8] used by the staff assumes the following:

(1) All flows are steady, the ambient current is uniform, and the extent of receiving water is infinite.

(2) The jet is two-dimensional (i.e., no vertical entrainment occurs).

(3) Turbulent mixing into the jet can be represented by a standard entrainment coefficient mechanism using a constant coefficient of entrainment, E.

(4) Changes of density along the jet axis are small compared with a reference density. Thus, inertial terms due to density gradients are negligible, and mass flux terms can be replaced by volume flux terms.

(5) Similar profiles of Gaussian form are chosen for velocity and temperature profiles.

(6) Pressure drag is included in a constant drag coefficient, C_d.

(7) Heat exchange to the atmosphere is expressed as a coefficient, K.

The Motz-Benedict model has been used to analyze both laboratory and field data with reasonable success.[9] However, the shallow nature of the Yadkin River, with depths of possibly only 2 to 3 ft at times, may cause substantial bottom interference with the discharge plume, and the results may have more qualitative than quantitative value. One aspect of the model that should be noted

*The low flow of record of 330 cfs occurred before construction of the Kerr Scott Dam; since then, the lowest instantaneous flow of record is 600 cfs.

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is the direct dependence upon the assumed coefficient of entrainment, E. Because there are no universally accepted values for E, the staff made two case studies, one with $E = 0.1$ near the lower end of the range of reported values, and another with $E = 0.25$ in the upper range of values.

Other data used in the staff's analysis and the results obtained are shown in Table 5.1, which indicates that under summertime conditions, the plume centerline temperature is predicted to be less than 5°F above ambient after a travel of about 20 ft from the discharge opening and that the extent of the mixing zone should be acceptable. Increases in the river velocity over the assumed rate of 1 fps would bend the plume more sharply downstream and would decrease the traverse of the plume across the river, but the volume of warmed water within the mixing zone would be about the same. Case C of Table 5.1 investigates the wintertime condition when the discharged water is assumed to be 30°F in excess of the assumed river temperature of 40°F and the river velocity is about 2 fps. In this case, the zone for the 5°F excess temperature at the plume centerline is reached at a distance of about 70 ft across the stream. The surface area of water having a 20°F excess in temperature is calculated to be about 20 ft^2 (probably representing a water volume of less than 40 to 50 ft^3), which indicates that the volume of heated water that might be attractive to fish in the winter months is relatively small. The staff agrees with the conclusions of the applicant that the thermal plume is not likely to extend across the entire river in either summer or winter conditions (ER, p. 5.1-2).

It has been previously noted that the intermittent discharge from the radioactive waste system ports in the blowdown headwall discharge structure will be at essentially river ambient temperature and will thus have no significant thermal impact on the Yadkin River. The staff's analysis has not considered the effect of simultaneous discharges from the two systems. This is a conservative assumption in that combined operation will produce more rapid mixing and dilution than is predicted when the blowdown water discharge alone is considered. Because the values for river flow velocities and temperatures assumed by the staff can vary over a relatively wide range, and because such factors as changing river bottom contours and bottom interference with the discharge jet can have important effects, the staff's calculated results should serve as a guide to the worst conditions that could reasonably be expected rather than as predictive quantitative data.

5.3.2 Cooling tower performance

5.3.2.1 Visible plumes

Under most meteorological conditions, the plume of air-water vapor mixture discharged from the cooling towers will be visible for only a short distance above the tops of the towers. However, on clear, cold winter days, white visible plumes may rise to some height and travel relatively long distances downwind. For example, the applicant estimated that during the winter months, a visible plume may travel about 15 miles downwind toward the SW about 5% of the time (Original ER, Figure 5.1.4.2).

Although the moisture content of the cooling tower plumes may seem impressive, the amount is nevertheless small in comparison with the burden of water in natural clouds. Outside of a radius of a few hundred feet from the cooling towers, no significant increase in the rainfall of an area due to cooling tower operation has been observed.

5.3.2.2 Ground-level fogging

An environmental impact of concern with regard to operation of cooling towers is the extent of the ground-level fogging that could occur as a result of the visible cooling tower plume touching the ground under certain meteorological conditions. However, when the atmospheric conditions are such as to cause ground-level fog formation, natural fog is also likely to exist. The staff analyzed the cooling towers at PNS for the number of hours per year of ground-level fog that might be produced in addition to that which would occur naturally. The estimate is based on counting the average number of hours per year during which the plume will touch the ground at a given point to cause 100% relative humidity when the atmospheric conditions at that point were not at 100% relative humidity or were free of ground fog. The staff's opinion is that this method is conservative, that is, it will cause estimates of more frequent fogging than will actually occur. The staff's analysis used ORFAD,[10] a predictive mathematical model based on the empirical plume rise equations of Briggs,[11] as modified by Hanna[12] and by Briggs,[13] to account for the increased buoyancy effect of multiple plumes. Credit was taken for the combined buoyancy effect for only three towers per group, however. The estimates did not take into account that the towers will be located on a somewhat elevated site, a factor that would tend to reduce the ground-level fogging effect in the surrounding terrain. The staff's analysis was based on U.S. Weather Bureau tapes of ten years of meteorological data (1955-1965) taken at Winston-Salem, North Carolina, which is located about 15 miles NNE of the PNS. Computer calculations were made at 1-hr intervals in the meteorological data, and the results were averaged to provide a 10-year average value. The data used in the analysis is listed in Table 3.2.

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Table 5.1. Results of the staff's analysis of heated water discharge into Yadkin River using the Motz-Benedict model[a]

Downstream distance (ft)	Across-stream distance (ft)	Plume half-width (ft)	Centerline excess temperature (°F)	Water area (ft^2) at temperature above or equal to		
				2°F	4°F	6°F
Case A						
0	0	1	10.0	23	19	16
14	17	4	4.7	155	95	30
23	24	6	4.1	253	122	30
94	52	12	2.4	1060	128	30
202	86	18	1.6	1570	128	30
Case B						
0	0	1	10.0	23	19	16
12	13	7	3.6	160	61	21
27	21	11	2.6	354	61	21
35	25	12	2.3	444	61	21
207	58	34	1.0	290	61	21
Case C						
0	0	1	30.0	27	24	15[b]
9	6	2	20.0	86	74	24[b]
19	10	3	16.1	167	141	24[b]
52	15	4	10.8	495	400	24[b]
96	18	6	7.8	1070	824	24[b]
216	20	11	4.6	3180	1960	24[b]
436	20	19	2.7	7660	2850	24[b]

[a]The following data were assumed for the particular case:

	Case A	Case B	Case C
Ambient river temperature, °F	77	77	40
Ambient river velocity, fps	1	1	2
Temperature of jet, °F	87	87	70
Entrainment coefficient, K	0.1	0.25	0.1

Other input data were common to all cases:

Ambient river salt concentration = 0.03 ppt
Heat exchange coefficient to the atmosphere = 90 Btu/day-ft^2-°F
Jet velocity = 4 fps
Jet discharge rate = 10 cfs
Equivalent half-width of discharge structure = 0.775 ft
Equivalent water depth of jet = 1.55 ft
Angle of discharge relative to bank = 90°
Drag coefficient = 0.5
Concentration of salt in jet = 0.3 ppt

[b]Surface area at temperature equal to or above 20°F.

The results of the staff's calculations are summarized in Fig. 5.3. The maximum amount of ground-level fogging was predicted to be about 4 additional hours per year of fog at points within about 1.5 mile and in a southwesterly direction from the towers. The staff considers this amount to be inconsequential.

During periods when fogging is occurring naturally, the cooling tower contribution is likely to be but a small portion of the total present and would probably be indistinguishable from it.

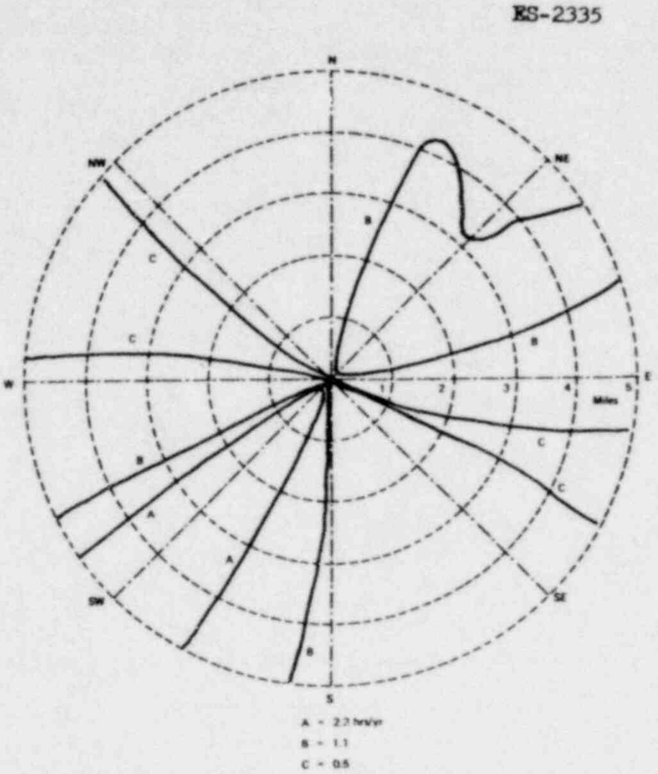

Fig. 5.3. Staff's analysis of hours of additional ground level fog caused by operation of Perkins Nuclear Station cooling towers.

5.3.2.3 Drift deposition

About 100 gpm of water in the form of droplets will be swept from the towers by the air stream and deposited on the surrounding terrain. The droplets will contain dissolved solids and chlorine concentrations essentially equal to those in the condenser circulating water. The concentration of dissolved solids will average about 530 ppm, and the maximum will be about 980 ppm. The average chlorine concentration in the droplets will be about the same as the average (from all nine towers) in the blowdown; the maximum will be 0.1 ppm. Based on the average concentration of dissolved solids of 530 ppm, a total of about 253,000 lb of solids per year will leave the towers in the drift. If this were deposited evenly over an area within a radius of 5 miles, the deposition rate would be about 5 lb/acre-year. The deposition rate is not uniform, however, because the larger drops will fall to the ground in the vicinity of the towers whereas the smaller drops will be transported by the plumes for relatively long distances. The drop-size distribution, as furnished by the applicant (ER, p. 5.1-6a), is given in Table 3.2.

The applicant predicted that the maximum amount of dissolved solids deposited at a distance of one mile from the towers at the PNS occurs in a northwesterly direction and is 50 lbs/acre-year (ER, Fig. 5.1.5-2, Amend. 2). The maximum amounts deposited at all distances tended to be in the northwesterly direction.

The staff analyzed the drift deposition rate for PNS by means of the analytical model described in Sect. 5.3.2.2 and the data shown in Table 3.2. The rate of drift loss and the distribution of drop-size diameters used by the staff are the same as those used by the applicant. The solids content in the drift was assumed by the staff to be 530 ppm, which is based on the average solids in the makeup water from the Yadkin River, although the applicant used a more conservative value of 1150 ppm. Both the applicant's and the staff's studies assume that the solids content of the drift is the same as that of the circulating water in the tower basin. The staff's results are summarized in Fig. 5.4. The staff estimated a maximum of about 13 lb/acre-year falling within the northeast and southwest sectors about 0.5 to 1 mile from the towers.

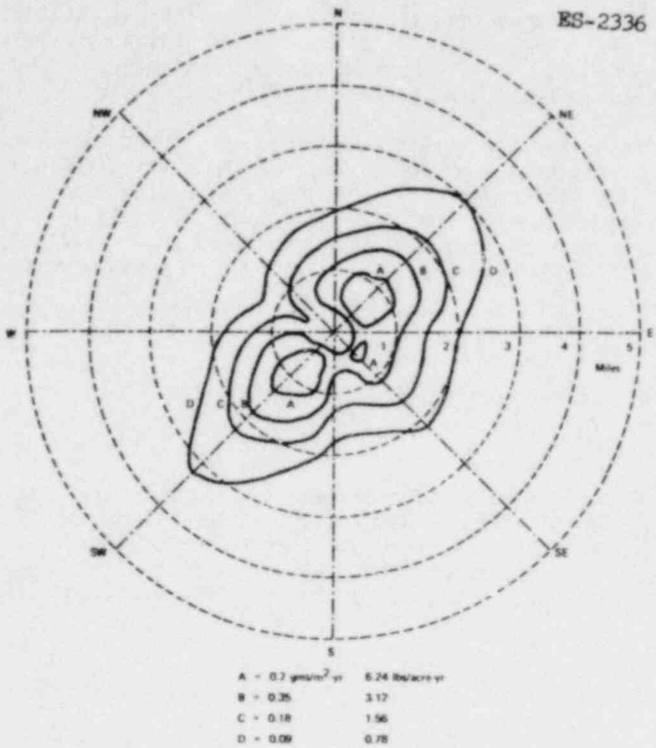

Fig. 5.4. Staff's estimate of drift deposition due to operation of cooling towers at Perkins Nuclear Station. The maximum calculated deposition rate was 13 lb/acre-year, which occurred in the SW sector about 1 mile from the towers.

5.3.2.4 Icing

Icing may occur in the immediate vicinity of cooling towers when water droplets fall or condense on cold surfaces and subsequently freeze. This effect is usually confined to the immediate vicinity of mechanical-draft towers and seldom occurs further than a few hundred feet away from tall, natural-draft towers. There are no widely accepted methods of calculating the extent of icing. One rough approximation is to assume that icing will occur when the plume touches the ground and the temperature is below 32°F. On this basis, the hours per year in which icing would occur at a given point in addition to that which would take place naturally could be no greater than the predicted hours of additional fog for that location and would probably be considerably less. Because the hours of additional fog predicted for the vicinity of the PNS cooling towers are low, the amount of icing can also be expected to be low.

5.3.3 Water quality standards and effluent limitations

5.3.3.1 State water quality standards

Water quality standards were adopted by the State of North Carolina on October 13, 1970.[14] The Yadkin River at the PNS site is classified as Class A-II waters. This class of waters can be used as a source of water for drinking, culinary, or food-processing purposes and any other best usage requiring waters of lower quality.[14] The staff considers that the construction and operation of PNS will comply with the State of North Carolina Standards if the procedures proposed by the applicant and required by the staff are followed.

5.3.3.2 Federal effluent guidelines and standards

On October 8, 1974, the EPA published regulations concerning thermal discharges and effluent guidelines for steam electric power generating plants.[15] The staff has reviewed the information that must be considered in determining whether PNS can be constructed and operated in conformity with the effluent limitations established by these regulations.

The Environmental Report describes the various effluents associated with the construction and operation of the facility. Assessment of the effects of these effluents are reported in this Environmental Statement. The staff's conclusion is that, except as noted below for zinc, phosphorous and chlorine all effluents from operation of the facility that are regulated by the EPA effluent limitations are in conformity with those limitations and reflect the "best available technology economically achievable" [40 CFS, 423-13(1)(1)]. A summary of the staff's findings follows:

Limitation 423.13(a)[15]

The pH discharges shall be within the range of 6.0 to 9.0.

Assessment

Discharges should fall within the pH control range. Effluents from the demineralizer systems will be neutralized before discharge. No sulphuric acid will be used in condenser cooling water systems. Control will be used to assure that the pH of other discharges remains within required levels, if necessary by the development of specific operating procedures for incorporation in the Technical Specifications to the operating licenses.

Limitation 423.13(b)[15]

There shall be no discharge of polychlorinated biphenol compounds.

Assessment

There will be no discharge of polychlorinated biphenol compounds.

Limitation 423.13(c)[15]

Low-volume waste source limitations on total suspended solids and oil and grease quantities.

Assessment

This limitation is not expected to be exceeded during plant operation. This may require the development of specific operating limitations to be incorporated as part of the Technical Specifications of the operating licenses to meet the applicable requirements of the NPDES permit when required.

Limitation 423.13(f)[15]

Metal cleaning waste pollutant discharges.

Assessment

Wastewater and waste solutions from cleaning operations will be treated during the construction period to remove suspended solids and chemicals. For limitation during operation, this may require the development of specific operating limitations to be incorporated as part of the Technical Specifications of the operating licenses.

Limitation 423.13(g)[15]

Boiler blowdown pollutant discharges.

Assessment

The system as detailed in the applicant's Environmental Report complies with the applicable EPA effluent limitations.

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Limitation 423.13(h) and (i)[15]

Cooling tower blowdown pollutant discharges.

Assessment

Zinc is present in Yadkin River water at concentrations up to 0.26 mg/liter (ER, Table 3.6.2-1); therefore, after a ten-fold concentration in the cooling towers it will be discharged in the blowdown at 2.6 mg/liter. The EPA limit allows a maximum of 1 mg/liter. Phosphorous (as P) is present in the river at maximum concentrations of 0.7 mg/liter; therefore, it will be concentrated to a maximum of about 7 mg/liter in the cooling tower blowdown. In addition, 0.9 mg/liter will be added as a constituent of the corrosion inhibitor; therefore a maximum of 7.9 mg/liter of phosphorous will be present in the blowdown. The EPA limit is 5.0 mg/liter.

The EPA standards for maximum and average concentrations of free residual chlorine allowed in cooling tower blowdown should be met during operation of the proposed facility. Chlorine is further discussed in Sect. 5.5.2.2. All other cooling tower pollutant discharges will comply with applicable EPA effluent limitations.

Limitation 423.13(j)[15]

Daily time limitation for discharge of chlorine.

Assessment

The applicant will chlorinate each unit sequentially for about 1 hr daily; however, some discharge of total residual chlorine will always exist in the blowdown, because a reserve of total residual chlorine will remain in the circulating water flow of the cooling towers (Sect. 3.6). EPA effluent standards limit discharges of residual chlorine for a period not to exceed 2 hr daily.

Limitation 423.13(1)(1)[15]

Discharge of heat from the main condensers.

Assessment

The facility will use closed-cycle cooling systems employing mechanical-draft cooling towers and cold side blowdown discharge of heat at a temperature that does not exceed, at any time, the lowest temperature of recirculating water prior to the addition of makeup water. This will conform to the applicable EPA effluent limitations.

Limitation 423.40[15]

Construction runoff.

Assessment

The applicant proposes construction practices to limit erosion and siltation resulting from construction practices. The staff is requiring that the applicant submit to the staff a surface runoff control plan to ensure that surface runoff will be adequately controlled to meet EPA standards.

The staff concludes that the facility, as designed by the applicant and as modified by staff requirements, will comply with State and Federal water quality requirements except for zinc, phosphorous, and chlorine. In addition, the applicant will be required to have a certification issued under Section 401 of the Federal Water Pollution Control Act stating affirmative compliance with applicable requirements prior to issuance of a construction permit.

5.4 RADIOLOGICAL IMPACTS

5.4.1 Radiological impact on biota other than man

5.4.1.1 Exposure pathways

The pathways by which biota other than man may receive radiation doses in the vicinity of a nuclear power station are shown in Fig. 5.5. Two comprehensive reports[16,17] concerned with radioactivity in the environment and these pathways can be read for a more detailed explanation of the subjects discussed below. Depending on the pathway considered, terrestrial and aquatic organisms will receive radiation doses approximately the same as or greater than those received by man. Although

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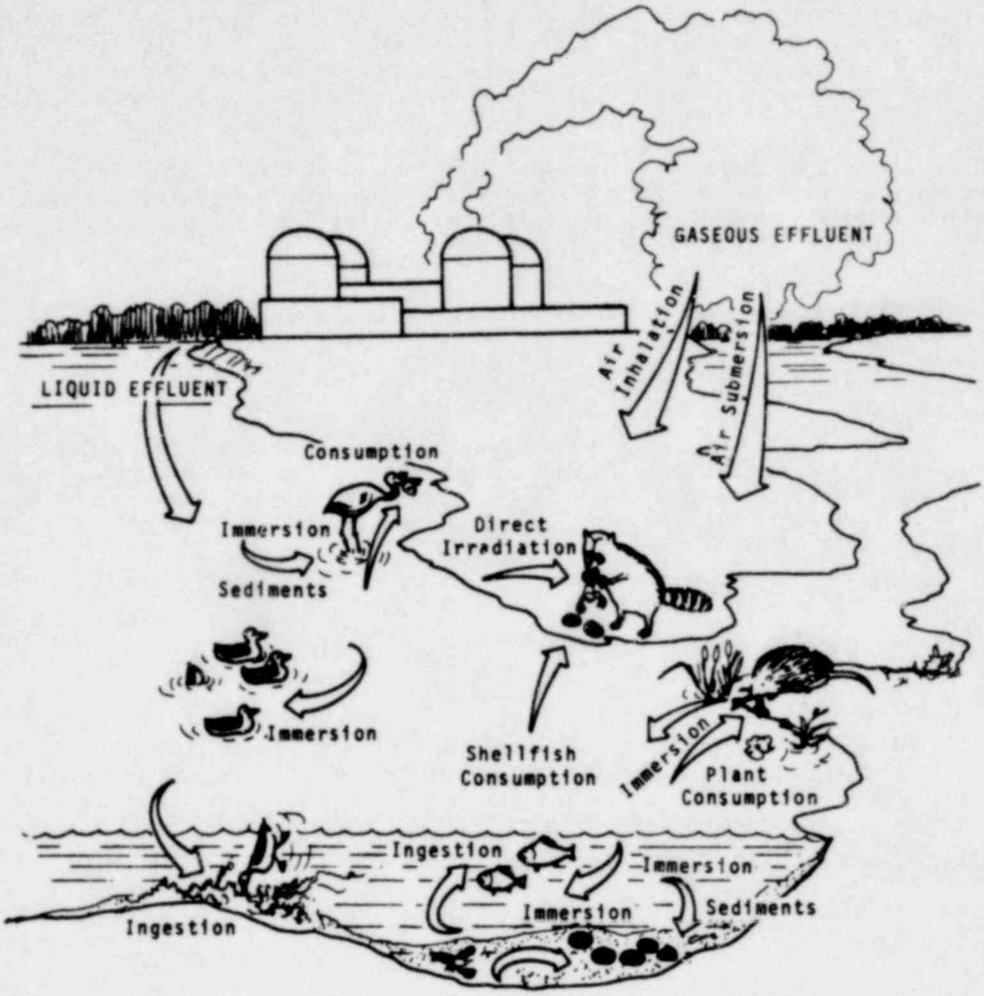

Fig. 5.5. Exposure pathways to biota other than man.

no guidelines have been established to set acceptable limits for radiation exposure to species other than man, there is general agreement that the guidelines established for humans are also conservative for these species.[18]

5.4.1.2 Radioactivity in the environment

The quantities and species of radionuclides expected to be discharged annually by PNS in liquid and gaseous effluents have been estimated by the staff and are given in Tables 3.4 and 3.5, respectively. The basis for these values is discussed in Sect. 3.5. For the determination of doses to biota other than man, specific calculations are made primarily for the liquid effluents. The liquid effluent quantities, when diluted in the PNS discharge, would produce an average gross activity concentration, excluding tritium, of 0.0011 pCi/ml in the plant discharge area. Under the same conditions, the tritium concentration would be 0.78 pCi/ml.

Doses to terrestrial animals such as rabbits or deer from the gaseous effluents are quite similar to those calculated for man (Sect. 5.4.2).

5.4.1.3 Dose rate estimates

The annual radiation doses to both aquatic and terrestrial biota were estimated on the assumption of constant concentrations of radionuclides at a given point in both the water and air. With reference to Fig. 5.3, radiation dose has both internal and external components. External components originate from immersion in radioactive air and water and from exposure to radioactive sources on surfaces, in distant volumes of air and water, and in equipment, etc. Internal exposures are a result of ingesting and breathing radioactive material.

Doses will be delivered to aquatic organisms living in the radionuclide-containing water discharged from the power station. This is principally a consequence of physiological mechanisms that concentrate a number of elements that can be present in the aqueous environment. The extent to which elements are concentrated in fish, invertebrates, and aquatic plants upon uptake or ingestion has been estimated. Values of relative bioaccumulation factors (ratio of the concentration of radionuclide in organisms to the concentration of radionuclides in the aqueous environment) of a number of waterborne elements for several organisms are provided in Table 5.2.

Table 5.2. Freshwater bioaccumulation factors (pCi/kg organism per pCi/liter water)

Element	Fish	Invertebrates	Plants
C	4,550	9,100	4,550
Na	100	200	500
P	100,000	20,000	500,000
Sc	2	1,000	10,000
Cr	200	2,000	4,000
Mn	400	90,000	10,000
Fe	100	3,200	1,000
Co	50	200	200
Ni	100	100	50
Zn	2,000	10,000	20,000
Rb	2,000	1,000	1,000
Sr	30	100	500
Y	25	1,000	5,000
Zr	3	7	1,000
Nb	30,000	100	800
Mo	10	10	1,000
Tc	15	5	40
Ru	10	300	2,000
Rh	10	300	200
Ag	2	770	200
Sn	3,000	1,000	100
Sb	1	10	1,500
Te	400	150	100
I	15	5	40
Cs	2,000	100	500
Ba	4	200	500
La	25	1,000	5,000
Ce	1	1,000	4,000
Pr	25	1,000	5,000
Nd	25	1,000	5,000
Pm	25	1,000	5,000
Sm	25	1,000	5,000
Eu	25	1,000	5,000
Gd	25	1,000	5,000
W	1,200	10	1,200
Np	10	400	300
Pu	4	100	350
Am	25	1,000	5,000
Cm	25	1,000	5,000

Source: S. E. Thompson, C. A. Burton, D. J. Guinn, and Y. C. Ng, "Concentration Factors of Chemical Elements in Edible Aquatic Organisms," UCRL-50564, Rev. 1 (1972).

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Internal doses (due to water uptake and ingestion) to aquatic plants and fish living in the discharge region were calculated to be 190 and 0.73 millirads/year, respectively. The discharge region radionuclide concentrations were those given above, and it was assumed that these organisms spent all of the year in water of maximum concentrations. All calculated doses are based on standard models.[19] The doses estimated for mobile organisms are quite conservative, since it is highly unlikely that these life forms will spend a significant portion of their life span in the maximum concentration of the discharge region. Both radioactive decay and additional dilution would reduce the dose at other points in the river.

External doses to terrestrial animals other than man are determined on the basis of gaseous effluent concentrations and direct radiation contributions at the locations where such animals may actually be present. Terrestrial animals in the environs of the station will receive approximately the same external radiation doses as those calculated for man.

An estimate can be made for the ingestion dose to a terrestrial animal such as a duck, which is assumed to consume only aquatic vegetation growing in the water in the discharge region. The duck ingestion dose was calculated to be about 240 millirads/year, which represents an upper limit estimate; equilibrium was assumed to exist between the aquatic organisms and all radionuclides in water. A nonequilibrium condition for a radionuclide in an actual exposure situation would result in a smaller bioaccumulation and, therefore, in a smaller dose from internal exposure.

The literature relating to radiation effects on organisms is extensive, but very few studies have been conducted on the effects of continuous low-level exposure to radiation from ingested radionuclides on natural aquatic or terrestrial populations. The "BEIR" report[20] states that evidence to date indicates that no other living organisms are very much more radiosensitive than man; therefore, no detectable radiological impact is expected in the aquatic biota or terrestrial mammals as a result of the quantity of radionuclides to be released into the Yadkin River and into the air by PNS.

5.4.2 Radiological impact on man

The NRC staff is presently reassessing assumptions and evaluating models for projected radioactive effluent releases and calculated doses in order to reflect the Commission's guidance in its Opinion issued April 30, 1975, in the rule-making proceeding RM-50-2, NCRI-75/4R, page 277 as amended 40 FR 40816, September 4, 1975.

The revised specific models for a detailed assessment of individual and population doses have not been completed. For the interim, it can be said that the individual doses associated with the radioactive releases of the Perkins Nuclear Station will be in accord with the requirements stated in Appendix I. Thus, no final plant design will be approved which will result in individual doses in excess of Appendix I requirements.

The staff has developed a procedure to quantitatively evaluate the maximum integrated doses that could be delivered to the U.S. population by radioactive emissions from PNS. A description of this procedure for gaseous effluents is contained in Appendix C. The intent of this estimate is to evaluate the radiological environmental impact of the facility by establishing an upper-bound population dose associated with plant operation which is unlikely to be exceeded when the detailed review is performed for the hearing before the Atomic and Safety Licensing Board.

5.4.2.1 Liquid effluents

Expected radionuclide releases in the liquid effluent have been calculated for PNS and are listed in Table 3.4. Doses to the population from these releases were calculated using dose procedures consistent with the recommendations of ICRP-2.[19]

According to the applicant, about 17,000 people currently derive their drinking water from the river within 50 miles downstream of the plant. The man-rem contribution from other intakes on the river is expected to be negligible.

The cumulative dose resulting from the consumption of fish harvested from the river was estimated. It was conservatively assumed that 100% of the population within 50 miles of the plant consumed 5 g of fish per day caught in the region of the river where the coolant water discharges were diluted by an additional factor of 250 over those dilutions in the immediate discharge region.

Because of the remoteness of the site and the lack of activity on the river, population doses from other possible pathways are expected to be small compared to the above pathways.

The tritium released to the receiving water is assumed to enter the biosphere in the same manner as tritium released to the atmosphere. Thus the tritium discussion in Appendix C applies to all tritium sources from the plant.

The information presented in Table 5.3 includes the doses to the population due to the release of radionuclides in the liquid effluents.

5.4.2.2 Gaseous effluents

NRC staff estimates of the probable gaseous releases listed in Table 3.5 were used to evaluate potential doses to the U.S. population. As discussed in Appendix C, these gaseous effluents were considered in five categories, namely, noble gases, radioiodines, particulates, C-14, and tritium. Krypton-85 was treated separately from the other noble gases because of its relatively long half-life (about 11 years).

The population can be exposed via the pathways discussed in Appendix C. External total-body irradiation results from submersion in dispersed noble gases and from standing on surfaces containing deposited radioiodines and particulates. Internal total-body and organ exposures result from inhalation of contaminated air or ingestion of contaminated foodstuffs. Three food pathways were evaluated which involved consumption: meat, milk, and food crops.

Doses to the population were calculated by assuming uniform dispersal of the radionuclides. Direct exposure pathways evaluation to the population (e.g., noble gas submersion) assume a uniform population density. Indirect food pathways evaluations were based upon the assumption that meat, milk, and food crop productivity of the region is such that the land area east of the Mississippi River is capable of supporting the U.S. population. Table 5.3 includes the population doses resulting from this analysis.

Table 5.3. Annual integrated dose to U.S. population

Radionuclide group	Annual dose (man-rems)	
	Total body	Thyroid
Noble gases	11	11
Radioiodine	0.14	55
Particulate	13	11
Tritium	2.5	2.5
C-14	50	50
Total	77	130

5.4.2.3 Evaluation of radiological impact

Using conservative assumptions, the staff has estimated an upper-bound integrated exposure to the population of the United States due to operation of the Perkins Nuclear Station. Appendix I to 10 CFR 50 requires that individual doses be kept to a small fraction of the doses implied by 10 CFR 20.

The above statements can be placed in perspective by noting that the individuals in the U.S. population receive an average of about 100 millirems/year from natural background radiation. Thus the annual population dose due to natural background to the U.S. population is about 21,000,000 man-rems.

Both the maximum individual doses and the upper-bound population doses resulting from operation of the Perkins Nuclear Station are fractions of the doses individuals and the population receive from naturally occuring radiation.

5.4.2.4 Direct radiation

Radiation from the facility

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The plant design includes specific shielding of the reactor, holdup tanks, filters, demineralizers, and other areas where radioactive materials may flow or be stored, primarily for the protection of plant personnel. Direct radiation from these sources is, therefore, not expected to be significant at the site boundary. Confirming measurements will be made as part of the applicant's environmental monitoring program after plant startup. Low-level radioactive effluent storage containers outside the plant are estimated to contribute less than 0.1 millirem/year at the site boundary.

Transportation of radioactive material

The transportation of cold fuel to a reactor, of irradiated fuel from the reactor to a fuel reprocessing plant, and of solid radioactive wastes from the reactor to burial grounds is within the scope of the NRC report, entitled *Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants* (WASH-1238). The environmental effects of such transportation are summarized in Table 5.4.

Table 5.4. Environmental impact of transportation of fuel and waste to and from one light-water-cooled nuclear power reactor

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 one per day
Rail	Less than three per month

Exposed population	Estimated number of persons exposed	Range of doses to exposed individuals per reactor year[a] (millirems)	Cumulative dose to exposed population per reactor year[b] (man-rems)
Transportation workers	200	0.0 to 300	4
General public			
Onlookers	1,100	0.003 to 1.3	3
Along route	600,000	0.0001 to 0.06	

[a]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 millirems/year for individuals as a result of occupational exposure and should be limited to 500 millirems/year for individuals in the general population. The dose to individuals due to average natural background radiation is about 130 millirems/year.

[b]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 millirems) each, the total man-rem dose in each case would be 1 man-rem.

Source: 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.

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Occupational radiation exposure

Based on a review of the applicant's Preliminary Safety Analysis Report, the staff has determined that individual occupational doses can be maintained within the limits of 10 CFR 20. Radiation dose limits of 10 CFR 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.[21] Using information compiled by the Commission[22] on past experience from operating nuclear reactor plants (with a range of exposures of 44 to 5134 man-rems/year), the average collective dose to all onsite personnel at large operating nuclear plants is estimated to be approximately 450 man-rems/year per unit. The total dose for PNS will be influenced by several factors for which definitive numerical values are not available. These factors are expected to result in lower doses to onsite personnel than those estimated above. Improvements to the radioactive waste effluent treatment system to maintain offsite population doses as low as practicable may cause an increase in 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 1400 man-rems will be used for the occupational radiation exposure for the three-unit PNS.

5.4.2.5 Summary of annual radiation doses

The annual population doses (man-rem) resulting from the plant operation are presented in Table 5.5. As shown in this table, the operation of the Perkins Nuclear Station will contribute a small fraction of the population dose that persons living in the United States normally receive from natural background.

Table 5.5. Summary of annual doses to the U.S. population

Category	Population dose (man-rems/year)
Natural environmental radioactivity	21,000,000
Nuclear plant operation	
Plant work force	1,400
General public	
Gaseous and liquid effluents (total body and thyroid)	210
Transportation of nuclear fuel and radioactive wastes	9

5.4.3 Environmental effects of the uranium fuel cycle

The environmental effects of uranium mining and milling, production of uranium hexafluoride, enrichment of isotopes, fabrication of fuel, reprocessing of irradiated fuel, transportation of radioactive materials, and management of low-level and high-level radioactive wastes are within the scope of the AEC report (WASH-1248) entitled *Environmental Survey of the Uranium Fuel Cycle*. The contribution of such environmental effects is summarized in Table 5.6.

5.5 NONRADIOLOGICAL EFFECTS ON ECOLOGICAL SYSTEMS

5.5.1 Terrestrial

5.5.1.1 Cooling towers

One of the possible principal impacts of wet, mechanical-draft cooling towers is the long-range change of environmental conditions caused by the release of large amounts of water vapor directly to the atmosphere. Such changes could involve increases in total regional rainfall, fog frequency, relative humidity, hours of cloud cover, days with precipitation, and frequency of thunderstorms. The occurrence of such changes over broad regions as a result of the operation of cooling towers could have unforeseen impacts on ecological systems and on use of these systems. To date, studies of possible regional environmental modifications have been few, because large cooling tower installations have been in use for a relatively short period of time. Also, large generating facilities are often located some distance from first-order U.S. Weather Bureau stations that have long-term climatological records for the several meteorological factors required to assess the effects of cooling tower plumes.

Using precipitation increase as a single indicator of environmental modification, a year-long study of two 325-ft high, natural-draft cooling towers at Keystone Generation Station (near Shelocta, Pennsylvania) showed that, except for substantial increases at two downwind stations during July 1969, precipitation measurements at nine U.S. Weather Bureau stations selected for monitoring purposes were within the range of variation established from an eight-year period just prior to plant operation.[23] All downwind stations did not register increased precipitation during the July period, however, which suggests that the increases noted at the two stations may have been purely chance events.

Table 5.6. 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 megatons)	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 megatons)	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 (megatons)		
Gases (including entrainment)[a]		
SO_2	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 megatons)	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.
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.

Deposition of drift solids due to cooling tower operation is described in Sect. 5.3.2.3. The majority of the deposition will occur to the northeast and southwest (Fig. 5.4). The maximum staff-calculated deposition rate was 238 lb/acre-year, which occurred in the north sector 1/4 mile from the cooling towers. Maximum drift depositions at 1 mile (just outside the site boundary) are estimated to be 30 lb/acre-year. The natural deposition rate, if one assumes 43 in. of precipitation per year (ER, Sect. 2.6.1) with a total dissolved solids concentration of 5 ppm (estimated from data of ref. 24), is 48.7 lb/acre-year.

Because of the relatively high deposition rates within 3/4 mile of the cooling towers, the staff anticipates that some damage might occur to vegetation in this area. The potential for detrimental effects on vegetation outside the site boundary is considered negligible. If the staff's maximum estimate of 30 lb/acre-year of drift solids at 1 mile from the cooling towers were diluted by annual precipitation (less 60% annual evapotranspiration[25]) and applied to the landscape as irrigation water, vegetation would be exposed to salt concentrations on the order of 13.5 ppm (mg/liter) including natural input. Dissolved solids concentrations of 13.5 ppm can be placed in perspective by considering that, within the eastern United States, water containing as much as 640 to 1280 ppm of total salts may be used for supplemental irrigation of plants having low salt tolerance.[26] Therefore, considering that no allowance has been given for dilution of drift solids by the moisture fraction of circulating water carried over as drift and considering further that the preceding calculations are based upon maximum deposition applying to the total landscape, serious vegetation damage resulting from root uptake or interference of normal absorption pathways by added salts is considered unlikely. Drift is not likely to have any measurable effect on vegetation at Boone's Cave State Park, located approximately 3.7 miles from the PNS site center.

5.5.1.2 Transmission facilities

The operational impact of the transmission lines will be largely determined by right-of-way management practices. According to the applicant (ER, Sect. 5.6), inspections of the rights-of-way will be done periodically from the air. Bush-hogging and hand-clearing is scheduled on a three-to-four-year cycle to control the resurgence of tall growth in the line corridors. No herbicides will be used.

After clearing, the right-of-way environment may experience increased use by off-road vehicles with their associated noise and damage to vegetation. However, this will be minimized because the construction access roads on the right-of-way are seeded and allowed to develop into dense vegetation as is the remainder of the right-of-way and because North Carolina laws restrict use of motorized vehicles on rights-of-way. Because of a dense cover of brush, which often develops on rights-of-way maintained by bush-hogging, such rights-of-way can be less accessible than surrounding forests.

An additional operating impact associated with transmission lines is the possible production of ozone around high-voltage carriers, which could damage nearby vegetation. Contributions of ozone in excess of ambient levels by transmission lines and substations are not well documented in the literature. Recent studies[27,28] suggest no measurable increase (less than 2 ppb) in ozone concentrations around 765-kV lines. Chronic exposures on the order of 30 to 150 ppb[29,30] are required to elicit damage in ozone-sensitive vegetation. Thus, considering that PNS lines will operate at 230 and 525 kV, vegetation damage due to ozone drift is considered unlikely.

Low-level electric fields produced by the two 230-kV fold-ins and the one 525-kV fold-in are not expected to have adverse effects on wildlife or humans (ER, Sect. 5.6). Since the general public is not expected to spend significant time in the transmission line corridors and on the basis of the expected ground-level electrostatic field values, the staff does not see any reason to believe that adverse physiological effects will result to the public from this source. Employees of the applicant, such as linemen, will be expected to work in fields of higher intensity. However, they should be protected by the provisions of the Occupational Safety and Health Act (OSHA).

Some avian mortality will result because of collisions with transmission lines and towers. Unfortunately, data on mortality caused by transmission lines is scant. The number of deaths caused by PNS lines should be insignificant compared with those caused by other transmission lines and other manmade obstacles, such as television towers, microwave towers, radio towers, and buildings.

5.5.2 Aquatic

5.5.2.1 Intake

Impingement

Cooling tower makeup water will be withdrawn from the Yadkin River. The intake structure will be located on the inside of a bend of the river located east of the reactor and turbine buildings (Fig. 2.1). Although river current past the site is normally quite fast ($\overline{x}$ = 2.6 fps), it varies substantially with river flow and could potentially approach a minimum of about 1.0 fps at low river flow (ER, Fig. 2.2.2-8). In comparison, the maximum intake velocity through the traveling screens will be about 0.5 fps (Sect. 3.4.2). The quantity of water withdrawn from the Yadkin River will vary between 88 and 270 cfs, depending on meteorological conditions, the percent load factor of the plant, and/or whether water for dilution of radioactive wastes is being pumped. The percentage of total river flow withdrawn would be about 4% on the average and about 37% at the maximum, with maximum pumping at minimum river flows

The intake structure design is presented in Fig. 5.6. The staff considers that the design of the intake structure will minimize fish impingement losses for the following reasons:

1. the intake velocity is slow (~0.5 fps).
2. the traveling screens are located flush with the front face of the structure with the result that river current can sweep across the screens (Fig. 3.5). Any fish that becomes impinged will be swept off the screens by the current.
3. lateral fish passages are present which will allow fish that pass through the trash racks to escape from the structure (Fig. 3.5).
4. no protected areas are present in front of the traveling screens (Fig. 3.5).

Because of the above mentioned factors, the staff does not consider that significant fish impingement losses will occur as a result of the operation of PNS.

A second source of potential fish impingement losses would be from pumping water from the Yadkin River to fill the Carter Creek Impoundment. The Carter Creek intake structure is shown in the ER, Fig. 5.1.4-2. Because the design of the structure should not create any significant areas of refuge, fish should not be attracted to the structure. Initial filling of the reservoir will take about 50 days; thereafter, pumping will be required to refill the reservoir only after releases or evaporative losses. Due to the small amount of time pumping will be required, the staff considers that the potential for fish impingement will be insignificant.

Entrainment

The cooling tower makeup water will contain entrained organisms that will pass through the 3/8-in. traveling screens and into the PNS heat dissipation system. A 100% mortality is assumed for these organisms from the combined effects of mechanical injury and chemical, thermal, and hydraulic stresses. Organisms expected to be entrained include bacteria, algae, zooplankton, drifting benthic invertebrates, and the eggs, larvae, and young juveniles of fish.

A random distribution of planktonic organisms is assumed from the turbulence and mixing of the river; therefore, the numbers of organisms removed from the Yadkin River will be directly proportional to the percentage of the total river flow withdrawn by PNS. The maximum percentage of the river flow would be withdrawn (about 16%) when the river flow is equal to 737 cfs (Table 5.7). This would produce a 16% loss of the planktonic organisms of the river passing the PNS site.

The initial filling of the Carter Creek Impoundment will constitute an additional entrainment loss of planktonic organisms from the Yadkin River. Based on a tentative agreement between the applicant and the State of North Carolina, the withdrawal of up to 25% of all flows in excess of 880 cfs plus consumptive withdrawals being made at the PNS intake will be allowed, with a maximum withdrawal of 200 cfs (ER, Carter Creek, Question 10). However, aside from the initial filling of the reservoir, the withdrawal of water from the Yadkin River should be very infrequent (Sect. 5.2.1).

River flows of 1000 cfs are exceeded in the Yadkin River 96% of the time (PSAR, Fig. 2.4.8-5). The occurrence of maximum entrainment losses would therefore be infrequent. The average expected monthly losses of plankton, as a percentage of river flow withdrawn by PNS, would range from a maximum of about 7% in July to a minimum of about 3% in March. Some losses of aquatic organisms

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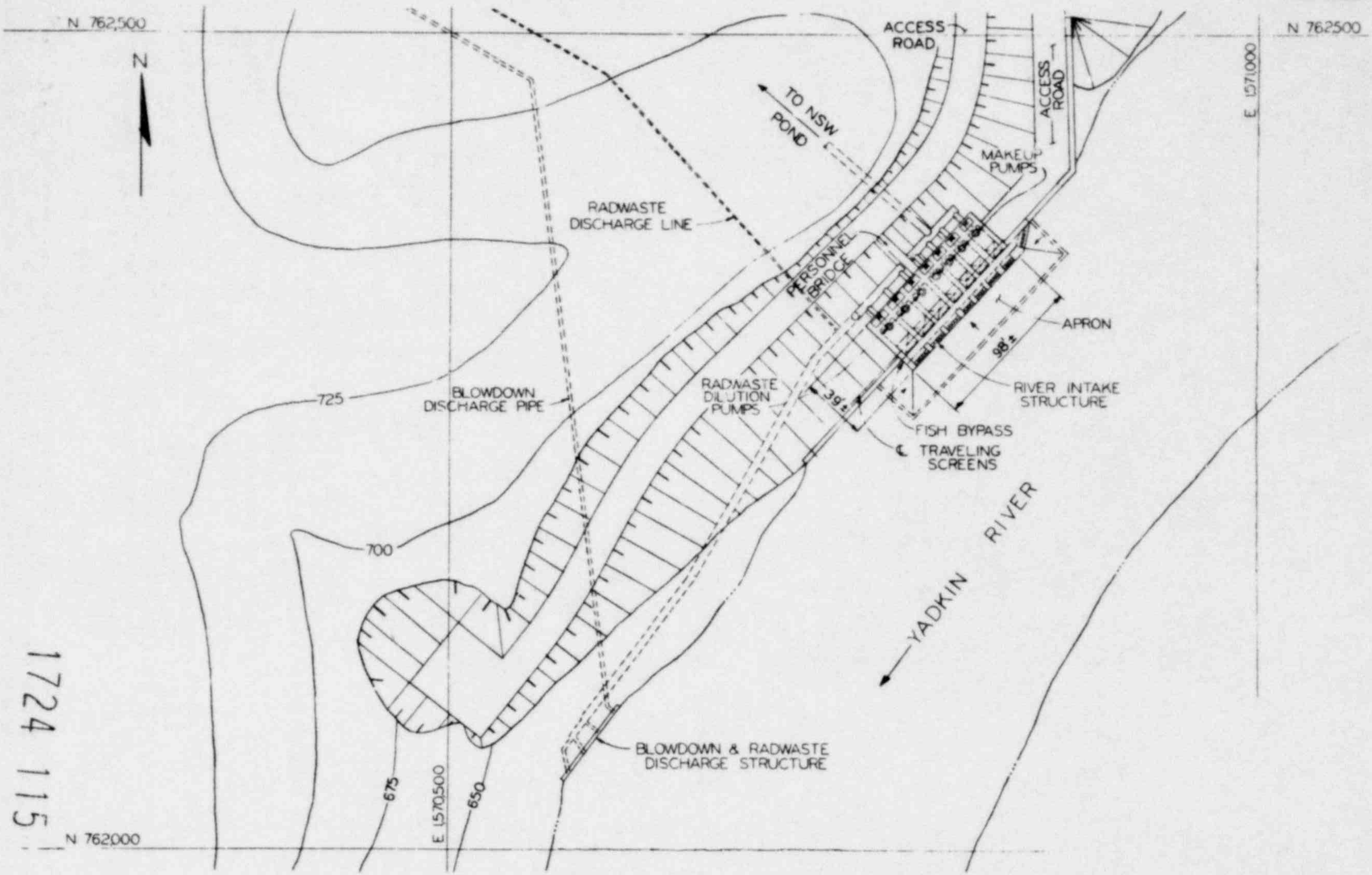

Fig. 5.6. River intake and discharge system layout. Source: ER, Fig. 3.4.1-1, Amend. 3.

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Table 5.7. The proportion of Yadkin River flow to be withdrawn by present facilities and by Perkins Nuclear Station during the months of the year when ichthyoplankton will be present in the river

	March	April	May	June	July	Minimum river flow expected
Average river flow at Yadkin College gauge, cfs[a]	4100	4000	2800	2500	1800	737[b]
Maximum withdrawals by PNS, cfs	122	122	122	122	122	122
Percentage of total river flow to be withdrawn by PNS, %	3	3	4	5	7	16
Average monthly flow into High Rock Lake, cfs[c]	7100	6200	4500	4000	2700	1200[d]
Present withdrawal by downstream facilities, cfs	612	612	612	612	612	612
Percentage of total river flow withdrawn by downstream facilities, %	9	10	14	15	23	51
Predicted total percentage of river flow to be withdrawn by both present downstream facilities and by PNS, %	12	13	17	19	28	59

[a]From Fig. 5.6.
[b]A flow of 737 cfs is equal to the $7Q_{10}$ flow (625 cfs) plus 112 cfs released from the Carter Creek Impoundment.
[c]From the ER, Fig. 2.5.2-21; includes flow from the Yadkin River and from other lesser tributaries of High Rock Lake.
[d]Extrapolated from Fig. 5.6 and from the ER, Fig. 2.5.2-21.

will result from the mechanical damage incurred during pumping of radioactive wastes dilution water; however, the infrequency of this pumping precludes it from being a major impact.

The staff considers that average monthly losses of from 3 to 7% of the phytoplankton and zooplankton would not reduce significantly the food available to benthos and fish in the river. This is because the phytoplankton and zooplankton communities are relatively unimportant components of the river's trophic structure (Sect. 2.7.2). Primary production by the phytoplankton is probably greatly inhibited by the high sediment load ($\bar{x}$ = 180 mg/liter) of the river. This is indicated by the low abundances of phytoplankton (Sect. 2.7.2) in the presence of high nutrient concentrations (ER, Sect. 2.5.1.3). The zooplankton of the river are characterized by a high proportion of small, unimportant (as fish food) rotifers and a low proportion of the more important fish food organisms such as copepods and cladocerans (Sect. 2.7.2).

Of primary concern to the staff is the impact that entrainment losses of the eggs, larvae, and young juveniles (ichthyoplankton) of fish would have on recruitment to important adult fish stocks. What makes entrainment losses of ichthyoplankton of such concern is the potential incremental impact of adding entrainment losses by PNS to the already substantial pre-existing entrainment losses. At the present time, there are three major users of Yadkin River water located between the PNS site and High Rock Lake. These three facilities, Buck Steam Plant, the City of Salisbury, and the North Carolina Finishing Company (ER, Table 2.2.2-6), withdraw a total of 612 cfs. Assuming a 100% entrainment mortality, the water withdrawn by these facilities is removing a monthly average of from 9 to 23% of the ichthyoplankton of the river passing by (Table 5.7).

The staff considers these pre-existing losses to be of sufficient magnitude to perhaps have an adverse impact on the fish populations of the area; however, no quantitative data are available to substantiate this supposition. The additional withdrawal of 122 cfs of water by PNS will increase the total entrainment losses in the river from the present monthly average of from 9 to 23% to total monthly averages of from 12 to 28%, about a 20 to 30% relative increase (Table 5.7).

Several important species of fish, including white bass and white and channel catfish, migrate out of High Rock Lake and up the Yadkin River to spawn in the river and its tributaries. Further upstream, migration is blocked 20 miles above the PNS by Idol's Hydroelectric Dam. Fish spawning, especially of white bass, would tend to be concentrated below the dam. At an average river velocity of 2.5 fps, any ichthyoplankton originating below the dam would pass by the PNS site within 12 hr. All the species listed above have demersal eggs, which probably would not drift with the current unless dislodged. However, the fry, after absorbing the egg sac, enter into the river current to drift until encountering a habitat suitable for further growth and development.[32,33] During the drifting stage, the fry would be susceptible to entrainment; this period of susceptibility would occur sometime in the spring, depending primarily on water temperature. Temperature is the principal factor governing the time of spawning, the time required for hatching, and the growth and development of young fish.[31]

Several other important Yadkin River fishes produce young that would be susceptible to entrainment: the bluegill, black and white crappie, whitefin shiner, and the carp.[34] These species are nonmigratory; therefore, the impacts of entrainment losses would be localized. Any significant entrainment losses would probably be replaced by recruitment of fish from adjacent areas.

The applicant has provided data, summarized in Table 5.8, on fish larvae sampling conducted in the spring and early summer of 1975. Although no data has yet been presented for the remainder of the summer, the staff considers that the most important component of the spawning season has been covered and only low numbers of larvae should be present during the remainder of the summer.

Table 5.8. Average densities and estimated annual entrainment of fish larvae at Perkins Nuclear Station based on data collected from April 21 through July 8, 1975

Taxa	Average density (number/1000 m^3)	Percent of total	Potential number entrained	Potential adult spawners lost
Catostomidae	42	79	991,000	200[a]
Ictaluridae	6	12	142,000	140[b]
Other taxa	5	9	118,000	120[b]
Total	53		1,251,000	460

[a]Survival of larvae to adults is estimated to be 0.0002 (Sect. 5.5.2.1).

[b]Survival of larvae to adults is estimated to be 0.001 (Sect. 5.5.2.1).

Source: ER, Sect. 2.7.2.4.

The densities of fish larvae encountered in the Yadkin River were relatively low. Larvae were found to be continuously present from April 21 through July 8. The average density of larvae in the river for this period was 62 per 1000 cu meters in night samples and 43 per 1000 cu meters in day samples. May was the month of the highest density of larvae averaging 124 per 1000 cu meters and 76 per 1000 cu meters in night and day samples, respectively. The collections were comprised of 79% Catostomidae (suckers), 12% Ictaluridae (catfish), and 9% other taxa including Clupeidae (shad), Centrarchidae (sunfish) and Percidae (perches). As a comparison to the fish larvae densities found in the Yadkin River, the applicant also sampled the Broad River in South Carolina during the same period in 1975. These collections had densities of larvae averaging 22 per 1000 cu meters in flowing parts of the river while the backwaters of a reservoir had densities averaging 800 per 1000 cu meters. This later figure is about 15 times higher than what was encountered in the Yadkin River.

Catostomid larvae were by far the predominate taxa encountered in the Yadkin River. Approximately one million catostomid larvae would be entrained annually by PNS, based on the 1975 data. The survival rate of catostomid larvae to mature adults is not well-known; however, their fecundity generally ranges from 10,000 to 50,000 eggs per female depending on size and species. As a conservative estimate of survival, the staff will assume that the average female in the Yadkin River produces 10,000 eggs, hatching success approaches 100% and that, on the average, two of the eggs survive to spawn successfully as adults. With this survival rate, the size of the population would remain relatively stable. Using this estimate of survival, the larvae entrained annually by PNS would result in a potential loss of about 200 adult catostomids per year (Table 5.8).

Catostomids are of only minor commercial and negligible sportfishing importance in the Yadkin River. They are benthic feeders, feeding primarily on benthic invertebrates and detritus. Small catostomids do serve as forage for predators; however, fish stomach content analyses made by the applicant for several fish species from the Yadkin River did not encounter any remains of catostomids, indicating that their importance as prey is minor compared to other species such as shad, minnows and sunfish (ER, Table 2.7.2-23).

The primary concern about entrainment losses of catostomids would be the potential threat to the survival of the population; however, as PNS will only entrain a small percentage (3 to 7%, Table 5.7) of the larvae passing the site, the staff does not consider that any significant adverse impacts on these populations, except for possibly a reduction in numbers, will result.

The second most abundant taxa encountered in the fish larvae collections were catfish, accounting for 6% of the total. Annual losses of about 140,000 larvae will result from PNS entrainment based on the 1975 data. The fecundity of white and channel catfish, the two most common catfish found in the Yadkin, ranges from 2000 to 70,000 eggs per female. Hatching success is high due to parental care of the eggs. The staff will assume as a conservative estimate of the survival of eggs to adults that the average fecundity is 2000 per female and that 2 out of every

2000 eggs spawned survives to spawn successfully as an adult. This would result in the population remaining relatifely stable. Assuming this survival rate, entrainment by PNS would result in a potential loss of about 140 adult spawners annually. Catfish are the most popular fish sought by fisherman in the Yadkin; however, the staff considers that losses in the range of 140 adults annually is insignificant. Density dependent compensation such as increased survival of those larvae escaping entrainment should adequately compensate for the losses and no adverse impacts to the catfish populations of the river should result.

Of the other fish taxa encountered in larvae samples, none were present in sufficiently high numbers to be of concern. Although white bass and white perch — two of the most important sport fishing species in High Rock Lake — spawn in the Yadkin River, no larvae of either of these species were collected in the applicant's sampling program. These species may spawn sufficiently upstream from the PNS site to allow the larvae to grow sufficiently before reaching the PNS vicinity, thus enabling them to avoid the fish larvae sampling nets.

Presently the three large users of Yadkin River water located between the PNS site and High Rock Lake withdraw about five times the water that PNS will withdraw when fully operational. A high percentage of the fish larvae entrained by these facilities are probably killed; although, without substantiating data, this cannot be definitively stated. Due to the much larger volume of water withdrawn, the impact of entrainment by these facilities is probably much greater than will be the impact of PNS. However, the applicant has plans to retire several of the units at Buck Steam Plant prior to the startup of PNS. The result of this retirement in relation to the startup of PNS will probably mean less entrainment mortality of fish larvae than what is presently occurring. As most of the fish being entrained are of minor ecological, commercial, or fishing importance, the staff considers that the adverse impact of entrainment by PNS on the fish populations of the Yadkin River and High Rock Lake will not be significant.

The initial filling of the Carter Creek Impoundment will constitute another potential loss of ichthyoplankton. The withdrawal of this water during periods when ichthyoplankton are present would result in another substantial incremental loss of ichthyoplankton from the Yadkin River. To reduce this adverse impact, the applicant will be required to limit the filling of the reservoir to the period from August through February, a period when few, if any, ichthyoplankton should be present in the river. Some subsequent withdrawals of water may be necessary to refill the impoundment to make up for evaporative losses or releases to the river; however, these withdrawals should be sufficiently infrequent to not create any additional significant entrainment losses.

The above conclusions are based on data collected during only one season. It is not known if this data is typical or atypical of long-term conditions in the river. The applicant will, therefore, be required to continue ichthyoplankton sampling so that the conclusions discussed above can be confirmed.

5.5.2.2 Discharge

Chemical

A description of PNS chemical and biocidal systems is given in Sect. 3.6. Tables 3.6 and 3.7 list the chemical species, their concentrations in the cooling tower blowdown, and their incremental increases in concentration in the Yadkin River after dilution with the minimum seven-day, once-in-ten-year flow of 625 cfs. Several chemicals of potential concern are discussed below.

Total dissolved solids (TDS). The cooling tower blowdown after an average 10 cycles of operation will have a maximum TDS concentration of approximately 1080 mg/liter. This will result in an incremental increase in the TDS of the Yadkin River at a flow of 625 cfs of 18 mg/liter. This increase will produce a TDS concentration that is still well within the normal range for fresh waters and will have no adverse effects on the biota of the Yadkin River. The median toxicity threshold of TDS for most freshwater invertebrates and fishes ranges from 3000 to 15,000 ppm.[35]

Dissolved oxygen. Cooling tower blowdown will have DO concentrations at saturation due to aeration in the cooling towers. Even considering its elevated temperatures, the blowdown will only produce negligible changes in the DO concentrations in the river due to the small volume of blowdown involved (12 cfs), the high ambient river oxygen concentrations, and the low ΔT expected (5°F) during the summer when oxygen levels are normally most critical.

Chlorine. The applicant's chlorination procedures are discussed in Sect. 3.6.1 and will consist of the application of 530 to 1070 lb of chlorine (as sodium hypochlorite) daily per unit (1600 to 3200 lb/day total) over a period of 1 hr. A free residual chlorine concentration in the cooling system of 1 ppm will result during warm weather, and 0.5 ppm will result during cold weather. Each unit will be chlorinated sequentially. Under this procedure, the blowdown woud have a maximum free residual chlorine concentration of 0.3 mg/liter and a total chlorine reaction

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products concentration of 50 mg/liter. After dilution in a flow of 625 cfs, this would produce a maximum incremental increase of about 0.14 mg/liter (Table 3.7).

The chlorine reaction products will consist of total residual chlorine and chloride, but the proportions cannot be predicted. The relationship between time of exposure and concentration of residual chlorine toxic to aquatic life (mostly freshwater fish) is summarized in Fig. 5.7. Figure 5.7 shows that, if even a small proportion of the chlorine reaction products consist of total residual chlorine, chronic or acute levels of chlorine would be present during periods of below normal (about 625 cfs) river flows. If river flow was to be reduced to a critically low flow (about 625 cfs) for even a few days, a fish kill could result. The time required for a fish population to recover from a large mortality would be necessarily long; therefore, even an occasional fish kill, if sufficiently severe, could significantly reduce the fish populations of the river. Chronic toxicity levels, though not sufficient to kill fish, may reduce reproductive success and increase the stress of other adverse environmental factors such as low oxygen concentrations.

The potential clearly exists for severe damage to the fish and other biota of the Yadkin River from releases of chlorine from PNS at levels specified in current EPA guidelines.

Zinc and phosphorus. Zinc is present in the Yadkin River at concentrations up to 0.26 mg/liter (Tables 3.6 and 3.7). After concentration in the PNS heat dissipation system, zinc will be released at 2.6 mg/liter, which is in excess of the 1.0 mg/liter allowed by the EPA. Phosphorus will be present in the blowdown at a maximum of 7.9 mg/liter (as P) (Section 5.3.3.2). The incremental increase of zinc and phosphorus in the river will be a maximum of about 0.04 mg/liter and 0.3 mg/liter, respectively. This should not adversely affect aquatic biota.

Alternative biocide

Only very limited data is available on the toxicity of the alternative biocide, *dodecylguanidine hydrochloride*, to aquatic organisms. The manufacturer of the biocide reported a 96-hr LC_{50} concentration of 7.5 mg/liter for the bluegill, *Lepomis macrochirus*. Bioassays using the alternative biocide were conducted by the applicant using the green algae, *Selenastrum capricornutum*. At concentrations expected to be used at PNS, the alternative biocide killed all cultures grown at 50°F and at 68°F but did not kill the cultures grown at 86°F, although growth rates were reduced by 50% (ER, Sect. 5.4.3).

When used, the alternative biocide would be present at 10 mg/liter in the blowdown and, after complete dilution in the Yadkin River in the $7Q_{10}$ flow of 625 cfs, it would be present at 0.09 mg/liter (Table 3.7). A concentration of 0.09 mg/liter would probably not be acutely toxic to most aquatic organisms; however, it may be chronically toxic if exposure was of a long duration.

Prior to approval of use of dodecyclguanidine hydrochloride as a biocide, the staff will require that adequate, acute and chronic toxicity data be provided for representative, indigenous species of all trophic levels to assure that release will not produce adverse effects to aquatic biota.

Scale inhibitors

The applicant has studied the effects of the scale inhibitor, aminomethylene phosphonate, on the green algae, *Selenastrum capricornutum*. At concentrations that are expected to be used at PNS, the compound did not substantially affect algal growth. The effects of the scale inhibitor on higher trophic level organisms, however, is not known. Before the staff will approve the use of this compound, adequate data must be provided on the acute and chronic toxicity of the compound to representative, indigenous organisms of all trophic levels.

Thermal

The operation of all three units of PNS will produce a cooling tower blowdown of 12 cfs. The blowdown will be discharged through a bankside, single-port discharge structure located about 250 ft downstream of the intake structure (Fig. 2.1).

Summer

Under summer conditions, the staff estimates that the maximum blowdown temperature will not exceed 90°F (Table 5.1). Due to entrainment of river water of ambient temperature into the discharge jet, mixing will be rapid and no appreciable zone with a temperature in excess of

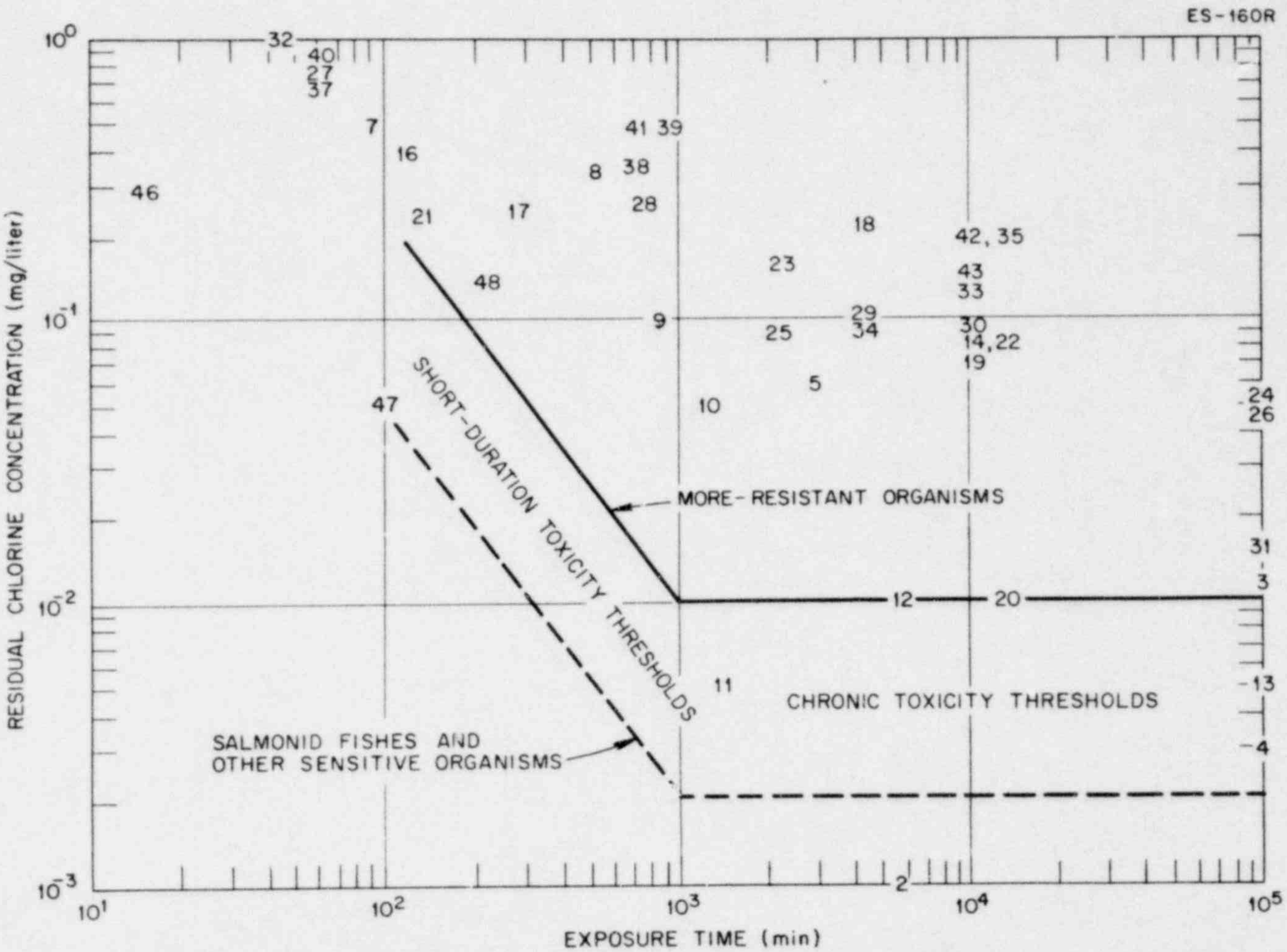

Fig. 5.7. Summary of residual chlorine toxicity.

Key to Fig. 5.7.
Exposures of aquatic organisms to total residual chlorine

All concentrations were measured

Organisms	Point No.	Effect end point[a]	Reference
Cladoceran	2	Lethal (4 days)	Biesinger, 1971
Scud	3	Safe concentration	Arthur, 1971
	4	Safe concentration	Arthur and Eaton, 1972
Trout fry	5	Lethal (2 days)	Coventry et al., 1935
Brook trout	7	Median mortality (90 min)	Pyle, 1960
	8	Mean survival time 8.7 hr	Dandy, 1967
	9	Mean survival time 14.1 hr	Dandy, 1967
	10	Mean survival time 20.9 hr	Dandy, 1967
	11	Mean survival time 24 hr	Dandy, 1967
	12	67% lethality (4 days)	Dandy, 1967
	13	Depressed activity	Dandy, 1967
	14	7-day TL50	Arthur, 1971
Fingerling rainbow trout	17	Lethal (4 to 5 hr)	Taylor and James, 1928
Rainbow trout	16	Lethal (2 hr)	Taylor and James 1928
	18	96-hr TL50	Basch, 1971
	19	7-day TL50	Merkens, 1958
	20	Lethal (12 days)	Sprague and Drury, 1969
	21	First death 2.2 hr	Holland et al., 1960
	22	7-day TL50	Arthur, 1971
Chinook salmon	23	100% kill (1–2 days)	Holland et al., 1960
Coho salmon	24	Maximum nonlethal	Holland et al., 1960
	25	100% kill (1–2 days)	Holland et al., 1960
	26	Maximum nonlethal	Holland et al., 1960
Pink salmon	27	TL50 (1 hr)	Arthur, 1972
	28	TL50 (12 hr)	Arthur, 1972
Fathead minnow	29	96-hr TL50	Zillich, 1969
	30	7-day TL50	Arthur, 1971
	31	Safe concentration	Arthur and Eaton, 1972
	32	Lethal (30–60 min)	Fobes, 1971
	33	7-day TL50	Arthur, 1971
White sucker	34	96-hr TL50	Arthur, 1971
	35	7-day TL50	Arthur, 1971
Black bullhead	37	TL50 (1 hr)	Arthur, 1972
Largemouth bass	38	TL50 (12 hr)	Arthur, 1972
	39	Median mortality (15 hr)	Pyle, 1960
Yellow perch	40	TL50 (1 hr)	Arthur, 1972
	41	TL50 (12 hr)	Arthur, 1972
	42	7-day TL50	Arthur, 1971
Walleye	43	7-day TL50	Arthur, 1971
Miscellaneous fish	46	Initial kill 15 min	Truchan, 1971
Rainbow trout	47	100% lethal in plant effluent	Michigan Water Resources Commission, 1971
Daphnia magna	48	0 recovery	National Water Quality Lab, 1971

[a]TL50: median tolerance limit.

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5°F will exist. The area enclosed within the 2°F isotherm will be a maximum of about 0.04 acre (Table 5.1). The maximum temperature of the summer blowdown will be less than the threshold lethal temperature for those fish species collected from the Yadkin River for which thermal tolerance studies have been made (Table 5.9).[36,37] Due to the small area of the plume, there should be no appreciable adverse thermal impacts from the blowdown under summer conditions.

Winter

Under winter conditions, the temperature differential between the warm blowdown (70°F) and the cold river (40°F) will be greater, and the zone of excess temperature will cover a larger area. The plume will tend to float on top of the river water. The applicant estimates that the 5°F

Table 5.9. Thermal tolerances of several fish species found in the Yadkin River

Species	Acclimation temperature (°F)	Stage/age	Locality	Upper lethal threshold (°F)	Lower lethal threshold (°F)
Micropterus salmoides[a]	68		Ohio	90.5	41.9
(largemouth bass)	77			94.1	
	86			97.5(u)	53.2
Notemigonus crysoleucas[a]	50	Adult	Composite of	85.1	34.7
(golden shiner)	59		Ohio, Florida,	86.9	39.2
	68		and Ontario	89.6	44.6
	77			92.3	55.2
	86			94.1	
Semotilus atromaculatus[b]	41	Adult	Ontario	76.4	
(creek chub)	50			81.1	
	59			84.7	
	68			86.5	33.3
	77			86.5	40.1
Catostomus commersonsi[b]	41	Adult	Ontario	79.3	
(white sucker)	50			81.9	
	59			84.7	
	68			84.7	36.5
	77			84.7	42.8
Dorosoma cepedianum[a]	77	Under-yearling	Ohio	93.2	51.4
(gizzard shad)	86			96.8	58.1
	95			97.7(u)	68.0
Gambusia affinis holbrooki[a]	59	Adult	Texas	95.9	34.7
(mosquito fish)	68			98.6	41.9
	77			98.6	
	86			98.6(u)	
Ictalurus nebulosus[a]	41		Florida to	82.2	
(brown bullhead)	50		Ohio (seasonal)	84.2	
	59			87.8	
	68			90.5	32.9
	77			92.8	39.2
	86			94.6	44.2
	93			94.6	
Ictalurus punctatus[a]	59	Adult	Florida and	86.7	0.0
(channel catfish)	68		Ohio	91.0	0.0
	77			92.3	0.0
Lepomis machrochirus purpurescens[a]	59	Adult	Florida	86.9	36.5
(bluegill sunfish)	68			89.6	41.0
	77			91.4	45.5
	86			94.2	51.8

(u) = ultimate lethal temperature.

[a]Source: J. S. Hart, "Geographic Variations in Some Physiological and Morphological Characters in Certain Freshwater Fish," *Publ. Ontario Fish. Res. Lab.* **LXXII** (1952).

[b]Source: J. S. Hart, "Lethal Temperature Relations of Certain Fish of the Toronto Region," *Trans. Roy. Soc. Canada* **51**(3):57–71 (1947).

isotherm will enclose about 0.5 acre and will extend across about 45% of the river's width at the $7Q_{10}$ flow (ER, Sect. 5.1.2.1, Fig. 5.1.2-2). The staff's estimate, based on less severe conditions, indicates that the 5°F isotherm would cover less than 0.1 acre (Table 5.1). The 20°F isotherm would only encompass about 24 sq ft. During the colder months of the year, fish are often attracted to thermal plumes, because the warmer water more nearly approaches their preferred temperature.[38] This attraction phenomenon creates a potential for cold shock fish kills. If all units of a power plant should stop operating, the temperature of the plume would suddenly drop to ambient temperature. If the drop in temperature is sufficiently large, depending primarily on the temperature to which the fish are acclimated, a fish kill can result. Studies of several fish species present in the Yadkin River indicate that these species would have to be acclimated to temperatures near 70°F to become susceptible to a cold shock mortality at an ambient river water temperature of 40°F (Table 5.9).[36,37] The temperature of the blowdown will be about 70°F as it leaves the discharge pipe, but it will immediately begin to decrease as mixing takes place in the river. The volume of water with a temperature of 70°F will be very small (<50 ft^3). Beyond a distance of about 9 ft below the point of discharge, the centerline temperature would be about 60°F (Table 5.1). In addition, the probability that all three units of PNS would cease operating at the same time is very small. The potential for cold shock fish kills will, therefore, be negligible.

The PNS blowdown will not create a thermal blockage to fish migrations, because the plume will tend to float above the river bottom and will only extend across about 45% of the width of the river. The blowdown will enter the Yadkin River at a velocity of about 5 fps horizontally and perpendicular to the river current (Fig. 3.4). Some scour may occur; however, the impact will be quite localized, because the warm plume will tend to rise above the river bottom.

Some planktonic organisms present in the river will be entrained in the blowdown plume. During the summer months when mixing will be the most rapid, the ΔT will be small and entrained plankton will experience only minor temperature changes. During the colder months, mixing will be much slower and relatively few organisms will be entrained in the plume. In either case, the overall impact will be negligible.

Summary

Operation of PNS could potentially result in adverse impacts to the aquatic environment through impacts associated with the withdrawal of cooling tower makeup water (impingement and entrainment) and through the discharge of effluents (chemical and thermal impacts).

The staff considers that fish impingement losses at PNS should be insignificant as the design of the intake structure should minimize fish impingement.

Entrainment losses of phytoplankton and zooplankton will not have serious impacts on the biota of the Yadkin River as these organisms are of minor importance in the trophic structure of the river. Entrainment losses of fish larvae will be highest for species of little commercial, sport fishing, or ecological importance. The only important species to be substantially affected may be catfish; however, entrainment losses should be mitigated by density-dependent compensation as the proportion of all larvae present in the river that will be lost to entrainment is small.

Total residual chlorine will be present in the blowdown to the Yadkin River in relatively high concentrations. After dilution in the low river flows expected during the summer months, total residual chlorine may be present at levels acutely or chronically toxic to many aquatic organisms.

During the summer, the blowdown temperature will not exceed 90°F. Mixing of the plume in the river will be rapid, and no thermal impacts on aquatic biota are anticipated. During the winter the ΔT will be a maximum of 30°F. The area enclosed by the 5°F isotherm will be less than 0.6 acre. Very little potential for cold shock will exist, because the volume of water with a temperature high enough to create a cold shock potential will be small (<50 ft^3). The blowdown discharge should not create any significant problems of thermal blockage or benthic scouring.

The impacts of the operation of PNS on the aquatic environment are summarized in Table 5.10.

5.5.2.3 Sanitary and other wastes

During the operation of PNS, domestic sewage will average an estimated 8000 gpd. The sewage will receive secondary treatment and chlorination (12 to 25 mg/liter). The effluent will be pumped to a holding pond and ultimately to the Yadkin River (ER, Sect. 3.7.2). The chemical composition

Table 5.10. Summary of environmental impacts due to operation of Perkins Nuclear Station

Potential impact	Applicant's plans to mitigate	Expected relative significance	Corrective actions available and remarks
Impingement of organisms on intake screens (Sect. 5.5.2)	Intake velocity <0.5 fps. Intake structure is designed to minimize fish impingement	Insignificant	Intake structure should not be conducive to producing fish impingement.
Entrainment of organisms in cooling tower makeup water (Sect. 5.5.2.1)			
Phytoplankton and zooplankton	Closed-cycle cooling	Insignificant	
Fish eggs, larvae, and juveniles	Closed-cycle cooling		Larvae of important fish species are present in very low densities.
Chemical discharges (Sect. 5.5.2.2)			
Total dissolved solids	None	Insignificant	
Dissolved oxygen	None	Insignificant	
Chlorine	Intermittent use. Units will be chlorinated sequentially.	Significant; total residual chlorine will be present at levels toxic to aquatic organisms during periods of low river flow.	Applicant will be required to limit total residual chlorine in blowdown to 0.1 mg/liter.
Zinc	None	Insignificant	
Phosphate	None	Insignificant	
Sanitary Wastes	Wastewater treatment system	Insignificant	
Thermal effects (Sect. 5.5.2.2)			
Maximum temperatures	Closed-cycle cooling	Insignificant	
Cold shock	Closed-cycle cooling	Insignificant	
Thermal blockage	Closed-cycle cooling	Insignificant	
Scour at discharge	Low volume, horizontal discharge 2 ft above bottom	Insignificant	

of the discharge to the river will contain a maximum of 36 mg of phosphate per liter, 4.8 mg of nitrates per liter, and 4 mg of ammonia per liter. When added to the nutrients released in the blowdown, incremental increases in a flow of 625 cfs equal to 0.3 mg of phosphate per liter, 0.6 mg of nitrates per liter, and 0.7 mg of ammonia per liter will result.

Incremental increases of the above magnitude in phosphates, nitrates, and ammonia could stimulate increased primary production in the Yadkin River. The amount that primary production will be increased will probably be minor. Due to high ambient turbidity (annual average TSS = 180 mg/liter), primary production in the Yadkin River is probably limited more by light than by any nutrient. Total residual chlorine will be present in the effluent at insignificant concentrations and will cause no adverse impacts to aquatic biota.

5.6 EFFECTS ON THE COMMUNITY

5.6.1 Population growth

A permanent work force of about 250 people will be required to operate the proposed facility. These employees are expected to reside principally in Davie, Davidson, and Rowan Counties. The increased burden on local schools and other demands for governmental services should be insignificant.

The applicant has predicted very modest population increases in the counties of Davie, Davidson, and Rowan due to construction and operation of the proposed Perkins facility. The effect of large property tax revenues on the property tax rate of Davie County and the subsequent effect on the in-migration of residents is unknown. The applicant estimates that the property tax liability would be over $3.5 million if construction began in 1975. The proposed Perkins facility would generate large tax revenues for Davie County, thus enabling the county to substantially reduce the property tax burden on residential property. As a result, Davie County would become an attractive place to live for people who presently reside in nearby urban areas. Large numbers of new residents could then possibly move into the county. These new residents would impose an increased demand for public services from the county, such as schools, police protection, and water and sewage facilities. Such demands could arise over a short period of time, before county officials would have sufficient time to plan for expansion of public services.

At the same time, land costs might become very high, putting the price of real estate out of reach of many local residents.

To minimize the problems of uncontrolled development brought about by construction and operation of a large tax-revenue-producing facility such as PNS, it is important that long-range planning be undertaken by the governmental units involved. The usual procedure is the development of a master plan followed by appropriate zoning laws and regulations to prevent unregulated development.

5.6.2 Physical impacts

The staff concludes that the operation of the station will not result in any detectable odor offsite. Pollutants from fossil fuels used in the emergency diesel generators will have negligible impact, since emissions will occur on an infrequent basis, be of short duration, and meet applicable standards.

Some noises will result from station operation. Major noise sources are the atmospheric steam dump, emergency diesel generators, air handling fans, switchyard, and cooling towers (ER, Sect. 5.7). The staff anticipates that the noisiest sources during normal operation will be the switchyard (primarily 60-cycle hum) and the mechanical-draft cooling towers. The applicant has indicated that noise levels due to cooling tower operation will not exceed 84 dB(A) at 250 ft from the towers (ER, Table 11.2.0-1). The shortest distance from cooling tower to site boundaries is about 3000 ft. Thus, the staff does not consider that noise from cooling tower operation will cause any inconvenience at site boundaries.

The three reactor containment vessels, each about 160 ft above grade level, will be the tallest structures on the site. However, the plumes from the cooling towers will sometimes extend to heights in excess of the towers and consequently will be the most visible feature of the site. The applicant has indicated that plume lengths will exceed one mile about 10% of the time and will exceed 20 miles about 1% of the time (ER, Fig. 5.1.5-1). Although these cooling tower plumes will contrast with the existing rural scene, they will not constitute a significant environmental cost.

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6. ENVIRONMENTAL MEASUREMENTS AND MONITORING PROGRAMS

6.1 PREOPERATIONAL

6.1.1 Meteorological

The preoperational onsite meteorological program,[1] i tiated in October 1973, consists of one 30-ft and one 130-ft tower (a converted electrical ansmission tower) located where the proposed cooling towers will be. These towers will be replaced by a permanent meteorological facility, to be initiated in October 1978. Wind speed and direction are measured at the top of the 30-ft tower. On the 130-ft tower, wind speed and direction are measured at the 130-ft level, vertical temperature gradient is measured between 30 ft and 130 ft, ambient air and dewpoint temperatures are measured at 30 ft, and precipitation is measured near the ground. The data are recorded on strip charts.

The accuracy of the Delta-T system did not conform to the recommendations of Regulatory Guide 1.23;[2] however, the applicant has installed (as of November 28, 1974) instruments that conform to the accuracy recommendation and performed a comparison (based on one month of simultaneous data) of relative concentration (χ/Q) values using each set of instrumentation. The staff's independent analysis of these data (for the period November 28, 1974, through December 29, 1974) indicates that relative concentration values calculated using each set of data differ by only about 10%.

The applicant has submitted one full year (October 11, 1973 through October 12, 1974) of onsite joint frequency distributions of wind speed and direction at the 30-ft level by atmospheric stability (as defined by the vertical temperature gradient between 30-ft and 130-ft) in the format suggested in Regulatory Guide 1.23. Similar distributions were submitted with wind data from the 130-ft level of the onsite tower. Also submitted were joint frequency distributions (with stability defined by the STAR program) for a 5-year period (1960-1964) from Winston-Salem. The staff has examined relative concentration (χ/Q) values using each joint frequency distribution (the wind speeds recorded at the 130-ft level were reduced to represent speeds recorded at 33-ft by use of the "power law" for wind profiles). A Gaussian diffusion model with adjustments for building wake effects, described in Regulatory Guide 1.42 (Ref. 6), will eventually be used to make estimates of annual average relative concentration values. The relative concentration values calculated using each onsite distribution were not significantly different in magnitude for pertinent distances and directions, and these values were more conservative than those calculated using the Winston-Salem data.

6.1.2 Ecological

6.1.2.1 Terrestrial

Cooling tower drift impact assessment

The applicant has presented an adequate statement of plans for determination of preoperational fog, visibility, and weather conditions for the Perkins site for later postoperational correlation with conditions during operation of the cooling towers (ER, Sect. 6.1.3.1). Two permanent plots of native vegetation have been selected by the applicant for preoperational monitoring purposes. No plans for preoperational monitoring of soil conditions in areas of future drift deposition were described, however. Therefore, the applicant should collect preoperational soil samples from several points where the drift is expected to be maximal for later studies of changes in salt content of the soil and other parameters resulting from cooling tower drift. Dissolved solids in groundwater should also be sampled so that any later changes in dissolved solids can be detected. As an alternative, soil and groundwater samples could be collected from affected areas after a timeof operation, and compared with samples from unaffected areas.

Terrestrial ecology

The applicant's data on terrestrial ecology were sufficient to determine, in general, the forest and vegetation types present on the Perkins site and to determine most of the plant and vertebrate animal species commonly found on the site. The data, however, were deficient with regard to species relative abundance and various population parameters of plant and animal communities on the site and to the occurrence of endangered species. Nonetheless, in the staff's judgement, the data supplied by the applicant, when supplemented by available literature on the ecology of the Piedmont Physiographic Province* and staff observations, were adequate to permit a valid impact analysis.

6.1.2.2 Aquatic

A preoperational ecological monitoring program has been undertaken by the applicant with the purpose of describing the important components of the aquatic ecosystem of the PNS site and environs. Sampling was initiated in October 1973 and has been continued to the present.

Major emphasis has been expended on studying the Yadkin River, High Rock Lake, and two onsite creeks (Fig. 6.1). In January 1975, a program was initiated to study the proposed site of the supplementary storage impoundment on Carter Creek.

The water quality parameters and biological communities studied, plus the applicant's sampling schedule, are presented in the ER, Sect. 6.1.1. A brief summary is presented in Table 6.1.

Several deficiencies existed in the applicant's first year of sampling (year I). No sampling of planktonic or otherwise entrainable fish eggs, larvae, and young juveniles was made, nor were sufficient data collected on the fish populations of the Yadkin River. These deficiencies have been rectified in the applicant's sampling program for the second year (year II). A sampling program for ichthyoplankton was initiated in September 1974. The fish sampling program has been intensified. Several distant sampling stations were eliminated while sampling has been intensified in the site vicinity.

6.1.3 Radiological

The applicant has proposed an offsite preoperational radiological monitoring program to provide for measurement of background radiation levels and radioactivity in the plant environs. The preoperational program, which provides a necessary basis for the operational radiological monitoring program, will also permit the applicant to train personnel and to evaluate procedures, equipment, and techniques, as indicated in Regulatory Guide 4.1.

A description of the applicant's proposed program is summarized in Table 6.2. Figure 6.2 shows the proposed sampling locations. The applicant has provided a commitment to monitor the radioiodine pathways discussed in Appendix C. More detailed information on the applicant's radiological monitoring program is presented in Sect. 6.1 of the applicant's Environmental Report. The applicant proposes to initiate parts of the program two years prior to operation of the facility, with the remaining portions beginning either 6 months or 1 year prior to operation.

The staff concludes that the preoperational monitoring program proposed by the applicant is generally acceptable. However, to improve the effectiveness of the program, the staff recommends that the applicant improve its analysis of milk samples to obtain a sensitivity of 0.5 pCi/liter for I-131.

6.2 OPERATIONAL

6.2.1 Ecological

6.2.1.1 Terrestrial

Cooling tower drift impact assessment

Because predictions of minimal vegetation damage were based on unverified drift deposition rates and plume behavior, the staff requires that the applicant establish a series of permanent plots at numerous locations within the area of cooling tower influence. The two plots (see Section 6.1.2.1) selected by the applicant for preoperational studies must be supplemented by additional plots for operational monitoring. The plots should be located in such a way that some lie in areas where the drift is expected or observed to be maximal. Sampling of these permanent plots must be thorough enough to detect major damage (e.g., killing of trees) to dominant vegetation. If such damage occurs, appropriate measures to reduce drift loss or to establish a sampling program to monitor possible increases in salt content of soils and groundwater may become necessary.

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*Such as the "Manual of the Vascular Flora of the Carolinas," Radford, Ahles and Bell, University of North Carolina Press, Chapel Hill, North Carolina, 1968.

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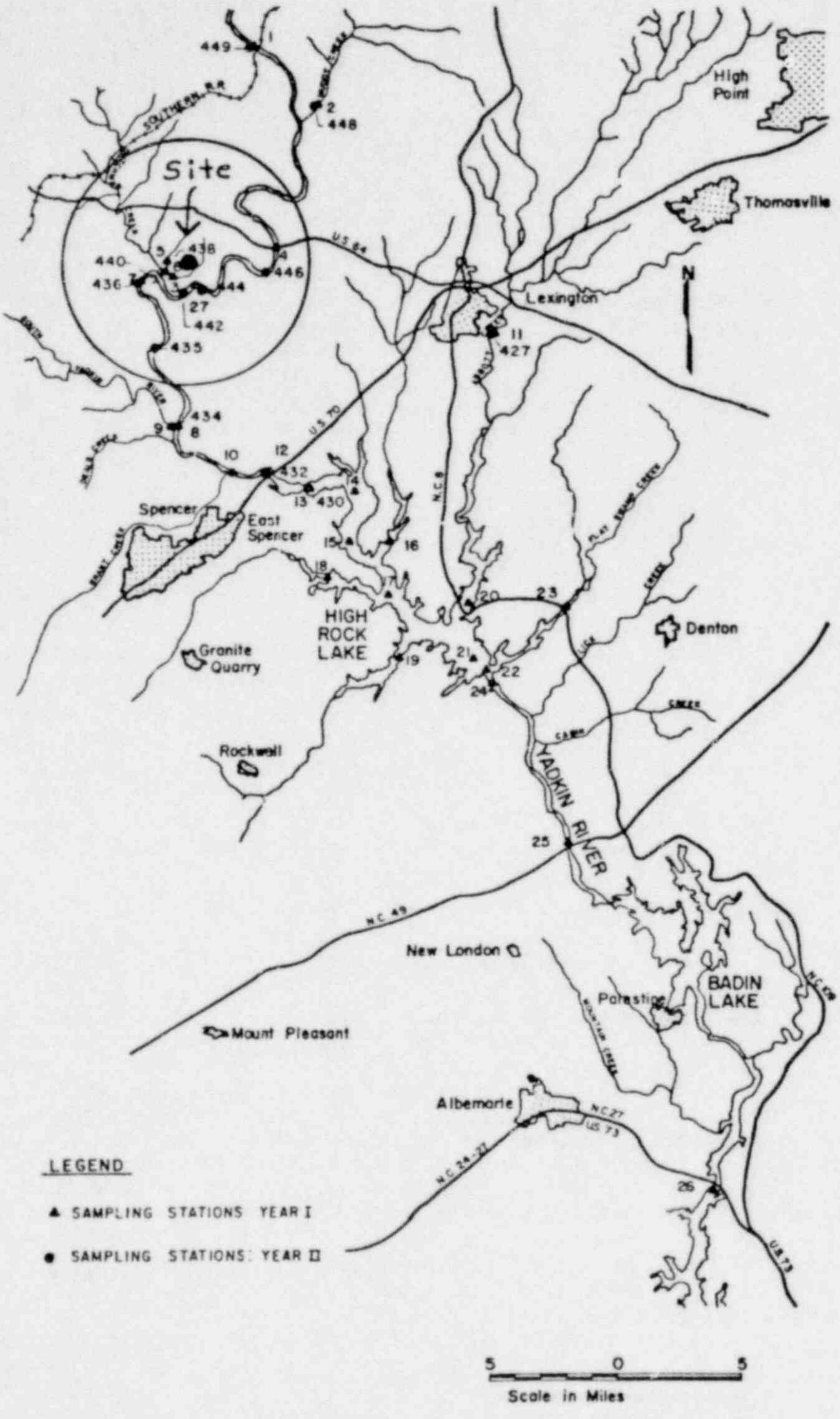

Fig. 6.1. Location of aquatic sampling stations on the Yadkin River system. Source: ER, Fig. 6.1.1-1.

Table 6.1. Sampling gear and methods used in the applicant's preoperational aquatic ecological monitoring program

Biological community	Sampling gear	Sampling methods
	Year I	
Phytoplankton	Polyethylene bottles, alpha bottles, and a kemmerer bottle	Polyethylene bottles used for surface sampling; alpha bottle used for surface sampling from bridges; kemmerer bottle used for mid-depth and bottom sampling.
Periphyton	Artificial substrates consisting of 1 × 3 in. glass slides embedded in weighted rubber stoppers	Samples are placed at each station each month; slides are removed every two weeks.
Zooplankton	Wisconsin plankton net and Clark-Bumpus net	Wisconsin plankton net is used in the river and Clark-Bumpus net is used in the backwaters of the reservoir. Fifty-meter tows for each net.
Benthos	Surber sampler, Ekman grab, and Ponar grab	Surber sampler is used for shallow ground and rocky riffler; Ekman grab is used for soft substrates; Ponar grab is used for sand and in fast water.
Fish	Backpack and boat shocker, seines, fyke nets, and trammel nets	Electroschockers, 100-m stretch is sampled; seines, 25- or 50-m haul; trammel and fyke nets are set for 72 hr.
	Year II	
Phytoplankton	Van Dorn bottle	Samples taken 0.3 m below surface, at middle, left, and right channel areas.
Periphyton	Vertically oriented glass slides	Duplicate slides are removed every four weeks.
Zooplankton	(Sample is collected with a 76-μ mesh 0.5-m net)	Samples taken at middle, left, and right channel areas and combined to form a composite sample.
Benthos	Modified Peterson grab, Surber sampler, drift nets	Peterson grab used for soft substrates and Surber sampler used for riffles.
Fish	Electrofishing, trotlines, and 0.5-m ichthyoplankton net	For electrofishing, a 100-m stretch is sampled. Trotlines are set for 24 hr. Ichthyoplankton nets are towed for 2.5 min.

Vegetation

The applicant stated that cleanup and restoration on transmission line rights-of-way entail smoothing and seeding of work areas, including the construction of access roads on the rights-of-way (ER, Sect. 4.2). Thus, all areas on the rights-of-way, according to the applicant's plans, should have a vegetative cover soon after construction is completed along each right-of-way. The staff requires that, after construction, the applicant survey the locations and approximate sizes of all areas on the rights-of-way where bare soil or subsoil is exposed and that the applicant make immediate attempts to revegetate such areas. This procedure would be most critical on slopes, where possible erosion would be maximal. As explained in Sect. 5.5.1, it is critical that vegetative cover be established before the topsoil is eroded away.

After all bare areas have been initially revegetated, searches for bare areas should be made simultaneously with the transmission line inspections and bush-hogging and hand-clearing operations mentioned by the applicant (ER, Sect. 5.6). For the station site, site construction access roads, and railroad spur, the applicant is required, as above, to survey and treat areas of bare soil.

Fauna

Because of the total ultimate dependency of all faunal populations on primary (plant) production, the staff places most emphasis on requirements that the applicant conserve topsoil and revegetate cleared areas with lush vegetation that forms a complete cover over soil. Given such conditions, animal populations should thrive, and on a long-term basis the total animal community should not experience serious reductions in numbers. Therefore, the staff does not require that the applicant establish a program for monitoring faunal populations.

Table 6.2. The preoperational radiological monitoring program

	Schedule	Gross alpha	Analyses: Gross beta	Analyses: Gamma analysis	Specific nuclides
1. Water	Monthly	x	x		^{89}Sr, ^{90}Sr, ^{3}H
	Quarterly	x	x	x	
2. Airborne particulates (including iodine, rain, and settled dust)	Monthly	x	x	x	^{131}I
3. Radiation dose and dose rate	Quarterly				
4. Bottom and shoreline sediment (including benthos)	Quarterly	x	x	x	^{60}Co
5. Aquatic vegetation and/or plankton	Quarterly (as available)	x	x	x	^{137}Cs, ^{40}K
6. Terrestrial vegetation, pasture grass, and crops (corn, beans, leafy green vegetables)	Quarterly (as available)	x	x	x	^{137}Cs, ^{40}K
7. Milk	Monthly			x	^{89}Sr, ^{90}Sr, ^{137}Cs, ^{40}K, ^{3}H, ^{131}I
8. Fish	Quarterly		x	x	^{89}Sr, ^{90}Sr, ^{137}Cs, ^{40}K

Source: ER, Table 6.1.1.

6.2.1.2 Aquatic

The applicant has not provided definitive plans for an operational aquatic monitoring program. Prior to completion of the preoperational program, the data obtained therefrom will be evaluated to determine which portions of the program should be continued for operational monitoring purposes.

At the time of issuance of an operating permit, the staff will issue Environmental Technical Specifications related to operational monitoring procedures.

6.2.2 Radiological

The operational offsite radiological monitoring program is conducted to measure radiation levels and radioactivity in the plant environs. It assists and provides backup support to the detailed effluent monitoring (as recommended by Regulatory Guide 1.21) which is needed to evaluate individual and population exposures and to verify projected or anticipated radioactive effluent concentrations.

The applicant plans essentially to continue the proposed preoperational program during the operating period. However, refinements may be made in the program to reflect changes in land use and preoperational monitoring experience.

An evaluation of the applicant's proposed operational monitoring program will be performed during the operating license review, and the details of the required monitoring program will be incorporated into the Environmental Technical Specifications for the operating license.

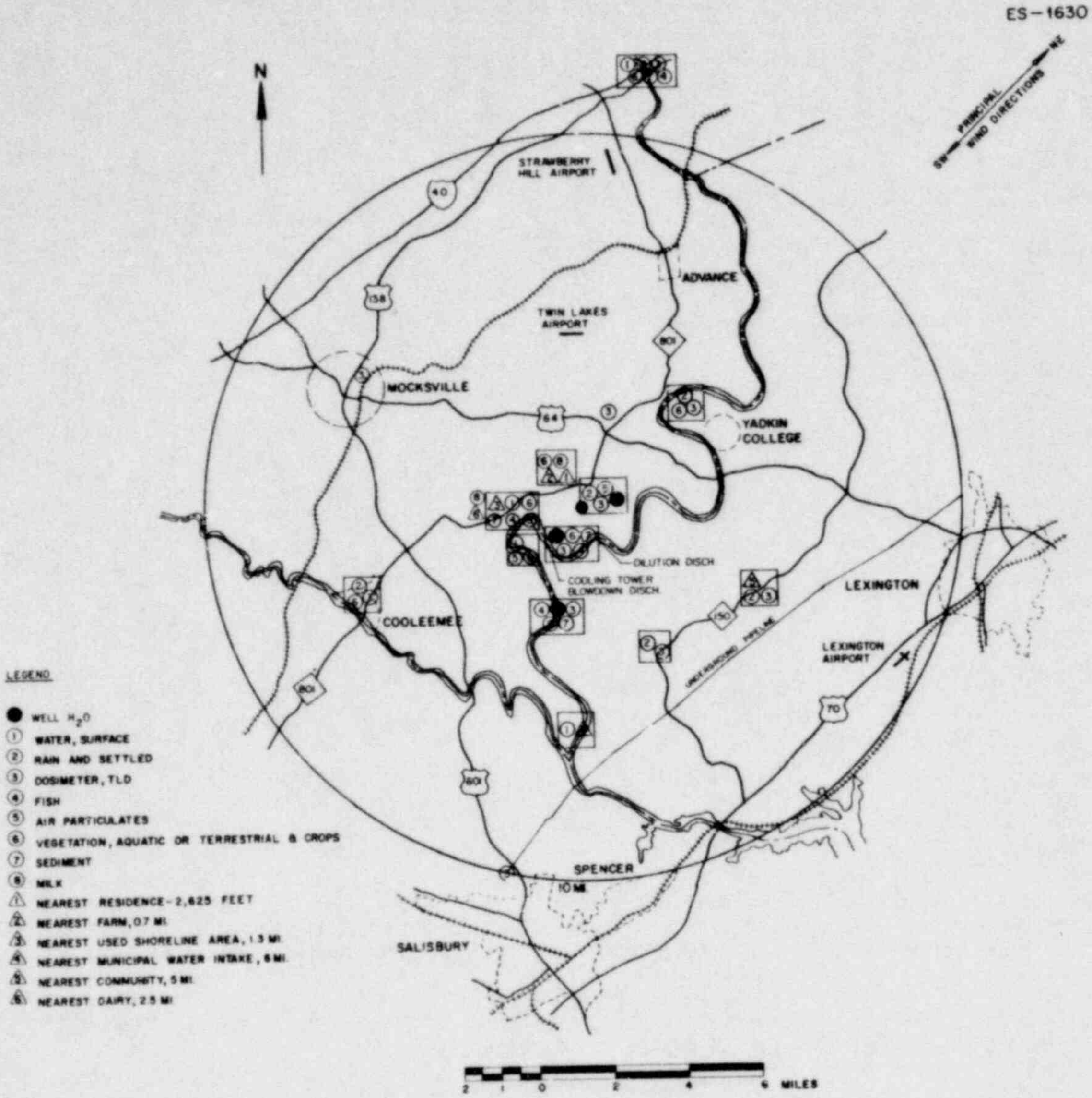

Fig. 6.2. Radiological sampling stations — Perkins Nuclear Station. Source: ER, Fig. 6.1.1.

REFERENCES FOR SECTION 6

1. Duke Power Company, *Perkins Nuclear Station Preliminary Safety Analysis Report*, Docket Nos. STN 50-488, 50-489, and 50-490.

2. U.S. Atomic Energy Commission, *Onsite Meteorological Programs*, Regulatory Guide 1.23, USAEC Directorate of Regulatory Standards, Washington, D.C., 1972.

3. U.S. Atomic Energy Commission, *Interim Licensing Policy On As Low As Practicable for Gaseous Radioiodine Releases From Light-Water-Cooled Nuclear Power Reactors*, Regulatory Guide 1.42, USAEC Directorate of Regulatory Standards, Washington, D.C., 1973.

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7. ENVIRONMENTAL IMPACTS OF POSTULATED ACCIDENTS INVOLVING RADIOACTIVE MATERIALS

7.1 PLANT ACCIDENTS

A high degree of protection against the occurrence of postulated accidents in PNS is provided through correct design, manufacture, and operation and through 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 designed to place and maintain the plant in a safe condition. Notwithstanding this requirement, the conservative postulate is made that serious accidents might occur, even though they may be extremely unlikely; engineered safety features will be installed to mitigate the consequences of those postulated events 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 by using best estimates of probabilities and realistic fission product release and transport assumptions. For site evaluation in the Commission's Safety Evaluation, extremely conservative assumptions are used to compare calculated doses that result 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 postulated accidents 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 by the Commission on December 1, 1971, as a proposed amendment to Appendix D of 10 CFR Part 50. Nine classes of postulated accidents and occurrences that range 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. The examples selected are reasonably homogeneous in terms of probability within each class.

Commission estimates of the dose that 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 witnin 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 that 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; however, events of this type could occur sometime during the 40-year plant lifetime. Although 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, they 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.

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Table 7.1. Classification of postulated accidents and occurrences

Class	AEC description	Applicant's examples
1	Trivial incidents	Evaluated under routine releases
2	Small releases outside containment	Minor spills and leaks; evaluated under routine releases
3	Radioactive waste system failure	Release of a waste gas sto'age tank; release of contents of a liquid storage tank
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; off-design transients that induce fuel failure above those expected and steam generator tube leak; steam generator tube rupture
6	Refueling accident	Fuel bundle drop inside the containment; heavy objects dropped onto fuel in core
7	Spent fuel handling accident	Fuel assembly drop in the fuel storage pool; heavy object dropped into a fuel rack; fuel cask drop
8	Accident initiation events considered in design-basis evaluation in the Safety Analysis Report	Loss of coolant accidents; rod ejection accident; steam line break
9	Hypothetical sequence of failures more severe than Class 8	Not considered

The NRC is continuing a study originated by the USAEC to assess these risks more quantitatively. The initial results of these efforts were made available in draft form on August 20, 1974.[1] This study, called the *Reactor Safety Study*, represents an effort to develop realistic data on the probabilities and sequences of accidents in water-cooled power reactors to improve the quantification of available knowledge related to nuclear reactor accidents probabilities. The Commission organized a special group of about 50 specialists under the direction of Professor Norman Rasmussen of MIT to conduct the study. The scope of the study, which has been discussed with EPA and described in correspondence with EPA, has been placed in the NRC Public Document Room.[2]

As with all new information developed that might have an effect on the health and safety of the public, the results of these studies will be made public and 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 those that would result from a year's exposure to the maximum permissible concentrations of 10 CFR Part 20. Table 7.2 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 those 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. The conclusion from the results of the realistic analysis is 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	0.073	6.9
3.2	Release of waste gas storage tank contents	0.29	27
3.3	Release of liquid waste storage contents	0.008	0.76
4.0	Fission products to primary system (BWR)	NA	NA
5.0	Fission products to primary and secondary systems (PWR)		
5.1	Fuel cladding defects and steam generator leaks	*c*	*c*
5.2	Off-design transients that induce fuel failure above those expected and steam generator leak	0.002	0.16
5.3	Steam generator tube rupture	0.096	9.1
6.0	Refueling accidents		
6.1	Fuel bundle drop	0.015	1.4
6.2	Heavy object drop onto fuel in core	0.26	25
7.0	Spent fuel handling accident		
7.1	Fuel assembly drop in fuel rack	0.01	0.91
7.2	Heavy object drop onto fuel rack	0.038	3.6
7.3	Fuel cask drop	0.23	22
8.0	Accident initiation events considered in design basis evaluation in the Safety Analysis Report		
8.1	Loss-of-coolant accidents		
	Small break	0.16	29
	Large break	0.20	72
8.1(a)	Break in instrument line from primary system that penetrates the containment	NA	NA
8.2(a)	Rod ejection accident (PWR)	0.02	7.2
8.2(b)	Rod drop accident (BWR)	NA	NA
8.3(a)	Steamline breaks (PWRs outside containment)		
	Small break	<0.001	<0.1
	Large break	0.001	<0.1
8.3(b)	Steamline break (BWR)	NA	NA

[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 inhaled 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 millirems, or the equivalent dose to an organ.

[c]**These radionuclide releases are considered in developing the gaseous and liquid source terms presented in Section 3 and are included in doses in Section 5.**

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7.2 TRANSPORTATION ACCIDENTS

As discussed in Sect. 5.4.2.5, the staff has completed an analysis of the potential impact on the environment of transporting fuel and solid radioactive wastes for nuclear power plants under existing regulations. The results of this analysis were published in a report entitled *Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants.*[3] The report contains an analysis of the probabilities of occurrences of accidents and the expected consequences of such accidents, as well as the potential exposures to transport workers and the general public under normal conditions of transport.

The initial fuel supply for each unit of PNS will be supplied from Windsor, Connecticut. New fuel elements will be shipped approximately 730 miles from the fabrication plant to the site by truck.

Each unit will replace about 81 of the 241 fuel assemblies each year. Spent fuel elements will be shipped from the site by truck or rail to Barnwell, South Carolina, a distance of about 240 miles.

Solid radioactive wastes will be shipped by truck to the nearest disposal site in Barnwell, South Carolina (Chem-Nuclear Services), a distance of about 240 miles. This will involve approximately 53 shipments per year for three units.

The transportation of cold fuel to the plant, of irradiated fuel from the reactor to a fuel reprocessing plant, and of solid radioactive wastes from the reactor to burial grounds is within the scope of the AEC report mentioned above.[3] The environmental risks of accidents in transportation are summarized in Table 7.3.[3] (Normal conditions of transport were summarized in Table 5.6.)

Table 7.3. Environmental risks of accidents in transport of fuel and waste to and from a typical light-water-cooled nuclear power reactor[a]

	Environmental risk
Radiological effects	Small[b]
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.

[b]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.

REFERENCES FOR SECTION 7

1. U.S. Atomic Energy Commission, *Reactor Safety Study: An Assessment of Accident Risks in U.S. Commercial Nuclear Power Plants, Draft*, Report WASH-1400, August 1974.

2. Letter from W. D. Doub, USAEC, to D. D. Dominick, Environmental Protection Agency, June 5, 1973.

3. U.S. Atomic Energy Commission, *Environmental Survey of Transportation of Radioactive Material to and from Nuclear Power Plants*, WASH-1238, December 1972.

8. THE NEED FOR POWER GENERATING CAPACITY

The staff's assessment of the applicant's need for additional power generating capacity in the period 1983-1989 is presented in this section. The evaluation includes discussions of the applicant's power system, power requirements, power supply and reserve requirements. It is assumed that one unit from the Perkins Nuclear Station will come on line each year in 1983, 1985, and 1987.

8.1 APPLICANTS SERVICE AREA AND REGIONAL RELATIONSHIPS

8.1.1 Applicant's service area

The applicant, Duke Power Company (DPC), supplies retail and wholesale electricity to a service area of about 20,000 sq miles located in western North Carolina and South Carolina (Fig. 8.1) and served populations of about 3,205,000 and 566,000 in these two states, respectively, in 1973.[1] Its service area includes 50 counties in North Carolina and South Carolina; DPC is the principal supplier of electricity in 44 of these.[2] Duke Power Company supplies retail electric service to about 211 cities and wholesale electric service to about 39 other municipalities for resale over their distribution systems. It also supplies wholesale electrical energy to Rural Electrical Association cooperatives and to other utilities. In 1973, 15% of DPC's total kilowatt-hour sales were at wholesale rates.[3] The applicant obtains about 70% of its operating revenue from its North Carolina customers and about 30% from those in South Carolina.

8.1.2 Regional relationships

The applicant's service area is within the Federal Power Commission's (FPC) Southeastern Power Survey Region[4] and is located nearly entirely within the FPC's power supply area (PSA) 21 (Fig. 8.2). The applicant is a party to the Southeastern Electric Reliability Council (SERC), which is one of the Nation's nine regional reliability councils. The Southeastern Electric Reliability Council encompasses the same area as the Southeastern Power Survey Region. This region has about 17.5% of the area of the continental United States and about 15.4% of the 1967 population.[5] Southeastern Electric Reliability Council is divided into four subregions: Florida (PSA 24), Southern Companies (PSAs 22 and 23), Tennessee Valley (PSA 20), and the Virginia-Carolinas PSAs 18 and 21). Areas of load concentration within SERC are shown in Figure 8.2. This figure indicates that within PSA 21, most of the major area of load concentration is located within the applicant's service area (as indicated in Fig. 8.1). The applicant is a member of the Virginia-Carolinas (VACAR) subregion. It is not currently a member of any power pool.

8.2 POWER REQUIREMENTS

Planning for electric utility needs is based on both a forecast of anticipated annual energy consumption and peak load demand over a given period of years. The applicant's historical and projected energy consumption and peak load demands, the effects of energy conservation and the staff's forecast of peak load demand are discussed in the following sections.

8.2.1 Energy consumption

Historical and forecast energy consumption and annual peak load for the applicant's service area are given in Table 8.1. Energy consumption grew from 20,322 x 10^6 kWhr in 1964 to 46,502 x 10^6 kWhr in 1973, a 9.6% compound annual rate of growth. Energy consumption was 45,630 x 10^6 kWhr in 1974, a 1.9% decrease from 1973. During the period 1964 to 1973 the applicant's service area experienced a rate of growth in energy consumption considerably greater than that of 7.3% for the nation as a whole.[6-8] In 1974 national energy consumption remained at the 1973 level. The lack of growth in energy consumption during 1974 is attributable to both a pervasive economic recession and an energy crisis due primarily to high prices and temporary shortages of oil.

Table 8.2 shows the percentage consumption of electricity in major customer categories for the applicant's system, compared with the South Atlantic states and the United States as a whole.

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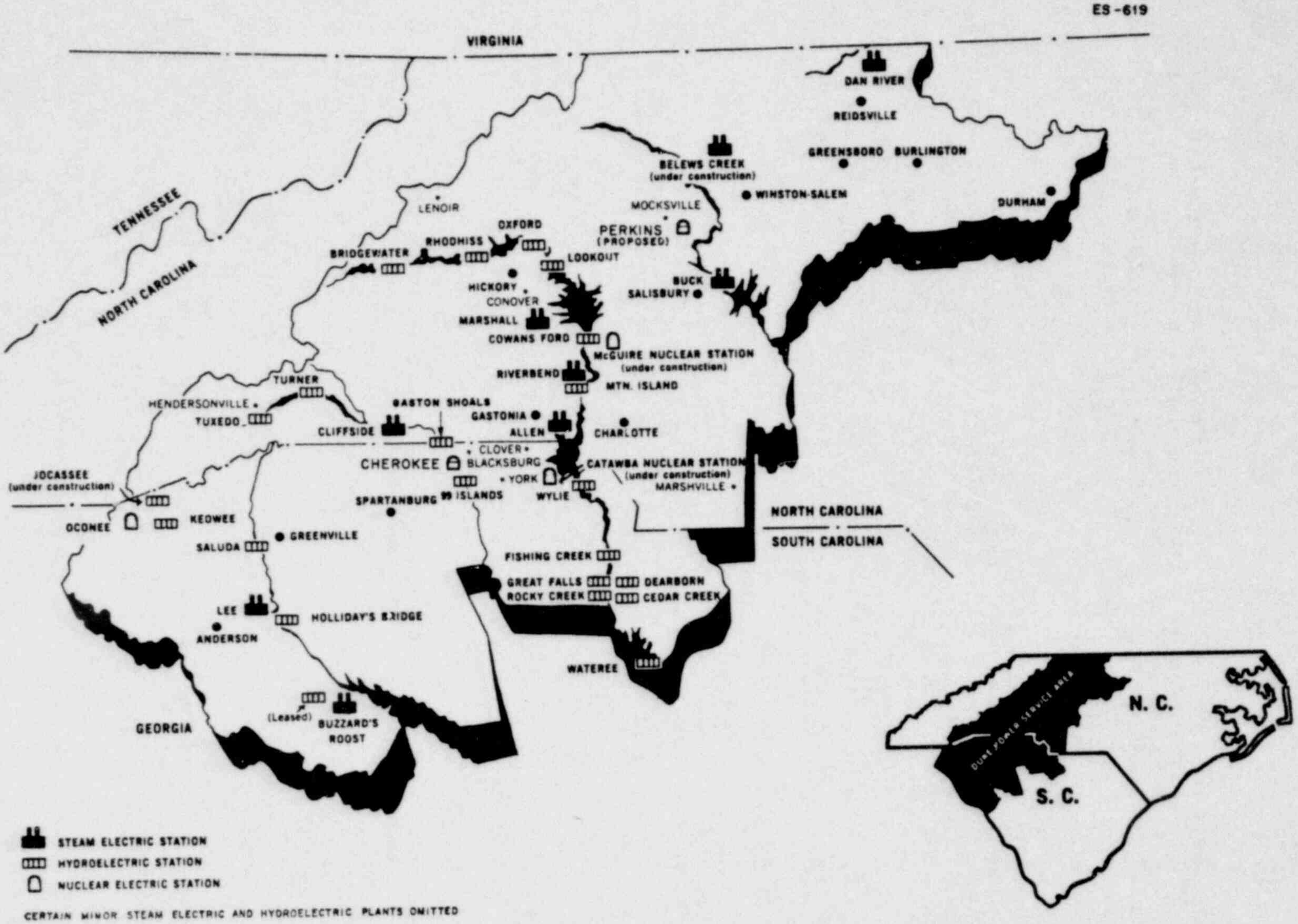

Fig. 8.1. Duke Power Company service area.

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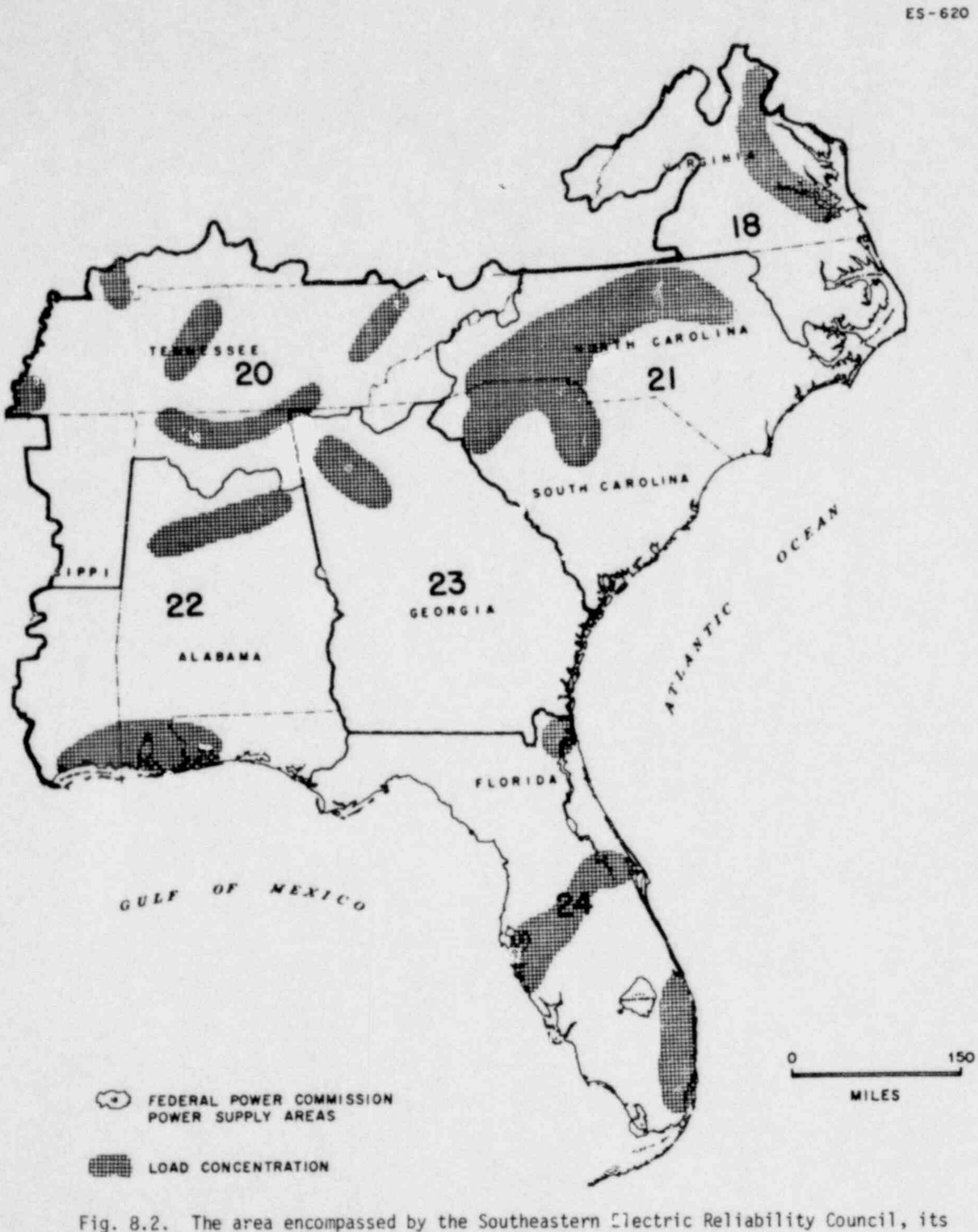

Fig. 8.2. The area encompassed by the Southeastern Electric Reliability Council, its FPC Power Supply Areas, and areas of load concentration.

TABLE 8.1

ENERGY CONSUMPTION AND SUMMER PEAK LOAD
DUKE POWER COMPANY, HISTORIC AND FORECAST, 1964-1988

Year	10^6 KWhr[a]	MWe[b]
Actual		
1964	20,322	3,522
1965	22,648	3,826
1966	25,692	4,440
1967	28,139	4,580
1968	31,032	5,364
1969	33,900	5,614
1970	36,641	6,284
1971	39,576	6,622
1972	42,990	7,450
1973	46,283	8,236
1974	45,240	8,058
Forecast		
1975	47,734	8,633
1976	52,387	9,721
1977	56,851	10,512
1978	61,346	11,341
1979	65,942	12,209
1980	70,637	13,119
1981	75,699	14,073
1982	81,041	15,074
1983	86,719	16,124
1984	92,746	17,226
1985	98,715	18,383
1986	105,239	19,598
1987	112,096	20,875
1988	119,629	22,217

[a]SOURCE: ER, Table 1.1.1-1.

[b]SOURCE: Actual, ER Table 1.1.1-1; Applicant's forecast of 12-23-74 attachment to letter from D. B. Blackmon to R. A. Gilbert dated January 31, 1975.

Table 8.2. Percentage consumption of electricity in several categories for the United States in 1960, for the United States and the South Atlantic states in 1972, and for the applicant's service area in 1973

	USA – 1960[a]	USA – 1972[a]	South Atlantic states – 1972[b,c]	DPC service area – 1973[d]
Residential	28.7	32.4	37.0	27.8
Commercial and industrial	67.3	63.5	59.0	71.3
Street and highway lighting	0.9	0.8	0.7	0.3
Other public authorities	2.3	2.7	3.2	0.6
Other	0.8	0.6	0.2	0.02

[a]Edison Electric Institute, *Statistical Yearbook of the Electric Utility Industry of 1972,* calculated from data presented on p. 31.

[b]Ibid., calculated from data presented on p. 33.

[c]Delaware, Maryland, Washington, D.C., Virginia, West Virginia, North Carolina, South Carolina, Georgia, and Florida.

[d]Duke Power Company, *Uniform Statistical Report – Year Ended December 31, 1973,* p. E. 14, data for 1973. Does not include 15.1% of the total DPC output that was in the category of "Sales for Resale."

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The figures in Table 8.2 indicate that the applicant's percentage of residential sales of electricity is lower than the U.S. average but that its commercial and industrial sales percentage is higher. These statistics reflect the degree of industrialization in the applicant's service area and especially reflect the importance of electricity-intensive industry, notably textiles.

In forecasting energy consumption, the applicant gives explicite consideration to a number of demographic, economic and technological factors.[9] Residential energy consumption forecasts incorporated federal population forecasts, other demographic trends, judgmental assumptions on the future availability of alternative sources of energy and appliance saturation. Industrial energy consumption forecasts are based on an assumption that industrial growth in the service area will be some what lower than in the recent past. Textile energy is specifically related to the Gross National Product (GNP) in the forecast.

Table 8.1 shows consumption is forecast to grow from 45,240 x 10^6 kwhr in 1974 to 86,719 x 10^6 kwhr in 1983 and 112,096 x 10^6 kwhr in 1987. The applicant forecasts a declining rate of growth over the period from 8.5% between 1976 and 1977 to 6.5% between 1986 and 1987.

8.2.2 Peak load demand

Historical and forecast annual maximum peak load demand for the applicant's system is given in Table 8.1. Peak load grew from 3522 MWe in 1964 to 8236 MWe in 1973, a 9.9% compound annual rate of growth. Peak demand was 8058 MWe in 1974 or 2.2% below the 1973 level. As in energy consumption, the rate of growth in peak load was considerably higher than that of the nation as a whole, 7.8% over the period 1964 through 1973.[6-8] National noncoincident peak demand in 1974 was 349,350 MWe, 1.0% over that in 1973.[7] As in the case of energy comsumption, this lack of growth is attributable to the recession and the consequences of an oil embargo and associated increases in the price of oil.

The applicant forecast of peak load considers base and weather responsive components (ER 1.1-4). Both summer and winter peaks are forecast. Forecasts of sales (energy consumption) and peak load are made independently and their consistency is checked by the reasonableness of the derived load factor.[9] In its system load forecast of January 10, 1975, the applicant revised its previous forecast downward to account for the anticipated impact of a load management program now being formulated.[10]

The applicant assumes that the present economic recession will retard an upturn in peak demand until 1976. Thereafter, peak demand is forecast to grow to 16,124 MWe in 1983 and 20,875 MWe in 1987. The applicant forecasts a rate of growth declining over the period from 8.1% between 1976 and 1977 to 6.5% between 1986 and 1987. During the forecast period 1975-1990, winter peak load is growing slightly faster than summer peak load, surpassing it in 1985 and being 2.0% higher by 1988.[11]

8.2.3 The impact of energy conservation and substitution on energy and peak load demand

The sudden distruption of oil supplies, shortages in natural gas supplies and drastic price increases for all forms of energy have focused the Nation's attention on the importance of energy conservation as well as on measures to increase the availability of alternative energy sources. A number of significant efforts have been made during the past several years in forecasting the nation's energy needs and in estimating the potential for conserving energy and developing alternative sources of energy.[12,13] The staff analysis of peak demand in Section 8.5.1 adopts certain results of the Federal Energy Administration's Project Independence analysis which accounts for potential energy conservation. In addition, a summary of conservation measures and considerations that have a specific bearing on energy requirements and peak load demand in the applicant's service area is useful.

8.2.3.1 Recent experience

Implementation of energy conservation measures by households, businesses, and government has already contributed to the lack of growth in the national consumption of electricity since the third quarter of 1973. Consumption of electricity in the applicant's service area has been less than previously forecast by an average of 29% during the period October 1973 to October 1974. Monthly peak load demand was lower than forecast by an average of 26% during the same period. While the technical feasibility of numerous energy conservation measures in residences, public buildings, factories, shops and transportation has been well documented, the degree to which these measures will be implemented on a permanent basis is quite speculative at this time and needs further analysis.

8.2.3.2 Promotional advertisement and conservation information services

In the past, Duke Power Company has attempted to accelerate the demand for electricity in its service area through advertising. Generally, the major thrust of advertising was to promote demand during off-peak periods, thereby covering expensive peaking capacity with expanded lower cost base-load capacity. Notably, electric space and water heating have been promoted to offset the higher seasonal peaking demands and to level loads.

The applicant terminated promotional advertising in March 1973[14] and, by direct mail and mass-media advertising, disseminated information designed to promote efficient residential use of electricity. Accordingly, elimination of promotional advertising is no longer an important measure for the applicant to use to dampen demand. On the other hand, promotional advertising of electrical appliances and equipment by manufacturers has not been eliminated. These manufacturers spent an estimated $450 million in promotional advertising in 1972.[15]

The staff's opinion is that there is increasing evidence that programs that promote conservation of electricity will have a significant impact on projected demand.

8.2.3.3 Change in utility rate structure

The Federal Power Commission regulates the rates for interstate wholesale electric energy,[16] while the North Carolina Utilities Commission and the South Carolina Public Service Commission regulate the rates that utilities charge the ultimate consumer in the applicant's service area.[17]

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. Under today's conditions of increasingly scarce fuel resources, declining block rates lead to excessive use of electricity by lowering the price of each additional kilowatt-hour. The most commonly mentioned alternatives to declining block rates to dampen demand for electricity are the increase of block rates, peak load pricing, and flat rates.

The applicant is continually studying the effects of alternative rate structures. The North Carolina Public Utilities Commission has stated that, among other considerations, an appropriate rate design should conserve energy resources.[18]

Table 8.3 presents statistics on the average cost of electricity to consumers and the average energy (kilowatt-hours) used per customer from 1964 through 1971. Statistics such as these indicate that increasing consumption of electricity may occur in spite of increasing prices. The question that statistics such as these do not answer is at what point the costs of residential and commercial electricity will cause the consumer to significantly decrease his demand. It is likely, however, that with sufficiently high prices the growth rate of total demand could be significantly reduced. Because the demand for electricity is dependent upon such other factors as GNP, the local economy, the substitution of electricity for scarcer fuels, population growth, and local temperature variations, the length of times necessary for a rate change to have a detectable effect is uncertain.

Table 8.3. Statistics on cost and consumption of electricity (1964–1971)

	Average cost to consumers per kWhr (cents)			Average kWhr per customer (thousands)		
	Residential	Commercial	Industrial	Residential	Commercial	Industrial
1971	2.32	2.20	1.10	7.639	42.598	1735.482
1970	2.22	2.08	1.02	6.700	40.480	1695.087
1969	2.21	2.06	0.98	6.246	37.607	1666.019
1968	2.25	2.07	0.97	5.706	35.009	1578.366
1967	2.31	2.11	0.98	5.220	32.234	1481.496
1966	2.34	2.13	0.98	4.931	30.238	1445.802
1965	2.39	2.18	1.00	3.618	28.093	1289.949
1964	2.45	2.26	1.02	4.377	25.450	1217.878

Source: Federal Power Commission, *Statistics of Privately Owned Electric Utilities in the United States, 1971*, FPCS 226, U.S. Government Office, Washington, D.C., October 1972.

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8.2.3.4 Load shedding, load staggering, and interruptible load contracts to reduce peak demand

Load shedding is an emergency measure employed to prevent system collapse when peak demand placed upon the system is greater than the system is capable of providing. This measure is usually not taken until all other measures are exhausted. The Federal Power Commission's report on the major load shedding that occurred during the northeast power failure of November 9 and 10, 1965, indicates that reliability of service of the electrical distribution systems should be given more emphasis, even at the expense of additional costs.[19] This report identified several areas that are highly impacted by loss of power, such as elevators, traffic lights, subway lighting and prison and communication facilities. The serious impact on areas such as these means that load shedding should only be considered a temporary method to overcome a shortage of generating capacity during an emergency.

Load staggering, especially if associated with some price incentive, may prove to have some limited potential as a conservation measure. Basically, this alternative involves shifting the work hours of industrial or commercial firms to avoid diurnal or weekly peaks and shifting now critical residential loads to off-peak hours. The applicant's load management program is considering several load staggering measures.[10]

For interruptible load contracts to be effective in system planning, the load reduction must be large enough to be effective in system stability planning. Thus, this type of contract is primarily related to industrial customers. Currently, the applicant does not have a rate schedule for interruptible loads. The acceptability of interruptible load contracts to industrial customers depends upon balancing the potential economic loss resulting from unannounced interruptions against the saving that results from the reduced price of electricity. If the frequency or duration of interruptions increases as a result of insufficient installed capacity, the customer will convert to a normal industrial load contract. Even if the applicant had a large interruptible load, it is speculative to project that customers would continue this contractual relationship if faced with frequent and long periods of no electrical service.

None of the above measures can be considered as viable alternatives for required additional capacity, and they can do little to solve the energy shortage.

8.2.3.5 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 during operation, (2) encourage the manufacturing and marketing of more energy-efficient products, 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. The 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 in environmental control processes. While many efficiencies in electricity usage have already been gained and further efficiencies will be realized, any present estimates of the magnitude of future electricity savings 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 consumption but not peak demand will have little or no impact on the need for capacity. The applicant's most recent forecasts for total sales and annual peak-load demand indicate that total sales are expected to grow at less than peak demand. The growth in peak demand will continue to be strongly influenced by installation of air conditioning and electric heating in an increasing percentage of residential, commercial and industrial buildings.

Considerable efficiency can be achieved in space conditioning by improved insulation and the use of building materials with better insulation properties as well as by using equipment that transfers or stores excess heat or cold. For example, the seven-story Federal Office Building to be built in Manchester, New Hampshire, illustrates the potential for energy conservation in future commercial buildings that will use existing technology.[20] 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, FHA established new insulation standards to reduce average residential heating losses by one third. Studies have shown that it is possible to gain even greater reductions in heat loss through improved insulation at costs that are economical over a period of years.[21] Improved insulation not only helps conserve energy 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.[22] Calculations reveal that adequate illumination in commercial buildings can be achieved at 50% of current levels through various design and operational changes.[23] Another study indicates that if all households in 1970 had changed from incandescent to fluorescent lighting, the residential use of electricity for lighting would have been reduced approximately 75%, and total electrical sales would be reduced approximately 2.5%.[24] However, since the majority of residential lighting occurs in off-peak hours, the reduction on peak demand would be 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 in a voluntary labeling program that would provide consumers with energy consumption and efficiency values for each appliance and educate them about the use of this information. Room air-conditioners are the first to be labeled. The next two categories of household appliances that will 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 entitled, "The Room Air Conditioner as an Energy Consumer," has estimated that an improvement in the average 1973 efficiency of 6 BTU/Whr to 10 Btu/Whr (a 67% increase) could hypothetically save electric utilities almost 58,000 MW in 1980.[25] This study was based on sales in 1972 and escalated these sales figures at the rate existing at that time to the 1980 date. It was further assumed that new and replacement air conditioners would have the higher efficiencies. Air conditioners that are more energy efficient require a combination of increased heat exchanger size and higher efficiency compressors that will result in higher initial cost. The consumer must be convinced that it is profitable for him in the long run 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. In addition, selection of central air conditioning by developers and many home owners 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 work they are to perform. Small savings can be realized by de-energizing 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 heating.[18]

The above examples of potential energy saving will certainly impact energy and peak load to some degree in the future. The precise degree, however, is speculative at this time. The applicant is aware of the desirability of promoting energy conservation and is considering the potential impact on peak demand in its system (ER 1.1.2, and Reference 10).

In addition, the staff is aware that 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.[26] This possible requirement would likely contribute to peak load demand.

8.2.3.6 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 applicant's service area because of the uncertainty of oil and gas supplies and because of the outlook for higher prices for them relative to the price of electricity produced from coal-fueled or nuclear-fueled plants. For instance, in the applicant's service area 25% of living units were electrically heated in 1970 and a projected 60% will be electrically heated by 1980. Other increases are forecasted in the growth of electric water heaters and ranges. The advent of electric automobiles or other new uses of electricity cannot be discounted but are not now quantified in projecting need for power since the use of such items is speculative. The staff concludes that substitution effect will, to some degree, offset savings from energy conservation techniques.

8.3 RESERVE REQUIREMENTS

8.3.1 Applicant's reserve requirements

Reliability of electricity supply is one condition which all electric power systems attempt to assure in capacity planning. As a member of the Southeastern Electric Reliability Council (SERC), the applicant supports the four objectives of the SERC Agreement:

(1) encourage the development of reliability agreements among the systems within the region;

(2) exchange information with respect to planning and operating matters relating to the reliability of bulk power supplies;

(3) review periodically activities within the region on reliability;

(4) provide information with respect to matters considered by the Council, where appropriate, to the Federal Power Commission and to other Federal and State agencies concerned with reliability (ER, Sect. 1.1-7).

Reliability is associated with an excess of generating capacity over the likely annual peak load. This excess is termed the reserve margin.

Reliability, although conceptually measurable in terms of probability of a set of coincident events which would lead to a loss of system load, is in practice quite difficult to estimate with any precision. While probabilistic computational routines such as loss-of-load computer codes are increasingly used for estimating reserve margins required to achieve specified levels of reliability, the applicant rejects this technique for its system at this time. Three reasons are given:

(1) no operating experience exists relative to the size and types of DPC's nuclear units;

(2) such calculations must consider interconnections of transmission systems which would require an overly burdensome data input; and

(3) the level of reliability to be chosen is arbitrary and the resulting reserve margins are dependent on the choice of reliability (ER, Sect. 1.1-11).

The applicant is cognizant of the work being conducted in the area of probabilistic techniques to compute appropriate reserve margins and, in fact, has had loss-of-load studies made for its system.[27] To reduce the loss-of-load probability for the applicant's system to one day in ten years would require over 30% reserve.

The applicant computes required reserve margin by adding to the forecast summer peak load a 4.35% allowance for extreme temperature, 1280 MWe for loss of the largest unit on the system, 4.42% for miscellaneous capacity reductions, and 1180 MWe for nuclear unit refueling (ER, Sect. 1.1-10). Thus, with a forecast peak of 20.875 MWe in 1987, required reserves would be 4291 MWe, and the reserve margin would be 20.6%. Because the allowances for loss of largest units on system and for nuclear unit refueling are constant, the required percentage reserve will decline over time as forecast peak increases.

In its 1970 National Power Survey, the Federal Power Commission estimated the reserve requirements for the Southeast Region to be 20-21% for the period 1970-1990.[28] The Federal Power Commission has indicated that most systems attempt to operate with a reserve margin of 15-25%. For long-range planning purposes, an increase of future reserve allowances by 5 to 10% of the forecast peak load as a contingency against unforseen construction delays or estimating errors is normal.[29] Therefore, the staff would not consider a reserve margin of up to 30% unreasonable for long-range planning in the applicant's system. The staff, however, does view reserve margins for the applicant's system below 15% as dangerously low for purposes of long-range planning.

8.3.2 Regional reserves

As mentioned previously, the applicant is a member of SERC, which reviews existing and planned power supplies and transmission systems within its region to ensure high reliability of the region's power supply. The projected reserve margin for SERC for the peak demand of the year is in the range 15-21% for the period 1975-1984 and is in the range of 17-18% for the period 1982-1988.[30] The reserve margins indicated above are for the summer peaks; reserve margins for the winter peaks are generally lower than for the summer peaks for this region.

Reserve margins for the VACAR Subregion of SERC for the peak demand of the year range from 9% to 29% during the period 1975-1984. Thus, within the SERC, the VACAR Subregion apparently will have a significantly higher reserve margin than the SERC average for the foreseeable future. Because the applicant's expected reserve margin averages about 17% for the period 1975-1983, the other VACAR members apparently are projected to have higher reserve margins than the applicant.

8.4 POWER SUPPLY

The applicant's planned system capacity 1975-1988 is shown in Table 8.4. Total installed generating capacity available for the 1975 summer peak is 11,214 MWe, and firm purchases are 169 MWe. A major unit addition to the system is planned every year from 1975 to 1988 except for 1977 and 1980. By 1988, total capacity, including firm purchases available for summer peak, will be 25,051 MWe.

8.5 STAFF FORECAST AND ANALYSIS OF RESERVES

The results of an independent analysis of staff demand forecasts and reserve margins are presented in this section. The analysis synthesizes the results of two recent federal studies, one concerned with future energy supply and demand and the other concerned with forecasting regional economic activity.

8.5.1 Peak load forecast

The *Project Independence Report*,[12] released by the Federal Energy Administration in November 1974, represents the most comprehensive energy analysis yet undertaken. The report was developed during the period of March to November 1974; thus, the long-run implications of economic and energy-related developments during the spring and summer of 1974 are reflected in the analysis.

The *Project Independence Report*[12] provides two projections of future electricity demand -- a business-as-usual case and an increased-electrical-use case that entails greater government participation in management of energy demand. The increased-electrical-use case is based upon redistribution of energy consumption toward those sources of energy that can be produced domestically. Specifically, this case substitutes electricity, using coal and uranium resources, for other energy end-use purposes. Under the business-as-usual case, with oil at $11/barrel, electric demand is projected to grow 6.3%/year between 1973 and 1985. Under the Demand Management Case, electric demand is projected to grow 7.4% annually during the same period. The results of these two projections are presented in Table 8.5.

The FEA report points out a number of uncertainties in the projections of future electricity requirements.[31] These uncertainties include relative availability and prices of alternative fuels, growth in peak demand relative to total kilowatt-hours consumed, the trend in generating efficiency, and the success of rate restructuring to lower growth in peak demand. Additional uncertainties discussed in the report concern potential financial and technical constraints on the rate at which generating capacity can be placed in operation.

FEA uses a long-run price elasticity of demand (depending on the assumptions about the price of oil) of about -0.44 for household and commercial and -1.20 to -1.36 for industrial and forecasts an average electricity price, in constant dollars, of 22.2 mills/kwh in 1985 compared to 18 mills/kwh in 1972.[32] If demand proves to be more responsive to price, future growth in national consumption of electricity would be lower than the estimated 6.3 %/year.

Another significant uncertainity is the relative rate of growth between peak load and energy requirement. From 1968 to 1972 peak load grew nationally at 8.4% annually compared with 7.4% for total output. While the staff has no conclusive estimates of the relative growth of peak load demand and energy demand over the next decade, the staff believes that, nationally, load leveling efforts will be only partially successful in reducing the peak load growth rate to equal that of total electrical energy consumption.

A 6.3% growth rate in total consumption could imply upwards of a 7.0% growth rate in peak load nationally by 1980. Load-leveling measures including revised rate structures, and modification of technologies and consumption behavior, will take a number of years to be fully realized.

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Table 8.4. Planned power capacity at the time of summer peak, Duke Power Company, 1975–1988 (MWe)

Item	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
Generating capability before additions or retirements	10,909	11,214	12,274	12,274	13,454	14,634	14,634	15,787	16,940	18,085	19,637	21,156	22,343	23,623
Firm purchases	169	169	169	169	169	148	148	148	148	148	148	148	148	148
Total production capacity before additions	11,078	11,383	12,443	12,443	13,623	14,782	14,782	15,935	17,088	18,233	19,785	21,304	22,491	23,771
Capacity additions														
Jocassee 3 and 4	305													
Belews Creek 2		1,060												
McGuire 1				1,180										
McGuire 2					1,180									
Catawba 1							1,153							
Catawba 2								1,153						
Perkins									1,280		1,280		1,280	
Cherokee										1,280		1,280		1,280
Bad Creek										500	500			
Capacity retirements														
Buck and Riverbend combined cycle									(135)					
Lee 5C, 6C; Dan River 4C, 5C; Buck 3, 4										(228)				
Dan River 6C; Riverbend 8–11C; Urquhart 3C, 4C; Cliffside 1, 2											(261)			
Buck 7–9C												(93)		
Total capacity for summer peak	11,383	12,443	12,443	13,623	14,803	14,782	15,935	17,088	18,233	19,785	21,304	22,491	23,771	25,051

Source: Enclosure to letter from D. B. Blackmon to R. A. Gilbert dated January 31, 1975, re: Catawba, Perkins, and Cherokee Nuclear Stations.

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Table 8.5. Electrical capacity projections (in gigawatts)

Items	Existing capacity, end-1973	1985 projections[a,b] Business-as-usual ($11/bbl)	1985 projections[a,b] Demand management
Total electricity capacity, GWE	424	992	1002
Hydro	65	100	100
Nuclear	20	204	240[b,c]
Coal	167	327	379
Oil	78	81	64[d]
Gas	61	48	48
Combustion turbine[e]	33	162	171
Growth rate 1973–1985, %/year		6.3	7.4

[a]Beginning of year projections (nuclear at end of year would be 234 and 275 for business-as-usual and demand management respectively).

[b]Without conservation.

[c]Accelerated nuclear construction schedules.

[d]The demand management projection includes conversion of about 16,500 MW of existing oil-fired generation capacity to coal.

[e]These figures reflect projected increased market penetration of intermediate load, combined cycle plants and continued use of gas turbine peaking plants.

Source: *Project Independence Report,* FEA, Table II-24.

Gross National Product has grown at an annual rate of 4.3% in real terms during the period 1962 to 1973. The growth rate of GNP in constant dollars in recent years has been -0.5% in 1970, 3.4% in 1971, 6.2% in 1972 and 5.9% in 1973. The growth rate for 1974 was negative. Forecasts of the growth rate in GNP and its components under alternative energy strategies are summarized in Table 8.6. Note that, in each case, economic growth is projected to recover slowly form its present low rate but not to reach the level experienced during the 1960s. Growth is projected to be higher in a $7/bbl of oil situation, which has a less dampening effect than the $11/bbl situation.

Identifying differences in projected growth of major economic variables such as population and income allows one to draw conclusions about the expected rate of growth in demand for electricity within a service area relative to the national rate of growth. The most widely used set of long-run regional economic projections, OBERS Projections, Regional Economic Activity in the United States, is prepared by the U.S. Department of Commerce, Bureau of Economic Analysis (BEA) and the U.S. Department of Agriculture, Economic Research Service for the U.S. Water Resources Council.[33] The complex projection procedure used is based on the empirical and theoretically supported observation that economic growth over time is related to the size and productivity of the labor force. Projections of population and the labor force are published by the U.S. Bureau of the Census. Estimates of future output per man-hour are based on detailed analyses of trends in productivity in each sector of the economy and judgmental forecasts of significant future developments that might affect productivity. While no projections coincide exactly with the applicant's service area, a reasonably representative forecast can be spliced together for the service area by totaling BEA Economic Areas 025, 026, 028, and SMSA (Standard Metropolitan Statistical Area) 065.

The relevant comparisons between the applicant's service area and the nation as a whole are laid out in Tables 8.7 through 8.11. Table 8.11 summarizes the comparison. Note that population is projected to grow 78% faster in the applicant's service area than for the nation during the period 1970-1980. From 1980 to 1985 population will grow 56% faster, whereas in 1985-1990 it will grow 40% faster. Total personal income will grow 17% faster from 1970 to 1980, 14% faster from 1980 to 1985, and 31% faster from 1985 to 1990. The deterioration in the relative growth rate of per capita income indicates that the period in which wages in the region began to catch up with the national average is probably over and that wages will probably stabilize slightly below the national average. Overall, the applicant's service area apparently will have a considerably higher rate of growth in population and income than the nation as a whole.

Table 8.6. Annualized compound rates of growth for gross national product, consumption, investment, employment, and productivity

Item	Base case ($11/bbl)	Accelerated supply ($11/bbl)	Base case ($7/bbl)
Gross national product[a]			
1973–77	2.4	2.4	4.3[b]
1973–80	2.8	2.8	3.8[c]
1973–85	3.2	3.2	3.7[d]
Personal consumption[a]			
1973–77	2.4	2.4	3.9[b]
1973–80	2.9	2.9	3.6[c]
1973–85	3.2	3.2	3.4
Gross private domestic investment[a]			
1973–77	2.5	2.5	7.5[b]
1973–80	2.5	2.6	5.5[c]
1973–85	3.1	3.1	4.9[d]
Employment			
1973–77	1.8	1.8	1.9[b]
1973–80	1.7	1.7	1.8[c]
1973–85	1.5	1.5	1.5[d]
Productivity			
1973–77	0.5	0.6	2.4[b]
1973–80	1.1	1.2	2.1[c]
1973–85	1.7	1.7	2.2[d]

[a]Based on 1971 dollars.
[b]Based upon 1974–78 period.
[c]Based upon 1974–80 period.
[d]Based upon 1974–85 period.
Source: *Project Independence Report*, FEA, Table VI-2, p. 320.

Table 8.7. United States population, employment, personal income, and earnings, actual and projected, selected years 1962–1990

Item	1962[a]	1970	1980	1985	1990
Population, mid-year, millions	185.7	203.9	223.5	234.5	246.0
Per capita income, 1967 $	2,585	3,476	4,700	5,400	6,100
Total employment, millions	66.4	79.3	96.1	101.1	106.4
Earnings per worker, 1967 $	n.a.	7,090	8,700	9,800	11,000
Total personal income, billion $	480	709	1,068	1,273	1,517

[a]Employment for 1960.
Source: *1972-E OBERS Projections*, Vol. 1, Table 1, p. 38.

Table 8.8. Average annual percentage rates of change, United States population, employment, personal income, and earnings, actual and projected, selected periods 1962–1990

Item	1962–1970[a]	1970–1980	1980–1985	1985–1990
Population	1.2	0.9	9.0	1.0
Per capita income	3.7	3.1	2.8	2.5
Total employment	1.8	1.9	1.0	1.0
Earnings per worker	n.a.	2.1	2.4	2.3
Total personal income	5.0	4.2	3.6	3.6

[a]Employment for the period 1960–1970.

Source: Estimated from Table 8.7.

Table 8.9. Population, employment, and personal income, total of BEA economic areas 025, 026, and 028 and SMSA 065, historical and projected, selected years 1962–1990

Item	1962[a]	1970	1980	1985	1990
Population, mid-year, thousands	3,307	3,647	4,288	4,586	4,906
Per capita income, 1967 $	2,037	3,024	4,158	4,744	5,413
Per capita income relative (U.S. = 1.00)	0.79	0.87	0.88	0.88	0.89
Total employment, thousands	1,261	1,576	2,015	2,145	2,284
Employment/population ratio	0.38	0.43	0.47	0.47	0.47
Total personal income, million 1967 $	6,738	11,029	17,831	21,758	26,553

[a]Employment for 1960.

Table 8.10. Average annual percentage rate of change, population, employment, and personal income, historic and projected, BEA economic areas 025, 026, and 028, and SMSA 065, selected periods 1962–1990

Item	1962–1970[a]	1970–1980	1980–1985	1985–1990
Population	1.2	1.6	1.4	1.4
Per capita income	5.1	3.2	2.7	2.7
Total employment	2.2	2.5	1.3	1.3
Total personal income	6.4	4.9	4.1	4.1

[a]Employment for 1960–1970.

Table 8.11. BEA economic areas 025, 026, and 028 and SMSA 065 as a ratio of United States average annual rate of change of population, employment, and income, historic and projected, selected periods 1962–1990

Item	1962–1970[a]	1970–1980	1980–1985	1985–1990
Population	1.00	1.78	1.56	1.40
Per capita income	1.38	1.03	0.96	1.08
Total employment	1.22	1.32	1.30	1.30
Total personal income	1.28	1.17	1.14	1.31

[a]Employment 1960–1970.

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An estimate of the likely growth rate of peak load in the applicant's service area was derived relative to forecast national rates of growth in electric demand population and economic activity. If the future national growth rate in peak load falls between the forecasted business as usual and the demand management cases, say a 7.0% growth rate, then growth of peak load nationally will average only about 10% or 11% below the rate experienced from 1964 through 1973. During the 1964 through 1973 period the growth rate of peak load in the applicant's service area was 27% greater than the national rate. If the applicant's rate of growth in peak load were to be lowered by 11%, it would be reduced from 9.9% to 8.8%. The relative demographic and economic information summarized in Table 8.11 supports a continuation of the substantially higher rate of growth of peak load in the applicant's service area than that nationally. Population will grow considerably faster in the applicant's service area. Assuming the fertility rate to be essentially the same as the national average and assuming considerable in-migration, there will be an accompanying net increase in new households. While per capita income will not increase relatively as fast as in the 1960's, it will at least keep pace with the national rate of growth. Applicance saturation data from the applicant's service area would indicate that there is still considerable opportunity to increase usage of electricity by existing household customers through substitution of electric heating for gas and oil and increased use of air conditioning. Even if it were assumed that considerable efficiencies could be realized in peak usage through load-leveling measures and considerably higher electricity prices, a 20% reduction from the 8.8% growth rate would result in a 7.0% growth rate. The conclusion drawn by the staff is that, over the period through the late 1980's, the applicant will experience an average compound rate of growth in peak load of well over 7.0% and perhaps as high as 8.8%. The staff considers the average 7.6% compound rate of growth in the applicant's peak load forecast, from 1975 through 1987, to be reasonable.

8.5.2 Analysis of the adequacy of reserve margins

The following analysis of the applicant's potential reserve situation in the late 1980's summarized in Table 8.12, clearly illustrates that actual peak load would have to be considerably below staff and applicant forecasts before the three Perkins units would not be needed in 1987. Under the staff's conservative lower forecast based on a 7.0% compound annual growth rate, the three Perkins units would be needed as scheduled. Any delay beyond 1987 would result in inadequate reserves. The reserve margins associated with the applicant's forecast are considered inadequate by the staff. A growth rate in peak load as high as 8.8% would completely jeopardize the reliability of the applicant's system. At the other extreme, using a 6.0% growth rate, which the staff considers quite unlikely, would allow the Perkins schedule to slip by two years and still maintain adequate reserve.

Extrapolation of the applicant's estimates of reduction in summer peak load indicates that in 1987 peak load could be reduced by about 4.9%. Assuming successful load management, the 7.0% growth rate forecast peak load would be reduced to 18,490 MWe in 1987, and the reserve margin would be 28.6%, within acceptable limits.

8.6 SUMMARY AND CONCLUSIONS

The staff has considered the historic electric power demand and electrical energy requirements of the Duke Power Company, Power Supply Area 21, the Southeastern Region, and the United States as a whole. Various electrical and economic forecasts have been evaluated. These include: energy and power forecasts of the applicant, electrical demand forecasts of the Federal Energy Administration and OBER's regional economic projections. Specific consideration was given to the potential for conservation of electricity on one hand and substitution of electricity for scarce and high-priced gas and oil on the other. The applicant's future reserve requirements and generating capacity placement plans were also examined.

The staff finds that peak load in the Duke service area should grow at compound annual rates well above 7.0% and perhaps slightly above 8.0% over the period to 1988. The staff also finds the applicant's load forecasts reasonable and on the lower side of the range of growth rates deemed likely. With the applicant's present construction schedule, the three Perkins units will be needed by 1987 at rates of growth of peak load of 7.0% and higher. Even at an unreasonably low assumed rate of 6.0%, the units would be required by 1989 or 1990 at the latest.

Table 8.12. Reserve margin analysis for applicant and staff peak load forecasts 1983–1990

Item	1983	1984	1985	1986	1987	1988	1989	1990
Forecast of summer peak load, MWe								
Applicant[a]	16,124	17,226	18,383	19,598	20,875	22,217	23,630	25,111
Staff								
at 8.8% growth	16,951	18,442	20,065	21,831	23,752	25,843	28,117	30,591
at 7.0% growth	14,833	15,871	16,982	18,171	19,443	20,804	22,260	23,818
Extreme lower limit assumption – at 6.0% growth	13,760	14,585	15,460	16,388	17,371	18,413	19,518	20,689
Total capacity for summer peak,[b] MW	18,233	19,785	21,304	22,491	23,771	25,051	25,051	25,051
Reserve margin, %								
Applicant	13.1	14.9	15.9	14.8	13.9	12.8	6.0	*c*
Staff								
at 8.8% growth	7.6	7.3	5.2	3.0	0.1	*c*	*c*	*c*
at 7.0% growth	22.9	24.7	25.5	23.8	22.3	20.4	12.5	5.2
Extreme lower limit assumption – at 6.0% growth	32.5	35.7	37.2	37.2	36.8	36.1	28.3	21.1

[a] Applicant's forecast of December 23, 1974.

[b] Applicant's capacity schedule of January 10, 1975. It is assumed that no additional capacity is added in 1989 and 1990.

[c] Negative reserve margins.

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30. Southeastern Electric Reliability Council, *Coordinated Bulk Power Supply Program -- 1974-1992*, April 1, 1975, pp. 5-6.

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9. COST-BENEFIT ANALYSIS OF ALTERNATIVES

9.1 ALTERNATIVE BASE-LOAD ENERGY SOURCES AND SITES

9.1.1 Alternatives not requiring creation of new generating capacity

9.1.1.1 Purchased power

The applicant has indicated (ER, Sect. 9.1) that purchase of base-load power is not a viable alternative in amounts in excess of those already scheduled (148 MWe, 19,000 MWhr, 1983-1987). Purchased energy is generally only a viable alternative when excess capacity exists in another region or system during the time period when the energy is needed by the applicant. Constructing new capacity in a different region or system especially to supply the needs of the applicant would merely shift the energy-producing burdens to another region without any significant overall advantages. Moreover, wheeling large blocks of power from one system to another inescapably results in transmission losses. Also, if large blocks of power were wheeled on a routine basis, the existing transmission interconnections would not be sufficient to wheel this power and also maintain existing reliability of service criteria. Thus, new transmission lines would undoubtedly be required from the power source to the applicant's system.

In its report to the Federal Power Commission for the 1970 National Power Survey, the Southeast Regional Advisory Committee discussed seasonal diversities within the Southeast as capacity sources. The Committee concluded that opportunities for seasonal exchange not already implemented were relatively small and uncertain so that little, if any, transmission for seasonal exchange purposes could be justified.[1]

The staff concludes that purchasing base-load power for a period of time corresponding to the expected lifetime of PNS is not a practicable alternative.

9.1.1.2 Postponed retirement or reclassification of existing units

The applicant has indicated an intent to retire some existing generating capacity (approximately 717 MWe) between 1975 and 1987 (Table 8.4). By 1987 all of the existing nonsupercritical base-load coal-fired stations (the supercritical coal-fired units are Belews Creek 1 and 2 and Marshall 3 and 4) will probably largely be used for intermediate-type operation. Because of the discrepancy between the planned retirement capacity and the capacity of the proposed station, postponed retirement cannot be considered a viable alternative to the proposed action.

9.1.1.3 Base-load operation of intermediate or peaking facilities

Extended operation of units designed for intermediate or peaking operation would result in extensive maintenance problems and reduced availability of the peaking capacity and reduced system reliability when it is needed, because these units are not designed for nearly continuous, base-load operation. This case is particularly true for the peaking units and, to a lesser extent, for intermediate-type units. Moreover, fuel costs for these units are generally higher than those designed for base-load duty (ER, Sect. 9.1.3); also, fuel for some of these units (oil and gas-fired) is expected to be in relatively short supply and may not be available for their continuous operation. Because a substantial portion of the applicant's peaking capacity is hydroelectric or pumped-storage hydroelectric capacity, the extent to which these facilities can be operated is dependent upon the water supply. The applicant has indicated that both types of hydroelectric facilities are limited to use for peaking purposes only (ER, Sect. 9.1.3). The applicant has also indicated that its system needs a major block of generation to operate in the load-following portion of the curve, and that to upgrade these units to base-load operation would deprive the system of an important part of the generation mix needed for efficient operation. Another aspect to be considered is that without the addition of new generating capacity the peak demand of the applicant's system will eventually outgrow the system's total generating capacity and will result in the absence of any reserve capacity. Thus, the staff concludes that base-load operation of existing intermediate or peaking facilities is not a feasible alternative for the long term.

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9.1.1.4 Reactivating or upgrading older plants

Because the applicant plans to retire only small existing units between 1975 and 1987 (Table 8.4) and because those scheduled to be retired in 1974 and 1975 are also relatively small (totaling only 151.7 MWe) and are used only for peaking purposes (ER, Sect. 1.1.2, Table 1.1.2-2), reactivating older plants apparently is not a viable alternative to building new base-load capacity in the amount to be supplied by PNS.

Upgrading existing facilities by a significant extent is generally not economically feasible, because most boiler and turbine-generator facilities are closely matched. Thus, upgrading would require replacement of boilers, turbines, and condensers with a resulting probable cost approaching that of new capacity. An associated additional disadvantage is that all output from these units would be lost during the rebuilding period. Furthermore, installation of higher capacity at a particular location would require additional capability to dissipate waste heat and probably additional transmission lines. The applicant has indicated that upgrading existing plants is not feasible (ER, Sect. 9.1.2). The staff does not consider upgrading to be a viable alternative to replace the power expected to be supplied by PNS.

9.1.1.5 Conclusions

The staff concludes that there are no feasible alternatives not requiring creation of new generating capacity to meet the projected energy requirements without the creation of new generating capacity.

9.1.2 Alternatives requiring the creation of new generating capacity

9.1.2.1 Energy type and source consideration

Coal

Coal supplied the energy for 84.1% of the power generated by the applicant in 1973.[2]

Low-sulfur coal, or an SO_2-removal system, is expected to be required in new stations that will begin operation during the time PNS is scheduled to begin generating power. Although southeastern coal is generally high-sulfur coal, the applicant has indicated that the coal that it currently uses is less than 1% sulfur (ER, Sect. 9.3.2). Another source of low-sulfur coal would be from western (Montana, etc.) mines; consequently, transportation costs would be high. The applicant has not indicated whether or not low-sulfur eastern coal would be available for the proposed units. Therefore, the staff has considered that any coal-fired plant in the applicant's system would use high-sulfur southeastern coal along with SO_2-removal systems.

The staff has estimated capital costs of a 3840-MWe coal-fired station located at the Perkins site and using mechanical-draft cooling towers and an SO_2-removal system. Table 9.1 compares the staff's and the applicant's cost estimates for a coal-fired station with the staff's and applicant's cost estimates for a uranium-fueled station. Operating and maintenance cost estimates are also given, and annual production costs are compared at plant factors of 0.8, 0.7, and 0.6.

Oil

Oil was used to generate about 2.5% of the applicant's power in 1973;[2] its use was mainly for intermediate-type and peaking units. Its relatively small usage, when compared with coal (see above, Coal), is indicative of the relative costs of these two sources of energy in the applicant's service area in 1973. Oil at a price of $11/bbl (about $1.90/MBtu) is about equivalent in electrical energy generation capability to coal at a price of $50/ton. Thus the applicant does not consider oil to be a feasible alternative fuel source (ER, Sect. 9.2.1). The staff concurs in this evaluation.

In addition to the economic aspects that preclude the further consideration of oil as a fuel for a large base-load power station, other reasons also discourage its use. An important factor is the future availability of oil in the United States as a fuel for base-load power stations. As events since late 1973 have shown, oil supplies from foreign countries (which make up a significant part of our total annual consumption) are subject to availability and costs as dictated, to a large extent, by political considerations. The cost factor is important not only in relation to predicting the economics of station operation but also with regard to national policies related to the U.S. balance-of-payments problems. The latter could lead to restrictions on the large-scale use of oil for power stations to conserve it for other purposes for which there are no readily available substitutes (such as fuel for internal combustion engines, raw materials

TABLE 9.1. Estimated Capital and Operating Costs for 3840-MWe nuclear (PWR) and coal-fueled power stations utilizing mechanical-draft cooling towers

All figures are 1987 dollars

	Nuclear			Coal: With SO_2-removal equipment			Coal: Without SO_2 removal equipment		
Capital, dollars/kWe[a]		632[b]			514			423	
Applicant's estimate[c]		589						364	
Unit production costs, dollars/MWhr									
Fuel		8.2[d]			23.8			27.1	
Operating/Maintenance		2.2[e]			3.6[g]			1.9[g]	
Total		10.4			27.4			29.0	
Annual Production costs, millions of dollars									
(Plant factor)	(0.8)	(0.7)	(0.6)	(0.8)	(0.7)	(0.6)	(0.8)	(0.7)	(0.6)
Fuel	221	193	166	640	560	480	729	638	547
Operating/maintenance[h]	59	52	44	97	92	73	52	45	39
	280	245	210	737	652	553	781	683	586
Present worth production cost, dollars/kWe[i]	687	602	516	1809	1601	1358	1918	1677	1439
Total present worth generating cost, capital plus production, dollars/kWe	1319	1234	1148	2323	2115	1872	2341	2100	1862
Kilowatt-hours generated/yr (10^9)	26.9	23.6	20.2	26.9	23.6	20.2	26.9	23.6	20.2
Annualized generating cost, mills/kWh[i]	20.0	21.3	23.2	35.2	36.6	37.8	35.4	36.3	37.6

[a]See Summary and Conclusions of this section for a description of the methods of estimating capital costs.

[b]Average value for three 1280-MWe units. Commercial operation of Units 1, 2, and 3 is scheduled for January 1983, 1985, and 1987 respectively. Length of workweek was considered to be 40 hr. Interest during construction was assumed to be 8%/year (compound). Escalation rates during construction used for the calculations were 8.5%/year for site labor, 7.5%/for site materials, and 7.5%/year for purchased equipment.

[c]ER, Table 9.3.1-1, plant cost. Excludes substation and transmission line costs.

[d]The Nuclear Industry, 1974, USAEC Report WASH 1174-74, Chapter 1. The estimated 1974 dollar cost of $3.02/MWhr was esclated to 1987 at 8%/year. The applicant has reported in Electrical World, July 15, 1975 an even lower cost of $2.23/MWhr.

[e]An operating and maintenance cost of $0.81/MWhr for 1974 derived from Chapter 1 of WASH 1174-74 was escalated to 1987 at 8%/year.

[f]Coal costs are based on March, 1975 data on the costs and quality of fossil fuels delivered to electric utility generating plants in the continental United States (Federal Power Commission News, Vol. 8, No. 25, June 20, 1975). The low sulfur coal contains 0.5% or less sulfur. The costs shown are for coal delivered in North Carolina and were 122.5¢/MBtu for low sulfur and 107.1¢/MBtu for high sulfur (2-3% sulfur). A heat rate of 8800 Btu/kWhr was assumed (Uniform Statistical Report-Year ending December 31, 1973, Duke Power Company, p. E-19, average value for base-load, supercritical Marshall Units 3 and 4). All costs were escalated at 8%/yr.

[g]Operating and maintenance costs for Duke Power Company for 1971 of $0.566/MWhr (Steam-Electric Plant Construction Cost and Annual Production Expenses, Twenty-Fourth Annual Supplement-1971, Federal Power Commission, February 1973, Table 10, XXIX) were escalated to 1987 at 8%/year. 1974 operating and maintenance costs for a working SO_2 removal system were 0.6/MWhr ("Stack Gas Scrubber Makes the Grade," Chem. Eng. News 53, p. 22 (Jan. 27, 1975)) and were escalated to 1987 at 8% per year.

[h]Calculated for a plant factor of 0.76 and ratioed to plant factors used.

[i]Assuming a 10% discount rate for a 30-year period.

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for synthetic organic chemicals, etc.). Therefore, even disregarding the economics of station operation, the unreliability of foreign supplies of oil make it desirable for a utility not to increase its dependence on oil as a fuel source. The staff concludes that it is not reasonable at this time for the applicant to plan a base-load electrical generating station that would consume large quantities of oil.

Natural gas

Only about 2.5% of the applicant's 1973 power was generated by the use of natural gas,[2] and this use was mainly for intermediate-type and peaking units. For the future, domestic supplies of natural gas are not expected to be available in the quantities required for long-term (30 to 40 years) operation of a natural gas-fueled power station to replace the applicant's proposed uranium-fueled station.[3]

Although consumption of gas by electric utilities for generation of electrical power increased by about 203% during the period 1962-1971,[4] the 1970-1971 consumption increased only 1.6%, and from 1971-1973 consumption decreased about 10% (Fig. 9.1).[5] In the South Atlantic states, consumption decreased by 1.7% during 1970-1971.[4] A major reason for the nationwide reduction in gas consumption by electric utilities is their difficulty in obtaining new supplies.[4] The trend is to channel the nation's limited supplies of natural gas away from use as a boiler fuel into household and other premium uses.

Therefore, the staff does not consider natural gas as a viable alternative fuel for the applicant's proposed base-load station.

Hydroelectric

Because of the characteristics of streamflows in the applicant's service area, hydroelectric power generation is limited in usefulness to peaking service (ER, Sect. 9.2.1). In 1973, hydroelectric facilities (including pumped storage) generated about 5.4% of the applicant's total power generation.[2] The applicant has indicated that there are only a few hydroelectric sites remaining that are suitable for development for peaking service and none that are suitable for base-load service (ER, Sect. 9.2.1). The applicant has stated that the Federal Power Commission lists 30 locations in its service area where hydroelectric power could be developed; the estimated total annual energy potential of all 30 sites is only about one-twelfth of the annual energy generation planned for PNS (ER, Sect. 9.2.1).[6] The staff concludes that it is not practicable to utilize hydroelectric power in the applicant's service area to supply base-load power in the amount expected to be generated by PNS.

Geothermal

Geothermal electric power generation, at favorable geologic sites, has been found to be feasible and competitive with other commercial sources of energy. However, world capacity was only about 1000 MW in 1973.[7] Geothermal power generation has made significant contributions to the power supply of northern California. The first geothermal plant (12.5 MW) in this field (the Geysers field) was commissioned in 1960. Subsequent additions (in units as large as 55 MW) have led to a 1972 capacity at this field of about 302 MW at an average total generating cost of less than 6 mill/kWhr; ultimate capacity of this field is estimated at between 500 and 1000 MW.[8] Total installed capacity at this field is expected to be 900 MWe in 1976.[9]

Development of geothermal energy as a source of steam for the production of electric power in the United States has occurred only in this one field in northern California. Other possible locations are under investigation but these are primarily in the western part of the United States. The staff is not aware of any other operable or under-construction geothermal electric power generating stations using hot-rock heat sources that are economically competitive with uranium-fueled central power stations.

Although a thermal spring does appear to exist near the applicant's service area in North Carolina,[10] the applicant has indicated that the kinds of geological formations that produce steam suitable for use in geothermal plants appear to be non-existent in the Carolinas (ER, Sect. 9.2.1).

Geothermal energy development is not without significant environmental problems. Chief among these are thermal effects, land despoilment, contamination of ground and surface waters, noxious gases, noise, land subsidence, and requirement of a supply of cooling water for closed-system generating modes.[11] The possibility of seismic effects also exists. A geothermal station also

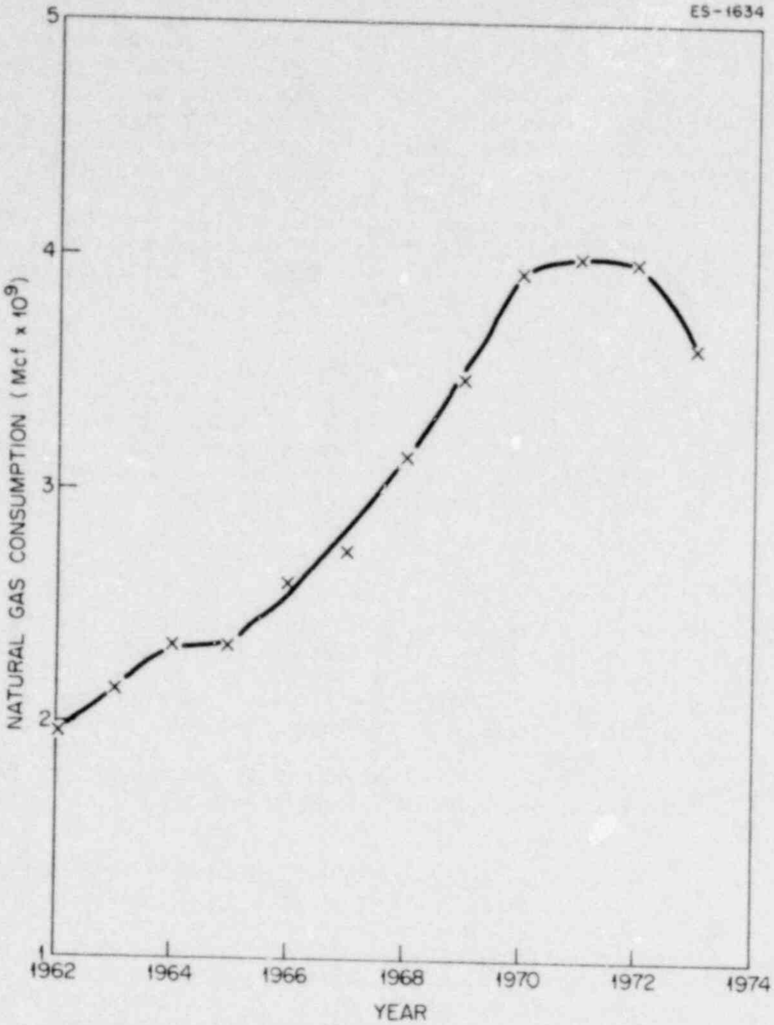

Fig. 9.1. Consumption of natural gas in the United States by electric utilities for electrical energy generation. Source: Edison Electric Institute, *Statistical Year Book of the Electric Utility Industry for 1973*, Table 41S.

requires more land than nuclear or fossil-fueled plants and has a greater water consumption and waste thermal discharge per unit of electricity because of lower turbine conversion efficiencies at the lower geothermal steam pressures and temperatures.

The staff concludes that the applicant cannot reasonably consider geothermal power as an alternative energy source for the applicant's proposed base-load uranium-fueled power station within the time frame required for the power to be available.

Solar power

Although solar generation of electricity may be a future supplier of electrical energy in the United States, a pilot plant has not yet been put into operation. To succeed as a base-load plant, low-cost methods of power storage (to supply power when the sun is obscured by clouds or at night) would have to be developed and coupled with the solar energy conversion units. Even if a considerable number of technological problems are solved, commercial operation of a solar power station would not be expected until about 1990.[12] If solar energy is used for a peaking power station (in localities where the peak occurs during hot, sunny days when air conditioning is a major load), even this energy source is not likely to be competitive before about 1990.[13] Although in certain locations the use of solar energy for heating and cooling of individual buildings may be economically feasible, the staff does not consider widespread generation of electrical energy at individual homes from solar energy to be, now or in the foreseeable future, economically feasible. Thus, the staff does not consider solar power a viable alternative to the applicant's proposed base-load uranium-fueled power station.

Wind power

Power from the wind has been obtained on a 1-MW scale in Vermont and currently there are plans to construct a 0.1-MW windmill in Ohio.[14] Because wind power is intermittent, it is unsuitable as a source of base-load power unless coupled with low-cost storage facilities, which have not yet been developed. Additionally, the use of large systems of windmills on land might change air current patterns, which would, in turn, affect local temperatures and humidities.[15] Proposed pairs of 800-ft-tall towers with wind-powered turbines slung from cables between the towers[14] also have obvious aesthetic problems.[16] However, tower heights of 100 to 150 ft are currently considered optimum in terms of trade-offs between construction costs and the increased strength and constancy of the wind with increasing altitude.[14] As a consequence of the above-mentioned considerations, the staff does not consider power from the wind a viable alternative to the applicant's proposed base-load station at this time.

Fusion power

The present status of nuclear fusion as a source of energy is such that a demonstration plant is not expected to be built before about 1990 and a commercial power station is not expected to be available before the year 2000.[17] Therefore, the staff does not consider fusion power to be a viable alternative to the applicant's proposed nuclear power station at this time.

Municipal solid wastes

In recent years, the increasing costs of conventional fossil fuels and of conventional disposal methods for municipal solid wastes (sanitary landfill and incineration) combined with the increased value of recoverable waste materials have increased the economic feasibility of using these solid wastes as a source of energy and of recycled materials.[18] Processed municipal wastes (shredded refuse with metals, glass, etc., removed or prepared refuse fuels in powdered, pellet, or briquette form) have been used at some power plants, and more such systems are under construction.[19] This prepared municipal refuse can be used as a supplementary fuel in large pulverized-coal-fired boilers where the milled refuse replaces about 10% of the heat value of the pulverized coal.[20]

In the United States, solid waste is generated at the rate of about 5 lb/person each day; this waste has an average heating value of about 5000 Btu/lb.[19] Thus, a community with a population of about 200,000 would generate about 500 tons of solid waste per day. This rate of solid waste production is within the range of existing and planned solid waste recovery and energy production facilities. Within the applicant's service area, several SMSAs have a population sufficient to support such a solid waste recovery and energy production system: the Greenville-Spartanburg SMSA (1972 population 497,000) in South Carolina; and the Charlotte-Gastonia (1972 population 571,000), Raleigh-Durham (1972 population 439,000), and Greensboro-Winston Salem-High Point (1972 population 745,000) SMSAs in North Carolina.[21]

The total 1972 population in these areas was about 2,250,000. Assuming a 1972-1985 population growth approximating that observed for the period 1960-1970 for these areas,[21] their 1985 population would total about 2,700,000. Assuming an average daily rate of solid waste production of 5 lb/person, an average heating value of the waste of 5000 Btu/lb, and an efficiency of 35% for conversion into electrical energy, the total electrical energy produced from energy recovery from solid wastes from SMSAs within the applicant's service area would be about 2.5 x 10 kWhr/year in 1985. This represents about 10% of the expected output from the 3840-MWe PNS if it operated at a plant factor of 0.76. Thus, although the use of municipal solid wastes from SMSAs would not generate sufficient energy to replace the proposed PNS, the staff concludes that there are several areas within the applicant's service area where municipal solid wastes might be used in fossil-fueled stations to generate significant quantities of electrical energy.

Coal gasification

Pilot plants for coal gasification have been constructed. This method appears to be a promising alternative for fueling large central power stations, but it has not been developed to the extent that it can be considered as an alternative to the applicant's proposal. A commercial process might be available by the late 1980s.

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Coal liquefaction

Development of coal liquefaction processes have not progressed to the same extent as for coal gasification processes. Although one or more processes might be commercially available by the late 1980s, this will not be in time to be considered as an alternative to the applicant's proposed station.

Magnetohydrodynamics

Construction of a large-scale magnetohydrodynamic electrical generating station depends upon the solution of a number of technological problems. Therefore, such a station is not expected to be available until even later than coal gasification or liquefaction technology and, consequently, will not be available in the time frame required by the applicant.

Other

There are a number of other alternative energy sources that might be mentioned, such as conversion of foreign natural gas to methanol and its transportation to the United States as a liquid; extraction of fuel oil from oil shale or from tar sands; or the use of fuel cells. However, these energy sources cannot be considered as viable alternatives to meet the applicant's requirements for power in the time frame that this power is needed, because they are either not technically feasible at this time or not available in the quantities needed.

Summary and conclusions

Of the various types of energy sources that were considered, the staff found that only coal was a viable alternative to nuclear power as fuel for a large base-load power station. The staff's cost comparison of these two types of power stations is given in Table 9.1. The following is a brief discussion of the staff's method of comparison.

A computer program has been used by the staff to estimate capital costs for the nuclear and coal stations. This computer program, CONCEPT (see Appendix D), was designed primarily for use in examining average trends in costs, identifying important elements in the cost structure, determining sensitivity to technical and economic factors, and providing reasonable long-range projections of costs. The main factor in this computerized approach is the technique of separating the plant cost into individual components, applying appropriate scaling functions (to account for the difference in size from a reference design) and location-dependent cost adjustments (to account for costs of materials and labor at particular regions of the country), and escalating these costs to different construction and startup dates. These capital cost estimates are given in Table 9.1 for both the coal-fired and uranium-fueled plants. The coal-fired plant was evaluated with and without SO_2-control equipment. From an economic standpoint, the values presented in Table 9.1 indicate that a nuclear power station is the clear choice of the two viable types considered whether or not SO_2-removal equipment is needed for the fossil plant.

From an environmental viewpoint, the major effects of the alternative generating system results from the condenser cooling water requirements and the radioactive and nonradioactive particulate and gaseous effluents. The coal-fired station would have essentially the same type of condenser cooling water system as the nuclear station; but because of its higher efficiency and the transfer of some heat to the atmosphere through stack gases, the intake water requirement, the quantity of water evaporated by the cooling tower, and the quantity of water returned to the Broad River as blowdown would be less (by about 30%) than for a nuclear station. The particulate and gaseous emissions from a coal-fueled station would be significantly higher than those from a nuclear station, but they would meet the applicable standards and thus should be acceptable. The radioactive effluents from a nuclear station are normally lower than those from a coal-fired station since the controls imposed on the nuclear station would result in such effluents being equivalent to only a fraction of the natural background radioactivity.

The creation and shipment of radioactive wastes from the nuclear station are adverse environmental effects, as are the transportation and onsite storage of coal for the coal-fueled station. In addition, the use of coal as a fuel would require the storage or disposal of large volumes of ash. From an aesthetic standpoint, the presence of smokestacks and their plumes at a coal-fired station is an additional feature not present with a pressurized-water nuclear reactor station. However, this feature will generally be overshadowed by the presence of the plumes from the mechanical-draft cooling towers.

The staff concludes that the significantly lower generating costs of a nuclear station, compared with the coal-fueled station, are not offset by any particular environmental advantage of the latter station; therefore, the selection of a nuclear station is warranted.

9.1.2.2 Candidate regions

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The applicant's service area encompasses about 20,000 sq miles in the Piedmont sections of North and South Carolina. Thus, the applicant has a large area from which to select a suitable site and has indicated that it has found no justifiable reason or advantage to consider sites outside its service area; neither the economic nor the environmental impact of the proposed project would thereby be improved (ER, Sect. 9.2.1).

From power network reliability and transmission considerations, the location of power stations reasonably close to those areas using their output is generally considered desirable. Thus, an initial major criterion with respect to power plant site selection is to consider the existing and predicted loads (and load-generation mix) with relation to the existing capacity, the capacity under construction, and the environmental and capital costs of transmission lines. A second major criterion is the availability of condenser cooling water, which is required in relatively large amounts for base-load power stations. As a consequence of the latter consideration, the applicant divided his entire service area into four load-generation regions that generally correspond to the four major river basins (Savannah, Broad, Catawba, and Yadkin) in the applicant's service area (Fig. 9.2) (ER, Sect. 9.2.1). Table 9.2 lists the four regions and the base-load capacity expected in each by 1983.

Table 9.2. Duke Power Company's four major load-generation regions, their major rivers, and their approximate 1983 base-load power capability

Region	Major river	Approximate base-load power capability in 1983 (MWe)
Greenville-Anderson	Savannah	2950
Spartanburg-Shelby	Broad	770
Hickory-Charlotte	Catawba	2440
Winston-Salem-Durham	Yadkin	3000

The four areas generally run from the northwest to the southeast and bear no relationship to the load development in the applicant's service area; load development has generally followed the main line of the regional railroad system, which runs generally from the northeast to the southwest. The transmission network within the applicant's system has been developed as an integrated network to permit installation of new generating capacity to economically serve the entire service area. However, in the long run, both economic and reliability considerations dictate a reasonable balance of load and generation within each of the areas even though an imbalance may exist for short periods of time (ER, Sect. 9.2).

The siting procedure for locating PNS was carried out simultaneously with the siting of the Cherokee Nuclear Station, because both are planned to be constructed on approximately the same time schedule. Each station will consist of three 1280-MWe nuclear units, with the Perkins units scheduled for commercial operation in 1983, 1985, and 1987 and the Cherokee units scheduled for commercial operation in 1984, 1986, 1988. The applicant has indicated that potential sites for these two stations exist in all four regions of its service area. However, the Broad River and Yadkin River regions were selected as the primary candidate areas primarily because of the resulting improved system reliability and operation with a minimum of new transmission-line mileage and the availability of sites for closed-cycle cooling operation with minimum land requirements. One additional site outside these two regions, on the lower Catawba River by the Wateree Reservoir, was also considered.

9.1.2.3 Candidate plant-site alternatives

The two viable alternatives for fueling the proposed station were uranium and coal (Sect. 9.1.2.1). Having reached this consideration, the applicant sought suitable locations for these plants in each of the two selected candidate areas (plus the location near the Wateree Reservoir as mentioned above). In making a selection of potential suitable sites, the applicant indicated that the following site criteria were used:

(1) Land area — sufficient acreage;

(2) Physical site characteristics — all characteristics must be suitable;

(3) Nature of surrounding area — low population density, minimally affected land use; and

(4) Benefits to surrounding area — local tax revenues, employment opportunities.

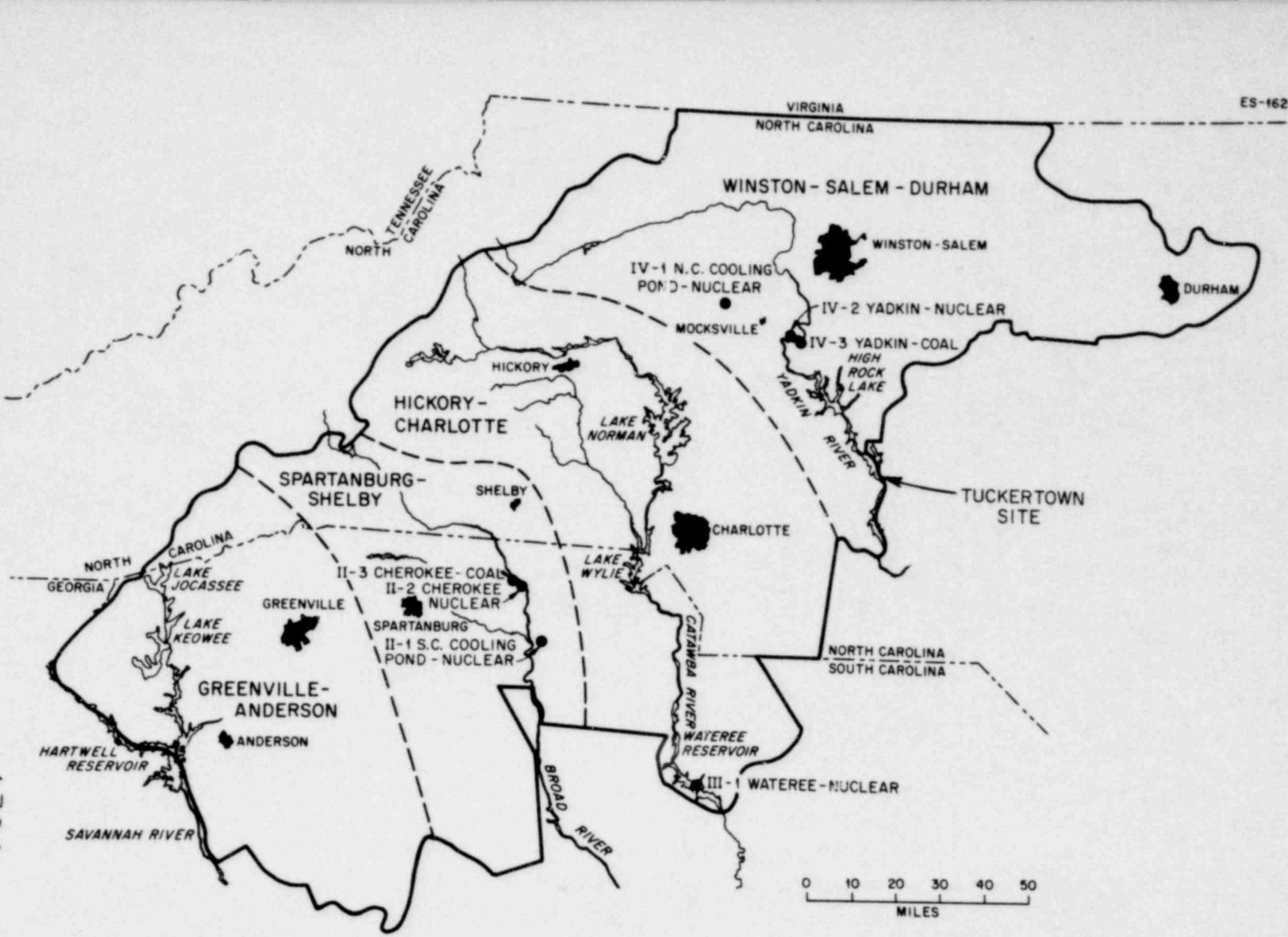

Fig. 9.2. Load-generation regions in Duke Power Company's service area. <u>Source</u>: ER, Fig. 9.2.2-1.

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With the use of these criteria, four plant-site alternatives were located in each of the two candidate areas, and two plant-site alternatives were located near the Wateree Reservoir, thus offering a total of ten plant-site alternatives. One potential nuclear station location that could use either a cooling pond or closed-cycle cooling towers was found in each candidate area; one potential site using closed-cycle cooling towers was found in each area to be suitable for either a coal or a nuclear station; and the Wateree Reservoir location was considered to be suitable for a nuclear station using either closed-cycle cooling or once-through cooling. A summary of the significant characteristics of the five potential sites (two of which are suitable for either coal or nuclear fuel) is given in Table 9.3.

Regarding costs of producing power in nuclear plants or coal-fired plants (see Sect. 9.1.2.1), the economic advantage belongs to the uranium-fueled stations at the plant factor anticipated by the applicant (0.76). In comparing the potential sites, there appears to be no significant environmental advantage for the coal-fired stations when compared with nuclear stations. Moreover, as indicated by Table 9.3, the coal-fired stations will generally require more land than the nuclear plants (for ash disposal purposes). Thus, when considering the plant-site alternatives presented by the applicant, the coal-fueled alternative apparently can be disregarded; the choice appears to be to select the better two nuclear plant locations from five potential choices — Turkey Creek, Cherokee, Hunting Creek, Yadkin (Perkins), and Wateree. Compared with Cherokee and Yadkin (Perkins), the Turkey Creek and Hunting Creek sites require considerably more land and also require significantly longer transmission lines. Thus, because there are no apparent environmental advantages to the Turkey Creek and Hunting Creek sites, when compared with Yadkin (Perkins) and Cherokee, and because there are additional environmental disadvantages associated with the requirement of additional land for storage reservoirs and transmission lines, the selection of Yadkin (Perkins) and Cherokee is reasonable. The other alternative site, Wateree, although not requiring as much land for the station, does require about 220 additional miles of transmission lines. There does not appear to be any environmental advantage to be gained by the additional expenditures required for this transmission line from Wateree. Therefore, the selection of the Yadkin (Perkins) and Cherokee sites, when compared with the Wateree site, is apparently a reasonable choice.

At the suggestion of the North Carolina Department of Natural and Economic Resources, the applicant has also investigated a potential site near Tuckertown, North Carolina. The Tuckertown site is located west of Tuckertown Reservoir, south of Flat Creek, in Rowan County, about 27 miles SE of the Perkins site. The applicant has indicated that a nuclear station would have to be located about 2 miles west of the Reservoir to avoid the probable maximum flood zone. Average river flow at the site is about 4700 cfs, compared with about 2850 cfs at Perkins. Population (1970) within 5 miles of the Tuckertown site was about 2400, compared with about 4500 near Perkins. Railroad access requirements would be similar for both locations. Current land use is also similar at both locations. Approximately 38 additional miles (compared with Perkins) of transmission lines, at an estimated additional cost of about $4 million, would be required. Availability of a construction force would be comparable at the two locations. Land requirements at the Tuckertown location would be about 1600 acres, substantially less than requirements for Perkins. According to the applicant, the major drawbacks to the Tuckertown site are the lack of control by the applicant over the operation of the Tuckertown Reservoir (which is operated primarily for hydroelectric purposes) and the increased costs and lowered reserve levels as a consequence of an approximate two-year delay, because developing plans for a nuclear station to be constructed at Tuckertown rather than at Perkins would necessarily result in a re-submittal of the license application. Since there appear to be no significant advantages to the Tuckertown site, when compared with the Perkins site, the staff concurs in the selection of the Perkins site.

Summary

The applicant has made a search for suitable sites within its service area. Two of the plant-site alternatives used coal as fuel. Because there was apparently no significant environmental advantage for a coal-fired station, as compared with a nuclear station, and because the coal-fired station has a significant economic disadvantage, the applicant's choice of a nuclear station appears reasonable. Of the five potential nuclear plant sites, the applicant selected the Perkins site and the Cherokee site for locations for the proposed six nuclear units to begin operation over the period 1983-1988. There appear to be no significant environmental disadvantages associated with nuclear plant operation at the selected sites, and the other three potential sites appear to offer no significant environmental advantage over those selected. Moreover, a significant amount of additional acreage for the plant site and for transmission lines would be required if power plants were constructed at the three alternative locations, as compared with the two selected sites. Therefore, the staff concludes that the applicant's method of site selection was reasonable and that none of the other sites offer any obvious superiority to the Perkins and Cherokee locations.

Table 9.3. Comparison of the applicant's feasible plant-site alternatives

All sites to utilize closed-cycle cooling towers

	Broad River region: Turkey Creek (nuclear)	Broad River region: Cherokee, Nuclear	Broad River region: Cherokee, Coal	Yadkin River region: Hunting Creek (nuclear)	Yadkin River region: Yadkin (Perkins), Nuclear	Yadkin River region: Yadkin (Perkins), Coal	Wateree Reservoir (Catawba River) (nuclear)
Location	30 miles ESE of Spartanburg, S.C.	21 miles ENE of Spartanburg, S.C.		9 miles NW of Mocksville, N.C.	6–8 miles SE of Mocksville, N.C.		20 miles S of Lancaster, S.C.
Topography	Gentle hills and slopes	Gentle hills and slopes		Gentle hills and slopes	Gentle hills and slopes		Gentle hills and slopes
Cooling water	7350-acre lake (to be constructed)	Broad River		7200-acre lake (to be constructed)	Yadkin River		Wateree Reservoir
Total land required, acres	8300	1567	2584	8124	2600	1100	710
Land excess costs over Cherokee, millions of dollars	12		4.5	10	2	3	0
Exclusion area, acres	450	450		450	450		450
Current land use	Rural	Rural	Rural	Rural	Rural	Rural	Rural
Transportation access (miles from interstate hwy)	Poor (20)	Good (7)		Good (10)	Good (10)		Poor (20)
Access road construction							
Highway, miles	0.5	0.2	0.5	0.2	0.3	0.2	1
Railroad, miles	8.9	7	6.5	16	6.5	6.4	12
Transmission line required, miles	110	21	21	117	16	26	240
Transmission line excess costs over Cherokee, millions of dollars	20		2	11	0.5	0.5	74
Switching stations, number	1	1	1	2	2	2	1
Construction labor force	Readily available	Readily available		Available	Available		Probably available
Major operation impacts	Minor	Potential ground fog		Minor	Potential ground fog		Minor
Aesthetic features	Cooling towers and plumes	Cooling towers and plumes	Cooling towers, plumes, and chimneys	Cooling towers and plumes	Cooling towers and plumes	Cooling towers, plumes, and chimneys	Cooling towers and plumes
Impacts on biota	Construction of new lake	Minor		Construction of new lake	Minor		Minor

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The applicant also compared the Perkins site with a suggested location near Tuckertown Reservoir. Because there appear to be no significant advantages to the Tuckertown location, as compared with Perkins and because there would be significant additional costs and delays if the location of the nuclear station were changed at this time, the staff concurs in the selection of the Perkins site.

9.2 ALTERNATIVE PLANT DESIGNS

9.2.1 Cooling Systems

9.2.1.1 Dry cooling towers

Dry cooling towers transfer heat by radiation and convection from water flowing inside finned tubes to a moving stream of air outside the tubes. The lowest temperature the water could possibly achieve is the dry-bulb temperature of the air. Thus, the condensing pressure of the turbines will be higher than if wet cooling towers were used (where the water temperature can approach the wet-bulb temperature of the air), and the system will have a significantly lower thermal efficiency. In addition, because the heat transfer coefficient to the dry air is relatively low, surface area requirements and costs are high. Large, dry-type cooling towers have not been developed commercially in the United States to the extent that cost and performance data are readily available. This method of cooling is not considered practical at this time.

9.2.1.2 Wet-dry cooling towers

This type of cooling tower has provisions for operating without the evaporation of water when outside temperatures are sufficiently low or when visible plumes, fogging, or icing would create a particular problem. The cost of these towers is significantly higher than for the wet type and they afford poorer plant thermal efficiencies. The wet-dry type of tower is not a viable alternative for PNS.

9.2.1.3 Cooling ponds and lakes

The water surface area required for a cooling pond is 1 to 3 acres for every megawatt of electricity generated; therefore, to cool the condensing water needed for the three units at PNS would require a surface area of 4000 to 12,000 acres. The water evaporation rate from the pond surface would not be greatly different from that in the cooling towers. If the bottom must be sealed against seepage losses or if caves and other underground passages must be plugged, these expenses can add significantly to the costs. The environmental impact and costs of creating a large lake make this alternative impractical for PNS.

9.2.1.4 Spray pond

A spray pond for PNS might require an area of 150 to 200 acres. Drift and ground-level fogging effects would be considerably greater for a spray pond than for cooling towers, but both would tend to be confined more to the general vicinity of the pond. A spray pond would probably be required in addition to the settling basin, because water supplied from the Yadkin River to make up for evaporation normally contains too much suspended material to be used directly. The nuclear service water and wastewater ponds could not be incorporated as part of the spray pond for cooling condensing water. A spray pond is considered to be one of the less attractive alternatives for the PNS cooling system.

9.2.1.5 Wet, mechanical-draft cooling towers with rectangular layout

The performance of wet, mechanical-draft cooling towers with the cells laid out in rows in a rectangular fashion would be similar to the proposed circular mechanical-draft (CMD) towers proposed by the applicant. However, during those periods when the wind direction tends to be perpendicular to the rows in the rectangular layout, the plume buoyancy forces will not be as great, because there will be less merging of plumes to gain increased buoyancy forces. The land area requirements for the rectangular layout was estimated by the applicant to be about 145 acres, as compared with about 37 acres for the CMD types (ER, Fig. 10.1.2-1). The applicant also estimates the capital cost of the rectangular layout to be more than that for the CMD type by about $12 million (ER, Table 10.1.0-1).

9.2.1.6 Natural-draft type cooling tower

The wet, natural-draft type of cooling towers is perhaps the most viable alternative cooling method for the PNS. Although the height of such towers (500 ft or more) would make them quite visible, this height contributes significantly to the plume rise performance and essentially avoids any ground-level fogging, icing, or drift problems. The natural-draft type of towers creates relatively little noise. Although the applicant estimates the capital cost to be considerably higher for the natural-draft type than for the CMD type, the savings in operating costs are offsetting, and the net costs are different by less than 1% (ER, Table 10.1.0-1). Three large natural-draft towers could serve in place of the nine CMD units proposed for PNS, but according to the applicant, the land area requirement would be about 52 acres compared with the 37 acres required for the CMD towers (ER, Fig. 10.1.3-1). However, since the impact of the CMD-type towers has been found to be acceptable and since natural-draft type towers offer no significant advantage, the staff agrees with the applicant in his choice of alternatives.

9.2.2 Intake systems

In selecting the appropriate intake structure for PNS, the applicant considered four alternative designs: (1) a bankside river intake structure, (2) an off-river intake structure, (3) a perforated pipe intake with off-river pump structure, and (4) an infiltration bed intake with off-river pump structure.

EPA guidelines for the best technology available for the design of intake structures[22] suggest that (1) an intake structure should be constructed flush with the riverbank; (2) the traveling screens should be located flush with the front face of the structure to allow the river current to sweep across the traveling screens; (3) provisions should be made to locate fish passageways between the screens and the trash racks.

The staff considers that the applicant's proposed design, the bankside river intake structure, which incorporates these guidelines, is the best among the four alternatives considered.

9.2.3 Transmission lines

The applicant has outlined a proposed and an alternative routing for each of the three fold-ins connecting with other lines of the applicant's existing transmission system (Fig. 3.7). Comparisions for each of the three fold-ins, based mainly on staff estimates concerning alternative routes, are given below.

Marshall to Beckerdite (230-kV) fold-in

The 2.7-mile selected route is 0.8 mile shorter than the estimated 3.5-mile alternative route. Land use in terms of the proportion of land in forest and field is similar for both routes.

Winecoff to Beckerdite (230-kV) fold-in

The selected 8.3-mile route is 0.6 mile shorter than the estimated 6.1-mile alternative. Land use for the two is similar.

McGuire to Pleasant Garden (525-kV) fold-in

The 7.9-mile proposed route is 0.2 mile longer than the estimated 7.7-mile alternative. Land use along the two is similar, but the alternative route crosses the Yadkin River twice and the South Yadkin River once, whereas the proposed route involves only one river crossing over the Yadkin River. Clearly, the proposed route is more desirable than the alternative with regard to river crossings.

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9.2.4 Carter Creek Impoundment sizes

The staff assessed in some detail the impact of the Carter Creek Impoundment based on an impoundment size such that operation of PNS would not be allowed to contribute, through its consumptive water use, to a lessening of the Yadkin River flow below 880 cfs (see Sects. 3.3, 4, and 5). The applicant has estimated the relative impacts of Carter Creek Impoundment designed for Yadkin River flow restrictions of 625 and 1000 cfs. The 625-cfs stream flow corresponds to the seven-day average, once-in-ten-years low flow (7Q10) for the period of record (1929-1973). Prior to construction of the upstream W. Kerr Scott Reservoir (for the period 1929-1962), this 7Q10 flow 597 cfs; since impoundment of this reservoir, the 7Q10 flow has been 760 cfs. A summary of the applicant's comparison of the impacts of three Carter Creek Impoundment sizes as required for the flow restrictions of 625, 880, and 1000 cfs is presented in Table 9.4.

The applicant concluded that the additional cost of the impoundment required for the 1000-cfs flow restriction (see Table 9.4) is not cost effective considering the additional 2% of the time when it may have to be used. The significantly larger impacts of the pond required for the 1000 cfs flow restriction generate additional costs. The staff concurs with the applicant's evaluation.

Table 9.4. Comparison of Carter Creek impoundment impacts for Yadkin River flow restrictions of 625, 880, and 1000 cfs

Impact	Flow restrictions		
	625 cfs	880 cfs	1000 cfs
Hydrologic features			
Yadkin River			
Flow exceeds restriction, % of time			
1929–1961	99	95	93
1962–1971	100	98	96
Flow restriction, % of average flow (2853 cfs)	22	31	35
Reservoir design criteria			
Live storage required for drought of record, acre-ft	8,200	15,502	32,888
Carter Creek Reservoir			
Full pond elevation, ft, MSL	713	723	740
Area at full pond, acres	605	860	1,400
Volume at full pond, acre-ft	11,500	18,800	38,000
Maximum drawdown elevation, ft, MSL	693	693.5	697
Maximum drawdown, ft	20	29.5	43
Area at maximum drawdown, acres	245	250	305
Volume at maximum drawdown elevation, acre-ft	3,300	3,298	5,112
Volume in maximum drawdown, acre-ft	8,200	15,502	32,888
1-in-10-year drawdown elevation, ft, MSL	703	702.5	717
1-in-10-year drawdown, ft	10	20.5	23
Area at 1-in-10-year drawdown, acres	400	390	705
Volume at 1-in-10-year drawdown elevation, acre-ft	6,500	6,358	14,000
Volume in 1-in-10-year drawdown, acre-ft	5,000	12,442	24,000
Dam			
Crest length, ft	1,800	1,900	3,400
Maximum height, ft	90	100	105
Volume, million yd^3	0.9	1.1	1.6
Environmental effects			
Land usage within reservoir, acres at contours of 713, 720, and 740 ft respectively			
Pastures, cropland, and other cleared land	191	256	497
Ponds	2	2	8
Total forested acreage	412	530	896
Total acreage	605	780	1,401
Buildings affected			
Homes	4	10	13
Mobile homes	0	3	3
Farm buildings	1	2	2
Relocations			
Roads (new), miles	0	1.2	1.2
Roads (abandoned), miles	0	1	1
Costs			
Capital cost, million $ (1983)	12.0	14.0	22.0
Annual fixed charges, million $ (1983)	2.1	2.4	3.8

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10. EVALUATION OF PROPOSED ACTION

10.1 UNAVOIDABLE ADVERSE ENVIRONMENTAL EFFECTS

10.1.1 Abiotic

10.1.1.1 On land

The applicant plans to own about 2400 acres at the primary site of PNS. About 931 acres will be enclosed by the station boundary fence, with about 617 of these acres actually affected by construction. Of the 617 acres affected by construction, about 60% (367 acres) is forested, with the remainder being pasture or cropland. About 7,600,000 yd^3 of material at the site will be excavated during station construction. Of this total, about 5,435,000 yd^3 will be used as fill during construction of the collection basin, NSW Pond, and other station facilities; the remaining excavated material will probably be used to fill in low areas to be used as construction yard space.

The Carter Creek Impoundment, required to supplement Yadkin River flow during periods of low water flow, will require about 1401 acres of land. About 860 acres would be flooded, including 572 acres of forested land and about 285 acres of pastures, cropland, and other cleared land.

Transmission lines associated directly with PNS will require about 631 acres. Their principal impact will be the conversion of about 416 acres of forested land to low-growing grassland and herbaceous cover. The impact on the remaining acreage will be limited to that from grading and other actions associated with construction; these lands will be allowed to revert to their former uses (active and inactive croplands and pasture) following construction.

Construction of the railroad spur line will permanently remove about 77 acres of land from other uses, including 15 acres of harvested cropland, 32 acres of pasture, and 30 acres of forest. The required new access road to the site, about 0.26 mile in length, will traverse primarily cleared land and will thus have little impact on land use.

The approximately 1385 acres of forested land that will be cleared for construction of the station, transmission line, Carter Creek Impoundment, and railroad spur will reduce the 1967 inventoried forest acreage of Davie County by about 1.9% (0.008% statewide). The conversion of about 716 acres of cropland and pasture to other uses will reduce the 1967 inventoried acreage of this type in Davie County by about 1.0% (about 0.009% statewide). Assuming that cropland and pasture on all land acquired and used in connection with Perkins (1517 acres) will be lost from inventoried status, the 1967 inventoried land of this type in Davie County would be reduced by 2.1% (0.02% statewide). Removal of 1517 acres from agricultural production may reduce the total annual agricultural income in Davie County by about $293,000 (Sect. 4.1.7). Removal of the aforementioned acreages from their current land uses is not expected to have a significant effect on area land use patterns.

10.1.1.2 On surface water

Construction associated with PNS is not expected to significantly affect surface water usage of local streams for recreational or other activities. Operation of the station will result in a maximum consumptive use of about 112 cfs of Yadkin River water through evaporation and drift; this represents about 4% of its average flow. Loss of this amount of water is not expected to significantly affect other uses of the Yadkin River, except for downstream hydroelectric generation; this loss is expected to average about 24.4 million kWhr annually (ER, Sect. 3.3-1). Station discharges are not expected to adversely affect other river water users.

10.1.1.3 On groundwater

During construction of PNS, wells will remove groundwater from its aquifer at a maximum rate of 60 gpm. No significant effects from this usage or from dewatering operations are expected on local groundwater.

Station operation is not expected to result in any deterioration of local groundwater quality. Even assuming that all salts deposited from cooling tower drift entered the groundwater with no dilution or dispersion in the soil, the dissolved solids content of the local groundwater would increase by a maximum of only 14 mg/liter. Therefore, salt deposition from cooling tower drift is not expected to adversely affect groundwater quality in the vicinity of PNS.

10.1.1.4 On air

The staff does not expect discharges to the air as a result of PNS construction and operation (including effects of dust, radioactive and nonradioactive gaseous effluents, fogging and icing effects, and effects of heat added to the atmosphere) to significantly affect air quality or usage. Cooling tower operation will produce visible plumes that may extend for as much as 15 miles for 5% of the time during the winter months. Ground-level fogging, as a consequence of cooling tower operation, was predicted by the staff to occur an additional 37 hours per year at some points within 3/4 mile of the towers. This additional fogging is considered to be small and not of major concern. Additional icing from cooling tower operation is usually confined to the immediate vicinity of the towers and is expected by the staff to have inconsequential effects. Salt deposition from cooling tower drift is expected to have a negligible impact on areas outside the site boundary (maximum deposition, 13 lb/acre-year within the northeast and southwest sectors about 0.5 to 1 mile from the towers).

10.1.2 Biotic

10.1.2.1 Terrestrial

The major adverse environmental impacts on terrestrial ecosystems during construction will result from land clearing and erosion. Impacts to terrestrial wildlife as a consequence of these activities will range from temporary disturbances to complete loss of some individuals due to direct destruction (the less mobile forms) or to habitat destruction and subsequent relocation of some species. The clearing of approximately 2% of Davie County's forested land for this construction will probably reduce the county's population of wildlife inhabiting this type of habitat by about the same percentage. However, successional stages of vegetation are important to some species (e.g., white-tailed deer, bobwhite quail, cottontail rabbit), and the subsequent revegetation of some of the cleared areas will tend to increase the population of those species. Area waterfowl populations are not expected to be significantly affected by PNS construction or operation.

In view of the potential for serious erosion during station and transmission line construction and its potential adverse consequences on terrestrial vegetation and wildlife, the staff has required that the applicant submit a detailed erosion control plan prior to start of construction. As a consequence of erosion control criteria to be imposed by the staff, the staff expects that the potential for significant erosion effects will be reduced to acceptable levels.

10.1.2.2 Aquatic

Turbidity in the Yadkin River will increase during construction as a consequence of surface runoff during and after rainstorms. Effects of increased turbidity on Yadkin River biota are expected to be limited to the portions of the river near the station (construction of Carter Creek Impoundment is not expected to significantly affect the Yadkin River), and, as a consequence of erosion control requirements to be imposed by the staff, those effects are not expected to significantly affect this biota.

Construction of the intake and discharge structures will involve only a small area of the Yadkin River and is expected by the staff to have insignificant impact.

The damming of three creeks will significantly affect 8 to 10 miles of these Yadkin River tributaries. Further use of these streams as spawning or nursery areas for some aquatic biota will be prevented; however, due to the small sizes of the creeks and their relative unimportance to the Yadkin River system, the potential impact is considered minor.

Withdrawal of water from the Yadkin River for PNS usage will range from 3 to 6% of the river's average monthly flow, depending upon withdrawal rates and seasonal river flows. Although the State of North Carolina has not as yet specified a minimum river flow below which station pumpage will not be allowed without compensatory makeup from the Carter Creek Impoundment, the staff has assumed, for its evaluation, that river flow below the site would not be reduced below 980 cfs because of consumptive usage. Assuming a maximum consumptive use rate for PNS of 112 cfs, maximum river flow reduction would be about 12%. Maximum withdrawal will be about 122 cfs.

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(12 cfs returned to the Yadkin River as cooling tower blowdown), about 14% of the minimum river flow. The staff has assumed that all aquatic biota in the withdrawn water will be destroyed as a result of entrainment effects. Thus, under certain conditions, about 14% of certain Yadkin River biota (bacteria, algae, zooplankton, drifting benthic invertebrates, and the eggs, larvae, and young juveniles of fish) will be destroyed. The staff considers that the average monthly losses (ranging from 3 to 14%) of phytoplankton and zooplankton from entrainment will not significantly reduce the productivity of the Yadkin River. However, entrainment losses of eggs, larvae, and young juveniles of fish may significantly affect their populations in the river, particularly if these losses and losses caused by pre-existing river facilities are cumulative. In the event of cumulative losses, monthly entrainment losses could reach 34% or more. Because it is not possible at this time to quantitatively assess these potential impacts, the staff is requiring more data from the applicant relating to a better evaluation of this problem. If the evaluation of the additional data indicates serious negative impact on the biota of the Yadkin River, the applicant will be required to take remedial action to mitigate this impact.

Current design of the intake structure incorporates several undesirable features that tend to increase impingement losses. The staff will require design changes to substantially reduce potential losses due to fish impingement.

Chemical concentrations in the station's discharges have a potential for adversely affecting the aquatic biota in the Yadkin River. Thermal discharges, resulting from cooling tower blowdown, are expected to have negligible impact on these biota.

10.1.2.3 Radiological

The staff finds that impacts resulting from radioactive effluents produced during normal operation of PNS are acceptable.

10.2 RELATIONSHIP BETWEEN SHORT-TERM USES AND LONG-TERM PRODUCTIVITY

10.2.1 Scope

The purpose of this section is to set forth the relationship between the proposed use of man's environment implicit in the proposed construction and operation of the Perkins Nuclear Station (as permitted under the terms of the proposed construction permit) and the actions that could be taken to maintain and enhance the long-term productivity.

10.2.2 Enhancement of productivity

The construction of PNS will have potentially beneficial effects on the economics of both North and South Carolina. The capacity of PNS represents 15.7% of the total projected system dependable capacity of Duke Power Company at the time the plant is to be in operation. At present, the applicant's service area includes about 20,000 sq miles in west-central North Carolina and northwestern South Carolina.

10.2.3 Uses adverse to productivity

10.2.3.1 Land use

Approximately 2400 acres will be required for the PNS primary site, with approximately 631 acres for transmission and an additional 1401 acres for the proposed Carter Creek Impoundment. Of this acreage, about 289 acres will be under permanent usage, that is, permanent facilities. There will be 26 families displaced as a result of the applicant acquiring land for the construction of PNS proper, while 16 families will be affected in the Carter Creek Impoundment area. Since about 40% of the area within 5 miles of the site is cleared land suitable for pasture or farming, some impact on agricultural products is expected to result from the construction of PNS. The state and local taxes on the property (estimated to be $61 million annually) greatly out-weigh any loss from agricultural production.

10.2.3.2 Water use

About 2×10^{10} gal per year will be consumptively used by PNS, representing approximately 4% of the annual flow of the Yadkin River at the site. This use is not considered a significant impact on present or future uses of the river. Releases from the circulating water system and the waste treatment system, when mixed with the Yadkin River flow, will be within State and Federal water quality standards except as noted (Sect. 5.3.3). The staff concludes that there will be no significant adverse effect on water use due to construction and operation of PNS.

10.2.4 Decommissioning

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

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

The following alternatives 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 that 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 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 radioactive material 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.[1] Estimates vary from case to case with 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.[2] At present land values, consideration of an economic balance alone likely would not justify a high level of restoration. However, planning required of the applicant at this stage will ensure that variety of choice for restoration is maintained until the end of useful plant life.

The degree of dismantlement would be determined by an economic and environmental study involving the land and scrap value versus the complete demolition and removal of the complex. In any event, the operation will be controlled by the rules and regulations to protect the health and safety of the public that are in effect at the time.

10.3 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

10.3.1 Scope

Irreversible commitments generally concern changes set in motion by the proposed action that, at some later time, could not be altered 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 Sects. 4 and 5. Also, commitments that involve local long-term effects on productivity are discussed in Sect. 10.2.

10.3.2 Commitments considered

The types of resources of concern in this case can be identified as (1) material resources, such as materials of construction, renewable resource material consumed in operation, and depletable resources consumed, and (2) nonmaterial resources, including a range of beneficial uses of the environment.

Resources that, generally, may be irreversibly committed by the operation are (1) biological species destroyed in the vicinity, (2) construction materials that cannot be recovered and recycled with present technology, (3) materials that are rendered radioactive but cannot be decontaminated and materials consumed or reduced to unrecoverable waste including the U-235 and U-238 consumed, (4) the atmosphere and water bodies used for disposal of heat and certain waste effluents to the extent that other beneficial uses are curtailed, and (5) land areas rendered unfit for other uses.

10.3.3 Biotic resources

10.3.3.1 Terrestrial

A total of about 1500 acres will be covered by structures and ponds, including the Carter Creek Impoundment. Of this total, permanent station structures and cooling towers will cover about 289 acres. This acreage represents a habitat loss, but only that part of the site that cannot be recovered after dismantlement of the plant can be considered a permanent loss.

10.3.3.2 Aquatic

Because of the thermal, mechanical, chemical and hydraulic stresses, there will be an irretrievable loss of some fish and planktonic organisms from the Yadkin River during the process of withdrawal of the makeup water necessary for operation of PNS.

10.3.4 Material resources

10.3.4.1 Materials of construction

Materials of construction are almost entirely of the depletable category of resources. Concrete and steel constitute the bulk of these materials; numerous other mineral resources are incorporated in the physical plant. No commitments have been made on whether these materials will be recycled when their present use terminates.

Some materials are of such value that economics clearly promote recycling. Plant operation will contaminate only a portion of the plant to such a degree that radioactive decontamination would be needed to reclaim and recycle the constituents. Some parts of the plant will become radioactive by neutron activation. Radiation shielding around each reactor and around other components inside the primary neutron shield constitutes 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 variable degrees of surface contamination, some of which would be removed if recycling is desired. The quantities of materials that could not be decontaminated for unlimited recycling probably represent very small fractions of the resources available in kind and in broad use in industry.

Many materials on the "List of Strategic and Critical Materials"[3] (e.g., Aluminum, Asbestos, Beryllium, Cadmium, Lead, Nickel, Platinum, Silver, Tin, Tungstun, and Zinc) are used in nuclear plants. Construction materials are generally expected to remain in use for the full life of the plant, 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 on need.

10.3.4.2 Replaceable components and consumable materials

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Uranium is the principal natural resource irretrievably consumed in plant 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 U-235 and U-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.[4]

The three reactors in PNS will be fueled with uranium enriched in the isotope U-235. After use in the plant, the fuel elements will still contain U-235 slightly above the natural fraction. This slightly enriched uranium, upon separation from plutonium and other radioactive materials (separation takes place in a chemical reprocessing plant), is available for recycling through the gaseous diffusion plant. Scrap material containing valuable quantities of uranium is also recycled through appropriate steps in the fuel production process. Fissionable plutonium recovered in the chemical reprocessing of spent fuel is potentially valuable for fuel in power reactors.

If the three units of this plant operate at 80% of capacity, about 15,000 metric tons of contained natural uranium in the form of U_3O_8 must be produced to feed the plant for 40 years. The assured U.S. reserves of natural uranium recoverable at a cost of $8 or less per pound of U_3O_8 are 210,000 metric tons of uranium.[5] In addition to the assured reserves, the amount of natural uranium recoverable at $10 or less per pound of U_3O_8 is estimated to be 500,000 metric tons, but this increment will require a major effort in exploration and development to bring it into production.[5] The long-term uranium resource situation in the U.S. will depend on the larger expected reserves of ore recoverable at greater cost as well as on utilization of breeder reactors.

The 15,000 metric tons of mined natural uranium required to feed the fuel cycle for this three-reactor plant consist of 110 metric tons of U-235, with the balance consisting of U-238. In the power plant itself, 77 metric tons of U-235 and 71 metric tons of U-238 will be consumed by fission or transmutation. In this process, 23 metric tons of recoverable fissionable plutonium will be produced. The staff has estimated the additional irretrievable losses of uranium in other portions of the fuel cycle to amount to 2.3 metric tons of U-235, and 180 metric tons of uranium depleted to about 0.2% of U-235 would remain. In the long term, this stock of depleted uranium may be used as feed material in other reactor fuel cycles. In consideration of the reserves of all depletable fuels, uranium consumption in the proposed operation is a reasonable productive use of this resource.

In view of the quantities of materials in natural reserves, resources, and stockpile and the quantities produced yearly, the expenditure of such material for the power plant is justified by the benefits from the electrical energy produced.

10.3.5 Water and air resources

A maximum of about 2×10^{10} gal per year of water will be consumptively used by PNS. However, the use of the water can be viewed as an irreversible loss only in the same sense that natural evaporation from water bodies is an irreversible loss. The staff does not believe that such usage will have a long-term effect.

The effect of construction and operation of the proposed PNS will have little effect on air resources beyond the minimal damage caused by the various equipment emissions.

10.3.6 Land resources

About 3900 acres of land would be committed to the construction and operation of PNS for the years the plant would be licensed to operate. The staff does not expect this land to be returned to present usage after decommissioning of the station. The applicant will probably continue to use the land for some form of power production.

10.4 BENEFIT-COST BALANCE

The benfits and costs are summarized in Tables 10.1 and 10.2 and are discussed below.

10.4.1 Benefits

The major direct and indirect benefits are discussed below and tabulated in Table 10.1.

Table 10.1. Benefits from the proposed Perkins Nuclear Station

Direct benefits	
Capacity, MWe	3840
Electrical energy generation	
Average annual electrical energy generation, GWhr (0.76 plant factor)	25.57
Proportional distribution of electrical energy, %	
Residential	23.9
Industrial	44.2
General service	17.1
Other	14.8
Other products	None
Indirect benefits	
Employment	
Construction, million man-hours	37.5
Construction payroll (total), million $	335
Operation, number of permanent employees	250
Operation, annual payroll, million $	7
Taxes	
Federal, annual, million $	71.8
State, annual, million $	50.1
County, annual, million $	11.2

10.4.1.1 Expected average annual electrical energy generation

The principal benefit of the proposed facility will be the availability to the applicant's service area of 3840 MWe of base-load capacity and of an annual expected generation of electrical energy of 25,565,000,000 kWhr (assuming a plant factor of 0.76). Station output at plant factors of 0.8, 0.7, and 0.6 are presented in Table 9.1.

10.4.1.2 Expected proportional distribution of generated electrical energy

The electrical energy generated by this facility will go directly into the applicant's transmission grid to supply the electrical power needs within its service area. This electrical energy is expected to be distributed to the several categories of the applicant's customers as shown in Table 10.2. These estimates are based on the applicant's observed 1973 distribution of sales in these categories (ER, Table 8.1.1-2).

10.4.1.3 Other products from the facility

The applicant does not plan to sell steam or other beneficial products from this facility.

10.4.1.4 Taxes

Federal, state, and local (county) taxes are expected by the applicant to be about $71.8, $50.1, and $11.2 million annually, respectively, for a total of about $133.1 million annually (ER, Sect. 8.1.2.2).

10.4.1.5 Local purchases during construction

Although most of the large capital investment for PNS will be spent outside the area, the applicant has estimated that during construction, an average of about $700,000 will be spent annually for regional and local materials, services, and supplies (ER, Sect. 8.1.2.4).

10.4.1.6 Research

Other than the required monitoring programs associated with PNS operation, the applicant does not plan any specific research program in conjunction with the operation of this facility. The staff considers that the ecological research conducted as necessitated by the pre- and post-operational monitor'ng programs will be of some benefit.

10.4.1.7 Environmental enhancement

The applicant has indicated that PNS operation would permit the retirement of older, less environmentally pleasing fossil-fueled generating units (Table 8.4).

10.4.1.8 Employment

An average of about 1480 employees per year over a projected 12-year construction period is expected to result in a total construction payroll of about $416,000,000 (ER, Table 8.1.2-4). The staff estimates that site labor requirements will be about 9.76 man-hr/kWe, resulting in a total station site labor requirement of 37.5 million man-hr. Permanent station operation will require an estimated 250 full-time employees, with an expected annual payroll of about $7 million (ER, Sect. 8.1.2.3).

10.4.1.9 Regional development

Operation of PNS will increase the reliability of the applicant's and the region's power supply and will help satisfy the area's electrical energy requirements, thereby making possible some of the commercial and economic activities and residential amenities that the people of this area demand. The availability of the added electrical energy will permit the regional development to occur, but it will not necessarily cause it to occur. The applicant's program of recruiting and training unskilled laborers for construction work will contribute to the skilled manpower pool of the region.

10.4.2 Costs

The major direct and indirect costs are discussed below and tabulated in Tables 9.1 and 10.2.

10.4.2.1 Energy generation costs

The staff estimated the cost of the completed (in 1987) PNS to be $2.43 billion. The annual operating, maintenance, and fuel costs in 1987, the projected first year of full operation, are estimated by the staff to total about $266 million, assuming an average plant factor of 0.76, a fuel cost of $8.2/MWhr, and operating and maintenance costs of $2.2/MWhr (see Table 9.1). Using the applicant's fixed charge rate of 17.4% of the capital cost (ER, Table 9.1.4-1), the annualized cost of capital investment would be $632 million. Total cost of electrical energy generation from PNS during its first full year of operation would therefore be $898 million.

10.4.2.2 Community service and social costs

Social impacts and impacts on community services were discussed in Sects. 4.4 and 5.8. Davie County will probably experience the greatest impacts associated with the construction and operation of PNS. Significant impacts are also expected to be observed in Davidson and Rowan Counties, with some impacts also being observed in neighboring Forsyth, Iredell, and Yadkin Counties. The counties experiencing significant impacts will probably have to provide some increased public services. In most instances, such as in education, housing, water, and sewage facilities, police and fire protection, and medical facilities, the existing services and planned improvements can accommodate the impacts of the construction and operating phases. In general, the costs associated with the additional required facilities and services will be compensated for by the additional revenues arising from the construction and operation labor forces.

10.4.2.3 Environmental costs

The major environmental impacts expected to be incurred by construction and operation of the proposed PNS are summarized in Table 10.2.

Table 10.2. Environmental costs of Perkins Nuclear Station

Effect	Reference section	Summary description
		Land use
Land required for Station	4.1	2402 acres at Station site; 1401 acres at Carter Creek Impoundment.
Land required for transmission lines	4.1.3	631 acres; 416 forested acres to be cleared.
Railroad spur	4.1.4	77 acres ($293,000/year)
Access roads	4.1.5	No clearing required; included in Station requirements.
Forest land cleared	4.1.7	1385 acres total.
Loss of agricultural production	4.1.7	1517 acres total.
Erosion	4.3.1.2, 4.3.2.3	Can be minimized by good construction practices.
Visual	5.1.1.1, 5.3.2.1	Extensive visibility of cooling tower plumes.
		Water use
Evaporative consumption	5.2.1	112 cfs evaporative and drift losses (2.5–6.1% of average monthly Yadkin River flow at site).
Chemical discharges to Yadkin River	3.6, 5.2.1.1	18 mg/liter maximum increase of TDS from cooling tower blowdown.
Thermal discharges to Yadkin River	5.3.1	Yadkin River temperature rise generally less than 0.5F°
Cooling tower plumes	5.1.1.1, 5.3.2	Minimal fogging and icing effects.
		Social and economic effects
During construction	4.4	Potential effects on local communities probably can be accommodated by them without significant inconvenience.
During operation	5.6	Minor adverse effects on local communities.
		Radiological impact
Cumulative U.S. population dose	5.4.2.5	210 man-rems/year
Occupational	5.4.2.5	1400 man-rems/year
Integrated dose to construction personnel	4.4.5	80 man-rems
		Ecological impacts on aquatic life
Construction	4.3.2	Potential problems from erosion impacts; minor lasting impact on Yadkin River.
Entrainment	5.5.2.1	Average expected losses from 3–7% of river flow; maximum 16% loss. Potential adverse effects on Yadkin River due to ichthyoplankton losses.
Impingement	5.5.2.1	Intake velocities less than 0.5 fps. Re-design of intake structure will obviate current potential problems.
Chemical discharges	5.5.2.2	Potentially severe effects at levels specified in current EPA guidelines. Zinc and phosphate concentrations in the discharge will not meet EPA standards.
Thermal discharges	5.5.2.2	Minimal effects; area enclosed by 5F° isotherm of less than 0.6 acre.
		Ecological impacts on terrestrial life
Construction of Station	4.3.1	Potential erosion problems; minor lasting impact otherwise.
Construction of transmission lines	4.3.1.2	Potential erosion problems; minor lasting impact otherwise;
Operation of Station	5.5.1	Minimal impact if vegetative cover is re-established after construction.
Operation of transmission lines	5.5.1.2	No significant impact if proper maintenance procedures are followed.

10.4.2.4 Decommissioning costs

No specific plan has been developed for decommissioning PNS, but estimated decommissioning costs range from $1 million plus an annual maintenance charge of about $100,000 to a cost of about $70 million for complete restoration of the PNS site (Sect. 10.2.4).

10.4.2.5 Other costs

The environmental costs associated with the nuclear fuel cycle have been treated generically.[6] The contribution to environmental effects associated with the uranium fuel cycle are sufficiently small as not to significantly affect the conclusion of the benefit-cost balance.

10.4.3 Cost-benefit balance of Commission's RM-50-2, "as low as practicable"

Since issuance of the Draft Environmental Statement, the Commission on April 30, 1975, issued its opinion in RM-50-2, 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 Reactor Effluents, CLI-75-5, NRCI-75-4/R, p. 227. The Commission's opinion has put an interim value of $1000 per man-rem dose reduction that can be achieved by use of additional radioactive waste treatment equipment. The total dose to the U.S. population annually (total body plus thyroid) from operation of the Perkins Nuclear Station is estimated as 210 man-rems as an upper bound (see Table 5.5). At $1000 per man-rem, an additional expenditure of $210,000 could be justified. However, for each $1000 spent, the dose must be reduced by at least 1 man-rem. This upper-bound figure of $210,000 (0.21 million dollars) per year for PNS for dose reduction costs can be compared to the total annualized cost difference of $359 million between a coal-fired station (with SO_2 removal equipment) and the above station calculated from the data in Table 9.1, using a 0.7 plant factor. Even this $0.21 million per year additional cost would not change the staff's original conclusions as shown in Sect. 9.

10.4.4 Summary

In 10 CFR 51, the NRC has required that a benefit-cost analysis be prepared for each nuclear station considered for licensing. This analysis has attempted to identify and describe all the potentially significant benefits and costs (or risks) expected to accrue if the proposed PNS is constructed and operated according to the applicant's proposal (on which is superimposed the conditions to be required by the staff). 10 CFR 51 (and the spirit and language of the National Environmental Protection Act which it implements) requires consideration of all potentially adverse effects on the broadly defined environment. No method for assigning dollar values to many of the diverse considerations now commands general acceptance, or has even been developed; therefore, it is not possible to rest the required cost-benefit balance on a simple monetary balance. However, in this environmental statement the staff has attempted to describe, to the extent practicable, the environmental costs and benefits in quantitative terms by indicating, for example, expected ranges of percentage losses of affected biota, specifically affected land uses in relation to the total land in the area currently so used, and the incremental effects of the station's thermal and chemical discharges on the Yadkin River. Those costs and benefits that the staff has identified and considers to be of the most importance in reaching a conclusion with respect to the proposed action have been summarized in the earlier portions of Sect. 10.

Overall, the major benefit is the electric power to be generated by PNS, which will allow economic growth (assuming that this base-load power is necessary in the time frame projected) in the applicant's service area during the period of PNS operation. Most of the costs are more diffuse; they will be borne unequally by people according to when, where, and how they live. Construction activities will cause some inconvenience and costs to local communities. Station operation should cause only minor inconvenience to local residents. The increased tax base as a consequence of the large capital investment in PNS will benefit Davie County.

Construction of the station and transmission lines will cause some damage to aquatic and terrestrial biota. However, this should not result in the long-term disturbance of any major ecosystem. Station operation will be in accordance with staff requirements so that no significant adverse effect is expected on aquatic or terrestrial biota.

As indicated in Sect. 9, the staff believes that there would be no reduction in overall costs of base-load power by the use of an alternative site, the use of alternative fuels, or any combination of these.

The staff concludes, on the basis of the assessments summarized in this environmental statement, that the construction and operation of PNS, with modifications as recommended by the staff, is needed by the applicant's service area in the time frame projected and will have accrued benefits that outweigh the economic and social costs. The staff concludes that the distribution of costs and benefits does not place unreasonable costs on any segment of the population.

REFERENCES FOR SECTION 10

1. *Atomic Energy Clearing House*, 17(6): 42 (1971); 17(18): 7 (1971); and 16(35): 12 (1970).
2. Pacific Gas and Electric Company, *Supplement No. 2 to the Environmental Report, Units 1 and 2, Diablo Canyon Site*, Docket Nos. 50-275 and 50-323, July 28, 1972.
3. G. A. Lincoln, "List of Strategic and Critical Materials," *Federal Register* 37(39): 4123 (1972).
4. U.S. Department of the Interior, Bureau of Mines, *Mineral Facts and Problems*, 1970, p. 230.
5. U.S. Atomic Energy Commission, *Statistical Data of the Uranium Industry — January 1, 1972*, Report GJO-100, Grand Jurction Office, Grand Junction, Colorado.
6. U.S. Atomic Energy Commission, *Environmental Survey of Nuclear Fuel Cycle*, November 1972.

11. DISCUSSION OF COMMENTS RECEIVED ON THE DRAFT ENVIRONMENTAL STATEMENT

Pursuant to 10 CFR 51.25 the Draft Environmental Statement for the Perkins Nuclear Station, Units 1, 2 and 3 was transmitted with a request for comments to:

Advisory Council on Historic Preservation
Department of Agriculture
Department of the Army, Corps of Engineers
Department of Commerce
Department of Health, Education and Welfare
Department of Housing and Urban Development
Department of the Interior
Department of Transportation
Energy Research and Development Administration
Environmental Protection Agency
Federal Energy Administration
Federal Power Commission
Office of Intergovernmental Relations, State of North Carolina
Piedmont Triad Council of Governments, Greensboro, North Carolina
County Manager, Davie County, Mocksville, North Carolina

In addition, the NRC requested comments on the Draft Environmental Statement from interested persons by a notice published in the Federal Register on May 16, 1975 (40 FR 21513). Comments in response to the requests referred to above were received within the specified 45 day comment period from:

Department of Agriculture, Forest Service (AGFS)
Department of Agriculture, Agricultural Research Service (AGRS)
Department of Agriculture, Soil Conservation Service (AGSC)
Department of Commerce (DOC)
Department of Transportation, U.S. Coast Guard (DOTCG)

Comments were received after the expiration of the comment period from:

Duke Power Company (DPC)
Department of Health, Education and Welfare (HEW)
Energy Research and Development Administration (ERDA)
Environmental Protection Agency (EPA)
North Carolina Department of Administration
    Department of Natural and Economic Resources (DNER)
    Department of Human Resources (NCDHR)
Federal Power Commission (FPC)
Department of Interior (DOI)
David Springer, The Point Farm, Mocksville, North Carolina (DSPF)

The staff consideration of comments received and the disposition of the issues involved are reflected in part by text revisions in other sections of the Final Environmental Statement (FES) and in part by the following discussion which will reference the comments by use of the abbreviations indicated above. As note earlier, all comments received are included in Appendix A of this statement.

11.1 RESPONSES TO COMMENTS BY FEDERAL AND STATE AGENCIES AND OTHER INTERESTED PARTIES

11.1.1 Introduction

11.1.1.1 Dredge or Fill Permit (EPA-A33)

The applicant has agreed, based upon recent publication of Corps of Engineers regulations, that if a "dredge or fill" permit is required under Section 404, one will be obtained from the Corps.

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11.1.2 The Site

11.1.2.1 Reference for the Joint Distribution of Wind Speed and Wind Direction (EPAA37)

One full year (September 11, 1973 through September 11, 1974) of onsite joint frequency distributions of wind speed and direction at the 33-ft level by atmospheric stability (as defined by vertical temperature gradient between 30-ft and 130-ft) are presented in ER Table 2.6.2-1. Similar distributions with wind speed and direction from the 135-ft level are presented in ER Table 2.6.3-2.

11.1.2.2 Historical and Archaeological Information relating to "The Point" section of Davie County (DSPF-A52)

Although no structures connected with the Perkins Nuclear Station will cross or impact with "The Point", the staff appreciates the historical reference furnished by Mr. Springer relative to its past and the information as to its future development and is including it in the FES as requested by him by including his comment in Appendix A.

11.1.3 Facility Description

11.1.3.1 Exhausts of Radioactive Noble Gases (DOC-A3)

The staff's source term and calculated exposures from releases of noble gases are based on the premise that a large number of nonaccidental releases from the Gaseous Waste Processing System (GWPS) occur under normal operating conditions over the projected 40-year plant life. On this basis, the staff has assumed that the releases occur randomly and that average X/Q values apply.

While the staff recognizes that unfavorable dispersion conditions could arise during any given release, the assumption is made that the average value for X/Q for a large number of releases occurring randomly over the 40-year plant life will approach the annual relative concentration (X/Q) and, therefore, this value has been used.

There are a number of factors which substantiate this assumption:

(1) Discrete releases of gaseous effluents will be governed by the limiting conditions of the Environmental Technical Specifications. It will be incumbent upon the plant operator to establish procedures for the control of gaseous releases to assure that the technical specifications limiting conditions are not exceeded. The procedure usually employed to control doses at or beyond the site boundary from releases of noble gases is that of permitting release only under favorable meteorological conditions.

(2) The typical mode of release of gases from waste gas storage tanks is by a slow bleed, e.g., 1 to 2 scfm, into the plant vent. This provides a dilution factor prior to release which increases the effective dispersion. Release of the contents of a 700 ft^3 tank containing gases at 345 psig would require approximately 12 days at 1 scfm.

(3) Staff calculations show that the GWPS has adequate capacity to permit holding one tank in reserve for back-to-back shutdowns. There should be no reason to require the operator to dispose of GWPS tank contents over a short period of time, i.e., less than one hour.

From the above, the staff concludes that releases will occur randomly during the year because the releases will be made during more favorable meteorological conditions, that individual releases will be of several hours duration, and that substantial dilution of tank gases will occur prior to discharge from the plant vent. For these reasons, the staff considers that the use of the annual average relative concentration (X/Q) in determining annual dose to the population is appropriate and is valid for the purposes of the Environmental Statement.

11.1.3.2 Discharge of Vent Gases (EPA-A28)

Waste gases displaced from aerated tanks, demineralizers, BRS and waste evaporators will exhaust to the gas collection header which will be vented through the auxiliary building exhaust vent. The auxiliary building exhaust air will be continuously monitored prior to release to the envrionment. The staff calculates the iodine-131 releases from the auxiliary building exhaust air, including the waste gases from the gas collection header, to be 0.008 Ci/yr/reactor.

11.1.3.3 Collection of Liquid Leakage to the Turbine Building (EPA-A28)

The applicant has stated that he will transfer the liquid waste contents of the turbine building sump to the MLWMS whenever primary to secondary leakage exists as determined by continuous monitoring of the steam jet air ejector and the steam generator blowdown effluent release lines. The turbine building sump contents will be sampled and monitored prior to release.

11.1.3.4 "Water of the United States" for Treating Waste Waters (EPA-A33, 34)

In Amendment 3 to the applicant's Environmental Report, the Waste Water Treatment System has been modified (FES, Section 3.6). Under the new design, treatment will be provided prior to release.

11.1.3.5 Applicant Estimate of Gaseous I^{131} Discharge (EPA-A37)

The applicant calculated the turbine building iodine-131 releases to be 0.002 Ci/yr/reactor. The value of 0.007 Ci/yr/reactor was in error and has been corrected in the FES.

11.1.3.6 Radioactive Liquid Waste Dispersion Models (EPA-37)

These models were discussed in Section 3.5 not 2.5 as was indicated in the DES and are presented in Section 3.5 of the FES.

11.1.3.7 Use of Mechanical Draft instead of Natural Draft Cooling Towers (DNER-A38)

The circular mechanical-draft type of cooling tower proposed by the applicant for the Perkins Station will loft the plumes to a higher altitude than would conventional mechanical-draft towers. The staff's analysis indicates that the fog and drift effects from the circular mechanical-draft towers are minimal and will not have a significant environmental impact. While the noise level of this type of tower will be higher than for a natural-draft type, the location of the Perkins towers will be such as to not make this an environmental issue. The towers proposed by the applicant are environmentally very comparable to natural-draft cooling towers. Thus, there does not appear to be a compelling reason for use of natural-draft towers. It was on this basis that the staff elected to not make a detailed analysis of their performance.

11.1.3.8 Impact on Boone's Memorial Park and Cooleemee Plantation (DOI-A49)

Figure 2.4 is too small scale to include the above recreational facilities. However, Figure 3.7 has been modified to show the outline of the portion of Cooleemee Plantation that the proposed transmission line crosses and also Boone's Memorial Park. The text has been revised to show that the Winecoff-Beckerdite tie-in does cross game land that was leased by the state from Duke. The lease has expired but will be renewed if the state desires to do so. In any case Duke will permit hunting on the land. To avoid any visual impact to the Cooleemee Plantation House itself north of the river, there is a "vista easement" (ER, Figure 3.9.3-1) to protect scenic and aesthetic values.

11.1.3.9 Radioactive Wastes (DOI-A50)

Release of radioactive material to the environment will be in accordance with the Technical Specifications issued to the PNS as part of the operating license.

11.1.4 <u>Environmental Impacts of Construction</u>

11.1.4.1 Capability of Agricultural Land Taken out of Production (AGSC-A2, AGRS-A4)

AGSC's comment is partially answered by text revisions in Section 4 including a new Table 4.2 which describes the agricultural capability of land in Davie County. The land on the PNS site can be assumed to have similar capability for assessment purposes but it is the staff's opinion, based on site visits, that the site land is of poorer agricultural quality than the average for Davie County.

11.1.4.2 Erosion Control Plan and Construction Runoff (EPA-A33)

The applicant has committed to complying with EPA limitations regarding runoff and will be required by NRC to submit to the staff a detailed erosion control plan prior to the initiation of construction activities.

11.1.4.3 Noise Impacts (EPA-A34, 35)

The staff continues to be of the opinion (Section 4.4) that noise will not be a major impact to the human environment. The applicant has committed (Section 4.5) to reduce construction noise to acceptable levels and to equip motor-powered equipment with noise reducing devices.

11.1.4.4 Particulate Emission Control for Concrete Batch Plant (EPA-A37)

The applicant states that the concrete batch plant is located near the center of the construction site and is approximately 2000 feet from the site boundary. Offsite effects of the particulate emission from the batch plant are, therefore, minimized. The batch plant will be equipped with conventional filter vents to aid in reducing particulate emissions.

11.1.4.5 Traffic Problems during Construction (DNER-A40)

The staff has addressed this concern in Section 4.4.1 of the DES and FES.

11.1.4.6 Disposal of Excess Excavated Material (DOI-A49)

The applicant will be required to submit an erosion control plan for staff review before construction starts and will follow EPA limitations on surface runoff. The staff expects that handling of excess excavated material will be included in this erosion control plan.

11.1.4.7 Geologic Information and Erosion Control (DOI-A49)

The NRC staff in this environmental statement describes in general and with minimal detail the geologic features of the site since such information will be covered in much greater detail in the staff's Safety Evaluation Report from information presented in the applicant's ER and particularly in the PSAR. This information together with the visit to the site has resulted in an evaluation for potential erosion considered valid by the staff.

11.1.4.8 Site Vegetation Management (DOI-A49)

Although the applicant has not developed a wildlife management program for the site, a commitment to clean up and appropriately landscape the site as expediously as possible after construction has been made (Section 4.5.1). In Section 4.3.1.1 the staff has made recommendations concerning implementation of the above commitment.

11.1.4.9 Impacts on Groundwater Use

Since dewatering of the site is a significant strain on groundwater flows, the staff has recommended (Section 4.5.2) that the applicant monitor the nearest well while dewatering is in process. This should evaluate the impacts of water migration.

11.1.4.10 Impact on Recreation Capacity of the Area (DOI-A50)

Discussions with North Carolina state recreation personnel during the staff's site visit in July 1974 led to the staff conclusion that there would be no major impact on the recreational capacity of the area. The terrestrial and aquatic ecological portions of Sections 4 and 5 describe the effect on recreation uses in more detail.

11.1.5 Environmental Impacts of Facility Operation

11.1.5.1 Environmental Dose Commitment (EPA-A30)

The staff does not believe that the environmental dose commitment concept need be introduced into the assessment of environmental impact of a nucelar power reactor. The annual population dose estimates, which embody individual dose commitments to the U.S. population are given in Section 5.4.2. It has been the staff's experience that information indicating the 'maximum effect' in terms of annual population dose (man-rem) adequately characterizes the impact of a nuclear power reactor.

11.1.5.2 Chemical Effects (EPA-A32, 33)

The staff is of the opinion that the Waste Water Treatment System (WWTS) proposed by the applicant will reduce the amounts of chemicals before release to values which will not exceed EPA effluent guidelines. The WWTS is capable of treating these wastes by coagulation, precipitation, pH adjustment and sedimentation as suggested in the EPA Development Document.

The applicant has stated that the WWTS will meet the following effluent characteristics:

1) pH - 6.0 to 9.0
2) Total Suspended Solids - 30 mg/l average and 100 mg/l maximum
3) Oil and grease - 15 mg/l average and 20 mg/l maximum
4) Settleable Solids - <0.1 mg/l

5) Iron, total - 1 mg/l
6) Copper, total - 1 mg/l

A summary of the staff's conclusions is given in Section 5.3.3.

EPA effluent limitations for cooling tower blowdown include a 24 hour average concentration of 5.0 mg/l for phosphorus (as P) and 1.0 mg/l for Zinc. Referring to Table 3.7, the PNS cooling tower blowdown will release an average of 22.6 mg/l of phosphate (PO_4) which is equivalent to 7.4 mg/l of phosphorus (as P) and 2.6 mg/l of Zinc. The EPA limitations for both phosphorus and zinc will be exceeded.

11.1.5.3 Emissions from the Diesel Generators (EPA-A37)

Air pollutants from diesel generator operation are presented in the applicant's ER (ER, Section 3.7.7). The applicant has stated that final design criteria for the equipment has not been established and therefore a fuel use rate cannot be calculated at this time.

11.1.5.4 Cumulative and Annual Cumulative Population Doses (EPA-A37)

The population doses estimated for the Perkins Nuclear Station FES were annual doses calculated for the entire U.S. population. The cumulative population doses for the period of plant operation would just be the listed annual doses times 40.

11.1.5.5 Population Doses to Persons Within 50 Miles of Perkins (EPA-A37)

The Environmental Statement for the Perkins Nuclear Station only discusses the radiological impact of the Perkins facility on the environment. The question of regional impact was discussed in WASH-1258. It was estimated that both the annual average (per capita) total-body dose and the average (per capita) thyroid dose to the population in the year 2000 from the effluents of all LWR stations projected for that time to be about 0.1 millirem if the proposed Appendix I guideline values are met. For perspective, the annual per capita radiation dose from natural sources is about 130 millirem. Variations (as much as a factor of two) in the dose from natural radiation sources are not uncommon. (WASH-1258) Although Appendix I design objectives have changed since this report, it is not expected that the impact will significantly change.

11.1.5.6 Increased Shoaling in the Yadkin River due to PNS Operation (DNER-A39)

The staff does not consider that the operation of PNS will contribute to increased shoaling in the Yadkin River since the volume of water is slightly (not markedly) reduced.

11.1.5.7 Effects of Chemicals on Flora and Fauna (DNER-A39)

The predicted chemical effects from the operation of PNS are presented in Section 5.5.2.2 of the FES.

11.1.5.8 Comments on "Radiological Impact" (NCDHR-A40, 41)

The population dose expressed in units of man-rem is clearly defined in Table 5.4 of the Perkins FES. The environmental statement for the Perkins Station discusses the radiological impact of the Perkins Facility. The question of regional impact was discussed in WASH-1258. In that document, it was concluded that the cumulative per capita population doses from all LWR stations in operation in the year 2000 was 0.1 millirem and doesn't constitute a significant impact on the population.

11.1.5.9 Fishing Potential of Carter Creeek Impoundment (DOI-A49, 50)

The applicant does not plan to allow recreational use of the Carter Creek impoundment.

11.1.5.10 Chlorine Releases (DOI-A51)

Text changes in Section 5.5.2.2 partially respond to this comment. Procedures to guarantee compliance with chlorine release limitations will be included in the Technical Specifications to be issued to the PNS as part of the Operating license.

11.1.6 Environmental Measurements and Monitoring Programs

11.1.6.1 Groundwater Sampling Program (HEW-A5)

Since the groundwater in the site vicinity is suitable for domestic use without treatment (Section 2.5.2), the staff believes that a groundwater sampling program which includes bacteriological and sanitary chemical analyses is unnecessary.

11.1.6.2 Expanded Description of Sampling Methodologies (DNER-A39)

The sampling methologies for ecology are presented in detail in the applicant's ER. The staff has studied and commented on the methodologies (Section 6) and believes that description of the methodologies in the FES is not warranted.

11.1.6.3 Radiological Monitoring Program (NCDHR-A41)

The evaluation of the proposed "preoperational radiological monitoring program" included a recommendation to monitor soil. The applicant has stated in their response to Agency comments that they will monitor soil.

11.1.7 Environmental Impact of Postulated Accidents Involving Radioactive Materials

11.1.7.1 Waste Disposal (AGFS-A2)

The solid waste will be shipped to Chem-Nuclear Services in Barnwell, South Carolina (Section 7.2). This facility is licensed by the state. The concerns with respect to the license provisions, existing environmental analysis report for the site, surveillance and monitoring required, etc. were examined by the state before the license was issued. The state license predates the requirement for a NEPA review. At one time the company had a federal license but relinquished it before NEPA became law. Recently Chem-Nuclear Services has requested permission to dispose of greater than critical quantities of waste which requires a federal license. Prior to issuance of such a license an environmental review will be conducted and an environmental impact statement written.

11.1.7.2 Comments on Section 7.1 (NCDHR-A41)

The estimated individual radiation exposures at the site boundary in the downwind direction may be determined by multiplying the estimated fraction of 10 CFR Part 20 limit times the 10 CFR Part 20 limit for the appropriate organ or for the whole body.

The estimated exposures presented in Table 7.2 are for gaseous releases and are calculated assuming that the event has occurred and assuming no remedial action has been taken. The staff believes that exposures through other pathways are more easily controlled and that the radiological impact to the average individual will be limited.

The estimated exposure at the site boundary is provided as a measure of the potential impact to an individual near the facility. The integrated man-rem to 50 miles is provided as a measure of the impact to a large population around the plant. The contribution to the 50-mile man-rem dose from the integration to 10 miles is about 17% in the case of Perkins.

The accident consequences presented in Section 7.1 are calculated assuming the event occurs and assuming no remedial action or offsite protective action occurs.

11.1.7.3 Impacts of Postulated Accidents Involving Radioactive Materials (DOI-A51)

The current staff position on Class 9 accidents is stated in Section 7.1 of this environmental statement. The applicability of the draft Reactor Safety Study to any specific site is also discussed in Section 7.1. The Commission's interim general statement of policy on the draft Reactor Safety Study states, in part, that ". . . the contents of the draft study are not an appropriate basis for licensing decisions."; therefore, the staff does not use the draft Reactor Safety Study in making a determination as the potential environmental impact of postulated accidents at any site. Our conclusions on food and water pathways to man are stated in footnote "a" to Table 7.2 of this statement.

11.1.8 The Need for Power-Generating Capacity

11.1.8.1 Southeastern Electric Reliability Council (SERC) Responsibilities (FPC-A42)

The applicant is of the opinion that the statement that SERC "coordinates the planning of the members' generation and transmission facilities" is not accurate because, as a reliability council, one of SERC's stated objectives is to "encourage the development of reliability agreements among the systems within the region." The applicant further states that SERC has no authority, per se, to effect such coordination. The staff concurs with this position.

11.1.9 Cost-Benefit Analysis of Alternatives

11.1.9.1 Conservation or Reduction in Demand as an Alternative (ERDA-A26)

Section 8.2.3 of this FES discusses in detail the effect of conservation on the demand for electrical energy. From this discussion the staff drew the conclusion that conservation would not provide a viable alternative not requiring new generating capacity.

11.1.9.2 Staff Conclusion that the present Perkins Site is Superior to Tuckertown (DNER-A38)

The staff based its above conclusion on what is considered to be two serious deficiencies in the Tuckertown site.

1. The plant would have to be located two miles from the water source for safety reasons which would increase the capital costs considerably.

2. The license application would have to be resubmitted causing an additional delay in the on-line dates for the station units. Since the staff is of the opinion that the need for the plant is indicated on the present schedule, the additional delay could have caused a serious deficiency in the applicant's reserves.

11.1.10 Evaluation of Proposed Action

11.1.10.1 Staff Environmental Impact Analysis (DNER-A38)

The staff considers that it has carried out its mandate under NEPA to evaluate the effect of PNS on the environment.

11.2 RESPONSES TO COMMENTS BY THE APPLICANT

Following publication of the Draft Environmental Statement (DES), the applicant issued an Amendment 3 to the Environmental Report which made extensive changes in the parameters used in the staff's analysis for the DES. The applicant then filed comments on the DES which reflected these changes. Since most of the changes (and therefore responses to the applicant's comments) were reflected by textual revisions of the DES, the list of such revisions would be inordinately lengthy and only those comments which required a non-textual response are presented in Section 11.

11.2.1 Land Use Impacts (DPC-A7, A12, A19, A20)

The staff has re-examined its acreage figures, which were based on maps and figures supplied by the applicant and is of the opinion that its original values are essentially correct. Minor adjustments in acreage data and also minor text revisions have been made to update the material presented in this FES to conform to information furnishe by the applicant after the publication of the DES. The "about 3900 acres" reported in Section 10.3.6 is the sum of 2402 acres for the primary site, 1401 acres for the Carter Creek impoundment and 77 acres for the rail spur. This adds to 3880 or "about 3900 acres". The 631 additional acres for transmission lines were removed from consideration because this land can have productive uses except for the land occupied by the towers.

11.2.2 Bottom Substrates in River (DPC-A8)

From the data presented in the ER, the staff could not discern any biological difference in the taxa present on the fine sand-silt substrate as opposed to that on the fine to coarse sand substrate and considers these substrates indistinguishable.

11.2.3 Differences in Species Composition in Dutchman Creek (DPC-A9)

The staff beleives that differences in sampling effectiveness in small streams as contrasted to river sampling accounts for some of the difference in species gathered from the two sources.

11.2.4 Radwaste Discharge Procedure (DPC-A9)

Figure 5.5 in the DES shows the piping and discharge nozzles for the radwaste discharge. This figure appears in the FES as Figure 5.6.

11.2.5 Spent Condensate Polishing Resins (DPC-A9)

In the PSAR, section 11.5.2.1, the applicant has stated that spent resins from the plant ion exchangers which process potentially radioactive liquids are inputs to the SWP. Since the condensate polishing ion exchangers process secondary coolant, the staff considers that resins from these ion exchangers (demineralizers) will be inputs to the solid waste processing system. The staff requirement at the CP stage will be based on this conclusion. The applicant may provide additional information and supporting analysis for a proposed method change for review at the OL stage.

11.2.6 Chemicals Added to Liquid Effluent (DPC-A10, 11)

A careful examination of the right hand column of Figure 3.6 of the DES and FES will reveal that the staff has indicated that the amines mentioned, as well as lithium hydroxide and boric acid, are not being discharged into the Yadkin River.

11.2.7 Maximum Increase in Chemical Effluent Concentrations (DPC-A11, A14)

The applicant's statement that sedimentation will remove some suspended solids is true. However, no evidence has been furnished that dissolved solids will be removed by the sedimentation process. The staff, therefore, has no alternative but to consider the dissolved solids to be concentrated by a factor of ten. The staff is uncertain where the Figure of 12.5 mg/l of phosphorus (as PO_4), as reported by the applicant in his comments (p A14), was obtained since Table 3.7 of the DES (and FES) show the total phosphate (PO_4) concentration in the blowdown to be 22.6 mg/liter. This is equivalent to 7.4 mg/l phosphorus (as P) and is above the EPA limits.

The experience reported by the applicant at the Cliffside Station is also not the evidence needed and the staff must treat the situation conservatively.

11.2.8 Federal Discharge Requirements (DPC-A13)

As discussed in Section 5.3.3.2, the discharge of Zinc, Phosphorus and Chlorine will not meet EPA limits.

11.2.9 Water Use by the Buck Steam Station (DPC-A13)

The staff has not alleged that all the water drawn into the Buck Station would be consumptively used. Such use is approximately 7 cfs.

11.2.10 Reducation in Flows into High Rock Lake Increasing the Probability of Fish Kills (DPC-A13)

The staff stands by its original statement in Section 5.2.1.2 that, combined with the other effects mentioned, any reduction in flow by PNS would increase the probability of fish kills. The staff further believes that the final paragraph in the section qualifies its position sufficiently.

11.2.11 Release of Water from Carter Creek during River Flows Below 880 cfs Improving the Quality of Water Flowing into High Rock Lake (DPC-A13)

Since stream flows below 880 cfs may occur only 2% of the time (Section 5.2.1), this effect is extremely minimal and should not even compensate for the impurities introduced into the river at higher flows (Section 3.6) when releases from Carter Creek are not being made.

11.2.12 Visible Plumes from Cooling Tower Operation (DPC-A14,A19)

The basis for the staff's statement that cooling tower operation will produce visible plumes that may extend for as much as 15 miles was Figure 5.1.4-2 of the applicants original ER. Figure 5.1.5-1 of Amendment 2 to the ER is not directly comparable since it is apparently based on an annual average and is not for the winter months. Thus, the staff has no basis for changing its original evaluation.

11.2.13 Drift Rate for the Perkins Nuclear Station (DPC-A14)

When the staff made its analysis of the cooling towers, the average drift rate was given by the applicant as 100 gpm. Although the average drift rate is now given as 87 gpm, and the dissolved solids deposition rates would be decreased proportionately, the changes in estimated values are small and are of little environmental concern.

11.2.14 Duck Radiological Ingestion Dose (DPC-A14)

The staff estimate is based upon the duck's tissue at equilibrium with aquatic plants in the radwaste discharge region and, as such, is a conservative estimate.

11.2.15 Entrainment of Ichthyoplankton (DPC-A15, A16)

The data presented by the applicant leaves the staff with no alternative except to assume random distribution of ichthyoplankton. The staff, therefore, believes the 9-23% figure is still valid.

11.2.16 Exposure of Aquatic Organisms to Blowdown (DPC-A16)

Since there is no restriction on releases of blowdown, the latter will be essentially continuous (unless the entire station is shut down). The staff is, therefore, of the opinion that fish and plankton will be exposed continually to residual chlorine from the blowdown.

11.2.7 Sensitivity of Analysis for I^{131} in Milk (DPC-A17)

The analyt cal sensitivity for radioiodine in milk should be the same in the pre-operational and operational programs. The staff considers an I^{131} sensitivity of 0.5 pCi/liter of milk to be necessary for validation of the grass-cow-milk pathway model. The sensitivity, moreover, is not related to the number of units at a site.

11.2.8 Improved Understanding of Doses Received from Accidents by Reference to the χ/Q Values Used (DPC-A17)

The guidance in the proposed Annex to Appendix D, 10 CFR Part 50, which is intended to approximate the 50 percentile χ/Q values, was followed for Section 7.1 of the Perkins DES. The weighting of the consequences by wind direction is performed only for the man-rem estimates to obtain average man-rem. The site boundary consequences are calculated in the downwind direction assuming 50 percentile meteorological conditions. The relative concentration value used at this boundary for short term releases was 1.51×10^{-4} sec/m^3. This is one-tenth the relative concentration given in the regulatory guide for a ground level release with no building wake effect considered. It should be noted that the staff does not consider the precise meteorological dispersion values critical because increasing the computed dose by even a factor of ten would not alter the conclusions as to the low environmental risk due to those accidents.

11.2.19 Comment on Table 8.12 (DPC-A18)

The staff analysis in Section 8.5.2, which references Table 8.12, makes the point that, at an extreme lower limit growth rate of 6% in the peak load, the Perkins schedlue could slip by two years and still have adequate reserves maintained. The Table therefore reflects this slip and shows no capacity additions for 1989 and 1990.

11.2.20 Material Resources (DPC-A20)

Details containing information on Uranium depleted to 0.2% may be found in WASH-1242 and WASH-1243.

11.3 LOCATION OF PRINCIPAL CHANGES IN THE STATEMENT IN RESPONSE TO COMMENTS

Topic Commented Upon	Section Where Topic is Addressed
Krypton-85 Release (EPA-A37)	Table 3.5
Drawdown in High Rock Lake (FPC-A44)	5.2.1.3
Energy Loss Downstream of PNS (FPC-A45)	5.2.1.4
Changes in Intake Structure (DOI-A51)	3.4.2
Entrainment Losses (DOI-A51)	5.5.2.1
Schools Within 10 Miles of the Site (DNER-A40)	2.2.1
Transportation System (DNER-A39)	3.9
Transmission Line Operation (DNER-A39)	5.5.1.2
Health Effects from Transmission Lines (DNER-A39)	5.5.1.2
Effects of PNS on White Perch (DNER-A39)	5.5.2.1
Effect of PNS on Boone's Cave State Park (DNER-A39)	5.5.1.1, 5.1.1.1
Impact of Carter Creek Impoundment on High Rock Lake (DOI-A49)	5.2.1.3
Effects of Radwaste Dilution Water on Fish Eggs and Larvae (EPA-A37)	5.5.2.1
Dose Assessment (EPA-A29)	5.4
Reduction of Flow into High Rock Lake (DOI-A50)	5.2.1.3
Clearing Forest to Replace Cropland (AGRS-A4)	4.1.7
Effect of Operation of PNS on High Rock Lake (DOTCG-A4)	5.2.1.3

APPENDIX A

COMMENTS ON

DRAFT ENVIRONMENTAL STATEMENT

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UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
Southeastern Area, State and Private Forestry
1720 Peachtree Road, N.W.
Atlanta, Georgia 30309

June 18, 1975

RECEIVED JUN 24 1975

Mr. Wm. H. Regan, Jr.
Chief, Environmental Projects Branch 4
Division of Reactor Licensing
Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Mr. Regan:

Here are U. S. Forest Service, State and Private Forestry comments on the draft environmental statement covering Perkins Nuclear Station, Units 1, 2, and 3.

Additional information is needed on decommissioning of the facility and on off-site disposal of radioactive waste generated by the facility.

Although consistent with current Commission regulations, the deferment of specific planning for decommissioning until near the end of the reactor's useful life appears in conflict with NEPA Sections 101b(1), (3), and (6). Through such action, the cost of dismantling and possibly guarding, indefinitely, a non-productive facility and an environmentally degraded site will fall upon subsequent, non-benefitting generations. Also, unless the site is completely restored (which is doubtful), the land area occupied by the abandoned facility, and the exclusion area will be irretrievably committed. This acreage should be listed as an irretrievable land loss in the statement.

Plant generation of 3150 drums of radwaste per year for off-site disposal places a considerable impact on the receiving site. Therefore, additional information on the disposal site is needed such as: It's location, it's regulation, the acreage which will be made unfit for other usage by the cumulative waste from the Perkins Nuclear Station, the effects of radwaste disposal on ground waters and on plant and animal life, etc. That area of the disposal site which is made unfit for other use by Perkins' radwaste should be shown in the statement as land area irretrievably committed by the Perkins project.

The statement should contain reference to the EIS covering the licensed radwaste disposal site.

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

Sincerely,

Paul E. Buffam

PAUL E. BUFFAM
Area Environmental Coordinator

1724 194

6748

6200-11b (4/74)

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
P. O. Box 27307, Raleigh, North Carolina 27611
Telephone 755-4210

June 19, 1975

RECEIVED JUN 26 1975

Mr. William H. Regan, Chief
Environmental Projects Branch 4
Division of Reactor Licensing
U.S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Mr. Regan:

The draft environmental statement for the Perkins Nuclear Station Units 1, 2, and 3 in Davie County that was addressed to me on May 9, 1975 has been reviewed by appropriate members of my staff.

This nuclear station will not have any adverse effect upon projects of the Soil Conservation Service. The project will involve the Dutchman's Creek Watershed project. This is covered in the EIS.

We believe that the capability of the agricultural land being taken out of production by the Carter Creek Impoundment, the prime site, and rights-of-way should be discussed. This should be based on soil types. We do not agree that this agricultural land taken out of production can be replaced by other land now largely forested. Generally, land that is in forest is less adapted to farming and has less capability for crop production and the erosion problem would be greater. We feel these alternatives need to be discussed more fully in the EIS.

The erosion problems can be reduced by the use of fertilizer with the recommended seeding in the EIS on Page 4-5.

The Soil Conservation Service assists soil and water conservation districts in technical phases of their program. If desired, consultive services that are consistent with priorities for work established by the districts are available from the Service in reviewing or developing plans for controlling erosion during and after construction.

6823

We appreciate the opportunity to review and comment on the proposed project and would like to receive a copy of your final statement.

Sincerely,

Billy M. Johnson

for Jesse L. Hicks
State Conservationist

cc:
Council on Environmental Quality, 722 Jackson Place, N.W., Washington, D.C. (5 copies)
Office of Coordinator of Environmental Quality Activities, Office of the Secretary, U.S. Department of Agriculture, Washington, D.C. 20250
R. M. Davis, Administrator, SCS, Washington, D.C.
Grady Lane, Director, State Soil & Water Conservation Commission, Raleigh, N.C.
W. A. McLeod, AC, SCS, Salisbury, N.C.

1724 195

UNITED STATES DEPARTMENT OF COMMERCE
The Assistant Secretary for Science and Technology
Washington, D.C. 20230

June 20, 1975

Mr. William H. Regan, Jr.
Environmental Projects Branch 4
Division of Reactor Licensing
U.S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Mr. Regan:

The draft environmental impact statement "Perkins Nuclear Station, Units 1, 2 and 3" which accompanied your letter of May 9, 1975, has been received by the Department of Commerce for review and comment.

The statement has been reviewed and the following comments are offered for your consideration.

The radioactive gaseous waste released to the atmosphere by way of the decay tanks is described as "infrequent exhausts" (page 3-12) and as such should not be included with the more routine and regular emissions to which an average annual concentration factor (chi/Q) is applied.

Thank you for giving us an opportunity to provide these comments, which we hope will be of assistance to you. We would appreciate receiving two copies of the final statement.

Sincerely,

Sidney R. Galler

Sidney R. Galler
Deputy Assistant Secretary
for Environmental Affairs

6875

UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH SERVICE
WASHINGTON, D.C. 20250

June 23, 1975

RECEIVED JUN 30 1975

Subject: Draft Environmental Statement: Perkins Nuclear Station, Units 1, 2, and 3, Duke Power Company Docket No. STN 50-488/489/490

To: William H. Regan, Jr.
Environmental Projects Branch 4
Division of Reactor Licensing
Nuclear Regulatory Commission

While we recognize the need for increased electrical generating capacity, we are concerned that large acreages of land are required for this. The proposed facility will be removing over 1,500 acres of crop and pasture land from the resource base. It is estimated that this will amount to a loss of about $193 per acre. What will be the local impact of this loss?

On page 4-3, section 4.1.7, it is stated that "the land taken out of agricultural production can, if necessary, be replaced by use of other land now largely forested." Has it been determined that the forested land is equally suited for crop and pasture production as the land now being used for this purpose?

We have nothing to add to the recommendations of the staff regarding steps to be taken to minimize adverse environmental effects.

H. L. Barrows
H. L. Barrows
Deputy Assistant Administrator

1724 196

6857

DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD

MAILING ADDRESS:
U.S. COAST GUARD (G-WS/73)
400 SEVENTH STREET SW.
WASHINGTON, D.C. 20590
PHONE: 426-2262

STN-50-488
50-489
50-490

27 June 1975

RECEIVED JUN 30 1975

Mr. Wm. H. Regan Jr., Chief
Environmental Projects Branch 4
Division of Reactor Licensing
Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Mr. Regan:

This is in response to your letter of 9 May 1975 addressed to Mr. Benjamin O. Davis concerning a draft environmental impact statement for Perkins Nuclear Power Plant, Units 1, 2, and 3, Davie County, North Carolina.

The concerned operating administrations and staff of the Department of Transportation have reviewed the material submitted. The Coast Guard commented as follows:

"The Coast Guard claims jurisdiction over the Yadkin River to and including High Rock Reservoir.

"The draft ES states that the operation of the PNS would increase the frequency of low flow conditions in the Yadkin River, which, in turn, would increase the frequency of lower than normal water levels at High Rock Lake. It is agreed that the degree of adverse impact of this additional loss of normal water level cannot be accurately predicted. However, the ES should indicate the following points:

"a. High Rock Lake is an uncleared lake, making it one of the most hazardous lakes for boating activities in the High Rock chain.

"b. Any increased frequencies of lower than normal water levels would be expected to increase the boating hazards in this already hazardous lake.

"Section 5.2.1 of the draft ES indicates that the allowable minimum flow rate for the Yadkin River has not been established. Any decision on this minimum flow rate should show that consideration was given to the effect of this flow rate on the water level and boating safety on High Rock Lake.

"Section 10.1.1.2 of the draft ES should include a discussion of the anticipated increased hazard in boating activities on High Rock Lake if the Perkins Nuclear Station is expected to increase the frequencies of lower than normal water levels at this lake."

6987

The Department of Transportation has no other comments to offer nor do we have any objection to this project. The final statement, however, should address the concerns of the Coast Guard.

The opportunity to review this draft statement is appreciated.

Sincerely,

W. R. RIEDEL
Acting Deputy Chief, Office of
Marine Environment and Systems
By direction of the Commandant

1724 197

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20201

JUL 1 1975

Mr. William H. Regan, Jr.
Chief, Environmental Projects Branch 4
Division of Reactor Licensing
Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Regan:

We have reviewed the draft Environmental Impact Statement concerning the Thomas L. Perkins Nuclear Station, Units 1, 2, and 3. On the basis of our review, we recommend that the groundwater sampling program include bacteriological and sanitary chemical analyses.

Thank you for the opportunity to review the document.

Sincerely,

Charles Custard
Director
Office of Environmental Affairs

7113

DUKE POWER COMPANY
GENERAL OFFICES
422 SOUTH CHURCH STREET
CHARLOTTE, N. C. 28201

P. O. BOX 2178

TELEPHONE: AREA 704
374-4011

June 30, 1975

Mr. William H. Regan, Jr., Chief
Environmental Projects Branch 4
Division of Reactor Licensing
United States Nuclear Regulatory Commission
Washington, D.C. 20555

RE: Project 81
Perkins Nuclear Station
Docket Nos. STN 50-488, 50-489, and 50-490
File No. PK-1444.00

Dear Mr. Regan:

Please refer to your letter of May 9, 1975, enclosing the Notice of Availability of the NRC Draft Environmental Statement for Perkins Nuclear Station.

Pursuant to 10 CFR Part 51, we are enclosing our comments on the subject document.

We appreciate the opportunity to comment on the Draft Environmental Statement and trust that the Commission will deem it fit to include these comments in the Final Environmental Statement.

Yours very truly,

L. C. Dail, Chief Engineer
Civil-Environmental Division

LCD:WBS:pt

Enclosure - 10 copies

cc: W. L. Porter (w/enc.)

DUKE POWER COMPANY

COMMENTS ON DRAFT ENVIRONMENTAL STATEMENT

PERKINS NUCLEAR STATION

Docket Nos. STN 50-488, 50-489, and 50-490

June 30, 1975

1724 198

SUMMARY AND CONCLUSIONS

DES, Item 3, Page i

a. The DES states that 2402 acres will be used for the Perkins site. Duke's estimate of the area affected is 1424 acres.

b. The DES states that 16 families will be displaced from the Carter Creek area. Section 2.1.1, Amendment 3, states that 16 families in the Carter Creek area will be affected by the creation of the reservoir, not necessarily displaced.

1. INTRODUCTION

1.1 THE PROPOSED PROJECT

Page 1-1

The DES states "the applicant's 2402 acre primary site ..." see comment DES Item 3, Page i (a).

2. THE SITE

2.1 PLANT LOCATION

Page 2-1

The source (ER Figure 3.1.10-2) of DES Figure 2-1 has been revised by Amendment 3 of the Perkins ER.

2.2 REGIONAL DEMOGRAPHY AND LAND AND WATER USE

2.2.1 Regional Demography

Page 2-2

The DES states that Cooleemee has a population of 1,800. The 1970 census gives a population of 1,115 for Cooleemee.

2.2.3 Water Use

2.2.3.1 Surface Water

Page 2-5

The DES states that there are 14 other (excluding nearest downstream municipal intake) water intakes on the Yadkin River or its tributaries within a 50 mile radius of the site having a combined capacity of 61 MGD. As shown in ER Figure 2.2.2-7, these 14 water intakes on the Yadkin or its tributaries are within 20 miles upstream and 50 miles downstream of the site.

2.2.3.2 Groundwater

Page 2-5

The DES states that Tyro School is located about three miles southeast of the site. As stated in ER Subdivision 2.2.1.2, Transient Population, Tyro School is located five miles east southeast of the site.

2.7 ECOLOGY

Page 2-11 - Zooplankton

The DES discusses important components of zooplankton being nauplii, copepods, etc. and mentions the percentage composition. The measurements on which this data is taken should be specified.

1724 200

Page 2-12 - Benthos

It would be more correct to state that three bottom substrates are present in the Yadkin River. Fine to coarse sand is characteristic of channel areas and the second most common substrate is the fine sand-silt along the banks. The rocky shoal areas are the third most common substrate type in the Yadkin River near PNS.

Demicryptochironomus should be nr. *Demicryptochironomus*.

Orthocladius spp. and *Cricotopus* spp. should be added to the list of common taxa.

Fish

None of the percentages for numbers and biomass cited corresponds to the data presented in Table 2.2.

The Applicant questions the appropriateness of characterizing fishing in the vicinity of the Perkins Nuclear Station as "very popular and productive".

In reference to fish abundance, the DES should clarify whether the reference is to numbers or weight of fish.

Moxostoma sp. should be *Moxostoma* spp.

A reference is needed indicating migratory habits of gizzard shad, white and channel catfish.

Page 2-13

It is not clear how the values listed in Table 2.2 were determined. In particular, are the numerical abundances given taken from Year I and Year II data, while the biomass values are only for the limited Year II collections? *Ictalurus punctatus* constitutes 5.0 percent of the total biomass of the Yadkin River collections according to the data given. This value is omitted, as are all values under the columns headed % of total number (Dutchman Creek), Mass (Site Creeks) and % of total mass (Site Creeks). The numerical totals for Dutchman Creek and Site Creeks are both incorrect, as are the values in the % of total number column for the Site Creeks.

It appears Table 2.2 has been compiled by pooling different sets of data. It should be stated which stations were included under the heading Yadkin River. Also, the value for percent total number of largemouth bass should be 3.1 percent.

An ichthyoplankton survey program was instituted by the Applicant in February, 1975 and will be continued until August, 1975.

Page 2-14 - Dutchman Creek

Although Dutchman Creek may be somewhat turbid, it is generally much less turbid than the river proper.

Nothing is said about differences in species composition in Dutchman Creek compared to the river. Differences in species composition is surely not due to ease of sampling. Bluegill, carp, and catfish are common species throughout the river not just Dutchman Creek, in fact catfish are relatively rare in Dutchman Creek.

Page 2-14 - Site Creek

Citation 19 is not listed in references.

Page 2-15

Reference 14 is for Cherokee Nuclear Station.

3. THE STATION

3.3 STATION WATER USE

Page 3-2

The maximum and average evaporative and drift losses from cooling towers are 50,514 and 36,887 gpm respectively.

ER Figure 3.3.0-1, ER Table 3.3.0-1, ER Table 3.3.0-3 and ER Tables 3.6.2-1, referenced in the DES, have been revised by Amendment 3. The corresponding DES tables and figures should be revised to reflect these changes.

3.5 RADIOACTIVE WASTE SYSTEMS

No indication is made that the staff has taken credit for removal of radioiodines with the condensate polishers.

3.5.1 Liquid Waste

Page 3-10

Figure 3.5, Liquid Radioactive Waste System Schematic Diagram, shows turbine building drains, cooling tower blowdown and monitored radwaste tanks all flowing through one pipeline to the Yadkin River Discharge Structure. To clarify Figure 3.5, the following items are noted:

1) Turbine building drains do not flow directly to the river discharge structure. When radioactivity is absent, turbine room sump pumps discharge to the Waste Water Treatment System. When radioactivity is present, the sumps are routed to the Miscellaneous Liquid Waste Management System.

2) Cooling Tower Blowdown flows through a separate 21-inch diameter pipe in the river discharge structure and there are three cooling towers/units rather than the configuration shown on Figure 3.5.

3) The contents of monitored radwaste tanks are pumped at a rate of 250 gpm directly into a dilution flow of 67,350 gpm through a 60-inch diameter pipe that discharges through three nozzles. These nozzles are of smaller size and are directed at various angles to the discharge structure.

4) Figure 3.5, Liquid Radioactive Waste System shows VCC (Volatile Chemistry Control) Powered Resin Condensate Polishing Demineralizers with spent resin transferred to solid waste treatment for packaging, storage, and transfer to a land based burial site. Provisions for handling spent resin, under radioactive conditions are correct. However, non-radioactive condensate polishing resins at Perkins Nuclear Station can be sluiced to the Waste Water Holdup Basin for disposal by sedimentation. (Duke Power Company has operated three nuclear units from startup through May 1975 with no leakage of primary system radioactivity into the secondary steam-condensate systems. Spent condensate polishing resins have remained non-radioactive.)

Page 3-11

The DES states that spent resins from these (condensate polishing) demineralizers will be transferred to the solid waste system. The words "when radioactive" should be added to the sentence. Refer to comments for Page 3-10, Item (4).

Page 3-11

TURBINE FUILDING FLOOR DRAINS

The comments for Page 3-10, Item (4) apply also to Paragraph 3. In the absence of radioactivity, Turbine Building Floor Drains collect in sump pits when the pumps discharge normally to the Waste Water Treatment System. When leakage from primary to secondary coolant system occurs, Turbine Building Drains from the leaking unit can be pumped to the Miscellaneous Liquid Waste Management System for treatment. See DES Figure 3.1, Note 8. The reference to ER Figure 3.1.0-2, Amendment 2, is incorrect. It should be ER Figure 3.3.0-1.

Page 3-11

LIQUID WASTE MANAGEMENT SYSTEM SUMMARY

Estimated release of tritium by the Applicant should be 77 ci/year per reactor of tritium, not 177 ci/year as stated in the DES.

3.5.2 Gaseous Waste

Page 3-14

The turbine bypass capacity is 55 percent (PSAR Section 10.4.1, Amendment 15), not 40 percent as stated in the DES.

Page 3-15

The DES states "... the annual dose to an individual by all pathways as evaluated in Section 5.4 will exceed 15 millirems". Comparison with DES Table 5.5 shows that the staff calculated dose is 6.3 millirems/yr and the statement should read "... will not exceed...". Comparisons, conclusions, etc. should be made with 10 CFR 50 Appendix I as adopted by the NRC, not with "as proposed". Comparison with Appendix I "as proposed" leads to the conclusion that more gaseous-radwaste-system augments are required than are necessary under the adopted Appendix I.

Page 3-16

Table 3.6, Chemicals Added to Liquid Effluent during Station Operation, and Table 3.7, Maximum Increase in Chemical Effluent Concentration due to Cooling Tower Blowdown, are based on the Environmental Report ER Table 3.6.2-1. Many numbers are comparable. Other numbers require comments.

1724 202

On Table 3.6, note the following items:

1) Cyclohexylamine and hydrazine are volatile amine materials used in the high purity condensate system. Part of these volatile amines will leave the condensate cycle through the rado-jet vacuum pump vents, and amines in leakage from the condensate system will be treated in the WWTS. The entire usage of amines cannot be assumed to be added to Yadkin River.

2) Lithium hydroxide and boric acid are used in the primary coolant system and will be discharged to the MLWMS where most of the materials go to off site disposal and only a minor proportion of the materials are discharged to Yadkin River.

3) Note (e) of Table 3.6 shows that prior to startup only, chemicals added to liquid effluent will include 2,142 pounds/day of trisodium phosphate (Na_3PO_4) calculated as the anhydrous material.

   Section 3.6.6, Miscellaneous, page 3-18, describes the use of 36,000 pounds of trisodium phosphate and 138 gallons of detergent for degreasing and cleaning condensers before startup of each unit. Commercial trisodium phosphate, crystal, is $Na_3PO_4 \cdot 12H_2O$ and this is the material that will be used in the amount of 30,000 pounds to clean each condenser.

   The anhydrous trisodium phosphate daily average discharge of 2,142 pounds of Na_3PO_4 corresponds to 4,966 pounds of commercial crystal $Na_3PO_4 \cdot 12H_2O$. At a release rate of 4,966 lbs/day, the entire 30,000 pounds of $Na_3PO_4 \cdot 12H_2O$ would be discharged in six days. Such a high rate of release is not contemplated. The Waste Water Treatment System has parallel ponds of 7.5 million gallons capacity arranged so one basin can be isolated to receive the used phosphate solution Alternate methods of disposal will be considered and specific operating procedures will be formulated.

4) Alum is shown to be added to the station effluent at the rate of 900 lb/day. Section 3.6.2, Filtered Water Treatment, mentions the use of 900 lb/day alum as a coagulant. The term alum refers to commercial aluminum sulfate, $Al_2(SO_4)_3 \cdot 18H_2O$. When alum is used for the coagulation of muddy water, the reaction produces insoluble aluminum hydroxide "floc" that separates from the treated water in a clarifier or in water filters. The waste aluminum hydroxide will flow from the water treatment area to the WWTS for sedimentation. Only traces of aluminum hydroxide will pass through WWTS to Yadkin River.

   Revised plans for water purification have eliminated the proposed use of alum and caustic and have proposed to use 2-4 ppm of a cationic polyelectrolyte in deep-bed up-flow filters. The polyelectrolytes are bridging agents of minimal volume, they occlude to the surface of particulate matter in the water and promote removal of solids from water into filter surfaces.

Filter backwash wastes flow to the Waste Water Treatment Systems where solids settle out and clear water returns to the Yadkin River.

Page 3-17

Table 3-7, Maximum Increase in Chemical Effluent Concentration Due to Cooling Tower Blowdown, assumes ten concentration of Yadkin River intake parameters.

Other factors will influence cooling tower blowdown concentrations:

1) River water will flow through the Nuclear Service Water Pond before it enters the circulating cooling water system. Sedimentation will remove some suspended solids and biological activity will assimilate soluble nutrients and decrease the biochemical oxygen demand of the water. Cooling tower makeup water will be of better quality than river water.

2) Operating experience with cooling towers at Duke's Cliffside Steam Station, Unit 5, demonstrated that cooling tower blowdown contained about one-third less nitrate nitrogen and five-day BOD than a straight line projection of makeup water quality and cycles of concentration would predict.

3) Cooling towers wash pollen and other dust particles from the air. Ammonia, oxygen and other gases dissolve in the circulating cooling water.

4) The three preceding paragraphs discuss variables that involve site specific factors that must await station operation for precise determinations.

3.6.1 Condenser Cooling Systems

Page 3-17

Biocides will be applied near the cooling tower basin outlet rather than the suction side of the circulating pumps as stated.

3.6.2 Filtered Water Treatment

Pages 3-17 and 3-18

The water for the cooling tower makeup and station water use will be obtained from the NSW Pond, which also serves as a sedimentation basin.

3.6.3 Demineralizer Regeneration

Page 3-18

Amendment 3 to the Environmental Report, Section 3.3, shows changes in filtered water treatment, in demineralizer capacity and in frequency of demineralizer regeneration.

3.6.6 Miscellaneous

Page 3-18

The DES states that 36,000 pounds of trisodium phosphate per unit will be discharged after dilution and neutralization. The estimate was for 30,000 pounds crystalline TSP per unit ($Na_3 PO_4 \cdot 12H_2O$). Alternate methods for disposal of the spent phosphate solution will be considered.

3.7 SANITARY WASTES AND OTHER EFFLUENTS

3.7.2 Permanent Sewage

Page 3-19

Domestic sewage from the plant, estimated at 8,000 gpd, will be treated in a septic tank and sand filter with tertiary treatment. (Emphasis added for clarification.)

4.1 ENVIRONMENTAL IMPACTS OF CONSTRUCTION

4.1 IMPACTS ON LAND USE

Page 4-1

The DES states that the area included within the site boundary fense is 931 acres, while the primary site owned by the applicant is 2402 acres. Duke's estimate of these acreas are 822 acres and 1424 acres respectively. Total acreage involved in property and right-of-way is 3532 acres, against 4511 acres reported in DES.

4.1.2 Carter Creek Impoundment

Page 4-2

The applicant has a tentative agreement with NCDNER to make no consumptive withdrawals when the river flow is below 880 cfs. NCDNER has no objections to the Carter Creek proposal which would allow satisfactory operation of PNS in accordance with NCDNER stream use regulations. However the applicant has no firm obligation to locate an offstream supplemental storage pond on Carter Creek. At elevation 723 ft msl the pond will inundate about 860 Ac.

The DES states that creation of the reservoir will displace 13 houses, 3 moble homes and 2 farm buildings. ER Amendment 3, Section 2.1.1, states that 13 houses, 3 moble homes and 2 farm buildings will be affected by creation of the reservoir, not necessarily displaced.

4.1.7 Conclusion and Summary

Page 4-3

The DES states "A total of 1517 acres of cropland and pasture (including abandoned fields) will be lost from active use as a result of property acquisition for the primary site (973 acres of cropland and pasture)..."

The applicant estimates a total of 1044 acres of cropland and pasture will be lost from active use as a result of property acquisition, of which 500 acres are within the primary site. (ER Table 4.3.1-1 Amendment 3)

The total forest in the applicant's primary site area and at Carter Creek site is 2235 acres (ER Table 4.3.1-1, Amendment 3 and ER Table 2.7.1-37, Amendment 3), as against 2771 acres reported by the Staff.

4.3 EFFECTS ON ECOLOGICAL SYSTEMS

4.3.1.1 The Primary Site

Page 4-5

The statement under Fauna, Paragraph 2, lines 9-13 could be misinterpreted as a requirement for an active management program for these species on the grounds surrounding the station, beyond normal landscaping and associated plantings. Duke feels that there is no need for such a management plan.

4.3.1.2 Transmission Facilities

Page 4-6 Erosion Problems

Applicant has developed its right-of-way seeding practices through many years of experimentation with different cover species and feels that the current use of fescue millet, Sericea lespedeza, etc., is the best mixture for achieving rapid growth over the corridor while keeping erosion at a minimum. Also, this mixture provides suitable food and cover for certain wildlife species.

However, the applicant does modify its seedings mixture depending on terrain, soil type, climate, etc., and will consider these factors when clearing the Perkins rights-of-way.

Applicant feels that Bicolor lespedeza, in large amounts, is not particulary suitable right-of-way cover because its tall growth may interfere with the operation of the lines.

Page 4-7

Under Fauna, paragraph 2, lines 3 and 4, the Applicant feels the word "not" belongs between "will" and "be".

4.3.2.2 Construction of the Nuclear Service Water Pond and Auxiliary Holding Pond

Page 4-8

The DES states that the area of the auxiliary holding pond is 4 acres. The pond is approximately 2.6 acres (ER Figure 2.1-2, Amendment 3).

4.4 IMPACT ON PEOPLE

4.4.1 Physical Impacts

Page 4-10

The DES states that 16 families will be displaced by the Carter Creek Impoundment. Section 2.1.1, Amendment 3 of the ER, states that 16 families will be affected by the creation of the reservoir, not necessarily displaced. (emphasis added)

4.4.2 Population growth and construction worker income

The DES states that 13 percent of the construction work force is expected to move into the area. ER Subdivision 4.1.1.2, Amendment 3, and Appendix III, states that 12 percent of the work force is expected to move into the area.

4.5 Radiation Exposure to Construction Workers

Page 4-11

The dose rates to construction workers are 9.0×10^{-6} rem/hr from Unit 1 and 1.2×10^{-6} rem/hr from Units 2 and 3 as against 9.4×10^{-3} millirem/hr and 1.3×10^{-3} millirem/hr noted in the Des. The dose rate at Unit 3, resulting from operation of Units 1 and 2 is 1.02×10^{-5} rem/hr as against 1.07×10^{-2} millirem/hr mentioned in the DES. (ER Subdivision 4.1.1.5, Amendment 3)

1724 205

5. ENVIRONMENTAL IMPACTS OF FACILITY OPERATION

5.1 IMPACTS ON LAND USE

DES states that a total of 2402 acres at the site will be owned by the Applicant and that approximately 1785 acres will be left as is (after any logging by previous landowners). Refer to comments, DES Item 3, page i, (6) and 4.1 Impacts On Land Use, page 4-1.

5.2 IMPACTS ON WATER USE

5.2.1 Surface Water

Page 5-2

About 10 cfs will be returned to the river as blowdown resulting in a maximum consumptive loss of about 112 cfs. (ER Table 3.3.0.2). PNS discharges will meet applicable Federal, and State discharge requirements and should not decrease water quality, as suggested in possible effects number (1).

The DES states that the maximum percentage of river flow would be withdrawn when river flows were equal to or greater than 880 cfs plus 110 cfs. In order for this statement to be correct, "or greater than" should be omitted.

5.2.1.2 Waste Assimulative Capacity

Page 5-2

The DES states that about 51% of the water flowing past the Buck Steam Station would be withdrawn. It should be pointed out that this is not a consumptive loss; the water is used for condenser cooling and is returned directly to the Yadkin River after use.

This paragraph states that any reduction in flows in High Rock Lake by PNS would increase the probability of fish kills. The Applicant feels that this paragraph is out of proportion with the amount of withdrawal by PNS. The absolute maximum withdrawal by PNS of 110 cfs will amount to only 2.5% of the average flow into High Rock Lake.

Page 5-3

As noted in ER Subdivision 5.1.4.2.2, Amendment 3, the operation of the proposed Carter Creek Reservoir during periods of streamflow below 880 cfs should improve the quality of water flowing into High Rock Lake.

5.2.1.2 WATER AVAILABLE FOR INDUSTRIAL AND MUNICIPAL USE

Impact on High Rock Lake

Reference to ER Figure 2.5.2-14 should be changed to ER Figure 2.5.2-19.

5.3 PERFORMANCE OF THE HEAT DISSIPATION SYSTEM

Page 5-5

The DES states "...the seven-day average lowest flow during the past ten years is given as 625 cfs". This should be changed to "...the seven-day average lowest flow with a ten-year recurrance interval (7Q10) is 625 cfs".

It should be pointed out that the lowest flow on record, 330 cfs, occurred before construction of the Kerr Scott Dam and since then, the lowest instantaneous flow on record is 600 cfs.

5.3.2 Cooling Tower Performance

5.3.2.1 Visible Plumes

Page 5-7

Updated cooling tower analysis (ER Figure 5.1.5-1, Amendment 2) indicates that the 5% isopleth of visible plume frequency passes 5 miles southwest of the towers on an annual basis. This is in contrast to a distance of 15 miles based on a seasonal occurrence stated in the DES.

5.3.2.3 Drift Deposition

Page 5-7 and 5-8

The cooling tower drift analysis has been updated (ER Sub-Section 5.1.5, Amendment 2) and the DES should be revised accordingly. The maximum salt deposition rate is 40 lb/acre-month.

Page 5-7

The DES uses a flowrate of 100 gpm as the basis for estimating the deposition of solids on areas near the cooling towers. A maximum drift rate of 114 gpm is based on the guaranteed drift rate of 0.005% at 100% load factor. At the average load factor of 76% the drift rate is expected to be 87 gpm.

Assuming the average load factor, drift deposition would be 87% of the numbers estimated for Figure 5.2.

5.3.3.2 Federal Effluent Guidelines and Standards

Page 5-10

Limitation 423.13(a)

The DES states that "Effluents from the mineralizer system will be neutralized before discharge. No sulphuric acid will be used in condenser cooling water systems."

Effluents from demineralizer regeneration will be neutralized to the required pH range in the Waste Water Treatment System.

ER Subdivision 3.6.1.1 states: "The addition of acid to control pH is not expected but will be used if found to be necessary."

Page 5-11

Limitation 423.13 (h) and (i)

Refer to U.S. Environmental Protection Agency, "Steam Electric Power Generating Point Source Category, Effluent Guidelines and Standards," Federal Register 39(196) (1974).

The Best Available Technology Economically Achievable, effective 7-1-83 is presented as "Limitation 423.13(i)". The quantity of pollutants discharged from cooling tower blowdown shall not exceed ....

Effluent Characteristic	Maximum Concentration	Average Concentration
Free available chlorine	0.5 mg/l	0.2 mg/l
Zinc	1.0 mg/l	1.0 mg/l
Chromium	0.2 mg/l	0.2 mg/l
Phosphorus	5.0 mg/l	5.0 mg/l

Each material is specified as the element. In the specification for phosphorus, 5.0 mg/l is equivalent to 15.33 mg/l of phosphate ion, PO_4; therefore the 12.5 mg/l of Phosphorus (as PO_4) estimated by the Staff to be in cooling tower blowdown would comply with EPA effluent limitations.

Since ER Table 3.6.2-1 took no credit for sedimentation and stabilization of Yadkin River water as it passed through the Nuclear Service Water Pond, ten cycles of concentration of parameters in river water represent a worst case for cooling tower blowdown. Since zinc, chromium and phosphorus compounds tend to be associated with particulate matter, and 60-70% removal is achievable by plain sedimentation, the cooling tower blowdown is expected to meet EPA Effluent Guidelines in 423.13 (i) for zinc, chromium and phosphorus.

5.4 RADIOLOGICAL IMPACTS

Since 10CFR50 Appendix I has been adopted by the NRC, calculated radiation doses should be compared with the "as adopted" limitations and not with the "as proposed" limitations; comparison with "as proposed" leads to incorrect conclusions.

5.4.1.3 Dose Rate Estimates

Page 5-13

The X/Q values used in the calculation of values in Table 5.3 have been revised in Subdivision 2.6.3.2 and ER Table 2.6.2-5, Amendment 3. Table 3.5 should be revised to reflect these changes.

The dose rate to a duck (1.9×10^2 millirads/year) appears to be a factor of 10 too high.

5.5 NONRADIOLOGICAL EFFECTS ON ECOLOGICAL SYSTEMS

5.5.1.2 Transmission Facilities

Page 5-22

Applicant does keep current files on the use of herbicides for controlling undesirable vegetation on rights of way and has used herbicides in the past. Applicant agrees that herbicides are effective in brush control and may in the future implement the selective use of herbicides as a right of way maintenance tool.

5.5.2.1 Intake (Also 9.2.2 Intake Systems, pages 9-13)

Impingement

Page 5-22

The river intake structure at Perkins has been redesigned to minimize fish impingement (ER Subdivision 10.2.2.1, Amendment 3, and Figure 3.4.1-1 Amendment 3). The new design has eliminated the training walls and submerged weir, while placing the face of the traveling screens flush with the shoreline. The intake structure is also located on the outside bend of the river.

Page 5-24

Item (1) is somewhat misleading in the fact that Pomoxis spp. accounted for only 0.7% of the total number of fish collected in the Yadkin River (Table 2.2). No Pomoxis have been collected at the proposed intake site.

The last sentence refers to sunfishes, shads, and minnows as being the most abundant groups of fishes in the river. Catfishes should be included in this list.

Lepomis sp., Pomoxis sp. and Dorosoma sp. should be Lepomis spp., Pomoxis spp. and Dorosoma spp.

The Applicant feels that several factors which will mitigate impingement should be mentioned here.

1. Water temperatures below 50°F are prevalent from November through March, as noted; these are also months of high river discharge.

2. The applicant feels that the Ictaluridae, especially Ictalurus catus and I. punctatus, should be counted as one of "the three most abundant" groups in the Yadkin River. The applicant also notes that very few white crappie (Pomoxis annularis) and black crappie (P. nigromaculatus) have been collected in the vicinity of the site over the past two years.

3. Impingement has not been a problem at Buck Steam Station. Attachment 1 to these comments is a report on fish impingement at Buck based on data gathered over a one year period.

The comparison of the Yadkin River to impingement problems experienced in the Great Lakes region needs a supporting reference to clarify similarities in facility design and operation which may exist.

4. There is no indication in Applicant's data that large numbers of any species, including white bass (Morone chrysops), spawn in the immediate vicinity of the intake.

5. Applicant feels that the statement in paragraph 7 that "any reduction in (fish) populations could adversely affect the Yadkin River and High Rock Lake fishery" is too strong and does not take into account the density dependent nature of population adjustments.

6. The DES mentions that Morone chrysops would be negatively rheotaxic following spawning. If so, since they spawn in the spring when water flow is high and the velocity past the screens is much higher than the 0.5 fps through the screens, it would appear that impingment of white bass would be insignificant.

Netropis sp. should be Notropis spp.

It is stated that gizzard shad, bluegills, shiners, and white bass are all important forage or game species. Data indicate that gizzard shad are of limited forage value in the Yadkin River, and then primarily to large predators. Also, the importance of bluegill as a game fish in the Yadkin River can be argued. It was previously stated in the DES (page 2-12) that fishing in this section was very productive for channel and white catfish and seasonally for white bass. Nowhere else is mention made of the importance of bluegill as a game fish.

Also, it is stated that "Any reduction in their (the previously mentioned fishes) populations could adversely affect the Yadkin River and High Rock Lake fishery." How can this statement be supported in view of the fact that "several large fish kills have occurred in the Yadkin River during the last several years? The principal species killed have been gizzard shad, though numerous game and food species have been included at times" (page 2-13); and still, fishing is "productive" in this area.

Entrainment

Page 5-26

Ichthyoplankton cannot be assumed to be randomly distributed (with the exception of drifting eggs). Larvae and juveniles may hug the banks of the river and remain there until large enough to inhabit the mainstream. Catfish alevins are obviously not randomly distributed. They are guarded in the nest until able to swim against the currents, at which time they probably seek the protection of stream banks.

The loss of a small percentage of the plankton in the river to entrainment will be further mitigated by the addition of plankton from tributaries below the intake (especially Dutchman Creek) and by replacement by reproduction (especially phytoplankton).

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Page 5-27

The assumption of random distribution of ichthyoplankton does not apply to many larval and juvenile forms, thus the values of 9 to 23% entrainment are not necessarily valid.

Applicant does not feel that the assumption of 100% mortality of entrained organisms at Buck Steam Station, a once through facility, is valid.

In order for the 9 to 23% entrainment figures to be valid, the larvae would have to be randomly distributed and pass by all four major water intakes. Applicant has examined the assumption of random distribution, and believes the assumption of larvae passing all four water intakes is in even greater error. The DES states that "All the species listed above have demersal eggs, which probably would not drift with the current unless dislodged. However, the fry, after absorbing the egg sac, enter into the river current to drift until encountering a habitat suitable for further growth and development". Applicant does not believe that larvae hatched below Idol's Hydro would have to drift over 36 miles (the distance to Buck Steam Station) to encounter habitat suitable for development.

The Applicant feels this is an inaccurate prediction of entrainment, based on two invalid and unsupported assumptions.

Gizzard shad are stated as nonmigratory, but on page 2-12 the DES states gizzard shad migrate up the Yadkin River. Such statements need supporting reference for clarification.

Page 28

Applicant believes that the concern over the effects of PNS entrainment on High Rock Lake fishery is somewhat over-emphasized. In view of considerations listed above, the relatively small volume of make up water withdrawn, the distance of PNS from High Rock Lake, and the presence of suitable spawning areas downstream and in alternate streams (e.g. Abbott Creek), the effect of PNS entrainment on the High Rock Lake fishery should be minimal.

Icthyoplankton samples are taken weekly in the vicinity of PNS during the major spawning period to provide information on the magnitude of potential entrainment.

Page 5-31 - Table 5.7

The "Species" column in Table 5.7 ought to be labelled "Organisms", since Protozoa, Cladocera, and Miscellaneous fish are not species.

None of the more sensitive organisms listed is found in the Yadkin near Perkins.

Points numbered 1, 6, 15, 36, 44 and 45, listed in the key, are not plotted in Figure 5.7.

"Effect and points" are all given in terms of hours or days; no fish or plankton in the open river will be exposed to blowdown for extended periods.

5.6 EFFECTS ON THE COMMUNITY

5.6.1 Population Growth

Page 5-36

The DES states that approximately once a year an additional 150 to 200 personnel will be required for refueling and maintenance operations. Applicant is unable to verify source of this number and requests clarification.

6. ENVIRONMENTAL MEASUREMENTS AND MONITORING PROGRAMS

6.1 PREOPERATIONAL

6.1.2 Ecological

Page 6-1

Two permanent plots of native vegetation have been selected for pre-operational monitoring purposes as described under Cooling Tower Drift Impact Assessment.

Plant community species composition data and animal population data were updated in Amendment 2 of the Perkins ER. The second sentence in paragraph 1 under Terrestrial Ecology should be modified or deleted as it conflicts with the preceding sentence in the same paragraph.

Page 6-4 - Table 6-1

During Year II, zooplankton samples are being collected with a 76μ mesh 0.5 m net.

Drift nets should be added to benthos sampling gear for Year II.

6.1.3 Radiological

Page 6-2

Sensitivity to 0.5 pCi/l is not appropriate for Appendix I as adopted, as applied to Perkins; this value should be 1.5 pCi/l.

The text refers to Section 5.3.4, which apparently does not exist.

6.2 OPERATIONAL

6.2.1 Ecological

Page 6-2

Refer to comment for 6.1.2, Ecological.

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7. ENVIRONMENTAL IMPACTS OF POSTULATED ACCIDENTS INVOLVING RADIOACTIVE MATERIALS

7.1 PLANT ACCIDENTS

Applicant believes that the doses presented would be more easily understood if reference was made to the X/Q values used in the calculations.

In Table 7.2, reference should be made to Appendix I and not proposed Appendix I. Based on the assumptions in the Perkins ER and Regulatory Guide 4.2, the difference in the dose from the large and small LOCA's should be greater.

Since the population doses are site related, the Perkins and Cherokee population doses should not be identical.

7.2 TRANSPORTATION ACCIDENTS

Page 7-4

The nearest disposal site is Barnwell, South Carolina, a distance of about 240 miles.

8. THE NEED FOR POWER GENERATING CAPACITY

8.1 APPLICANT'S SERVICE AREA AND REGIONAL RELATIONSHIPS

8.2.1 Energy Consumption

Page 8-4

The energy forecast shown in Table 8.1 has been revised in a forecast dated March 17, 1975. The values given in ER Table 1.1.1-1, Amendment 3, are as follows:

Year	10^6kWhr
1974	45,240
Forecast	
1975	47,734
1976	52,387
1977	56,851
1978	61,346
1979	65,942
1980	70,637
1981	75,699
1982	81,041
1983	86,719
1984	92,746
1985	98,715
1986	105,239
1987	112,096
1988	119,629

Note: The only change is for the energy. The demand figures are correct as shown.

Page 8-5

The last paragraph in Section 8.2.1 should be revised to agree with revised Table 8.1.

8.2.3 The Impact of Energy Conservation and Substitution on Energy and Peak Load Demand

Page 8-8

The DES states that improved air-conditioners "... could hypothetically save electric utilities almost 58,000 MW in 1980". This statement seems to be in error.

8.6 SUMMARY AND CONCLUSIONS

Page 8-18

Table 8.12 is based on an assumption of no capacity additions after 1988, which is not realistic.

9. COST-BENEFIT ANALYSIS OF ALTERNATIVES

9.1 ALTERNATE BASE-LOAD ENERGY SOURCES AND SITES

9.1.2 Alternatives Requiring the Creation of New Generating Capacity

Page 9-3

Applicant has evaluated the cost effectiveness of the PNS and its fossil fueled alternative and agrees with the DES that the lower generating costs associated with the nuclear station warrant its selection. Applicant's cost estimates have been revised and are presented in ER Tables 9.3.1.1 and 9.3.4.1, Amendment 3.

Page 9-4

The DES states that there is one hydroelectric site in the Applicant's service area suitable for base-load service. Applicant's ER (Subsection 9.2.1) has been revised to correctly indicate that there are no hydroelectric sites in the service area suitable for base-load service.

9.2 ALTERNATE PLANT DESIGNS

9.2.3 Transmission Lines

Page 9-14

Applicant has made a thorough investigation of two alternate routes located east of the selected McGuire-Pleasant Garden 525 kV fold-in. Although the selected route includes more forested acres (all of which is merchantable), Applicant chose this route because it affects fewer people and has less impact on present and planned land uses of the area (see Tables 1 and 2 and Figure 1 attached to these comments).

If the fold-in was shifted .75 miles to the east, as the staff recommends, it would be located nearer to existing roads and would be within 500 feet of approximately three times as many houses as the selected route. Not only would the aesthetic impact be increased on these residents and on passing motorists, the additional cost of obtaining a right of way through this area would greatly inflate the total cost of the line.

Also the connection point of one alternate with the existing McGuire-Pleasant Garden Line is located within the flood plain of High Rock Lake which is owned by Yadkin, Inc., an FPC controlled company. Locating the fold-in connection in the flood plain would require special tower foundations, and would be subject to the approval of the Federal Power Commission.

After consideration of all these factors, not just forested acres, Applicant maintains that the selected route for the McGuire-Pleasant Garden fold-in is the most environmentally and economically acceptable.

10. EVALUATION OF PROPOSED ACTION

10.1 UNAVOIDABLE ADVERSE ENVIRONMENTAL EFFECTS

10.1.1.1 On Land

Page 10-1

The DES states that the Applicant plans to own about 2400 acres at the primary site and that about 931 acres will be enclosed by the station boundary fense. Refer to comments, DES Item 3, Page i (a) and 4.1 IMPACTS ON LAND USE, page 4-1.

The DES states that 1517 acres of cropland and pasture will be lost from agricultural production. Refer to comment 4.1.7 Conclusion and Summary, page 4-3.

10.1.1.2 On Surface Water

Page 10-1

The maximum loss generation for downstream hydroelectric stations due to the operation of Perkins is about 32 million kWh annually. Based on average concumptive water use at Perkins, the average loss generation is 24 million kWh annually. (ER Subsection 3.3.1, Amendment 3).

10.1.1.4 On Air

Page 10-2

Analysis of plume effects and solids deposition have been revised; refer to comments on DES Subdivisions 5.3.2.1 and 5.3.2.3.

10.1.2 Biotic

10.1.2.2 Aquatic

Page 10-3

The entrainment estimates generated here are worse than "worst case"; refer to comments on entrainment in Section 5.5.

10.2 RELATIONSHIP BETWEEN SHORT-TERM USES AND LONG-TERM PRODUCTIVITY

10.2.3 Uses Adverse To Productivity

10.2.3.1 Land Use

Page 10-3

State and local taxes are estimated to be $61-million (ER Subsection 11.2.4, Amendment 3)

The DES states that approximately 2400 acres will be required for the PNS primary site and that 16 families will be displaced from the Carter Creek impoundment area. Refer to comments of DES item 3, page i, a and b.

10.2.3.2 Water Use

Page 10-3

About 2.0 x 10^{10} gal/yr will be consumed by PNS, not 1.7 x 10^{10} gpd as stated in the DES. This represents about 2.9 percent of the average river flow (ER Table 11.2.0-1, Amendment 3).

10.3 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

10.3.4 Material Resources

Page 10-6

The derivation of the statement, "...and 180 metric tons of uranium depleted to about 0.2 percent of U-235 would remain," which appears in paragraph 3, needs to be clarified.

10.3.5 Water and Air Resources

Page 10-6

About 2.0 x 10^{10} gal/yr will be consumed by PNS, not 1.7 x 10^{10} gpd as stated in the DES.

10.3.6 Land Resources

Page 10-6

The DES states that about 3900 acres of land would be committed to construction and operation of Perkins. The land area being acquired for the Perkins Nuclear Station is 3532 acres. It is estimated that only about 2100 acres of it would be removed from its present use during construction. However, only 1250 acres will be under permanent facilities. The remaining area of about 2250 acres will be available for other uses, such as forest and low crops, under Duke control.

Table 10.2 - Environmental Costs of Perkins Nuclear Station

Page 10-9

The DES states that 2402 acres of land is required for the station site and that loss of agricultural production would be 15:7 acres. Refer to comments, DES Item 3 (a) and 4.1.7 Conclusion and Summary.

10.4.1.4 Taxes

Federal, state, and local (county) taxes are expected to be about $71.8, $50.1, and $11.2 million annually, respectively, for a total of about $133.1 million annually (ER Subdivision 8.1.2.2, Amendment 3). Table 10-1 should be revised to reflect these changes.

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Table 1
Perkins Nuclear Station
Basic Tabulation to be Used in Comparing Alternative Plant Systems

	Units	Alternate A (Selected Route) Magnitude	Alternate B Magnitude	McGuire-Pleasant Garden Alternate C* (Suggested by NRC) Magnitude	Alternate D* (Suggested by NRC) Magnitude
4.5 Transmission Route Selection					
4.5.1 Land, Amount	Miles	7.9	7.8	7.7	7.9
	Total Acres in R/W	362.0	357.4	355.1	364.2
Current Market Value Total $		221,475.00	214,787.00	235,041.00	274,396.00
4.5.2 Miles & Acres Through Sensitive	Miles	.02	.04	.26	.66
Areas and Loss of	Acres	.92	1.84	11.98	30.40
Adjacent Property Value	$	0	0	0	0
4.5.3 People (Aesthetics)					
Major Road Crossings	Number	0	0	0	0
Major Water Crossings	Number	1	3	1	1
Crest, Ridge Crossings	Number	0	2	2	5
Long Views	Number	2	3	1	3
Houses Within ± 500' of CL	Number	7	11	17	28
4.6 Transmission Facilities Construction					
4.6.1 Land Adjacent to Right of Way (New Access Roads)	Miles	7.9	7.8	7.7	7.9
4.6.2 Land Erosion	Tons/Acre/Yr.	-	-	-	-
4.6.3 Wildlife	Number	0	0	0	0
4.6.4 Flora	Number	0	0	0	0
4.7 Transmission Line Operation					
4.7.1 Land (No Multiple Use Planned)	%	0	0	0	0
4.7.2 Wildlife	Qualified Opinion (see Perkins ER)				

*Alternates C & D were recommended by the NRC staff in their Draft Environmental Statement on Perkins Nuclear Station.

Table 2 (Sheet 1 of 3)
Perkins Nuclear Station
Basic Tabulation to be Used in Comparing Alternative Transmission Routes

	Units	Alternate A (Selected Route) Magnitude	Alternate B Magnitude	McGuire-Pleasant Garden Alternate C (Suggested by NRC) Magnitude	Alternate D (Suggested by NRC) Magnitude
1. Land Use (Rank alternative routes in terms of amount of conflict with present and planned land use.) Minimum conflict=0	Number	0	0	1	2
2. Property Values (Rank alternative routes in terms of total loss in property values.)	$	0	0	0	0
3. Multiple Use (Rank alternative routes in terms of envisioned multiple use of land preempted by rights of way.)	Number of uses	5	5	4	4
4. Length of New Rights of Way Required	Miles	7.9	7.8	7.7	7.9
5. Number and Length of New Access and Service Roads Required	Miles (temporary)	7.9	7.8	7.7	7.7
6. Number of Major Road Crossings in Vicinity of Intersection or Interchanges	Number	0	0	0	0
7. Number of Major Waterway and Railroad Crossings	Number	1	3	1	1
8. Number of Crest, Ridge, or Other High Point Crossings	Number	0	2	2	5
9. Number of "Long Views" or Transmission Lines Perpendicular to Highways and Waterways.	Number	2	3	1	3

Table 2 (Sheet 2 of 3)
Perkins Nuclear Station
Basic Tabulation to be Used in Comparing Alternative Transmission Routes

	Units	Alternate A (Selected Route) Magnitude	Alternate B Magnitude	McGuire-Pleasant Garden Alternate C (Suggested by NRC) Magnitude	Alternate D (Suggested by NRC) Magnitude
10. Length of Above Transmission Line in or through the Following Visually Sensitive Areas					
10.1 Natural Water Body Shoreline	Miles	0	0	0	0
10.2 Marshland	Miles	0	0	0	0
10.3 Wildlife Refuges	Miles	0	0	0	0
10.4 Parks	Miles	0	0	0	0
10.5 National and State Monuments	Miles	0	0	0	0
10.6 Scenic Areas	Miles	.02	.04	.06	.06
10.7 Recreation Areas	Miles	0	0	0	0
10.8 Historic Areas	Miles	0	0	0	0
10.9 Residential	Miles and Number of Houses	0 - 7	0 - 11	.2 - 17	.6 - 28
**10.10 National Forests and/or Heavily Timbered Areas	Miles	0	0	0	0
10.11 Shelter Belts	Miles	0	0	0	0
*10.12 Steep Slopes (35% or greater)	Number	1	4	0	0
10.13 Wilderness Areas	Miles	0	0	0	0
10.14 to (Other Sensitive or Critical Areas, 10.20 Specify)	Miles	0	0	0	0

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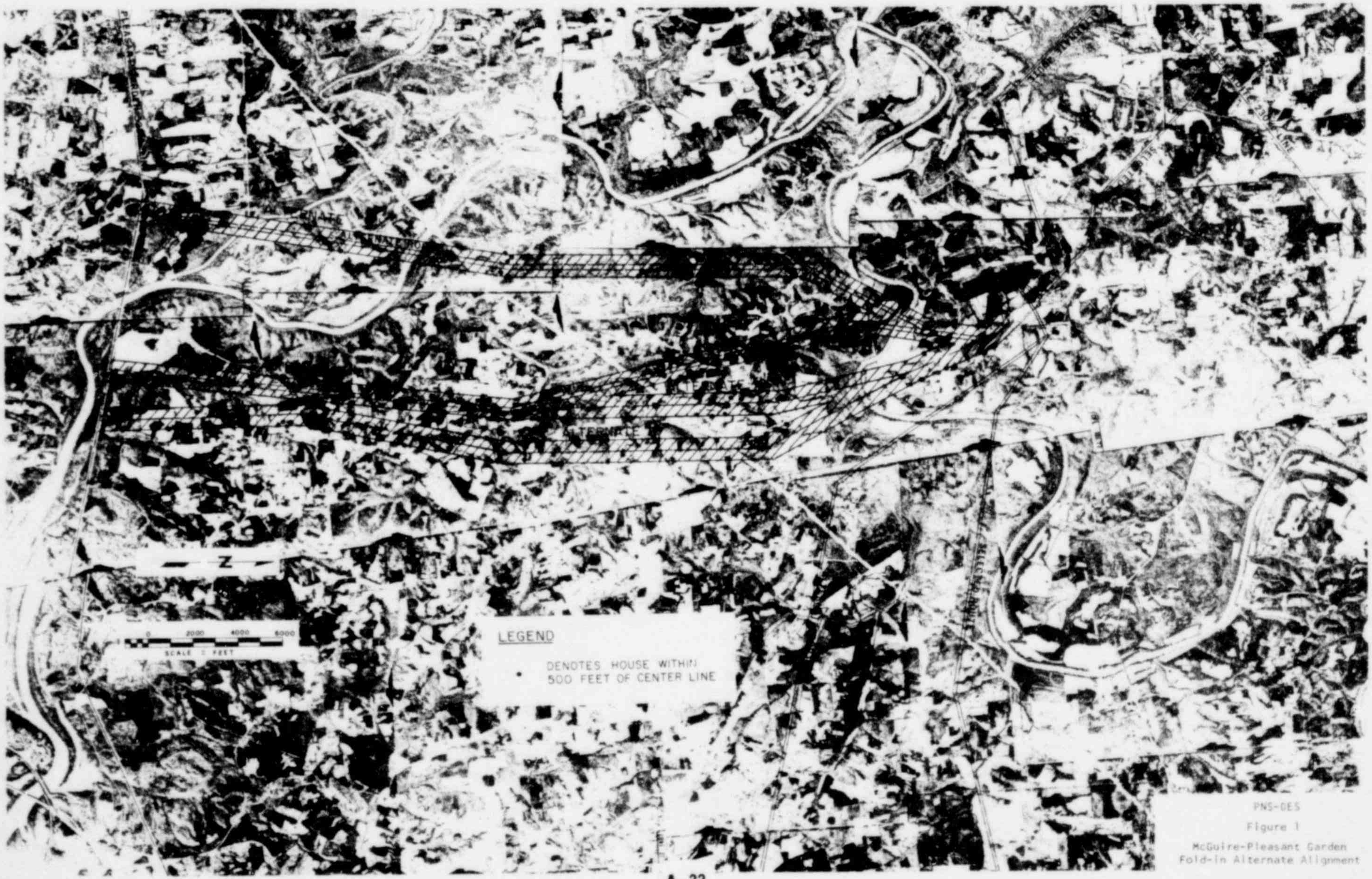

PNS-DES

Figure 1

McGuire-Pleasant Garden
Fold-in Alternate Alignment

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Table 2 (Sheet 3 of 3)
Perkins Nuclear Station
Basic Tabulation to be Used in Comparing Alternative Transmission Routes

		McGuire-Pleasant Garden			
	Units	Alternate A (Selected Route) Magnitude	Alternate B Magnitude	Alternate C (Suggested by NRC) Magnitude	Alternate D (Suggested by NRC) Magnitude
10.21 Total Length through Sensitive Areas (Sum 10.1-10.20)	Miles & Number	.02 - 8	.04 - 15	.26 - 17	.66 - 28
10.22 Total Net Length through Sensitive Areas (Sum 10.1-10.20 Eliminate Duplication)	Miles & Number	.02 - 8	.04 - 15	.26 - 17	.66 - 28

*In the AEC Regulatory Guide 4.2 - Preparation of Environmental Reports for Nuclear Power Plants, the term "steep slope" is not defined. However, during the staff visits to the Perkins and Cherokee sites, a slope of 35 percent was selected for use in comparing the selected and alternate transmission lines. This percentage was agreed on by both the NRC and Duke Power Company.

**No national forests or heavily timbered areas are crossed by the selected or alternate routes for the McGuire-Pleasant Garden Fold-in. The woodlands included in the rights of way are small, privately owned tracts that are not managed for timber production. Most of the woodlands consist of small, slow-growing trees along with various "scrub" type vegetation. Because the tracts are not managed and produce a low grade of merchantable timber, they are not considered to be scenic or visually sensitive areas.

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Fish Impingement at Buck Steam Station and Projected Impingement at Perkins Nuclear Station.

Buck Steam Station, located in Rowan County, North Carolina, draws condenser cooling water from the Yadkin River near its mouth at High Rock Reservoir. A six unit coal burning facility, it began operation in 1926 and has a total capacity of 488 MW.

The intake structure at Buck is located on the shoreline of the river and parallel to the river flow. There are no retaining walls, weirs, or other structures which would tend to create a quiet refuge area for fish at the intake. There are 10 pumps in the intake structure capable of drawing water at a total rate of 21 m^3/sec. There are two traveling screens associated with each of Units 1, 2, 3, and 4. Three screens are associated with each of Units 5 and 6. Maximum intake velocities are 79.25 cm/sec for Units 1 and 2, and 82.90 for Units 3, 4, 5, and 6.

An environmental investigation of the Yadkin River, including a field study of the river's fishery, has been conducted.[1] Forty species representing 11 families were collected from October 1973 to September 1974. Collections from all stations sampled were comprised primarily of the families Cyprinidae, Ictaluridae, Centrarchidae, and Clupidae. Important sport fishes in the area include several species of centrarchids, as well as white and channel catfish. Abundant forage species are gizzard shad, satinfin shiner, and whitefin shiner.

Impingement sampling began at Buck on May 7, 1974. Data are provided through June 5, 1975. Impinged fishes were collected from one screen associated with each of Units 3, 4, 5, and 6. Units 1 and 2 are run only intermittently and were not sampled. Screens to be sampled were rotated, cleaned and left stationary for a maximum of 24 hours. Screens were then rotated, cleaned and all fish and debris collected in a wire mesh catch basket. An effort was made to be as consistent as possible regarding the actual screen sampled and total time screens were left stationary. On occasion, alternate screens were sampled as a result of operating difficulties or required repairs. Total sample periods were less than 24 hours when heavy accumulation of debris necessitated early cleaning of intake screens. A total of 18 samples were collected from May 7, 1974 through July 4, 1974. Unfortunately, these samples were mistakenly combined at the steam station and data for this period are therefore presented as a total for each individual screen sampled.

At Buck, samples were collected twice each week (Tuesdays and Thursdays when possible). Impinged fishes were counted, identified to species when possible, measured, and degree of decomposition noted.

A special study was conducted on July 26, 1974, and again on February 13 and 14, 1975, in an effort to determine whether or not samples collected from representative screens were providing unbiased data from which total impingement could be reasonably estimated. During these studies, all operable screens at Buck were inspected. Numbers of fish were extremely low and suggested that there was no variation in impingement rates between screens.

Summary data are provided in Table 1, including total monthly impingement by species and estimated impingement rates (fish/screen/day and total daily impingement). Estimated rates were determined by extrapolating from actual collected data (fish/representative screen/24 hour period).

Fish impingement has generally been very low in the summer and moderate in the winter. A total of 1271 fish have been collected from May 1974 through June 1975. Of the fish impinged, 95.5% were gizzard shad, *Dorosoma cepedianum*. Gizzard and threadfin shad, *Dorosoma petenense*, combined account for 98.6% of the total. The 818 fish collected during May and June represent the highest estimated impingement rate through June 1975 (140 fish/day). Most of the specimens collected were in an advanced stage of decomposition indicating that most were not impinged alive. During this period numerous stressed gizzard shad were observed immediately above the Buck intake. It is believed that the increased impingement rates during this period were a response to upstream pollution. Fishes identified in the Buck samples are as follows:

- gizzard shad, *Dorosoma cepedianum*
- threadfin shad, *Dorosoma petenense*
- white catfish, *Ictalurus catus*
- brown bullhead, *Ictalurus nebulosus*
- channel catfish, *Ictalurus punctatus*
- bluegill, *Lepomis macrochirus*
- black crappie, *Pomoxis nigromaculatus*

Using Buck Steam Station as an indicator, it is possible to predict the magnitude of impingement at Perkins Nuclear Station. The Perkins site is located about 16 miles upstream from Buck. Like Buck, the intake structures at Perkins will be flush with the bank. The Perkins intake is located on the outside bend of a meander. Although sedimentation characteristically occurs on the inside bends of meanders[2], a submerged weir in front of and parallel to the intake structure is anticipated. It is expected that trash racks will project about six feet into the channel just above the intake structure. However, neither the submerged weir nor the trash racks are expected to appreciably decrease the velocity of the river at the intake structure. A quiet area which might attract fish is not expected with the Perkins design.

Although Buck Steam Station has relatively high intake velocities at all times (38.10 - 82.90 cm/sec), it exhibits relatively low impingement rates. It is anticipated that the intake velocities at Perkins will be about 15.30 cm/sec, less than half the minimum intake velocity encountered at Buck.

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Perkins Nuclear Station, like Buck Steam Station, will be located on the Yadkin River. It will have a similar intake design, and much lower intake velocities than Buck. Impingement rates at Perkins, therefore, should be even lower than impingement rate currently encountered at Buck.

Literature Cited

1. Duke Power Company, Environmental Report, Project 81, Perkins Nuclear Station, Volume 1, 1975.

2. Leopold, L. B., M. G. Walman, and J. P. Miller. 1964. Fluvial Processes In Geomorphology. W. H. Freeman and Company. San Francisco. 522 pp.

Attachment 1
Table 1

Monthly summary of fish impingement at Buck Steam Station. Fish/screen/day and total fish/day is estimated from the number of fish impinged on representative screens.

Common Name	Scientific Name	May-June*	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June
Gizzard shad	Dorosoma cepedianum	809	370	17	4	0	0	0	1	0	0	0	0	0
Threadfin shad	Dorosoma petenense	5	1	0	0	0	0	0	0	0	0	0	0	0
	Dorosoma sp.	0	33	0	0	0	0	0	0	0	0	0	12	0
White catfish	Ictalurus catus	2	3	1	0	0	0	0	0	0	0	0	1	0
Brown bullhead	Ictalurus nebulosus	1	0	0	0	0	0	0	0	0	0	0	0	0
Channel catfish	Ictalurus punctatus	0	0	0	1	0	0	0	0	0	0	0	0	0
	Ictalurus sp.	0	2	1	0	0	0	0	0	0	0	0	0	0
Bluegill	Lepomis macrochirus	1	3	2	0	0	0	0	0	0	0	0	0	0
Black crappie	Pomoxis nigromaculatus	0	1	0	0	0	0	0	0	0	0	0	0	0
Total number impinged on representative screens**		818	413	21	5	0	0	0	1	0	0	0	13	0
Estimated fish/screen/day		14	12	0.58	0.16	0	0	0	0.03	0	0	0	0.39	0
Estimated total fish/day		140	120	5.80	1.60	0	0	0	0.30	0	0	0	3.9	0

* May and June samples accidentally combined at Buck Steam Station

** one screen from each of four units

50-488/489/490

UNITED STATES
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
WASHINGTON, D.C. 20545

JUL 1 1975

RECEIVED 7-9-75 U.S. NUCLEAR REGULATORY COMMISSION Mail Section

Mr. B. J. Youngblood, Chief
Environmental Projects Branch 3
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Youngblood:

This is in response to your transmittal dated April 25, 1975, inviting the U.S. Energy Research and Development Administration to review and comment on the Commission's Draft Environmental Statement related to the construction of the Perkins Nuclear Station, Units 1, 2, and 3 in Davie County, North Carolina.

We have briefly reviewed the Statement and would suggest that the Commission might consider in the preparation of Chapter 9 of the final statement, conservation, or reduction in demand, as one of the alternatives not requiring new generating capacity.

Thank you for the opportunity to review this Statement.

Sincerely,

P. A. Leone for
W. H. Pennington
Assessments and Coordination Officer
Division of Biomedical and Enviornmental Research

cc: CEQ (5)

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

JUL 3 1975

Mr. Daniel R. Muller
Assistant Director
for Environmental Projects
Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Muller:

The Environmental Protection Agency (EPA) has reviewed the draft environmental impact statement issued May 12, 1975, by the U.S. Nuclear Regulatory Commission in conjunction with the application by Duke Power Company for a permit to construct the Perkins Nuclear Station, Units 1, 2, and 3. Our detailed comments are enclosed.

EPA's independent analysis of the information in the draft statement and the Applicant's environmental report indicate that the proposed gaseous and liquid waste management systems are capable of limiting radioactive releases to within the "as low as practicable" guidance of the recently issued Appendix I to 10 CFR Part 50. Therefore, we conclude that the anticipated radiological impact of normal plant operations will be acceptable.

Perkins Nuclear Station is expected to be able to be operated in general compliance with the Federal Water Pollution Control Act Amendments of 1972 (FWPCA) relative to the discharge of thermal effluents. However, sufficient data have not been presented in the draft statement on chemical effluents to determine whether appropriate chemical discharge guidelines will be achieved. The data, as discussed in our detailed comments, should be presented in the final statement. In addition, construction of the Auxiliary Holding Pond (AHP) for the purpose of chemical treatment appears to be inconsistent with the intent

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of Section 301 of the FWPCA, that no waters of the United States be utilized directly for treating wastewaters. Discharges to the AHP, which would be created by impounding "waters of the United States," must meet EPA's effluent guidelines before discharge.

In light of our review and in accordance with EPA procedure, we have classified the project as ER (Environmental Reservations) and rated the draft statement Category 2 (Insufficient Information). If you or your staff have any questions concerning our comments or classification, we will be happy to discuss them with you.

Sincerely yours,

Sheldon Meyers

Sheldon Meyers
Director
Office of Federal Activities

Enclosure

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EPA-D-NRC-A06155-NC

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ENVIRONMENTAL PROTECTION AGENCY

WASHINGTON, D.C. 20460

July 1975

ENVIRONMENTAL IMPACT STATEMENT COMMENTS

Perkins Nuclear Station

Units 1, 2, and 3

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INTRODUCTION AND CONCLUSIONS

The Environmental Protection Agency (EPA) has reviewed the draft environmental statement issued in conjunction with the application of Duke Power Company for a permit to begin construction of the Perkins Nuclear Station, Units 1, 2, and 3. This facility is proposed to be situated on a site adjacent to the Yadkin River, in Davie County, North Carolina. The following are our major conclusions.

1. The proposed radioactive waste management systems for Perkins Nuclear Station are expected to be capable of limiting normal releases of radioactive effluents to "as low as practicable" discharges. Consequently, the radiation doses are expected to be maintained to levels within those specified in the recently published Appendix I to 10 CFR Part 50. Therefore, we conclude the radiological impacts of routine operation are expected to be acceptable.

2. EPA believes that Perkins Nuclear Station, Units 1, 2, and 3 can be operated in general compliance with Federal Water Pollution Control Act Amendments of 1972 (FWPCA) as regards thermal effluents. However, sufficient data have not been presented on chemical effluents to determine whether appropriate discharge guidelines can be met. In addition, construction of the Auxiliary Holding Pond (AHP) for the purpose of chemical treatment appears to be inconsistent with the intent of Section 301 of the FWPCA, that no waters of the United States be utilized directly for treating wastewaters. Discharges to the AHP, which would be created by impounding "waters of the United States," must meet EPA's effluent guidelines before discharge.

RADIOLOGICAL ASPECTS

Radioactive Waste Management Systems

Based on our evaluation of the draft statement and the environmental report, the proposed gaseous and liquid waste management systems are expected to be capable of limiting the radioactive releases and the resulting doses to within the "as low as practicable" guidance of the recently published final version of the Appendix I to 10 CFR Part 50. As a consequence, we conclude that the radiological impacts of routine plant operation are expected to be acceptable. Even though we believe the plant radioactive effluent control technology will be capable of limiting discharges to acceptably low levels, several important aspects which need clarification are discussed below.

According to the draft statement (page 3-12), vent gases from the boron recycle system and miscellaneous waste system evaporators will be discharged to the atmosphere without treatment. The contribution of this source relative to radioiodine discharges is uncertain due to lack of detail in the draft statement as to the frequency of venting and the quantities of I-131 involved. The final statement should provide these details as well as the basic assumptions used in the development of these source-terms.

According to page 3.11 of the draft statement, liquid leakage to the turbine building will be collected in the turbine building floor drain system and will be released without treatment. However, the schematic diagram, Figure 3.1, indicates that the turbine building drain system is intertied with the miscellaneous liquid waste management system. While it may not always be necessary to provide treatment of these wastes in order to achieve the design basis objective given in Appendix I, the interties would provide the plant operator improved waste treatment flexibility. The final statement should clarify whether such interties for the turbine building liquids will be included in the plant design. Also, Figure 3.7 indicates that liquids from the turbine building drains will be released to the Yadkin River via the River Discharge Structure without radiation monitoring or control isolation. The final statement should clarify whether such interties and monitoring and control systems for the turbine building liquids will be included in the plant design.

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We believe the plant design stage is the best time to ensure that anticipated plant effluent release points will be adequately monitored and that sufficient effluent sampling points will be provided to ensure documentation of plant effluent releases. We urge NRC to ensure that these provisions are included according to the guidance of Regulatory Guide 1.21.

Dose Assessment

Based upon independent calculations, we estimate that the radiological doses off-site due to radioactive wastes discharged from Perkins Station, including the thyroid dose via the grass-milk pathway, are expected to be within the guidance of Appendix I to 10 CFR Part 50. However, on page 3-15 of the draft statement reference is made to Section 5.4 where dose estimates from I-131 are said to exceed 15 mrem/yr. No further reference to dose estimates of this magnitude could be found in Section 5.4 or elsewhere in the draft statement. The final statement should clarify this conflict and summarize the major calculational steps used in arriving at values such as those given in Table 5.5. Similarly, Table 5.5 gives a total liquid effluent dose rate of 3.7 mrems/yr; however, all previous information relating to liquid effluents (in Table 5.4) indicates dose rates are three orders of magnitude lower than this value. The final statement should clarify this conflict.

We concur with the NRC staff that the Applicant's milk analyses sensitivity for measuring I-131 should be 0.5 pCi/l. Furthermore, the Applicant should undertake periodic audits of the location and number of lactating cows and goats so that the critical exposure pathway will be known throughout the lifetime of the plant.

EPA expects that the results from current EPA/NRC and industry cooperative field studies in the environs of operating nuclear power facilities will increase knowledge of the processes and mechanisms involved in the exposure of man to radiation produced through the use of nuclear power. We believe that, overall, the cumulative assumptions utilized to estimate various human doses are conservative. As more information is developed, the models used to estimate human exposure will be modified to reflect the best data and most realistic situations possible.

Reactor Accidents

EPA has examined the NRC analyses of accidents and their potential risks which the NRC has developed 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 the NRC approach to evaluate the environmental risk for each accident class on a generic basis. The AEC has in the past and NRC continues to devote extensive efforts to ensure safety through plant design and accident analyses in the licensing process on a case-by-case basis.

For the past two years, AEC sponsored an effort to examine reactor safety and the resultant environmental consequences and risks on a more quantitative basis. We have strongly encouraged this effort and continue to do so. On August 20, 1974, the AEC issued for public comment the draft Reactor Safety Study (WASH 1400), which is the culmination of the extensive effort to quantify the risks associated with light-water-cooled nuclear power plants. EPA is conducting a review of this document, including in-house and contractual efforts through June 1975, after which we will issue a final set of comments. Initial comments, issued November 27, 1974, indicate the AEC's efforts represent an innovative step forward in concept and methodology in the evaluation of risks associated with nuclear power plants. The study appears to provide an initial meaningful basis for obtaining useful assessments of accident risks.

If future NRC efforts in this area indicate unwarranted risks are being taken at the Perkins Nuclear Station, we are confident the NRC will ensure appropriate corrective action. Similarly, if EPA efforts identify any environmentally unacceptable conditions related to reactor safety, we will make our views known. Until our review of the Reactor Safety Study is completed, we believe there is sufficient assurance that no undue risks will occur as a result of the continued planning for the Perkins Nuclear Station.

Transportation

EPA, in its earlier reviews of the environmental impacts of transportation of radioactive material, agreed with the 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 their regulations (10 CFR Part 51) which summarizes the environmental impacts resulting from the

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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 this nuclear power plant appears to meet these conditions and EPA has agreed that the transportation impact values in the table are reasonable, this approach appears adequate for this action.

While the impact resulting from the routine transportation of radioactive materials was chosen at that level within which the impact of 90% of the reactors currently operating or under construction fell, the basis for the impact, or risk, of transportation accidents is not as clearly defined. There are current efforts by both EPA and ERDA (the Energy Research and Development Administration) (and/or NRC) to more fully assess the radiological impact of transportation accidents. As the quantitative results of these analyses become available, EPA intends to conduct reviews to ascertain the acceptability of the potential transportation risks. If EPA efforts identify any environmentally unacceptable conditions related to transportation, we will make our views known. Until our reviews of the transportation accident analyses are completed, we believe there is sufficient assurance that no undue risks will occur as a result of transportation accidents for this nuclear power plant.

Fuel Cycle

The NRC's predecessor, the AEC, issued a document (WASH-1248) titled, "Environmental Survey of the Uranium Fuel Cycle" in conjunction with a regulation (10 CFR 50, Appendix D) for application in completing the cost-benefit analyses for individual light-water reactor environmental reviews (39 FR 14188). The information therein is employed in NRC draft statements to assess the incremental environmental impacts that can be attributed to fuel cycle components which support nuclear power plants. In our opinion, this approach appears adequate for plants currently under consideration, and such estimates of the incremental impacts for the Perkins Nuclear Station are reasonable. However, as suggested in our comments on the proposed rulemaking (January 19, 1973), if this is to continue for future plants, it is important for the NRC to periodically review and update the information and assessment techniques used. EPA intends to monitor developments in the fuel cycle area closely and will bring to the NRC's attention any factor or

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concerns we believe relevant to continued improvement in assessing environmental impacts.

The concept of environmental dose commitment is a recent development which we believe should be included in the assessment of the environmental impact of the fuel cycle. The information presented in the draft statement indicates the "Maximum Effect" in terms of annual person-rems (man-rems) within a 50-mile radius. As many of the radionuclides involved persist in the environment over extremely long periods, their impact is not adequately represented by an annual dose. Instead, we recommend that the maximum effect for fuel cycle releases be indicated by an environmental dose commitment, that is, by the projected person-rems which will be accumulated over several half-lives of the radioisotopes released annually from these facilities. (This would involve decades for very long-lived isotopes.) Also, such evaluations should be done for the total U.S. population exposure. Radionuclides of importance in this approach include Kr-85, I-129, tritium, radium, C-14, and the actinides.

High-Level Waste Management

Environmental impacts will arise as a consequence of the techniques and procedures utilized to manage high-level radioactive wastes. These impacts have some relevance to the environmental considerations regarding each nuclear power plant in that the reprocessing of spent fuel from each will make some contribution to the total waste. EPA concurs, however, with the NRC's approach of handling waste management impacts on a generic basis rather than by including a specific, in-depth analysis in each nuclear power plant's environmental statement. As part of this effort the 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 such wastes can be devised. EPA is available to assist the NRC and ERDA in their efforts to ensure that an environmentally acceptable waste management program is developed to meet this critical need. In this regard, EPA provided extensive comments on WASH-1539 on November 21, 1974. Our major point of criticism was that the draft statement lacked a program for arriving at a

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satisfactory method of "ultimate" high-level waste disposal. We believe this is a problem which should be resolved in a timely manner, since the country is committing an increasingly significant portion of its resources to nuclear power and wastes from operating plants are already accumulating.

ERDA now intends to prepare a new draft statement which will more broadly discuss waste management and emphasize ultimate disposal. EPA concurs with this decision. We will review the new draft statement when it is issued and will provide public comments.

NON-RADIOLOGICAL ASPECTS

Condenser Cooling System and FWPCA Requirements

EPA will be responsible for issuance of a discharge permit for Units 1, 2, and 3 under the National Pollutant Discharge Elimination System (NPDES)—Section 402 of the Federal Water Pollution Control Act Amendments of 1972 (FWPCA). Issuance of the permit will be based upon review and analysis of all relevant information supplied by the Applicant. Consideration will be given to requirements of Sections 301 and 316(b), and all other provisions of the FWPCA and the final permit will be conditioned accordingly.

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." EPA concurs with the NRC analysis of the intake system and supports its recommended modifications to the intake structure. These modifications consist of (1) eliminating the jetties and the submerged weir which effectively acts as a fish trap, (2) relocation of the intake structure flush with the river bank, and (3) relocation of the traveling screens flush with the front face of the intake structure to allow fish escapement. Adoption of these modifications along with the low intake velocity of 0.5 fps should minimize adverse environmental effects due to impingement.

Section 301 of the FWPCA stipulates that effluent limits for various 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, October 8, 1974.

Perkins Units 1, 2, and 3, employing nine circular, mechanical-draft, wet cooling towers for the dissipation of waste heat from the closed-cycle condenser cooling system, can operate in conformance with these guidelines and standards and, in most instances, in compliance with Federally approved State water quality standards in regard to thermal effluents. However, there remains some question concerning compliance with chemical effluent standards.

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Chemical Effects

The regulations in EPA's effluent guidelines for steam electric power generating point sources include effluent limitations for such waste streams as low volume, metal cleaning, boiler (steam generator) blowdown and cooling tower blowdown which are applicable to the Perkins Nuclear Station. Pollutants from these discharges which are limited include total suspended solids, oil and grease, pH, free available and total residual chlorine, total iron, total copper, zinc, chromium and/or phosphorus.

Although NRC has generally assessed these requirements, very limited discussion of the proposed waste treatment facilities and their operation is provided and no estimate of the expected pollutant concentrations in the effluent is provided. Although some of this information is provided in the Environmental Report (ER), it is not complete. Since Duke Power Company has not yet submitted its application for an NPDES permit, EPA has not yet been provided adequate information to allow independent determination as to whether the proposed waste discharges will comply with applicable Federal regulations. Therefore, the NRC should provide information, evaluation, and discussion of these waste streams in the final environmental statement.

Low volume wastes, as defined in the effluent guidelines, are generally equivalent to the normal waste discharged to the wastewater treatment system. Such wastes are subject to limitations on total suspended solids, oil and grease, and pH. Data presented in Table 3.6 and elsewhere in the draft statement do not include expected discharge concentrations for these parameters. Consideration should be given to providing oil traps in floor drains which may be subject to oil leakage and at other points where oil could exist in high concentrations. This would allow significantly greater oil removal than the proposed wastewater treatment system.

Metal cleaning wastes are not discussed in the draft statement and are subject to limitations on total suspended solids, oil and grease, pH, total copper, and total iron. (Iron and copper are included as indicator parameters.) Treatment of these wastes is subject to requirements for two-stage coagulation, precipitation, pH adjustment and sedimentation, or

equivalent, as indicated in the effluent guidelines. This will be a requirement of the NPDES permit.

The proposed treatment of pre-operational cleaning wastes does not appear adequate in that significant and unacceptable quantities of phosphorus will be released to the Yadkin River. About 850 gallons of liquid detergent will be used for degreasing and spray cleaning of pipe assemblies and will be discharged to the temporary sewage system for treatment. Phosphorus removal by this system will be minimal. Additionally, 36,000 pounds of trisodium phosphate and 138 gallons of liquid detergent will be used for condenser degreasing and cleaning of each of the three units. The proposed treatment includes dilution and neutralization over a 14-day release period. Again, this treatment will be inadequate for phosphorus removal. However, if facilities (as indicated above) for chemical waste treatment are provided, treatment with lime to an initial pH of 11 to 11.5, followed by subsequent coagulation, pH adjustment and sedimentation would result in phosphate removals to as low as 1.0 mg/l, or less. Such treatment is recommended to minimize releases of phosphorus to the Yadkin River and subsequently to High Rock Lake.

Steam generator blowdown is subject to limitations on total iron, total copper, oil and grease, and total suspended solids in accordance with the "boiler blowdown" limitations of the effluent guidelines. Since these wastes are to be recycled within the condensate feedwater demineralizing system, effluent limitations are expected to be achieved. Although pollutant concentrations from this plant could be anticipated to be significantly below effluent guideline limitations, no estimate of effluent iron and copper concentration is presented.

The cooling tower design generally appears to meet the requirements of the effluent guidelines as to cold side blowdown and minimization; however, it is to be noted that conditions of 76°F wet-bulb temperatures are exceeded for 2-1/2 percent of the time during the summer months and that 77°F is exceeded one percent of the time. Even though discharge temperatures greater than those evaluated in the draft statement may occur, we concur that the discharge is expected to meet requirements of the North Carolina Water Quality Standards.

Chemical discharges in the cooling tower blowdown are of concern. EPA's effluent guidelines limit the discharge of free

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available chlorine to a 0.5 mg/l maximum and 0.2 mg/l average concentration during a maximum of two hours per day per unit and do not allow free available or total residual chlorine to be discharged from more than one unit at a time. Less stringent limitations may be imposed if the Applicant can demonstrate that the units in a particular location cannot operate at or below this level of chlorination, and if such higher concentration limits will meet applicable requirements of water quality standards. However, more stringent limitations can be required for water quality protection. Since free residual chlorine concentrations of up to 0.3 mg/l and chlorine reaction products of up to 50 mg/l (some of which may be highly toxic) can be anticipated, unacceptable concentrations of total residual chlorine can be expected under low-flow conditions. EPA recommends that all practicable methods be instituted to minimize chlorine discharges, including discontinuation of cooling tower blowdown during chlorination and subsequent periods of high chlorine concentration. EPA further recommends that total chlorine residual be limited to 0.20 mg/l for a period not to exceed two hours per day at the edge of a limited mixing zone, or such higher concentrations which will protect aquatic organisms if present for more than two hours per day.

Effluent guideline limitations for cooling tower blowdown also include 24-hour average concentrations for zinc, chromium, and phosphorous of 1.0, 0.2, and 5.0 mg/l (not 2.0 mg/l for phosphorous as indicated on page 5-11), respectively. Although it appears that no zinc or chromium will be added to the tower, zinc and phosphorus concentrations may exceed allowable limitations. Available data on toxicity to aquatic organisms of the proposed corrosion-deposit inhibitor, aminomethylene phosphonate, and the proposed alternative biocide, dodecylguanidine hydrochloride, is inadequate. Additional toxicity data, especially on indigenous fish species which might be attracted to the heated discharge in the winter, is necessary before final definitive conclusions can be reached regarding the toxic effects. Prior to approval of use of these chemicals, adequate 96-hour median tolerance limit (TLM 96) data for indigenous aquatic organisms at various levels of the food web must be provided to assure that releases are within acceptable limits.

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. Duke Power Company apparently has not provided a detailed erosion control plan to the NRC but has proposed to minimize erosion by providing detention ponds and berms. 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. As previously noted, no application for an NPDES permit has yet been received from Duke Power Company. To assure that construction is not delayed, application should be received not less than 180 days prior to the proposed start of construction.

Although the Yadkin River has not been considered to be within the jurisdiction of the Army Corps of Engineers, the Corps has recently published new determinations regarding definition of navigability of streams which may result in a need for a Section 404 permit for Perkins Station. (See CFR Vol. 40 No. 98 Part 3 pp. 19766-19794.) The Applicant, therefore, should request further clarification from the Corps as to whether a "dredge or fill" permit will be required. Regardless of whether such a permit is required, all available precautions, techniques and equipment should be utilized to minimize any further siltation of the Yadkin River and High Rock Lake due to plant and facility construction. Further siltation will have serious effects on the aquatic population in the lake. Specific and detailed plans should be provided in the final statement to allow interested Federal and State agencies to comment on the erosion control plan.

Wastewater Impoundment

Duke Power Company proposes the construction of two earth-fill dams to form a Nuclear Service Water Pond and an Auxiliary Holding Pond. These impoundments will be formed by the obstruction of two onsite creeks (p. 4-8). These impounded waters will be considered as "waters of the United States," since they were so considered prior to damming. The Auxiliary Holding Pond is to be used to collect effluent that is discharged from the wastewater treatment facility before release to the Yadkin River (ER p. 2.5-15). However, use of "waters of the United States" for the purposes of final wastewater treatment is inconsistent with the FWPCA. Consideration must be given to providing treatment equivalent to that provided by the Auxiliary

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Holding Pond, if required to meet effluent limitations, before the wastes are discharged to any "waters of the United States," which, in this case, is the Auxiliary Holding Pond.

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Noise Impacts

The potential noise impact from this project was inadequately discussed in the draft statement. Noise problems are generally associated with the construction and operation of this type of project. In both instances, concern focuses on occupational noise hazards as well as the noise which propagates from the project into the surrounding community. There are insufficient details to enable identification of the impact of environmental noise on the surrounding land uses. The site plan should show the location of major noise generators on the site; and the map of the surrounding area should show standard land-use categories (e.g., residential, commercial, industrial, etc.), population densities, and the location of specific sensitive receptors, such as hospitals. The noise analysis should then indicate the extent the noise levels in Table 1 are exceeded for specific land uses. While levels indicated in Table 1 do not constitute a standard, they should be used as a bench mark or reference for describing the magnitude of the noise impact.

Inadequate documentation of existing acoustic environment has been provided. In addition, the noise level of 84 dbA at 250 feet for the cooling tower operation extrapolates to approximately 62 dbA at the site boundary (3,000 feet from tower). For continuous operation, this could be annoying to surrounding residential areas. Existing conditions at the site boundary should be developed utilizing acceptable acoustical sampling methodology. These levels should be compared with predictions of site boundary noise from the operation of the plant. Only in this way is it possible to assess potential noise impacts.

Noise generated by traffic resulting from the project can be significant sometimes. With respect to this project, it appears that the only potential problem which might result would be from truck traffic during construction. Truck traffic generated during construction should be indicated and the potential noise problems addressed.

Construction workers and plant operating personnel should not be exposed to noise levels in excess of those specified in Table 2. The final statement should demonstrate that such noise levels will not be exceeded, and that plans exist to reduce human exposure in high noise level areas to levels below those indicated. In addition, impulse noise from equipment such as

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jackhammers and pile drivers should not exceed the limits established in Figure 1. During plant operation potential noise sources will be associated with transformers, turbines, atmospheric steam venting, ventilating systems, and circulating water pumps. Anticipated noise emission levels from each of these sources should be included in the final statement.

For your convenience, Table 3 lists basic information on sound levels associated with various types of construction equipment. Since these levels are averages, actual noise levels will vary somewhat from those indicated. In particular, noise levels will generally be higher than those in Table 3 for products within each category having a higher than average capacity. Level 1 indicates current, quiet products, and Level 2 lists equipment which can be quieted by the use of best demonstrated technology.

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TABLE 1

YEARLY AVERAGE* EQUIVALENT SOUND LEVELS IDENTIFIED AS REQUISITE TO PROTECT THE PUBLIC HEALTH AND WELFARE WITH AN ADEQUATE MARGIN OF SAFETY

	Measure	Indoor Activity Interference	Indoor Hearing Loss Consideration	Indoor To Protect Against Both Effects (b)	Outdoor Activity Interference	Outdoor Hearing Loss Consideration	Outdoor To Protect Against Both Effects (b)
Residential with Outside Space and Farm Residences	L_{dn}	45		45	55		55
	$L_{eq(24)}$		70			70	
Residential with No Outside Space	L_{dn}	45		45			
	$L_{eq(24)}$		70				
Commercial	$L_{eq(24)}$	(a)	70	70(c)	(a)	70	70(c)
Inside Transportation	$L_{eq(24)}$	(a)	70	(a)			
Industrial	$L_{eq(24)}$(d)	(a)	70	70(c)	(a)	70	70(c)
Hospitals	L_{dn}	45		45	55		55
	$L_{eq(24)}$		70			70	
Educational	$L_{eq(24)}$	45		45	55		55
	$L_{eq(24)}$(d)		70			70	
Recreational Areas	$L_{eq(24)}$	(a)	70	70(c)	(a)	70	70(c)
Farm Land and General Unpopulated Land	$L_{eq(24)}$				(a)	70	70(c)

Code:

a. Since different types of activities appear to be associated with different levels, identification of a maximum level for activity interference may be difficult except in those circumstances where speech communication is a critical activity. (See Figure D-2 for noise levels as a function of distance which allow satisfactory communication.)
b. Based on lowest level.
c. Based only on hearing loss.
d. An $L_{eq(8)}$ of 75 dB may be identified in these situations so long as the exposure over the remaining 16 hours per day is low enough to result in a negligible contribution to the 24-hour average, i.e., no greater than an L_{eq} of 60 dB.

Note: Explanation of identified level for hearing loss: The exposure period which results in hearing loss at the identified level is a period of 40 years.

*Refers to energy rather than arithmetic averages.

Source: EPA Document 550/9-74-004 (March 1974) "Levels Document" -- Table 4

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TABLE 2

NOISE EXPOSURE LEVELS, STEADY STATE

Duration (per day) in hours	EPA Max. Sound Level (dBA)
8	85
4	88
2	91
1	94
1/2	97
1/4 or less	100

Source: EPA's Occupational Noise Exposure Regulation, Federal Register dated December 18, 1974

POOR ORIGINAL

TABLE 3 BASIC INFORMATION ON CONSTRUCTION EQUIPMENT (1972).

Equipment Types	Present		Quiet Products Level 1		Best Technology Level 2		
	Sound Level (a)	Average Unit Price	Sound Level (a)	Average Unit Price	Sound Level (a)	Average Unit Price	Units Produced Per Year (b)
Air Compressor	81	$ 3,500	71	$ 3,300	65	$ 11,000	12,000
Backhoe	85	18,000	80	18,500	76	19,300	18,000
Concrete Mixer	85	25,000	83	25,400	75	27,500	7,000
Concrete Pump	82	50,000	80	50,650	75	55,000	500
Concrete Vibrator	76	2,000	70	2,060	66	2,200	6,000
Crane, Derrick	88	110,000	80	111,000	76	113,000	2,200
Crane, Mobile	83	50,000	80	51,000	76	53,000	4,200
Dozer	87	28,000	83	28,300	78	30,800	18,000
Generator	78	1,000	71	1,100	65	1,400	70,000
Grader	85	22,000	80	22,800	75	24,200	7,000
Jackhammer (P.B.)	88	800	80	850	75	950	(90,000)(c)
Loader	84	20,000	80	20,600	76	22,000	30,000
Paver	89	42,000	80	43,000	76	44,200	500
Pile Driver	101	33,000	90	33,500	80	37,000	350
Pneumatic Tool	85	300	75	320	65	400	(100,000)
Pump	76	430	71	450	65	580	50,000
Rock Drill	98	35,000	90	36,000	80	39,000	(1,000)
Roller	80	11,000	75	11,330	70	12,100	6,000
Saw	78	100	70	110	65	150	(500,000)
Scraper	88	70,000	83	71,500	78	75,000	5,000
Shovel	82	71,000	80	72,000	76	74,000	3,000
Truck	88	18,000	83	18,250	75	19,500	75,000

a. Sound level refers to average level during operation in dBA at 50 ft.

b. Estimated from Department of Commerce published data and industry sources (sales may include other industries).

c. Parenthesis enclose preliminary estimate.

Source: BBN Report No. 2887 dated 27 November 1974, Regulation of Construction Activity Noise -- Table S1

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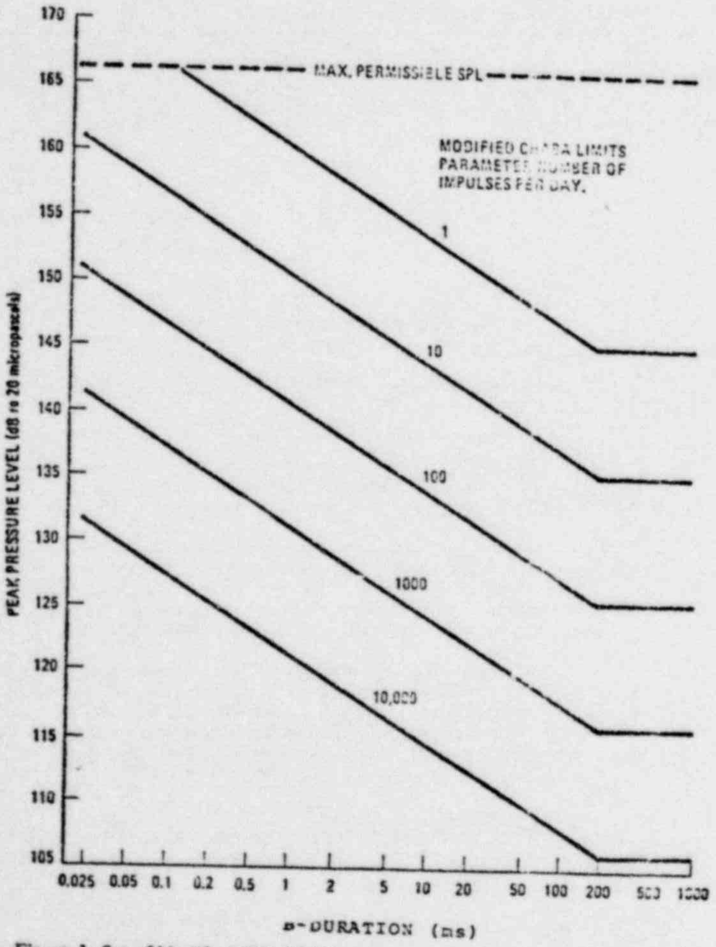

Figure 1 Set of Modified CHABA Limits for Daily Exposure to Impulse Noises Having B-Durations in the Range 25 Microseconds to 1 Second. (Parameter: number (N) of impulses per daily exposure. Criterion: NIPTS not to exceed 5 dB at 4 kHz in more than 10% of people.)

Source: EPA Document 550/9-74-004 (March 1974) "Levels Document" --Figure 4

POOR ORIGINAL

ADDITIONAL COMMENTS

1. The final statement should clarify the Applicant's estimate of gaseous I-131 discharges. For example, page 3-14 of the draft statement (paragraph 3) indicates the Applicant has estimated 0.007 Ci/yr/unit of I-131 from the turbine building only, but subsequently in paragraph 6 the total estimated release is given as 0.004 Ci/yr/unit.

2. The draft statement (p. 5-12) indicates the radioactive liquid waste dispersion models are discussed in Section 2.5. However, no such discussion was found. The bases for the river dispersion calculations should be presented in the final statement.

3. The draft statement (page 3-18) concludes that the gaseous emissions from the diesel generator would be within the limits set in State regulations. Even though the impact on air quality may be minimal, emissions of air pollutants from the diesel generators should be calculated and shown in the final statement. Also, the final statement should include the fuel use rate and the size of the diesel generators so that independent assessments can be made.

4. The final statement should provide the cumulative population and annual cumulative population doses (person-rem) for the period of plant operation (1982-2022).

5. The final statement should provide an estimate of the cumulative population doses to persons within 50 miles of Perkins from radioactive effluents predicted to be discharged from the Perkins and McGuire nuclear plants in order to consider the cumulative regional impacts.

6. The joint distribution of wind speed and wind direction for the various stability categories needs to be either included in the final statement or referenced from the environmental report.

7. No discussion is presented on the effects to fish eggs and larvae from the intermittent use of 150 cfs of water for dilution of radwastes. Recent data indicate significant damage to these life stages due to the mechanical effects of pumping. This should be evaluated and discussed in the final statement.

8. The final statement should indicate the method which will be used to control particulate emissions from the on-site concrete batch plant.

9. On page 3-15, the krypton-85 release should be 1097 Ci/yr.

1724 229

North Carolina Department
of Administration

OFFICE OF
INTERGOVERNMENTAL
RELATIONS

EDWIN DECKARD
DIRECTOR

JAMES E. HOLSHOUSER, JR., GOVERNOR • BRUCE A. LENTZ, SECRETARY

July 21, 1975

Dr. Robert A. Gilbert
NRC Environmental Project Manager
Office of Nuclear Reactor Regulation
Nuclear Regulatory Commission
Washington, D.C. 20555

Re: Draft Environmental Statement Perkins Nuclear Station, Units 1,2, and 3, Docket No. STN 50-488, 489, and 490, SCH No. 054-75

Dear Dr. Gilbert:

The North Carolina State Clearinghouse has received and reviewed the above referenced draft environmental impact statement. However, the State Clearinghouse cannot concur with the findings of this statement until those concerns raised in the attached comments are carefully and adequately addressed by the Duke Power Company and the NRC.

The attached comments have been submitted by Mr. Art Cooper, N.C. Department of Natural and Economic Resources and Mr. Dayne Brown, Radiation Protection Branch, Division of Facility Services, N.C. Department of Human Resources. The additional comments referenced in Mr. Art Cooper's letter, July 14, 1975, are also attached.

Your attention to the concerns raised in these comments is appreciated. Thank you for the opportunity to comment on this project and the requested time extension for review.

Sincerely,

Jane Pettus

Jane Pettus
Clearinghouse Supervisor

cc: Art Cooper
Dayne Brown
Louis G. Christian
Region G

7752

118 WEST JONES STREET RALEIGH 27603 (919) 829-2594

14 July 75

MEMO TO : Ms. Jane Pettus

FROM : Art Cooper Art Cooper

SUBJECT : Comments on DEIS related to construction of Perkins Nuclear Station Units 1,2 and 3 - CIC-054-75

In accordance with CEQ Guidelines #1500.2 (b)(3) published in Volume 38 Number 147 Part II of the Federal Register (August 1, 1973), it is proper that the responsible Federal Agency (NRC) include in a DEIS a description of possible alternative actions. Furthermore, it is stated therein that this description should serve as a methodology for assessing the relative advantages and disadvantages of each alternative and not as a justification for decisions already made. The NRC appears obviously negligent in fulfilling this objective. The comparisons of the desirability between the proposed site and the Tuckertown site can serve as a good example of this deficiency. The one paragraph dedicated to this evaluation concludes that the Perkins site is inferior to the Tuckertown site in three out of four characteristics analyzed and yet the NRC favors the Perkins site. The substantiation for this position is predicated on the assumption that the alternative analysis is a foregone conclusion.

The use of mechanical-draft cooling towers instead of natural-draft towers also illustrates an inadequate comparisons of alternatives. Considering the advantages of reduced fogging, noise and drift solids associated with the natural draft towers, it is difficult to understand the limited discussion of this alternative in the DEIS.

Additionally, the impact analysis of this project appears to be incomplete and overly abbreviated. The DEIS should certainly consider in greater detail the environmental impact of the water demands of PNS on present and future utilization of the Yadkin and its associated reservoirs. The substantial reduction of available surface water for future industrial use should be considered a commitment of long-term resources. The ultimate effect of plant operation on water levels in High Rock Lake and on the other downstream reservoirs should be ascertained in greater detail, the impact on residential, recreational and industrial users examined and the relationship of these events to existing release agreements developed. DNER can assist in the development of appropriate models if Duke Power can supply us with their operating rules.

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The NRC should additionally consider the possibility of increased shoaling below the intake structure as the volume of water is markedly reduced. Will this create any meandering problems? Will the biotic character of the Yadkin change from the resultant deposition?

An examination of the adequacy of the existing transportation system necessary to transport fuel to and from the plant site should be included in the analysis. Although a discussion of the impacts of a railroad spur and access roads is included, no mention of the condition of the existing facilities is. Should these facilities be improved in order to safely transport the fuel and waste? The upgrading of the existing highways and railroad lines may be considered necessary in order to accommodate the additional traffic and the extreme tonage to be installed on the site. This should be mentioned in the DEIS as well as the expected impacts of any construction such as traffic disruptions, noise, sedimentation, etc.

The impact of the operation and maintenance of the associated transmission lines should be more fully developed. For example, it can be expected that the convenience and accessibility of power line right-of-ways will attract numerous off-road vehicles and hikers. This situation will cause some increase in annoyances to adjacent property owners, in game poaching, and in vandalism.

The NRC should also investigate the possiblity of health effects occurring to those individuals who may be exposed to intense electrical fields of the magnitude proposed. Although only limited research is available, there is evidence that significant damage to the human nervous system can result from chronic exposure to electrical fields of the intensity used in this project.[1]

The DEIS is deficient in not examining the effects of the Perkins plant on white perch. If the amount of detail dedicated to each species is intended to reflect its relative importance, the DEIS is in error. Indeed, the catches of white perch from High Rock Lake greatly outnumber those of white bass and like the white bass the fish ascends the Yadkin on spawning migrations.

The Department of Natural and Economic Resources also believes that a more thorough examination of the implications of Perkins operation on the existing Boone's Cave State Park is warranted. Since this park represents an important recreational resource within a rapidly urbanizing region of the state, it should be considered an adversely affected public asset.

Emphasis should be placed on those effects that could detract from the existing attractions of Boone's Cave and result in the waste of a public investment. Visual pollution from the fogging, distractions resulting from the noise of plant operation and the destruction of the natural flora from drift solids could all be negative environmental impacts that are significant to the future utilization of Boone's Cave. Mitigation measures should be explored with regard to satisfying the recreational needs of the area if the impacts to Boone's Cave can not be avoided.

The Department believes that a more comprehensive description of the sampling methodologies should be provided. Included in this description should be:

a) The sampling schedule and description for the terrestrial and aquatic ecological components.

b) the statistical results and,

c) reference sources used.

Additionally, the effects expected to flora and fauna of releases of amines, suffates and chlorine should be described in greater detail. This analysis should consider the effects of thermally enhanced chloroxyamines and other synergistic effects expected to occur.

Finally, the Department may have additional comment forthcoming in the very near future. Consequently, would you please inform the NRC that we would appreciate their consideration of our further remarks to be forwarded to them within the next ten days.

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[1] Young, Louise B. Power Over People, Oxford University Press, New York, 1974.

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JUL 22 1975

MEMORANDUM

July 21, 1975

TO: Jane Pettus

FROM: Art Cooper *Art Cooper*

SUBJECT: Additional Comments on the DEIS Related to the Construction of Perkins Nuclear Station Units 1, 2 and 3--CIC-054-75

The DEIS is incorrect in stating that there are three schools within a ten-mile area of the site. In fact, five schools are located within ten miles, including:

Shady Grove School at Advance	Grades 1-8
Cooleemee School	Grades 1-8
Mocksville Elementary School	Grades 1-5
Mocksville Middle School	Grades 6-8
Davie County High School	Grades 9-12

Major problems could result in Davie County along NC801 if anticipated traffic volumes occur to and from the site. Highway 801 is narrow and contains several dangerous curves. Two hazardous intersections exist at its junction with 601 (Greasy Corners) and US 64 (Fork). Realignment and traffic signals will probably be necessary.

cc Mike Black

RECEIVED

JUL 14 1975

STATE OF NORTH CAROLINA

DEPARTMENT OF HUMAN RESOURCES

Division of Facility Services

P. O. BOX 12200 RALEIGH 27605

JAMES E. HOLSHOUSER, JR.
GOVERNOR

DAVID T. FLAHERTY
SECRETARY

I. O. WILKERSON, JR.
DIRECTOR
TELEPHONE

In reply specify code: LC-RP

1724 232

M E M O R A N D U M

TO: Mr. Hal Maness, Director
Division of Plans and Programs

FROM: Dayne H. Brown, Head *Dayne H. Brown*
Radiation Protection Branch

DATE: July 11, 1975

SUBJECT: Draft Environmental Statement
Perkins Nuclear Station
Units 1, 2 and 3
S.C.H. File No. 054-75

Radiation Protection Branch staff members have reviewed the subject document as it relates to radiological considerations. Based upon this review we have the following comments:

1. Section 5.4 entitled "Radiological Impact"

The term "man-Rem" is used throughout Section 5.4 (also in Section 7), yet there is only an obscure definition provided as a footnote in Table 5.6. In order to avoid confusion and promote better understanding by the public, it is suggested that this Section be revised to include a clear discussion of this term and its application in the evaluation of potential health effects.

Most of the discussions in this Section related to the radiation exposure of individuals is in terms of decimal millirems, yet tables 5.3, 5.4 and 5.7 utilize a commonly used notation which will serve to confuse the less informed public. (e.g., 6.9E-02 millirem is used instead of the more easily understood 0.069 millirem) Consequently, it is suggested that these tables be revised to list radiation exposures in terms of decimal millirem. This would be consistent with the intent of the Environmental Statement since the Statement does go to some lengths in showing the relationship between natural background and other radiation exposures, and the radiation exposures expected from the operation of the subject proposed facility.

It is noted that this Section addresses itself to the radiological impact of the proposed Perkins Nuclear Station to a distance in all directions of 50 miles. In addition, there is a discussion of the natural background radiation exposure of persons living within this area. However, no reference is made to the cumulative contributions to radiation exposure which may result from the construction and operation of nearby nuclear electric generating plants. Specifically the McGuire Nuclear Station which is currently under construction is physically located at least 10 miles within this 50 mile radius circle. In addition, the proposed Catawba Nucle... Station in South Carolina lies less than 20 miles from the perimete. of the 50 mile circle around the proposed Perkins Nuclear Station. Therefore, there is a significant overlap represented by the circles of 50 mile radius around each of these facilities.

It is suggested that this Section of the draft environmental statement be revised to provide some discussion of the cumulative effects upon radiation exposure resulting from the future operation of the McGuire Nuclear Station and the Catawba Nuclear Station.

2. Section 6.2.2 concerning Radiological Monitoring Program.

It is suggested that the pre-operational environmental radiation surveille ce program be expanded to include a minimal number of soil samples in order to provide some facility base line data. We are well aware of the rationale for not routinely including soil sample analyses in radiation surveillance programs. However, it seems desirable to us to at least obtain some pre-operational soil data. We feel that such data would be of some merit in the event of certain abnormal events which might occur over the lifetime of the facility. However, we are not recommending the inclusion of routine soil sampling into the operational stage.

3. Section 7 entitled "Environmental Impacts of Postulated Accidents involving radioactive materials."

Based upon our review of this Section, we feel that the coverage of radiological accident situations is substantially too light and void of significant desirable information. As noted in previous comments, this Section, in particular Table 7.2, does not provide the public with adequate and reasonable information to promote understanding. In order to correct these weaknesses, it is suggested that the text of this Section and Table 7.2 entitled "Summary of Radiological Consequences of Postulated Accidents" be revised as follows:

A. The footnotes b and c which were omitted from Table 7.2 should be included.

B. In reference to Table 7.2, it is of some value to list the consequences of postulated accidents in terms of the estimated fraction of 10 CFR Part 20 limit at the site boundary. However, it is suggested that an additional column be provided in this Table to list the actual estimated individual radiation exposures at the site boundary for each of the innumerated occurrences.

C. We feel that Table 7.2 would be much more informative if it were not totally limited by Footnote a of the Table. Specifically, it is of more than passing interest to the average individual to know what the estimated individual radiation exposures would be in the event that no remedial action were undertaken for each of the innumerated occurrences. Accordingly, it is suggested that such data be included.

D. It is generally accepted that most remedial action in the event of accidents at nuclear facilities would be limited to well within a 10 mile radius of the plant. Hence, it is deductively true that the radiological consequences of accidents on an individual basis would be substantially more significant for persons living within 10 miles of a nuclear facility than for those living 50 miles away. Therefore, it is suggested that Table 7.2 be revised to include an additional column giving the estimated man-Rem dose to the population within a 10 mile radius of the proposed facility. The current presentation of estimated doses to the population within a 50 mile radius of the proposed facility conveys virtually no information on the potential impact of accidents on nearby residents.

E. It is suggested that this Section be revised to briefly describe some of the off-site protective actions which one might expect in the event of various Class 7 and Class 8 accidents.

Other than the foregoing, we have no comments on the subject document or recommendations for the conclusion of additional information.

DHB:rbj

CC: O. Wade Avant, Jr.

JUL 29 1975

FEDERAL POWER COMMISSION
WASHINGTON, D.C. 20426

JUL 25 1975

Mr. William H. Regan
Chief, Environmental Projects Branch No. 4
Division of Reactor Licensing
U.S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Mr. Regan:

This is in response to your letter dated May 9, 1975, requesting comments on the NRC Draft Environmental Statement related to the proposed issuance of a construction permit to the Duke Power Company (Applicant) for the construction of the Perkins Nuclear Plant Units 1, 2, and 3 (Docket Nos. STN 50-488, STN 50-489, and STN 50-490), located in Davie County, North Carolina. The proposed Perkins Units 1, 2, and 3 are scheduled for commercial operation in January 1983, January 1985, and January 1987, respectively.

These comments by the Federal Power Commission's Bureau of Power staff are made in compliance with the National Environmental Policy Act of 1969, and the August 1, 1973, Guidelines of the Council on Environmental Quality, and are directed to the need for the capacity represented by the proposed units and matters related thereto and effects on hydroelectric projects licensed by the Federal Power Commission.

In preparing these comments, the Bureau of Power staff has considered the Draft Environmental Statement; the Applicant's Environmental Report; related reports made in accordance with the Commission's Statement of Policy on Reliability and Adequacy of Electric Service (Docket No. R-362); and the staff's analysis of these documents together with information from other FPC reports. The staff generally bases its evaluation of the need for a specific bulk power facility upon long-term considerations as well as upon the load-supply situation for the peak load period immediately following the availability of the new facility. Each proposed unit is expected to have a useful life of 30 years or more; during that period, each unit will contribute significantly to the reliability and adequacy of electric power supply in the Applicant's service area.

The Applicant is one of several utility systems located in the Virginia-Carolinas (VACAR) area of the Southeastern Electric Reliability Council (SERC). The Applicant's system is interconnected

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with the utility systems in the SERC area. SERC coordinates the planning of the members' generation and transmission facilities to assure reliability of the members' bulk power supply.

The Federal Power Commission has found that many power systems plan for reserve generating capacity margins between 15 and 25 percent of annual peak load. The actual planned reserve margin for a particular system depends on such factors as the number, size and types of units, and interconnections with adjacent utility systems.

The following tabulations show the Applicant's and VACAR's projected capabilities, peak loads, and reserve margins for the 1983, 1985, and 1987 summer peak periods, and the effect of the capacity of the Perkins Units 1, 2, and 3 on the reserve margins.

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1983 Summer Peak Load-Supply Situation

With Perkins Unit 1 (1,280 Megawatts)	Applicant 1/	VACAR 2/
Total Peak Capability - Megawatts	18,153	50,794
Peak Load - Megawatts	16,124	46,782
Reserve Margin - Megawatts	2,029	4,012
Reserve Margin - Percent of Peak Load	12.6	8.6
Minimum Reserve Margin (Based on 15 Percent of Peak Load) - Megawatts	2,419	7,017
Reserve Deficiency - Megawatts	390	3,005
Without Perkins Unit 1		
Reserve Margin - Megawatts	749	2,732
Reserve Margin - Percent of Peak Load	4.6	5.8
Minimum Reserve Margin (Based on 15 Percent of Peak Load) - Megawatts	2,419	7,017
Reserve Deficiency - Megawatts	1,670	4,285

1/ Data Source: NRC Draft Environmental Statement, Tables 8.1 and 8.4.

2/ Data Source: SERC's response to FPC Docket No. R-362 (Order 383-3) dated April 1, 1975.

1985 Summer Peak Load-Supply Situation

With Perkins Units 1 and 2 (2,560 Megawatts)	Applicant 1/	VACAR 2/
Total Peak Capability - Megawatts	21,304	63,199
Peak Load - Megawatts	18,383	54,254
Reserve Margin - Megawatts	2,921	8,945
Reserve Margin - Percent of Peak Load	15.9	16.5
Minimum Reserve Margin (Based on 15 Percent of Peak Load) - Megawatts	2,757	8,138
Reserve Deficiency - Megawatts	-	-
With Only Perkins Unit 1 (1,280 Megawatts)		
Reserve Margin - Megawatts	1,641	7,665
Reserve Margin - Percent of Peak Load	8.9	14.1
Minimum Reserve Margin (Based on 15 Percent of Peak Load) - Megawatts	2,757	8,138
Reserve Deficiency - Megawatts	1,116	473
Without Perkins Units 1 and 2		
Reserve Margin - Megawatts	361	6,385
Reserve Margin - Percent of Peak Load	2.0	11.8
Minimum Reserve Margin (Based on 15 Percent of Peak Load) - Megawatts	2,757	8,138
Reserve Deficiency - Megawatts	2,396	1,753

1/ Data Source: NRC Draft Environmental Statement, Tables 8.1 and 8.4.

2/ Data Source: SERC's response to FPC Docket No. R-362 (Order 383-3) dated April 1, 1975.

1987 Summer Peak Load-Supply Situation

With Perkins Units 1, 2, and 3 (3,840 Megawatts)	Applicant 1/	VACAR 2/
Total Peak Capability - Megawatts	23,771	71,779
Peak Load - Megawatts	20,875	62,577
Reserve Margin - Megawatts	2,896	9,202
Reserve Margin - Percent of Peak Load	13.9	14.7
Minimum Reserve Margin (Based on 15 Percent of Peak Load) - Megawatts	3,131	9,387
Reserve Deficiency - Megawatts	235	185
With Only Perkins Units 1 and 2 (2,560 Megawatts)		
Reserve Margin - Megawatts	1,616	7,922
Reserve Margin - Percent of Peak Load	7.7	12.7
Minimum Reserve Margin (Based on 15 Percent of Peak Load) - Megawatts	3,131	9,387
Reserve Deficiency - Megawatts	1,515	1,465
With Only Perkins Unit 1 (1,280 Megawatts)		
Reserve Margin - Megawatts	336	6,642
Reserve Margin - Percent of Peak Load	1.6	10.6
Minimum Reserve Margin (Based on 15 Percent of Peak Load) - Megawatts	3,131	9,387
Reserve Deficiency - Megawatts	2,795	2,745
Without Perkins Units 1, 2, and 3		
Reserve Margin - Megawatts	-944	5,362
Reserve Margin - Percent of Peak Load	-4.5	8.6
Minimum Reserve Margin (Based on 15 Percent of Peak Load) - Megawatts	3,131	9,387
Reserve Deficiency - Megawatts	4,075	4,025

1/ Data Source: NRC Draft Environmental Statement, Tables 8.1 and 8.4.

2/ Data Source: SERC's response to FPC Docket No. R-362 (Order 383-3) dated April 1, 1975.

If the Perkins Units 1, 2, and 3 are available as planned, the Applicant's reserve margins for the 1983, 1985, and 1987 summer peaks will be 12.6 percent, 15.9 percent and 13.9 percent, respectively. VACAR's reserve margins for 1983, 1985, and 1987 will be 8.6 percent, 16.5 percent and 14.7 percent, respectively. In every instance except two (1985), the projected reserve margins would not lie in the range of reserve margin values (15 to 25 percent) the Federal Power Commission has found to exist for most systems in the United States.

Without the Perkins units, the Applicant's projected reserve margins for 1983, 1985, and 1987 summer peaks would be 4.6 percent, 2.0 percent and negative 4.5 percent, respectively. VACAR's reserve margins for 1983, 1985, and 1987 will be 5.8 percent, 11.8 percent and 8.6 percent, respectively. In every instance, the projected reserve margins would not lie in the 15 to 25 percent reserve margin range. Although the tabulations use 15 percent as a minimum reserve margin for the Applicant and VACAR systems, a reserve margin of about 20 percent is considered to be more appropriate for systems in the Southeast Region. Part I of the FPC's 1970 National Power Survey estimates the reserve margin for the Southeast Region to be 20 percent and 21 percent for 1980 and 1990, respectively.

The Perkins Nuclear Station would be located approximately 16 miles upstream from Yadkin, Inc.'s High Rock Lake Development. This development is part of Yadkin Hydroelectric Project (FPC No. 2197). The Federal Power Commission issued a license for Project No. 2197 effective on May 1, 1958. Sections 5.2.12 and 5.2.3 of the Draft Environmental Statement briefly discuss the impact on High Rock Lake and other downstream hydroelectric developments licensed by the FPC, including the Falls, Narrows, and Tuckertown developments of Project No. 2197 and the Blewett Falls and Tillery dev[illegible]ments of Project No. 2206, caused by a loss of 110 cfs of water.

By order dated March 29, 1968 (copy enclosed), the FPC approved as part of the license an agreement between Yadkin, Inc. and Carolina Power & Light Company whereby Carolina would pay $62,500 annually to Yadkin, Inc. for headwater benefits [illegible]ing to Carolina's downstream Project No. 2206. This agreement sp[illegible]ed minimum average weekly stream flows to be released from High Rock Reservoir.

By a further order dated March 29, 1968 (copy enclosed), the FPC ordered (Article 33) that High Rock Lake be operated pursuant to "Operating Guides for Operation of Badin Works" Parts I through IV, filed by Yadkin, Inc. on January 8, 1968. The effect of this amendment was to reduce drawdown of High Rock Lake to 4 feet through mid August 96% of the time. Enclosed is the operating schedule. Prior to the FPC's order, the High Rock Lake drawdown reached, for example, 12 feet in 1967. Several hundred letters of complaint regarding such drawdowns

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were received in the period 1966-67, and in early 1968 over 600 additional letters were received, 95% of which requested that the drawdown be limited to five feet from May 15 to September 15. Because of this public concern, NRC should expand the Final Environmental Statement to detail the effects on High Rock Lake levels during the recreation season.

The basis for the 32 million kWh loss of energy annually from downstream hydroelectric plants should be given. In addition, the value of such loss, $120,000, appears to be low based on present day power values. There is also no discussion of any loss of dependable capacity of downstream plants. It would appear that any permit or subsequent license issued for the subject Nuclear Station should require the Applicant to adequately compensate Yadkin, Inc. and Carolina Power & Light Company for any loss of energy and capacity.

The Bureau of Power staff concludes that additional capacity equivalent to that represented by the Perkins Units 1, 2, and 3 is needed to maintain the adequacy and reliability of the Applicant's and VACAR's bulk power system.

Very truly yours,

T. A. Phillips
Chief, Bureau of Power

Enclosure
2-FPC Orders dated March 29, 1968
High Rock Lake Operating Schedule

UNITED STATES OF AMERICA
FEDERAL POWER COMMISSION

Before Commissioners: Lee C. White, Chairman; L. J. O'Connor, Jr., Charles R. Ross, Carl E. Bagge, and John A. Carver, Jr.

Carolina Power & Light Company) Project No. 2206
)
Yadkin, Inc.) Project No. 2197

ORDER APPROVING HEADWATER
BENEFITS SETTLEMENT

(Issued March 29, 1968)

On January 24, 1968, Yadkin, Inc. (Yadkin) filed a letter agreement between itself and Carolina Power & Light Company (Carolina), with respect to the settlement of headwater benefits in the Yadkin Pee Dee River Basin. This agreement modifies an agreement of February 19, 1926. The new agreement is dated January 15, 1968, and was filed pursuant to Section 13.1 of the Commission's Regulations under the Federal Power Act. The previous agreement was approved by this Commission in an order issued July 12, 1965. The new agreement includes the following provisions for operation of the High Rock Reservoir.

1. During the ten week period preceding the recreation period (May 15 through September 15) such regulated weekly average stream flow would be reduced to a flow not less than 1500 cfs so as to permit High Rock reservoir to refill by May 15.

2. During the period May 15 through July 1, such regulated average weekly stream flow would be reduced to a flow not less than 1610 cfs.

3. During the period July 1 through September 15 such regulated average weekly stream flow would be reduced to a flow not less than 1400 cfs.

DC-2?

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The proposed new schedule of operations will reduce downstream benefits to Carolina because of the more limited operations of the High Rock reservoir as provided by the new "Operating Guides for Operation of Ba n Works" which we are approving by a separate order amending Article 33 of the license for Project No. 2197. The two parties have agreed that the payment by Carolina should be $5,208.33 monthly, which is equivalent to an annual payment of $62,500.

In its order issued July 12, 1965, the Commission found that the agreement dated February 19, 1926 between Yadkin and Carolina constituted an effective and reasonable method of compensation for headwater benefits provided by Yadkin's Project No. 2197 to Project No. 2206 of Carolina Power & Light Company in the Yadkin-Pee Dee River basin in North Carolina.

In accordance with the terms of that agreement Carolin paid $100,000 a year for headwater benefits provided by the operation of Yadkin's High Rock and Narrows reservoirs. Th reservoirs, according to the agreement of February 19, 1926 were to impound and subsequently release the flood waters o the Yadkin River so as to equalize, insofar as practicable, the flow of the river. The agreement made no mention of limiting the drawdown of the High Rock reservoir at any tim of the year, but did stipulate that the net effective stora capacity shall be at least 10 billion cubic feet, which is equivalent to a drawdown of about 28 feet.

The Commission finds:

The settlement contained in the agreement dated Januar 1968 between Carolina Power & Light Company and Yadkin, Inc constitutes an effective and reasonable method of compensat for headwater benefits in the Yadkin-Pee Dee River Basin r by Carolina at Project No. 2206 from Yadkin, Inc.'s Projec No. 2197 in accordance with Section 13.1 of the Regulation under the Federal Power Act.

The Commission orders:

The afore-mentioned settlement contained in the agreement dated January 15, 1968 between Carolina and Yadkin is hereby approved until further order of the Commission should be required by changes in conditions.

By the Commission.
(S E A L)

Kenneth F. Plumb,
Acting Secretary.

AMENDMENT NO. 5

UNITED STATES OF AMERICA
FEDERAL POWER COMMISSION

Before Commissioners: Lee C. White, Chairman; L. J. O'Connor, Jr., Charles R. Ross, Carl E. Bagge, and John A. Carver, Jr.

Yadkin, Inc. Project No. 2197

ORDER AMENDING LICENSE (MAJOR)

(Issued March 29, 1968)

On January 8, 1968, Yadkin, Inc., Licensee for FPC Project No. 2197, filed an application seeking authority to operate under a new operating rule curve for the High Rock reservoir. The proposed rule curve is designated "Operating Guides for Operation of Badin Works" and would replace the present rule curve designated in Article 33 of the license as "Preliminary Operating Guides for Operation of Badin Works."

According to the Licensee, the effect of using the proposed rule curve would be to maintain higher water levels in High Rock reservoir during the recreation season, May 15 to September 15. Drawdowns in excess of five feet are expected to be infrequent and would occur only during extremely adverse flow conditions. During the 1967 recreation season the drawdown reached a maximum of about 12 feet in August. If the new rule curve had been in effect during the 1967 recreation season, the Licensee estimates that the maximum drawdown during the month of August would have been about four and one-half feet.

With the new rule curve, there will be a reduction in storage benefits provided to Project No. 2206 of Carolina Power & Light Company and to Licensee's downstream power

plants. This has been anticipated and Yadkin's contract with Carolina Power and Light Company has been amended to reduce the annual headwater benefits payment to Yadkin from $100,000 to $62,500 1/.

The State of North Carolina Wildlife Resources Commission, the Corps of Engineers, and the Department of the Interior, each reported favorably on the proposal to limit the drawdown of the reservoir as outlined in the Licensee's application filed January 8, 1968.

During 1966-1967, this Commission received several hundred letters from individuals protesting drawdown of High Rock reservoir during the recreational season. These letters were submitted on behalf of individual land owners in the vicinity of the reservoir and others including an association known as High Rock Lake Association, Inc. Following public notice of the application, several hundred letters were received from North Carolina requesting that a limit be placed on the drawdown of High Rock reservoir during the non-recreational season. Two letters have been received from persons who oppose licensee's present proposal. Additionally, the Commission has received a communication from an individual representing the High Rock Lake Association urging favorable action on the application. At this time, no facts as to the extent to which the Lake is used between September 15th and May 15th for recreation have been called to our attention which warrant the loss of power that would result from the imposition of a drawdown limitation during that season.

The Commission finds:

(1) Public notice of the application has been given. Except for those mentioned above, no other protests and no petitions to intervene have been received.

(2) It is appropriate for the purposes of the Federal Power Act and is consistent with the public interest to amend the license for Project No. 2197 as hereinafter provided.

1/ By separate order, we are approving the amended headwater benefits settlement between the Licensee and Carolina Power and Light Company.

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The Commission orders:

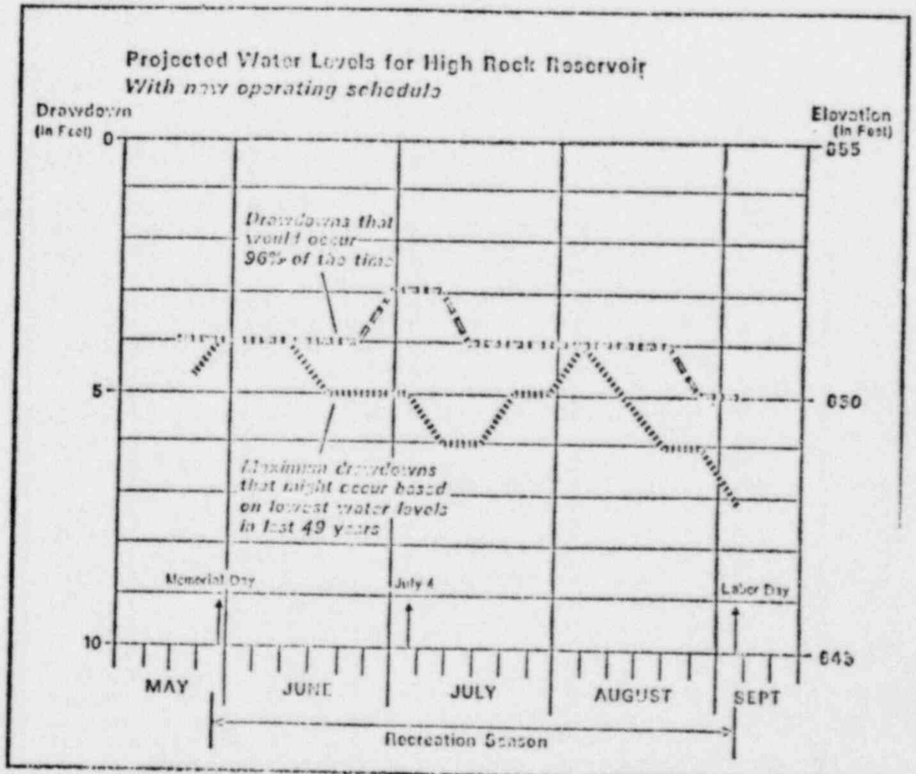
(A) Article 33 of the license is hereby amended to read as follows:

> Article 33. Until further order of the Commission, the Licensee shall, in the interest of power development, recreation and other beneficial purposes, operate the High Rock reservoir generally in accordance with the "Operating Guides for Operation of Badin Works," Parts I through IV, filed by Yadkin on January 8, 1968, with its application for amendment of license. Upon complaint or upon its own motion, after notice and opportunity for hearing, the Commission may order the Licensee to operate the project works of Project No. 2197 in such other manner as the Commission may find to be necessary and desirable for power, recreational and other purposes and consistent with the primary purpose and economics of the project.

(B) This order shall become final 30 days from the date of its issuance unless application for rehearing shall be filed as provided in Section 313(a) of the Act, and failure to file such an application shall constitute acceptance of this order.

By the Commission.

Kenneth F. Plumb,
Acting Secretary.



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United States Department of the Interior
OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

PEP ER 75/464

AUG 6 1975

Dear Mr. Regan:

Thank you for your letter of May 9, 1975, requesting the Department's comments on the Nuclear Regulatory Commission's draft environmental statement for the Construction of the Perkins Nuclear Station, Units 1-3, Davie County, North Carolina.

Our comments are presented according to the format of the statement or by subject.

Land Use

On page 2-5, reference is made to Boone's Memorial State Park and Cooleemee Plantation Game Land. In the final statement, both of these areas should be shown on Figures 2.4 and 3.7. This would not only clarify any reference to these areas but would also substantiate the statement that no recreation and wildlife areas would be crossed by transmission lines.

Impacts on Land Use at the Station Site

On page 4-1, it is indicated that the total fill requirements will be 5,435,000 yd^3 compared with the 7,600,000 yd^3 of excavated material. With regard to the 2,165,000 yd^3 of excavated material in excess of total fill requirements, the statement notes that "the applicant did not state where the excess excavated material would be placed." We suggest that the applicant be required to develop a disposal plan for the 2,165,000 yd^3 of excess excavated material, and the disposal plan should be described in the final statement.

Geology of the Site

The brief description of the geologic environment in this section on page 2-6 should be expanded to include more information on topography, bedrock geology, surficial deposits, and seismology. In this regard, devices such as maps, sections, columns, or diagrams depicting relevant aspects of soils,

physiography, topography, geology, and seismology would be helpful. Specifically, more detailed information on the distribution and physical properties of geologic materials, particularly of the 7.6 million cubic yards of material to be excavated for the station yard as indicated on page 4-1, should be provided in the final statement.

The draft statement gives little or no indication that the site is underlain by very deep residual soils. However, figure 2.5.4-3 in the applicant's Environmental Report indicates that thicknesses of 40 to 60 feet occur at the sites of the reactors. The draft environmental statement describes the surficial material on page 2-6 only by color and as sandy silt occurring in a surface zone of 0.3 to one-foot thick, underlain by a zone of clayey silt "ranging up to 3 ft. thick." Also, mention is made of a zone of weathered rock beneath which "the adamellite bedrock is found at varying depths throughout the proposed site." The general impression conveyed is that residual soil is not more than four feet thick, whereas the applicant's cross sections indicate that depths of 40 to 60 feet are more typical at the sites of major excavation. Below these residual soils are varying depths of weathered rock. The final statement should clarify the depth and character of the residual soils. We believe that this information would be helpful in evaluating the degree of soil erosion that can be expected as a result of residual soil compaction.

Effects on Ecological Systems at the Site

The draft statement indicates that cleared areas replaced by lawns, shrubbery and scattered groves of trees can, if properly managed, provide valuable habitat for a variety of wildlife species. A detailed discussion of the management program proposed for the Perkins Station should be provided in the final statement.

Carter Creek Impoundment

The Carter Creek Impoundment, which is to provide supplementary water to Yadkin River during periods of low flow, will inundate approximately 480 acres. An analysis of any mudflat exposure at High Rock Lake as a result of the Carter Creek impoundment should be presented in the final statement.

An impoundment of 480 acres could potentially support a significant sport fishery, as well as a number of

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other recreational uses. The final statement should explore the possibility of public utilization of this facility. Further, the effects of drawdown on the impoundment's recreational potential should be discussed in the final statement.

Impacts on Groundwater Use

We note in this section that the applicant believes that all groundwater flow from the site is to the Yadkin River, which is considered by the applicant to be a groundwater sink for the area. The applicant states that no flow is toward off-site wells. However, reference to available data [(1) water-table contours of ER figure 2.5.4-2 of the environmental report, (2) ER table 2.5.4-4, (3) water-table profiles of ER figure 2.5.4-3, (4) ER figure 2.1-2 Amendment 1, and (5) topography of the area as shown on the 1950 Churchland Quadrangle of the U.S. Geological Survey] suggests that much of the flow will be from the site to the northwest, west, southwest, south and southeast. It seems questionable therefore, to state that all groundwater flow is directly toward the river, even though ultimately most of it may become tributary to that stream. Also, it does not seem technically sound to say that there is no flow of groundwater toward those utilizing it in the vicinity. The final statement should address the possibility and evaluate the impacts of water migration toward existing or future off-site wells.

The fractures in the average rock permeabilities as noted in ER table 2.5.4-1 are quite significant, as most of the indicated fluid movement in the crystalline rock tested flows through a comparatively small-fracture cross section within any given interval (commonly 10 to 12 feet, according to the table). Therefore, the consequent fluid velocities would be quite high. The final statement should clearly indicate that if the groundwater became contaminated, pollutant dispersal would be more rapid with such fracture permeability than it would be if the material was of an intergranular permeable character.

Impact on Recreation Capacity of the Area

In order that the stated conclusion of "no major impact" on page 4-11 be substantiated, the final statement should reference appropriate consultation with State recreation planning and State park personnel in the North Carolina Department of Natural and Economic Resources (James Harrington, Secretary, North Carolina Department of Natural and Economic Resources, P.O. Box 27687, Raleigh, North Carolina 27611).

Reduction of Flow Into High Rock Lake

The final statement should indicate how often the flows into High Rock Lake are less than 1400 cfs during the summer, and also how often the flows would be less than this level during the operation of the plant. With this accumulated data, it should be possible to reasonably predict the extent of the drop in lake level. Further, a more extensive analysis of the impact of the industrial discharge into the Yadkin River between the Perkins site and High Rock Lake would be desirable.

Radioactive Wastes

On page 3-11, liquid radioactive wastes discharged into the environment exclusive of tritium and noble gases are estimated by the staff to be 0.4 curies per year for each reactor. Releases will be in batches and "about 150 cfs will occasionally be pumped from the river to dilute" them. We believe that the estimated gross activity concentration in the vicinity of the station discharge of 8.0×10^{-3} pCi/ml appears to be low. It appears that, if the radionuclide releases reach the 15 Ci/year level, continuous rather than occasional pumping would be necessary to maintain the discharge concentrations below those required under 10 CFR 20, Appendix B, Table II. The frequency of dilution pumping should be reevaluated in the final statement.

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Operational Non-radiological Effects on Aquatic Ecosystems

We agree with the NRC staff's position as stated on page 5-24 that the applicant's design of the makeup water intake structure is such that the potential for impinging a significant proportion of the Yadkin River Fishery exists. We further agree that the applicant "be required to eliminate the jetties and the submerged weir and to relocate the traveling screens to conform to the intended purpose of EPA guidelines." The final statement should describe how these requirements will be met and should also reference the specific provisions for the return of impinged fish that "the applicant will be required to incorporate into the intake structure design."

The additive effects of ichthyoplankton entrainment losses caused by the Perkins Nuclear Station, Buck Steam Station, the City of Salisbury, and the North Carolina Finishing Company could have severe adverse impacts on fishery resources in the Yadkin River. High entrainment losses could affect local, as well as downstream population dynamics and recruitment of fishes. Therefore, the data requested by the Nuclear Regulatory Commission staff concerning species composition, abundances, and distribution of ichthyoplankton in the Yadkin River should be provided in the final statement.

It is noted on page 5-29 that since high concentrations of chlorine from blowdown operations could cause severe damage to aquatic communities, the commission is requiring the applicant to limit releases of total residual chlorine to meet applicable Environmental Protection Agency standards. Procedures to effectively guarantee compliance with these standards should be described in the final statement.

Ebvironmental Impacts of Postulated Plant Accidents Involving Radioactive Materials

Major facility accidents are not evaluated in the statement, but reference is made to page 7-2 of the draft of the Reactor Safety Study in which major reactor accidents were evaluated. Our review of the draft of the Reactor Safety Study indicated that effects of contamination on water resources were not considered in detail, either in respect to radionuclides escaping from the containment to the atmosphere or those entering the ground. Estimates of radionuclides entering

groundwater were ignored. It was concluded that the Reactor Safety Study had concentrated on short-term health effects and had not considered long-term effects on the water environment. In addition, the study considered effects under generalized site conditions, rather than at specific sites. Because of these shortcomings of the Reactor Safety Study, the potential for contaminating water resources should be examined in detail with regard to the specific environment of the site in the final statement.

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

Sincerely yours,

(Sgd) Stanley D. Doremus

Deputy Assistant Secretary of the Interior

Mr. William H. Regan, Jr.
Chief, Environmental Projects
Branch 4
Division of Reactor Licensing
Nuclear Regulatory Commission
Washington, D. C. 20555

1724 243

The Point Farm
Route 4
Mocksville, North Carolina 27028

August 6, 1975

Docket No. STN 50-488
STN 50-489
STN 50-490

RECEIVED AUG 13 1975

Robert A. Gilbert PhD, Project Manager
Enviromental Projects Branch 4
Directorate of Licensing
Atomic Energy Commission
Washington, D. C. 20545

Dear Dr. Gilbert:

Am writing to request inclusion in the final Enviromental Impact Statement, an expansion and correction of statements appearing in paragraphs 3.9.2 and 3.9.3 of Duke Power Co. Project 81, Perkins Nuclear Station Enviromental Report, Vol. 1 documented historical and archaeological information concerning "The Point" section of Davie County, North Carolina. The proposed alternate route for the Perkin's Plant transmission lines crosses this area.

As you will recall we have had previous correspondence seeking the method of furnishing information for inclusion in the final enviromental impact statement. I have also been in touch with Duke Power Co. on this same subject. I have delayed further correspondence until such time as I could furnish documented substantiation which is now at hand. A voluminous report prepared by a nationally recognized archaeologist, entitled "An Archaeological Survey of "The Point" Section of Davie County, North Carolina" is now on file in the Archives and History Department of the State of North Carolina, Raleigh, N.C. They will furnish you a copy on request.

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This report tends to establish the following:

"The Point", lying as it dces between the two major rivers of Piedmont, North Carolina, and because of its terrain, containing woodlands, grasslands, hilly lands and caves suitable for habitation of all forms of both vegatative and animal life has always undoubtedly been inhabited by man. Verified sites at which verifiable artifacts exist and are catalogued appear to confirm that all presently known and recognized cultures of the Southeast lived on "The Point". In addition "The Point" is the site of the historic city of Clinton - not to be confused with the present existing Clinton in eastern North Carolina - as well as confirmed pre-revolutionary English occupation, post bellum, and ante bellum sites - and reaching into and through the industrial and agricultural revolutions.

Small areas of land that have supported all cultures of man are extremely rare. Scattered stratified sites of hunting, agrarian or city cultures are commonplace. I have been advised and believe that a small area of land on which all known cultures of man have lived and on which verifiable artifacts of these cultures exist is a rare treasure.

Based on this it has long been planned to develope the area, commercially or otherwise as a museum of man in the Southeast as suggested in the report on "The Point" on file with Archives and History.

I would request that this information be incorporated into the final Enviromental Impact Statement.

Sincerely,

[signature]

cc: Duke Power Co.

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APPENDIX B

APPLICANT's COMMITMENT LETTER RELATING TO THE STAFF'S "UPPER BOUND" RADIOLOGICAL DOSE ANALYSIS

B. Gilbert

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DUKE POWER COMPANY
POWER BUILDING, BOX 2178, CHARLOTTE, N. C. 28242

W. H. OWEN
VICE PRESIDENT,
DESIGN ENGINEERING

1724 245

August 8, 1975

8-21-75

Mr. Daniel R. Muller
Assistant Director for Environmental Projects
Division of Reactor Licensing
U. S. Nuclear Regulatory Commission
Washington, D. C.

Re: Project 81
Application of 10CFR50, Appendix I
Duke File: P81-1412.06

Dear Mr. Muller:

This is in response to your letter of July 30, 1975 requesting confirmation of our intent to satisfy the requirements of Title 10, Chapter I, Code of Federal Regulations, Part 50, Appendix I.

The proposed design for which we seek a construction permit includes the radwaste equipment presently described in the Project 81 PSAR Section 11.0. We do not intend, in connection with our construction permit application, to remove any presently proposed equipment or systems.

In connection with the hearings, to consider the radiological safety aspects of the facilities, we will provide such additional equipment determined to be necessary to meet the requirements of 10CFR50, Appendix I. We understand that the determination will be a realistic and detailed assessment based on best available data. Furthermore, the upper bound estimates of radiological impact referred to in your letter of July 30, 1975 have no bearing on the assessment required by 10CFR50, Appendix I, but will be used with respect to the radiological environmental impact assessment required by NEPA which is discussed in your Environmental Statement.

Very truly yours,

SKBlackley Jr
for
W. H. Owen

RMW/bjg

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Appendix C

DESCRIPTION OF THE UPPER-BOUND PROCEDURE FOR CALCULATING POPULATION DOSES

This appendix describes the models and assumptions used to make upper bound estimates of population dose for interim assessment of the potential radiological impact from normal operation of nuclear power stations in the United States.

DOSE DEFINITIONS

Individual doses from specific radionuclides were estimated using standard internal dosimetric techniques in accordance with the recommendations of the ICRP.[1,3] All internal dose conversion calculations have been made using the maximum permissible concentrations listed in ICRP Publications 2 and 6. Data on breathing rates, organ masses, and other physiological parameters are those implied by the standard man of ICRP 2.

The isotopic concentration levels in the environment used in the dose calculations were conservatively assumed to be those which would exist during the final year of plant life. A 30-year plant operational lifetime was assumed for calculating buildup of long-lived radioactivity in the environment. Calculated doses represent a 50-year dose commitment which would be received by the population during 1 year of exposure to radioactive releases from the facility at the levels described; that is, the calculated doses reflect the dose that a person would receive over 50 years from radioactive materials to which that person was exposed for 1 year. For isotopes with a short effective half-life, essentially all the exposure occurs in the year of the intake. For isotopes with a longer effective half-life, the dose resulting from intake in any one year may be spread over a long period. The 50-year dose commitment method computes the dose associated with any given year's intake, even if that dose is due to a long-lived isotope and is spread out over the lifetime of the person exposed.

RECEIVING WATER

The liquid effluent population doses previously used by the staff were conservative. For example, fish were assumed to have come to equilibrium with the radioactivity content of the water in which they were caught. Thus, the man-rem developed previously has been accepted for this evaluation and incorporated into the sum. In any case, the liquid effluents contribute only small fractions of the total impact of the station.

ATMOSPHERIC EFFLUENTS

For a uniform population density the population dose may be written as

$$\text{population dose} = K\,\overline{\Psi}\,P \quad ,$$

where $\overline{\Psi}$ is the spatially averaged concentration time integral appropriate for a population of P individuals.

ATMOSPHERIC EFFLUENTS THAT DEPOSIT (RADIOIODINE AND PARTICULATES)

At any point, the concentration time integral, Ψ, will be related to the ground concentration, w, and the deposition velocity, V_g, by

$$V_g = w/\Psi \quad .$$

Thus the population dose can be expressed as

$$\text{population dose} = K\,\overline{W}\,P/V_g \quad ,$$

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where $\overline{W}$ is the average ground concentration appropriate for the population P. In the above equation, only the average ground concentration, $\overline{W}$, is needed. Noting that whatever is released will eventually settle, we can define the average $\overline{W}$ over a large arbitrary area as

$$\overline{W} = Q/A ,$$

where Q is the total source released. This gives

$$\text{population dose} = (K\ Q\ P)/(A\ V_g) ,$$

where P/A is the average population density (people/m^2), Q is the total source released (Ci), V_g is the deposition velocity (m/sec), and K is the dose conversion factor (rem/Ci-sec/m^3). The above equation was used to determine upper-bound population doses for the generic case.

The doses resulting from ground-plane irradiation of the population were primarily based on the Oak Ridge EXREM III Code.[4] Data on certain other isotopes were based on Batelle studies.[5] Basically, the method used consists of determining the gamma energy at 100 cm above an assumed infinite ground plane. Buildup of long-lived radioactivity on the ground from 30 years of continuous deposition includes ingrowth of radioactive daughter products. No beta doses from ground-plane irradiation were treated because vegetation on the ground, clothing, and the travel distance in air all combine to make this dose contribution very small. In any case, the contribution to the total U.S. population dose from ground-plane radiation is negligible.

FOOD UPTAKE

Population exposure from airborne radioisotopes resulting from food uptake is determined, not by the density of people in the area of the food crop, but by the number of persons that can be fed by the affected crop. We have considered the exposure associated with three principal pathways: direct ingestion of affected vegetation, consumption of meat from animals fed on affected vegetation, and consumption of milk from animals fed on affected vegetation.

For our interim estimates, ground deposition was computed as described above. Vegetation density used was 2300 g of vegetation per square meter and 440 g of grass per square meter of pasture,[6] which is typical of average agricultural and pasture land.

Concentrations of isotopes on the soil assumed buildup of the isotope from continuous deposition over the facility lifetime (30 years). Also included was ingrowth of radioactive daughter products. Isotopes were assumed to be deposited directly on vegetation as well as on soil and to be taken up by plant roots. No loss of radioisotopes from soil by weathering or other removal mechanisms is included; so the calculated results tend to be conservative.

Concentrations of isotopes deposited directly on vegetation assumed an effective 13-day weathering-removal half-life from plant leaves in addition to the radiological half-life. Since both soil deposition and vegetation deposition are treated assuming the full original airborne concentration (i.e., deposition of isotopes on the soil was not depleted to account for the isotopes deposited on vegetation before they reach the soil), material weathered from the plants to the soil has already been accounted for. Thus, the doses do not need to be treated separately. Of the amount directly deposited on vegetation, 30% was assumed to be absorbed by the plant.

This results in a computed concentration of radioisotopes in agricultural vegetation in the affected area. For that portion of the vegetation that is assumed to go directly to human consumption, a decay time of 7 days was assumed in the transfer of foodstuffs from the field to ultimate consumption.

In addition to the portion going directly to human consumption, vegetation containing radioisotopes as computed above is assumed to be fed to meat and milk animals. Cattle were assumed to have ingested at a rate equivalent to 200 kg "grass" per day.[7] Assuming a grass dry matter content of 25%, the above rate corresponds to 50 kg dry "grass" per day. This ingestion rate is not to be considered as the daily mass intake of feed, but only the "grass equivalent" intake. The development of this estimate is outlined below.

To maintain a high productivity, animals are generally offered feeds, such as grains and harvested forages, to supplement or to totally replace their pasture intake.[7-9] The U.S. Department of Agriculture[9] has estimated that one-fifth of the diet of milk cattle is obtained from pasturing. This percentage is based on the energy requirements of milking animals.

In evaluating the transport of radioiodine (I-131) in the milk pathway, it is generally accepted that a pasture intake of 10 kg dry grass per day is applicable.[10-12] Assuming that the energy content of various feeds is equivalent to that of grass, the above statement implies a total daily intake rate of 50 kg dry "grass" or 200 kg wet "grass." Beef animals were assumed to be subject to the same feeding practices as milk cattle.

For the animal feed coming from stored feeds, a two-month delay was assumed, which results in decay of short-lvied isotopes. For the portion coming directly from pastureland uptake, no decay was assumed between deposition and animal uptake.

Transfer factors from animal uptake to milk and meat were taken from UCRL-50163.[13] For population dose estimates, a 1-day milk supply delay factor was used, and a 7-day meat supply delay factor was used between consumption of vegetation by the animal and ultimate consumption of meat or mik from that animal by persons in the population. This gives a concentration of radioisotopes in meat and milk from agricultural lands in the affected area.

To convert from concentration of radioactivity in foodstuffs to population dose, it has been assumed that the affected land has an average agricultural productivity equivalent to assuming that the entire U.S. population was fed from that portion of the land area of the U.S. east of the Mississippi River. Assuming an average daily diet for an adult of 400 g of vegetation, 250 g of meat, and 350 g of milk would result in an average daily land productivity of 100 kg of vegetation per square mile, 65 kg of meat per square mile, and 90 kg of milk per square mile.

This compares fairly conservatively with the daily agricultural land productivity for the United States of about 50 kg per square mile for milk[14] and 10 kg per square mile for meat.[15]

ATMOSPHERIC RELEASES THAT DO NOT DEPOSIT (NOBLE GASES, C-14, AND TRITIUM)

Short-lived noble gases were assumed to disperse to the atmosphere without deposition, but radioactive decay that limits spread of the gas was explicitly treated. The population dose, assuming an infinite integration along the plume pathlength, is given by

$$\text{population dose} = (K\ Q\ P)(\lambda L\ A) ,$$

which is the same form as used for particulate deposition, except that the deposition velocity is replaced by λL, where λ is the radioactive decay constant (sec^{-1}) and L is the height of the assumed vertical air mixing. An L value of 1000 m was used in the calculations.

The long-lived gaseous radioisotopes, K-85 and C-14, were assumed to be distributed by dilution in the earth's atmosphere. Both were considered to build up over 30 years of plant life. Carbon-14 was assumed to be released in oxide form, which maximizes its availability to the population via food chains. Other chemical forms such as methane would not be as readily available.

The C-14 was considered to be completely mixed in the troposphere with no removal mechanisms operating; that is, the absorption of carbon by the ocean and by long-lived biota not strongly coupled to man were neglected. In actuality, the atmospheric residence time of carbon is about 4 to 6 years,[16,17] with the ocean being the major sink. The neglect of carbon sinks yields an overestimate of the steady-state or end-of-plant-life (30-year plant life) atmospheric concentration by a factor of about 6.

Unlike radioactivity ejected into the stratosphere and then appearing in the high-latitude troposphere, as in weapon testing, the emission of concern here is directly introduced into the mid-latitudes of the troposphere. Transfer of tropospheric air between the two 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 hemispheric mixing.[4] This time constant is quite short with respect to the expected plant lifetime, and mixing in both hemispheres can be assumed for end-of-plant-life evaluations.

Doses were calculated assuming that all carbon in the body reaches the same equilibrium ratio of C-14 to natural carbon as exists in the air.

TRITIUM

Tritium was assumed to mix uniformly in the world's hydrosphere. The hydrosphere was assumed to include all the atmospheric water and the upper 70 m of the oceans. Having determined this equilibrium concentration of tritium in the world, doses to man were calculated by assuming that all the hydrogen in the body reaches the same equilibrium ratio of tritium to hydrogen as exists in the air and water of the environment.

POPULATION DENSITY AND CHANGES — LOCAL IMPACT

The doses calculated for shine dose from radioactive materials deposited on the ground and for short-lived noble gases were based on a population density of 160 persons per square mile, which is characteristic of the U.S. population east of the Mississippi River. These components of dose would be increased if the close-in populations (the populations principally exposed) exceeded this value substantially. However, as noted, these components do not significantly affect the total and would be reviewed on an individual-case basis for the Appendix I cost-benefit analysis.

Local food uptake exposures are not based on population density but rather on agricultural productivity and consequently are not directly affected by population growth, but more by changes in land use. Similarly, the principal future impact on estimates from liquid effluents would result from changes in water use patterns in the nearby areas, for example, if a drinking-water intake for a large city were constructed near the plant discharge. Such future changes are difficult to predict.

To assure adequate control of releases while allowing for future changes in water or land use, the operating license Technical Specifications will provide for periodic reassessment of changes in land and water use patterns. This will provide a periodic reassessment of the adequacy of facility performance in order to maintain exposures to the public within the Appendix I guides.

CONCLUSIONS

The main contributions to the population dose to the United States is from C-14 and I-131. The generic estimates are about 2 man-rems/year for C-14 and about 300 man-rems/year for I-131 per curie released per year of plant operation for 30 years. All other releases and pathways are minor contributors.

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REFERENCES FOR APPENDIX C

1. *Recommendations of the International Commission on Radiological Protection*, ICRP Publication 2, Pergamon Press, Oxford, 1959.

2. *Recommendations of the International Commission on Radiological Protection*, ICRP Publication 6, Pergamon Press, Oxford, 1962.

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Appendix D

COST ESTIMATES FOR ALTERNATIVE BASE-LOAD GENERATION SYSTEMS

A 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[1-3] was developed as part of the program analysis activities of the AEC Division of Reactor Research and Development, and the work was performed in the AEC Division of Reactor Research and Development, and the work was performed in the Studies and Evaluations Program at the Oak Ridge National Laboratory. The code was designed primarily for use in examining average trends in costs, identifying important elements in the cost structure, 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 may be tailored to a particular project. Use of the computer provides a rapid means of calculating 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 and 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,[4-5] and fossil-fired plants.[6-7] These cost data have been revised to reflect plant design changes since the 1971 reference date of the initial estimates.

The 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 detailed breakdown of each cost account into costs for factory equipment, site materials, and site labor. 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 AEC system of cost accounts[8] is used in CONCEPT.

To generate a cost estimate under specific conditions, the user specifies the following input: plant type and location, net capacity, beginning date for design and construction, date of commercial operation, length of construction workweek, and rate of interest during construction. If the specified plant size is different from the reference plant size, the direct cost for each two-digit account is adjusted by using 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 base date and location.

The code has access to cost index data files for 20 key cities in the United States. These files contain data on cost of materials and wage rates for 16 construction crafts as reported by trade publications over the past 15 years. These data are used to determine historical trends of site labor and material costs, providing a basis for projecting future costs of site labor and materials. These cost data may be overridden by user input if data for the particular project are available.

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.

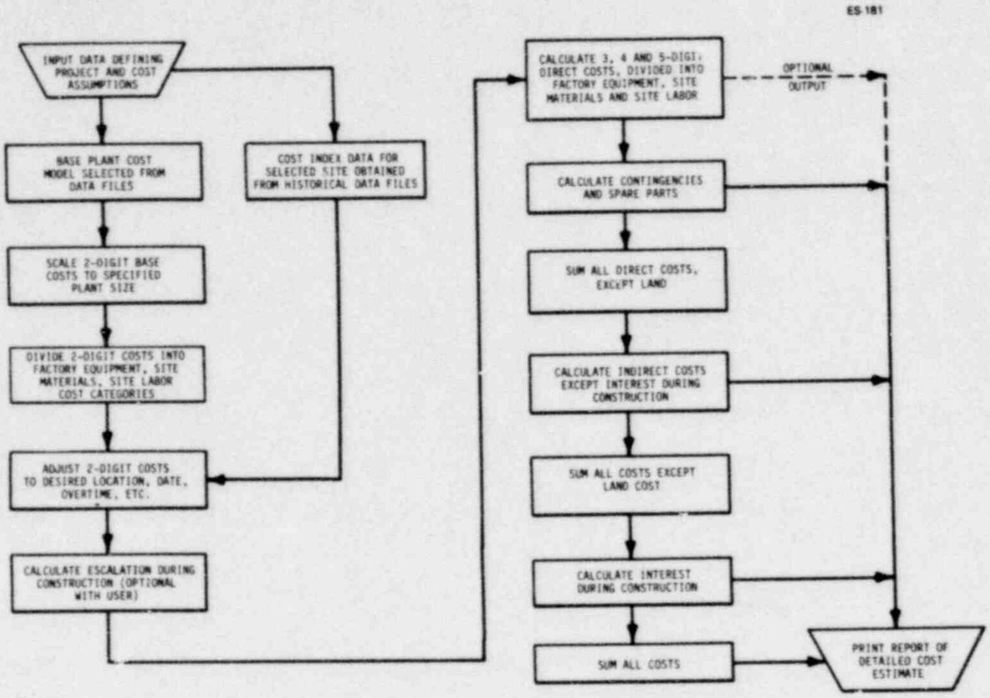

Fig. 1. Use of the CONCEPT program for estimating capital costs.

ESTIMATED CAPITAL COSTS

The assumptions used in the CONCEPT calculations for this project are listed in Table. 1. Table 2 summarizes the total plant capital investment estimates for the proposed nuclear station. Table 3 compares this reference system with a cost estimate for the nuclear plant with natural draft evaporative cooling towers.

Estimated costs for alternative fossil-fired plants are presented in Table 4. The estimated costs for SO_2 removal equipment are based on a study performed by Oak Ridge National Laboratory.[9] The assumptions used in that study are summarized in Table 5.

As stated previously, the above cost estimates produced by the CONCEPT code are not intended as substitutes for detailed engineering cost estimates, but were prepared as a check on the applicant's estimate and to provide consistent estimates for the nuclear plant and fossil-fired alternatives.

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Table 1. Assumptions Used in CONCEPT Calculations

Plant name	Perkins Nuclear Station, Units 1, 2 and 3
Plant type	PWR
Alternate plant types	Coal-fired
Unit size	1280-MW(e)-net, each unit
Plant location	
Actual	Mocksville, N. C.
CONCEPT calculations	Atlanta, Georgia
Interest during construction	8%/year, compound
Escalation during construction	
Site labor	8.5%/year
Site materials	7.5%/year
Purchased equipment	7.5%/year
Site labor requirements	9.76 manhours/kW(e)
Length of workweek	40 hours
Start of design and construction date	
NSS ordered	April 1973
Fossil alternatives	January 1977
Commercial operation dates	
Unit 1	January 1983
Unit 2	January 1985
Unit 3	January 1987

Table 2. Plant Capital Investment Summary for
3840-MW(e) Pressurized Water Reactor Nuclear Power Plant
Utilizing Mechanical Draft Cooling Towers
(Duke Power Company, Perkins Nuclear Station)

	Unit 1	Unit 2	Unit 3	Total
Net capability, MW(e)	1280	1280	1280	3840
Direct Costs (Millions of Dollars)				
Land and land rights	3	0	0	3
Physical plant				
Structures and site facilities	48	40	40	128
Reactor plant equipment	88	87	87	262
Turbine plant equipment	90	88	88	266
Electric plant equipment	28	25	25	78
Miscellaneous plant equipment	5	3	3	11
Subtotal (physical plant)	259	243	243	745
Spare parts allowance	2	2	2	6
Contingency allowance	17	15	15	47
Subtotal (total physical plant)	278	260	260	798
Indirect Costs (Millions of Dollars)				
Construction facilities, equipment and services	18	12	12	42
Engineering and construction management services	44	33	33	110
Other costs	14	10	10	34
Interest during construction	150	162	200	512
Total Costs				
Plant capital cost at start of project				
Millions of dollars	507	477	515	1499
Dollars per kilowatt	396	373	402	390
Escalation during construction	236	298	394	928
Plant capital cost at commercial operation				
Millions of dollars	743	775	909	2427
Dollars per kilowatt	580	605	710	632

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Table 3. Plant Capital Investment Summary for the Perkins Nuclear Station with Alternative Heat Rejection Systems

	Mech. Draft Evap. Towers	Nat. Draft Evap. Towers
Net capability, MW(e)	3840	3840
Direct Costs (Millions of Dollars)		
Land and land rights	3	3
Physical plant		
Structures and site facilities	128	127
Reactor plant equipment	262	262
Turbine plant equipment	266	281
Electric plant equipment	78	76
Miscellaneous plant equipment	11	11
Subtotal (physical plant)	745	757
Spare parts allowance	6	6
Contingency allowance	47	48
Subtotal (total physical plant)	798	811
Indirect Costs (Millions of Dollars)		
Construction facilities, equipment and services	42	43
Engineering and construction management services	110	112
Other costs	34	35
Interest during construction	512	519
Total Costs		
Plant capital cost at start of project		
Millions of dollars	1499	1523
Dollars per kilowatt	390	397
Escalation during construction	928	944
Plant capital cost at commercial operation		
Millions of dollars	2427	2467
Dollars per kilowatt	632	642

Table 4. Total Plant Capital Investment Cost Estimated for a 3840-MW(e) Coal-Fired Plant as an Alternative to the Perkins Nuclear Station, Units 1, 2 and 3

	Without SO_2 Abatement System		With SO_2 Abatement System	
	Mechanical Draft Towers	Natural Draft Towers	Mechanical Draft Towers	Natural Draft Towers
Direct Costs (Millions of Dollars)				
Land and land rights	3	3	3	3
Physical plant				
Structures and site facilities	91	91	110	110
Boiler plant equipment	299	299	387	387
Turbine plant equipment	267	285	272	291
Electric plant equipment	51	49	72	71
Miscellaneous plant equipment	10	10	10	10
Subtotal (physical plant)	718	734	851	869
Spare parts allowance	5	5	6	6
Contingency allowance	45	47	54	55
Subtotal (total physical plant)	768	786	911	930
Indirect Costs (Millions of Dollars)				
Construction facilities, equipment and services	36	37	65	66
Engineering and construction management services	60	61	70	72
Other costs	22	23	30	30
Interest during construction	338	345	418	425
Total Costs				
Plant capital cost at start of project				
Millions of dollars	1227	1255	1497	1526
Dollars per kilowatt	320	327	390	397
Escalation during construction	396	407	478	490
Plant capital cost at commercial operation				
Millions of dollars	1623	1662	1975	2016
Dollars per kilowatt	423	433	514	525

Table 5. Basis for SO_2-Removal Equipment Cost Estimate

Type of process	Wet scrubbing of flue gas by a limestone slurry
Cost basis	Integrated installation in a new plant (no backfitting required)
Fuel Composition (Design Values)	Coal-Fired
Sulfur content, % by weight	5
Ash content, % by weight	25
Energy value	10,000 Btu/lb
Abatement level, % SO_2 removal (minimum)	76
Plant Operating Date*	
Net plant heat rate without SO_2 control, Btu/kWh(e)	9000
Capability loss due to SO_2 control, %	2.5
Net plant heat rate, Btu/kWh(e)	9230
Assumed plant capacity factor	0.80
Annual Mass Flows*	
Fuel consumption	3230 tons/MW(e) net
Limestone used, tons/MW(e) net	790
Sulfur removed, tons/MW(e) net	120
Waste disposal, tons/MW(e) net	
Slurry	900
Fly ash	720

*With once-through cooling; evaporative cooling towers will increase heat rate and mass flows about 2%.

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