P R E F A C E

This report is submitted by Duke Power Company in support of its application to the U. S. Atomic Energy Commission for permits to construct the William B. McGuire Nuclear Station, Units 1 and 2, in Mecklenburg County, North Carolina. This report is intended to be fully responsive to Code of Federal Regulations, Part 50, Appendix D as published in the Federal Register on December 4, 1970, pursuant to the National Environmental Policy Act of 1969.

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1. INTRODUCTION

Duke Power has a long history of environmental concern and commitment. In 1923 the Company's first full-time environmental department was established, headed by a public health physician. Subsequently, additional groups of full-time environmental specialists have been formed and are continuing to work towards assuring that the Piedmont Carolinas is indeed an attractive place to live.

The Company's commitment to environmental quality is for two fundamental reasons. First, the type of environment directly affects the quality of life of the people who live in the Company's service area, and it is recognized that no electric utility can long succeed serving an area marred by blight. Secondly, man has not yet devised a way to generate large quantities of electricity needed to meet the public demand without involving land, water and air resources. To minimize adverse impact on the environment and even to enhance the environment wherever possible has been a fundamental consideration in the Company's planning of generation facilities for many years. In support of this objective, the Company has long engaged in environmental research and investigations.

Plans for the McGuire Nuclear Station on Lake Norman in Mecklenburg County have been supported by long-term environmental studies, as well as continuing programs. For example, in 1957 limnological and water quality studies began as part of the design studies for Lake Norman, then in the planning stages; in 1961, more than fourteen years before the first generating unit at McGuire is scheduled for commercial service, plans for the McGuire cooling water intake structure and related thermal effects were coordinated with appropriate federal and state agencies; in 1962, consistent with this planning, the low-level cooling water intake structure to serve the future McGuire Station was completed and lies waiting on the bottom of Lake Norman; in 1963, Lake Norman filled and the Company's water quality monitoring and sampling program was expanded to include the lake waters, thus beginning the development of water quality parameters serving as input to the detailed design of McGuire; and in 1967, after several years of coordination with the planning agencies of the three other counties neighboring on Lake Norman, the Charlotte-Mecklenburg Planning Commission zoned the McGuire site appropriate to power plant use. From the environmental studies, it is concluded that McGuire Nuclear Station can be developed at its site; will be environmentally compatible in all significant respects; will fully comply with all current environmental quality standards of cognizant governmental regulatory agencies; and any adverse environmental impact will be minimal when compared to alternative means of generating the same electricity.

McGuire's power generation is essential to meet the area's needs of population growth coupled with the increase in the per capita use of energy as reflected in residential, commercial and industrial demands. Only with additional energy can there be gains in production, comfort, health care, education, communications, the economic status of people in the area and even environmental quality. Failure to provide additional generating capacity <u>when needed</u> can have traumatic consequences on human and environmental values.

During the pre-operational and operational periods, environmental studies and monitoring programs associated with McGuire Nuclear Station will continue. If subtle adverse effects should be identified from these programs, timely corrective action will be taken as appropriate.

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2. DESCRIPTION OF McGUIRE NUCLEAR STATION

2.1 STATION AND CYCLE DESCRIPTION

The McGuire Nuclear Station will have two units each with electrical output of about 1150 Mw (1 Mw=1000 kw). The Westinghouse Electric Corporation will furnish the nuclear steam systems, some of the engineered safety features and most of the waste disposal equipment for the station. The nuclear steam systems are of the four-loop pressurized water design similar to twelve other four-loop plants which precede McGuire. The waste disposal equipment will be the very latest and most efficient available. A description of the radioactive waste disposal system's performance can be found in Section 4.2 of this report.

In the pressurized water design (see Figure 2.2-1), a closed system of water, known as the Primary Coolant is circulated through the fuel elements in the reactor vessel. This water picks up heat produced by the nuclear reaction but is kept under sufficient pressure that, even though it rises to about 600°F it does not boil but remains liquid.

This hot water is then pumped into adjacent "steam generators." There the water flows through thousands of U shaped tubes and gives up its heat to another, entirely separate water system, called the Secondary Coolant. The Primary Coolant is then pumped back into the reactor vessel where it is used over and over.

The Secondary Coolant flows around the tubes carrying the hot Primary Coolant in the Steam Generator, picking up the heat from the Primary Coolant. The secondary Coolant boils and produces steam to drive the turbine.

After doing its work in the turbine, this steam is condensed into water and pumped back into the Steam Generator, forming the second closed cycle. The waters of these two systems do not contact each other.

A third water system is used to condense the Secondary Coolant steam back into water as it leaves the turbine. This cooling water is taken from Lake Norman and is discharged back to the lake. This system is separated from the reactor by the two closed cycles, the Primary and Secondary Coolant systems.

The electrical output of the McGuire units will be delivered thru 230 Kv and
1. 525 Kv transformers to the switching station, south of N. C. Highway 73.
Construction of this switching station began in 1970 to serve system 1.
transmission needs during the 1971-1975 period prior to operation of McGuire. In connection with construction of McGuire, the switching station will be expanded to receive and transmit the nuclear station's output.

The two units to be installed at McGuire are estimated to cost $440,964,000
1. exclusive of fuel. The cost of initial fuel cores is estimated to be $64,550,000 1.
for a total station cost of over $505 million. The significant economic impact of this investment in Mecklenburg County is discussed in Section 4.6 of this report.

2.2 SITE DESCRIPTION

The McGuire Nuclear Station will be located in Mecklenburg County, North Carolina, near the Cowans Ford Dam approximately 17 miles northwest of Charlotte. The plant site is on the shore of Lake Norman about 1000 yards east of the Catawba River Channel as shown on Figure 2.2-1.

The plant site is bounded on the west by the Catawba River channel immediately downstream of Duke Power Company's Cowans Ford Hydroelectric Station, on the north by Lake Norman impounded by Cowans Ford Dam, on the east by private property and Lake Norman, and on the south by N. C. Highway 73. The intersection of the centerline of the two reactor buildings and the centerline between the reactor buildings is located at Latitude 35°-25'-59" north and Longitude 80°-56'-55" west.

The Exclusion Area is that area within a 2500-foot radius centered at the intersection of the two centerlines mentioned above.[1] The Low Population Zone as that area within five and one-half miles of the plant.[1] There are 26 population centers within 100 miles of the site. The largest of these are as follows:

Population Center	1970 Population	Distance From Site	Direction from Site
Charlotte, N. C.	239,049	17 miles	South-Southeast
Winston-Salem, N. C.	133,820	59 miles	North-Northeast
Greensboro, N. C.	140,660	78 miles	Northeast
Columbia, S. C.	111,706	98 miles	South

The Exclusion Area will be posted. A security fence will be erected around the immediate site area. A plot plan showing major plant features in the Exclusion Area, the site boundary and the controlled access areas within the site boundary are shown on Figure 2.2-2. Transmission lines and right-of-ways in the site area are discussed in Section 4.4.2.

[1] As defined by Code of Federal Regulations, Title 10, Part 100.

2.3 BASIS OF NEED

At the present time Duke Power has a total generating capability of 6744 Mw with an additional 14 Mw resulting from net purchases and interchanges for a total net resource of 6758 Mw. During the period 1964 through January, 1971, the peak demands experienced by Duke were as follows:

1964	3522 Mw
1965	3826 Mw
1966	4440 Mw
1967	4579 Mw
1968	5364 Mw
1969	5614 Mw
1970	6284 Mw
1971 (to date)	6399 Mw

The demand for electricity in Duke's service area is increasing at a rapid rate. This is due to a continuing growth, both in the number of customers served and in usage by all classes of customers. There is a continuing strong trend in usage for comfort conditioning, that is for air conditioning during the summer and heating during the cold weather months. Air conditioning is expected to have an increasing effect in our peak loads and will require increasing amounts of capacity dedicated to supplying weather induced peaks.

The 1969 peak load of 5614 Mw which occurred at noon on July 21 was exceeded less than six months later on January 8, 1970, when the load reached 6023 Mw, and exceeded once again on July 29, 1970, when the load reached 6284 Mw. A peak of 6399 Mw occurred in January, 1971. It is expected that this most recent peak will be exceeded during the 1971 summer. Future peak loads as currently estimated are:

1971	6856 Mw
1972	7516 Mw
1973	8237 Mw
1974	9027 Mw
1975	9890 Mw
1976	10833 Mw
1977	11862 Mw

Severe weather occurrences could add as much as 563 Mw to the estimates in 1977.

Duke's planned capacity in 1976, including McGuire 1, is 14,172 Mw and in 1977, including McGuire 2, is 15,322 Mw. Including an allowance for severe weather, the Company's reserve in these years will be 31% and 29% respectively. Without either McGuire unit the reserves would be 20% and 10% respectively in 1976 and 1977, and in the event of severe summer weather would drop to 15% and 5% well below accepted levels. Therefore, the McGuire units must go in service as scheduled to assure an adequate and dependable supply of electricity. Whereas McGuire Unit 1 is needed to meet the summer 1976 load, it is scheduled for service in late 1975 to permit flexibility in maintenance and operation of other equipment in the 1975-76 winter.

Schedule highlights are tabulated below:

Unit 1	Unit 2	
May, 1971	With Unit 1	Break ground and start pre-construction earthmoving
November, 1971	With Unit 1	Receive construction permits
November, 1971	August, 1973	Start concrete foundation
May, 1973	September, 1974	Set reactor vessel
June, 1974	October, 1975	Start turbine-generator erection
December, 1974	April, 1976	Start precritical testing
June, 1975	October, 1976	Load fuel
November, 1975	March, 1977	Begin commercial operation

2.4 NATURAL ENVIRONMENT OF THE SITE

To better understand the site, its natural properties, its compatibility with the planned development and the long-term phenomena to which the site may be subjected, studies of the site and general vicinity meteorology, geology, hydrology and seismology have been made and design criteria relative to these study areas have been established from evaluation of these studies.

2.4.1 METEOROLOGY

The long-term climatology of the McGuire Nuclear Station site can be described by data from the local Weather Bureau at Charlotte, North Carolina. The following summary is from material prepared by the Environmental Science Services Administration of the U. S. Department of Commerce (now the National Weather Service of the National Oceanic and Atmospheric Administration).

"Charlotte is located in the southern Piedmont, an area of rolling country transitional between the mountains to the west and the Coastal Plain to the east. The mountains extend from southwest to northeast, being about 80 or 90 miles from Charlotte on both the west and north. The general elevation of the area around Charlotte is about 730 feet, with the land rising toward the mountains to the southwest, west and north and decreasing toward the Coastal Plain to the east and southeast. The ocean is about 160 miles distant in the nearest direction, which is southeast, and is about 260 miles distant to the east.

"The mountains have a moderating effect on winter temperatures, causing appreciable warming of cold air coming in on west or northwest winds. The ocean is too far away to have any immediate effect on summer temperatures but in winter an occasional general and sustained flow of air from the warm ocean waters to the southeast results in considerable warming.

"Charlotte enjoys a moderate climate, characterized by cool winters and quite warm summers. Because of the sheltering effect of the mountains winter temperatures average about three degrees higher than at weather stations in the northern Piedmont section of the state. Temperatures fall as low as the freezing point on a little over one-half of the days in the winter months. Winter weather is changeable, alternating between mild and cool spells, with occasional cold periods. Extreme cold is rare, below zero temperatures having occurred only four times since 1878. Snow is infrequent, occurring on the average only once in each month, December through March. The first snowfall of the season usually comes in late November or December. Heavy snowfalls have occurred, but any appreciable accumulation of snow on the ground for more than a day or two is rare.

"Summers are long and quite warm, with afternoon temperatures in the low nineties rather frequent. There is considerable cooling at night; however, as the temperature usually falls to the upper 60's or low 70's by norming in the warmest months. On the average, temperatures as high as 100 degrees are experienced about twice in three years. The growing season is also long, the average length of the annual freeze free period being a little over 230 days. On the average, the last date in spring with a temperature of 24 degrees is February 21; of 28 degrees, March 10; and of 32 degrees, March 21. In the fall, the average date of the first minimum temperature of 32 degrees is November 15; of 28 degrees, November 29; and of 24 degrees, December 11.

"Rainfall is generally rather evenly distributed throughout the year, the driest weather usually coming in the fall. Summer rainfall, which comes principally from thundershowers, is sometimes erratic, with occasional dry spells of one to three weeks' duration. The longest dry period on record was in the fall of 1886, when there were 40 consecutive days with less than .01 of rain each day.

"Hurricanes which have struck the coastal areas have not as a rule caused severe winds at Charlotte. However, a hurricane that moved northwestward across South Carolina, July 14, 1916, caused an hourly wind of 47 mph, five-minute wind of 60 mph and a fastest mile of 74 mph. The greatest rainfall with passage of a hurricane, 7.22 inches, occurred September 16-18, 1945."

Tornado frequency in the site area (square area about 125 miles by 125 miles) totaled 50 for the period 1916 to 1955.(1) To put in terms of probability for a point (nuclear plant), such a translation predicts a recurrence interval of 4,405 years.(2)

Nuclear Safety related structures and equipment will be designed for appropriate combinations of wind velocities up to 360 mph, positive differential pressures of three psi and resistance to tornado missiles.

2.4.2 GEOLOGY

Studies of site and regional geology have been made to identify the various general and specific geologic features underlying the site and the surrounding area.

In general, the site is located in the Charlotte Belt within the Piedmont Geologic Province. This belt consists of metamorphosed sedimentary and volcanic rocks of which granitic gneiss is the principal intrusive unit. At a later time gabbro, diorite and syntite were intruded into the Charlotte Belt rocks. Several ancient faults have been mapped within the region; the closest being the Kings Mountain Fault which is about 12.5 miles from the site as shown on Figure 2.4-1. None of the known faults have been active since the end of the Triassic Period, about 180 million years ago. Air photo studies were made of the general vicinity to verify and supplement geologic features shown on published maps and described in the published literature. These studies of the regional and vicinity geology revealed no geologic structures which would adversely affect the site.

Over 100 borings were made at the site to determine subsurface conditions under the major structures, and the suitability of those underlying materials from site development. Also, rock cores from borings made in the nearby Cowans Ford Dam area had been retained and were examined. An examination of rock cores from these sources and a petrographic analysis of rock samples generally confirmed the published literature relative to emplacement order, age and rock

(1) United States Department of Commerce, Weather Bureau, Technical Paper No. 20, Tornado Occurrences in the United States, L. V. Wolford, Office of Climatology, Washington, D. C., Revised 1960.

(2) Thom: Tornado Probabilities, Monthly Weather Review, Washington, D. C., 1963.

types. The four major rock types found include dark green meta-gabbro, light gray fine and medium grained granite, black and white fine grained diorite and black and white coarse grained diorite. Though the geologic structure at the site is very complex and old, there were no features in evidence which would present any problems in the design, construction and future operation or safety of the plant.

2.4.3 SEISMOLOGY

The regional ancient faults and geologic structures have not been active during the past 180 million years. The historical record of earthquakes in the southeast indicates that there is no known relationship between known faults and historic earthquakes.

Detailed studies of the larger earthquakes near the site have been made using newspaper accounts, interviews with older residents, examination of damage which is still visible and a study of local geologic conditions. These studies indicate that the greatest seismic intensity the site has experienced due to these larger earthquakes has been VII, Modified Mercalli Scale, from the Charleston earthquake, August 31, 1886, located 185 miles southeast of the site.

Three earthquake epicenters have been reported within 50 miles of the site. All three of these earthquakes are reported to have produced an epicentral intensity of V, Modified Mercalli Scale.

No identifiable active faults that could be expected to produce surface displacement have been recognized within 200 miles of the site or anywhere within the Piedmont Geologic Region of the site.

The foundations of the Reactor and Auxiliary Buildings will be located on rock which has excellent strength properties and small amplification of ground motion resulting from an earthquake. The operating basis earthquake(1) has been given a value of acceleration of six percent of gravity at the top of rock and the design basis earthquake(2) has been given a value of acceleration of twelve percent of gravity at the top of rock.

Seismologically the site is well suited for a nuclear station.

2.4.4 HYDROLOGY

Hydrology studies for site suitability included characteristics of vicinity streams and their associated drainage areas, Catawba River flood studies and site groundwater.

The principal stream which drains the site is the Catawba River. The Catawba River begins at the Blue Ridge Divide near Old Fort, North Carolina, and flows in an easterly direction to a point near Millersville, North Carolina. It then flows in a southerly direction and becomes the Wateree River near Camden, South Carolina. The Catawba upstream of Wateree Dam has a length of approximately 240 miles and a drainage area of approximately 4,750 square miles.

(1)Plant designed for continuous operation during operating basis earthquake
(2)Plant designed for safe shutdown during design basis earthquake

Lake Norman and Cowans Ford Dam are a part of Duke's Catawba River hydroelectric system containing eleven hydroelectric reservoirs and dams, and extending along approximately 221 miles of the Catawba River. Lake Norman forms the tailwater of Lookout Shoals Dam, located 34 miles upstream from Cowans Ford, and Mountain Island Lake forms the tailwater for Cowans Ford. Mountain Island Dam is located 15 miles downstream from Cowans Ford. Refer to Figure 2.4-2, Plan and Profile of the Catawba River.

A United States Geological Survey Gaging Station was located 30 miles upstream from the present location of Cowans Ford Dam near Catawba, North Carolina, until it was inundated by the waters of Lake Norman in 1962. The average discharge past this point for a period of record of 30 years and a drainage area of 1,535 square miles was 2,337 cubic feet per second (cfs). The maximum flow recorded at this point was 177,000 cfs on August 14, 1940, and the minimum flow was 85 cfs occurring on September 15, 1957. The average flow at the Cowans Ford site is approximately 2,670 cfs. On July 16, 1916, the river reached a known flood stage of 44.1 feet at the USGS gage near Catawba, N. C. It has been estimated that this storm produced a flow of 199,500 cfs at the McGuire site on July 17, 1916.

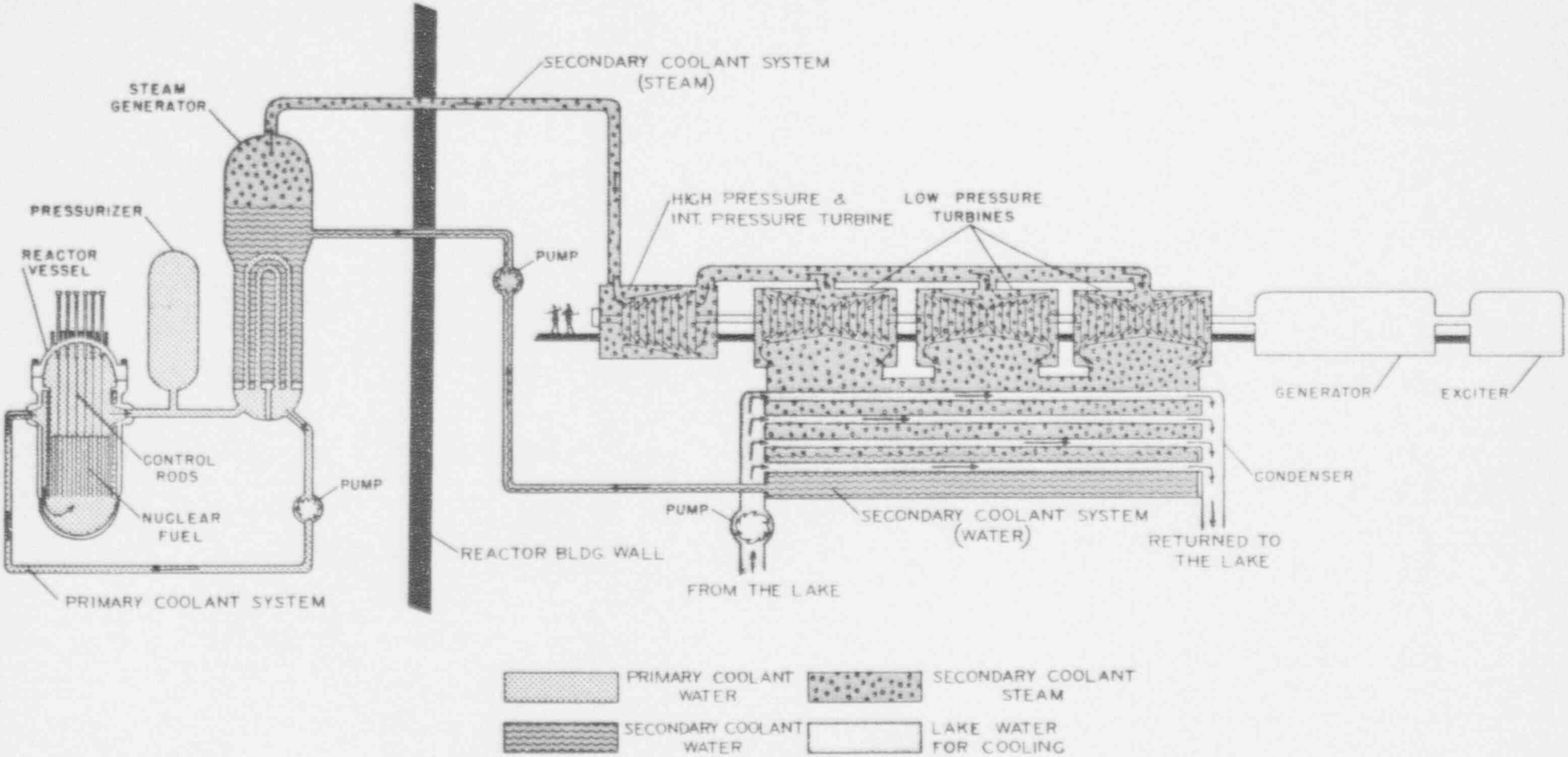
Lake Norman has a surface area of 32,510 acres and a volume of 1,093,600 acre-feet at a surface elevation of 760 feet above mean sea level (MSL). Cowans Ford Dam's spillway is equipped with eleven gates with a total spillway capacity of 210,650 cubic feet per second with upstream water surface elevation at elevation 760.

The proposed site lies within the Piedmont Groundwater Province. All groundwater in this area is derived from precipitation. The depth to the water table depencs primarily on topography and rock weathering. The level of the water table varies from the ground surface in the valleys to more than 100 feet below the surface on sharply rising hills.

The level of Lake Norman is the primary factor which governs the location and movement of the groundwater at the site. The elevation of groundwater coincides with the elevation of Lake Norman along the northern boundary of the site, and the groundwater moves downward in a south and southwesterly direction until it intersects the Catawba River and a small stream which drains into the Catawba.

There is no potential for harmful radioactive contamination of well water supplies via introduction of Lake Norman waters into groundwater. The concentration of radioactivity in Lake Norman is shown in Section 4.2 to be a small fraction of the limits imposed by AEC regulations. These concentrations would be further reduced by the ion exchange action of the soil through which the groundwater flows. Chemical analyses were made to determine the cation exchange capacity of the soils at the site. The results of these analyses have shown that any radioactive contaminant will move less rapidly through the soil than the groundwater (by a factor of 45 to 1 for strontium) because of the absorption of the contaminant by the soil particles.

Groundwater studies indicate that the groundwater conditions, including local wells used for water supply, will not be adversely affected by the construction of McGuire Nuclear Station.



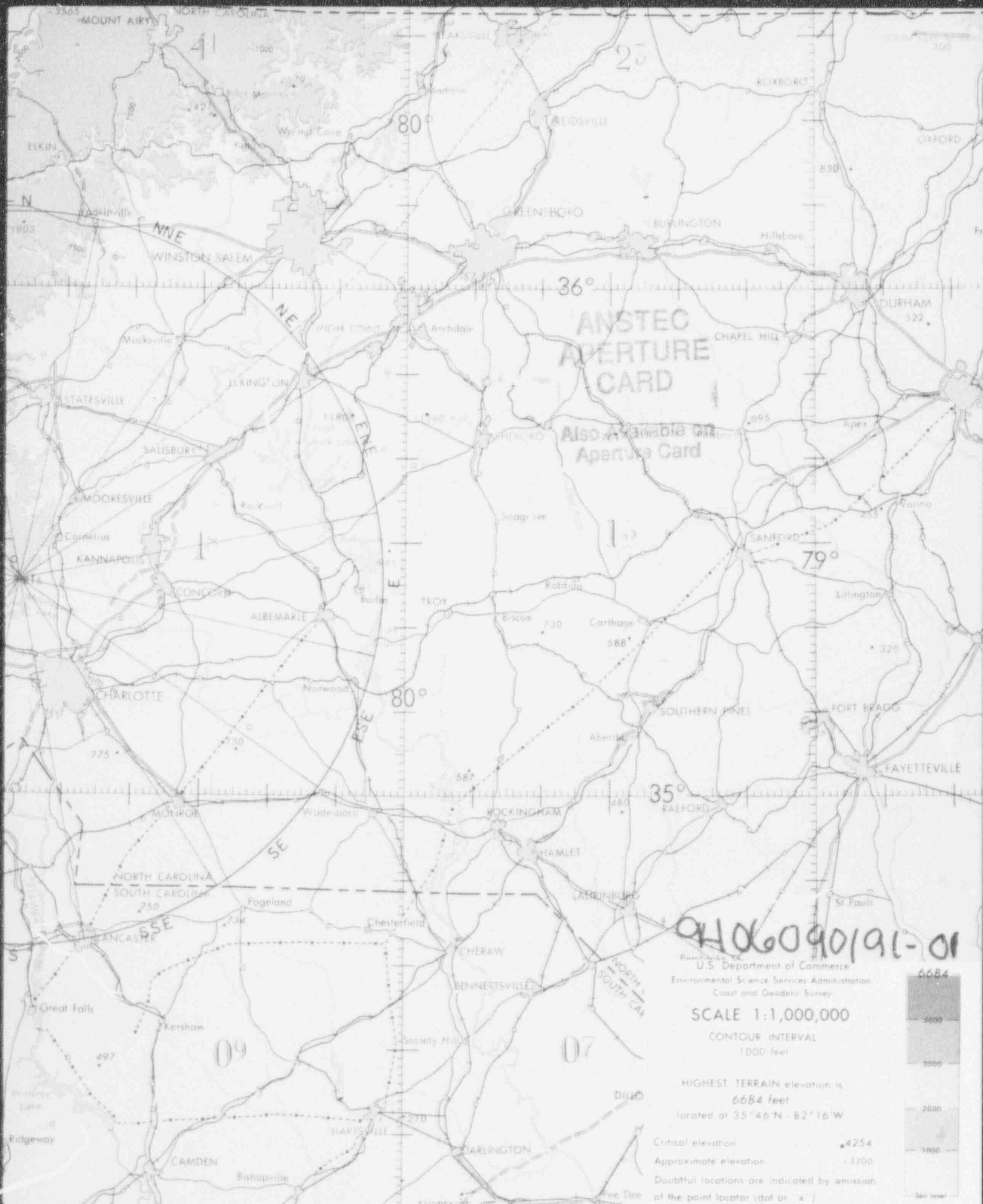
SIMPLIFIED FLOW DIAGRAM

McGUIRE NUCLEAR STATION

Figure 2.1 - 1

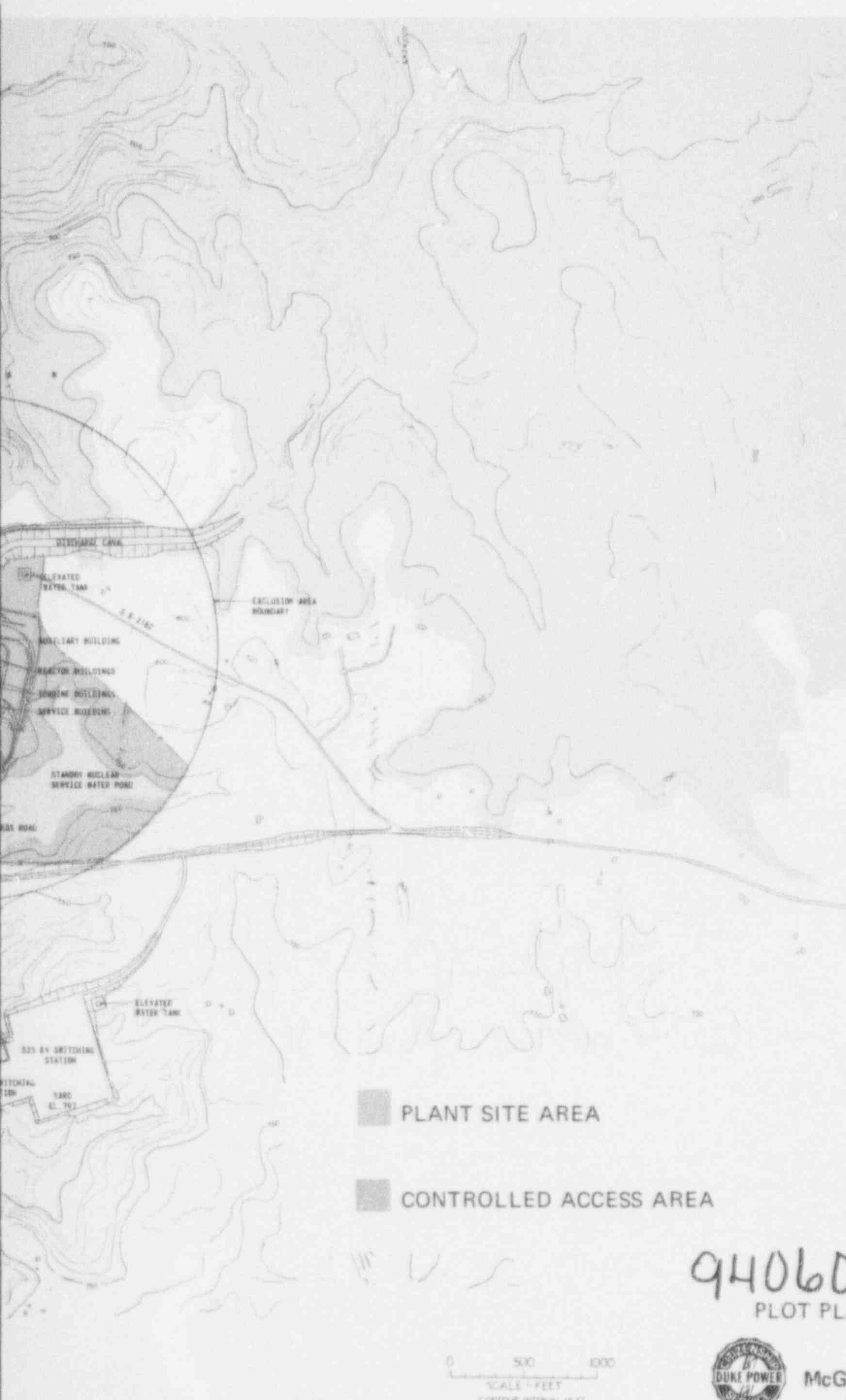
Lambert Conformal Conic Projection Standard Parallels 33°20' and 38°40'
Topographic data corrected to February 1968

STATUTE MILES 10 0 10



GENERAL AREA MAP
McGUIRE NUCLEAR STATION
Figure 2.2 - 1

DISCHARGE STRUCTURES
INTAKE STRUCTURE
MICROWAVE AND METEOROLOGICAL TOWER
COWANS FORD HYDRO STATION
LOW LEVEL CONDENSER COOLING WATER PIPE
LOW LEVEL PUMP STRUCTURE
ADMINISTRATION BUILDING
ACCESS R R
CATAWBA RIVER



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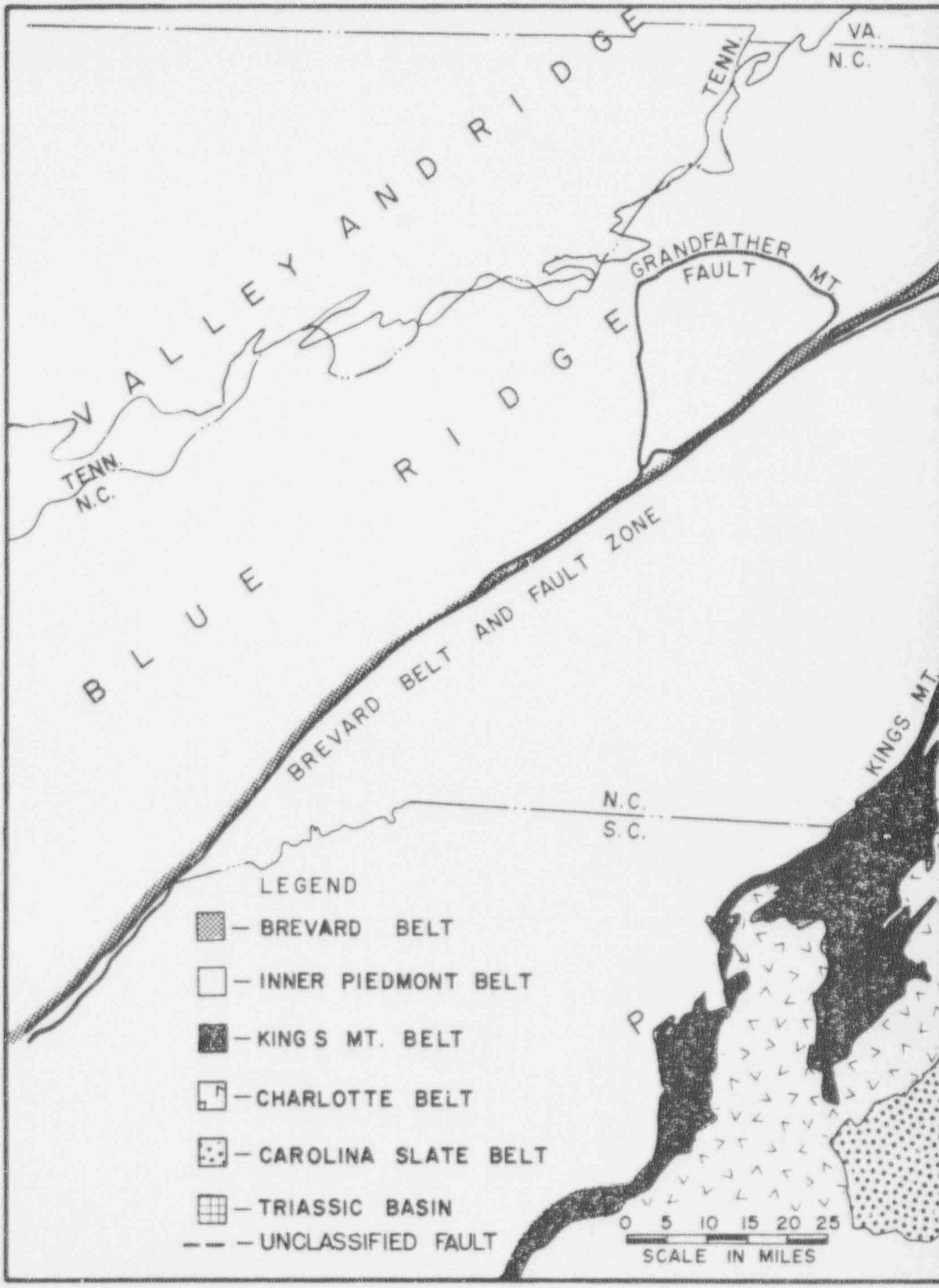
PLOT PLAN AND SITE BOUNDARY

McGUIRE NUCLEAR STATION

Figure 2.2 - 2



VALLEY AND RIDGE
TENN.
VA.
N.C.
TENN.
N.C.
GRANDFATHER MT.
FAULT
BLUE RIDGE
BREVARD BELT AND FAULT ZONE
KINGS MT.
N.C.
S.C.
P
LEGEND
— BREVARD BELT
— INNER PIEDMONT BELT
— KING S MT. BELT
— CHARLOTTE BELT
— CAROLINA SLATE BELT
— TRIASSIC BASIN
— UNCLASSIFIED FAULT
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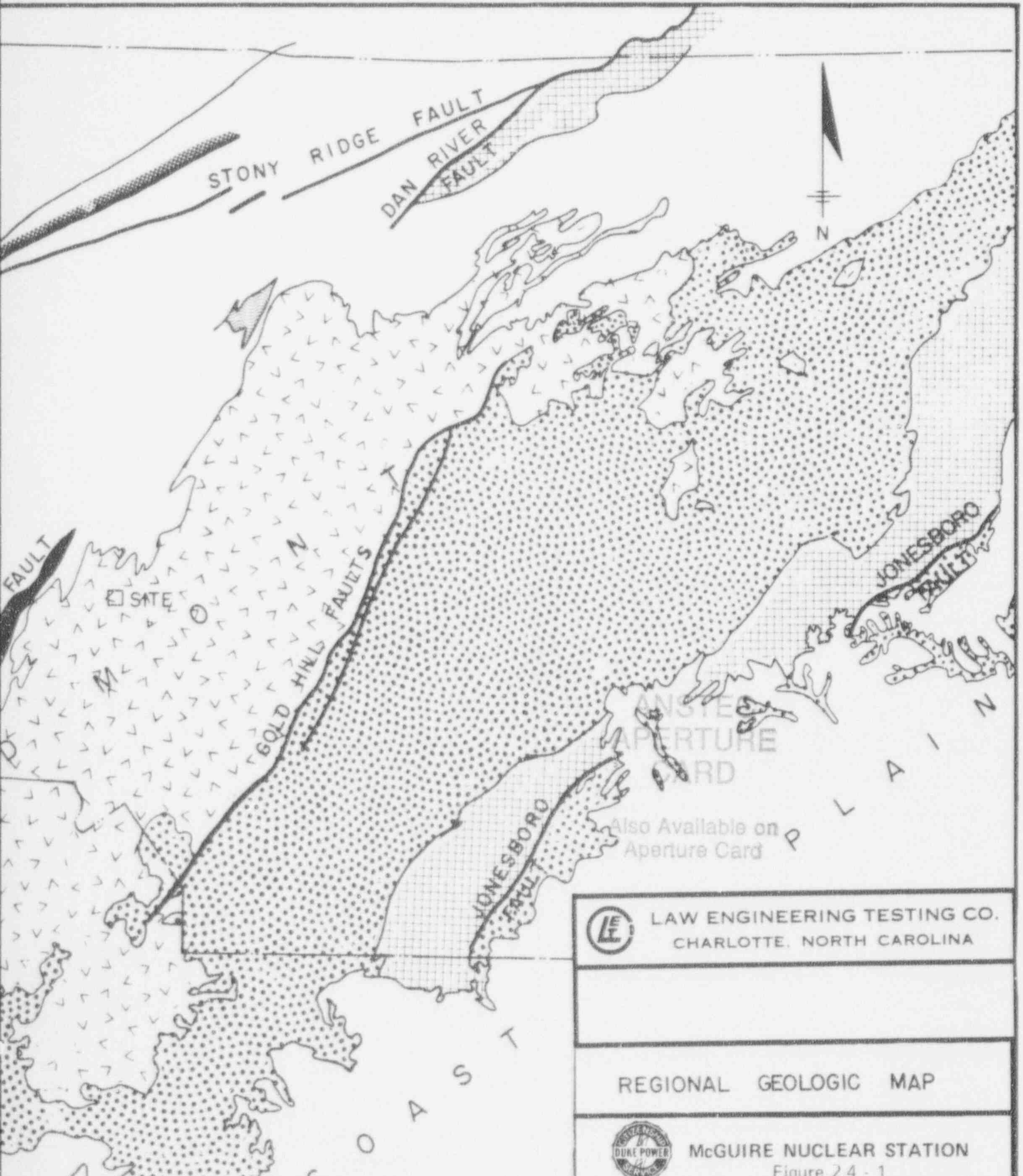

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CHARLOTTE, NORTH CAROLINA

REGIONAL GEOLOGIC MAP

McGUIRE NUCLEAR STATION
Figure 2.4 - 1

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3. LAKE NORMAN GENERATING COMPLEX AND ITS ENVIRONMENTAL FEATURES

3.1 DESCRIPTION AND MULTIPLE USE FEATURES

Lake Norman and its impounding structure, Cowans Ford Dam were completed by Duke Power Company in 1963. This event marked the final major step in a comprehensive plan to develop the hydroelectric power potential of the Catawba-Wateree River system in North and South Carolina. The plan was conceived by Duke's founders in the early 1900's and was implemented in stages between 1904 and 1967 with the construction of eleven reservoirs and thirteen hydroelectric generating plants having a total installed capacity of 804,940 kw. The fourth and final hydro unit was installed at Cowans Ford in 1967 to give that plant an installed capacity of 372,000 kw.

In 1935, the extent of the basin's development was recognized by Mr. A. E. Morgan, then Chairman of the Board of the Tennessee Valley Authority. Mr. Morgan wrote in the December, 1935, issue of Civil Engineering:

> "On the Catawba River in North and South Carolina, the Duke Power Company has worked out a completely unified development for power with results, I understand, that reflect great credit on the technical skill involved in that great undertaking."

Attached Figure 2.4-2, Plan and Profile of Catawba River shows the completed hydro development scheme which utilizes 86 percent of the available head in the included reach of the river.

Beginning in the 1920's and continuing through current engineering design for McGuire Station, Duke has further developed the water resources of the Catawba Valley by using three of the hydro reservoirs for condenser cooling water at three large steam-electric generating plants. McGuire Station will be the fourth such plant on Catawba reservoirs and the second on Lake Norman. Duke's recently completed 2,137,000 kw Marshall Steam Station has been operating on Lake Norman since 1965 and has, for five consecutive years, been recognized as the most efficient steam-electric plant in the United States. Lake Norman continues to serve as the site for one of the most comprehensive research projects yet undertaken to gather scientific data on thermal effects of large steam-electric plants on lakes and reservoirs. This project is discussed in Section 4.1.4.

Before Lake Norman was built, Duke's engineering and environmental studies showed that the reservoir was capable of supporting more than 10,000,000 kw of thermal cooling capacity. Existing Marshall Station and proposed McGuire Nuclear Station will together utilize less than half the projected safe cooling capacity of Lake Norman. Additional sites on the east shore of the lake will be developed as needed and will utilize the cooling water resource of the Lake Norman generating complex. Such development will be done in full compliance with then applicable state and federal water and air quality standards, best available research data and operating experience from existing plants and Duke's long standing commitment to maintain a high quality environment in its service area.

The following comments were made on September 29, 1964, by North Carolina Governor Terry Sanford as he took part in dedication ceremonies for newly completed

Lake Norman and Cowans Ford Dam:

> "Because of its conviction in regard to the steady economic growth of this area (and) the consequently increasing demands for electricity, Duke Power Company today announces for the first time the full dimensions of its development plans for the Lake Norman area. It is a program calling for the construction of ten million kilowatts of new steam-electric generating capacity around the shores of Lake Norman and designed to make this vast project a well spring of power for the growing Piedmont Crescent."
>
> "Now under construction (is) the first of this new era of generating plants, Plant Marshall, located on the shore of the lake near Terrell in Catawba County. Other plants will follow Marshall until a total of four or five generating centers have been built around Lake Norman."
>
> "Whereas the first two units at Plant Marshall will use coal as fuel it is entirely conceivable that other capacity in this new program will utilize the energy of the atom and be nuclear powered."

The Lake Norman generating complex is geographically and electrically near the center of the Duke service area and of the Piedmont section of North and South Carolina. This area is recognized as one of the fastest growing market and population regions in the United States and yet it continues to be considered one of the most desirable areas in which to live and work. The continued orderly and prudent development of the water resources of the Catawba Valley including the Lake Norman generating complex is deemed to be in the best interests of maintaining a high quality environment in the geographic region served by Duke Power Company.

3.2 COORDINATED PLANNING

As long-range planning and orderly implementation of work were hallmarks of the development of the Catawba for hydro-power, so has carefully coordinated planning continued to characterize the development of the Lake Norman generating complex.

Relocations of and alterations to roads, water works and other public and private facilities necessitated by the construction of Lake Norman were provided for and coordinated with a number of public agencies. These included the North Carolina State Highway Commission who jointly with Duke held a number of public hearings on relocation of roads. Duke worked with governing bodies of three municipalities to relocate and upgrade raw water pumping facilities and sanitary waste facilities. Detailed coordination was also carried out with a railroad, a gas pipeline company and a number of telephone, electric and gas utilities in relocation of their facilities. There was and continues to be careful coordination with the North Carolina State Board of Health, Board of Water and Air Resources and a number of county health departments in matters of public health, water supply, mosquito control and disposal of solid waste and sewage.

Before beginning of filling of Lake Norman, an association of three county planning boards and a city-county planning commission was formed for the purpose of coordinating land use planning and regulations in all of the four counties around Lake Norman.

This body studied land use patterns, zoning needs, health and sanitation requirements, transportation access and acted as a general coordinating group between local and state governmental agencies and Duke Power Company. In 1962, before the lake was filled, a General Development Plan was published by the four-county group. The majority of the recommendations made in this report were adopted and are being implemented by the individual counties. While the four-county association is no longer functioning, it made a substantial contribution to the orderly development of the Lake Norman area. Duke worked closely with the planning bodies of the four counties and with a number of local bodies in matters of solid waste disposal and control of litter, boating safety, waterway markers and area development.

Duke has historically worked closely with individual property owners whose lands or residences were affected by necessary power developments. Many of the company's land purchases date back to the days of a predominately agricultural economy. Duke has normally been willing to purchase not only the needed low lying bottom lands but also the then less valuable uplands which were outside reservoir limits. This often allowed a farmer to relocate his entire operation to a nearby area rather than have to give up agricultural work due to loss of his most productive lands. By means of land trades, fair purchasing practices and careful planning, Duke has been able to assist many families in relocation to nearby comparable areas. While there were some landowners and residents who were not entirely satisfied with sale of their properties, it is significant that of 1200 individual property transactions completed in development of Lake Norman, only about two percent of these acquisitions were made through condemnation.

In 1961, fourteen years before the currently planned operating date for McGuire Unit 1, Duke made provisions for development of a future steam-generating site adjacent to Cowans Ford Dam by construction of a low-level intake structure and cooling water conduits. This work was coordinated with and approved in advance by the Federal Power Commission and the North Carolina Department of Water and Air Resources. Installation of necessary facilities to utilize the cold waters from the lowest levels of Lake Norman to minimize thermal effects would not have been practical after the lake was filled. Thus, the combination of long-range planning and early investment in needed facilities will provide means to operate the McGuire units in compliance with current environmental standards which were not drafted until many years after these provisions were made.

3.3 RECREATION

Public recreation usage of Lake Norman waters has been encouraged by Duke in many ways. Consequently public, private and Company developed recreational facilities have become firmly established and widely used in all of the four county areas contiguous to Lake Norman.

Appendix 3A, "Lake Norman - The Inland Sea" describes boating, fishing and water sports usage of the lake, public access and recreational areas, fishing and boating regulations and water safety rules, parks, campgrounds and access areas. Also described is the program to make much of the company-owned shoreline available for leased recreational lots. There are illustrated some of the cottage sites that have been developed by individuals under this program.

In 1962, before Lake Norman filled, Duke donated to the State of North Carolina a 1328 acre tract of land for development as a state park. Now known as Duke Power State Park, this facility has become very popular over a wide area and is continuing to be developed in stages by the state to meet the growing recreation demands.

3.4 FISHING

Even before it completed filling in 1963, Lake Norman was beginning to gain a reputation as a fine sport fishery. Native species including largemouth bass, crappie and a variety of bream and sunfish experienced such rapid population growth that stocking was unnecessary. The North Carolina Wildlife Resources Commission has subsequently stocked several non-native species including the striped bass, the gizzard shad and the threadfin shad, the latter two species being forage fish for game varieties.

Sport fishing is not only one of the major recreation activities on the lake, but also an important contributor to the economy of lake-side communities through sales of boats, tackle, fuel, food and other supplies. In 1970, the North Carolina Championship Bass Tournament was held on Lake Norman and is scheduled to be held again in May, 1971, under sponsorship of Sportsman's Shows of the Carolinas.

Primarily to enhance fish life downstream of Cowans Ford Hydro Plant, Duke constructed an underwater weir to insure that water discharged through the hydro units would be drawn from the oxygen-rich upper levels of Lake Norman. This structure, which was built at a cost of over $480,000, has functioned as planned to maintain levels of dissolved oxygen downstream which have served to support and enhance the fisheries resources of the Catawba.

3.5 WILDLIFE

In cooperation with the North Carolina Wildlife Resources Commission, in 1962 Duke established the Cowans Ford Waterfowl Refuge downstream of Lake Norman. No hunting is allowed by the commission in this refuge and consequently substantial numbers of migratory waterfowl use this area in transit and on a semi-permanent basis.

In all other areas around the shoreline of the lake, state hunting-fishing regulations are monitored and enforced by the game protectors of this commission. In addition to geese and ducks, a variety of small game including rabbit, quail, racoon, fox, dove, muskrat, opossum and other species is taken by licensed hunters. Deer and turkeys are occasionally sighted, but there is no legal hunting season for these in this area of the state.

3.6 WATER SUPPLY

The towns of Mooresville, Davidson and Huntersville, North Carolina, take their raw water supplies from Lake Norman. Charlotte, North Carolina, takes its raw water supply from Mountain Island Lake at a point about eleven miles downstream from Lake Norman. The large volume of Lake Norman assures these four towns and cities an almost unlimited supply of high quality raw water.

Duke has never made any charge for raw water withdrawn from its reservoirs for municipal use. A total of 21 cities and towns in North and South Carolina, having a total population of almost one-half million obtain their water supplies from Duke reservoirs.

3.7 FLOOD CONTROL

There are four hydroelectric reservoirs upstream of Lake Norman (Lakes James, Rhodhiss, Hickory and Lookout) which were built and placed in operation from 1919 to 1928. Lake Norman and Cowans Ford Station were placed into commercial operation in 1963. Allowances for flood capacity, freeboard and wave run-up for these reservoirs were provided in accordance with sound and accepted engineering principles in use during these periods. These hydro developments were reviewed by the Federal Power Commission and Corps of Engineers as a prerequisite of the issuance of FPC License No. 2232 in 1958 covering these developments plus six other developments downstream. (See Figure 2.4-2, Section 2.)

Two notable floods have occurred within recent times in the Catawba River Basin. The July, 1916, flood resulted in record flood flows upstream of Catawba, North Carolina, which is about 30 miles upstream of Cowans Ford Dam. The August, 1940, flood resulted in record flood flows downstream of Catawba, North Carolina.

Geological Water Supply Paper 1066, "Floods of August, 1940, in the Southeastern U. S.," describes the 1940 flood and credits the four upstream reservoirs with reducing flood flows as follows:

Reservoir	Plant	Maximum Mean Hourly Inflow (cfs)	Outflow (cfs)
Lake James	Bridgewater	141,760	43,700
Lake Rhodhiss	Rhodhiss	167,740	104,000
Lake Hickory	Oxford	183,620	158,060
Lake Lookout	Lookout	191,320	177,400

The paper further states "The storage in these reservoirs undoubtedly prevented a very severe and destructive flood in South Carolina." The flood flow at Catawba, North Carolina, was 177,000 cfs.

Physical data on Cowans Ford and developments upstream are as follows:

Development	Individual Drainage Area (Sq. Miles)	Cumulative Drainage Area (Sq. Miles)
Bridgewater	380	380
Rhodhiss	710	1090
Oxford	220	1310
Lookout	140	1450
Catawba (Gaging Station)	85	1535
Cowans Ford	340 (Lookout to Cowans Ford)	1790

In 1968, the engineering firm of Charles T. Main, Inc. of Boston, Massachusetts, was retained to review the major storms on the Catawba Basin and to evaluate the safety of the dams. This report covered the five developments mentioned above plus six hydro developments downstream of Cowans Ford. Eight storms were studied:

a. August, 1940, as it actually occurred.

b. August, 1940, with 90 percent surface runoff.

c. August, 1955, transposed "Diane"* with runoff as it occurred.

d. August, 1955, transposed "Diane" with 90 percent surface runoff.

e. August, 1955, transposed "Diane" rainfall data and unit hydrographs based on storm "Gracie"** with retention based on no preceding rainfall.

f. Same as (e.) except retention based on 24 hours prior rainfall.

g. July, 1916, with retention based on no prior rainfall.

h. July, 1916, with retention based on 24 hours prior rainfall.

* New England hurricane
** September, 1959, hurricane storm over Catawba Basin

The Main report included the following comparison of Probable Maximum Precipitation (PMP) with rainfall from the July, 1916, storm and the transposed Diane storm. The precent of PMP shown is based on 90 percent runoff from these storms divided by 70 percent runoff from PMP.

		July, 1916, Storm		Diane	
Drainage Area Sq. Miles	48-Hour PMP Inches	48-Hour Precipitation Inches	% of PMP	48-Hour Precipitation Inches	% of PMP
500	28	18	83	17	78
1000	26	17	84	16	79
4750	19	8	54	12	81

The Main report concluded that the developments from Cowans Ford upstream had adequate freeboard during floods except for Rhodhiss. Subsequently the concrete bulkheads at Rhodhiss have been raised 2'-6" to assure its adequate freeboard.

Having a yard elevation of 760 feet above mean seal level, the McGuire site is just downstream of the east earth section of the Cowans Ford Dam. Pertinent elevations and flood levels are tabulated below:

Lake Norman, normal full pond level - - - - - - - Elevation 760
Level of maximum flood waters - - - - - - - - - - - Elevation 764.1
Top of Cowans Ford Dam, concrete sections - - - - Elevation 770

Top of Cowans Ford Dam, earth embankments - - - - Elevation 775
Minimum freeboard, flood level to top of earth
embankments - - - - - - - - - - - - - - - - - - - Elevation 10.9 ft.

In accordance with our recent understanding of AEC requirements, we have retained Charles T. Main, Inc. to prepare additional flood studies based on the following:

a. Calculation of the Probable Maximum Flood on the drainage basin upstream of Cowans Ford and an assessment of its effects on the McGuire site.

b. Calculation of a Standard Project Flood on the drainage basin upstream of Cowans Ford coincident with a failure of any single upstream dam and an assessment of its effects on the McGuire site.

In summary, Duke's hydro developments upstream of the McGuire site, which have been licensed by the FPC, will safely pass and control major floods. Results of additional current flood studies, being performed by Charles T. Main will be available upon request after the studies are completed.

3.8 FORESTRY AND SOIL CONSERVATION

Duke Power's comprehensive, scientifically-managed forestry program plays a vital part in the preservation and restoration of the Piedmont Carolinas' environment.

The company owns a large amount of property that is not presently needed for the production or delivery of electricity. The land is, however, very important to Duke's watershed management. To make sure this land is definitely separated from the land for utility purposes, Duke has transferred it to a wholly-owned subsidiary, Crescent Land and Timber Corporation.

Crescent is continuing the policies of watershed management, recreation and conservation established long ago by Duke Power. Through these policies, thousands of acres of land in the watershed of the Lake Norman generating complex have been placed under scientific forest management to maintain soil stability, rebuild topsoil, eliminate erosion and return worn-out farm land to productive use.

Currently, Crescent is planting seedling trees at a rate of over two million each year. In the past 30 years, Duke Power and its subsidiary have planted over 38 million trees on 49,812 acres. Besides soil stability and erosion elimination, these trees contribute to a good environment in other ways. For instance, each acre of planted southern pine returns between two and three tons of organic matter to the soil each year.

Several years ago, Duke started a program for utilizing the cleared land under existing transmission lines as cover and food for small wild game. Duke offered owners of the land under the transmission lines a free and complete job of preparing the land for planting and growing various kinds of vegetation. On newly constructed transmission lines, at the request of the landowners, Duke clears, plants and fertilizes the rights-of-way so that quail, rabbits and other small game are provided cover and food. In one year the company buys 100,000 pounds of seed and over a million pounds of fertilizer just for this purpose. Under both these programs, hundreds of miles of transmission lines rights-of-way have been restored to attractive, productive use.

Duke's new construction activities often involve large scale land clearing and earth excavation operations. For years it has been company practice to restore grass and tree cover to such disturbed areas in early stages of construction to reduce erosion and downstream siltation. Roadway banks, earth borrow pits, slopes of dams and other earth structures and banks of canals are thus provided with vegetation cover and restored to a stable condition and pleasing appearance.

3.9 PUBLIC HEALTH AND SANITATION

The entire basin of Lake Norman was completely cleared of all trees and brush before impoundment. The basin was under continual surveillance by state and local public health officials and Duke Power Company's Environmental Health Department before clearing operations were begun. Through filling operations, surveillance is continued today.

Mosquito surveys were conducted before and during filling of the reservoir. Control measures were introduced when necessary during clearing and filling operations. A larviciding program for mosquito control is carried on each year during mosquito breeding season; usually April through October. No insecticides are used in larviciding operations. A mixture of No. 2 diesel fuel and transformer oil is used as recommended by the North Carolina State Medical Entomologist.

As a result of coordinated development of sanitary standards with four counties prior to lake construction, other sanitary conditions around Lake Norman are excellent. The majority of the residents live in modern homes with approved sewage disposal systems and protected water supplies.

Solid waste disposal is the sanitary problem of the greatest magnitude in the greater Lake Norman area today, but the problem is spotty and not of a general nature. The problem is improving as both local and state health officials are aware. For his work in solid waste management, the sanitarian for two of the counties surrounding Lake Norman received the 1969 award given by the North Carolina Board of Health for the most outstanding project of an environmental health nature.

Public Health Personnel of Duke Power Company work closely on a continuing basis with officials of local health departments and the North Carolina State Board of Health on matters concerning mosquito control, water supplies, sanitary waste, solid waste and any other public health problem.

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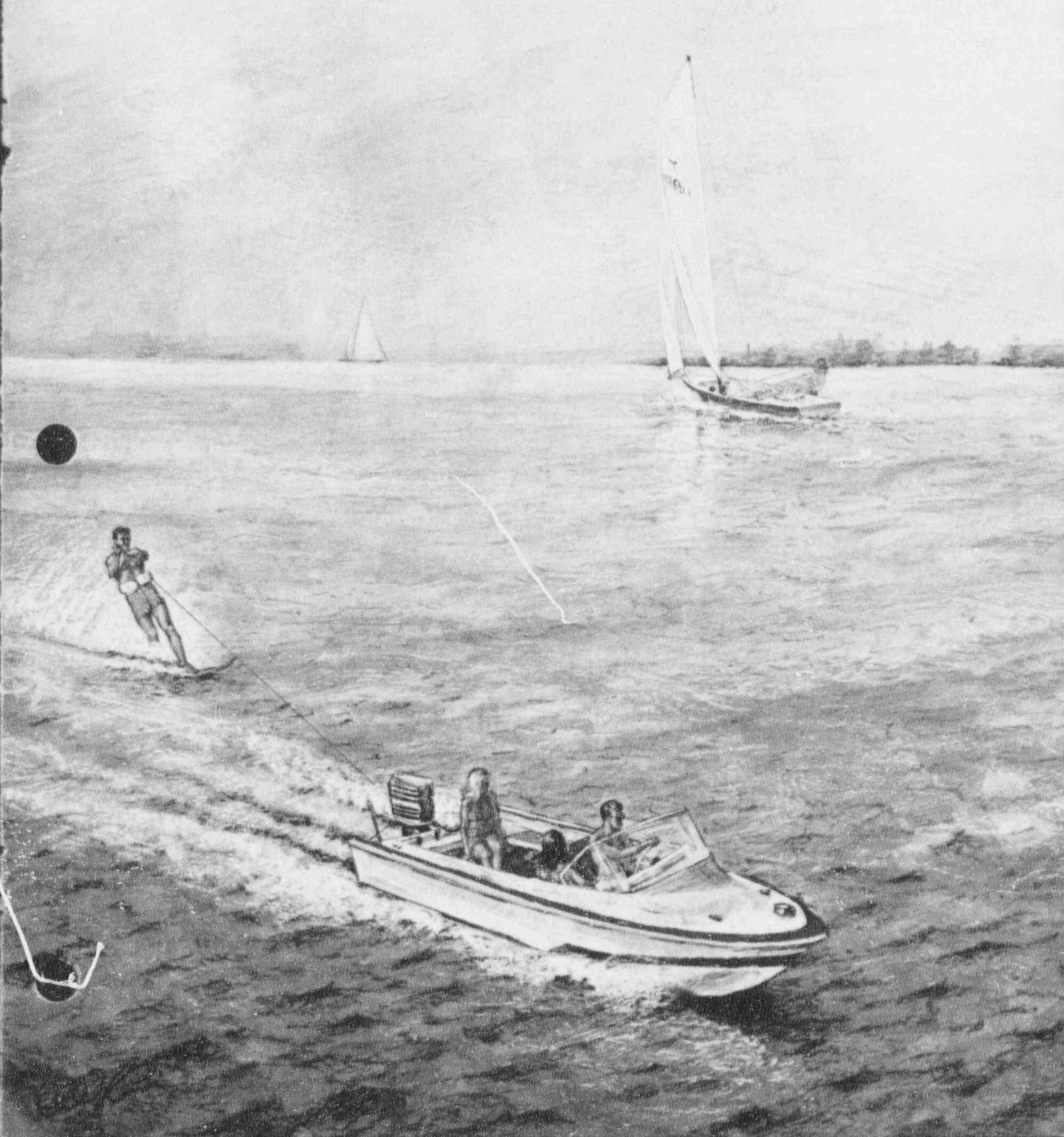
Lake Norman

THE INLAND SEA

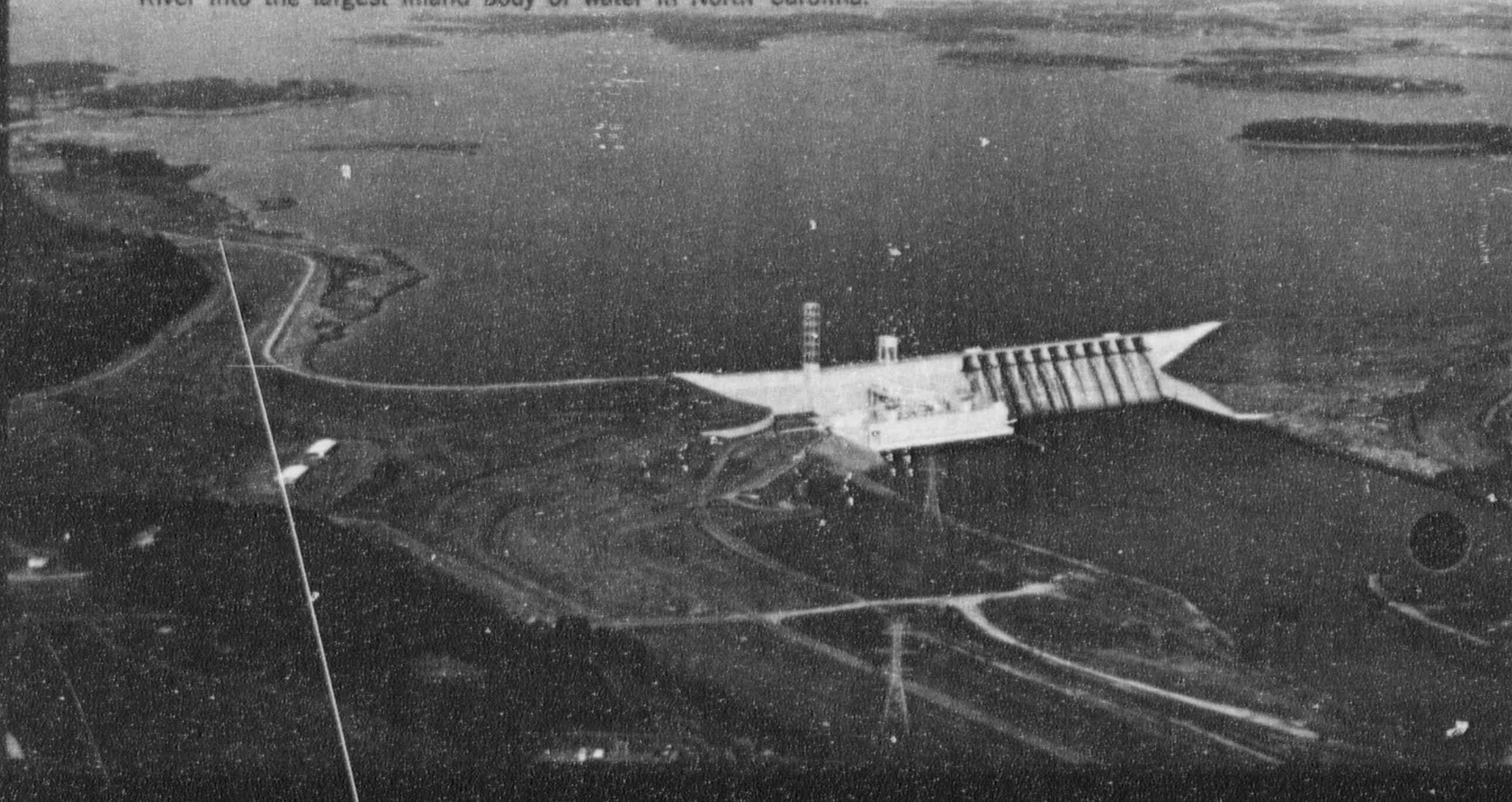


Horses reared and lunged in wild-eyed fright. The crack of musketry mingled with screams of the newly wounded and sobs of the dying. Frantic hands rammed home powder, patch, ball and a final patch. Angry eyes lined up the long rifle barrels, and fingers squeezed deadly triggers.

That was Cowans Ford, a narrow, shallow spot in the slow-flowing Catawba River—184 years ago.

Today, a high bank of white concrete holds out two arms of red Carolina clay, and together they push back a shimmery lake that fingers its way 34 miles in a northwesterly direction. Twenty miles away to the southwest a switch is flipped and the silence is interrupted by the boil of suddenly-freed water behind the bank of concrete.

This is Cowans Ford now—a mile-long hydroelectric dam transforming that same, slow-flowing Catawba River into the largest inland body of water in North Carolina.



It was February 1, 1781, when a band of North Carolina militia, commanded by General William Davidson, fought a heroic battle it had no hope of winning at Cowans Ford. Davidson's forces merely hoped to delay British Commander Lord Cornwallis in his pursuit of General Daniel Morgan and his American irregulars.

General Davidson died in the battle, and a tri-cornered stone near Cowans Ford Dam contains a marker commemorating the historical skirmish.

A few hundred yards away another metal marker contains these "nameplate" facts about Cowans Ford Dam, the 11th and last hydroelectric installation built by Duke Power Company on the Catawba, and the resulting Lake Norman.

The length of the dam, including its earthen arms, is 7,906 feet—stretching between the counties of Mecklenburg and Lincoln, with the generating facilities on the Lincoln side.

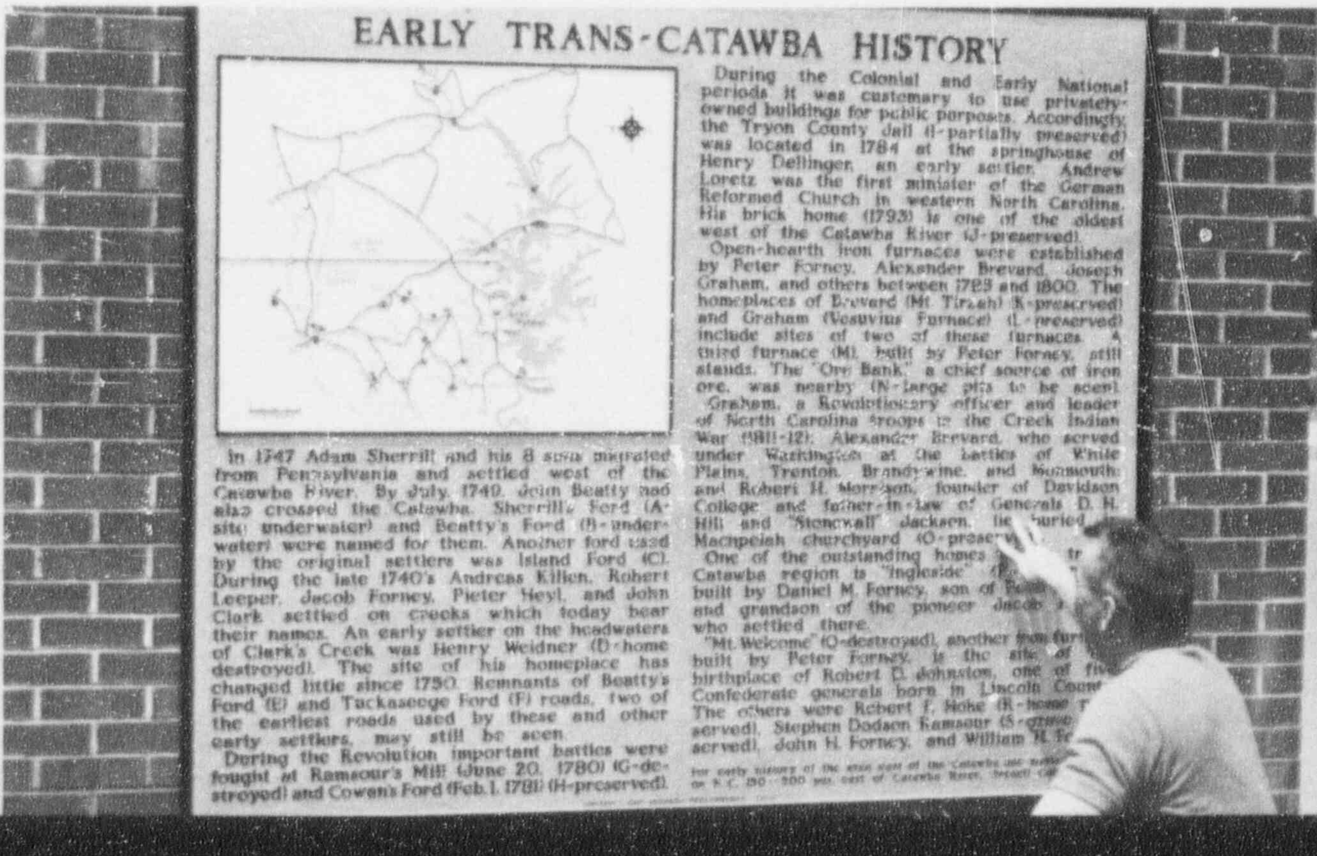
Construction of the dam was begun in 1959 and completed in 1964, and the peaking power capacity of its four units is 372,000 kilowatts.

The height of the dam is 150 feet, 25 feet above the maximum water depth in front of the dam. Surface area of Lake Norman, when full, is 32,510 acres and this massive body of water is encircled by 520 miles of shoreline bordering four counties.

Plant Marshall, the first of a $1 billion steam generating complex planned for Lake Norman, is under construction on the Catawba County extremity of Highway 150. Marshall has activated two of four eventual units, and when completed it will be one of the world's largest capacity steam plants at over 2 million kilowatts. Cost of construction for the first two units was $80 million, with the completed plant to cost $198 million.

The lake was named for Norman Atwater Cocke, retired Duke Power president, and was dedicated to the service and growth of the Piedmont Carolinas, along with Cowans Ford Station, by Governor Terry Sanford on Sept. 29, 1964.

NORMAN ATWATER COCKE



LAKE NORMAN - THE INLAND SEA

By Brooks Lindsay, AP

Charlotte Power Squadron

"Welcome to the Inland Sea!"

He looked like every old fisherman in the world—short grey hair, a day-old stubble of beard, a cigarette in the side of his mouth and a sizable string of fish in his hand.

I was anxious to get my boat off the trailer but I couldn't pass that up.

"Come again?"

"I've caught fish this morning," he said, as he moved off to his car, "on a lake that in some places would be called a sea."

"Read your Bible!"

Later, I did. Also, I did some quick research.

FACT: Sea of Galilee—fourteen miles long, eight miles across at widest point. Fresh water.

FACT: Dead Sea— forty-eight miles long, ten miles across. Salt water.

FACT: Lake Norman—eight miles wide at one point, thirty miles long. Fresh water. Largest inland lake in North Carolina.

FACT: Lake Norman—built by Duke Power Company, it helps carry the "peak electricity loads" of the Piedmont Carolinas.

Admittedly, it isn't the shape one normally thinks of as a sea, but there are similarities.

So what does this mean to you? Nothing, except that like the well-known storm on the Sea of Galilee, Norman can throw up some nasty weather occasionally. It's deceptive! On a calm day, it looks like the neighborhood pond. In ten minutes time it can whip up wind and waves to swamp a small fishing boat. This is because the wind has a chance to build up waves over a long distance. If it doesn't swamp you, it can turn your heart to ice as you fight your way to shore. It's worse if you have loved ones aboard.

Perhaps if one were to throw all the facts about boating, lake size and knowledge of boating by the average user of the lake into a computer it would be possible to come up with a good recommended boat size. If we had to guess, to pick a size, it would probably be around seventeen feet.

The reason for this is the larger boats are designed so well today they'll usually get a poor sailor home. But what about our old, salty, dyed-in-the-wool fisherman? He wants to fish off the points, in the reeds, bullrushes and up the coves. He likes the small, flat-bottomed skiff. Okay, here it is straight. He'd better be a **better boatman** than the large boat sailor . . . Not **claim** to be, but **be.** He'd better **know** what that little skiff can take and **know** when to try for home or when to try for a lee shore. Lake Norman isn't interested in his pride. When he plays with her, he plays her rules.

The "Ragpicker" or sailboat man, if he's experienced at all, will love this lake. He understands wind and waves because it's the first thing he learns. It propels his boat.

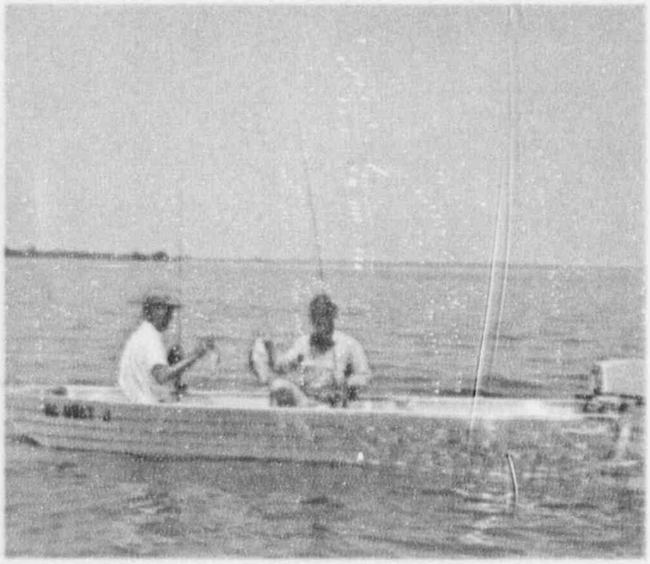
So, if one learns a bit about boats, a little about the weather and something about the Rules of the Road (driving regulations) this "Inland Sea," in addition to being a power producer, is also perhaps the most pleasant recreation area in the state.

As we said, it produces power (which Galilee doesn't), it gives more immediate recreational advantages than the ocean, there is no charge for its use, and it's close to home.

So, I'll see you around Lake Norman . . . either at the State Park or at one of the many access areas; at my own lot at the foot of Crazy Man Bay (leased to me by Duke Power), or in the middle of the lake. And if I blow my whistle (horn) I'm not telling you to get out of the way, I'm only telling you which way I'm steering my boat.

And if you'd like to know more about anything you've read here, including Lake Norman, come look us up in Charlotte in the Spring or Fall. A great bunch of guys who like people, boats and boating just like you, the Charlotte Power Squadron, will be happy to share their knowledge with you—and the nice thing about it is . . . It's FREE!

Happy boating!

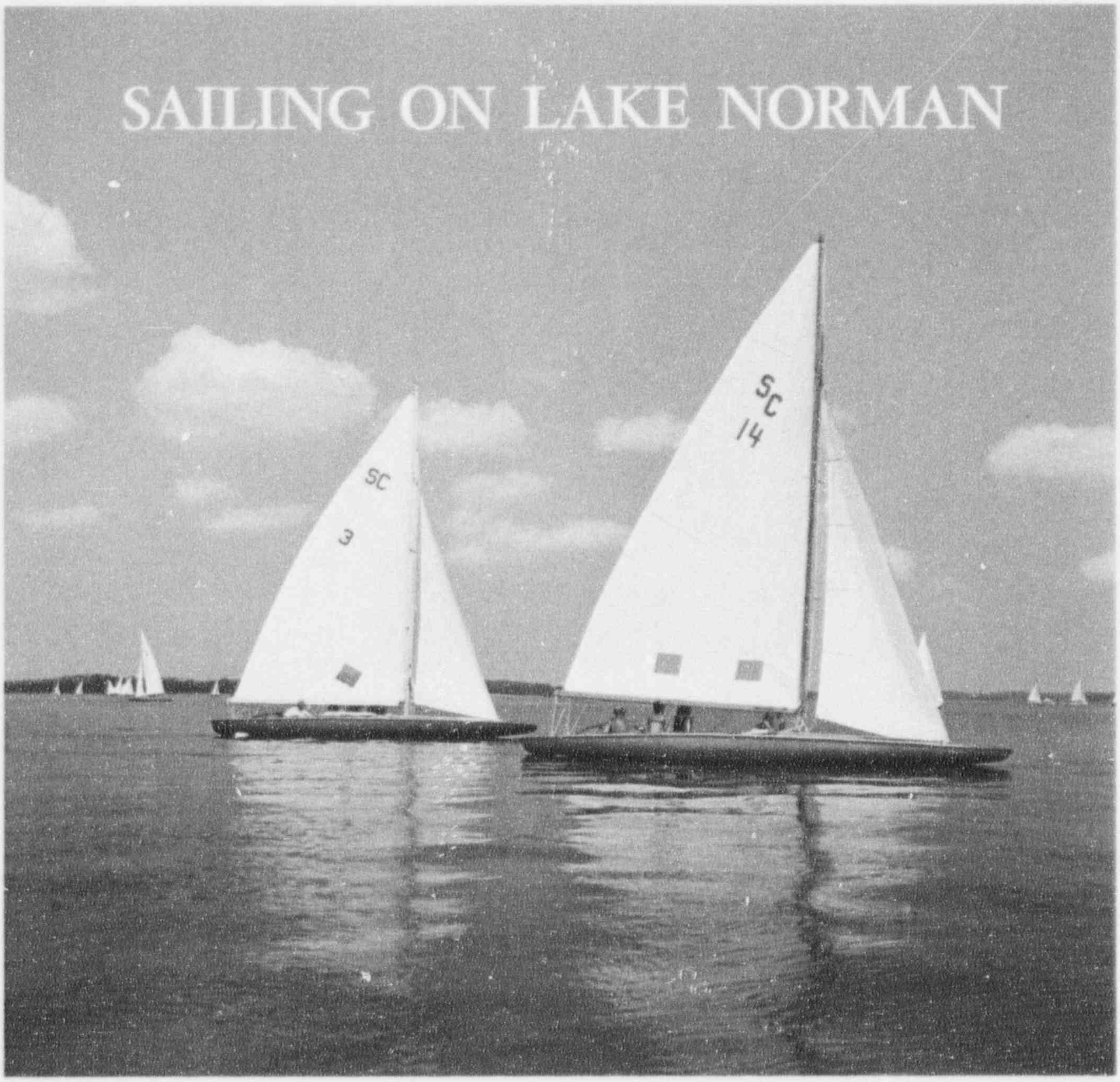


L. Brooks Lindsay, Jr. has long been associated with boating activities and boating safety in the Carolinas. He is a charter member of the Charlotte Power Squadron and was a driving force in formation of the Squadron.

Lindsay is a past commander of the Charlotte Power Squadron and holds permanent rank of commander in the U.S. Power Squadrons. He holds the educational grade of Advanced Pilot, having progressed through Piloting, Seamanship and Advanced Piloting courses.

He has attained five merit marks, awarded one per year by the Chief Commander of the U.S. Power Squadrons for service beyond normal duties, and this qualifies him as a senior member of the U.S. Power Squadrons.

Lindsay is an instructor for the Charlotte Power Squadron, as are all Squadron members, and is a key figure in the several 11-weeks piloting courses offered free to the public each year by the Charlotte Squadron. For information about the next class contact Lindsay or any Squadron member.



By Sandy McKeel

Lake Norman Yacht Club

With much wider expanses of open water and generally lower shoreline than other Piedmont power impoundments, Lake Norman offers excellent opportunities for pleasure sailing, competitive sailing and overnight cruising. However, the larger body of water will present conditions which should be anticipated by the novice and even by experienced sailors who have confined their sport to smaller lakes.

Whereas high winds usually produce only a chop on smaller lakes, a moderate breeze on Lake Norman can build substantial waves. Wave height depends upon not only wind velocity, but also the length of time the particular wind blows and the "fetch," or distance from the windward shore (the shore from which the wind is blowing).

While it requires 10 hours and a 75-mile fetch for a 20-knot wind to build waves to their maximum height, the violent winds in a sudden line squall have been observed to develop 2-3 foot waves (some swamped skippers have claimed 4 feet) on Lake Norman in 10-15 minutes over a 1½-2 mile fetch.

It should be remembered that there can be as much as an 8-mile fetch when a NE wind is blowing toward Cowans Ford Dam out of Reeds Creek.

Whitecaps first begin to appear in a moderate breeze of about 13-18 mph, generally safe for 10-12 foot boats. A fresh breeze of 19-23 mph produces long waves with whitecaps covering the water, and is safe for larger boats—although sailing may be rough and wet.

When you see a cumulo-nimbus cloud, you have about 30 minutes to make shore before the thunderstorm hits. If you can't reach safety, prepare to take the usual precautions. Don't be deceived by the first moderate winds blowing toward the storm. They will be followed by sudden gusts striking savagely from several directions.

When day sailing in a sustained, moderate or fresh breeze, remember that the waves which may be small when you start out will be bigger later in the day with no increase in wind velocity.

When beating into waves, try to meet them head-on and then bear off to pick up speed before heading up into the next one. Non-breaking waves release very little energy and don't push you back. Gravity makes the boat slide backward down the face of a wave, and the wind striking the increasingly exposed hull as it rises in the water pushes the boat back.

Breaking waves in shallow water (depth less than half a wave length) release considerable energy and should be avoided. In a heavy sea, try to plan your course near the windward shore where the waves will be smaller, and by all means keep your boat moving. It's easy to be stalled completely by a second wave while recovering from the previous one. The chances of swamping or capsizing are then very good.

Have fun sailing, but make sure that your boat and rigging are sound and that you are familiar with heavy weather sailing before venturing onto Lake Norman. It's a great lake for the "bed sheet brigade" but it's also different.

Charles B. (Sandy) McKeel is a former commodore of the Catawba Yacht Club, located on Duke Power's Lake Wylie, and the Lake Norman Yacht Club. He has been sailing for sport for 20 years, and it's now a family fun affair with his wife, Mary Frances, and daughter, Debbie, joining in.

The Lake Norman Yacht Club is a member of the South Atlantic Yacht Racing Association and the North American Yacht Racing Union. Although the club's facilities do not accommodate casual visitors, persons interested in sailing or joining the club are invited to contact a member.

Complete sailing facilities are available and are gradually being expanded at the club site off County Road 1100. Regular class races are held on weekends, and as many as 150 boats from all over the Southeast participate in the club's annual invitational regatta each May.

STATE FISHING AND BOATING REGULATIONS

Fishing in Lake Norman will be among the best available anywhere in the state of North Carolina during the lake's first decade. This is the biological history of such power impoundments, and it follows the truth that Nature abhors a vacuum. New lakes usually have excellent food conditions, and this sets off a fish population explosion that continues for some five to seven years after the lake fills.

Lake Norman includes largemouth bass, crappie, bream, white bass and sauger (an import from Tennessee) among its game fish, plus catfish, carp and threadfin shad. The shad were introduced to provide food fish for the carnivorous game fishes.

North Carolina Wildlife Resources Commission fishing regulations apply to Lake Norman waters, just as they do to all public waters in the state.

A county resident may fish in Norman waters bordering his county without a license—provided he uses live bait. The use of artificial bait requires a county license costing $1.65. A state license, costing $4.25 for a North Carolina resident, will allow a person to fish anywhere in the state, including all the waters of Lake Norman, and use all types of lures and baits.

Special regulations cover the use of seines, fish traps, trotlines, and "bottle" or "can" fishing. Be sure to check these regulations before engaging in these types of fishing.

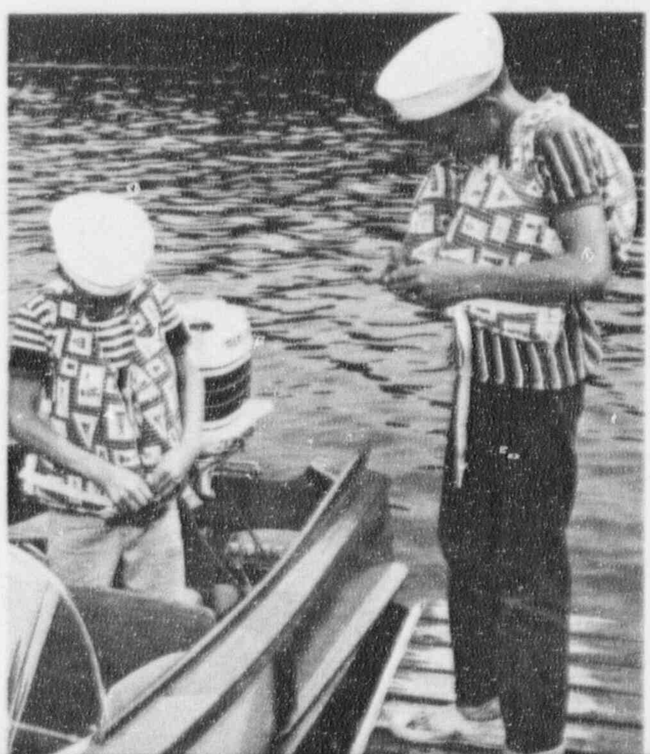
The wise fisherman, should he be fishing Lake Norman or any strange waters for the first time, will inquire of marina or fishing dock operators what recent conditions have been in regard to fishing. These people will gladly offer advice, instructions and directions as to how best to fill your stringer that particular day.

The North Carolina Wildlife Resources Commission is charged also with the enforcement of boating regulations and safety laws on inland state waters such as Lake Norman. In brief, these regulations require that all boats mounting motors of over 10 horsepower must be registered with the state and mount easily visible state registration numbers, and that a lifesaving flotation device be carried for every person aboard a boat.

All boat operators are expected to follow the usual "rules of the road" safety precautions, and reckless operation or operation of a boat while under the influence of alcohol can lead to citation and arrest by Wildlife Commission personnel or other peace officers.

Regulations concerning water skiing require that the tow boat either carry an observer in addition to the driver, or be fitted with a rear view mirror of sufficient size and design to allow the driver to observe his skier, or the skier must wear a flotation device. The use of the "downed" skier flag is recommended.

The Wildlife Commission urges that all persons boating, skiing, or fishing in public waters such as Lake Norman observe all safety precautions and practice courtesy in their relations with other users. This will lead to safer, happier use of these recreational facilities with which the people of North Carolina have been so wonderfully endowed.




WATER SAFETY RULES
SWIMMERS
Do not swim across channels. If possible, designate swimming areas with floats or markers, and stay within these.
BOATERS
Keep 300 feet from shore, and if boat is brought closer slow it down to "no wake" speed. Boats also should be slowed to "no wake" in coves around dock facilities—unless dropping a skier.
for damage caused by boat's wake.
Slow, no wake speed is recommended in and around all congested areas.
•Power boats should stay clear of row boats, sail boats and swimmers.
All boatmen should remain alert and be courteous.
•Operators will be prosecuted for operating craft while intoxicated
•Nautical Rules of the Road apply to all traffic systems.
•Buoyage system is Federal and Uniform Marking System.
•Proper night lighting and life preservers required.
•Lake Norman waters are dangerous to small boats in bad weather.

RULES OF TH

—IF two boats are approaching each other at an ngle and there is a possibility of a collision, the boat o port (left) must give way to the boat to starboard right).

—WHEN meeting another boat head-on, keep to tarboard (right) unless you are too far to port (left) make this practical.

—W overta overta course

—S/ the rig boat is

1966—DUKE POWER CO. 17038

WHY A POWER LAKE RISES AND FALLS

Lake Norman, like all power impoundments used for hydroelectric generation, will fluctuate in level according to the generation needs for which it was built.

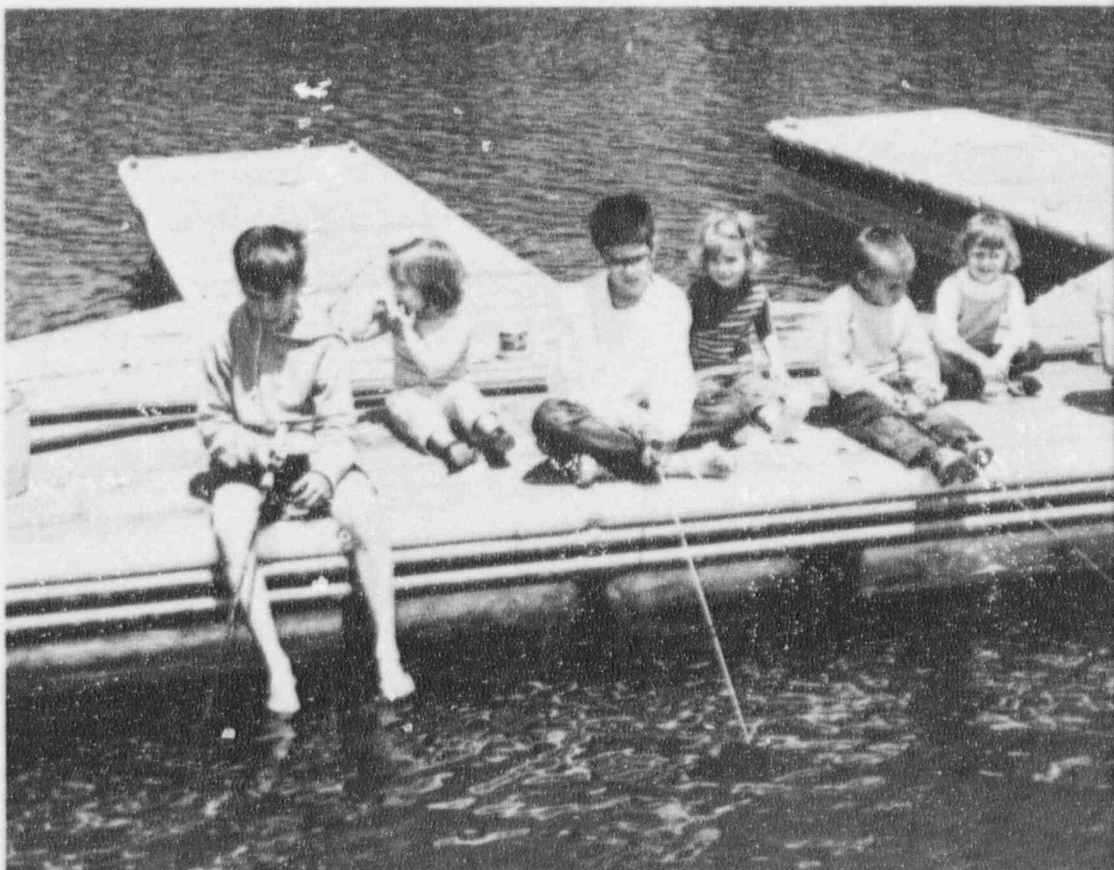
To meet the needs for electric service, the Cowans Ford Hydroelectric Station, which is part of the Cowans Ford Dam, was designed to operate at maximum efficiency from full pond to 15 feet drawdown, and to operate satisfactorily to 25 feet drawdown.

The operation of Cowans Ford has to be coordinated with the operation of other plants on Duke's Catawba River system to fit into the overall system operation in the most efficient manner.

The level of Lake Norman, as is customary with all power lakes, will vary from time to time. This is due to several factors such a fall, Duke's need for hydroele given time, and emergency op Ford due to removal of other u servicing, etc.

Generally, during an average ra sonal fluctuation of the pond eight feet over a period of thr This may be exceeded, howeve conditions. Maximum drawdown is seldom more than two feet, ations, or emergencies may c

If boat docks or piers are con side lots, it is suggested tha given to a hinged, floating porti of course, rises and lowers with



PARKS
CAMPGROUNDS
ACCESS AREAS

In 1962 Duke Power Company made available to the state of North Carolina a 1,328-acre tract on the Iredell County shores of Lake Norman for a state park. Some portions of the park are now in use, and additional facilities will be added in later years.

The park, known as Duke Power State Park, features a 33-acre, constant-level swimming lake, an initial camping area of 150 sites, picnic areas and a boat-launching ramp. Both the camping and picnic areas will have running water and electricity.

A dam holds the swimming area at a constant level, and heavy sand covers the 400 yards of beach. Bathhouses and all other swimming facilities are provided.

The State Advisory Budget Commission approved in 1965 an additional $220,000 appropriation for further development of the park during the next few years. Oren Hawkins has been named superintendent of the park.

In addition to the boat-launching facility at the park, and numerous launching ramps at privately-owned marinas around the lake, Duke Power also has provided 10 access areas open to the boating or fishing enthusiast. Parking space that could accommodate 30,000 cars has been made available at these 10 areas.

Lake Norman's "big" waters have caused changes in the boating habits of the Piedmont water enthusiast. With some 33 miles of open channel from the dam to the lake's headwaters, and with numerous deep coves to explore, the cabin cruiser has become a common sight on the lake.

The large boats still are outnumbered by outboard and stern-drive runabout units, however, and advocates of these smaller craft have discovered that weather must now be included in their boating plans. Squalls over the wide sections of the lake (eight miles at its widest point) can cause uncomfortable moments for small boats, particularly if heavily loaded.

The sailboater can find plenty of uncrowded water to pursue his sport, and the sight of jaunty sails billowing in the breeze has become a common sight on brisk summer afternoons.

COTTAGE SITES

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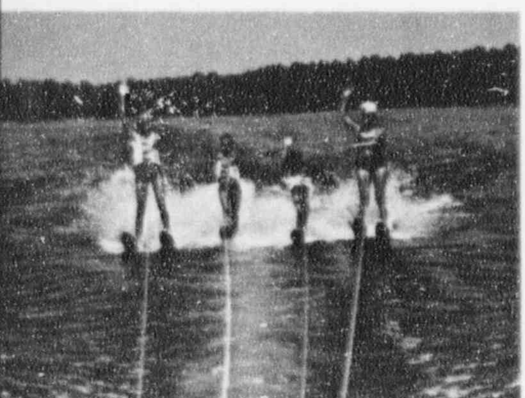

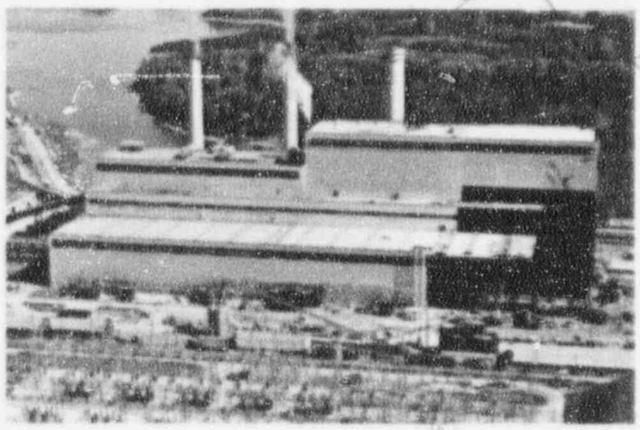

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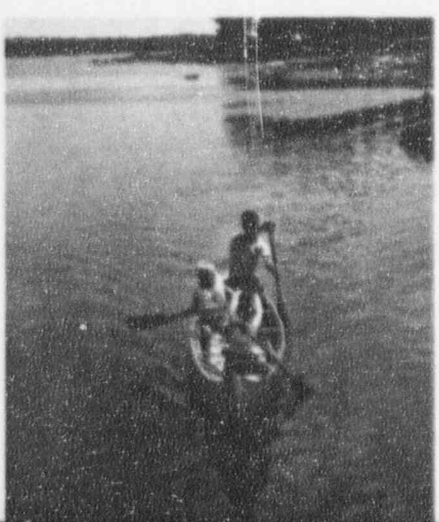
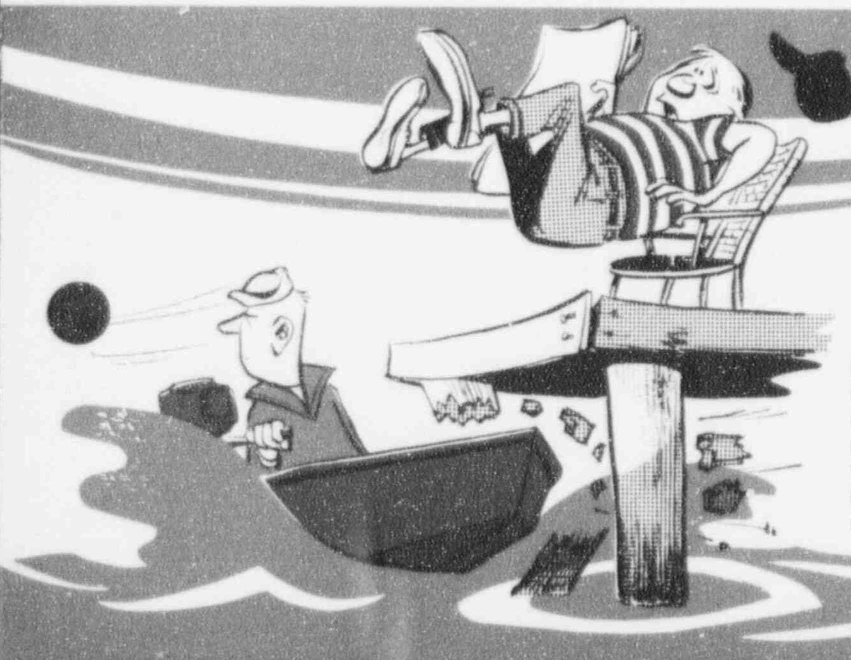


WATER SAFETY RULES

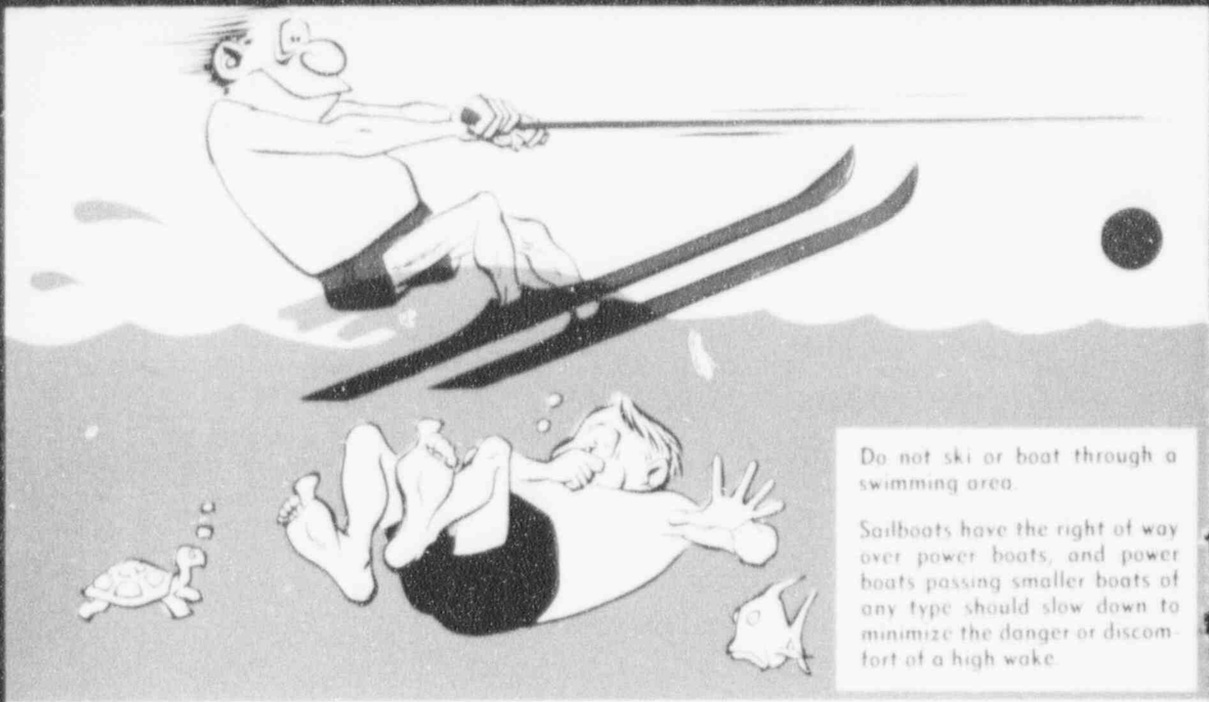
SWIMMERS

Do not swim across channels. If possible, designate swimming areas with floats or markers, and stay within these.



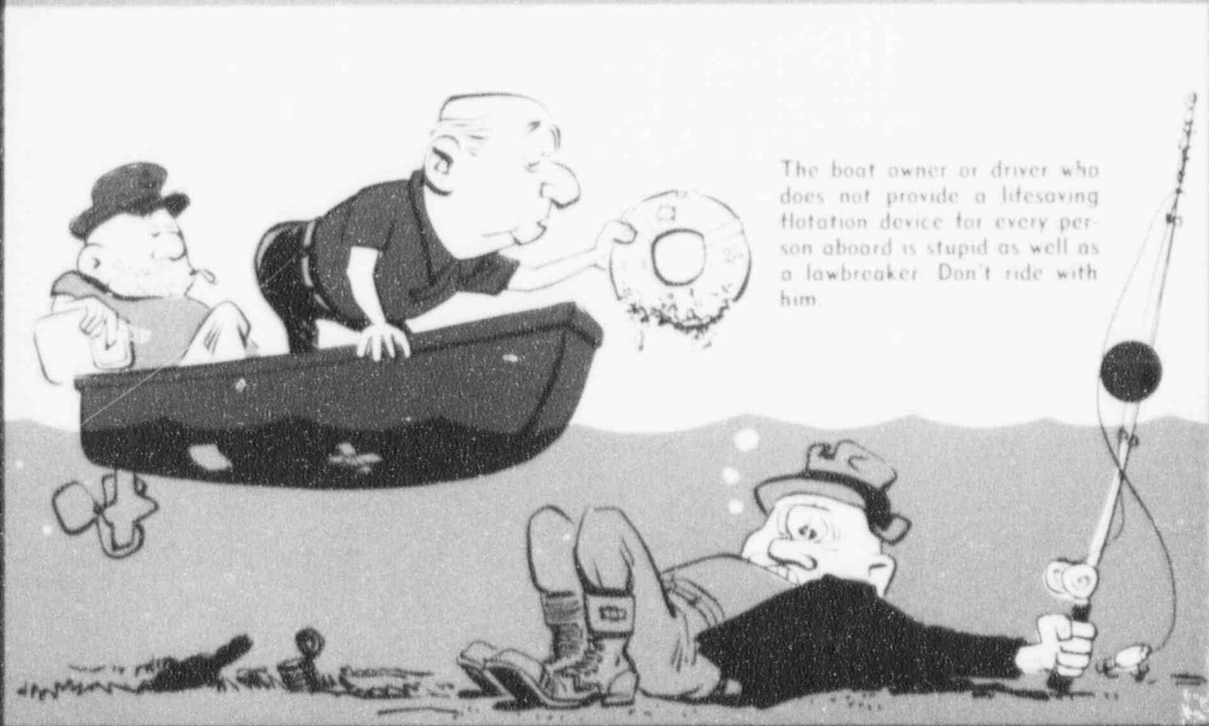
BOATERS

Keep 300 feet from shore, and if boat is brought closer slow it down to "no wake" speed. Boats also should be slowed to "no wake" in coves around dock facilities—unless dropping a skier.

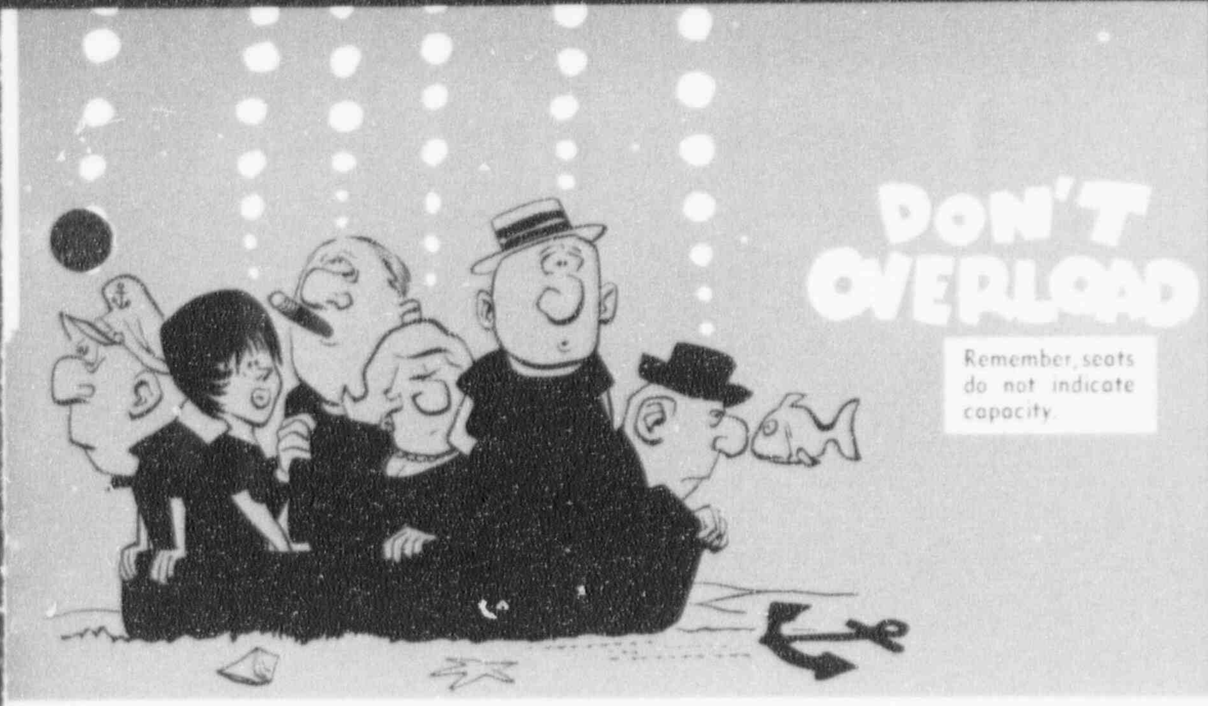


Do not ski or boat through a swimming area.

Sailboats have the right of way over power boats, and power boats passing smaller boats of any type should slow down to minimize the danger or discomfort of a high wake.



The boat owner or driver who does not provide a lifesaving flotation device for every person aboard is stupid as well as a lawbreaker. Don't ride with him.


DON'T OVERLOAD
Remember, seats do not indicate capacity.


DON'T STAND UP
If you must stand, or change seats, keep to the center with both hands on gunwales, keep low.

RULES OF THE ROAD

—IF two boats are approaching each other at an angle and there is a possibility of a collision, the boat to port (left) must give way to the boat to starboard (right).

—WHEN meeting another boat head-on, keep to starboard (right) unless you are too far to port (left) to make this practical.

—WHEN overtaking another boat, the boat being overtaken has the right-of-way. If you are being overtaken or being passed, you must maintain your course and speed.

—SAILBOATS or boats without motors always have the right-of-way over power boats unless the motor boat is being overtaken.

© 1966—DUKE POWER CO. [illegible]

This booklet courtesy Duke Power Co. in the interests of your Safety.

It should be remembered that there can be as much as an 8-mile fetch when a NE wind is blowing toward Cowans Ford Dam out of Reeds Creek.

Whitecaps first begin to appear in a moderate breeze of about 13-18 mph, generally safe for 10-12 foot boats. A fresh breeze of 19-23 mph produces long waves with whitecaps covering the water, and is safe for larger boats—although sailing may be rough and wet.

When you see a cumulo-nimbus cloud, you have about 30 minutes to make shore before the thunderstorm hits. If you can't reach safety, prepare to take the usual precautions. Don't be deceived by the first moderate winds blowing toward the storm. They will be followed by sudden gusts striking savagely from several directions.

When day sailing in a sustained, moderate or fresh breeze, remember that the waves which may be small when you start out will be bigger later in the day with no increase in wind velocity.

When beating into waves, try to meet them head-on and then bear off to pick up speed before heading up into the next one. Non-breaking waves release very little energy and don't push you back. Gravity makes the boat slide backward down the face of a wave, and the wind striking the increasingly exposed hull as it rises in the water pushes the boat back.

Breaking waves in shallow water (depth less than half a wave length) release considerable energy and should be avoided. In a heavy sea, try to plan your course near the windward shore where the waves will be smaller, and by all means keep your boat moving. It's easy to be stalled completely by a second wave while recovering from the previous one. The chances of swamping or capsizing are then very good.

Have fun sailing, but make sure that your boat and rigging are sound and that you are familiar with heavy weather sailing before venturing onto Lake Norman. It's a great lake for the "bed sheet brigade" but it's also different.

Charles B. (Sandy) McKeel is a former commodore of the Catawba Yacht Club, located on Duke Power's Lake Wylie, and the Lake Norman Yacht Club. He has been sailing for sport for 20 years, and it's now a family fun affair with his wife, Mary Frances, and daughter, Debbie, joining in.

The Lake Norman Yacht Club is a member of the South Atlantic Yacht Racing Association and the North American Yacht Racing Union. Although the club's facilities do not accommodate casual visitors, persons interested in sailing or joining the club are invited to contact a member.

Complete sailing facilities are available and are gradually being expanded at the club site off County Road 1100. Regular class races are held on weekends, and as many as 150 boats from all over the Southeast participate in the club's annual invitational regatta each May.

STATE FISHING AND BOATING REGULATIONS

Fishing in Lake Norman will be among the best available anywhere in the state of North Carolina during the lake's first decade. This is the biological history of such power impoundments, and it follows the truth that Nature abhors a vacuum. New lakes usually have excellent food conditions, and this sets off a fish population explosion that continues for some five to seven years after the lake fills.

Lake Norman includes largemouth bass, crappie, bream, white bass and sauger (an import from Tennessee) among its game fish, plus catfish, carp and threadfin shad. The shad were introduced to provide food fish for the carnivorous game fishes.

North Carolina Wildlife Resources Commission fishing regulations apply to Lake Norman waters, just as they do to all public waters in the state.

A county resident may fish in Norman waters bordering his county without a license—provided he uses live bait. The use of artificial bait requires a county license costing $1.65. A state license, costing $4.25 for a North Carolina resident, will allow a person to fish anywhere in the state, including all the waters of Lake Norman, and use all types of lures and baits.

Special regulations cover the use of seines, fish traps, trotlines, and "bottle" or "can" fishing. Be sure to check these regulations before engaging in these types of fishing.

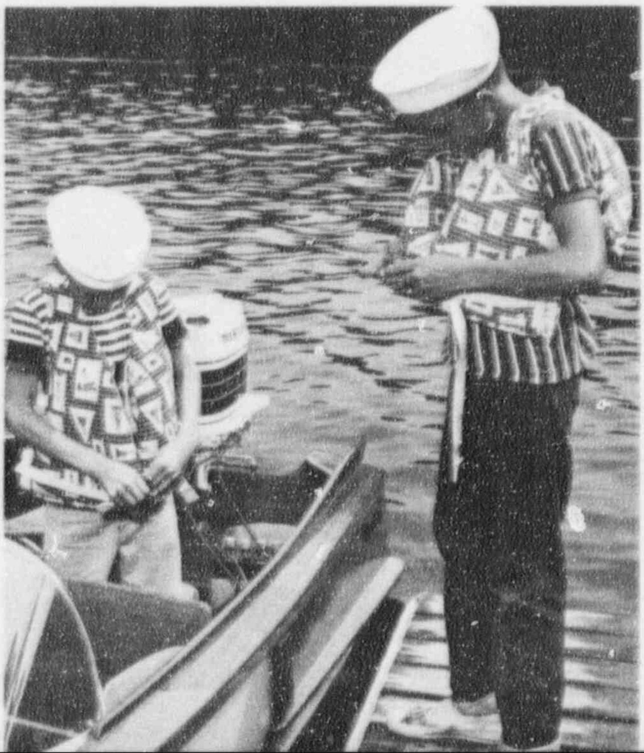
The wise fisherman, should he be fishing Lake Norman or any strange waters for the first time, will inquire of marina or fishing dock operators what recent conditions have been in regard to fishing. These people will gladly offer advice, instructions and directions as to how best to fill your stringer that particular day.

The North Carolina Wildlife Resources Commission is charged also with the enforcement of boating regulations and safety laws on inland state waters such as Lake Norman. In brief, these regulations require that all boats mounting motors of over 10 horsepower must be registered with the state and mount easily visible state registration numbers, and that a lifesaving flotation device be carried for every person aboard a boat.

All boat operators are expected to follow the usual "rules of the road" safety precautions, and reckless operation or operation of a boat while under the influence of alcohol can lead to citation and arrest by Wildlife Commission personnel or other peace officers.

Regulations concerning water skiing require that the tow boat either carry an observer in addition to the driver, or be fitted with a rear view mirror of sufficient size and design to allow the driver to observe his skier, or the skier must wear a flotation device. The use of the "downed" skier flag is recommended.

The Wildlife Commission urges that all persons boating, skiing, or fishing in public waters such as Lake Norman observe all safety precautions and practice courtesy in their relations with other users. This will lead to safer, happier use of these recreational facilities with which the people of North Carolina have been so wonderfully endowed.



LAKE NORMAN COMMISSION

The four counties surrounding Lake Norman—Lincoln, Catawba, Iredell and Mecklenburg—have joined in creating a Lake Norman Commission to assist in promoting safe use of the lake's waters. This commission, authorized by state law, consists of representatives from each of the four counties involved.

The Commission, after several study sessions, agreed to establish a uniform marking system on the lake and asked that, under the authority of the "Four County Act" Chapter 1025 of the 1965 Session Laws of the State of North Carolina, and also under General Statute 75A-10 through 75A-15 that the following ordinances be passed into law:

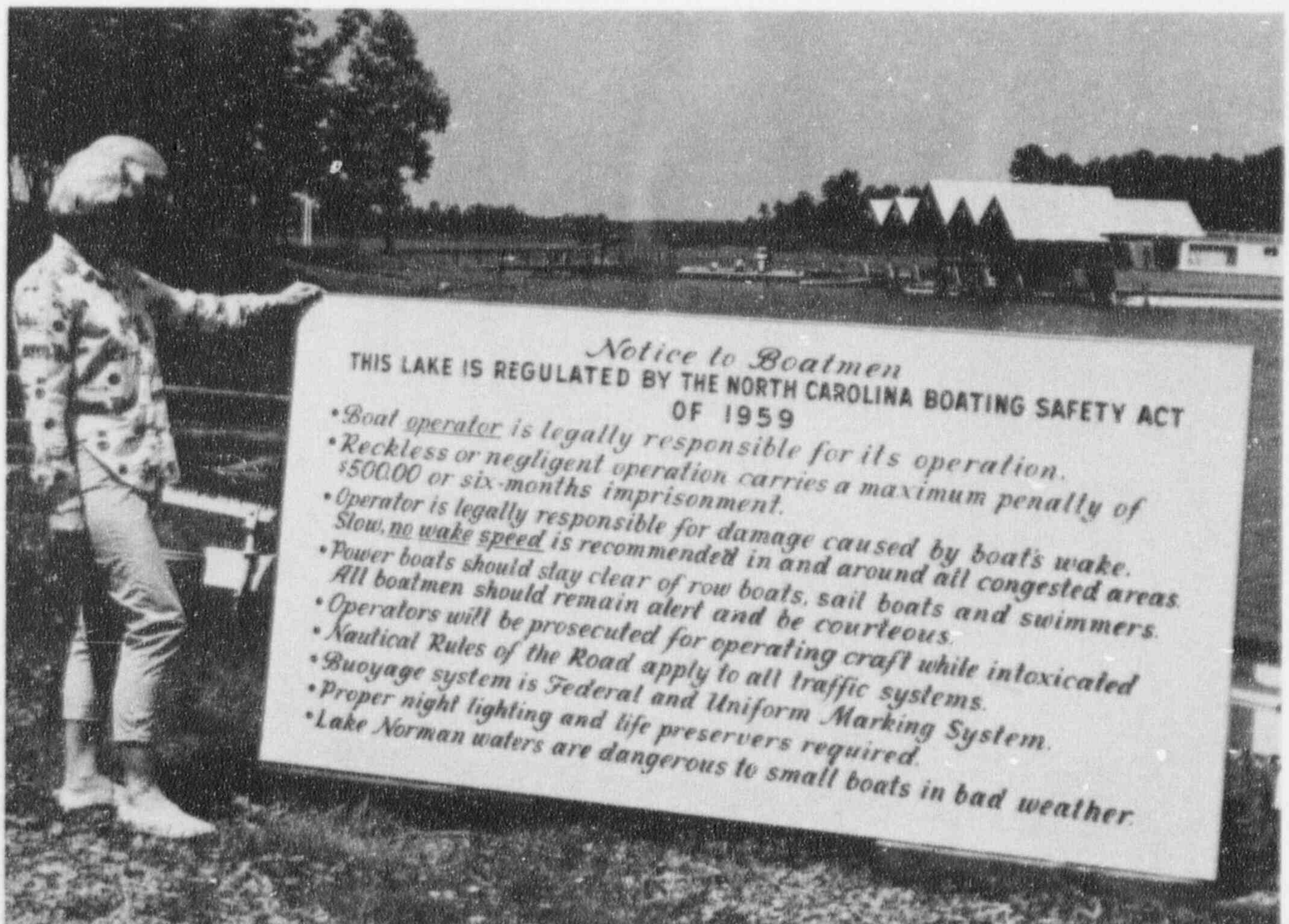
SECTION I:

It shall be unlawful for any person to move, remove, deface, damage or destroy or obliterate any navigational marker, safety marker, danger marker, or information sign or structure erected upon or in the waters of Lake Norman, or upon the immediate shores thereof, by the Lake Norman Commission acting as the joint regulating authority of Catawba, Iredell, Lincoln and Mecklenburg Counties.

SECTION II:

It shall be unlawful for any person to operate any water borne craft upon the waters of Lake Norman within one hundred fiftv feet (150') of any launching area, dock, pier, marina, boat storage structure, marked swimming area, or private or public boat service areas, at greater than "No Wake" speed if said areas are marked by a "No Wake" sign. These regulations will be enforced by N. C. Wildlife Commission personnel and officers representing the Lake Norman Marine Commission.

These ordinances became effective after adoption by all four counties in June, 1966.



WHY A POWER LAKE RISES AND FALLS

Lake Norman, like all power impoundments used for hydroelectric generation, will fluctuate in level according to the generation needs for which it was built.

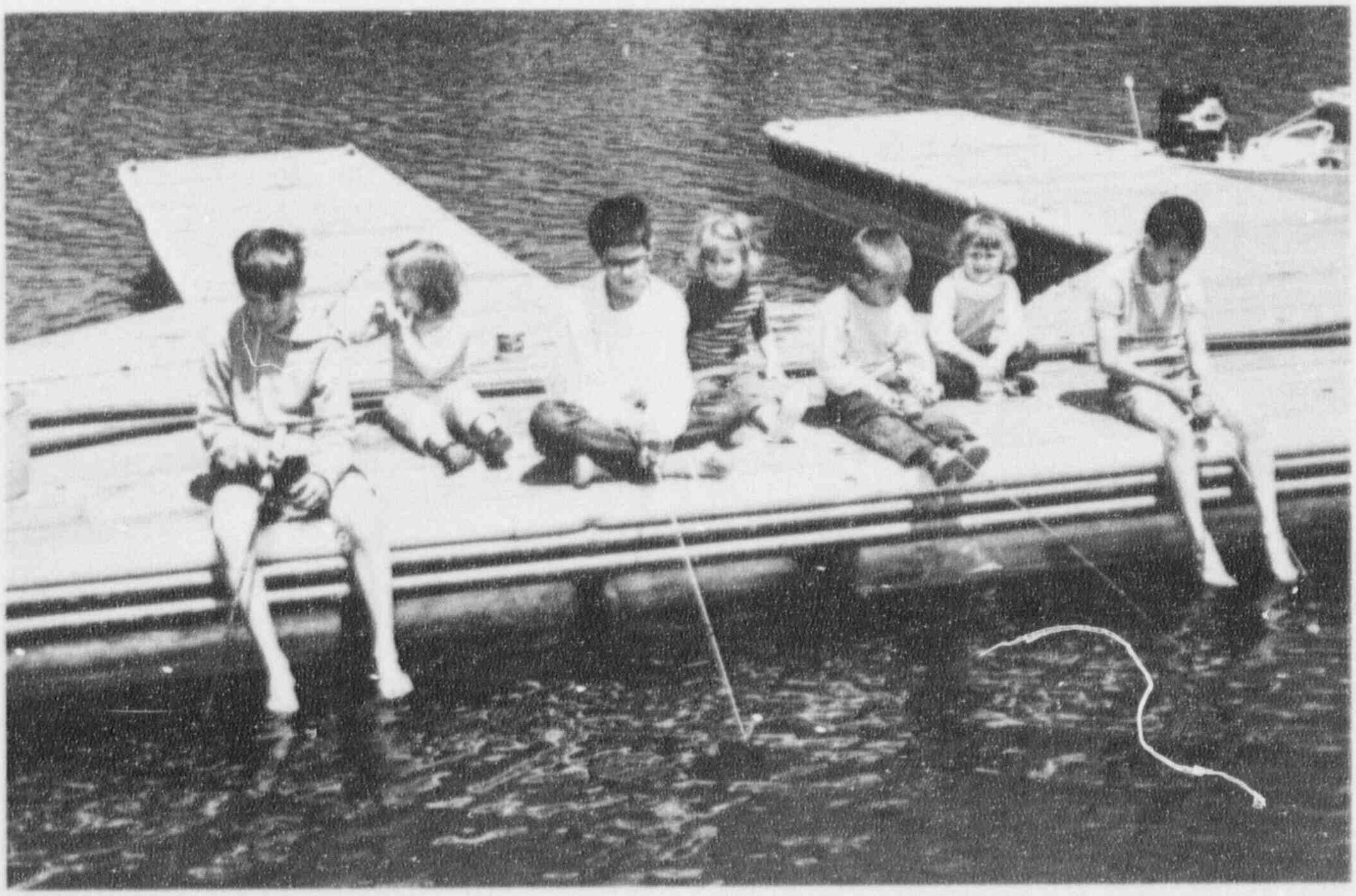
To meet the needs for electric service, the Cowans Ford Hydroelectric Station, which is part of the Cowans Ford Dam, was designed to operate at maximum efficiency from full pond to 15 feet drawdown, and to operate satisfactorily to 25 feet drawdown.

The operation of Cowans Ford has to be coordinated with the operation of other plants on Duke's Catawba River system to fit into the overall system operation in the most efficient manner.

The level of Lake Norman, as is customary with all power lakes, will vary from time to time. This is due to several factors such as: amount of rainfall, Duke's need for hydroelectric power at any given time, and emergency operation of Cowans Ford due to removal of other units on system for servicing, etc.

Generally, during an average rainfall year, the seasonal fluctuation of the pond level will be about eight feet over a period of three or four months. This may be exceeded, however, due to unusual conditions. Maximum drawdown for any one week is seldom more than two feet, but extreme situations, or emergencies may change this rapidly.

If boat docks or piers are constructed from lakeside lots, it is suggested that consideration be given to a hinged, floating portion at the tip which, of course, rises and lowers with the water.



PARKS
CAMPGROUNDS
ACCESS AREAS

In 1962 Duke Power Company made available to the state of North Carolina a 1,328-acre tract on the Iredell County shores of Lake Norman for a state park. Some portions of the park are now in use, and additional facilities will be added in later years.

The park, known as Duke Power State Park, features a 33-acre, constant-level swimming lake, an initial camping area of 150 sites, picnic areas and a boat-launching ramp. Both the camping and picnic areas will have running water and electricity.

A dam holds the swimming area at a constant level, and heavy sand covers the 400 yards of beach. Bathhouses and all other swimming facilities are provided.

The State Advisory Budget Commission approved in 1965 an additional $220,000 appropriation for further development of the park during the next few years. Oren Hawkins has been named superintendent of the park.

In addition to the boat-launching facility at the park, and numerous launching ramps at privately-owned marinas around the lake, Duke Power also has provided 10 access areas open to the boating or fishing enthusiast. Parking space that could accommodate 30,000 cars has been made available at these 10 areas.

Lake Norman's "big" waters have caused changes in the boating habits of the Piedmont water enthusiast. With some 33 miles of open channel from the dam to the lake's headwaters, and with numerous deep coves to explore, the cabin cruiser has become a common sight on the lake.

The large boats still are outnumbered by outboard and stern-drive runabout units, however, and advocates of these smaller craft have discovered that weather must now be included in their boating plans. Squalls over the wide sections of the lake (eight miles at its widest point) can cause uncomfortable moments for small boats, particularly if heavily loaded.

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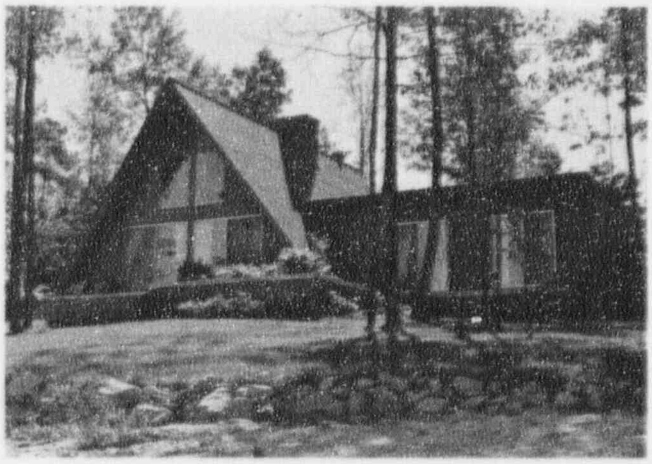

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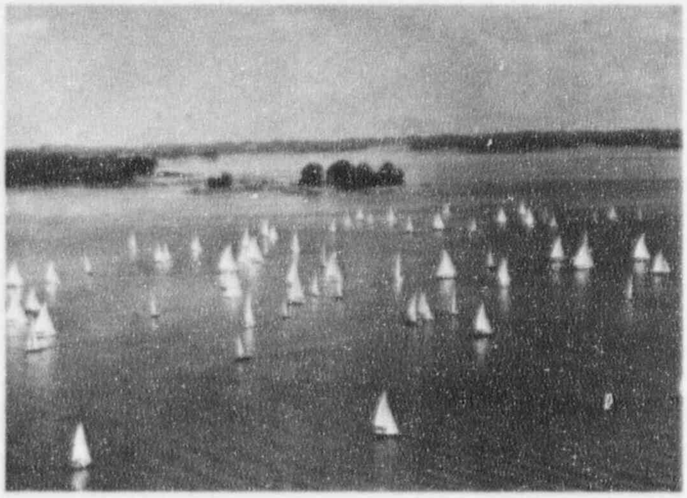

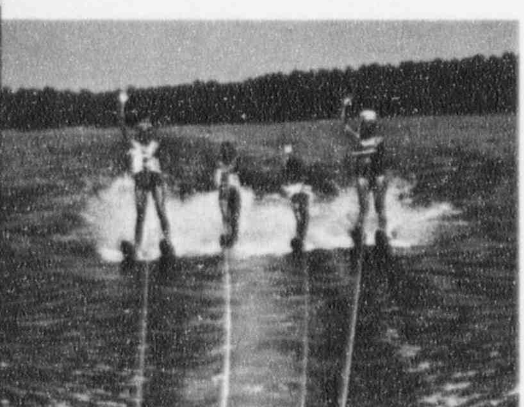

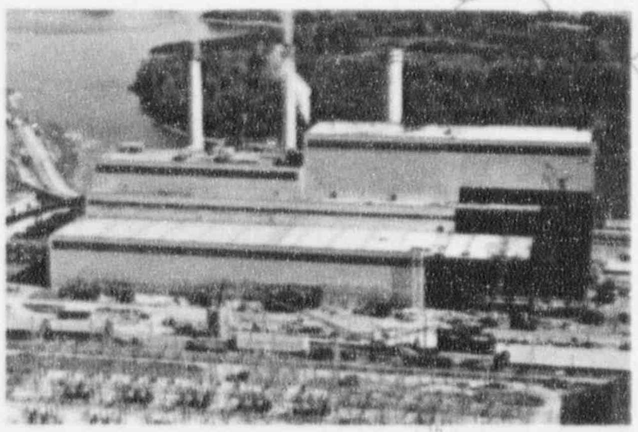

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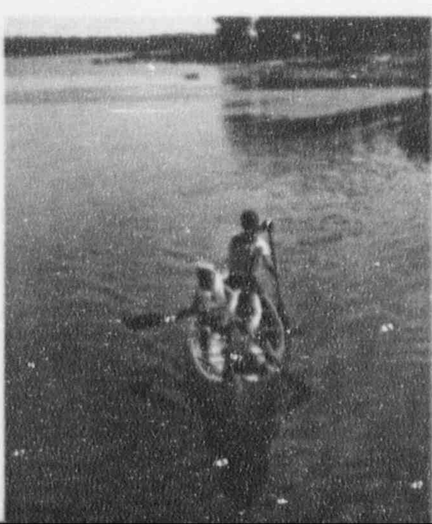
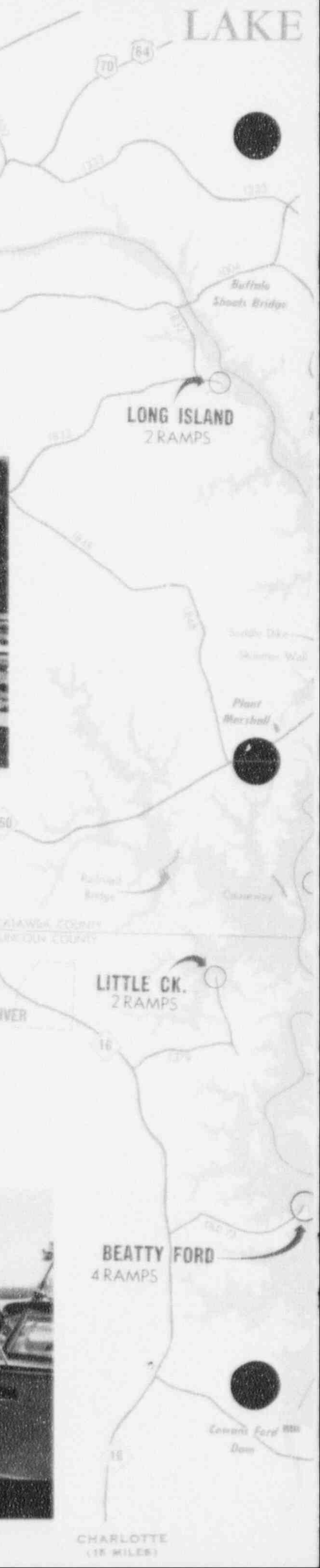
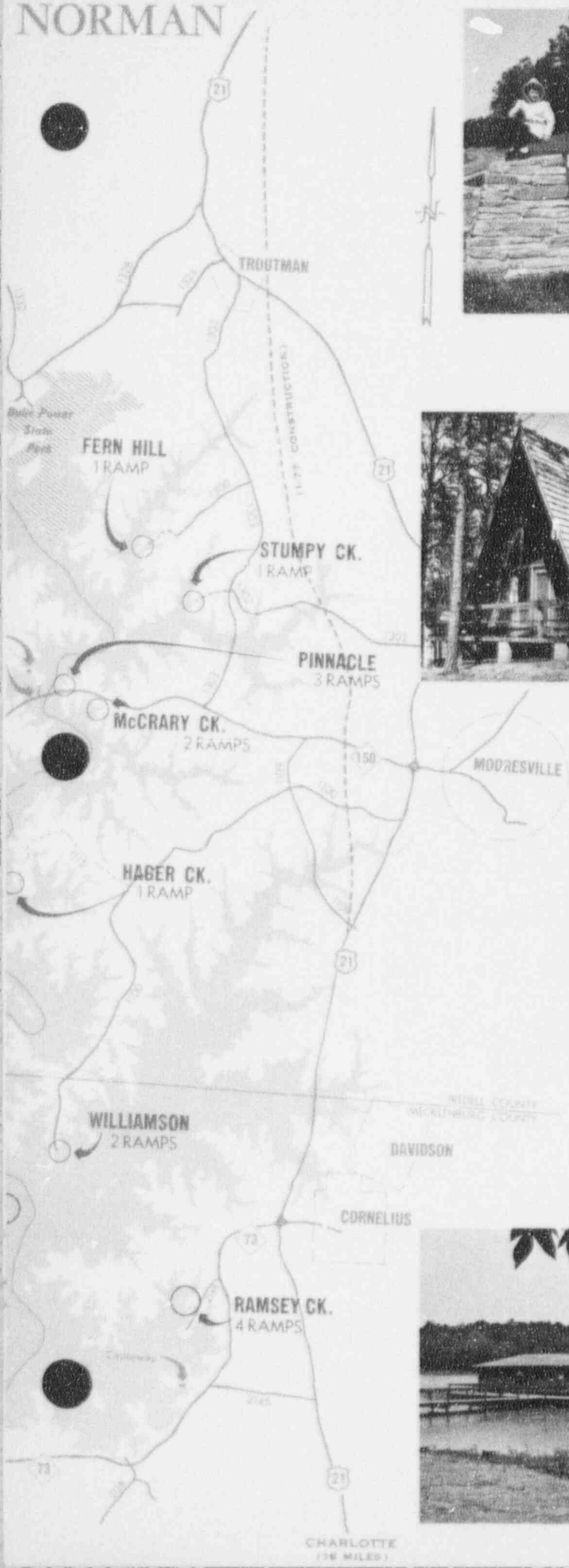
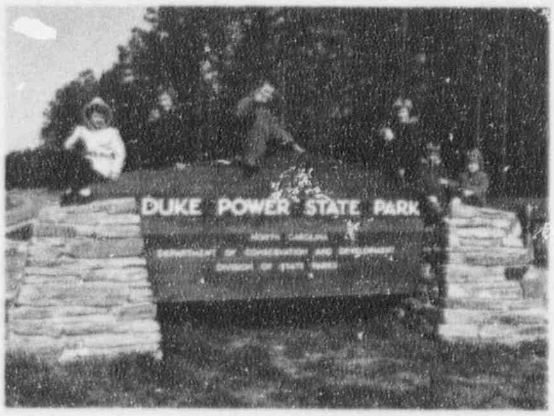




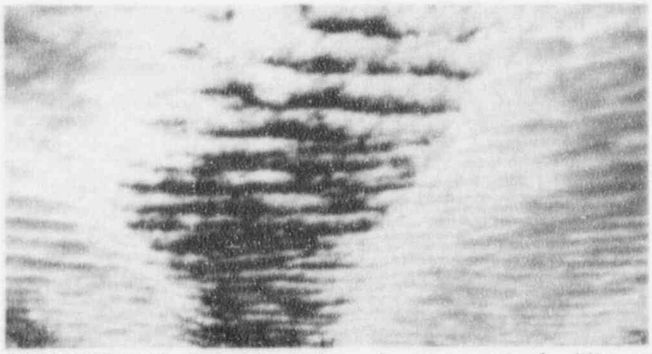
NORMAN


TROUTMAN
Duke Power State Park
FERN HILL
1 RAMP
STUMPY CK.
1 RAMP
PINNACLE
3 RAMPS
McCRARY CK.
2 RAMPS
MOORESVILLE
HAGER CK.
1 RAMP
WILLIAMSON
2 RAMPS
DAVIDSON
CORNELIUS
RAMSEY CK.
4 RAMPS
CHARLOTTE
(I-77 CONSTRUCTION)
IREDELL COUNTY
MECKLENBURG COUNTY
21
150
73


DUKE POWER STATE PARK

WEATHER? Watch it!

FAIR WEATHER CUMULUS—This cloud form is aptly called the fair weather cloud. It has little or no vertical development and is usually accompanied by light winds and mostly clear skies. However, under certain conditions, in summer, this cloud can achieve gradual, vertical development and increase in magnitude to a towering cumulus and a cumulonimbus. Normally when these stages occur the resultant thunderstorm will be isolated and take place during the late afternoon.



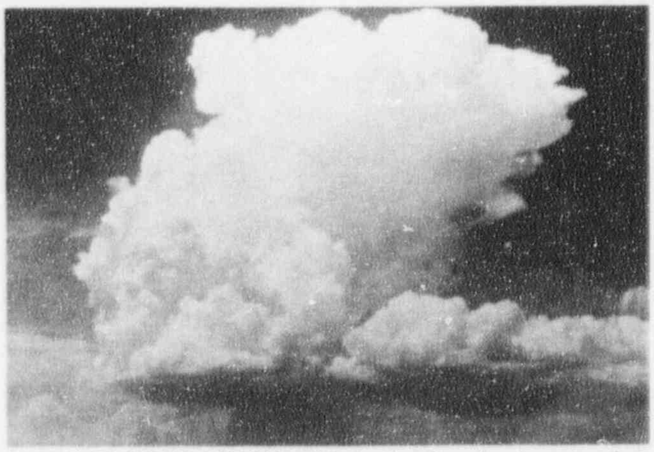
ALTOCUMULUS—This cloud form is composed of white or gray layers or patches of solid cloud often with a wavy or rolling appearance. This type cloud indicates the approach of a front. If the clouds thicken and the sky becomes overcast, precipitation can be considered imminent.

This cloud can be accompanied by strong winds but the increase in velocity will be steady producing a gradual buildup of the waves.

STRATUS FRACTUS OF BAD WEATHER—This cloud form indicates that bad weather is occurring over the area. Usually the weather is in the form of intermittent or continuous rain with decreased visibilities accompanied by gusty or moderately strong winds.

Over water areas waves can attain dangerous heights depending upon the fetch and direction of the wind.

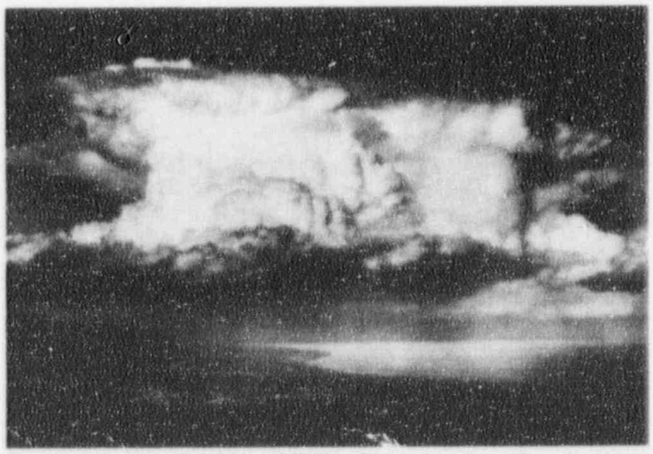
This cloud form will be the finale in a gradual sequence of deteriorating weather conditions. This situation can persist over long periods of time, therefore extreme caution is warranted if boating takes place under such inclement conditions.



CUMULONIMBUS-CALVUS—This is the thunderstorm producing type of cloud which, because of its limited vertical development, lack of sharp outlines, and absence of **the anvil** or plume, is not as potentially dangerous as the cumulonimbus capillatus or anvil type.

The weather associated with this cloud includes gusty winds, rain, thunder and lightning. However, the intensity of each weather element is to a lesser degree than that which is experienced in an anvil-shaped cumulonimbus.

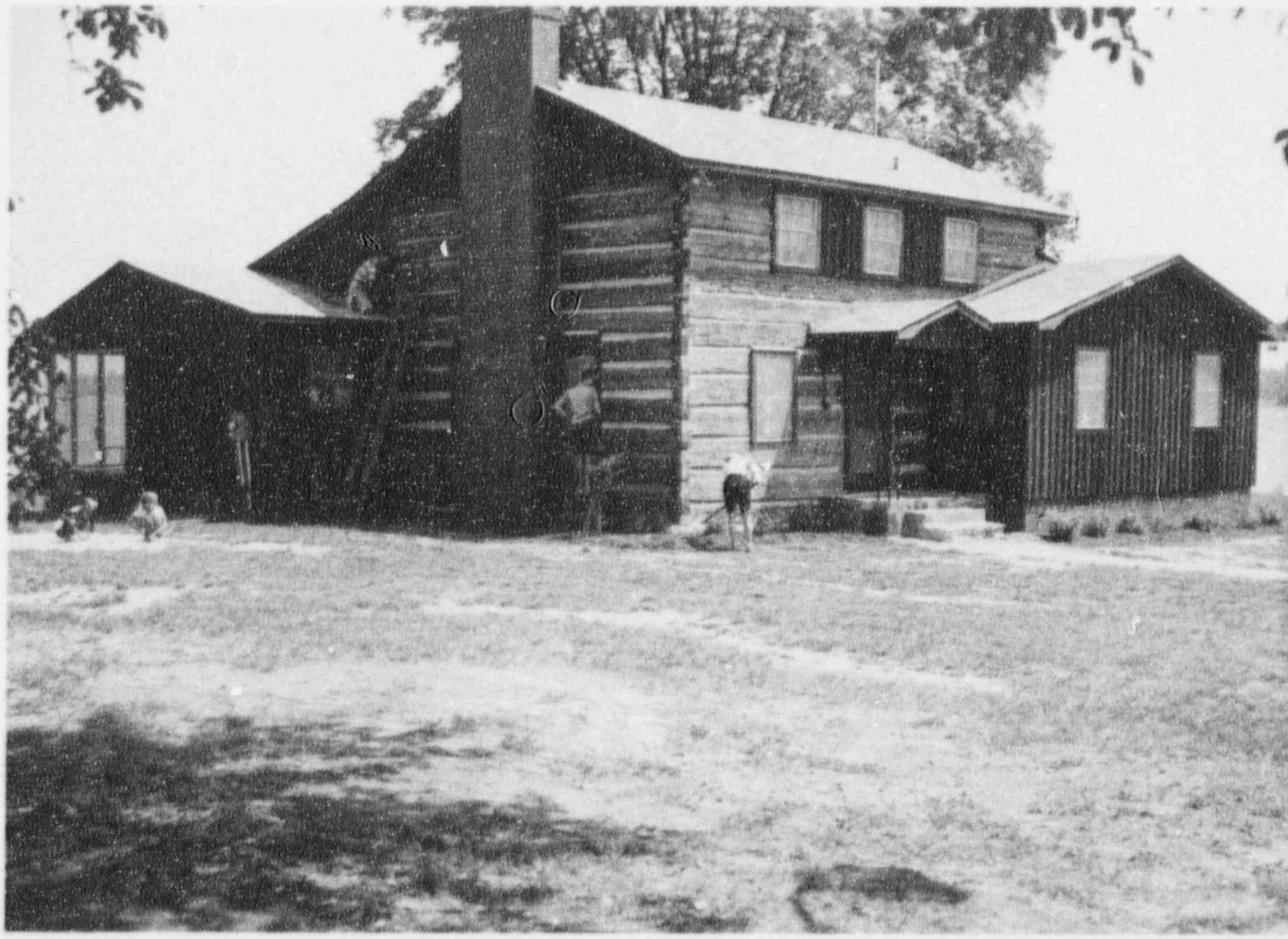
In view of the difficulty in ascertaining whether this type cloud will retain its form or increase to an anvil type, all mariners should proceed with extreme caution. Normally the cloud is scattered and forms during the late afternoon in spring and summer. Radio static is also produced by the activity within the cloud.



CUMULONIMBUS-CAPILLATUS — This is the thunderstorm producing cloud. It has a heavy and dense structure with considerable vertical development in the form of a mountain or a massive tower. Often the cloud top is in the form of an anvil or vast plume, the leading edge of which indicates the direction of movement of the clouds. The base of the cloud is often very dark with low ragged clouds.

This is a potentially dangerous cloud. It is frequently accompanied by strong and gusty winds, moderate to heavy rain, thunder, lightning and sometimes hail. Occasionally it produces a tornado or waterspout. Over water areas it can produce dangerous waves within a relatively short time (less than an hour) after the onset of the strong winds.

These clouds are caused by the approach and passage of warm and cold fronts. Frequently they occur as late afternoon thundershowers on days with high humidity in spring and summer. The duration varies quite widely depending on the type of weather pattern prevailing. Thunderstorm activity is usually accompanied by radio static and therefore should be used as a cautionary sign by the boatman.



One of the several hundred total-electric homes dotting the shores of Lake Norman is this beautiful recreation residence built by Charles C. Johnson, Jr. of Winston-Salem. It incorporates a 160-year-old log cabin still standing and in excellent condition on a Duke Power lease lot. The intricately fitted logs are still as solid as the day they were put into place for a doctor, also named Johnson, who served western Iredell County during the early 1800's. Mr. Johnson is director of purchasing for R. J. Reynolds Tobacco Company.

If you want convenience, low cost and trouble-free operation, then insist on electric heating for that lakeside recreation lodge or weekend cottage.

Electric heating is constantly ready. Even if you're using the cottage for the first time in a month, just flick or twist—and you've got instant heat with no fuel storage problem.

Electric heating offers unbeatable convenience for those unseasonably cool nights and chilly mornings, or to maintain a low heat in the dead of winter when pipes and toilet tanks and bowls might be in danger of freezing.

There's a thermostat in each room with electric comfort heating. You may heat only those areas that require it, dialing temperatures precisely to your choosing. And, thrifty electric heating floods out to fill every nook and cranny with an even, gentle warmth.

Flameless heating means no smoke or soot, so things just naturally stay cleaner much longer. This means fewer housekeeping hours, assuring more of what you built or bought the lakeside house for anyway—leisure.

Finally, electric heating is easy and economical to install. It's the perfect heat for that lakeshore home. For that matter, it's the perfect heat for any home. Call your nearest Duke Power office for information on your needs.

CITIZENSHIP DUKE POWER SERVICE

LAKE NORMAN WATERWAY MARKERS

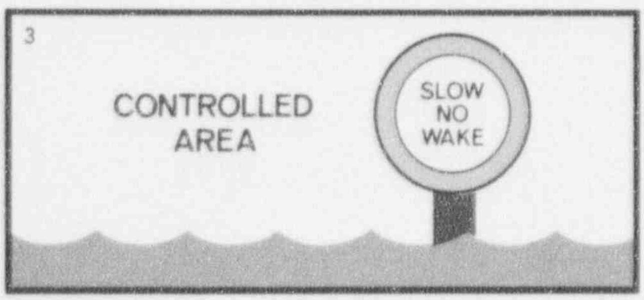
The Federal-Uniform Marking System adopted by national boating organizations for use in both ocean and inland waters is the system now in effect on Lake Norman.

Large information signs are on land tips at major water junctions to give further directions. Signs listing safety rules and boating regulations are posted at most marinas and public boat launching areas.

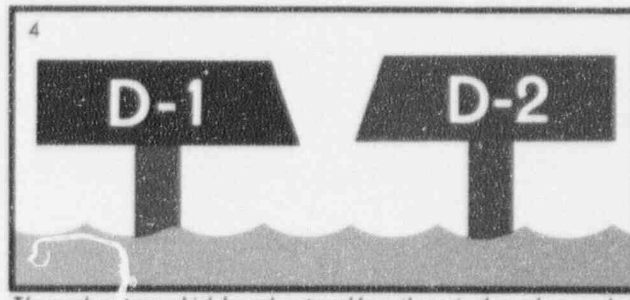
NOTE: Individuals shall not erect any sign such as those in figures 1 through 5. All such signs are erected by the Four-County Lake Norman Commission, and it is unlawful to deface, damage or destroy any of the signs.

The left side of the channel going upstream from Cowans Ford Dam will be marked with odd numerals on square, black signs. The right side of the channel going upstream from Cowans Ford Dam will be marked with even numerals on red triangle signs.

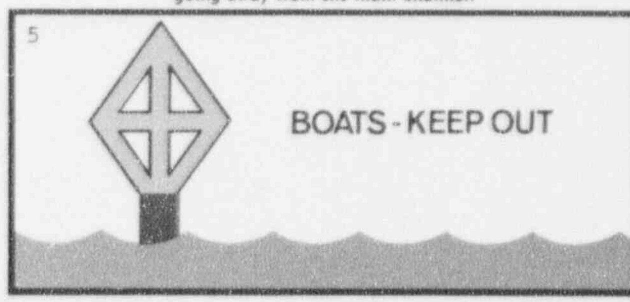
A yellow diamond indicates danger with the hazard painted on the sign in black.



A yellow circle indicates a controlled area (such as a dock) and boats should heed explanation within circle.



The creek systems which branch outward from the main channel are marked with pointer signs. Black signs with odd numbers are on the left going away from the main channel, and red signs with even numbers are on the right going away from the main channel.



A yellow diamond with cross is another danger indicator, and boats should not progress beyond that point.

Individuals may use a blue-banded white buoy with an anchoring ring for anchoring boats near shore or docking areas.

A red flag with a white diagonal band on a float indicates a skin diver. Give at least 25 yards clearance.

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4. ENVIRONMENTAL EFFECTS OF McGUIRE NUCLEAR STATION

4.1 THERMAL EFFECTS

4.1.1 SUMMARY

The construction and commissioning of McGuire Nuclear Station on Lake Norman is another step in the development of the Lake Norman generating complex conceived in the late 1950's.

Realizing that larger generating facilities must mean greater involvement in water resources, Duke Power launched a comprehensive water research program described in other sections of this report. In the late 1950's, the findings of this program were incorporated in the design of Lake Norman and four thermal station sites were selected on the lake. Examples of important results of water research factored into the Lake Norman facility are -

a. Cowans Ford submerged weir - for the purpose of discharging high quality water downstream from hydro units.

b. Marshall Steam Station - skimmer wall to provide condenser cooling water supply from lake bottom.

c. Low-level (bottom) intake for future thermal station near Cowans Ford Dam - now the site of McGuire Nuclear Station.

As each step was taken in the planned development of the Lake Norman generating facility, field studies were made to check predictions and establish further base-line data for the next step in the development. Based on field performance, where appropriate, similar features have been incorporated in the design of Duke's Lake Keowee-Oconee Nuclear Station now under construction in northwestern South Carolina.

To confirm measured influences of the physical thermal effects of Marshall Steam Station on Lake Norman, infra-red thermal imagery aerial mapping was made of the project in the fall of 1970. The fall season was chosen because water discharge temperatures would be highest. The black and white image shown on the left of Figure 4.1-1 was made by an infra-red scanner from an altitude 8,200 feet above Lake Norman. The scanner converts the intensity of the infra-red light which it "sees" to an intensity of visible light which is recorded on photographic film. Since infra-red intensity depends on the temperature of the "seen" object, a thermal image (picture) is produced in which the coolest areas are the darkest and the warmest areas are the lightest, or whitest.

The "Inlet" arrow on the figure indicates the point of entry of the cooling water into Marshall Station, and the "Discharge" arrow shows its point of re-entry into Lake Norman after passing through a short discharge canal.

The condenser inlet water is the darker (cooler) water in the cove to the upper right of Marshall. The far-right boundary of this cove (the short, straight line between the dark and lighter water) is the skimmer wall. This wall with openings at its bottom has allowed only the cool water at the lake's bottom to be drawn into the cove. Subsequently after the water has passed through the

Marshall condensers, it re-enters the lake in this instance only a few degrees warmer than the lake's surface. The low-level intake which will be utilized at McGuire will have a similar effect on water temperatures there.

The photograph was made in the late forenoon and southern slopes of shores, parking lots, exposed fields, a golf course and other areas such as highways which have been warmed by the bright sun also appear white. The white bank immediately north of the McGuire site represents the southerly slope of the Cowans Ford Dam. The area to the south of the site is partially wooded and appears darker since the forested areas are cooler than the lake. The significance of this photograph lies in portraying the limited area of the warm water plume leaving Marshall Steam Station, thus confirming rapid heat dissipation when the warm water enters Lake Norman. The distance separating the Marshall and McGuire sites prevents interaction of their thermal effluents. The warmed waters leaving the thermal station are out of natural temperature equilibrium and rapidly cool over a predictable area.

The colored photograph on the right of Figure 4.1-1 is a color enhancement, reduced in size, of the black and white imagery (photograph) shown on the left in this figure. Color enhancements are often made to aid in the interpretation of thermal imagery. Over twenty different colors can be introduced to span the temperature range seen by the infra-red camera, ranging from the coolest to warmest scenes in the imagery. In this particular color enhancement, the warmest colors are reddish and the coolest bluish.

Infra-red scanning and color enhancement of the resulting thermal imagery to indicate exact surface temperatures is a direct result of space technology. The use of this technique by Duke Power Company represents Duke's continuing policy of utilizing modern technology to help solve future problems before they actually occur. The physical behavior and thermal characteristics of Lake Norman will be objectives of continuing studies.

A study of the aquatic ecosystem of Lake Norman is, of course, linked with the physical studies. These studies, which are continuing, are described within this section of this report.

McGuire Nuclear Station will operate in compliance with RULES, REGULATIONS, CLASSIFICATIONS AND WATER QUALITY STANDARDS APPLICABLE TO THE SURFACE WATERS OF NORTH CAROLINA, adopted by the North Carolina Board of Water and Air Resources on October 10, 1970, and approved by the Environmental Protection Agency on January 20, 1971. Applicable regulations include REGULATION NO. XI 4.j. which states that Class A-II water (Lake Norman is A-II) is not "to exceed 5°F above the natural water temperature, and in no case to exceed....90°F.", REGULATION NO. XI 4.k. which limits gross beta activity, and REGULATION NO. IV which provides that tests for compliance with the standards be made only after "reasonable opportunity for dilution and mixture".

In summary, responsible usage of water resources by McGuire Nuclear Station is a product of long-range planning, confirmed by extensive field testing, and this usage will comply with all applicable water quality standards. As the station site is developed, an environmental water quality monitoring program (Section 4.1.3) will monitor activities as a safeguard. This program will also establish the significance of any environmental change produced by McGuire, as well as establish base-line data and guidance for planning and design of future developments.

4.1.2 BACKGROUND STUDIES AND LONG-RANGE PLANNING

McGuire Nuclear Station is the second of four thermal stations planned for Lake Norman. Environmental considerations played a major role in initial and final concept of this project. Models of natural thermal regimes in Lake Norman were based on limnological studies of other reservoirs in this region. Models of natural thermal regimes were then expanded to include artificial heat rejected from the planned thermal stations, thus developing an inventory of water resources stored in the zones of the epilimnion, thermocline and hypolimnion during lake stratification. Limnological studies dictated the uses of these zones of water. One example is the submerged weir around the hydroelectric units in Cowans Ford Dam. This weir effectively curbs hypolimnetic waters and thus only high quality waters are discharged downstream by the hydroelectric units. Further, it was clear that by using a skimmer wall to curb epilimnetic (surface) waters, the waters of the hypolimnion (bottom) could effectively be used as thermal station condenser cooling water supplies. Hypolimnetic waters in regional lakes during periods of lake stratification are relatively barren biologically, very cool and devoid of oxygen. These cool waters can be passed through the condensers of a thermal station and returned to the lake at temperatures near the lake's surface temperature. The use of hypolimnetic (bottom) waters as a cooling water source was employed in the design and development of the first thermal station on Lake Norman, Marshall Steam Station. Since Marshall's initial operation in 1965, predictions have been confirmed by field studies. For the fifth consecutive year, Marshall has been the nation's most efficient thermal station which means the waste heat rejected to the environment per kilowatthour output is the lowest in the U. S.

Quantitative knowledge of hypolimnetic resources in the late 1950's led to the design and installation of a low-level cooling water intake system, for a future thermal station, during the construction of Cowans Ford Dam. This site has been chosen for McGuire Nuclear Station. Originally conceived as a fossil station site, cooling water supply arrangements have been adequately revised to conservatively accommodate the nuclear station commensurate with minimal thermal effects.

4.1.3 LAKE NORMAN MONITORING PROGRAM

Upon filling in 1963, Lake Norman was included in Duke's routine reservoir limnological program. Natural thermal regime forecasts were checked and the design of the condenser cooling water system for Marshall Steam Station was finalized. The 350 Mw Unit No. 1 at Marshall began service in March, 1965, and an expanded physical study of the lake in the vicinity of this first thermal generating facility was also started. In April, 1966, Unit No. 2 at Marshall began commercial operation bringing the nameplate capacity of Marshall Station to 700 Mw. During 1969 and 1970, Units 3 and 4 were brought into commercial service at Marshall, completing development of the site with a station nameplate capacity of 2000 Mw and a peak capability of 2137 Mw.

The scope of Duke's continuing sampling program is described below:

a. Sampling has been conducted at twenty-six (26) selected synoptic stations throughout the lake as follows:

   1. At nineteen (19) stations to gather physical data for lake water profiles.

2. At fourteen (14) stations to measure as many as twelve (12) different parameters such as phosphates, nitrogen, iron, silica, manganese, etc.

3. At six (6) stations to establish plankton species distributions and populations in support of coincident fish sampling by the N. C. State Fisheries biologists.

4. At nine (9) stations, including Cowans Ford tailrace, to fit Lake Norman into a regular monthly limnological program covering Duke's other lakes as well.

b. Continuous sampling consists of:

1. Four (4) permanently installed continuously recording instruments in operation since October of 1967 at the following locations for water temperature profile measurements:

   a. Adjacent to McGuire site just upstream from Cowans Ford Dam.

   b. On a fixed raft in the discharge from Marshall Steam Station into Lake Norman.

   c. On both the lake and station sides of the skimmer wall in the Marshall intake cove.

2. Continuous recording of dissolved oxygen and temperature in the waters discharged downstream from Cowans Ford Dam.

Analytical models used in the design of McGuire's cooling water system were based on the results of seven years' sampling on Lake Norman as outlined above.

The present monitoring program will be expanded to assess the influence and significance of McGuire Nuclear Station on Lake Norman. It is also the goal of this program to develop further factual information to guide the development of the two remaining thermal sites.

4.1.4 RESEARCH PROJECT RP-49

Supplementing a comprehensive physical study, which began in the summer of 1966 to assess Marshall Steam Station's influence on Lake Norman, a coincidental field biological research program was initiated in mid 1968 to study aquatic life in the zone of Marshall Steam Station. In this research, Duke Power Company is cooperating with the Edison Electric Institute which sponsors the study and Johns Hopkins University in Baltimore, Maryland, which directs it. The project is identified as Research Project 49 (RP-49). Lake Norman is one of several sites across the nation which were chosen for this study. The N. C. Wildlife Resources Commission is cooperating and has assigned fisheries biologists and other personnel to conduct the Lake Norman fisheries studies. Under the guidance of Duke's consulting limnologist at the University of North Carolina at Chapel Hill, an ecologist at University of North Carolina at Charlotte is making species and population studies of fresh water plankton, which are important links in the fish food chain. Studies of Benthic organisms and fish diseases are an important part of this program. Duke's Water Research, Chemical and Environmental Engineering groups are conducting segments of this program.

The goal of this project is to establish the significance of any offset in the aquatic ecosystem of Lake Norman due to the use of the lake waters as a source of thermal station cooling.

RP-49 is a broad study of thermal effects, encompassing more than the Lake Norman investigation. Though no final results of the Lake Norman studies have been published to date, the RP-49 project has generated six reports covering physical, biological and siting considerations of thermal effects.

4.1.5 DESCRIPTION OF CONDENSER COOLING WATER SYSTEM

Each of the three chief components of the McGuire condenser cooling system, i.e., the intake structures, the condenser and the discharge canal has features designed to safeguard the aquatic life in Lake Norman.

There will be two intake structures. One was built adjacent to and upstream of the base of Cowans Ford Dam before the lake filled, and will be used during the summer to draw cold water from the bottom of the lake. The other intake will draw water from about 30 feet under the lake surface. Both intakes have low intake velocities so as to avoid physical and biological harm to the lake, with the lower one capable of providing less than half the required flow and the upper one able to furnish the whole flow by itself. The water from the lower intake will feed into the pump forebay of the upper intake. Trash racks and intake screens will be provided for both intakes. During unusual or extreme weather conditions, when the upper water is warm enough to produce discharge temperatures higher than the N. C. water quality criteria limits, the cold water from the lower intake can be mixed with the warmer upper water to lower the discharge temperature.

The condenser will utilize mechanical methods for tube cleaning, eliminating the need for injecting chlorine, or other biocide, into the circulating water. The McGuire condensers are also sized to permit water temperature rises as low as 16°F when the units are at full load. Duke's previous experiences have been with condensers allowing an 18°F minimum rise, and though no aquatic damage has been evident, it is felt that the added flexibility of the 16° condensers will be beneficial.

The discharge facilities at McGuire will be designed to allow the warmed water to float on the surface. This will facilitate cooling and will allow passage for fish and other aquatic life beneath the plume.

4.1.6 EFFECT OF WARMED DISCHARGE ON LAKE WATERS

The ecological and direct biological impact of warmed effluent from McGuire Nuclear Station are discussed in paragraph 4.1.7, Ecological Effects.

Estimated condenser cooling water intake and discharge temperatures are based on current analytical (mathematical) modeling of Lake Norman. The first such model was developed in the late 1950's to predict the limnological behavior - including temperature and dissolved oxygen - of the then proposed Lake Norman. Subsequent refinements of this model were developed in the early 1960's to forecast intake and discharge cooling water temperatures expected at Marshall Steam Station on Lake Norman. Extensive field testing (1966 to date) has validated the predictive techniques used. In 1961, the initial concept of the cooling water system at the McGuire site was incorporated into the model, and the results of these studies were submitted to the North Carolina State Stream Sanitation Committee leading to Federal Power Commission approval of construction of the low-level cooling-water intake structure now to be used for McGuire.

The maximum cooling water flow required for the condensers serving McGuire Nuclear Station is 4400 cubic feet per second.

In the analytical technique used to determine probable water temperatures to be experienced during operation of McGuire Nuclear Station, it was necessary to begin with historical water temperatures in Lake Norman and to assess the effects of adding the rejected heat in the condenser cooling water to the reservoir. Historical water temperatures reflect effects of meteorology, in flows, hydro operation and any influence of Marshall Steam Station. The following parameters were considered basic to the studies made:

a. Extreme monthly Lake Norman surface elevations (full pond, El. 760') are assumed as 745' in July and August, and 750' for all other months.

b. Based on Charlotte, North Carolina ESSA (now the National Weather Service of the National Oceanic and Atmospheric Administration) 30-year (1940-1969) meteorological records, extreme monthly conditions, as adversely affect surface cooling, are assumed to exist.

c. Maximum condenser cooling water outlet temperatures of both 90°F and 95°F are considered.

d. Maximum withdrawal through McGuire's existing low-level cooling-water intake at Cowans Ford Dam is limited to 2000 cfs.

e. Monthly inflows to and outflows from the condensers in McGuire Nuclear Station are considered as discrete layers of water within Lake Norman. Volumes of water assigned to the layers were determined from the Lake Norman Area-Volume Curve.

f. Seven years of historical water temperature profiles on Lake Norman are considered with particular emphasis on the monitoring station located upstream of Cowans Ford Dam adjacent to McGuire's low-level cooling-water intake.

g. The opening of the high-level intake is being designed to withdraw between elevations 720' and 735', while the opening of the existing low-level intake was designed to withdraw approximately between elevations 655' and 670'.

The cooling water temperature prediction methodology is briefly summarized as follows:

Starting with the warmest Lake Norman water temperature profile of record for each month, condenser cooling water temperature rise and flow rate is computed to meet a specified maximum condenser discharge temperature. The initial step in the analytical procedure is to select a starting month in the series of twelve months and proceed throughout a twelve-month period. Using the extreme historical temperature profile for the month selected to initiate the study, a new expected temperature profile is constructed reflecting adjustments required by operation of McGuire, lake level variation, rate of heat dissipation based on meteorological conditions for the month and postulated artificial heat residual. Low-level intake water is used only as necessary to avoid exceeding the specified maximum cooling water discharge temperature.

The condenser cooling water temperature, although not to exceed the maximum monthly averages indicated, is intentionally maintained above the computed equilibrium (natural) temperature of the lake to maximize surface cooling mechanisms in order to conserve lake heat sink potentials for use during abnormally hot summer months. Having constructed a lake temperature for the starting, or initial month, the method proceeds chronologically to the second month. Here again the extreme (warmest) historical profile of the second month is reconstructed to represent withdrawals, any lake level changes, any artificial heat residual from previous month and water temperature constraints. This iterative analytical procedure is followed until the particular study is completed.

Based on studies outlined above, Table 4.1-1 presents monthly average condenser cooling water inlet and outlet temperatures for Extreme Conditions of record, and a 95°F maximum condenser outlet temperature with a 16°F temperature rise during the warmest months. The forecast under these extreme conditions is conservative inasmuch as the composite year is made up of the twelve warmest months from seven years of lake records and 30 years of meteorological records.

Studies also show that based on Probable Conditions, using monthly average Lake Norman water temperatures and meteorology, a 90°F maximum condenser outlet temperature can be attained as shown in Table 4.1-2. As an additional degree of conservatism, the forecasts of water temperature are based upon continuous full load operation of McGuire throughout the year, whereas actually there will be periods of lower loads.

Tables 4.1-1 and 4.1-2 present analytical results reflecting minimum condenser cooling water flows consistent with limitations on condenser discharge temperatures shown. As the lake begins to stratify in the spring, it is important to conserve the cool hypolimnetic waters for later use should the summer prove exceptionally warm.

In the cooler months of the year, the condenser cooling water system has the flexibility to increase cooling water flows to reduce cooling water temperature rise to 16°F should this mode of operation be found necessary.

The following conclusions are drawn from the studies outlined above:

a. Under probable, or average experienced conditions of record, the condenser cooling water discharge temperature will not exceed a monthly average of 90°F.

b. In the improbable compilation of the twelve warmest months in 30 years of Weather Bureau records, January was the warmest winter month and June the warmest summer month. These months represent, therefore, the extreme improbable, adverse cooling conditions. Under these conditions studies show:

1. During the warmest June, the natural equilibrium water temperature at the surface is 88°F, and 3500 surface acres are required to cool the McGuire condenser effluent from 95°F to comply with 90°F maximum temperature criterion.

2. Again during this same June, only 940 acres are required to cool the effluent to 5°F above the natural equilibrium water temperature, or to 93°F.

3. During the warmest January, coincidentally, again 3500 acres are required to cool the McGuire condenser effluent to within 5°F of the natural equilibrium water temperature.

4. No cooling allowances due to advection or precipitation were included in the above calculations. Any residual heat at the end of one month was carried forward into the next month as described earlier in this section.

c. From the above, 3500 surface acres (10.8% of the lake's surface area) will provide the required cooling area to comply with water quality temperature criteria. Measurements of existing warm water effluent plumes, particularly at Marshall Steam Station on Lake Norman, enable prediction of actual volumes of water both within the mixing or dilution zone and the remainder of the relatively undisturbed body of water. The volume of water within the mixing or dilution zone will:

1. Under drawdown to elevation 745 feet m.s.l.

    a. Represent 12.5% of the lake volume beneath the 3500 acre surface area and

    b. Only 2.1% of the entire lake volume

2. And at surface elevation 760 m.s.l. (full pond)

    a. Represent 11.9% of the lake volume beneath the 3500 acres and

    b. Only 1.3% of the entire lake volume

d. Duke concludes that the prescribed mixing or dilution zone defined herein provides aquatic biota and wildlife a safe, adequate and usable passage up and down Lake Norman.

4.1.7 ECOLOGICAL EFFECTS

Research Project EEI RP-49 (see paragraph 4.1.4) and "Organic Productivity as Determined by Periphyton Accumulation on Glass Slides" by Dr. Charles M. Weiss, Consulting Limnologist, Chapel Hill, North Carolina, are two principal studies defining the aquatic ecology of Lake Norman.

The important sport fishes in Lake Norman are listed by the North Carolina Wildlife Resources Commission in terms of percent - catch as follows: "41% sunfish, 33% crappie, 13% largemouth bass, 5% catfish, 4% white bass, 3% carp" (A Catalog of the Inland Fishing Waters in North Carolina, 1968). A more recent publication notes that "the lake currently supports good warm-water sport fisheries for largemouth bass, white bass and crappies" (Effects of Thermal Pollution Upon Lake Norman Fishes, North Carolina Wildlife Resources Commission, 1970, see Appendix 4A).

There are no commercial fisheries in Lake Norman and no unique fish species present in the lake, with possible exception of stocked striped bass and threadfin shad. Threadfin shad, Dorosoma petenense, is the primary forage species required to sustain the important game species.

Since the locale under consideration is a lake community, no barrier to migration is likely. It is anticipated that some spawning will occur in the region of the McGuire discharge. Although spawning times of some species may be modified by variations in water temperatures between the discharge and ambient lake areas, no detrimental effects are expected (Appendix 4A).

McGuire Nuclear Station will probably have its most noticeable impact on local fish populations during the winter period of low ambient water temperatures. During this period, the plant's heated effluent will facilitate the overwintering of threadfin shad. It is anticipated that in response to the concentrations of threadfin shad in the region of the plant's discharge, a migration of piscivorous (fish-eating) species into the region of the discharge is likely, with a consequent development of sport fisheries (Appendix 4A).

As mentioned in the preceding section, the volume of the lake effected by McGuire will be only 1% to 2% of the lake's total volume.

Aquatic ecological and limnological programs will be expanded under the guidance of consultants to detect any significant ecological changes which may result from McGuire Nuclear Station. The ecological monitoring program will include thermal, chemical, radiological, hydrological, mechanical and meteorological effects of McGuire Nuclear Station on the ecology.

4.2 RADIOLOGICAL EFFECTS

4.2.1 SUMMARY

Conservative analyses demonstrate conclusively that there will be no adverse effects on the environment from discharges of radioactive material resulting from normal or unusual operation of McGuire. The evaluation of the expected performance of the waste disposal systems shows that these systems will process potentially radioactive wastes and reduce discharges to levels far below the limits of 10 CFR 20.

When viewed in perspective, the radiological effect of McGuire upon a person living continuously next door to the station property is negligible. The effect of the station may be compared to radiation from other causes as follows:

Source	Annual Average Dose in U. S. (millirem)
Background radiation from cosmic rays earth, etc.(1), (2)	74 - 159
Normal food, water and air intake(1)	21
Estimated dose from man's activities-medical x-rays, materials of construction, weapons fallout, etc.(2), (3), (4)	84 - 145
Total without McGuire	179 - 325

An individual living at the site boundary will receive an additional estimated dose due to normal operation of McGuire of 0.22 millirem

An environmental radioactivity monitoring program will be established to verify that discharges from the station are as predicted. This program will monitor all critical exposure pathways which could possibly lead to radiation exposure to man, at activity levels far below those that may be considered harmful; thereby allowing ample opportunity for corrective action.

4.2.2 RADIOACTIVE LIQUID RELEASES

Operation of the station results in some waste liquids which must be treated before they can be reused or discharged. The liquid waste disposal system provides this treatment capability for liquids which may contain radioactivity.

(1) "Report of the United Nations Scientific Committee on the Effects of Atomic Radiation," General Assembly, Official Records: 21st Session, Suppl. No. 14 (A/6314), p. 35, United Nations, N. Y. (1966).
(2) L. R. Solon et al., "Investigations of Natural Environmental Radiation," Science, 131, 903 (1960).
(3) R. L. Penfil and M. L. Brown, "Genetically Significant Dose to the United States Population from Diagnostic Medical Roetgenology, "Radiology," 90, 209 February, 1968), 1964.
(4) "Population Dose from X-Rays," U. S. 1964, U. S. Department of Health, Education and Welfare, Public Health Service, PHS Pub. No. 2001 (October, 1969).

The liquid waste disposal system is designed to (1) collect reactor grade water and process it for reuse and (2) to collect potentially radioactive liquid wastes and process them to forms suitable for release or shipment offsite. This design objective is attained by segregation of equipment drains and waste streams to prevent mixing of water which is normally reused with that which is normally discharged. Process equipment includes holdup tanks, filters, demineralizers and an evaporator.

In addition to the waste liquids described above, discharge of some reactor coolant may be necessary for control of tritium concentrations in the station. Routine discharge of this reactor coolant will not be necessary. However, the contribution to the liquid waste discharge from the station of the largest amount of reactor coolant which may be discharged in one year has been included in the analyses incorporated in this section. This quantity of reactor coolant can be treated for release by either the liquid waste disposal system or the boron recycle system.

The estimated volumes of potentially radioactive liquid wastes resulting from operation of the station are presented in Table 4.2-1. Liquid radioactive discharges are far below the limits of 10 CFR 20, as shown in Table 4.2-3. Discharges are shown for two conditions: (1) normal operation and (2) design (upper limit) conditions. Routine station discharges are expected to be no more than those shown for normal operation. Design condition discharges are shown to illustrate the expected performance of the liquid waste disposal system during limited periods of operation with minor defects in one percent of the fuel. The radioactive discharges shown in Table 4.2-3 are based on the following assumptions:

a. Fission product and corrosion product concentrations in the reactor coolant as shown in Table 4.2-2.

b. Non-recycleable reactor coolant leakage of 13,000 gallons per year.

c. Maximum discharge of 150,000 gallons of reactor coolant in one year for control of tritium concentration.

d. An eight-hour process period.

e. A process decontamination factor of 6.1×10^3.

f. Dilution in the average condenser cooling water flow of 1.63×10^6 gpm.

The maximum instantaneous concentration of radioactivity in the condenser cooling water discharge is based on the flow of condenser circulating water. The instantaneous discharge concentration is shown in Table 4.2-4 for the normal flow and for minimum flow.

The increment of radioactive material released due to fuel defects and miscellaneous system leakage is already included in the discharge quantities shown in Table 4.2-3. Defects in steam generator tubes, which results in small leaks from the reactor coolant system into the secondary side of the steam generator, will not result in radioactive liquid discharge. In the unlikely event of steam generator tube defects, the steam generator blowdown water will be treated and reused.

The potential buildup of radioactivity concentrations in Lake Norman was investigated by a conservative model which utilized a portion of the lake waters (less than two percent of total lake volume) near the station for dilution of station discharge. The result of this analysis is reported in Table 4.2-6. These concentrations are far below the limits of 10 CFR 20 and would be diluted even further before reaching any of the public water supply intakes on Lake Norman or downstream from the lake.

These analyses demonstrate that concentrations of radioactivity in Lake Norman resulting from normal operation of the station are quite small when compared to the limits of 10 CFR 20 and there will be no adverse environmental effects from liquid releases from the station.

4.2.3 RADIOACTIVE GASEOUS RELEASES

The gaseous waste disposal system functions to remove potentially radioactive gaseous contaminants from the reactor coolant and to collect gases generated by operation of the boron recycle evaporator. These gases are contained during normal station operation, and there is no need for intentional discharge of radioactive gases via the gaseous waste disposal system.

A portion of the non-recycleable reactor coolant leakage denoted in Section 4.2.2 was assumed to occur inside the containment and the remainder inside the auxiliary building. Gases resulting from leakage inside the containment will be contained until the containment is purged. The containment will be purged periodically to increase the time an operator can spend in the containment. This added time permits more frequent inspections of equipment, particularly instrumentation, inside the containment. The activity level in the containment atmosphere was based on an assumed reactor coolant system leak. Activity buildup in the containment was calculated for a seven-day period. This activity was then discharged to the atmosphere by the containment purge system. Gases resulting from leakage inside the auxiliary building were assumed to be released without further decay to the atmosphere via the auxiliary building ventilation system. The concentrations of gaseous activity at the Exclusion Area boundary resulting from the combined releases from the containment and the auxiliary building are presented in Table 4.2-7 and are based on the following assumptions:

a. Fission product and tritium concentrations in the reactor coolant as shown in Table 4.2-2.

b. All the tritium contained in the leaking reactor coolant remains in the vapor state and is discharged to the atmosphere. All the xenon and Krypton and one percent of the iodine is released from the reactor coolant.

c. Total leakage of reactor coolant of 13,000 gallons per year, of which 4,000 gallons is assumed to leak inside the containment and the remainder inside the auxiliary building.

d. Dispersion in accordance with the 30-day and annual atmospheric diffusion models for release from containment and auxiliary building, respectively.

Defects in steam generator tubes, as discussed in Section 4.2.2, are a possible source of radioactive gaseous releases from the secondary side through the air ejector. The resulting discharge of radioactivity will be controlled and limited. The analysis of a radioactive discharge resulting from a postulated steam generator tube defect, including simultaneous fuel defects (design conditions), is summarized in Table 4.2-5.

These analyses demonstrate that the concentrations of gaseous radioactivity at the Exclusion Area boundary resulting from operation of the station are quite small when compared to the limits of 10 CFR 20. There will be no adverse environmental effects resulting from gaseous releases from the station.

4.2.4 SOLID WASTE DISPOSAL

The solid waste disposal system provides the capability to package solid wastes for shipment in a variety of AEC or Department of Transportation approved containers to an offsite licensed disposal facility. Evaporator concentrate and spent resin will be handled in the waste drumming room or directed to a truck-mounted shipping container. Other solid wastes of low activity or no activity, such as soiled clothing, rags, paper and gloves, will be compressed in drums by a hydraulic compactor. Adequate monitoring of this material will be provided to assure safe storage prior to shipment.

Shipping container design and permissible radiation levels external to the containers are governed by regulations of the AEC and the Department of Transportation. Duke will meet the requirements imposed by these regulations to assure safe transportation of solid wastes.

Ultimate disposal of solid wastes will be by burial in an AEC or Agreement State licensed facility meeting the requirements for such facilities imposed by the AEC. These requirements govern the form of the solid wastes and the integrity of the burial container, assuring safe disposition of solid wastes.

4.2.5 COMPARISON OF RADIOACTIVE GASEOUS AND LIQUID WASTE RELEASES WITH ESTABLISHED STANDARDS AND LIMITS

a. Gaseous and Liquid Releases

The radioactive waste handling and processing systems at McGuire are designed in accordance with the latest available technology. Therefore, it may be expected that any release of radioactive materials will be as low as is practicable. It has been shown in Tables 4.2-6 and 4.2-7 that expected radioactive liquid and gaseous releases result in concentrations of radionuclides which are small fractions of the applicable maximum permissible concentrations (MPC) found in 10 CFR 20. Correspondingly, the resulting doses to individuals are expected to be a small fraction of the applicable limits.

Using the results of Tables 4.2-3 and 4.2-7, dose estimates were made for radioactive effluents. These dose estimates are presented in Table 4.2-8 which compares these doses with naturally occuring background doses and concentrations and with applicable limits.

The dose estimates from radioactive gaseous releases are conservatively calculated assuming that an individual is continuously exposed to the maximum downwind concentration of radionuclides at the Exclusion Area boundary (Table 4.2-3) for one full year.

Dose estimates from radioactive liquid releases were made in two parts. First, the dose resulting from assuming that an individual's total water intake for one year came from that portion of Lake Norman containing the maximum concentration of radionuclides as shown in Table 4.2-7. Second, the dose resulting from continuous exposure due to swimming, boating, fishing or walking along the shore of the lake for one year was calculated.

These doses may be summarized as follows:

	Dose Estimates (millirem per year)	
	Normal Operation	Design Conditions
Gaseous Waste Releases[2]	.11	10
Liquid Waste Releases (drinking)	.11	.18
Liquid Waste Releases (swimming, etc.)	7×10^{-6}	.0005
TOTAL	.22	10.2

The total liquid and gaseous dose estimate of .22 millirem for normal operation and 10.2 millirem for design conditions may be compared directly to the Federal Radiation Council/AEC limit (Radiation Protection Guide) of 500 millirem per year maximum dose to an individual and 170 millirem per year to a suitable sample of the exposed population group.

The resulting gaseous doses of .11 millirem for normal operation and 10 for design conditions may be evaluated as follows:

> A study by the National Center for Radiological Health,[1] shows the average gamma background dose rate for the measurements made in Eastern North Carolina to be 8.0 uR/hr (.008 mRem/hr) and the average for similar measurements made in Tennessee to be 9.4 uR/hr (.0094 mRem/hr). Assuming the dose rate at McGuire to be somewhere within this range, which has been confirmed by measurements made at the site by Duke, the annual gamma background dose at this location prior to construction is between 70 and 82 mRem. (This dose represents gamma only and excludes other contributions to the total background dose.)

(1) Radiological Health Data and Reports, Vol. 9, No. 11, November, 1968, "Summary of Natural Environmental Gamma Radiation Using a Calibrated Portable Scintillation Counter," National Center for Radiological Health.

(2) The doses resulting from containment purge as discussed in Section 4.2.3 are based on a 30-day atmospheric diffusion model. This is conservative since the purging could be accomplished during more favorable atmospheric conditions in which case the resulting doses would be lower.

In order to evaluate the significance of liquid waste releases from McGuire as they relate to background conditions, comparisons have been made with published data taken from "Radiological Health Data and Reports," a publication of the U. S. Public Health Service. A study made in 1967 by the Radiological Health Section of the North Carolina State Board of Health[(1)] shows the average background radioactivity concentration in the Catawba River at Charlotte, North Carolina, and presumably also in Lake Norman as being 2.65 pCi/l (2.65 X 10^{-6} uCi/ml), gross beta (other than tritium). This value may be compared with Table 4.2-6 which shows that the maximum equilibrium concentration of activity in the affected portion of Lake Norman as a result of expected liquid waste releases is 2.5 X 10^{-12} uCi/ml for design conditions. Sampling results for the year 1970 by this same agency[(2)] show the gross beta activity other than tritium to average 2.4 pCi/l (2.4 X 10^{-9} uCi/ml).

Comparison of these gross concentrations may be made with the U. S. Public Health Service drinking water standards. These standards, based on consideration of Federal Radiation Council recommendations, set the limits for approval of a drinking water supply at 1000 pCi/l (1.0 X 10^{-6} uCi/ml) gross beta radioactivity (when strontium 90 is at a negligibly small fraction of its limit of 10 pCi/l or 1.0 X 10^{-8} uCi/ml. It can thus be seen that concentrations resulting from radioactive liquid waste releases are small in comparison to the U. S. Public Health Service drinking water standards.

Using the average concentration noted in the study referenced above, (2.65 pCi/l), the total amount of background radioactivity in Lake Norman at full volume was calculated to be 3570 mCi at any moment during 1967 (and about the same in 1970[(3)]). Also, based on average streamflow, more than 6300 mCi of activity flowed by Cowans Ford during the year. These amounts may be compared directly with the eight mCi per year of gross beta activity, other than tritium, expected to be released from the station in liquid effluents during normal operation and with the 710 mCi per year during design conditions. In other words, the concentration and the gross beta radioactivity other than tritium in Lake Norman resulting from liquid waste disposal operations will only be a small fraction of the amounts that have existed there and that exist there now without the nuclear station. The source of this existing background radioactivity in Lake Norman is described as follows:

> "All waters contain traces of radioactivity originating from naturally radioactive minerals dissolved from rock strata or from radioactive particulate matter or gases in the atmosphere. Common among these

(1) Radiological Health Data and Reports, Vol. 10, No. 5, May 1969, "Radioactivity in North Carolina Surface, Ground and Cistern Waters, January-December, 1967," Sanitary Engineering Division, Radiological Health Section, North Carolina State Board of Health.

(2) Radiological Health Data Reports, Vol. 9, No. 11, November, 1968, "Summary of Natural Environmental Gamma Radiation Using a Calibrated Portable Scintillation Counter," National Center for Radiological Health.

(3) Unpublished data (1970). Gross beta activity, Charlotte Surface water. North Carolina State Board of Health, Radiation Protection Program.

materials are trace elements of potassium-40, radium, thorium and uranium. Such trace elements are dissolved by water, both on its way to and flowing in the water courses. Precipitation is the major mechanism by which particulate matter or radioactive gases such as thoron and radon are removed from the atmosphere. The combined radioactivity of these materials constitutes what is known as background radioactivity of the water. The total radioactivity would include both background radioactivity and contributions from fallout and other man-made sources.

"A knowledge of the concentration of the background radioactivity, as well as the total activity, is an important factor in the appraisal of water quality since standards pertaining to radiation exposure or concentration within drinking water are expressed in terms of additions to the natural background."(1)

The above comparison was made based on gross beta activity other than tritium. The remainder of this paragraph will consider the significance of tritium in liquid waste releases from McGuire. Table 4.2-6 shows the maximum equilibrium concentration of tritium in Lake Norman. The resulting dose from drinking this water would be 0.11 mRem per year. This 0.11 mRem dose is 1/4500th of the Radiation Protection Guide for an individual and 1/1500th of the Radiation Protection Guide for a suitable sample of the exposed population.

b. Evaluation of Possible Exposure Pathways to Man

Although the amount of radioactivity added to the environment from station operation is minimal, possible critical exposure pathways to man have been evaluated in order to estimate the maximum dose to an individual and to establish the sampling requirements for the Environmental Radioactivity Monitoring Program. These pathways include:

1. Drinking water from that portion of Lake Norman affected by the radioactive liquid waste releases or from wells directly associated with this portion of the lake.

2. Swimming, boating, fishing or walking along the shore of lake within this same area.

3. Eating fish from within this portion of the lake.

4. Whole body dose from gaseous waste releases.

5. Drinking milk from locations affected by gaseous waste releases.

6. Eating foods grown in areas affected by gaseous waste releases.

Items 1, 2 and 4 above have been enumerated previously in this section. In regard to item 3, an individual would have to eat a minimum of 1,452

(1) Radiological Health Data and Reports, Vol. 10, No. 5, May 1969, "Radioactivity in North Carolina Surface, Ground and Cistern Waters, January-December 1967," Sanitary Engineering Division, Radiological Health Section, North Carolina State Board of Health.

pounds of fish a day, every day, in order to reach the allowable annual dose limit (Radiation Protection Guide), under the maximum design conditions and assuming the maximum reconcentration factors in the environment. See Table 4.2-9.

Concerning exposure pathways 5 and 6 outlined on the preceding page:

> An extensive study of the Dresden Nuclear Station was made by the U. S. Public Health Service[1] using very sensitive instruments. The Dresden Nuclear Station is an early boiling water type reactor which discharged more than 800,000 curies of radioactivity in gaseous and liquid waste effluents in 1969 (compared with less than 927 curies total expected from McGuire). No radioactivity attributable to Dresden was found in samples of rainwater, soil, cabbage, grass, corn husks, milk, deer, rabbit, surface water, drinking water or fish. However, traces of radioactivity, far below acceptable limits, were found in three other samples. The study concludes with the statement that, "On the basis of these measurements, exposure to the surrounding population through consumption of food and water from radionuclides released at Dresden was not measurable."

The extremely small amounts of iodine and other radioactive particulates that are expected to be released, even at design conditions, make milk and other food crops of no significance as a possible critical pathway to man. Use of Lake Norman water for irrigation purposes will also not be of significance in regard to radioactivity in food crops. It is also important to note that although tritium is the major constituent in the waste releases, tritium does not reconcentrate in biological materials beyond the concentrations found in water.

In conclusion, it has been shown that the normally expected releases of radioactivity from McGuire are far below applicable safe standards and regulatory limits for the release of these materials in air and water. The resulting doses to man, even assuming large reconcentrations in the environment, are negligible and well below applicable Radiation Protection Guides. Although the amounts released, concentrations and resulting doses can be calculated, it is doubtful that concentrations of radioactivity so far below limits in the environment can actually be measured beyond the Exclusion Area and differentiated from the normally existing background radiation. The radiological effects on man and his environment from releases of gaseous and liquid waste from the McGuire Nuclear Station will be essentially nil.

4.2.6 THE ENVIRONMENTAL RADIOACTIVITY MONITORING PROGRAM

The goal of the Environmental Radioactivity Monitoring Program will be to measure and evaluate the extremely small population dose and ecological significance of the contributions to the existing environmental radioactivity levels that result from station operations.

(1) "Radiological Surveillance Studies at a Boiling Water Nuclear Power Reactor," Report DER 70-1, March 1970, U. S. Public Health Service.

This program will, by measuring the concentrations of radioactivity that occur in the biological and physical environment, serve primarily as a check upon the adequacy of controls exercised by the station over the release of radioactivity in effluents and over the sources of radiation. It will also serve to monitor any critical pathways that could possibly lead to significant radiation exposure to man.

This monitoring program will include the published recommendations of the U. S. Public Health Service in its design and will be conducted in cooperation with various state and federal agencies having appropriate jurisdiction or concern in the area of environmental radioactivity. Among such agencies will be the N. C. Wildlife Resources Commission and the N. C. State Board of Health, Radiation Protection Program.

Summary reports of radioactive waste releases and environmental monitoring results will be given appropriate distribution to these agencies and other interested persons.

The Environmental Radioactivity Monitoring Program will be put into effect at least one year prior to the operation of Unit 1 and will continue during the operating period. The preoperational and operational phases of the program will therefore be similar.

Radioactive materials from station gaseous and liquid waste releases, if detectable at all in the environment, are most likely to be found in samples of air and water from locations where these materials are dispersed by stream flow and wind. Air and water samples also serve as one of the earliest indicators of change in environmental radioactivity. Therefore, air and water samples will receive primary emphasis, both in the number of samples collected and in the frequency of collection. These samples will ordinarily be counted for gross alpha and gross beta activity. If the gross activity exceeds a predetermined small fraction of any effective maximum permissible concentration (mpc) allowed in such a sample (such as one percent of the mpc's for air and water in an unrestricted area, listed in 10 CFR 20 Appendix B), analysis to determine the component radionuclides will be made by use of a multichannel gamma analyzer. Additional radiochemical analyses will be made for Strontium 89 and 90, which are beta emitters and cannot ordinarily be detected by gamma analysis.

Measurements of gamma dose and dose rate will also be made. Thermoluminescent dosimeters located both in the prevailing wind direction and immersed in water downstream of the liquid effluent release point will measure the direct dose effects of gaseous and liquid activity releases during the operating period. Water will also be analyzed for tritium. The sensitivity of these analyses and the size of the samples taken will permit absolute measurement of existing preoperational and operational radioactivity levels to be made even though they may be far below permissible limits.

Samples of secondary importance in regard to numbers of samples and frequency of collection include lake bottom sediment, terrestrial and aquatic vegetation and plankton, fish and milk. Fish samples will include both game fish and rough species (bottom feeders). Bottom sediment, vegetation and plankton will also be counted for gross alpha and gross beta activity. Again, if the gross activity exceeds a predetermined small fraction of any effective mpc limit, additional analyses will be made by use of a multichannel gamma analyzer and by radiochemical means. Fish and milk will be subjected to gamma analysis as well as radiochemical analyses for gross beta minus Potassium 40, Strontium 89 and 90.

Since reconcentration of radioactivity can occur in the environment, particular attention will be devoted to evaluating the significance of any buildup of activity in these samples and in determining any unusual or unexpected critical pathways to man. Dose estimates to man will be made if the above analyses show that significant amounts of radioactivity from station releases are accumulating in environmental samples, i.e. amounts that could possibly result in doses in excess of one percent of applicable limits. The design of the sampling program will be such that these dose estimates can be made. Analysis and concentrations of specific radionuclides in environmental samples will be correlated with known station releases of the same nuclide. Although the one year of preoperational monitoring results may serve as a base line for comparison with operational levels, such comparisons have been complicated in the past by fallout from nuclear testing and variations in naturally occurring radioactive materials and radiation. Therefore, to assist further in evaluating the effect of the station releases on the environment during the operating period, the station contribution of activity will be differentiated from existing environmental levels by comparing levels found in similar samples collected at the same time in different locations. This is done by collecting samples both within and beyond the Exclusion Area, upstream and downstream, upwind and downwind from the station and in control locations sufficiently far removed from the station to be beyond its influence.

Table 4.2-10 describes the Environmental Radioactivity Monitoring Program for the McGuire Nuclear Station. The samples and measurements include all critical exposure pathways relating to dose to man that have been determined to be of possible significance for this station.

4.2.7 POSSIBILITIES AND CONSEQUENCES OF ACCIDENTAL RELEASES

Liquid and gaseous waste releases resulting from normal station operation are described in Sections 4.2.2 and 4.2.3, respectively. Inadvertent releases are precluded by design features of both liquid and gaseous waste disposal systems. Liquid wastes are released in batches by deliberate operator action from the waste monitor tanks only to the condenser cooling water system. The liquid discharge valve is interlocked with a process radiation monitor and will close automatically when the radioactivity concentration in the liquid discharge exceeds a preset safe limit. During normal operation of the gaseous waste disposal system, the gaseous inventory can be contained for the life of the station.

Certain postulated hypothetical accidents resulting in the release of radioactive gases were analyzed. (None of these accidents results in the release of liquid waste from the station.) These analyses demonstrate conclusively that doses resulting from these hypothetical accidents are far below the limits of 10 CFR 100.

4.2.8 EMERGENCY PLANS

There is no credible accident that can endanger the public because of the redundant structures and systems provided in the plant to control the consequencies of any mishap. No member of the public and no plant employee has ever received radiation injury from a nuclear power plant. This includes Duke Power's experience in the operation of the CVTR Nuclear Station in Parr, S. C. which was built by Carolinas-Virginia Nuclear Power Associates of which Duke was the major partner. Nevertheless, to be on the safe side the results of an incredible accident are evaluated so that there will be a positive program to protect the public. Thus, a comprehensive emergency plan is developed and rehearsed to be available in the event of this incredible accident situation.

An emergency plan for the McGuire Nuclear Station will be established for the protection of life and property in all emergency and accident situations. It will particularly apply to those situations involving radiation and contamination where the health and safety of station personnel and the general public may be involved, but it will also include other general industrial emergency and accident conditions such as fire, vehicular accidents on site, natural disasters, medical injury or illness and civil disturbance.

The emergency plan will be a coordinated effort involving station personnel, facilities and equipment; the emergency resources and capabilities of Duke Power Company; outside emergency services; and various local, state, and federal agencies having appropriate jurisdiction or concern for the public health and safety including: the North Carolina State Board of Health Radiological Protection Program, Charlotte-Mecklenburg County Civil Defense Agency, the Sheriff's Department for Mecklenburg County, the Mecklenburg County Police, the North Carolina Highway Patrol, the AEC Emergency Radiological Monitoring Team, the AEC Region II Compliance Office and the Mecklenburg County Health Department.

The plant will include the protection of construction forces who will be on site during the operation of Unit 1 for the construction of Unit 2, members of the public who will be within the Exclusion Area at various times (through highway traffic, visitors, boating and recreation on Lake Norman, etc.) and the general public and property in locations beyond the Exclusion Area.

4.2.9 TRANSPORTATION AND REMOTE PROCESSING OF SPENT FUEL

The spent fuel shipping cask design and permissible radiation levels external to the cask are governed by regulations of the Department of Transportation and the AEC. Duke Power Company will meet the requirements imposed by these regulations to assure safe transportation of spent fuel.

1. Duke has entered into agreements with Allied-Gulf Nuclear Services for spent fuel reprocessing through 1984. The Allied-Gulf reprocessing facility is located in Barnwell, S. C. (approximately 140 air miles from the McGuire site). Releases from the reprocessing facility will be only a small percentage of the 10CFR20 limits. Reference the Barnwell Nuclear Fuel Plant Environmental Report for detailed information on the reprocessing facility. 1.

1.

The design, construction and operation, including waste storage, of a spent fuel reprocessing facility are subject to review and licensing by the AEC and conformance to the same AEC regulations for protection of the public to which McGuire is subject. The inventory of radioactive wastes accumulated (a (after recovery of fuel materials and isotopes useful in medical and other applications) in reprocessing will be stored in liquid form for periods up to five years in high integrity containers under controlled conditions and continuous surveillance. These wastes are then converted to a solid, insoluble form and shipped to a federal repository within a specified time period. The federal repository will assume responsibility for long-term storage and surveillance of these solid radioactive waste materials, although this service is paid for by the user.

4.3 OTHER WATER QUALITY EFFECTS

4.3.1 MECHANICAL CLEANING OF CONDENSER TUBES

McGuire Station will be equipped with a mechanical system for cleaning of condenser tubes to prevent the fouling of condenser heat transfer surfaces. Cleaning of these tubes is necessary to avoid a reduction of thermal efficiency and a corresponding increase in waste heat rejection to the cooling water. The mechanical cleaning system injects sponge rubber balls into the condenser inlet water box where they disperse and flow with the water through the condenser tubes to achieve a scrubbing of the tube surfaces. The sponge balls are collected by a strainer in the condenser discharge water pipe and pumped back for reinjection into the inlet water box.

Operating experience with this type system at the Marshall Steam Station, which uses Lake Norman water for cooling, has shown it to be a satisfactory method for maintaining clean condenser tubes without the use of chemical treatments.

4.3.2 MECHANICAL FILTRATION OF STATION WATER SUPPLY

At McGuire Station, the supply system for filtered water will utilize diatomaceous earth filters to accomplish the filtration process without the use of chemicals.

The 1,000 gallon per minute purification system uses a layer of inert diatomaceous earth as the filtering media, and the spent material is periodically flushed with the filter backwash water to a waste water collection basin (described in Section 4.3.3, paragraph f) where the filter media and the collected solids settle out and are retained.

The environmental effect of using this filter system is a reduction of more than 100,000 pounds per year in the dissolved chemicals being passed downstream as compared to amount which would result from the use of conventional municipal type water purification.

4.3.3 NON-RADIOACTIVE WASTE WATER DISCHARGES

a. Summary

In addition to the potentially radioactive liquid wastes described in Section 4.2.3, there are other miscellaneous liquid wastes which are not radioactive but which may require treatment from a chemical or public health standpoint. These liquid wastes include the station's domestic sewage, drains which may contain small quantities of industrial chemicals and ordinary floor drains.

Each of these sources of waste water is treated as required to make it suitable for transfer to a single waste water collection basin which serves the entire station. In this collection basin, settleable materials are removed and further treatment such as chemical neutralization can be carried out if needed prior to discharge of the waste water to the river.

b. Temporary Sewage Treatment Systems

During the period of plant construction, all domestic sewage from the field toilets, field office toilets and mess hall will be collected and treated in three pre-fabricated extended aeration type sewage treatment plants having a combined capacity of 20,500 gallons per day. The effluent from these treatment plants will receive further treatment by the use of gaseous chlorine in a chlorine contact chamber, and then be pumped to the station's waste water collection basin (described in paragraph f) where the water ultimately is discharged back to the Catawba River.

These sewage treatment facilities meet all applicable standards of the State of North Carolina; approval of their construction and operation will be obtained from the North Carolina Department of Water and Air Resources and the Mecklenburg County Health Department; and they will be operated under the supervision of a trained waste treatment plant operator who is certified by the State of North Carolina.

c. Permanent Sewage Treatment System

All domestic sewage from the station will be collected and treated in one 4,500 gallon per day capacity pre-fabricated extended aeration type sewage treatment plant. The effluent from the treatment plant will receive further treatment by the use of gaseous chlorine in a chlorine contact chamber and then pumped to the station's waste water collection basin (described in paragraph f) where the water ultimately is discharged back to the Catawba River.

This sewage treatment facility meets all applicable standards of the State of North Carolina; approval of its construction and operation will be obtained from the North Carolina Department of Water and Air Resources and the Mecklenburg County Health Department; and it will be operated under the supervision of a trained water treatment plant operator who is certified by the State of North Carolina.

d. Waste Water Containing Chemicals

A representative listing of chemicals which are expected to be used in various plant processes and the waste disposal considerations for each of these chemicals is as follows:

Chemical Process	Chemicals Typically Used	Disposal Considerations
Secondary Coolant Feedwater Conditioning	Very dilute water solution containing Ammonia, Hydrazine, Sodium Phosphate	Small quantities and no special hazards involved. Drains containing these chemicals normally will be pumped to the plant waste water collection basin (described in Section 4.3.3.f) with no special treatment required.

Chemical Process	Chemicals Typically Used	Disposal Considerations
Equipment Cleaning Solutions	Dilute water solutions of Sodium Phosphate, Phosphoric acid, Organic acids such as EDTA, Household Detergents	These are all mild chemicals and normal disposal is to the plant waste water collection basin with no special treatment required.
Demineralizer Regeneration	Water solutions of Sulfuric Acid and Sodium Hydroxide	These are strong chemicals but involve no harmful residues after neutralization. The spent acid is mixed with the spent caustic to assure neutralization, then the waste water is pumped to the plant waste water collection basin.
Corrosion Control in Closed Cooling Systems	Dilute water solution of Sodium Nitrite and Borax	These treatment chemicals are not normally discharged but no special hazards would be involved and any leakage or spills from these cooling systems would be pumped to the plant waste water collection basin.
Primary Coolant Water Conditioning	Dilute water solutions of Boric Acid, Lithium Hydroxide, Hydrazine	No special chemical hazards are involved with dilute solutions of these chemicals. Any spillage or leakage of these chemicals during storage or handling would be recovered or appropriately neutralized for discharge to the waste water collection basin. (Note: Since the primary coolant itself will contain some radioactivity, any primary coolant drains will be processed through the radioactive liquid waste disposal system described in Section 4.2.2.)
Chemical Laboratories	Misc. chemical reagents	Very small quantities of chemicals are involved in the laboratory procedures and no special chemical waste treatment is required. (Note: Drains from the "Hot Lab" may contain small quantities of radioactivity so all

Chemical Process	Chemicals Typically Used	Disposal Considerations
Chemical Laboratories (Continued)	Misc. chemical reagents	drains from this lab will be processed through the radioactive liquid waste disposal system described in Section 4.2.2.)
Drinking Water Disinfection, Sanitary Waste Water Post-Treatment	Chlorine	No disposal considerations involved.

In addition, the station's overall waste disposal capabilities take into account the possible need for the handling of other chemicals. For example: if some new chemical or combination of chemicals should be needed for the cleaning of plant equipment items, the resulting waste water could be appropriately purified for release or concentrated and collected for disposal as chemical or radioactive waste material.

e. Other Drains

All miscellaneous floor drains from the turbine building and similar plant areas where radioactive systems are not involved will be collected in sumps and pumped to the station waste water collection basin (described in paragraph f) where the water ultimately is discharged back to the Catawba River.

A system of yard drains collects the ordinary surface water runoff in the vicinity of the station and conducts this runoff to the Catawba River.

f. Waste Water Collection Basin

All non-radioactive waste water from the station except the cooling water and the surface runoff from the yard is conducted to a single outdoor collection basin which is sized for a retention time of approximately 30 days. Provisions are made for sampling at the single discharge from the basin and the water level can be controlled by discharge valves to allow for planned holdup as desired.

The water discharge from this basin will be completely suitable for unrestricted discharge to Lake Norman or to the Catawba River, and the discharge will be returned to the Catawba River at a point between the Cowans Ford Dam and the adjacent Highway 73 bridge.

The construction and operation of this waste water facility will be carried out in full compliance with the permit to be obtained from the North Carolina Department of Water and Air Resources and the Mecklenburg County Health Department.

4.4 LAND USE

4.4.1 McGUIRE NUCLEAR STATION

McGuire Nuclear Station is largely situated on properties acquired for siting the existing Cowans Ford Dam and the 230 and 525 KV switching station located to the west and south of the plant site. All property within the 2500-foot radius Exclusion Area, 452 acres, will be owned by Duke. Lake Norman constitutes approximately 25 percent of the Exclusion Area.

The portion of the site occupied by the plant proper, its yard, waterways and transmission rights-of-way was prior to development, covered with scrub pines, brush and a very sparse amount of timber. The ground on which the plant buildings and most of the yard will be situated is the site of an old borrow area from which materials for the east Cowans Ford earth dam were excavated and has remained cleared. Coordination of land use with appropriate planning agencies is described in Sections 3.2 and 6.3, paragraph c.

The site is ideally suited for plant development for the following reasons:

a. Requires no public road relocation.

b. Requires relocation of only one private home.

c. Utilizes switching station facilities sited for system requirements independent of station siting.

d. Utilizes to a large extent properties owned by Duke prior to plant construction.

e. Utilizes many existing transmission rights-of-way.

f. Site topography provides natural site for standby nuclear service water pond and other ideal surface drainage features.

g. Utilizes low-level intake installed in Cowans Ford Dam during its construction, adding a feature not otherwise available.

h. Has remoteness advantages without access disadvantages.

i. Utilizes land which is not otherwise suited for any other type of development due to site's proximity to Cowans Ford Dam.

j. Is close to public highway and railroad access.

Lands not owned by Duke adjacent to the plant property consists of small developed and undeveloped farm lands and a small number of part and full-time resident lake cottages and homes along the edge of Lake Norman east of the plant site. Except for the lake homes and cottages the area is typically rural for Piedmont Carolina. These properties should in no way be affected by the nuclear plant aesthetically, functionally or value-wise except for some increased traffic and activity in the general site area during and due to plant construction. Of the area within a two-mile radius of the site, 33 percent is lake surface at elevation 760, 31 percent is Duke property, excluding the impoundment and the remaining 36 percent is other privately owned property.

Immediately to the south of the plant site, downstream of Cowans Ford Dam and on either side of upper Mountain Island reservoir, company-owned lands have been leased to the North Carolina Wildlife Resources Commission for a waterfowl refuge area. (See Section 3.5.)

The switching station has been located approximately 1400 yards south of the plant and incoming and outgoing transmission lines (Figure 4.4-1) routed along rights-of-way some distance from the plant to improve aesthetic appearance of plant.

Although the site is located geographically in the heart of the highly industrialized and populated region of the Carolinas, the immediate vicinity of the site is relatively unpopulated and without industry or commerce of any importance except for electric power and recreational opportunity. Figure 4.4-2 shows the population distribution within five miles of the site for 1970 and the estimated distribution for year 2015. Figure 4.4-3 shows distribution for the same years for areas five to twenty miles from the site and Figure 4.4-4 for areas twenty to fifty miles from the site. Figures 4.4-5 and 4.4-6 show agricultural land usage within a fifty-mile radius of the site.

The nearest commercial product industries are located between six and seven miles from the plant site in six locations in or near Cornelius and Huntersville, North Carolina. The nearest airport with scheduled commercial service is 14 miles south of the site. The nearest airport is ten miles southeast of the site serving only light private aircraft. The nearest commercial airway is approximately one and one-half miles east of the site. No active military installations are located within a fifty-mile radius of the site. A natural gas pipe line is routed south of the plant approximately one mile away at the nearest point.

4.4.2 NEARBY TRANSMISSION LINES

The McGuire 525/230 KV switching station now under construction and scheduled for initial system service April, 1971, is located about three-fourths of a mile south of the plant as shown on Figure 4.4-1. The station was planned at this location to meet system requirements and will now be used for plant needs. It was purposefully located remote from the plant site in order to route incoming and outgoing transmission lines some distance from the plant and improve the overall plant appearance.

The transmission lines leaving the station on routes which must cross to the west side of the Catawba River do so on the downstream side of the N. C. Highway 73 bridge so that lines will not obstruct or impair view of the McGuire plant site or Cowans Ford Dam when viewed from the highway and historical observation area. The only overhead lines routed onto the plant site will be those connecting the plant's transformer station with the 230 KV and 525 KV portions of the switching station.

Rights-of-way have been selected, insofar as was practical for the land available, to preserve the natural and developed landscape and minimize conflict with the present and planned uses of the lands on which they are located. The joint use of rights-of-way by more than one line to reduce the number of rights-of-way has been planned wherever feasible. Where natural growth exists fringes of growth will be left standing to screen the view of parallel lines or line crossings wherever possible. Where natural growth does not exist planted screens will be placed at appropriate locations to improve the view from public roads and access areas. Low growth will be left standing in rights-of-way where clearing to the ground is not necessary for construction reasons. Low growth will be restored to areas cleared to the ground wherever practical. Cover planting of cleared rights-of-way with grass, etc., will provide cover and feed for wildlife. Refer to Section 3.8 for Duke's soil conservation practices on transmission rights-of-way. For appearance reasons, the galvanized steel switching station structures are of low-profile, rigid frame or cantilever construction. Transmission towers for all permanent incoming and outgoing lines are and will be conventional laced self-supporting galvanized steel structures.

Where feasible and practical the guidance and suggestions for reduction of environmental impact of transmission systems contained in the U. S. Department of the Interior and Agriculture publication "Environmental Criteria for Electric Transmission Systems" will be implemented.

4.4.3 HISTORIC LANDMARKS

Cowans Ford Dam, located immediately west and upstream of the McGuire Plant, was the site of a Revolutionary War Battle in which American General William Davidson was killed when his forces encountered British Commander Lord Cornwallis' troops in 1781. A marker commemorating this historic event was erected in the plant yard accessible to the public at the entrance to Cowans Ford Dam by the Battle of Cowans Ford Chapter of the Daughters of the American Revolution.

During site exploration for McGuire Nuclear Station, an old monument, lost and covered with vines and brush, erected to commemorate the falling of General Davidson was found and preserved. A new landscaped site with access road and parking facilities has been constructed to relocate the old monument at the entrance road to the plant's switching station on company property. This site affords the public conspicuous access to the historic marker. Duke Power Company undertook this project in cooperation with the Mecklenburg Historical Association and a formal dedication of the plaque was held February 1, 1971. See Appendix 4B for copy of letter regarding dedication ceremony, invitation to ceremony and newspaper clipping.

Immediately west of the plant site across the Catawba River and north of N. C. Highway 73, another historic marker has been erected in a public observation area provided for public viewing of the Cowans Ford Dam and its associated structures from a downstream vantage. This marker prepared and furnished by the North Carolina Archives and Highway Departments, depicts early Trans-Catawba history giving location and brief description of many of the more important historic sites in the vicinity of the dam. This observation area is also located in a conspicuous location and provides off-road public parking facilities. The marker was relocated in this area, by Duke, from a location nearby in cooperation with the North Carolina State Highway Commission and the North Carolina Department of History and Archives.

4.5 CONSTRUCTION EFFECTS

During construction, efforts will be made to reduce the environmental impact. Erosion, sedimentation, dust, smoke, noise, unsightly landscape and waste disposal will be controlled to practicable levels.

Erosion in the construction area and the resulting sedimentation will be controlled by providing piped drainage systems, intercept and berm ditches and ground covers where necessary to control the flow of surface water. Spoiled earth materials will not be deposited in or near the lake or river in such an uncontrolled manner that high water or surface runoff will transport materials to the water body.

Good drainage, dry weather wetting and the paving of the most traveled construction roads will reduce dust generated by vehicular traffic. Bare areas will be sown to provide a ground cover of vegetation wherever and whenever practicable.

Excessive and objectionable construction noises will be reduced to acceptable levels where possible and practicable. Contractor's and the company's motor powered equipment will be equipped with the available noise reducing equipment and maintained in good order. Tree lined fringes left around most construction areas for appearance reasons will contribute to noise reduction.

Care will be taken to control smoke or other undesirable emissions to the atmosphere during construction. Duke Power will adhere to applicable air pollution control regulations of Mecklenburg County and the State of North Carolina as they relate to open burning and the operation of certain fuel-burning equipment. Permits and operating certificates will be secured where required. Efforts will be made to keep fuel-burning construction equipment in good mechanical order to reduce excessive emissions. All reasonable precautions will be taken to prevent accidental fires on the construction site and brush or forest fires on adjacent lands.

Wastes such as chemicals, fuels, lubricants, bitumens and raw sewage will not be deposited or discharged onto the natural watershed where surface runoff can transport these materials to Lake Norman or the Catawba River adjacent to and downstream of the site.

Traffic problems will be reduced by providing parking and unload points for commercial carriers off public roads with convenient points of access. On-site parking will be provided for construction workers. Since an access railroad will be provided, many of the large commercial hauls for transporting large equipment to the site will not require use of the public roads.

Wherever possible in areas where trees stand, tree fringes will be left to screen the construction plant and activities from the public view. Construction buildings, storage and maintenance areas and parking areas will be maintained in a neat manner to improve the construction plant appearance. When construction nears completion, the areas used for construction purposes will be restored where practicable by landscaping to blend with the natural and developed landscape.

4.6 AESTHETIC IMPACT

The McGuire Nuclear Station architectural concept will be contemporary in spirit and fact, and imaginative in functional design.

The rectangular forms of the enclosed turbine buildings and auxiliary building related to the cylindrical forms of the reactor buildings will provide surface planes to break up the massive areas into aesthetically pleasing patterns. The administration building, approached on a gracefully curving entrance roadway, will be in the same contemporary spirit as the other structures. An aesthetic blend of contemporary building materials, in earth colors, will be used to relate structures to one another.

Yard areas around all structures, as well as parking areas, will be landscaped with native growth to blend with the site. The existing forested areas on the site will be disturbed as little as possible and selected areas will be reforested at the completion of construction.

The station switchyard is located across N. C. Highway 73 from the station and screened from the highway by the topography. The switchyard is constructed of low-profile, rigid framed structures. Overhead lines will connect the station with the switchyard.

4.7 McGUIRE NUCLEAR STATION AND THE ECONOMY

Construction and operation of the McGuire Nuclear Station will have important direct and indirect effects upon the economy of both the area immediately in the vicinity of the station and of the entire Duke Power service area.

Among the direct effects are: construction and operating payrolls and local purchases; direct taxes, such as property taxes and indirect taxes, such as income taxes coming from the business represented by the sale of the electrical output of the station.

The principal indirect effect is the benefit to the economy of the area from the assurance of an adequate, reliable supply of additional electric power at a reasonable rate.

Construction of a project of this size is a major engineering effort. Construction employment is expected to reach a peak of 1500 and will run about 1100 during most of the construction stage. Since Duke Power constructs its own generating stations, a substantial number of the workers are regular company employees who will move to the McGuire site as other projects now underway are completed. There are, however, a number of construction skills which are not needed continually. These skills will be employed from the local work force or brought in from other areas for the time their work is needed. It is a characteristic of labor in this part of the country to commute from considerable distances. This will spread over a number of communities any strain on local employment and avoid a serious dislocation of existing work forces.

Locally purchased materials and services are expected to total $13,600,000 in addition to the $1),000,000 to be spent on turbine blades manufactured in Winston Salem and the $22,000,000 for the low-pressure turbines themselves which will be made in Charlotte. The total construction payroll will be about $67,000,000. Most of this will be spent in communities near the site.

Upon completion of the plant, the annual operating payroll is expected to be about $737,000. The number of employees as related to the plant investment will be small. About 66 full-time employees will be required for regular operation of the station. These employees and their families will add to the economy of the area but do not comprise a sufficiently large group to produce any serious effect on schools and other public services. The plant itself will be self sufficient requiring no addition to tax-paid police or fire staffs.

The station is adjacent to North Carolina Highway 73 which was rebuilt to modern standards early in the 1960's. This was done largely at Duke Power expense as part of the highway relocation made necessary by the construction of Lake Norman. No additional public highway construction will be required by construction or operation of the nuclear station.

Although the permanent payroll is not large, it is a steady payroll. Employment at the station will not vary materially with fluctuations in the general business cycle. Station employment will therefore exert stabilizing influence on the local economy. The McGuire Nuclear Station will create very substantial revenues for Mecklenburg County. The investment of $431,000,000 will be the largest in the two Carolinas. The investment in this single facility is greater than the appraised value of all property in each of 82 of the 100 counties in North Carolina.

As mentioned earlier, this plant is an unusual asset to the county as it is practically free of demands on tax supported agencies of the county. No publicly supported water, sewer or trash disposal services will be required.

Almost the entire county tax payment ($4,000,000 per year in property taxes), therefore, is a net gain to the county government whereas tax income from most industrial investments are to quite some extent offset by related expenses to tax supported services.

The business created by the sale of electricity from the McGuire Station will add substantially to state and federal tax revenues. According to the formula used by the Federal Power Commission, an investment in generating facilities of $431,000,000 will create over $13,000,000 in federal taxes each year.

While it is more difficult to measure in dollars and cents, the indirect importance of this station to the economy of the Duke Power service area is significant. The area served by the company, the Piedmont section of North and South Carolina, is a growth area. There are no indications that this growth will slow down in the foreseeable future. It is, however, predicated upon a continuing adequate supply of electricity.

In the past Duke Power has kept pace with the economic development of its service area and at no time has a new business or industry been turned away due to the inability of the company to provide the electric power it needs. The massive construction program Duke Power now has under way is intended to meet the growing needs of the area for electricity. The McGuire Nuclear Station is a vital part of this program.

The economy of the Piedmont Carolinas has undergone a dramatic revolution since the end of World War II. At that time, textiles was by far the predominant industry with furniture and tobacco manufacture making up most of the remainder. These industries have grown substantially in the post-war period. Yet, even with this growth, they represent a much smaller portion of the total industry of the area today than ever before.

The reason for this is that there has been a large influx of widely diversified industries ranging from light industry such as Western Electric's several manufacturing facilities to heavy industry such as the Westinghouse and General Electric turbine plants.

This trend has created a labor market which has offered a wide spectrum of opportunity to workers of this area. With the aid of the outstanding technical education programs of both Carolinas, native workers from this section have had little difficulty mastering the skills and trades required by this wide diversity of industrial opportunities.

Some environmentalists have claimed that industrial development is a harmful factor to an area and should not be encouraged. There may be certain heavily built-up portions of the country where this is true, but the Piedmont Carolinas are far from reaching this point and regional planning is aimed at avoiding such concentrations. This part of the country is not developing into large metropolitan centers which may create more problems than they solve. Most new industrial plants are locating in the large expanses of open space in rural area utilizing land that has largely been lying idle since the demise of cotton as the money crop of the South. The state has been among the nation's leaders in establishing effective pollution control standards for environmental protection. The excellent network of existing paved rural roads gives employees easy access to the plant and to the cultural advantages of the neighboring small cities.

This program of encouraging diversification of industry is making headway on one of the most pressing economic problems of the region - that of raising the per capita income. In 1960, North Carolina ranked 45th and South Carolina 48th among the states in income per capita. In 1969, North Carolina had improved to 41st and South Carolina to 47th. If the people of this area are to enjoy a standard of living equal to the average in this country, per capita income in the area must be drastically further improved. It will be if the selective industrial recruiting programs of the two Carolinas can be maintained. For this momentum to be maintained, however, it is essential that power generating facilities be built to sustain the industrial development. The two generating units of the McGuire Nuclear Station must be in operation by the dates scheduled if the development of the Duke Power service area is not to be hampered by a shortage of electricity.

4.8 UNAVOIDABLE ADVERSE ENVIRONMENTAL EFFECTS

Public need for electricity requires generating plants which, of whatever type, will have some unavoidable environmental effects. The design of McGuire Nuclear Station has been aimed at avoiding adverse effects wherever possible. Those unavoidable effects, which some may consider adverse are:

a. Use of land for generating plant and transmission facilities. This impact is minimized by aesthetic design and plantings described elsewhere in this report.

b. Use of natural material resources, such as uranium and other metals, in the consumed fuel.

c. Production of fission by-products which, in view of the extensive control and containment procedures and regulations, will have no adverse impact except ultimate occupancy of space in storage.

4.9 RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

McGuire Nuclear Station during its useful lifetime and thereafter will not release heat, radiation or radioactive materials in a manner or in sufficient quantities to harm life around the station.

Energy from minerals whose other uses are limited to military purposes will be converted into more useful electric energy, using these materials in the process of conversion. Needed electrical energy will be available for production, transportation, waste treatment and the creation of many useful artificial environments (home and office interiors, refrigerators and freezers, medical life-support systems).

After the nuclear station's useful lifetime has been served, all highly radioactive materials, such as spent fuel in the reactor, will be removed, reprocessed and residuals sent to federal repository facilities. Public access to areas of remaining low-level radioactivity will be carefully controlled as required until, by combination of cleaning and/or decay time, these areas can have unrestricted access. This restriction will be of little, if any, significance to long-term productivity or use of station environs.

4.10 IRRETRIEVABLE AND IRREVERSIBLE COMMITMENTS OF RESOURCES

The recreation, fisheries resources, water conservation, flood control and beauty afforded to the general public by Lake Norman makes the lake so attractive that few, if any, would want to return the lands beneath the lake to their former uses. Building McGuire Nuclear Station is another carefully planned step in the development of the Lake Norman electrical generating complex.

The fuel which McGuire Nuclear Station will convert into energy will be irretrievably lost. In the sense that man may not use them in the near future, the highly radioactive waste by-products and the off-site caverns in which they will be stored might be considered irreversible losses, but the passage of time or the advent of new technology may make them available again to future generations. All other resource uses by McGuire will be temporary.

TABLE 4.1-1

McGuire Nuclear Station
Extreme (Warmest) Climatic Conditions
Forecast of Monthly Average Water Temperatures

Condenser Cooling Water (°F)

Month	Inlet (°F) Low Level Intake	Upper Level Intake	Average After Mixing	Discharge (°F)	Surface of Main Body of Lake (°F)
January	----	48.5	48.5	80.5	48.5
February	----	46.0	46.0	78.0	46.5
March	----	48.5	48.5	80.5	53.5
April	----	68.0	68.0	95.0	70.5
May	----	65.0	65.0	95.0	72.5
June	----	75.0	75.0	95.0	88.0
July	59.5	86.0	79.0	95.0	86.5
August	64.5	86.0	79.0	95.0	87.5
September	64.0	80.5	79.0	95.0	80.5
October	----	69.5	69.5	95.0	71.0
November	----	63.0	63.0	95.0	65.0
December	----	53.0	53.0	85.0	54.0

NOTE: Low-level intake used in only July, August and September

TABLE 4.1-2

McGuire Nuclear Station
Normal Climatic Conditions
Forecast of Monthly Average Water Temperatures

Condenser Cooling Water (°F)

	Inlet (°F)			Discharge (°F)	Surface of Main Body of Lake (°F)
Month	Low Level Intake	Upper Level Intake	Average After Mixing		
January	----	44.0	44.0	76.0	44.0
February	----	42.0	42.0	74.0	43.0
March	----	45.0	45.0	77.0	47.0
April	----	53.5	53.5	85.5	59.0
May	----	60.5	60.5	90.0	66.0
June	----	67.5	67.5	90.0	77.0
July	53.0	76.0	74.0	90.0	82.0
August	55.5	79.0	74.0	90.0	81.0
September	58.5	76.0	74.0	90.0	76.5
October	----	69.5	69.5	90.0	69.5
November	----	59.0	59.0	90.0	60.0
December	----	50.0	50.0	82.0	51.0

NOTE: Low-level intake used only in July, August and September

Table 4.2-1

Design Estimates of Annual Waste Quantities from Two Units

	Volume (gal/yr)
Reactor Coolant Treated and Discharged for Tritium Control[1]	150,000
Treated Non-Recycleable Reactor Coolant System Leakage	13,000
Decontaminations, Lab Rinses, Laundry, Showers, Other Leakage (all treated)	329,000
TOTAL	492,000

[1] If discharge for tritium control is required, maximum quantity discharged in one year is shown. This effluent can be processed in boron recycle system.

Table 4.2-2

Equilibrium Fission Product and Corrosion Product Concentrations in Reactor Coolant

Isotope	Concentration (uCi/ml)[1],[4]	
Fission Products	Normal Operation[2]	Design Conditions[3]
H-3	1.1	1.1
Sr-89	5.0×10^{-4}	2.8×10^{-3}
Sr-90	3.4×10^{-5}	8.1×10^{-5}
Sr-91	8.5×10^{-2}	1.4×10^{-3}
Sr-92	--------	5.4×10^{-4}
Y-90	--------	9.6×10^{-5}
Y-91	5.8×10^{-4}	4.0×10^{-3}
Y-92	9.1×10^{-2}	5.3×10^{-4}
Zr-95	6.1×10^{-5}	4.9×10^{-4}
Nb-95	6.1×10^{-5}	4.7×10^{-4}
Mo-99	1.1×10^{-2}	3.9
I-131	1.9×10^{-3}	1.8
I-132	5.3×10^{-2}	0.66
I-133	2.9×10^{-2}	2.9
I-134	.1	.41
I-135	5.2×10^{-2}	1.6
Te-132	7.0×10^{-3}	0.19
Cs-134	--------	0.15

(1) Concentration based on reactor coolant temperature of 585°F and pressure of 2235 psia.
(2) No defects in fuel. Trace uranium contamination on fuel rod exterior surfaces.
(3) Cladding defects in one percent of the fuel pins.
(4) Concentration is given in scientific notation where, for example, 5.0×10^{-4} means .0005 or 5 parts in 10,000 parts.

Table 4.2-2 (Continued)

Equilibrium Fission Product and Corrosion Product
Concentrations in Reactor Coolant

Isotope	Concentration (uCi/ml)[(1),(4)]	
Fission Products	Normal Operation[(2)]	Design Conditions[(3)]
Cs-136	2.6×10^{-6}	.1
Cs-137	--------	0.76
Ba-140	2.6×10^{-4}	3.1×10^{-3}
La-140	2.1×10^{-2}	1.1×10^{-3}
Ce-144	1.2×10^{-4}	2.0×10^{-4}
Kr-85m	2.3×10^{-2}	1.6
Kr-85	--------	3.4
Kr-87	4.1×10^{-2}	.9
Kr-88	5.2×10^{-2}	2.7
Xe-131m	--------	2.0
Xe-133m	2.4×10^{-3}	2.3
Xe-133	2.9×10^{-2}	210
Xe-135m	2.4×10^{-2}	.14
Xe-135	5.2×10^{-2}	4.6
Xe-138	8.3×10^{-2}	.5
Corrosion Products		
Mn-54	5.6×10^{-4}	5.6×10^{-4}
Mn-56	2.1×10^{-2}	2.1×10^{-2}

(1) Concentration based on reactor coolant temperature of 585°F and pressure of 2235 psia.
(2) No defects in fuel. Trace uranium contamination on fuel rod exterior surfaces.
(3) Cladding defects in one percent of the fuel pins.
(4) Concentration is given in scientific notation where, for example, 5.0×10^{-4} means .0005 or 5 parts in 10,000 parts.

Equilibrium Fission Product and Corrosion Product Concentrations in Reactor Coolant

Isotope	Concentration (uCi/ml)(1),(4)	
Corrosion Products	Normal Operation(2)	Design Conditions(3)
Co-58	1.8×10^{-2}	1.8×10^{-2}
Co-60	5.4×10^{-4}	5.4×10^{-4}
Fe-59	7.5×10^{-4}	7.5×10^{-4}
Cr-51	6.8×10^{-4}	6.8×10^{-4}

(1) Concentration based on reactor coolant temperature of 585°F and pressure of 2235 psia.
(2) No defects in fuel. Trace uranium contamination on fuel rod exterior surfaces.
(3) Cladding defects in one percent of the fuel pins.
(4) Concentration is given in scientific notation where, for example, 5.0×10^{-4} means .0005 or 5 parts in 10,000 parts.

Table 4.2-3a

Normal Operation Estimates of Annual Radioactivity Releases in Liquid Waste from Two Units

Isotope	Annual Release (uCi)	Average Additional Discharge Concentration (uCi/ml)	Fraction of Limit(1)
Fission Products			
Sr-89	1.5×10^{1}	4.7×10^{-15}	1.6×10^{-9}
Sr-90	1.0	3.2×10^{-16}	1.1×10^{-9}
Sr-91	1.5×10^{3}	4.5×10^{-13}	6.4×10^{-9}
Sr-92	---------	-----------	----------
Y-90	---------	-----------	----------
Y-91	6.9×10^{1}	2.1×10^{-14}	7.1×10^{-10}
Y-92	2.3×10^{3}	7.0×10^{-13}	1.2×10^{-8}
Zr-95	1.8	5.7×10^{-16}	9.5×10^{-12}
Nb-95	1.8	5.7×10^{-16}	5.7×10^{-12}
Mo-99	1.2×10^{3}	3.7×10^{-13}	1.9×10^{-9}
I-131	5.6×10^{1}	1.7×10^{-14}	5.8×10^{-8}
I-132	1.5×10^{2}	4.5×10^{-14}	5.6×10^{-9}
I-133	6.8×10^{2}	2.1×10^{-13}	2.1×10^{-7}
I-134	5.6	1.7×10^{-15}	8.6×10^{-11}
I-135	6.9×10^{2}	2.1×10^{-13}	5.3×10^{-8}
Te-132	2.0×10^{2}	6.1×10^{-14}	2.0×10^{-9}
Cs-134	---------	-----------	----------
Cs-136	3.1×10^{-1}	9.4×10^{-17}	1.0×10^{-12}
Cs-137	-----------	-----------	-----------
Ba-140	7.8	2.3×10^{-15}	8.0×10^{-11}

(1) Fraction of 10 CFR 20 Limit

Normal Operation Estimates of Annual Radioactivity Releases in Liquid Waste from Two Units

Isotope	Annual Release (uCi)	Average Additional Discharge Concentration (uCi/ml)	Fraction of Limit[1]
Fission Products			
La-140	5.6×10^{2}	1.7×10^{-13}	8.6×10^{-9}
Ce-144	3.6	1.1×10^{-15}	1.1×10^{-10}
Corrosion Products			
Mn-54	1.7×10^{1}	5.2×10^{-15}	5.2×10^{-11}
Mn-56	7.4×10^{1}	2.3×10^{-14}	2.3×10^{-10}
Co-58	5.4×10^{2}	1.7×10^{-13}	1.7×10^{-9}
Co-60	1.6×10^{1}	5.1×10^{-15}	1.0×10^{-10}
Fe-59	2.3×10^{1}	7.0×10^{-15}	1.2×10^{-10}
Cr-51	2.1×10^{1}	6.3×10^{-15}	3.2×10^{-12}
TOTAL	8.0×10^{3}	2.5×10^{-12}	3.6×10^{-7}
Tritium	911 curies	2.8×10^{-7}	9.4×10^{-5}

[1] Fraction of 10 CFR 20 Limit

Design Condition Estimates of Annual Radioactivity Releases in Liquid Waste from Two Units

Isotope	Annual Release (uCi)	Average Additional Discharge Concentration (UCi/ml)	Fraction of Limit(1)
Fission Products			
Sr-89	9.8×10^{1}	3.0×10^{-14}	1.0×10^{-8}
Sr-90	3.5	1.1×10^{-15}	3.6×10^{-9}
Sr-91	1.5×10^{3}	4.6×10^{-13}	6.5×10^{-9}
Sr-92	2.1	6.5×10^{-16}	9.4×10^{-12}
Y-90	1.1×10^{1}	3.2×10^{-15}	1.6×10^{-10}
Y-91	5.5×10^{2}	1.7×10^{-13}	5.6×10^{-9}
Y-92	2.3×10^{3}	7.0×10^{-13}	1.2×10^{-8}
Zr-95	1.7×10^{1}	5.1×10^{-15}	8.6×10^{-11}
Nb-95	1.6×10^{1}	4.9×10^{-15}	4.9×10^{-11}
Mo-99	4.3×10^{5}	1.3×10^{-10}	6.6×10^{-7}
I-131	5.3×10^{4}	1.6×10^{-11}	5.5×10^{-5}
I-132	1.9×10^{3}	6.0×10^{-13}	7.5×10^{-8}
I-133	6.9×10^{4}	2.1×10^{-11}	2.1×10^{-5}
I-134	2.8×10^{1}	8.7×10^{-15}	4.4×10^{-10}
I-135	2.2×10^{4}	6.7×10^{-12}	1.7×10^{-6}
Te-132	5.6×10^{3}	1.7×10^{-12}	5.8×10^{-8}
Cs-134	1.8×10^{4}	5.5×10^{-12}	6.1×10^{-7}
Cs-136	1.2×10^{4}	3.7×10^{-12}	4.1×10^{-8}
Cs-137	9.0×10^{4}	2.8×10^{-11}	1.4×10^{-6}
Ba-140	1.0×10^{2}	3.1×10^{-14}	1.0×10^{-9}

(1) Fraction of 10 CFR 20 Limit

Design Condition Estimates of Annual Radioactivity Releases in Liquid Waste from Two Units

Isotope	Annual Release (uCi)	Average Additional Discharge Concentration (uCi/ml)	Fraction of Limit (1)
Fission Products			
La-140	5.8×10^{2}	1.8×10^{-13}	9.0×10^{-9}
Ce-144	9.7	3.0×10^{-15}	3.0×10^{-10}
Corrosion Products			
Mn-54	1.7×10^{1}	5.2×10^{-15}	5.2×10^{-11}
Mn-56	7.4×10^{1}	2.3×10^{-14}	2.3×10^{-10}
Co-58	5.4×10^{2}	1.7×10^{-13}	1.7×10^{-9}
Co-60	1.6×10^{1}	5.1×10^{-15}	1.0×10^{-10}
Fe-59	2.3×10^{1}	7.0×10^{-15}	1.2×10^{-10}
Cr-51	2.1×10^{1}	6.3×10^{-15}	3.2×10^{-12}
TOTAL	7.1×10^{5}	2.2×10^{-10}	8.0×10^{-5}
Tritium	911 curies	2.8×10^{-7}	9.4×10^{-5}

(1) Fraction of 10 CFR 20 Limit

Table 4.2-4

Estimate of Maximum Instantaneous Radioactivity Discharge Concentration

	Fraction of Limit[1]	
	Normal Operation	Design Condition
Normal Condenser Cooling Water Flow	0.051	0.072
Minimum Condenser Cooling Water Flow	0.21	0.29

[1] Fraction of 10 CFR 20 Limit

Table 4.2-5

Steam Generator Tube Leak Analysis

Assumptions:

(1) Steam generator tube leak of 1 gpm.

(2) Duration of leak is 30 days.

(3) Discharge averaged over one year.

Air Ejector Gaseous Release	Average Downwind Concentration at Exclusion Area Boundary (uCi/ml)	Fraction of 10 CFR 20 Limit
Normal Operation	1.1×10^{-11}	2.4×10^{-4}
Design Conditions	2.0×10^{-8}	7.9×10^{-2}

Table 4.2-6

Maximum Radioactivity Concentrations in the Effected Portion of Lake Norman Resulting from Operation of McGuire

Isotope	Concentration (uCi/ml) Normal Operation	Concentration (uCi/ml) Design Conditions	Fraction of Limit[1] Normal Operation	Fraction of Limit[1] Design Conditions
Fission Products				
Sr-89	1.1×10^{-14}	7.0×10^{-14}	3.6×10^{-9}	2.3×10^{-8}
Sr-90	7.5×10^{-16}	2.5×10^{-15}	2.5×10^{-9}	8.5×10^{-9}
Sr-91	3.6×10^{-13}	3.7×10^{-13}	5.1×10^{-9}	5.2×10^{-9}
Sr-92	-----------	2.3×10^{-16}	----------	3.3×10^{-12}
Y-90	-----------	5.6×10^{-15}	----------	2.8×10^{-10}
Y	4.9×10^{-14}	3.9×10^{-13}	1.6×10^{-9}	1.3×10^{-8}
Y-92	3.0×10^{-13}	3.0×10^{-13}	5.0×10^{-9}	5.0×10^{-9}
Zr-95	1.3×10^{-15}	1.2×10^{-14}	2.2×10^{-11}	2.0×10^{-10}
Nb-95	1.3×10^{-15}	1.1×10^{-14}	1.3×10^{-11}	1.1×10^{-10}
Mo-99	6.5×10^{-13}	2.3×10^{-10}	3.3×10^{-9}	1.2×10^{-6}
I-131	3.6×10^{-14}	3.4×10^{-11}	1.2×10^{-7}	1.1×10^{-4}
I-132	1.4×10^{-14}	1.9×10^{-13}	1.8×10^{-9}	2.4×10^{-8}
I-133	2.4×10^{-13}	2.5×10^{-11}	2.4×10^{-7}	2.5×10^{-5}
I-134	2.4×10^{-16}	1.2×10^{-15}	1.2×10^{-11}	6.2×10^{-11}
I-135	1.4×10^{-13}	4.3×10^{-12}	3.5×10^{-8}	1.1×10^{-6}
Te-132	2.3×10^{-14}	6.5×10^{-13}	7.6×10^{-10}	2.2×10^{-8}
Cs-134	-----------	1.3×10^{-11}	-----------	1.4×10^{-6}
Cs-136	2.1×10^{-16}	8.1×10^{-12}	2.3×10^{-12}	9.0×10^{-8}
Cs-137	------------	6.6×10^{-11}	------------	3.3×10^{-6}

(1) Fraction of 10 CFR 20 Limit

Maximum Radioactivity Concentrations in the Effected Portion of Lake Norman Resulting from Operation of McGuire

Isotope	Concentration (uCi/ml) Normal Operation	Concentration (uCi/ml) Design Conditions	Fraction of Limit[1] Normal Operation	Fraction of Limit[1] Design Conditions
Fission Products				
Ba-140	5.2×10^{-15}	6.8×10^{-14}	1.7×10^{-10}	2.2×10^{-9}
La-140	2.6×10^{-13}	2.7×10^{-13}	1.3×10^{-8}	1.4×10^{-8}
Ce-144	2.6×10^{-15}	7.0×10^{-15}	2.6×10^{-10}	7.0×10^{-10}
Corrosion Products				
Mn-54	1.2×10^{-14}	1.2×10^{-14}	1.2×10^{-10}	1.2×10^{-10}
Mn-56	7.8×10^{-15}	7.8×10^{-15}	7.8×10^{-11}	7.8×10^{-11}
Co-58	3.9×10^{-13}	3.9×10^{-13}	3.9×10^{-9}	3.9×10^{-9}
Co-60	1.2×10^{-14}	1.2×10^{-14}	2.4×10^{-10}	2.4×10^{-10}
Fe-59	1.6×10^{-14}	1.6×10^{-14}	2.7×10^{-10}	2.7×10^{-10}
Cr-51	1.4×10^{-14}	1.4×10^{-14}	7.2×10^{-12}	7.2×10^{-12}
Total	2.5 X 10	3.9 X 10	4.4 X 10	1.5 X 10
Tritium	6.6×10^{-7}	6.6×10^{-7}	2.2×10^{-4}	2.2×10^{-4}

[1] Fraction of 10 CFR 20 Limit

Table 4.2-7a

Normal Operation Estimates of Annual Radioactivity Releases in Gaseous Waste from Two Units

Isotope	Annual Release (uCi)	Average Downwind Concentration at the Exclusion Area Boundary (uCi/ml)	Fraction of Limit[(1)]
Kr-85m	1.1×10^{6}	2.3×10^{-13}	2.3×10^{-6}
Kr-85	---------	----------	----------
Kr-87	2.0×10^{6}	4.0×10^{-13}	2.0×10^{-5}
Kr-88	2.6×10^{6}	5.2×10^{-13}	2.6×10^{-5}
Xe-131m	---------	-----------	----------
Xe-133m	1.4×10^{5}	3.5×10^{-14}	1.2×10^{-7}
Xe-133	1.8×10^{6}	5.1×10^{-13}	1.7×10^{-6}
Xe-135m	1.2×10^{6}	2.3×10^{-13}	7.8×10^{-6}
Xe-135	2.6×10^{6}	5.5×10^{-13}	5.5×10^{-6}
Xe-138	4.1×10^{6}	8.1×10^{-13}	2.7×10^{-5}
I-131	1.2×10^{3}	3.6×10^{-16}	3.6×10^{-6}
I-132	2.6×10^{4}	5.3×10^{-15}	1.8×10^{-6}
I-133	1.5×10^{4}	3.4×10^{-15}	8.6×10^{-6}
I-134	4.9×10^{4}	9.8×10^{-15}	1.6×10^{-6}
I-135	2.6×10^{4}	5.4×10^{-15}	5.4×10^{-6}
Sub-total	1.6×10^{7}	3.3×10^{-12}	1.2×10^{-4}
H-3	7.3×10^{7}	2.3×10^{-11}	1.1×10^{-4}
Total	8.9×10^{7}	2.6×10^{-11}	2.3×10^{-4}

(1) Fraction of 10 CFR 20 Limit

Table 4.2-7b

Design Condition Estimates of Annual Radioactivity Releases in Gaseous Waste from Two Units

Isotope	Annual Release (uCi)	Average Downwind Concentration at the Exclusion Area Boundary (uCi/ml)	Fraction of Limit[(1)]
Kr-85m	8.0×10^{7}	1.6×10^{-11}	1.6×10^{-4}
Kr-85	2.4×10^{8}	7.4×10^{-11}	2.5×10^{-4}
Kr-87	4.4×10^{7}	8.8×10^{-12}	4.4×10^{-4}
Kr-88	1.3×10^{8}	2.7×10^{-11}	1.3×10^{-3}
Xe-131m	1.3×10^{8}	3.9×10^{-11}	9.8×10^{-5}
Xe-133m	1.3×10^{8}	3.4×10^{-11}	1.1×10^{-4}
Xe-133	1.3×10^{10}	3.7×10^{-9}	1.2×10^{-2}
Xe-135m	6.9×10^{6}	1.4×10^{-12}	4.5×10^{-5}
Xe-135	2.3×10^{8}	4.9×10^{-11}	4.9×10^{-4}
Xe-138	2.5×10^{7}	4.9×10^{-12}	1.6×10^{-4}
I-131	1.2×10^{6}	3.4×10^{-13}	3.4×10^{-3}
I-132	3.3×10^{5}	6.6×10^{-14}	2.2×10^{-5}
I-133	1.5×10^{6}	3.4×10^{-13}	8.6×10^{-4}
I-134	2.0×10^{5}	4.0×10^{-14}	6.7×10^{-6}
I-135	8.1×10^{5}	1.7×10^{-13}	1.7×10^{-4}
Sub-total	1.4×10^{10}	3.9×10^{-9}	2.0×10^{-2}
H-3	7.3×10^{7}	2.3×10^{-11}	1.1×10^{-4}
Total	1.4×10^{10}	3.9×10^{-9}	2.0×10^{-2}

[(1)] Fraction of 10 CFR 20 Limit

Table 4.2-8

a. Annual Whole Body Dose Added by McGuire (mrem)

	Normal Operation	Design Operation	FRC/AEC Limit
From Gaseous Waste Releases	.11	10	
From Liquid Waste Releases	.11	.18	
Total	.22	10.2	500

b. Annual Atmospheric Dose (mrem)

Normal Operation Addition by McGuire	Design Condition Addition by McGuire	Existing Background
.11	10	70 - 82

c. Radioactivity Concentration in Lake Norman Excluding Tritium (uCi/ml)

Normal Operation Addition by McGuire	Design Condition Addition by McGuire	Existing Background
2.5×10^{-12}	3.9×10^{-10}	2.4×10^{-9}

Table 4.2-9

Effect of Reconcentration

Showing Effect of Reconcentration of Various Representative Radionuclides of Interest in Fish in that portion of Lake Norman containing the Highest Equilibrium Concentration of Radioactivity:

Radionuclide	Concentration Factor* l/Kg	Hypothetical Concentration in Fish, uCi/Kg, (wet wt.)	Intake Limit for Fish Corresponding to Limit for Waters** Kilograms per day (wet st.), every day
H-3	0.9	5.96×10^{-4}	1.1×10^{4} (24,200 pounds)
Co-60	500	5.95×10^{-9}	1.8×10^{7} (39,600,000 pounds)
Sr-90	40	1.01×10^{-10}	6.53×10^{6} (14,300,000 pounds)
I-131	1	3.42×10^{-8}	1.8×10^{4} (39,000 pounds)
Cs-137	1000	6.56×10^{-5}	6.6×10^{2} (1,452 pounds)
Nb-95	30,000	3.36×10^{-7}	6.5×10^{5} (1,430,000 pounds)

* Assuming density of 1 Kg/l in fish flesh.

**At water intake of 2.2 liters/day; i.e., wt. of fish in Kg/day = 2200 ml/day X soluble 10 CFR 20 limit in uCi/ml divided by concentration in fish in uCi/Kg.

NOTE: (1) Maximum Design Figures of radioactivity were used to prepare this table.

(2) Intake limit in pounds of fish that can be eaten, every day, so as not to exceed 500 mRem per year, Radiation Protection Guide, for highest individual.

Table 4.2-10

The Environmental Radioactivity Monitoring Program for the McGuire Nuclear Station

TYPE SAMPLE OR MEASUREMENT	CRITERIA FOR SELECTION OF SAMPLING LOCATIONS	COLLECTION FREQUENCY
1. Water	For comparison purposes water samples are collected: a. Upstream, well beyond Site and Exclusion Area, (Lake Norman, control location) b. Within 500 ft. of point where liquid effluent enters Lake Norman c. Downstream, well beyond Site and Exclusion Area (Mt. Island Lake) d. Charlotte Water Supply (11 miles downstream) Huntersville, Mooresville and Davidson Water Supplies (Lake Norman) e. Well water samples at nearby locations and elsewhere within Low Population Zone	Monthly; sample b will be collected continuously during operation; Sample e will be collected semi-annually
	Measurements of Tritium in above samples.	Quarterly for a, b, c, d. Semi-annually for e.
2. Airborne Particulates Rain and Settled Dust	Comparison of on-site vs. off-site locations at distances up to 10 miles near towns and populated areas; and in prevailing wind directions and control location.	Monthly, sample collected continuously
3. Radiation Dose and Dose Rate	Comparison of on-site vs. off-site locations near towns and populated areas; at distances up to 10 miles and in prevailing wind directions; also within 500 ft. of point where liquid effluent enters Lake Norman; and control locations.	Dose: Quarterly, Integrated total, duplicate samples at each location Dose Rate: Quarterly Single Measurement

The Environmental Radioactivity Monitoring Program for the McGuire Nuclear Station

TYPE SAMPLE OR MEASUREMENT	CRITERIA FOR SELECTION OF SAMPLING LOCATIONS	COLLECTION FREQUENCY
4. Lake Bottom Sediment	For comparison purposes, sediment samples are collected:	
	a. Upstream, well beyond Site and Exclusion Area (Lake Norman, control location)	Quarterly
	b. Within 500 ft. of point where liquid effluent enters Lake Norman	Quarterly
	c. Downstream well beyond Site and Exclusion Area (Mt. Island Lake)	Quarterly
5. Aquatic Vegetation, Plankton, Bottom Organisms	For comparison purposes, samples are collected:	
	a. Upstream, well beyond Site and Exclusion Area (Lake Norman control location)	Quarterly (as available)
	b. Within 500 ft. of point where liquid effluent enters Lake Norman	Quarterly (as available)
	c. Downstream, well beyond Site and Exclusion Area (Mt. Island Lake)	Quarterly (as available)
6. Terrestrial Vegetation and Crops	Comparison of nearby upwind and downwind directions in Low Population Zone and in control locations.	Quarterly Crops (in season), corn, beans, others
7. Milk	From nearby farms in prevailing wind directions and from control locations.	Quarterly
8. Fish	Fish samples will include both game fish and rough species (bottom feeders) collected:	Quarterly (as available)
	a. Upstream, well beyond Site and Exclusion Area (Lake Norman, control location)	
	b. Within Exclusion Area where liquid effluent enters Lake Norman	
	c. Downstream well beyond Site and Exclusion Area (Mt. Island Lake)	

Table 4.2-10

The Environmental Radioactivity Monitoring Program for the McGuire Nuclear Station

TYPE SAMPLE OR MEASUREMENT	CRITERIA FOR SELECTION OF SAMPLING LOCATIONS	COLLECTION FREQUENCY
9. Miscellaneous	Investigation of special situations found as a result of the monitoring program and/or station operations, to provide extended coverage; also as may be required due to nuclear testing or unusual fallout conditions not associated with the McGuire Nuclear Station.	As Necessary

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THERMAL IMAGERY
SURVEY

October 1, 1970

DUKE POWER — McGUIRE NUCLEAR STATION
Figure 4.1 - 1


MICROWAVE AND
METEOROLOGICAL
TOWER
LOW LEVEL
CONDENSER
COOLING
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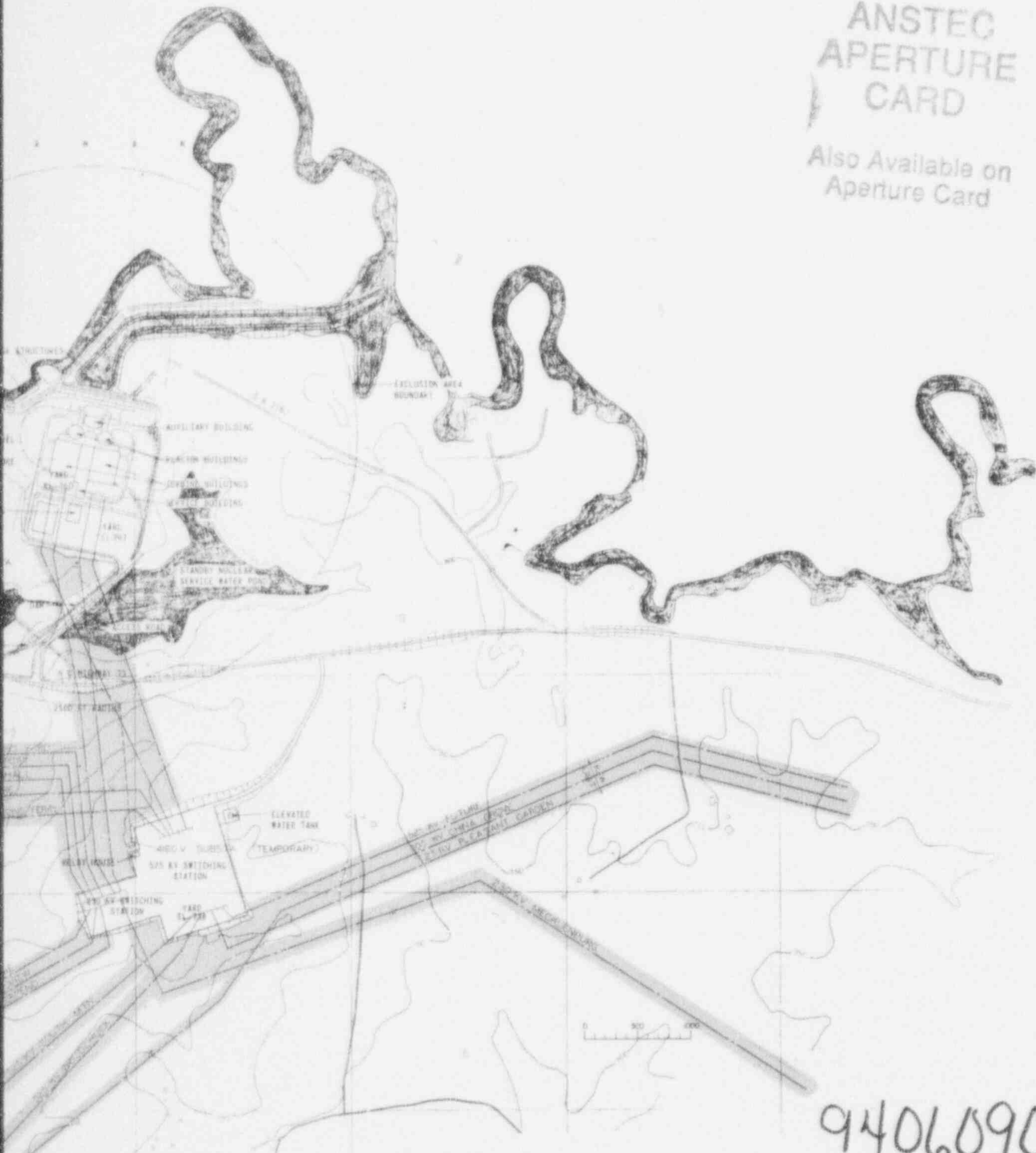

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TRANSMISSION LINES AND
RIGHTS-OF-WAY

McGUIRE NUCLEAR STATION

Figure 4.4 - 1

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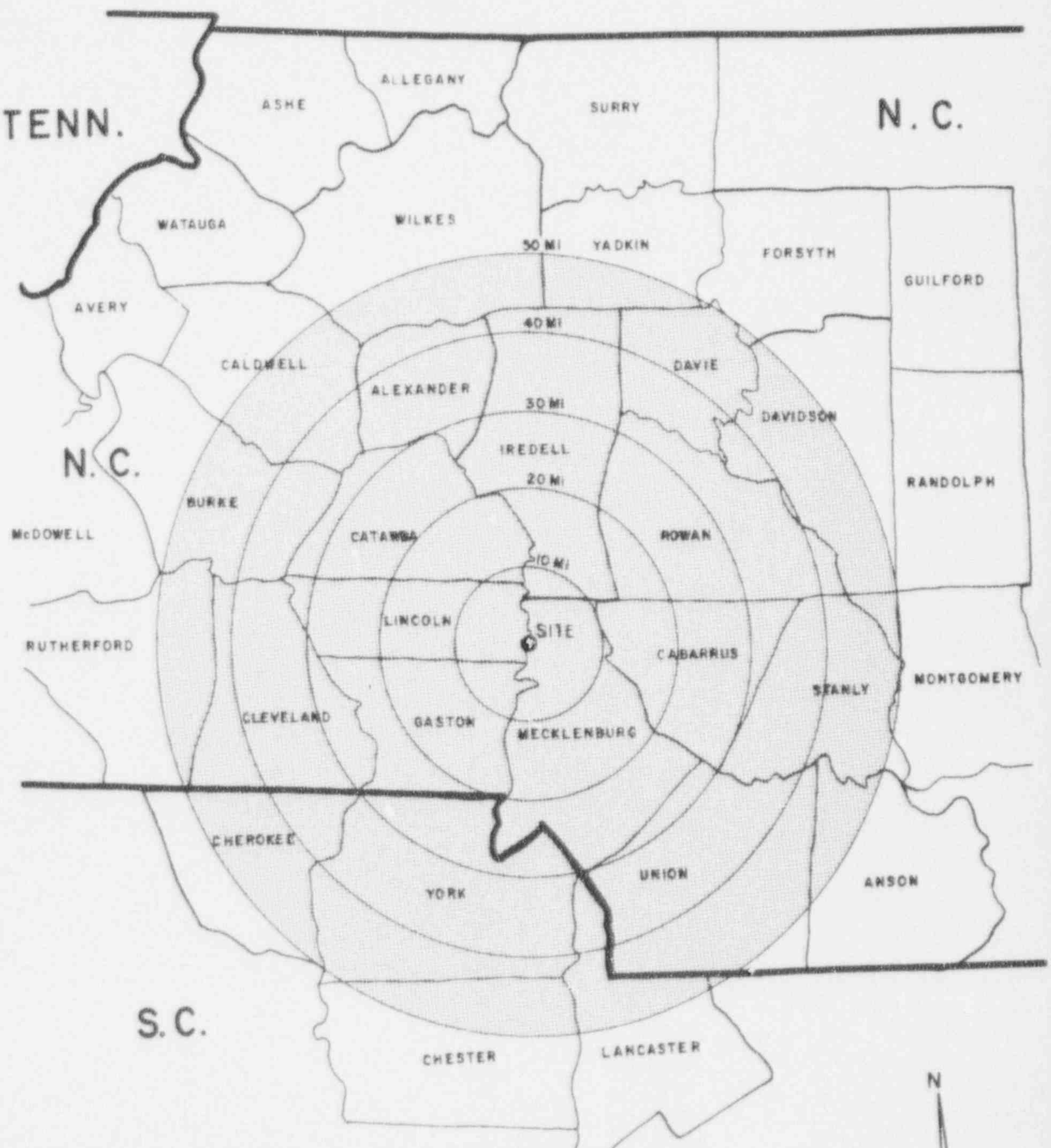

[1] North Carolina Farm Census summary 1969. Compilation for North Carolina counties made by Professor Guy S. Parsons, Extension Dairy Husbandry Department, North Carolina State University.

[2] United States Census of Agriculture for South Carolina 1964.

[3] Denotes percent of county area falling within the 50 mile radius.

[4] North Carolina and USDA crop reporting service. 1967 crop year.

[5] Tabulation gives the total land use acreage for each county, although 14 counties are only partially within the 50 mile radius.

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LAND USE (ACRES) WITHIN A 50 MILE RADIUS

NORTH CAROLINA[1]

County	% Area[3]	Cropland Harvested	Cropland Idle	Pasture Improved	Pasture Unimproved	All Other Land
Alexander	100	14,709	11,595	18,140	6,553	84,347
Anson	16	34,383	20,185	24,273	4,154	131,412
Burke	58	13,010[5]	12,499	10,228	4,642	90,316
Cabarrus	100	35,257	20,248	27,265	9,333	80,367
Caldwell	53	5,524	19,056	6,808	8,506	104,286
Catawba	100	37,616	31,332	27,664	5,896	86,303
Cleveland	100	42,873	65,757	37,719	5,121	101,172
Davidson	58	39,443	46,367	22,974	11,959	136,362
Davie	100	23,868	18,487	28,166	5,213	77,285
Forsyth	02	24,959	24,532	15,581	5,858	89,620
Gaston[4]	100	20,077	23,003	15,282	6,968	60,303
Iredell	100	55,229	45,059	55,720	11,549	132,099
Lincoln	100	33,903	29,003	14,908	5,455	66,316
Mecklenburg	100	20,155	38,399	20,603	13,294	93,354
Montgomery	06	16,622	9,184	5,745	1,767	96,138
Rowan	100	58,131	37,828	35,791	16,464	98,493
Rutherford	31	19,396	36,214	20,657	6,182	141,097
Stanly	99	48,370	25,859	30,696	4,563	92,139
Union	94	89,049	40,874	49,448	11,808	169,991
Wilkes	26	26,520	13,895	27,105	12,552	197,546
Yadkin	35	51,455	19,384	19,810	5,863	101,762
		710,549	588,760	514,583	163,700	2,210,708

SOUTH CAROLINA[2]

County	% Area[3]	Cropland Harvested	Cropland Idle	Pasture Improved	Pasture Unimproved	All Other Land
Cherokee	65	20,554	10,622	28,545	15,653	44,036
Chester	28	24,068	7,770	60,567	43,339	73,595
Lancaster	29	12,130	3,375	34,194	20,873	44,177
York	100	31,420	12,101	62,461	34,647	75,789
		88,172	33,868	185,767	114,512	237,597

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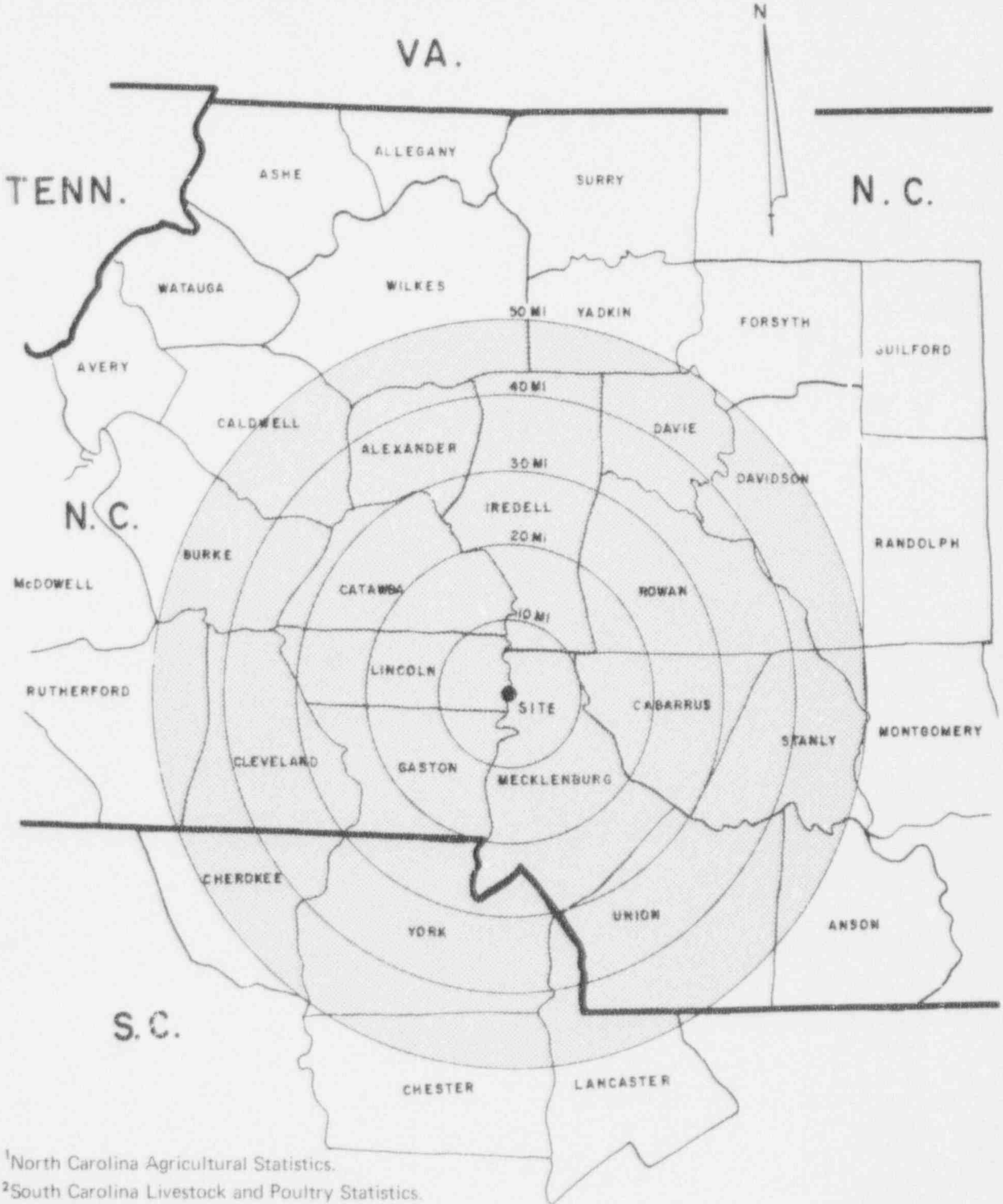
LAND USE (ACRES) WITHIN A 50 MILE RADIUS

DUKE POWER

McGUIRE NUCLEAR STATION

Figure 4.4 - 5



[1]North Carolina Agricultural Statistics.

[2]South Carolina Livestock and Poultry Statistics.

[3]Tally compiled by Professor Guy S. Parsons, Extension Dairy Husbandry Department, North Carolina State University.

[4]Denotes per cent of county area falling within the 50 mile radius.

[5]Tabulation gives the total number of milk cows for each county, although 14 counties are only partially within the 50 mile radius.

MILK COWS WITHIN A 50 MILE RADIUS[3]

[1]North Carolina - January 1, 1969

County	% Area[4]	Number
Alexander	100	2,850
Anson	16	1,700[5]
Burke	58	1,300
Cabarrus	100	3,300
Caldwell	53	1,600
Catawba	100	4,800
Cleveland	100	4,700
Davidson	58	4,050
Davie	100	5,500
Forsyth	02	2,600
Gaston	100	3,100
Iredell	100	12,150
Lincoln	100	3,150
Mecklenburg	100	3,450
Montgomery	06	900
Rowan	100	8,350
Rutherford	31	2,150
Stanly	99	3,650
Union	94	5,500
Wilkes	26	2,750
Yadkin	35	4,300
		81,850

[2]South Carolina - January 1, 1969

County	% Area[4]	Number
Cherokee	65	900[5]
Chester	28	3,400
Lancaster	29	300
York	100	2,000
		6,600

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MILK COWS WITHIN A 50 MILE RADIUS

McGUIRE NUCLEAR STATION

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STUDY IX. River Basin Studies

Job IX-C. Effects of Thermal Pollution Upon Lake Norman Fishes

William D. Adair
David J. DeMont

Fishery Biologists

Raleigh, N. C.

June, 1970

Study IX: River Basin Studies
Job IX-C: Effects of Thermal Pollution Upon Lake Norman Fishes
Period Covered: July 1, 1968 to June 30, 1970
Prepared by: William D. Adair and David J. DeMont

-SUMMARY-

A study of the effects of a heated effluent from the Marshall Steam Plant of Duke Power Company upon the fishes of Lake Norman is reported for the period January 1, 1969 to April 1, 1970. Profound differences were noted between the fish populations of the intake and discharge coves when compared to the two control coves. Seventeen of the thirty species of fishes known to occur in Lake Norman showed concurrent significant numerical differences between the discharge cove and the control coves, while ten species showed similar significant numerical differences between the intake cove and the control coves. Marked differences were noted in the reproduction of certain species when comparing the intake and discharge coves to the control coves. Fishes avoided the discharge during the late summer when dissolved oxygen concentrations were low. The warm-water discharge facilitated the overwintering of threadfin shad in the discharge cove with a consequent movement of piscivorous species into the cove in response to the abundant food supply. Fungus of the family Saprolegniaceae was noted to infest 12.5 percent of the largemouth bass taken from the discharge cove during the winter, while no fungus infestations were noted in other areas.

-INTRODUCTION-

The use of water by the electric generating industry for condenser cooling may pose a threat to the natural aquatic environment and its dependent organisms. This industry accounts for approximately 80 percent of all industrial cooling water used in the United States and, with the expected increases in electric production by both fossil-fueled and the less efficient (from a waste heat standpoint) nuclear fueled steam electric stations, the amount of heat rejection is predicted to increase almost ninefold by the year 2000 (Federal Water Pollution Control Administration, 1968).

Steam electric stations presently are discharging cooling water into several major reservoirs and rivers in North Carolina. To help evaluate the impact of these discharges upon the aquatic environment, a study was initiated in July, 1968 to investigate the effects of the heated effluent from a steam electric station upon the fishes of Lake Norman.

Lake Norman is a hydroelectric impoundment of the Catawba River located in the Piedmont region of North Carolina (Figure 1). The Lake was impounded in 1963 by the construction of Cowan's Ford Dam by Duke Power Company. It has a surface area of 32,500 acres, a maximum depth of 120 feet, and a shoreline of 520 miles at full-pool elevation of 760 feet (Geyer, et al., 1968). Annual fluctuations in water surface elevation approximate 12 feet. The lake currently supports good warm-water sport fisheries for largemouth bass, white bass, and crappies.

The study area is located near the Marshall Steam Plant of Duke Power Company. This is a base load plant which operates continuously throughout the year. Rapid changes in power generation, with associated abrupt changes in discharge volumes and discharge temperatures, are minimal.

The generating plant draws condenser cooling water from the main reservoir under an inverted skimmer wall. The wall extends from the surface to a depth of 60 feet when the lake is at full-pool elevation (Gray and Stephenson, 1968). Thus, the cooler hypolimnetic waters are utilized during the summer period of thermal stratification, an important factor in enabling this plant to be rated the most efficient (in terms of Btu/kilowatt hour) of all steam electric stations in the United States for the last four consecutive years (Edison Electric Institute, 1970).

Marshall Steam Plant employs a "once-pass" cooling system with the intake water passing through an intake cove of approximately 200 surface acres into the condenser system and then discharged via a 2,200-foot canal into a receiving cove of the lake. Retention time of the water in the intake cove, with three units operating, is approximately 30 hours.

The discharge canal and cove combined have a surface area of approximately 60 acres. The distance from the intake at the skimmer wall to the discharge structure is approximately 2.5 river miles.

Marshall Steam Plant had a three-unit nameplate generating capacity of 1,348 megawatts during most of the report period (April 15, 1969 to April 1, 1970). Average discharge volumes during this period varied from 505,000 gpm in winter to 633,000 gpm in summer with the greatest volume, 698,000 gpm, being discharged during the fall overturn.

A period (January 1, 1969 - April 14, 1969) when only two generating units were in operation also is reported. Average discharge volumes were approximately 252,000 gpm during this period. Results obtained during the periods of two- and three-unit operation were compared.

-OBJECTIVES-

The objectives of this study are to isolate and evaluate the separate effects of the increased temperatures, induced currents, and seasonally depressed dissolved oxygen concentrations caused by the cooling water discharge from the Marshall Steam Plant upon the fishes of Lake Norman, and to compare these effects with conditions concurrently found in unaffected portions of the reservoir.

-METHODS AND PROCEDURES-

Gill-Netting

Gill-nets were set at monthly intervals at sampling stations located as follows: the intake cove (#2), discharge cove (#4), upstream and downstream control coves (#1 and #6, respectively), and two main-lake stations (#3 and #5) (Figure 1). While the main-lake stations were intermittently influenced to varying degree by the discharge, both control coves were well out of any zone of influence. Physical characteristics of the control coves (such as bottom type, slope, and shoreline distances) were similar to those of the discharge cove.

Three 120-foot gill nets in bar mesh sequences of 2:1:2 inches, respectively were set in parallel at each station. The nets were checked at the end of 24 and 48 hours. This sampling technique generally provided a sample of the larger littoral zone fishes with some pelagic forms being collected.

Electrofishing

Monthly electrofishing was initiated in the discharge cove and two control coves during March, 1969. Each cove was sampled on one of three consecutive days. A Smith-Root Mark V electrofishing unit was used to produce 425 volts of pulsed D.C. current at 60 Hertz with a pulse width of 6 milliseconds.

Electrofishing operations generally were confined to the shoreline area in water less than three feet deep. This sampling technique generally yielded a sample of the small fishes of the littoral zone.

Trawling

Monthly trawling was initiated in the discharge and two control coves during August, 1969. Each cove was sampled on one of three consecutive nights at approximately the time of the new moon. The midwater trawl, composed of a 25-foot long net mounted on a 3- by 9-foot rectangular frame, could be regulated to fish as a surface tow (between the surface and a depth of four feet) or as a deep tow (between depths of eight and twelve feet). The towing speed was approximately 4.5 mph.

Both surface and deep tows were made in the two control coves and the discharge cove. Discharge cove samples were comprised of separate tows made in the discharge canal and in the receiving cove. This technique yielded a sample of the fishes, mostly shad, present in the pelagic zone.

Cove Sampling with Rotenone

Portions of the intake, discharge, and control coves were sampled with five percent emulsifiable rotenone at an estimated final concentration of 0.05 ppm rotenone on one of four consecutive days between June 2nd and 5th, and again between September 22nd and 25th of each year. The areas sampled were small coves of approximately 1.5 surface acres (Figure 1). These samples indicated the relative abundance and reproductive success of the various species of fish in each cove.

Catch Data Recorded

All fishes collected by gill nets, electrofishing, and trawling were identified, weighed, total length measured, and tagged when of appropriate size (see tagging procedure). Fishes collected from the rotenoned coves were measured to inch-class, and weighed.

Fish Tagging

A tagging study was initiated to learn about the horizontal migrations of fishes. The minimum lengths of fishes considered suitable for tagging were: game species ≥ 6.0 inches; and rough fishes ≥ 7.0 inches.

Creek Census

A creel study of the discharge canal and cove was initiated in March, 1969 to provide supplemental information concerning fish populations and fisherman usage. The census was taken each Saturday from 0800 to 2000 hours. Census data collected yielded information about the number of fishermen per day, total time fished, baits used, species sought, and size of fish caught.

Temperature and Dissolved Oxygen Determinations

Water temperatures and dissolved oxygen concentrations were determined and profiled by the Environmental Testing Section of Duke Power Company. Profiles were obtained at the end of the first 24-hour period at the offshore end of each net set. Profiles for the trawling samples were obtained on the middle day of sampling at the mouth of each cave, with an additional determination being made in the discharge canal approximately half the distance from the point of discharge to the end of the canal. Profiles also were obtained at the mouth of each cove to be sampled just prior to the application of rotenone.

Determination of Statistical Differences

To detect differences between the fish populations of the intake and discharge coves and those of the controls, a statistical comparison was made of the total number of fish obtained for each species by the different sampling techniques during the entire sampling period. This was accomplished by testing for significant differences between the expected and actual catches in the test cove (intake or discharge) as opposed to the controls. Since the same effort was expended in each cove, it was assumed that each test cove should produce 33 percent of the total number recovered from all three coves (test cove plus two controls). The actual percentage contributed to the total by the test cove was compared to 33 percent in the binomial tables at the 95 percent level of confidence.

A similar test was used to provide a month-to-month comparison between the discharge cove and each control cove using monthly totals from each sampling technique. Since the discharge cove was compared to each control cove individually, the actual percentage of the total number of each species contributed by the discharge cove was compared to 50 percent in the binomial tables. Again, the 95 percent level of confidence was used.

-RESULTS AND DISCUSSION-

Species Composition and Variation

A total of 30 species of fishes representing 10 families have been collected since the project was initiated (Table 1). Computation of the total number of species caught in each cove by the various sampling techniques disclosed that both the discharge cove and the upstream control cove yielded the greatest number of species -- 29 (Table 2). Thus, the discharge cove yielded at some time during the sampling period the total complement of species found in the lake except the mosquitofish. This rarely caught species was also not collected in the downstream control cove. Only one blue catfish, the only species not caught in the upstream control cove was collected during the sampling period -- it was netted in the discharge cove.

The downstream control cove yielded a total of 24 species. The intake cove yielded the fewest number of species (23) but this cove was sampled only with gill nets and rotenone.

The total number of species caught per gill-net sample was chosen as an indicator of the monthly species variation between coves because of the sustained use of gill-nets throughout the sampling period and the large number of species obtained (Figure 2). The discharge gill-net station consistently yielded the greatest number of species of any cove during the entire sampling period except for the September and October samples. Although the intake cove usually yielded fewer species than the discharge cove, its seasonal fluctuation in numbers of species generally corresponded with that of the control coves.

Both discharge cove and intake cove populations were found to differ markedly from the two control cove populations when the results of statistical comparisons were compiled (Table 3). The conclusions reached for each species in Table 3 are necessarily based upon subjective decisions. For example: there was strong evidence that yellow perch were present in significantly greater numbers in the discharge cove than in the control coves considering the fact that that species was caught in significantly greater numbers with three out of the four sampling techniques. In addition, the technique (trawling) which noted no significant difference yielded a total of only seven individuals. Based on this information, the conclusion was made that significantly more yellow perch were in the discharge cove then in the control coves (Table 3).

Even though no Moxostoma spp. were collected by trawling and no significant difference was noted between the discharge cove electrofishing and rotenone samples, the significant difference noted in gill-net results determined the final decision of significance. Because the gill-net samples produced substantially more Moxostoma spp. than the rotenone and electrofishing samples combined, and because a significant variation was found in the gill-net sample, the conclusion was made that there was a significantly smaller population of Moxostoma spp. in the discharge cove than in the control coves (Table 3).

Furthermore, a significant difference between coves caused by large numbers of recently spawned fish was not considered to be a true indicator of the fish population. Thus, even though a significant variation was noted for black bullheads and largemouth bass collected in the intake cove by rotenone, the conclusion of no significant variation was reached considering the large number of recently spawned fish involved in that determination (Table 3).

As a result of the interpretation of various test results, it was concluded that 17 species (56.7 percent) of the 30 species present in the lake showed significant numerical differences between the discharge and the control coves (Table 3). Eleven species were found in significantly greater numbers in the discharge cove than in the control coves. These were as follows: (1) forage fishes -- gizzard shad, threadfin shad, golden shiner and satinfin shiner; (2) game fishes -- largemouth bass, striped bass, white bass and yellow perch; and (3) rough fishes -- carp, longnose gar, and white catfish.

Six species were caught in the discharge cove in significantly lesser numbers than in the controls. These were: (1) a forage fish -- Johnny darter; (2) game fishes -- bluegill, black crappie, white crappie, and redbreast sunfish; and (3) a rough fish -- Moxostoma sp.

Furthermore, ten species of the thirty species in the lake displayed significant numerical differences between the intake cove population and the controls. Three species were found in significantly greater numbers: (1) a forage fish -- golden shiner; and (2) rough fishes -- carp and white catfish. Seven species were found in significantly lesser numbers: (1) game fishes -- white bass, bluegill, black crappie, white crappie, redbreast sunfish, and warmouth; and (2) a rough fish -- Moxostoma sp.

Eight species were found to be in either significantly greater or lesser numbers in both the intake and discharge coves than in the controls. Found in significantly greater numbers were: golden shiner, carp, and white catfish; found in significantly lesser numbers were: bluegill, black crappie, white crappie, redbreast sunfish, and Moxostoma spp.

The definite differences noted between the populations of the four coves was not constant throughout the sampling period. Results of the monthly statistical comparisons between the catch in the discharge cove and each control cove noted periodic differences in the cove populations (Table 4). An attempt at explaining these differences and other notable occurrances will now be discussed in chronological order beginning with the start of the three-unit operation and continuing through an annual cycle. Months in the following headings denote general, rather than precise, time periods.

April (Reproduction)

All observations concerning reproduction will be presented in this section. Marked differences were noted in the reproduction of certain species when comparing the intake and/or discharge coves to the control coves.

Spawning by a clupeid fish occured in the discharge cove in April and May 1969. Eggs were observed most numerous near the point of discharge adhering to the discharge structure and to rocks and vegetation lining the discharge canal. The eggs became less numerous as the distance from the structure increased. While most were covered to varying degrees with fly ash and/or pollen, the eggs were found viable. They hatched in the laboratory in 2 to 24 hours at a temperature of 72°F. A reconnaissance of both control coves at that time revealed similar eggs, although not nearly so numerous as found in the discharge cove.

Similarly, on February 21, 1970 a small number of eggs were observed in the discharge canal. It is believed that this marked the onset of a spawn similar to that noted in 1969. Soon after this date, however, circulating pump tests for the new generating unit caused increased discharge volumes and decreased temperatures in the discharge canal. Spawning apparently stopped as a result of these discharges since no further observations of eggs were made during the sampling period.

Concurrently, the large schools of threadfin shad present in the discharge canal just prior to the February pump tests were not observed following the tests. In support of this observation, only 1.7 threadfin shad per minute were collected by trawling in the discharge in early March, 1970 compared to 87.2 threadfin shad per minute collected in early February. Threadfin shad did not emigrate from the discharge cove until early April the preceeding year.

In response to the higher water temperatures, largemouth bass spawned earlier in the region of the discharge cove than in the control coves. This conclusion is supported by the observation of numerous young-of-year largemouth bass in the discharge canal and cove in mid-April, 1969, while none were found in either control until mid-May. A standard "t"-test applied to data obtained from young-of-year largemouth bass collected during the May electrofishing sample showed discharge cove fish to be significantly larger (at the 99 percent confidence level) larger both in length and weight than those concurrently collected from the upstream control cove.

Early spawning of largemouth bass was further indicated by results from the June, 1969 rotenone cove samples in which largemouth bass in the two- and three-inch classes were collected in the discharge cove while no largemouth bass of these size classes were collected in either control cove (Figure 3).

Largemouth bass spawned later in the intake cove compared to the discharge and control coves during the periods of both two- and three-unit operations; this presumably in response to the slower rise in water temperature of the intake cove. Length-frequency data from rotenone samples disclosed that no one-inch largemouth bass were collected in the intake cove in June, 1969, while fish of this size class were collected from the other coves sampled (Figure 3). Also, largemouth bass from the one-inch class were collected from the intake cove in both September 1968 and 1969, whereas all fishes collected from the other coves sampled then were of larger size classes (Figure 3).

Yellow perch spawned earlier in the downstream control cove, and somewhat later in the discharge cove and upstream control cove, during 1969. This is indicated by the length-frequency rotenone data for June 1969 in which yellow perch had already grown to the two-inch class in dhe downstream control cove while they were still within the one-inch class in the discharge and upstream control coves (Figure 4).

Yellow perch either did not spawn, or spawned unsuccessfully, in the intake cove as indicated by the absence of one- and two-inch fish in the June, 1969 rotenone sample (Figure 4). Substantial immigration of yellow perch into the intake cove is indicated by the large number of two-inch individuals obtained in September, 1969 during three-unit operation, while no immigration apparently occurred in 1968 during two-unit operation (Figure 4).

Late spawning of bluegill in the discharge cove was disclosed by length-frequency data from the spring and fall, 1969 rotenone cove samples (Figure 5). Poor representation in the smaller size categories in the fall, 1969 intake cove sample disclosed that either no spawning, or an unsuccessful spawn, of bluegills occurred that year.

A pair of flathead catfish preparing to spawn were collected in the discharge rotenone cove during the June, 1969 sample.

May (Observations During Periods of Similar Temperatures in Discharge and Control Coves)

Water temperatures were similar (62.8°F. - 66.0°F.) in the discharge and control coves in May, 1969. During this period, the greatest number of species was caught at the discharge and upstream control cove gill-net stations, while the downstream control cove yielded but one species less than its greatest number (Figure 2). Even though the May sample yielded the greatest number of fishes caught during the entire sampling period, the only significant difference noted was that gizzard shad were more abundant in the upstream control cove compared to the discharge cove (Table 4).

In March, 1970, when water temperatures were again similar (53.1°F. - 57.9°F.), the number of species caught at the discharge cove and control cove gill-net stations once more reached its peak (Figure 2). The only significant difference noted from this sample was that Moxostoma spp. were more abundant in the downstream control compared to the discharge cove (Table 4).

Although little significant variation was noted between any gill-net catches in March, 1970, both electrofishing and trawling samples from the discharge cove yielded significantly more threadfin shad, gizzard shad, golden shiners, bluegill, and yellow perch than those from either control cove (Table 4).

Apparently caused by the slower increase in water temperatures, the number of species caught at the intake gill-net station during May, 1969 and March, 1970 lagged behind the increase noted for the discharge and control coves (Figure 2). Surface water temperatures in the intake cove were 51.6°F. in May, 60.1°F. in June, 1969, and only 45.0°F. in March, 1970.

June and July (Similar Temperatures in Control and Discharge Coves with Decreasing Dissolved Oxygen Concentrations in Discharge)

Temperature profiles for the discharge and control coves were similar during the months of June and July, 1969. The surface water temperature varied from 76.1°F. to 76.6°F. in early June and from 85.2°F. to 87.5°F. in early July. The only significant variation noted from gill-net samples taken during this period was that a significantly greater number of gizzard shad was caught in the discharge cove than in the control coves during June (Table 4).

A substantial difference did exist, however, between the fish populations of the upstream control cove and the discharge cove as noted in the June rotenone samples. Significantly more centrarchids were collected in the upstream control cove, while significantly more yellow perch and white bass were collected in the discharge cove (Table 4). The variation noted between the downstream control cove and the discharge cove was comparatively small, with significantly more bluegill being collected in the downstream control cove.

It should be noted that while the dissolved oxygen concentrations in the control coves were near 100 percent saturation, values of approximately 50 percent saturation were recorded in the discharge cove. The highest dissolved oxygen concentration recorded in the discharge cove just prior to rotenone application was 4.7 ppm.

August to Mid-September (Low Dissolved Oxygen Concentrations in the Intake and Discharge Coves)

As a result of thermal stratification, the dissolved oxygen concentrations of hypolimnetic water drawn into the intake cove were below the 10 percent of saturation in early August, 1969. The highest concentration noted at the intake gill-net station was 0.8 ppm at the surface at a temperature of 65.7°F. Concurrent determinations made at the two control coves yielded dissolved oxygen concentrations ranging from 80, to over 100, percent saturation. During this period of low dissolved oxygen concentrations the intake gill-nets yielded ten species of fishes, the same number as both control coves, and numerically more fishes than either the upstream or downstream control coves (Figure 2). The only significant numerical variation noted was that the intake cove yielded significantly more yellow perch than either control cove.

The discharge net station was not influenced by the effluent containing low dissolved oxygen concentrations since temperature and dissolved oxygen profiles obtained were almost identical to those of the control coves. The plant's discharge plume at that time apparently was hugging the opposite shore of the cove. Under these conditions, the discharge cove yielded the greatest: species variation; total number of fishes; and total weight of fishes of any net station for that sampling period.

By late August all water in the discharge canal contained extremely low dissolved oxygen concentrations (0.3 - 0.4 ppm), while water in the receiving cove contained somewhat higher concentrations (1.1 - 4.5 ppm). Concurrent electrofishing and trawling data indicated that fish were avoiding the discharge canal during this period. Only three fish (threadfin shad) were collected by electrofishing in the discharge canal, while 160 fishes -- representing 11 species -- were collected in the receiving cove. Only two white catfish and one threadfin shad were caught in the discharge canal by trawling, while 37 fishes -- representing five species -- were caught in the receiving cove with identical effort.

Dissolved oxygen concentrations still were quite low at both the intake (1.1 - 1.7 ppm) and discharge (1.1 - 3.5 ppm) gill-net stations during the September sample although the fall overturn had begun. Under these conditions both the intake and discharge net stations, uniquely, yielded fewer species than either control cove (Figure 2). Moreover, the decrease in number of species caught in both the intake and discharge coves coincided with an increase in number of species caught in both control coves (Figure 2). Also, the discharge gill-nets yielded fewer fishes than did either control cove, while the intake cove gill-nets yielded more fishes than either control cove (yellow perch and carp comprised 82.4 percent of the intake cove catch). These results are in complete agreement with those obtained during the earlier period of two-unit operation wherein the species variation in the discharge cove was minimum when the dissolved oxygen concentrations were the lowest.

The catch rates determined from creel census data also reached a low point during this period of low dissolved oxygen concentrations. The catch rates were 0.12 and 0.11 fish per hour of effort in August and September, respectively. On three census days (August 23, 30, and September 20), the catch dropped to zero.

Tagging data indicated that a carp migrated underneath the skimmer wall into the intake cove during the period when the dissolved oxygen concentrations were near zero.

Mid-September to Mid-October (Fall Overturn -- Increase in Both Temperature and Dissolved Oxygen Concentrations in the Discharge Cove)

An increase in both temperature and dissolved oxygen concentrations developed in both the intake and discharge cove waters with the fall overturn. The highest water temperature recorded at the point of discharge was 92.0°F. and it occurred on October 3, 1969; the dissolved oxygen concentration at that temperature was 3.5 ppm. This high temperature discharge was of short duration and affected only the immediate area of the discharge structure (for example, the maximum temperature obtained at the point of discharge only one week later on October 10, 1969 was 89°F.) Although the 92.0°F. temperature noted is above the recommended maximum for the growth of largemouth bass, bluegill, and crappie (National Technical Advisory Committee, 1968), no detrimental affects on the fish population were noted.

In fact, in response to the increased dissolved oxygen concentrations and the discharge current (Calhoun, 1969), an almost immediate influx of fishes, principally threadfin shad, developed into the discharge cove and the region of the discharge structure. These observations were confirmed by the electrofishing sample of October 1 when large numbers of threadfin shad were collected. Despite the large numbers of threadfin shad, however, the over-all catch rate by electrofishing in the discharge cove (0.86 fish per minute) was substantially less than that for either the upstream or the downstream control coves (2.0 fish and 2.1 fish per minute, respectively).

Although the discharge gill-net sample again yielded a low number of species in October, an increase in the catch of white bass and longnose gar was noted (Figure 2). Results of rotenone samples taken at the time of overturn revealed that significantly greater numbers of threadfin shad, satinfin shiners, yellow perch, and carp were taken in the discharge cove than in either control cove (Table 4). Also, the creel census catch rate increased to 0.50 fish per fisherman-hour (Figure 6).

These results concur with observations made during two-unit operations of the previous year when threadfin shad and piscivorous species migrated into the discharge cove soon after the onset of the fall overturn.

With the increase in dissolved oxygen concentrations, the intake gill-net station exhibited an abrupt increase in the number of species caught as illustrated by the October sample in comparison with the September sample (Figure 2).

Mid-September through November (Decreasing Ambient Water Temperatures)

A period of steadily decreasing ambient water temperatures occurred following the completion of the fall overturn. Following the initial influx of threadfin shad into the discharge cove during the overturn, a numerical decline then occurred. As noted in the trawling data, the catch per minute declined from a high of 8.7 in September to 1.5 in November.

In contrast, the creel data noted a sharp increase in the catch rate from its lowest point in September to its highest point (0.89 fish per hour of effort) during November (Figure 6). A great number (194) of the fish caught by anglers in the discharge cove were white bass.

December through February (High Discharge Temperatures and Low Ambient Temperatures)

With a continuing decrease in ambient water temperatures, threadfin shad again migrated into the discharge cove. The December trawling sample produced substantially more threadfin shad (9.5 fish per minute) in the discharge cove than were collected the previous month. This catch rate was also substantially higher than the December catch rate of either control cove. At the time of the December samples, the highest water temperature recorded at the point of discharge was 72.0°F. while those of the upstream and downstream control coves were 47.2°F. and 51.8°F. respectively.

With an even further decrease in ambient water temperatures to approximately 40°F. in late December, a massive migration of threadfin shad into the discharge cove (especially into the area of the discharge structure and the discharge canal) was noted. The trawling sample in the discharge cove on January 8th yielded the highest catch rate (432.7 threadfin shad per minute) for the entire sampling period.

A winterkill of threadfin shad occurred in other portions of the lake, including the control coves, in late December and January. This kill was so extensive in the intake cove that the generating plant's cooling water was threatened from the dead and dying threadfin shad clogging the intake screens.

Temperature profiles taken during the time of the kill (January 21, 1970) revealed essentially isothermal conditions in the main lake at 38.8°F., while the temperature at the point of discharge was 67.0°F. The surface temperature at the mouth of the discharge cove on that date was 58.0°F.

The temperature susceptibility of threadfin shad is apparently a major factor limiting populations outside its natural range (Domrose, 1963). Water temperatures below 41°F. usually are fatal (Parsons et al., 1954; Strawn, 1965) although it has been recorded that threadfin shad can successfully overwinter in a heated effluent (Dryer et al., 1957).

Thus, the massive migration and subsequently successful overwintering of this species in the discharge cove was facilitated by the increased discharge water temperatures. These results agree completely with those obtained under the two-unit operation the previous year.

Results of both trawling and electrofishing during January and February indicated that very small numbers, at best, of threadfin shad overwintered in the control coves. However, in lieu of the fact that this species maintains a continuing population only in North Carolina lakes having electric steam stations (McNaughton, 1967), it seems apparent that the fish overwintering in the discharge cove serve as the major spawning stock for the entire lake.

In response to the abundant supply of threadfin shad, and possibly because water temperatures were much nearer their optimum (Federal Water Pollution Control Administration, 1968), numerous piscivorous species also were collected in the discharge cove during the December, 1969 to February 1970 period. By January, although the creel catch rate was declining, a substantial increase in the discharge cove catch by all other sampling methods was noted. Along with the increase in threadfin shad already noted from trawling, the discharge cove yielded the greatest number of species (6) recorded for trawling during the entire sampling period. The discharge gill-net station yielded 11 species and 199 fishes, while the downstream control cove yielded only two fish -- both golden shiners. Ice cover prevented gill-netting in the upstream control cove in January. Although fewer fishes were caught, more species were obtained in the discharge electrofishing sample (10) than were collected from the two control coves (7).

Stomach analysis of predator species acquired from the discharge cove during the winter revealed an almost exclusive fish diet, with all but one of the identifiable fish remains being that of threadfin shad.

Tagging data indicated that white bass make feeding excursions into the discharge cove. Temperature profiles showed that these fish apparently moved freely from discharge cove temperatures of at least 60.0°F., to ambient temperatures of less than 45.0°F.

Fungal Infestation of Fishes in the Discharge Cove

During the sampling period, some largemouth bass, bluegill, white bass, and white crappie collected in the discharge cove were found to be infected with a fungus of the family Saprolegniaceae. Although this fungus is widespread geographically (Hoffman, 1967), no fishes exhibiting fungus infections have been collected from other areas of the lake to date. As noted in results of the electrofishing data, the incidence of infestation reached a considerable magnitude in largemouth bass during the winter (Table 5).

Tagging

As of the end of this study period, a total of 1,345 fishes have been tagged, with a return rate of 4.4 percent. Except for the migration of white bass already noted into, and out of, the discharge cove in winter, little movement of tagged fish from the point of release has been detected.

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-CONCLUSIONS-

1. The heated effluent had a profound effect upon the fish population present in the discharge canal and receiving cove. This was illustrated by the significant numerical differences noted for numerous species when comparing the discharge cove and control cove populations.

2. The variation noted between the populations of the intake and discharge coves compared to the control coves was not constant, but showed periodic differences in response to changes in temperature, dissolved oxygen concentrations, and current.

3. Spawning did occur in the discharge canal and cove. Due to water temperature differences, however, spawning by certain species did not occur at the same time in the discharge cove as in the control cove.

4. Due to a slower rise in water temperature, certain species spawned later in the intake cove than in the control coves. Some species either did not spawn, or spawned unsuccessfully, in the intake cove.

5. While fishes did survive in the intake cove during periods of extremely low dissolved oxygen concentrations, an almost complete avoidance of the discharge water of low dissolved oxygen concentrations was evident.

6. No detrimental effects upon fishes were noted during the short period when discharge temperatures were the highest (92.0°F.).

7. The discharge current did stimulate some migration of threadfin shad into the discharge canal. Higher discharge temperatures compared to ambient temperatures, however, was the cause of a massive migration of threadfin shad into the discharge canal and cove during the early winter. These higher temperatures facilitated the overwintering of threadfin shad in the discharge cove.

8. Piscivorous species migrated into the discharge cove during the winter to feed upon the abundant forage, and possibly partially in response to the temperatures being nearer to their optimum.

9. The heated discharge did facilitate a higher incidence of fungus infestations in certain species during the winter.

-RECOMMENDATIONS-

1. Continue the project as currently documented, to evaluate the difference, if any, between a three- and four-generating unit operation.

2. Intensify investigation of the fish populations in the discharge canal and receiving cove particularly as they relate to prevailing temperatures and dissolved oxygen concentrations. Investigate more thoroughly the species present in the intake cove as they relate to low dissolved oxygen concentrations.

3. Identify all species which reproduce in the discharge cove, as well as the effects of the warmer discharge upon their eggs and fry.

4. Determine the response of various fish species when exposed to the discharges containing low concentrations of dissolved oxygen.

5. Intensify the study of fish diseases and parasites as they relate to the warmer discharge waters.

Table 1

Common and scientific names of fishes collected from Lake Norman, North Carolina, July 1, 1968 - April 1, 1970.

Longnose gar	Lepisosteus osseus (Linnaeus)
Gizzard shad	Dorosoma cepedianum (LeSueur)
Threadfin shad	Dorosoma petenense (Gunther)
Carp	Cyprinus carpio (Linnaeus)
Golden shiner	Notemigonus chrysoleucas (Mitchill)
Satinfin shiner	Notropis analostanus (Girard)
Greenfin shiner	Notropis chloristius (Jordan and Brayton)
Redhorse suckers	Moxostomus spp.
Quillback	Carpiodes cyprinus (LeSueur)
White sucker	Catostomus commersoni (Lacepede)
Flathead catfish	Pylodictis olivaris (Rafinesque)
Channel catfish	Ictalurus punctatus (Rafinesque)
White catfish	Ictalurus catus (Linnaeus)
Blue catfish	Ictalurus furcatus (LeSueur)
Yellow bullhead	Ictalurus natalis (LeSueur)
Brown bullhead	Ictalurus nebulosus (LeSueur)
Black bullhead	Ictalurus melas (Rafinesque)
Flat bullhead	Ictalurus platycephalus (Girard)
Mosquitofish	Gambusia affinis (Baird and Girard)
Striped bass	Roccus saxatilus (Walbaum)
White bass	Roccus chrysops (Rafinesque)
Largemouth bass	Micropterus salmoides (Lacepede)
Warmouth	Chaenobryttus gulosus (Curier)
Pumpkinseed	Lepomis gibbosus (Linnaeus)
Redbreast sunfish	Lepomis auritus (Linnaeus)
Bluegill	Lepomis macrochirus (Rafinesque)
Black crappie	Pomoxis nigromaculatus (LeSueur)
White crappie	Pomoxis annularis (Rafinesque)
Yellow perch	Perca flavescens (Mitchill)
Johnny darter	Etheostoma nigrum (Rafinesque)

Table 2

List of the species known to occur in Lake Norman that were not collected in one or more coves sampled by the various sampling techniques during the period January 1, 1969 - April 1, 1970.1/ All other species known to occur in the lake were caught in all coves.

Species	Upstream Control	Intake Cove	Discharge Cove	Downstream Control
Black bullhead	+	+	+	-
Blue catfish	-	-	+	-
Channel catfish	+	-	+	+
Flathead catfish	+	-	+	-
Greenfin shiner	+	-	+	+
Johnny darter	+	-	+	+
Longnose gar	+	-	+	-
Mosquitofish	+	+	-	-
Satinfin shiner	+	-	+	+
Striped bass	+	+	+	-

1/ A plus (+) indicates that the species was caught, while a minus (-) indicates that the species was not caught.

Table 3

Statistical significance of numerical differences noted for each species between the test cove (intake or discharge) compared to the combined control cove data for each sampling technique during the period January 1, 1969 to April 1, 1970.

	Species	Longnose gar	Gizzard shad	Threadfin shad	Carp	Golden shiner	Satinfin shiner	Greenfin shiner	Moxostoma spp.	Quillback	White sucker	Flathead catfish	Channel catfish	White catfish	Blue catfish	Yellow bullhead	Brown bullhead	Black bullhead	Flat bullhead	Mosquitofish	Striped bass	White bass	Largemouth bass	Warmouth	Pumpkinseed	Redbreast sunfish	Bluegill	Black crappie	White crappie	Yellow perch	Johnny darter
Intake Cove	Gill Net	0	-	-	+	0	Ø	Ø	-	0	0	Ø	0	+	0	0	0	0	+	Ø	0	-	0	0	Ø	-	0	-	-	+	Ø
	Rotenone	Ø	+	+	+	+	0	Ø	0	Ø	0	0	0	0	Ø	0	0	+	-	0	0	0	-	-	0	-	-	-	-	-	0
	Conclusion 1/	0	0	0	+	+	0	Ø	-	0	0	0	0	+	0	0	0	0	0	0	0	-	0	-	0	-	-	-	-	0	0
Discharge Cove	Electrofish	0	+	NA	-	+	-	0	0	0	Ø	0	Ø	0	Ø	0	Ø	0	0	0	Ø	0	0	0	0	-	0	-	0	+	-
	Gill Net	+	+	+	+	0	Ø	Ø	-	0	0	Ø	0	+	0	0	0	0	0	Ø	+	+	+	0	Ø	0	0	0	0	+	Ø
	Rotenone	Ø	-	+	+	0	+	Ø	0	0	0	0	0	0	Ø	0	0	0	0	0	0	0	-	-	0	-	-	-	-	+	0
	Trawling	0	+	+	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	0	Ø	Ø	Ø	Ø	Ø	Ø	Ø	0	0	Ø	Ø	Ø	Ø	-	-	0	Ø
	Conclusion 1/	+	+	+	+	+	+	0	-	0	0	0	0	+	0	0	0	0	0	0	+	+	+	0	0	-	-	-	-	+	-

Key:
- \+ Significantly more fish.
- \- Significantly fewer fish.
- 0 No numerically significant difference.
- Ø No fish caught by the sampling technique noted.
- N. A. Not applicable (fish caught by the technique not recorded).

1/ The conclusion for each species is subjective rather than arithmetic.

Table 4

Significant monthly differences, by species, between coves as noted by the various sampling techniques. 1 & 2/

Month	Upstream Control	Discharge Cove	Downstream Control
Jan., 1969	-	Gizzard shad (n) Yellow perch (n)	-
March	Bluegill (e) Largemouth bass (e) Redbreast sunfish (e)	White bass (n) Yellow perch (e)	Redbreast sunfish (e)
April	Redbreast sunfish (e)	Bluegill (e) Carp (e) Gizzard shad (e) Largemouth bass (e) Yellow perch (e)	-
May	Gizzard shad (n)	-	-
June	Bluegill (r) Black crappie (r) Gizzard shad (r) Largemouth bass (r) Redbreast sunfish (r) Warmouth (r) White crappie (r)	Gizzard shad (n) Yellow perch (r) White bass (r)	Bluegill (r)
July	-	Yellow perch (e)	-
Aug.	Threadfin shad (t)	Gizzard shad (n) (e) Threadfin shad (n) Yellow perch (e)	Threadfin shad (t)
Sept.	Redbreast sunfish (e,r) Gizzard shad (r)	Carp (r) Satinfin shiner (r) Threadfin shad (t,r) Yellow perch (r)	-
Oct.	Gizzard shad (n) Johnny darter (e) Redbreast sunfish (e) Threadfin shad (t)	-	Bluegill (e) Redbreast sunfish (e) Satinfin shiner (e)
Nov.	Johnny darter (e) Redbreast sunfish (e) Warmouth (e)	-	Redbreast sunfish (e)
Dec.	Bluegill (e) Gizzard shad (e) Redbreast sunfish (e) Satinfin shiner (e)	Threadfin shad (t)	Satinfin shiner (e)
Jan. 1970	Gizzard shad (e)	Gizzard shad (n,t) Threadfin shad (t) White bass (n) Yellow perch (n)	Satinfin shiner (e)
Feb.	Bluegill (e) Largemouth bass (e)	Gizzard shad (n) Threadfin shad (t) White bass (n) White catfish (n) Yellow perch (n,e)	-
March	-	Bluegill (e) Gizzard shad (e) Golden shiner (e) Threadfin shad (t) Yellow perch (e)	*Moxostoma spp* (n)

1/ Species listed in the discharge cove were caught in significantly greater numbers than in either control, while species listed in a control were caught in significantly greater numbers in that cove compared to the discharge cove.

2/ The sampling techniques which yielded the significant differences are noted as follows: (e) electrofishing, (n) gill nets, (r) rotenone cove samples, and (t) trawling.

Table 5

The incidence of fungus (Saprolegniaceae) infections observed on fishes collected by electrofishing in the discharge cove of the Marshall Steam Plant, Lake Norman, March, 1969 - February, 1970.

	Largemouth bass		
Season	Number Caught	Number Infected	Infestation Rate
Fall (Sept. - Nov.)	32	0	0.0%
Winter (Dec. - Feb.)	24	3	12.5%
Spring (March - May)	62	2	3.2%
Summer (June - Aug.)	42	0	0.0%
Totals	160	5	3.2%
	Bluegill		
Fall (Sept. - Nov.)	82	0	0.0%
Winter (Dec. - Feb.)	78	1	1.3%
Spring (March - May)	326	1	0.3%
Summer (June - Aug.)	49	0	0.0%
Totals	535	2	0.4%

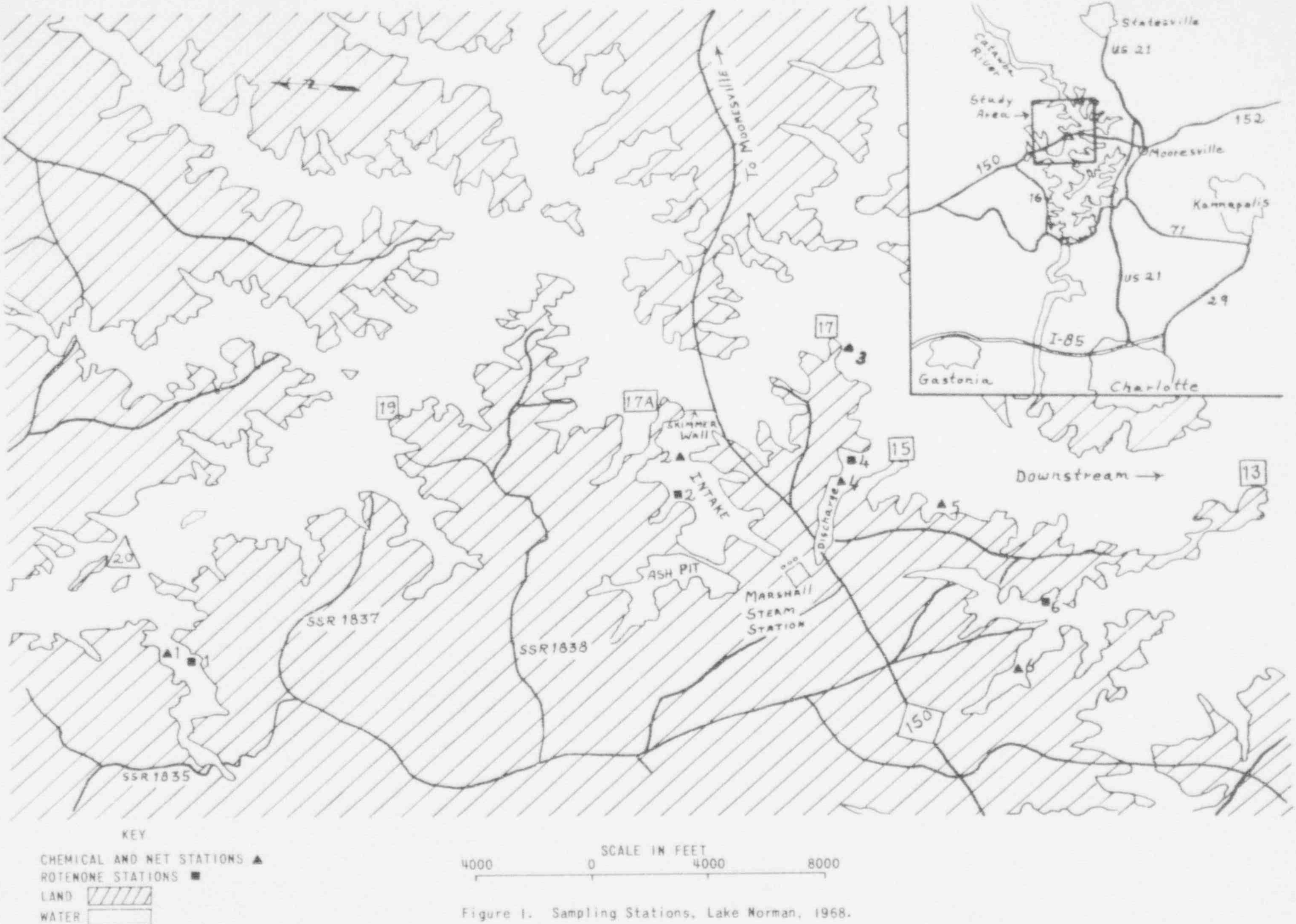

Figure 1. Sampling Stations, Lake Norman, 1968.

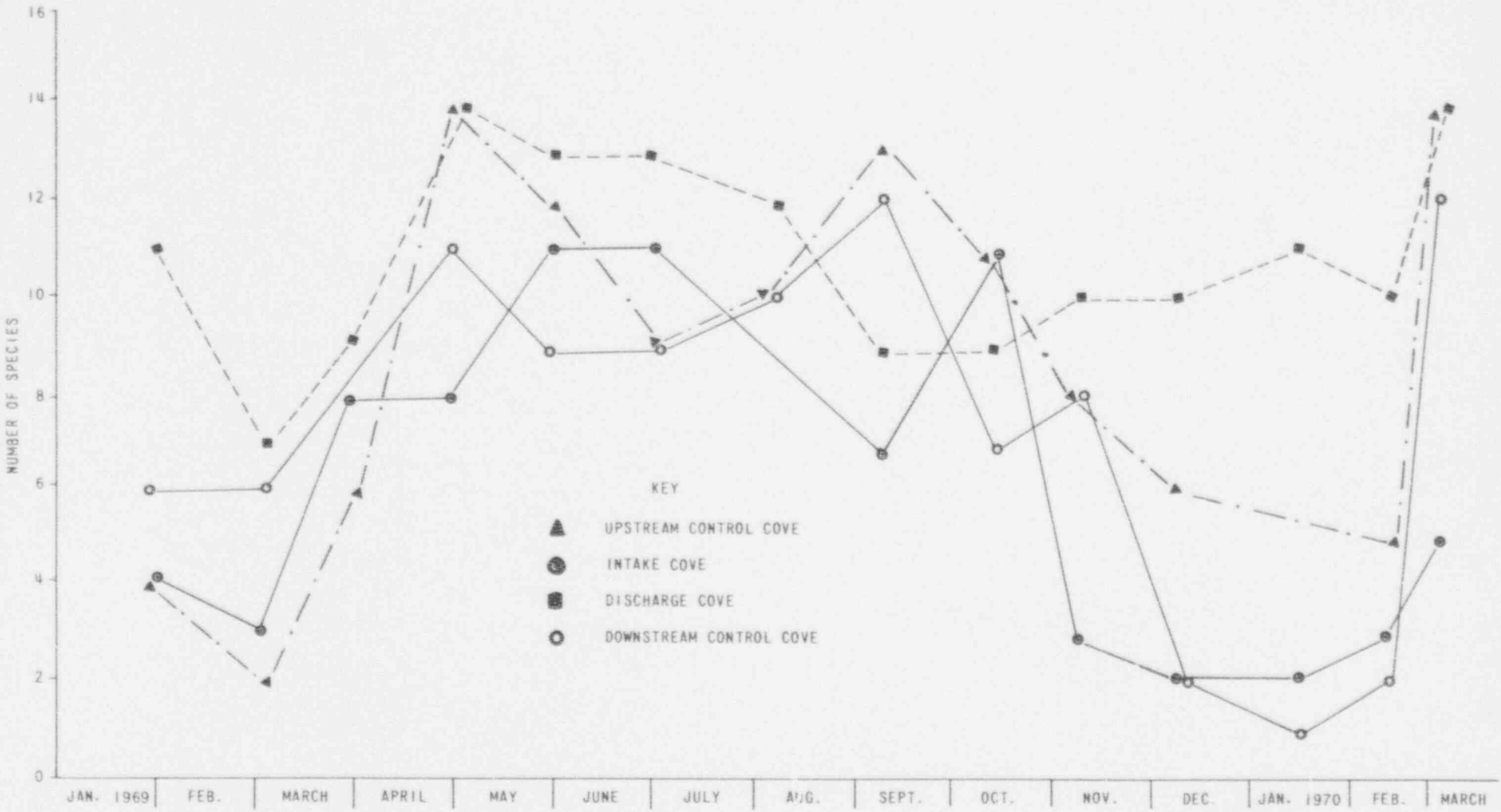

FIGURE 2. Number of Species Caught at Each Cove from Monthly Gill Net Samples, Lake Norman, January 1, 1969 - April 1, 1970.

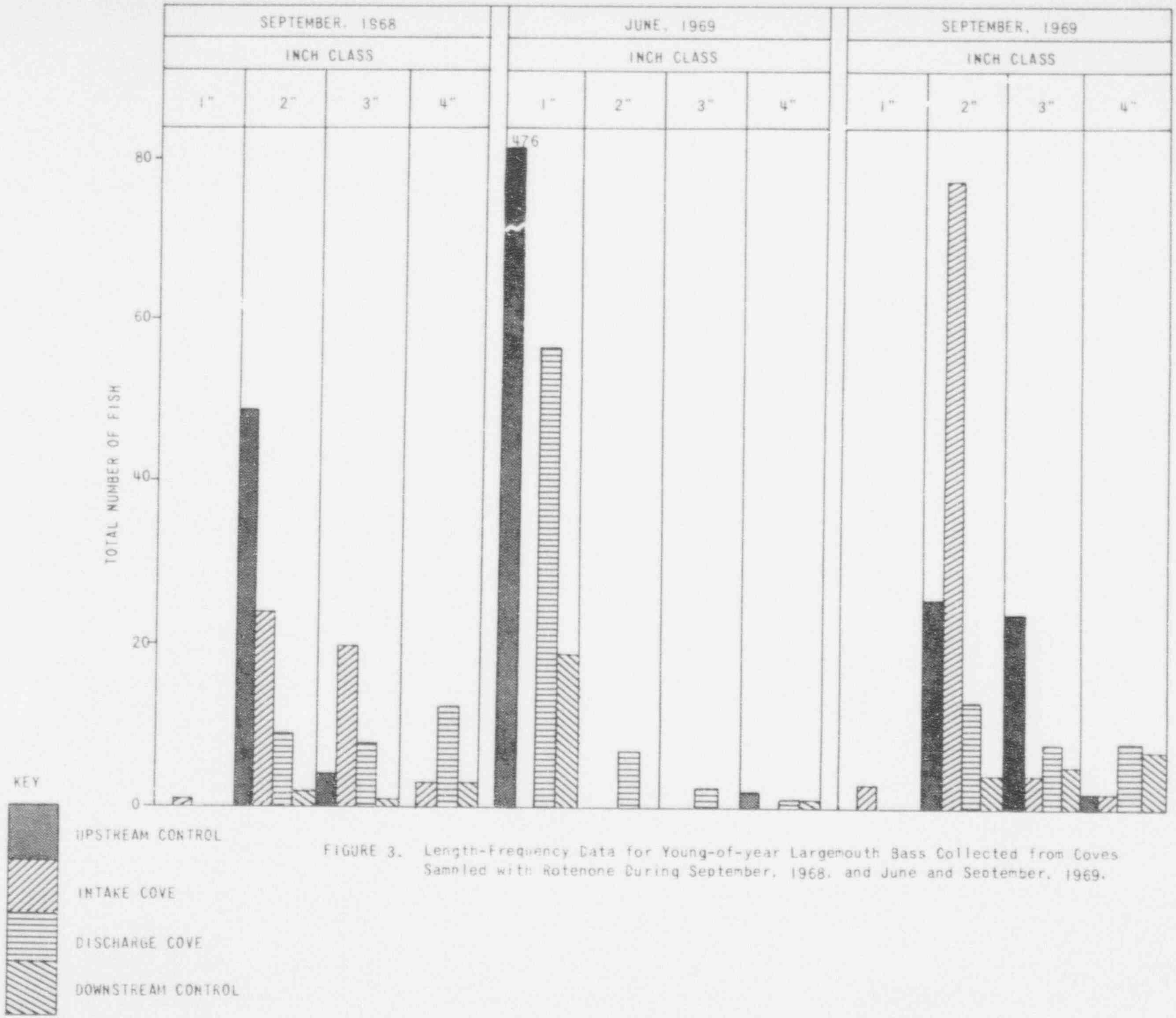

FIGURE 3. Length-Frequency Data for Young-of-year Largemouth Bass Collected from Coves Sampled with Rotenone During September, 1968, and June and September, 1969.

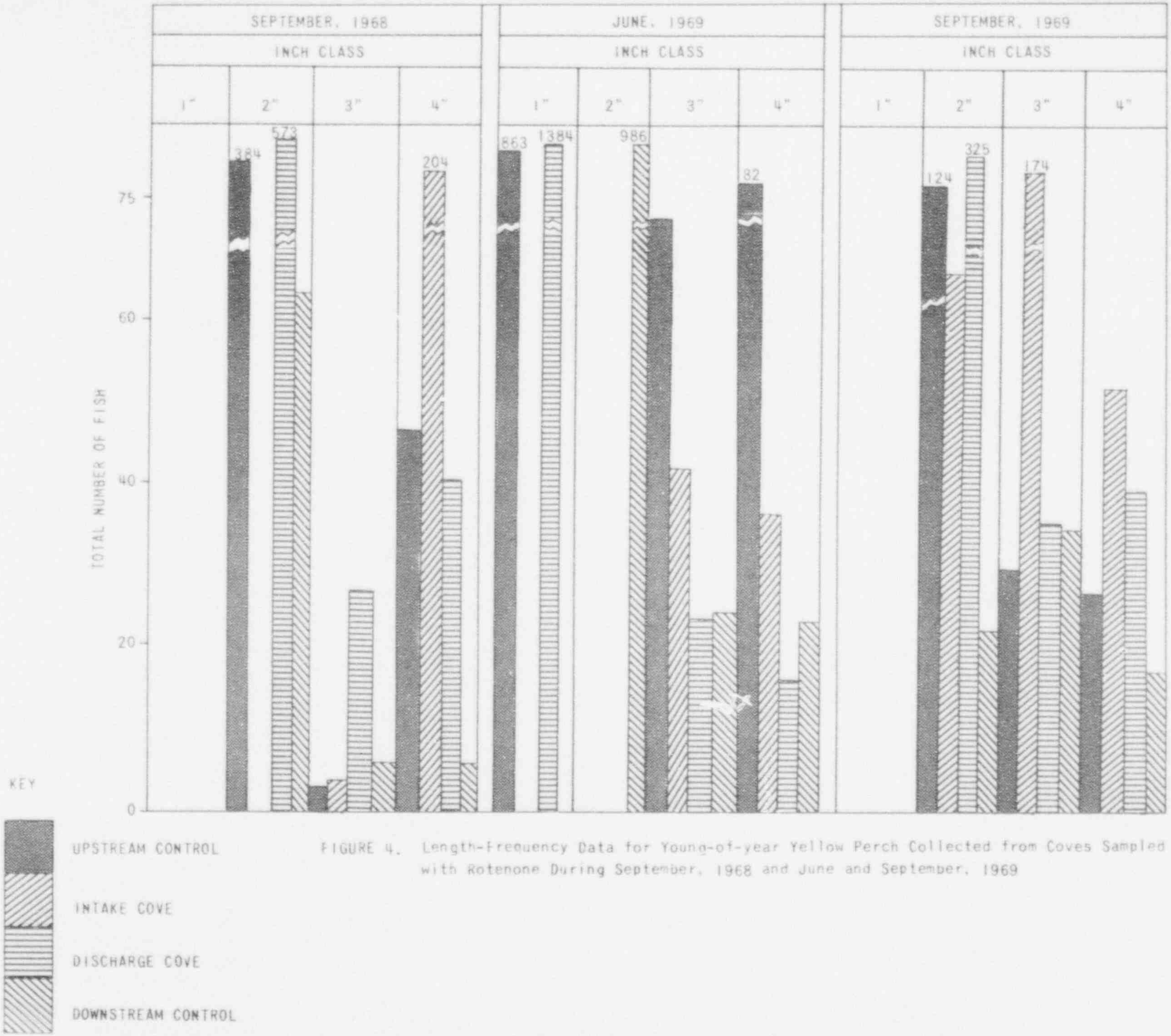

FIGURE 4. Length-Frequency Data for Young-of-year Yellow Perch Collected from Coves Sampled with Rotenone During September, 1968 and June and September, 1969

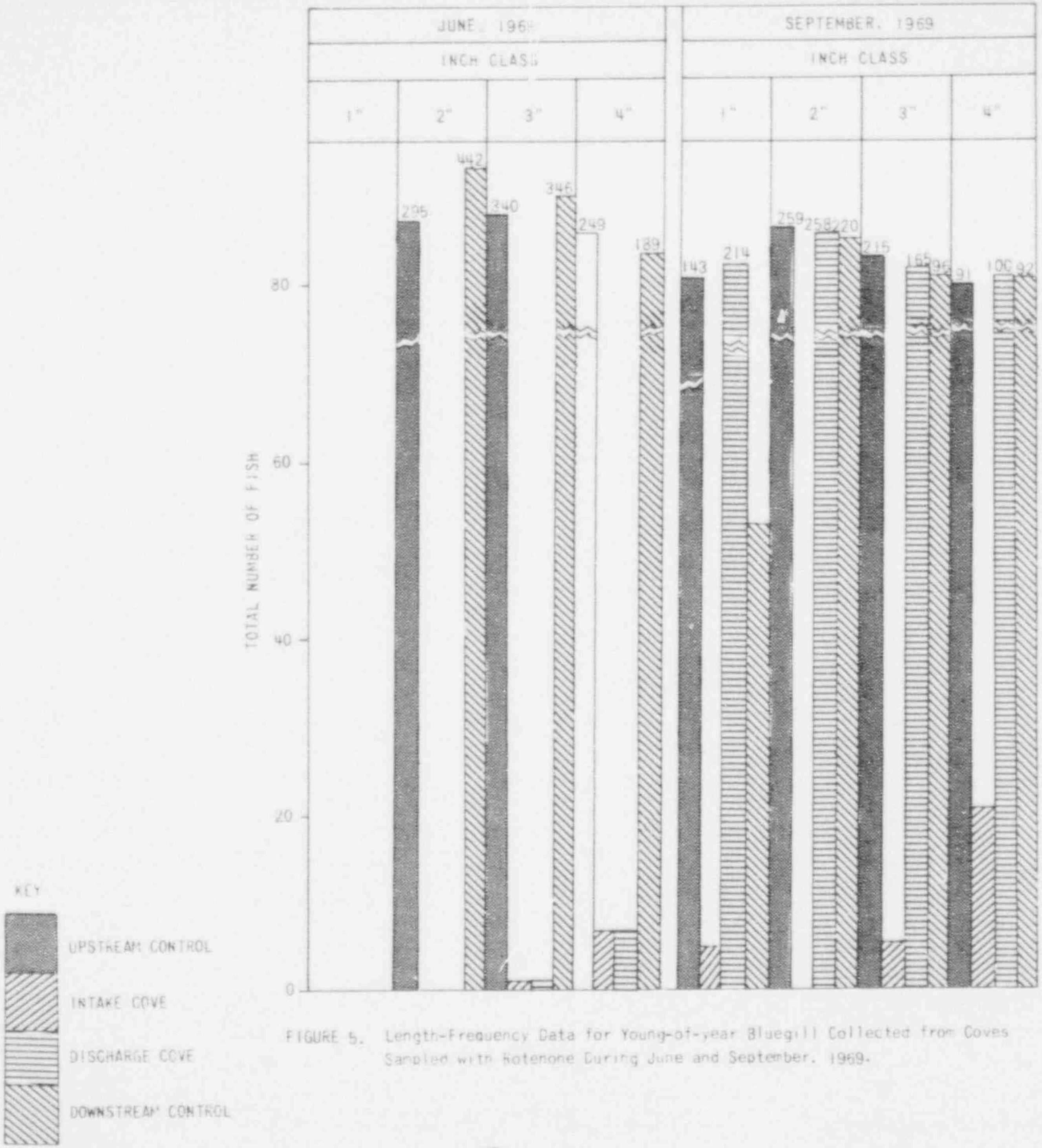

FIGURE 5. Length-Frequency Data for Young-of-year Bluegill Collected from Coves Sampled with Rotenone During June and September, 1969.

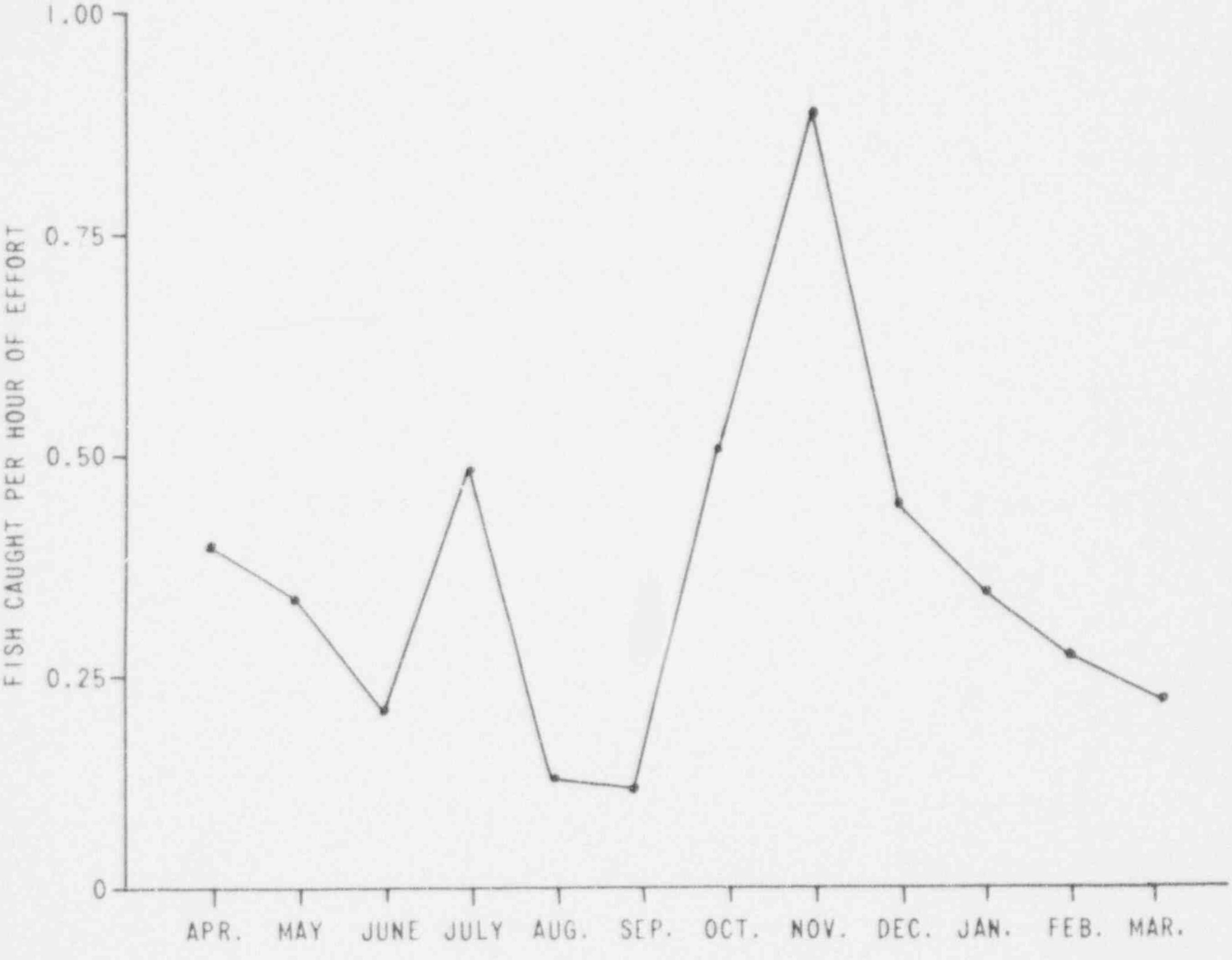

FIGURE 6. Catch Per Fisherman Hour of Effort in the Discharge Cove, Lake Norman, April, 1969 - March, 1970.

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The Duke Power Company

and

The Mecklenburg Historical Association

request the honour of your presence

at the dedication of the plaque

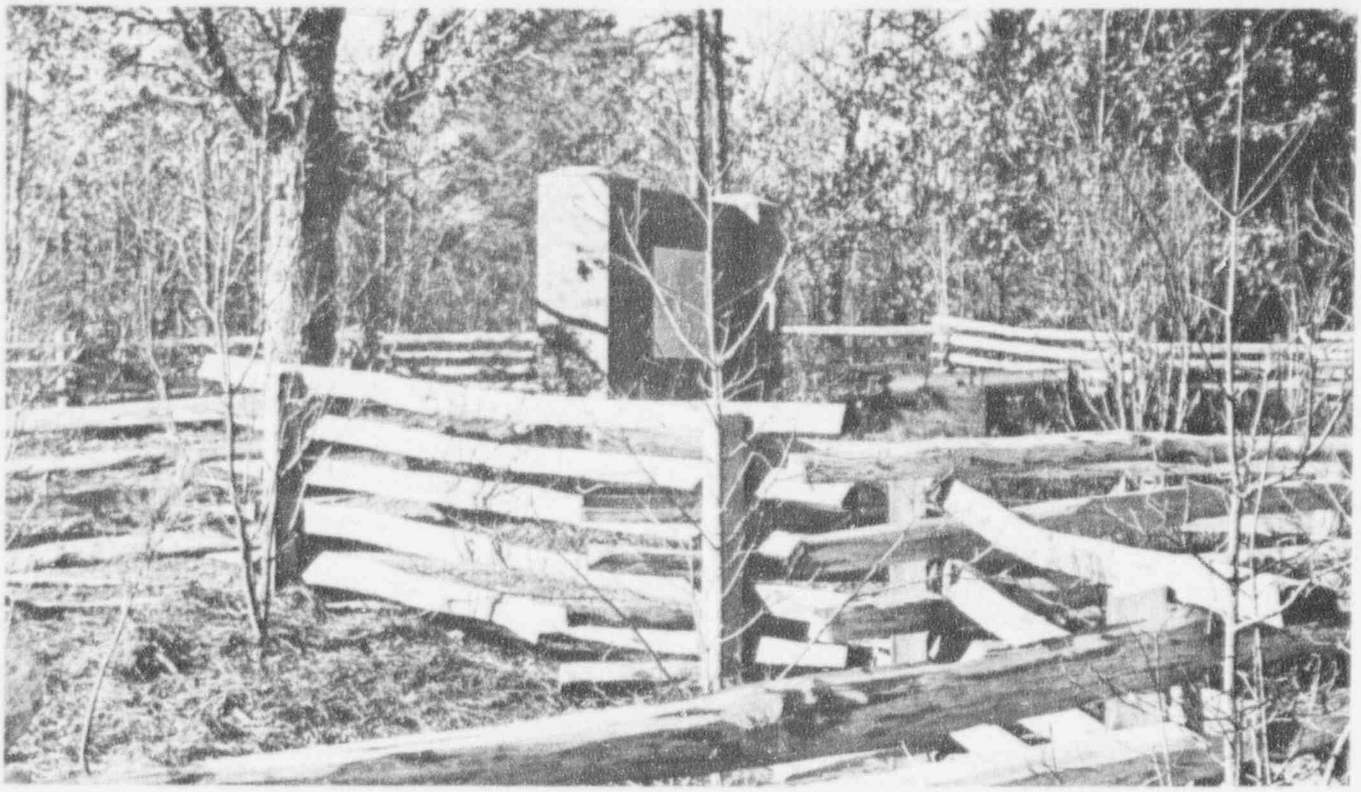
at Cowan's Ford Dam

to General William Lee Davidson

on the one hundred and ninetieth anniversary

of his death

February 1, 1971, at four-thirty P.M.



News Staff Photo by Jeep Hunter

Marker, Old Cannon Mark Spot Of History

TAPS AGAIN

Gen. Davidson Memorial Dedicated

By KAY REIMLER
News Staff Writer

Feb. 1, 1781: Bridg. Gen. William Lee Davidson and a small band of volunteer militia from Piedmont North Carolina were trying to slow British Gen. Cornwallis' crossing of the Catawba River near Cowan's Ford.

A Tory sympathizer shot and killed the 34-year-old revolutionary general after whom Davidson College and Davidson counties in North Carolina and Tennessee are named.

Almost 200 years later, a Duke Power Co. bulldozer operator, clearing a wooden area for the McGuire Station site near Cowans Ford Dam, found an eight-foot stone memorial, covered in ivy and honeysuckle, a forgotten monument to Gen. Davidson.

THE RECENT discovery by the bulldozer operator spurred an investigation by Duke Power people, the Mecklenburg Historical Association and specifically Dr. Chalmeres Davidson, head of Davidson College's history department and a descendent of the general.

This afternoon, on the 190th anniversary of Davidson's death, Duke Power and the historical association were to have dedicated a General Davidson Memorial Area on highway 73, a few miles from the Highway 21 intersection.

Duke Power landscaped the area, moved the old monument and erected a new one near it with a short history of the general, written by Dr. Davidson.

The old monument, put up by another descendent, Baxter Davidson, has a metal plaque which states that the memorial was erected at the site where Gen. Davidson fell off his horse and died after being shot about a quarter of a mile away on the riverbank.

Dr. Davidson's history, retold on the new memorial, has a slightly different story. It says the general died at the river bank, now under water.

HERE'S THE REST of the story as the Davidson College professor related it:

Lord Cornwallis' army was pursuing Gen. Nathanael Greene's main revolutionary forces when it encountered Gen. Davidson's small band of militia at Cowan's Ford. During the battle, Gen. Davidson was killed and the British crossed the river but the encounter slowed them "sufficiently to permit the main army to escape to Guilford Courthouse where Green gave successful battle to Cornwallis."

Gen. Davidson was, according to his descendent history professor, a popular leader and one upon whom Greene relied to bring out the "impulsive and often reluctant militia forces" of the area.

The general was buried in Hopewell Presbyterian Church yard rather than in his own church, Centre, because that are was "infested with British and Tories."

The new plaque reads: "He was married to Mary, daughter of patriot Squire John Brevard, and left a large family of small children."

A number of Davidson's descendents, including some from Alabama and Virginia, wer expected for today's dedication ceremony.

CHARLOTTE NEWS 2-1-71


GENERAL WILLIAM LEE DAVIDSON
BRIGADIER GENERAL WILLIAM LEE DAVIDSON, THE LEADING
PARTISAN OFFICER OF THE NORTH CAROLINA PIEDMONT IN
THE REVOLUTIONARY WAR, WAS KILLED ON THE MECKLENBURG
BANK OF THE CATAWBA RIVER AT COWAN'S FORD ON
FEBRUARY 1, 1781. THE EXACT SPOT IS NOW UNDER WATER
NEAR THE EAST END OF THE DAM. GENERAL DAVIDSON,
WITH A SMALL FORCE OF VOLUNTEER MILITIA, ATTEMPTED
TO STOP OR SLOW DOWN THE CROSSING OF THE CATAWBA
BY LORD CORNWALLIS AND THE BRITISH ARMY IN PURSUIT
OF THE MAIN AMERICAN FORCES UNDER GENERAL NATHANAEL
GREENE. THE YOUNG BRIGADIER (HE WAS ONLY THIRTY FOUR)
WAS SHOT FROM THE RIVER, PRESUMABLY BY A TORY GUIDE,
AND FELL DEAD FROM HIS HORSE ON THE BANK. ALTHOUGH
THE BRITISH MADE GOOD THEIR CROSSING, THE AFFAIR AT
COWAN'S FORD SLOWED THEM SUFFICIENTLY TO PERMIT THE
MAIN ARMY TO ESCAPE TO GUILFORD COURTHOUSE WHERE
GREENE GAVE SUCCESSFUL BATTLE TO CORNWALLIS.
DAVIDSON WAS REARED IN THE NORTH CAROLINA
PIEDMONT AND WAS THE MOST POPULAR COMMANDER IN
THE AREA. HE WAS THE CHIEF INSTRUMENT RELIED
UPON BY GENERAL GREENE FOR CALLING OUT THE
IMPULSIVE AND OFTEN RELUCTANT MILITIA (STATE) FORCES
IN DEFENSE OF THEIR COUNTRY. HE WAS BURIED BY
TORCHLIGHT IN HOPEWELL PRESBYTERIAN CHURCHYARD
IN MECKLENBURG COUNTY AS THE TERRITORY AROUND HIS
OWN CHURCH, CENTRE, WAS ON THAT NIGHT INFESTED
WITH BRITISH AND TORIES. HE WAS MARRIED TO
MARY, DAUGHTER OF THE PATRIOT SQUIRE JOHN BREVARD,
AND LEFT A LARGE FAMILY OF SMALL CHILDERN.
DAVIDSON COLLEGE AND DAVIDSON COUNTIES, NORTH
CAROLINA AND TENNESSEE, ARE NAMED IN HIS HONOR.

Mecklenburg Historical Association

Charlotte, North Carolina 28209

February 3, 1971

MRS. E. W. MORGAN
PRESIDENT
A. HAYNES DUNLAP
FIRST VICE PRESIDENT
J. RUDOLPH THOMPSON, JR.
SECOND VICE PRESIDENT

MRS. JANET S. THOMPSON
SECRETARY
A. NEAL GOODSON
TREASURER

Mr. W. B. McGuire, President,
Duke Power Company,
422 South Church Street,
Charlotte, N.C. 28201

Dear Mr. McGuire:

On behalf of Mecklenburg Historical Association I wish to thank you for inviting us to join with you in the dedication of the marker to General William Lee Davidson on Monday, February 1, 1971.

The park makes a significant roadside attraction. Duke Power Company did a fine thing in establishing this site that has now become a renewed part of Mecklenburg's history. It will be enjoyed by multitudes of natives and tourists alike who otherwise may never have known much about it.

It was such a pleasure working with Mr. Pierce and Mr. Hurst. They were thorough to the least detail, and the project from its inception to the conclusion of the dedication service attest to that.

Yours sincerely,

Mrs. E. W. Morgan

Mrs. E. W. Morgan, President,
Mecklenburg Historical Association.

Copies: Mr. R. R.. Pierce
Mr. J. H. Hurst
Dr. Chalmers Davidson

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5. ALTERNATIVES TO McGUIRE NUCLEAR STATION

McGuire Units 1 and 2 are needed to meet customers' requirements for electrical energy in 1975, 1977 and thereafter. The peak demands experienced and expected on the Duke Power system for the years 1964 through 1977 are tabulated and discussed in Section 2.2. Demonstrated growth in customer requirements for electric energy and long lead times necessary to perform environmental engineering, pursue regulatory proceedings, perform design, obtain timely delivery of high quality equipment and build plants on schedule make it incumbent on Duke to choose a specific site in time to perform all necessary work in orderly and timely fashion. It would be remiss for Duke or any other utility to delay, to waver, or to be less than forthright in making necessary commitments to meet anticipated public needs for electric energy. This could seriously dislocate the economy of the area served.

Based on its considerable experience and upon every reasonable assurance that a suitable generating facility could be built and operated safely, with minimum possible adverse effect on the environment, Duke's management did not consider the alternative of deliberately not building to meet expected customer requirements. Such an alternative is not acceptable to Duke Power nor to the public it serves.

As has always been Duke's practice in planning new generating facilities, management did consider a number of alternatives in order to develop the optimum plan to meet anticipated needs. The important alternatives are discussed below.

5.1 ALTERNATIVE TYPES OF GENERATION

In January, 1971, the Duke system's total generating capacity is slightly more than 6,700 Mw. The needed increment of capacity to be added by McGuire Units 1 and 2 is 2,360 Mw. The types of generation which might be considered to furnish all or part of this needed increment of capacity are hydro, fossil-fueled steam, combustion turbines, nuclear-fueled steam, purchased power and "exotic" sources.

5.1.1 HYDRO AND COMBUSTION TURBINE CAPACITY

On a practical basis, neither hydro nor combustion turbine capacity could be considered. Duke's total existing hydro capacity of about 860,000 Kw built in 26 plants over a period of nearly 70 years is less than half of the needed capacity at McGuire. The characteristically low flows of streams in the Duke territory further limit the usefulness of hydro capacity to short term peaking service. There remain only a very few hydro sites available and suitable for development for peaking service, and none in the Duke territory for base load service. For example, the Federal Power Commission lists(1) 66 locations in all of North and South Carolina where undeveloped hydroelectric potential exists indicating 4.2 billion kilowatt hours to be the total annual energy potential of all 66 sites combined. This is less than one-third the annual energy generation planned for McGuire.

(1) Hydroelectric Power Resources of the United States, Developed and Undeveloped, January 1, 1968, Federal Power Commission.

Likewise, combustion turbine units are small (20,000 - 50,000 Kw) and are not suitable for base load service. Duke's total existing combustion turbine capacity, about 460,000 Kw in 19 units, is less than one-fourth of needed capacity at McGuire. Combustion turbines have high fuel and operating costs. For example, during 1970 Duke's fuel cost per kilowatt hour for these combustion turbines was more than five times the expected fuel cost at McGuire. Even if an adequate supply of oil or gas were available, use of this type generation for around-the-clock service would be poor stewardship of the economic resources of Duke's customers and of the nation's oil or gas resources.

5.1.2 PURCHASED POWER

Power in the amount to be generated by McGuire Nuclear Station is not presently available nor will power in this quantity become available in the foreseeable future. If such quantities of power became available, the production costs of such power may be competitive with production costs by McGuire; however, the additional transmission costs would remove any such power from a competitive category.

5.1.3 "EXOTIC" SOURCES OF POWER

What about magnetohydrodynamics, solar power, tidal power and other sources of energy as an alternative to McGuire? Some of these may some day be practical. A great deal of research is now being done on such sources and Duke Power is contributing to segments of this research. When and if they become practical, we will be in a position to use them to supply our customers' power needs; however, none are now a substitute for McGuire Nuclear Station.

5.1.4 NUCLEAR AND FOSSIL FIRED STEAM-ELECTRIC CAPACITY

As Duke's evaluation of nuclear vs. competitive fuels continued with focus on the 1975 and 1977 units, planning studies showed these units to be required in the central part of the Duke system. In addition to nuclear and coal, the studies included a comprehensive evaluation of imported residual or crude fuel oil. Proposals were received from several petroleum marketing companies including engineering and cost studies of super-tanker terminal facilities on the coast and an oil pipeline to the new plant. Also considered was the conversion of several existing plants to oil firing which would have provided a greater annual volume and lower unit cost of oil to the proposed new plant.

The studies showed that a nuclear fueled plant would result in lowest system costs. Oil would have had to be available in future years at 32 cents per million Btu to be competitive with nuclear. Coal would have had to be available at 28 cents per million Btu to be competitive with nuclear. At the time of the study, fossil fuel prices were substantially higher than these break-even values, and have subsequently skyrocketed to much higher levels.

The studies included evaluation of competitive bids from suppliers of nuclear reactor systems for units in the 1150 Mw class. Among the bids received from four major suppliers of nuclear equipment, the most acceptable offer was submitted by Westinghouse Electric Corporation, and an order was placed with that firm. These two units will be the 13th and 14th nuclear units of essentially this size for which nuclear systems are being furnished by Westinghouse. Adequate time was provided in the design of the Duke units for startup and initial operation based on experiences of several of these sister units.

When compared to a coal-fired plant on an environmental basis, the nuclear plant had the advantage of presenting no air pollution problems.

5.2 ALTERNATIVE SITES FOR NEW CAPACITY

Following the addition of large units in the southwestern portion of the Duke system at Oconee and in the northeastern portion at Belews Creek, system planning studies indicated the optimum location for the next major generation would lie in the central part of the service area. Detailed economic and engineering studies compared the Allison Creek site on Lake Wylie and Site H (McGuire) near Cowans Ford Dam on Lake Norman. Site H was found to be the most economical primarily because of proximity to major system transmission facilities and the presence of cooling-water supply facilities built in conjunction with Cowans Ford Dam. Environmentally, the site offered no relative disadvantages when compared to other sites, but rather had a clear advantage with respect to thermal effects because of the cool water supply. The site is well suited to construction of a large coal-fired station if the nuclear alternative were not available. The following major factors were favorable to the location of a major nuclear station at Site H:

a. By using cool bottom waters from Lake Norman blended with the intake of surface waters, studies showed no expected adverse thermal effects from the warmed condenser discharge.

b. In 1965, a preliminary evaluation was made of the many site parameters influencing nuclear safety at this location, and the results were informally reviewed with officials of the Atomic Energy Commission. Their reaction was favorable.

c. Considering the proximity of Charlotte population and the Charlotte water intake on Mountain Island reservoir, special design criteria were established to assure that the environmental radioactivity effects from a nuclear plant at Site H would be substantially below regulations that prescribe safe levels.

d. Overall economics were in favor of Site H in spite of the higher ad valorem tax rate in Mecklenburg County when compared to some surrounding counties. Duke now has no generating plant in the county having its greatest number of customers. Location of this major facility in Mecklenburg will be beneficial to the economy of the county and to Duke system operation.

e. Preliminary and informal discussions with local and regional officials having responsibilities in the areas of environmental health and pollution control revealed no adverse factors or reactions.

f. Duke already owned most of the land required for the plant and the surrounding exclusion area.

5.3 ALTERNATIVE COOLING SYSTEMS

The unique advantages of the available means of cooling condenser water at McGuire site were a strong factor in selection of the site. This system is described in Section 4.1.5. For surface evaporative cooling, McGuire units will have available the largest acreage on an inland body of water in the Duke service area. In addition, the low-level intake constructed as a part of Cowans Ford Dam provides means to blend cold waters from lowest levels of the lake with nearer-surface waters drawn into plant condensers to insure that thermal discharge regulations are met and maintained under the most severe climatic conditions. In short, McGuire appears to be the optimum site in the Duke service area for use of the cooling resources of the region.

Natural and forced draft wet-type cooling towers and cooling ponds were evaluated in connection with some of the sites which preceded McGuire and one of the sites considered as an alternative to McGuire. These methods were found to be uneconomical and to have definite disadvantages in siting, conservation of water and appearance.

As a general rule in Duke's service area, where there exists a choice between use of large wet-type cooling towers and surface cooling from a large body of water, good conservation of the total water resource favors use of surface cooling. For large thermal generating units the total loss of water to the atmosphere from wet-type cooling towers averages about 25 cfs per 1000 Mw while forced evaporation from a cooling water surface is about seven cfs or about 70 percent less.

Dry type, or surface to air type cooling towers are not available for large size units and were consequently not considered a practical alternative.

5.4 ALTERNATIVE RADIOACTIVE WASTE TREATMENT SYSTEMS

One alternate liquid waste disposal system was evaluated. This alternate system did not incorporate the same degree of segregation of equipment drains and waste streams as the liquid waste disposal system in the present McGuire design. Consequently, none of the liquid waste processed by this alternate system would be reused; and the radioactive liquid discharges from the station, while far below 10 CFR 20 limits, would be somewhat greater than those resulting from the present McGuire design.

Two alternate design concepts were considered for the gaseous waste disposal system. One concept was to provide long-term holdup capacity for potentially radioactive gases, permitting considerable decay of radioactivity. Discharge of these gases from the station would result in offsite concentrations of radioactivity far below the limits of 10 CFR 20. However, the gaseous waste disposal system in the McGuire design is planned to operate without normal discharge of radioactive gases from the station.[1] The second alternate concept considered was the Freon gas-trapping process, announced in late 1970 by Oak Ridge National Laboratory (ORNL). The gaseous waste disposal system in the McGuire design achieves the same objective as the ORNL system.

The liquid and gaseous waste disposal systems designed for McGuire were selected for the following reasons:

a. These systems reduce discharges of radioactivity to the environment to levels far below the numerical limits of 10 CFR 20.

b. These systems permit reuse in the station of a substantial portion of the liquid wastes generated.

c. Normal discharge of potentially radioactive gases from the station is eliminated.

d. These systems truly represent the most advanced available and reduce discharges of radioactivity to the lowest practicable values.

(1) Except for those gases resulting from miscellaneous reactor coolant leakage in the containment or auxiliary building as described in Section 4.2.3.

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6. REGULATION AND COORDINATION WITH GOVERNMENT AGENCIES

6.1 FEDERAL AGENCIES

a. The Atomic Energy Commission, under the Atomic Energy Act as amended, has regulatory jurisdiction over design, construction and operation of the plant, specifically with regard to the nuclear aspects relating to assurances of public health and safety. Application, with supporting documents, was filed on September 18, 1970, for a construction permit for each of the two units. On the appropriate schedule, application will be filed for the operating license for the two units, a license for each of the reactor operators and senior operators, licenses to own and possess nuclear materials in the form of nuclear fuel and license to use gamma ray sources in nondestructive testing of piping and other materials during construction and maintenance. Periodic surveillance of construction, operation and maintenance will be performed by the Division of Compliance of the Atomic Energy Commission.

b. The Federal Power Commission, under the Federal Power Act as amended, has licensing jurisdiction over the Cowans Ford Dam and Lake Norman that it impounds. The license for Project 2232 was issued September 17, 1958, and included Cowans Ford Dam plus ten other hydroelectric plants on the Catawba-Wateree River in North and South Carolina. The original license reserved seven sites for thermal electric generating stations, three of which were located on Lake Norman. On July 31, 1961, application was made for a license amendment covering a fourth thermal plant site on Lake Norman and requesting permission to build the low-level intake structure described in Section 4.1.5 of this report at the time of constructing the Cowans Ford Dam. This intake structure and the use of Lake Norman as a source of cooling water were planned well in advance of need as a result of Duke's continuing environmental studies. By order issued Ocrober 2, 1961, the FPC approved this intake structure. Any major modifications to the Catawba-Wateree development covered by Project 2232, including Cowans Ford Dam, are subject to approval of the Federal Power Commission.

c. Other Federal Agencies

During the planning and development of its facilities, Duke has and will continue to cooperate with a number of federal agencies having specific areas of environmental interest. Examples include the Fish and Wildlife Service, the Bureau of Outdoor Recreation, the Geological Survey, the Army Corps of Engineers, the Public Health Service, the Federal Aviation Administration, the Forest Service, The Soil Conservation Service and the Water Quality and Air Pollution Control Offices of the Environmental Protection Agency.

6.2 STATE AGENCIES

a. The North Carolina Public Utilities Commission required, prior to beginning construction of a generating plant, that the need for the plant be established and a Certificate of Public Convenience and Necessity be issued by that agency. Duke filed application for such certificate on December 16, 1970. (The certificate is enclosed in Appendix 6A.) This Commission also has jurisdiction over many other utility matters, including, for example, the Company's issuance of new securities to obtain funds needed to finance the Company's construction program including McGuire Nuclear Station.

b. The North Carolina Board of Water and Air Resources regulates the control of water and air pollution in the state. For many years, the Company has worked closely with this Board and their staff (The Department of Water and Air Resources) to assure that Duke's facilities are conceived, planned, designed, built and operated in accordance with their regulations and good pollution control practices.

   Discussion of the then proposed Lake Norman generating complex, including its future thermal plant sites, was begun with the Board and staff in 1957. From time to time subsequently, the plans for each increment of this complex were reviewed in advance with the staff. Specifically with respect to McGuire Nuclear Station, long-range plans for the use of cooling water at this site and the related thermal effects were reviewed with the staff in 1960 and followed up with an exchange of correspondence including Duke's furnishing preliminary data in 1961. Note that this is more than fourteen years in advance of the scheduled commercial operation of McGuire Unit No. 1. Upon completion of Lake Norman in 1963, the lake's waters were embraced in Duke's continuing water quality sampling program, and the data obtained has been useful in the continuing review of future plants for the generating complex. This program has been coordinated with and the data collected shared with the Department of Water and Air Resources. In the fall of 1964 at the dedication of Cowans Ford Dam, then Governor Terry Sanford stated with respect to the thermal generation capacity around Lake Norman, "Whereas the first two units at Plant Marshall will use coal as fuel, it is entirely conceivable that other capacity in this new program will utilize the energy of the atom and be nuclear powered."

   In early 1970, prior to announcement of the specific timing and type of plant to be built at the McGuire site, plans for this plant were reviewed with the Department of Water and Air Resources. Following additional discussions in the ensuing months, on October 9, 1970, applications were filed for:

   1. A permit for the discharge of warmed cooling water into Lake Norman. (Permit enclosed in Appendix 6A.)

   2. Certification that there is reasonable assurance that this discharge will not violate the applicable water quality standards. Whereas this section of the Catawba River is not navigable as determined by the FPC licensing of Project 2232, this certification is similar to that required by Section 21b of the Water Quality Improvement Act of 1970. (Certification enclosed in Appendix 6A.)

3. A permit to construct the small dam impounding the nuclear safety pond in accordance with the Board's responsibility for review of dam safety in those cases where dams are not subject to other licensing jurisdiction. (Permit enclosed in Appendix 6A.)

At the appropriate time, additional applications will be filed before this Board for permits covering conventional sewage and waste treatment facilities, first to serve the temporary construction buildings and later to serve the plant. Any effluents from these facilities will fully comply with the water quality standards of the receiving body.

c. The North Carolina State Board of Health has responsibilities in the areas of vector control, sanitation, environmental radioactivity and other public health matters. Duke's vector control program, conducted on its hydroelectric reservoirs, has been closely coordinated with the State Board of Health for more than 40 years. In planning its new lakes such as Lake Norman several years ago, the Company works cooperatively with the State Board of Health to develop high-quality standards of sanitation that, when adopted by the Boards of Health in the counties involved, assure high sanitary quality and environmental protection with respect to shoreline developments around the periphery of these lakes. The Company and the Radiological Health Section, State Board of Health have consummated an agreement of cooperation with respect to radiological matters. (Appendix 6A)

d. The North Carolina Wildlife Resources Commission and Duke have cooperated for many years in programs directly related to Lake Norman and other Company lands and reservoirs. In addition to the many commer-
1. cial marinas and campgrounds to facilitate public recreation, the 1.
Company built and maintains ten public access areas around Lake Norman. Downstream of the Cowans Ford Dam, Duke has provided on a no-cost lease basis 1000 acres of land and water to the Commission as a waterfowl refuge. This refuge has been under Commission management since 1962 and their program has included enhancement of the natural waterfowl habitat by plantings of various legumes and feed. The success of this refuge is evidenced by the large fall and winter populations of mallard, black duck and other species that are attracted to the combination of food in the refuge and open water in the nearby Lake Norman.

Beginning in 1966, fisheries biologists from the Commission have been working with Company research personnel in studying the effects on aquatic biota of thermal discharges in Lake Norman. This program is a part of the Edison Electric Institute's Research Project No. 49 with overall management provided by Johns Hopkins University and additional support in the Lake Norman case from local universities. Within the overall project, the Commission staff has conducted the fish sampling and evaluation program. In the Commission's 1969 - 1970 biennium report to the Governor of North Carolina, their findings to date are summarized as follows:

"--THERMAL ENRICHMENT--"

"The warming of large quantities of water used for cooling condensers at steam plants, while conceivably beneficial up to a threshold point, ultimately may pose a serious threat to the aquatic environment. Fossil fueled and nuclear electric generating plants account for some 80 percent of all industrial cooling water used in the United States. A study of the effects of the warm water discharges upon Lake Norman fishes, undertaken during the 1966-1968 biennium, has continued. Results to date indicate no significant effects upon the reservoir as a whole, but certain localized effects have become quite obvious. Thermal enrichment of the waters in the cove receiving the discharge now permits the overwintering survival of threadfin shad, which has increased the forage-fish potential of the resevoir as well as stimulating an extremely popular sport fishery - particularly for striped bass and white bass. On the other hand, there is some evidence that the higher temperatures have slightly increased the incidence of winter-time fungus infections and infestations by ectoparasites.[11]

This slight increase in fungus and parasitic activity is not believed to be of serious significance, and it may well be influenced by the congregation of fish population near the source of food. The Commission and the Company plan continued cooperation on fishery programs on this and other Duke lakes.

The above research was conducted around Marshall Steam Station on Lake Norman. As pointed out elsewhere in this report, the cooling water supply for McGuire
1. Nuclear Station can be blended with water from low levels which also serves 1.
as a source of cooling water for Marshall Steam Station. The effect on fishes of low level water withdrawal at McGuire is expected to be similar to the effects at Marshall; however, a comprehensive aquatic biological study will be made to assess the impact of McGuire Nuclear Station on Lake Norman.

e. The Division of Recreation of the North Carolina Department of Local Affairs coordinates and promotes the development of recreation opportunities in the state. For many years, the company has coordinated its plans for generation development with the predecessor North Carolina Recreation Commission and now with this agency. The construction of McGuire Nuclear Station will have no adverse effect on the current use nor on the very large potential for expansion of recreation on Lake Norman.

f. The Division of State Parks of the Department of Conservation and Development in 1962 accepted title to 1328 acres of land donated by Duke Power for use as a state park on the shore of Lake Norman. Since its development, the annual usage of this park has increased year by year to where it is now among the most popular in the state. McGuire Nuclear Station will not affect the park.

g. From time to time there will be coordination with several additional state agencies such as the Highway Commission on moving heavy loads, the State Highway Patrol regarding emergency plans, and others.

6.3 LOCAL AGENCIES

a. Mecklenburg County Manager

Plans for McGuire Nuclear Station were discussed with the County Manager, who, as responsible county executive, receives copies of application papers that the Company files with the Atomic Energy Commission.

b. Mecklenburg County Commissioners

Plans for the McGuire Nuclear Station and its relationship to the environment were discussed with the Chairman and the minority leader of the County Commission prior to announcement of the project. From time to time, other matters have and will be coordinated with the County Commission.

c. Charlotte-Mecklenburg Planning Commission

During its early conceptual phases, plans for Lake Norman were coordinated with the Charlotte-Mecklenburg Planning Commission as well as similar commissions in the other three counties surrounding the lake area. For an interim period, the Lake Norman Planning Commission was formed to coordinate the planning fuction among these several counties. On November 20, 1967, the Charlotte-Mecklenburg Planning Commission zoned the site of McGuire Nuclear Station as "I-2", which is appropriate for power plant purposes.

d. County of Mecklenburg Health Department

Plans for McGuire and its relationship to the environment were discussed with the County Health Officer prior to public announcement. Duke has and will continue to coordinate its activities with the Health Department in all appropriate matters.

e. City of Charlotte Water Department

Plans for McGuire and its relationship to the environment were discussed with the Superintendent of the Charlotte Water Department prior to public announcement. Charlotte draws its source of raw water from the Company's Mountain Island Reservoir located downstream of Lake Norman. The Company will continue to cooperate with the Charlotte Water Department with respect to both quantity and quality of water required by the city system.

f. Mecklenburg County Police, Sheriff's Department, Civil Defense Agency and Hospital Authority

Emergency plans and appropriate security measures will be developed in coordination with the appropriate agencies.

g. Other agencies

Understandably with a project of this magnitude, there will continue from time to time coordination with departments and officials of the county and nearby cities and towns.

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AGREEMENT BETWEEN THE DUKE POWER COMPANY

AND

THE RADIOLOGICAL HEALTH SECTION

SANITARY ENGINEERING DIVISION

NORTH CAROLINA STATE BOARD OF HEALTH

WHEREAS the North Carolina State Board of Health has statutory responsibility for ensuring the protection of the public from unnecessary radiation exposure, and WHEREAS the Duke Power Company plans to construct and operate the McGuire Nuclear Station in Mecklenburg County, North Carolina, and wishes to ensure that the public is adequately protected from unnecessary radiation exposure, The Duke Power Company hereby agrees to:

1. Promptly advise the Radiological Health Section of the Sanitary Engineering Division of any radiation related incidents that are required to be reported to the U. S. Atomic Energy Commission,

2. Cooperate with the Radiological Health Section of the Sanitary Engineering Division in the development of an appropriate emergency plan that will protect the public's health and safety in the unlikely event of a nuclear accident, and

3. Permit the Radiological Health Section of the Sanitary Engineering Division to periodically review the results of the Duke Power Company's environmental surveillance program.

Jacob Koomen

Jacob Koomen, M.D.
State Health Director

Marshall Staton

Marshall Staton, Director
Sanitary Engineering Division

A. C. Thies

A. C. Thies, Vice President
Production and Operation

Dayne H. Brown

Dayne H. Brown, Chief
Radiological Health Section

Jan. 19, 1971

Date

State of North Carolina
Utilities Commission
Raleigh

DOCKET NO. E-7, SUB 124

BEFORE THE NORTH CAROLINA UTILITIES COMMISSION

In the Matter of

Application of Duke Power Company for a Certificate of Public Convenience and Necessity under Chapter 287, 1965 Session Laws of North Carolina (G. S. 62-110.1) Authorizing Construction of New Generating Capacity Near Its Cowan's Ford Dam in Mecklenburg County, North Carolina (McGuire Nuclear Station)	ORDER GRANTING CERTIFICATE OF PUBLIC CONVENIENCE AND NECESSITY

PLACE: Commission Hearing Room, Ruffin Building, Raleigh, North Carolina

DATE: March 5, 1971 and March 8, 1971

BEFORE: Chairman H. T. Westcott, Presiding; Commissioners John W. McDevitt, Marvin R. Wooten, Miles H. Rhyne, and Hugh A. Wells

APPEARANCES:

For the Applicant:

Carl Horn, Jr.
George W. Ferguson, Jr.
W. Larry Porter
Duke Power Company
Post Office Box 2178
Charlotte, North Carolina 28201

For the Intervener:

Arnold M. Stone
Sanders, Walker & London
900 Law Building
Charlotte, North Carolina
For: Carolina Environmental Study Group, Inc.
Mrs. Gayle Waller

For the Commission's Staff:

Edward B. Hipp and William E. Anderson
Commission Attorneys
Post Office Box 991
Raleigh, North Carolina 27602

BY THE COMMISSION. This proceeding was instituted on December 17, 1970, by the filing of Application by Duke Power Company (DUKE) for a Certificate of Public Convenience and Necessity under G. S. 62-110.1 to construct new generating capacity on a site adjacent to Lake Norman near its present Cowan's Ford Dam in Mecklenburg County, North Carolina. By Order of the Commission dated December 30, 1970, Notice of the Application was required to be published in newspapers of general circulation in Mecklenburg County. On January 26, 1971, the Commission, on its own motion, issued an Order setting public hearing on the Application for March 5, 1971, in the Commission Hearing Room, Raleigh, North Carolina. The Order further stated that Duke would have the burden of proof to support its Application by testimony of qualified witnesses together with exhibits and data and to establish for the record through competent testimony and evidence justification for the proposed plant from economic, power supply requirements, reliability, and environmental viewpoints.

Under the Application for a Certificate of Public Convenience and Necessity, Duke proposes to construct two nuclear fueled steam-electric generating units each with a nominal rating of 1150 megawatts, with Unit No. 1 to be completed to load fuel by June 1, 1975 and be in commercial operation by November 1, 1975, and Unit No. 2 to be completed approximately one year later. T . Application provides that cooling water for the steam pl nt will be drawn through two intakes from Lake Norman designed to draw water from the bottom of the lake and from the 40-foot depth foot level, to be returned to the lake through methods and at temperatures alleged to be compatible with the enjoyment of recreation and fish and wildlife propagation, and in compliance with water quality standards of the North Carolina Board of Water and Air Resources, and construction permits of the U. S. Atomic Energy Commission (AEC).

Under date of February 23, 1971, Petition to Intervene was filed by the Carolina Environmental Study Group, Inc., and an Order Allowing Intervention was issued by the Commission on the 26th day of February.

On March 2, 1971, the Commission received a letter requesting subpoena duces tecum for appearance for Mr. W. S. Lee, Vice President - Engineering, Duke Power Company, Charlotte, on behalf of the Carolina Environmental Study Group, Inc. Subpoena was issued by the Commission on March 2, 1971.

Public hearings were held in the Commission Hearing Room, Raleigh, North Carolina, on March 5, 1971, and on the afternoon of March 8, 1971, with counsel for all parties appearing and participating as shown heretofore. The Applicant offered testimony and exhibits of its witnesses, Mr. William S. Lee, Vice President - Engineering, for Duke, and Dr. Charles M. Weiss, Professor of Environmental Sciences and Engineering, College of Public Health, the University of North Carolina, Chapel Hill, North Carolina. The Carolina Environmental Study Group, Inc., offered testimony of its Secretary, Mrs. Gayle S. Waller, 1233 Biltmore Drive, Charlotte, North Carolina, in protest to the granting of a Certificate of Public Convenience and Necessity. The Utilities Commission Staff, through co-operation with the North Carolina State Board of Health and the North Carolina Department of Water and Air Resources offered the statements and testimony of Mr. Dayne H. Brown. Chief, Radiological Health Section, State Board of Health, and a written statement by Mr. E. C. Hubbard, Assistant Director, North Carolina Department of Water and Air Resources.

Testimony of Applicant's Witnesses

Mr. William S. Lee: Mr. William S. Lee testified and offered evidence as to the economic justification, power supply requirements, reliability, and environmental impact of the proposed McGuire Nuclear Plant (sometimes referred hereinafter as the McGuire Nuclear Station, McGuire Plant, or McGuire Units 1 and 2).

In reference to predicted power needs and available sources for Duke's total system, Mr. Lee testified that the probable peak load based on average weather conditions is expected to grow at an annual rate of about 9.5% over a ten-year period and that this compares to a growth rate of about 10.5% based on actual experience between 1965 and 1970 and an average annual growth rate of 9% between 1960 and 1970. Mr. Lee testified that in regard to 1976 and 1977, the years in which the proposed McGuire Nuclear Station Units 1 and 2 are to become commercial, Duke's predicted peak load for the summer of 1976 is 10,833 megawatts (MW), and that with the addition of McGuire Unit 1 at 1150 MW prior to that summer, the system capability would be 14,172 MW resulting in a reserve capability of 3,339 MW. Mr. Lee further testified that allowing for the demands created by extreme weather, for the possible outage of the largest unit on the system, for other outages and capacity reduction consistent with Duke's experience on a multi-unit system, and an allowance for other contingencies including forecast errors or severe outages, this reserve capability of 3,339 MW, which includes the McGuire Unit 1, would closely match the required reserve of 3,348 MW, which Mr. Lee alleged to be necessary for reliable service. Mr. Lee testified that at the summer peak of 1977, the time McGuire Unit 2 consisting of 1,150 MW is proposed to go into service, the total reserves will be 3,460 MW, against a reserve requirement of 3,469 MW.

In reference to the geographic location and justification of the proposed site, Mr. Lee testified that the McGuire site is located in Northern Mecklenburg County on a South shore of Lake Normen immediately East of the Cowan's Ford Dam. He further testified that this site is near the geographic center of the Duke service area and that its location is essentially at the intersection of existing major 230 KV transmission routes extending from near Durham, North Carolina on a Northeast edge of Duke's service area to Anderson, South Carolina, on the Southwest and from Hickory and Elkin, North Carolina, in the North to Newberry, South Carolina, in the South, that the site is also at the hub of Duke's developing 500 KV transmission system.

On an economic basis, Mr. Lee testified that taking full advantage of the transmission system which is now in existence or being built will effect considerable savings in transmission line costs. He testified that compared to an alternate site on Lake Norman, the saving in transmission plant investment would be approximately 11 million dollars and that compared to another possible location in South Carolina, which is similar to the McGuire site in that a minimum of transmission plant is required, the saving in transmission at McGuire would be approximately 5.8 million, but at that alternate site additional investment of 18 million would be required for cooling water facilities.

In reference to whether or not adequate generating capacity is available either from sources on the Duke system or available from adjacent systems as an economic alternative to construction of the McGuire Nuclear Station, Mr. Lee testified that there are no hydro sites on the Duke system with sufficient head or stream flow to support 2,300 MW of firm generation nor is there sufficient power available for 1976 and 1977 outside Duke's system which would eliminate the necessity of constructing the McGuire Plant.

In reference to justification of nuclear fuel as the fuel source of the proposed plant, Mr. Lee presented comparative cost studies which were made for a nuclear plant, a coal fired plant, and for a plant fueled with imported residual or crude oil. These studies showed that a plant using nuclear fuel would result in lowest system cost by a substantial margin. Mr. Lee testified that to be competitive with nuclear, oil would have to be available in future at 31 cents per million Btu whereas the best quotations received at the time of the decision in late 1969 indicated oil supply at 37 cents per million Btu, plus possible escalation in future years. To be competitive with nuclear, coal would have to be available on a delivered basis at 28 cents per million Btu. Mr. Lee stated that Duke's system-wide cost of coal burned in December, 1969, was 31 cents per million Btu and based on then current market conditions was being evaluated at 36 cents but had actually increased to 47.6 cents per million Btu in December, 1970. At the time of the study, Duke estimated the capitalized value of savings with the two unit nuclear plant at over 50 million when compared to oil and over 80 million when compared to coal. Using fuel costs data as of January, 1971, Duke estimated the capitalized value of savings to be 167 million dollars for coal and 376 million dollars for oil.

Mr. Lee testified the estimated construction cost of the McGuire Station is $372,220,000 with initial loads of nuclear fuel at a cost of $59,168,000. Mr. Lee further testified that generation costs are estimated to be 5.95 mills per Kwh. Mr. Lee testified that operating and maintenance labor and supplies expense for the proposed plant would be about equal to that required for a coal fired plant.

In reference to availability of nuclear fuel, Mr. Lee testified that Duke had negotiated long-term contracts for the supply of uranium and that these contracts plus options cover all of the uranium required for operation of the two proposed nuclear units through the 1970's plus about 60% of the requirements for operation during the period 1980 through 1985. Mr. Lee testified that while there are no plants of this size presently in operation, the McGuire

Nuclear reactor systems will be the 12th and 13th essentially duplicate systems to be supplied by Westinghouse and that this repetitive experience in design is expected to provide further increases in reliability. Mr. Lee stated that Duke expected the frequency of forced outages of McGuire units to be about the same as for fossil units of comparable size and that annually each McGuire unit will undergo a three to four-week shutdown for refueling on a scheduled basis. Even though no units of the size of the proposed McGuire Station are now in operation, Mr. Lee testified that similar units with a slightly less megawatt rating are in operation.

Mr. Lee next testified regarding the environmental impact of the proposed plant and the status of all permits required for construction and operation of the proposed McGuire units. He testified that an Application had been filed with the Atomic Energy Commission on September 18, 1970, for a construction permit for the two McGuire units. The AEC, Mr. Lee testified, has regulatory jurisdiction over design, construction, and operation of the proposed plant with regard to the nuclear aspects relating to assurances of public health and safety; that approval has not yet been received from the AEC for a construction permit; and that assuming approval of the construction permit, further application must be filed with the AEC for operating licenses for the two units. He further testified that these operating licenses include the license for each of the plant operators and senior operators, licenses to own and possess nuclear materials in the form of nuclear fuel and license to use gamma ray sources in non-destructive testing of piping and other materials during construction and maintenance.

Mr. Lee testified that the Federal Power Commission has licensing jurisdiction over hydroelectric generating facilities on Lake Norman and specifically the Cowan's Ford Dam which impounds Lake Norman; that the license for this FPC Project No. 2232 was issued September 17, 1958, and included the Cowan's Ford development plus ten other hydroelectric developments on the Catawba-Wateree River in North and South Carolina; that the original license for a term of 50 years from date of issue reserves seven sites for thermal electric generating stations, three of which were located on Lake Norman; that on July 31, 1961, the Application was made for a license amendment covering a fourth thermal plant site on Lake Norman and requesting permission to build a low level in-take structure that will serve the proposed McGuire Station; and that at the time of constructing the Cowan's Ford Dam by Order issued October 2, 1961, the FPC approved the in-take structure and use of Lake Norman waters for the purpose of cooling waters for the condensers proposed in this Application.

With respect to State Agencies, Mr. Lee testified that in addition to a Certificate of Public Convenience and Necessity being necessary from the State Utilities Commission, the Board of Water and Air Resources, through the North Carolina Department of Water and Air Resources, regulates the control of water and air pollution in the State. He further testified that Duke Power Company had applied for the following:

1. A permit for the discharge of warmed cooling water into Lake Norman.
2. Certification that there is reasonable assurance that this discharge will not violate the applicable water quality standards.
3. A permit to construct the small dam impounding the auxiliary pond in accordance with the Board's responsibility for review of dam safety in those cases where dams are not subject to other licensing jurisdiction.

Mr. Lee stated that the permits and certification approving these systems have been issued by the Department of Water and Air Resources. He further testified that at the appropriate time additional applications will be filed with that Board for permits covering conventional sewerage and waste treatment facilities, first to serve the temporary construction activities and later to serve the plant. Mr. Lee testified that any effulents from these facilities will fully comply with the water quality standards of the receiving body.

Mr. Lee testified that the North Carolina State Board of Health has responsibilities in the areas of vector control, sanitation, environmental radioactivitiy, and other public health matters. He testified that the Company and the Radiological Health Section, State

Board of Health, have consummated an Agreement of co-operation with respect to surveillance of radiological emissions.

In reference to local zoning requirements, Mr. Lee testified that the McGuire site was zoned for this use several years ago by the Charlotte-Mecklenburg Planning Commission.

In regard to the environmental justification of the geographical location on Lake Norman, Mr. Lee testified that the proposed McGuire site offers no disadvantages and two major advantages - the first advantage being that Duke can utilize the cool waters in the bottom of Lake Norman as the source of condenser cooling water and the temperature of the water return to the Lake in the summertime will be lower than possible at any other cooling lake site on the Duke system, and the second advantage is due to the close proximity of this site to Duke's largest 500/230 KV system transmission substation which would minimize the land required for delivery of the plant output to the system when compared to any alternate location. Mr. Lee testified that the output of the proposed McGuire plant would be delivered over two 500 KV transmission lines .6 miles in length to the 500/230 KV system transmission substation located South of the plant and across N. C. Highway 73. He further stated that there would be two 230 KV transmission lines of similar length between the substation and the plant to supply start-up power.

In reference to plans for disposal of waste heat including any studies made for beneficial use of such heat, Mr. Lee testified that only a small portion of the Lake would feel the extra warmth of the discharged water and that in this area the waste heat would be quickly given up to the atmosphere by the combined cooling effects of evaporation, radiation, and conduction. Mr. Lee further testified that a research program conducted on Lake Norman with the assistance of scientists at Johns Hopkins University, the University of North Carolina at Chapel Hill, the University of North Carolina at Charlotte, and the Division of Inland Fisheries of the North Carolia Wildlife Resources Commission clearly shows the beneficial effects of this waste heat on the fishery resources of this Lake. He testified that the objective of this program was to determine the effect of a similar cooling water system at Duke's Marshall Steam Station located on Lake Norman at a site 17 miles North of the

McGuire site. Mr. Lee quoted from the Wildlife Resources Commission's 1969-1970 biennium report to Governor Scott which stated, "A study of the effects of the warmed water discharges upon Lake Norman fishes, undertaken during the 1966-1968 biennium, has continued. Results to date indicate no significant effects upon the reservoir as a whole, but certain localized effects have become quite obvious. Thermal enrichment of the waters in the cove receiving the discharge now permit the overwintering survival of threadfin shad, which has increased the forage-fish potential of the reservoir as well as stimulating an extremely popular sport fishery - particularly for striped bass and white bass." Mr. Lee testified that after the McGuire units are placed in service, Duke will continue this study to establish that the thermal effects are consistent with the forecasts that serve as a basis for future siting of power plants.

In regard to radiation from the proposed nuclear reactors, Mr. Lee testified that the emissions from the McGuire Nuclear Plant will comply with the safety regulations of the AEC and that the dosage from the McGuire Plant of one millirem per year to a person next to the plant is less than 1/100 of that allowed by one of AEC's guidelines.

On cross examination by Commission Staff Counsel, Mr. Lee testified that the proposed nuclear fuel source would be more compatible with the environment than any alternative fuel source because of the inherent air polluting gases and fly ash resulting from the burning of coal when coal is used as a fuel source. Also, Mr. Lee testified that thermal effects from use of cooling water for the condensers would be no different except that the nuclear plant would use more water but would heat it to the same temperature as fossil plants; and that the nuclear plant would not require large land space for the storage of coal and ash resulting from burning the coal.

Extensive and thorough cross-examination was conducted of Mr. Lee by Counsel for the Intervener, Carolina Environmental Study Group, Inc. The record will show that many of the questions related to safety of the proposed nuclear plant, the ability of Duke to design and operate a 1,150 MW unit, the possibility that AEC may refuse licenses to Duke to build and operate the plant thus requiring Duke to build plants using alternate fuel sources, the possibility that fuel reprocessing facilities may not be available because of economic and environmental reasons, the possible dangers and problems of transporting nuclear fuel and nuclear wastes, and the correctness of the cost studies used in justifying the decision to install nuclear fueled units.

Dr. Charles M. Weiss, Professor of Environmental Sciences and Engineering, College of Public Health, the University of North Carolina, Chapel Hill, North Carolina: Dr. Weiss testified that based on the studies previously carried out at the Marshall Plant which is on Lake Norman and those studies in which he has personally participated, it is his opinion that no significant adverse effect on the aquatic biology will occur in the so-called mixing zone to be caused by the releasing of heated water used for cooling at the McGuire Nuclear Plant into Lake Norman.

Witnesses Presented by the Commission Staff

Mr. Dayne H. Brown, Chief, Radiological Health Section, State Board of Health: Mr. Brown testified that the State Board of Health maintains an effective program for the protection of the citizens of North Carolina from exposure to radiation; that this program was established under the provisions of Chapter 104 C, North Carolina Atomic Energy, Radioactivity and Ionizing Radiation Law, of the North Carolina General Statutes, and the Agreement between the U. S. Atomic Energy Commission and the Governor of North Carolina; that the North Carolina Radiation Protection Program is administered by the Radiological Health Section of the Sanitary Engineering Division; and that this program includes licensing of radioactive material, registration of x-ray equipment, monitoring of environmental radioactivity and responding to radiation emergencies.

Mr. Brown further testified that the radiation protection aspects of the proposed McGuire Nuclear Station are specifically under the jurisdiction of the AEC but that the State Board of Health's responsibilities and concern for the protection of North Carolina citizens require consideration of any possible public health hazards related to this facility.

Mr. Brown testified that his Staff has reviewed the Preliminary Safety Analysis Report of Duke for the McGuire Station and believes that the normal planned releases of radioactive effulents will result in environmental concentrations well below the limits which have been established by the Federal Radiation Council for protection of the public; that in order to ensure that environmental concentrations of radioactivity are well below these limits, the State Board of Health will supplement the surveillance program of Duke by maintaining independent radiation surveillance around the proposed facility and that this independent program will include surveillance of air, water, milk and direct radiation exposure at locations in the environs of the facility.

Mr. Brown further testified that based on review of the radiation protection aspects of the proposed McGuire Nuclear Station, the State Board of Health does not object to the issuance of a Certificate of Public Convenience and Necessity to construct and operate the Duke Power Company McGuire Nuclear Station at Lake Norman in Mecklenburg County.

Statement of North Carolina Department of Water and Air Resources: A statement from the North Carolina Department of Water and Air Resources confirming Applicant Witness Lee's testimony regarding the Department's issuance of the necessary permits for construction of the McGuire Plant was offered and received into evidence as Staff Exhibit No. 1.

Witnesses for the Intervener

Mrs. Gayle Waller, Secretary, Carolina Environmental Study Group; Residence - 1233 Biltmore Drive, Charlotte, North Carolina: Mrs. Waller testified that reactors require 50% more cooling water than conventional plants; that the question of how to disperse such large quantities of heated waters without harmful effects is a question of importance; that studies of the effects should be available to the public particularly since Duke began conducting studies in 1959; that the Commission should withhold any decision until such studies are thoroughly examined by experts who receive no benefits from industry or would suffer no recrimination for a knowledgeable opinion; that Lake Norman directly serves the water systems of Davidson and Huntersville and downstream Charlotte and because of this reason, radioactive effluents concern the public as well as heat discharges; and while planned and purposeful radioactive leakage into the cooling water may be at "permissible" levels, the long life of some of the isotopes seems to be overlooked as well as the reconcentration factor.

Mrs. Waller further testified that the McGuire Plant is sited in an area which has the worst air inversion factor in the East and is only 16 miles from the center of Charlotte; that there has never been a reactor with as little discharge as this nor with the proposed efficiency; that Duke has not furnished anything but conjectures on fuel costs and supplies, efficiency, economies, safety, reprocessing plants and waste storage; and that the future of the nuclear fission is based on conjecture.

Mrs. Waller further testified that a Certificate should not be granted to Duke until the Company produced its environmental studies.

Based upon the entire record of this proceeding, the Commission makes the following:

FINDINGS OF FACT

1. That Duke Power Company is a Corporation organized and existing under the Laws of the State of North Carolina, and is a public utility oprating in North and South Carolina where it is engaged in the business of generating, transmitting, distributing and selling electric power and energy.

2. That the Atomic Energy Commission and the North Carolina State Department of Health, through a working agreement with the AEC, have primary responsibility in ensuring public safety from radiation exposure generally as affected by the design and operation of the proposed nuclear plant; and that an Application has been made but that the AEC has not yet held hearings or granted a permit authorizing construction of the proposed plant.

3. That in regard to the normal planned releases of radioactive effluents, the State Board of Health finds that these releases will result in environmental concentrations well below the limits established by the Federal Radiation Council for protection of the public; that to ensure that these limits are maintained, the State Board of Health will conduct on-going and independent

radiation surveillance programs around the proposed facility; and the Commission finds that the project meets all safety requirements so established.

4. That the Department of Water and Air Resources, through its agreement with the U. S. Environmental Protection Agency, has primary responsibility over the use and/or pollution of the water and air resources generally of the State; that said Department has studied the environmental effects of the proposed McGuire Plant on Lake Norman and has issued permits authorizing the use of cooling water in the plant's operations as outlined in the Application; and the Commission finds that the project meets all environment requirements so established.

5. That while the AEC, the State Board of Health, and the Department of Water and Air Resources, have primary jurisdiction in the establishment, review, and surveillance of the design and operation of the proposed plant as it might affect the public from radiation exposure and as it might affect the water and air resources of the State, the Utilities Commission retains the over-all responsibility of determining whether Public Convenience and Necessity is to be served by construction and operation of the McGuire Plant.

6. That the proposed McGuire Nuclear Units of 1,150 MW each, if now if operation, would be the largest nuclear units in service; that, however, these units are the 12th and 13th essentially duplicate systems to be supplied by Westinghouse; that similar units of less megawatt rating are in operation; that the estimated construction cost of the McGuire Station is $372,220,000 with initial loads of fuel at a cost of $59,168,000; that based on all considerations, economic as well as environmental, there is no other alternate fuel for generation or site location more suitable than those chosen for the McGuire Station; that Duke will not be able to adequately serve its certificated area if the total amount of power proposed to be supplied by the McGuire Station is not available by the latter half of the 1970's; that Duke has the financial ability to pay for the construction and installation of the proposed units; and the Commission finds that public convenience and necessity requires the construction of the generation facility.

CONCLUSIONS

The Commission concludes that public convenience and necessity require construction and installation by the Company of the new generating capacity hereinafter described, subject to compliance with all design and safety standards which may be imposed by the AEC or the State Board of Health in regard to protection of the public from radiation exposure, and by the N. C. Department of Water and Air Resources for protection of the environment.

In arriving at this conclusion, the Commission has considered the testimony and evidence offered by experts from the State Board of Health and the Department of Water and Air Resources and the responsibility delegated by Law to the AEC in the areas of protection of the public from radiation hazards. Considering the evidence presented and based on the radiation limitations set by the Federal Radiation Council and administered by the AEC and the State Board of Health, the Commission concludes that the proposed McGuire Nuclear Station will not have any significant adverse effect on its environs and that, conversely, it will emit much less volume of gases and particulate matter than similar sized coal fueled steam plants.

The Commission also considered, in arriving at its conclusions, the Company's projected power requirements for 1976 and 1977 and while it is not convinced that the Company will require the amount of reserve margin indicated during those years, we have concluded that growth of power use in the Company's service area will continue at such a rate that the units will be required at least by 1977 and 1978 and that the Company should proceed to design and construct these units as planned in the Application. The Commission concludes that based on current fuel cost and cost considerations as developed in this record, these proposed units are the most economical and dependable type of generating units the Company can provide to meet its expected growth in demand, and that the site chosen is the most suitable from an economic and environmental standpoint.

The Commission further concludes that it will retain overall jurisdiction over the design of the plant, as well as its operation, and will require the backfitting of technological advancements, as they become available, that provide reasonable additional protection necessary for the public health and safety or protection of the environment.

IT IS, THEREFORE, ORDERED:

That a Certificate of Public Convenience and Necessity be, and it is hereby, granted to Duke Power Company for the construction of McGuire Nuclear Power Plant, having a nominal output of 2,300 megawatts, to be located on Lake Norman near the Applicant's Cowan's Ford Dam in Mecklenburg County, North Carolina, as applied for in this proceeding subject to the following conditions:

1. The plant will be constructed and operated in strict accordance with all applicable Laws and Regulations, including the construction and operation licenses to be issued by the Atomic Energy Commission and the permits issued by the North Carolina Department of Water and Air Resources.

2. Duke Power Company shall on a continuing basis promptly furnish the Commission with copies of reports made by and for the Company bearing on (a) the ecology of Lake Norman, (b) the effect of the operation of McGuire Nuclear Plant on the environments, and (c) technological improvements in the construction and operation of generating facilities. Also, the Company shall on a continuing basis make available for inspection by the Commission Staff all projections and studies made by or for the Company regarding system load projections, system generation outage and reliability records (or studies), its generation site studies (including a listing of possible sites held by any Company-owned affiliates), data on nuclear and fossil fuel sources including suppliers and costs and any contracts executed in regard to fuel obtainment, and data on disposal of fuel wastes.

3. During the month of January of each year, beginning with the year 1972, Duke shall furnish the Commission with a progress report, which shall provide information upon which the Commission may evaluate the current status of the construction of said facility and time at which it is anticipated said facility, or any part thereof, might become operational for the generation of electric energy.

ISSUED BY ORDER OF THE COMMISSION.

This the 18th day of May, 1971.

NORTH CAROLINA UTILITIES COMMISSION

By: Katherine M. Peele
Katherine M. Peele, Chief Clerk

(S E A L)

6 REGULATION AND COORDINATION WITH GOVERNMENT AGENCIES

A list of the agencies of the Federal, State and Local Governments, from whom licenses/permits were obtained for construction of the Cowans Ford Dam and also those who have been contacted in connection with the McGuire Nuclear Station is given in Table 6-1.

TABLE 6-1

LIST OF GOVERNMENT AGENCIES

Government Body or Agency	Date Contacted or Application	Public Hearing Date (If Any)	Type Agreement	Date Approved
Federal				
Atomic Energy Commission	9-18-70		Application for Construction Permit	
	3- 9-71		Submitted Environmental Report	
Federal Power Commission	7-31-61		Application for license amendment (Project No 2232, dated September 17, 1958) requesting permission to build low-level intake structure	10- 2-61
	3- 9-71		Submitted Environmental Report	
1.	2-18-72		Application for license amendment to permit withdrawal of 4500 cfs condenser cooling water and revision of Exhibits K and L	1.
U S Army Corps of Engineers	3- 9-71		Submitted Environmental Report	
U S Geological Survey	3- 9-71		Submitted Environmental Report	
Environmental Protection Agency Water Quality Office and Air Pollution Control Office	3- 9-71 and 3-16-71		Submitted Environmental Report	
Department of Commerce, Bureau of Commercial Fisheries, National Oceanic and Atmospheric Administration	3-16-71		Submitted Environmental Report	
U S Fish and Wildlife Service, Department of the Interior	3-16-71		Submitted Environmental Report	
Federal Communications Commission	August 1960		Microwave Construction Permit, Cowans Ford	10-28-60
	October 1961		Microwave Extension of Construction Permit, Cowans Ford	10-28-61
	September 1962		Microwave License to cover Construction Permit, Cowans Ford	11-28-62
	December 1963		Microwave Construction Permit, Cowans Ford	4-22-64
	March 1965		Microwave License to cover Construction Permit and Modification, Cowans Ford	5-13-65
	August 1968		Microwave Construction Permit, Cowans Ford	11- 5-68
	October 1969		Microwave License to cover Construction Permit, Cowans Ford	2-18-70
	August 1970		Microwave Modification, Cowans Ford	1- 7-71
	September 1971		Microwave Modification, Cowans Ford	-
	September 1959		Mobile Construction Permit and License,Cowans Ford	12-21-59
	April 1960		Mobile Modification, Cowans Ford	5- 4-60
	January 1968		Mobile Construction Permit and License, Cowans Ford	2-20-68
	August 1970		Microwave Construction Permit and License, McGuire Station	1- 7-71

TABLE 6-1 (Contd)

Government Body or Agency	Date Contacted or Application	Public Hearing Date (If Any)	Type Agreement	Date Approved
State				
North Carolina Public Utilities Commission	12-16-70	3- 5-71 and 3- 8-71	Certificate of Public Convenience and Necessity	5-18-71
	9-18-70		Submitted PSAR	
	3- 9-71		Submitted Environmental Report	
North Carolina State Highway Commission	7-10-70		Exchange of correspondence concerning construction of Access Railroad Bridge and Approaches adjacent to N C 73	11- 9-70
	6- 1-71		Exchange of correspondence concerning Temporary Access Road, abandonment of portion of SR 2182 and improvements to N C 73	10- 7-71
North Carolina Department of Water and Air Resources	9-18-70		Submitted PSAR	
	10- 9-70		Permits for cooling water discharge into Lake Norman and Standby Nuclear Service Water Pond	3- 4-71
	4-26-71		Permit to construct Wastewater Collection Basin	6-15-71
	5-25-71		Permit to construct sewage disposal facilities for McGuire Construction Jobsite	6-18-71
	8-12-71		Permit to construct 6000 gpd extended aeration type wastewater treatment plant (No 3) followed by chlorination facilities and fine solids settling basin to serve construction trailer camp	9-27-71
	3- 9-71		Submitted Environmental Report	
Department of Administration	4-15-71		Submitted Environmental Report	
North Carolina State Board of Health	9-18-70		Submitted PSAR	
Radiation Protection Program	3- 9-71		Submitted Environmental Report	
Sanitary Engineering Division	3- 9-71		Submitted Environmental Report	
1.	11- 2-71		Application for permit to impound water for Standby Nuclear Service Water Pond and Wastewater Collection Basin	11-16-71 1.
Radiological Health Section	8-19-70		Written Agreement (See Section 6A of original Environmental Report)	1-19-71
North Carolina Wildlife Resources Committee	9-18-70		Submitted PSAR	
	3- 9-71		Submitted Environmental Report	
Division of Inland Fisheries	3-29-71		Submitted Environmental Report	
North Carolina Department of Labor	3-17-71		Submitted Environmental Report	
North Carolina Department of Local Affairs, Recreation Division	3- 9-71		Submitted Environmental Report	
North Carolina Department of Conservation and Development	3-16-71		Submitted Environmental Report	
North Carolina State University	3- 9-71		Submitted Environmental Report	

TABLE 6-1 (Contd)

Government Body or Agency	Date Contacted or Application	Public Hearing Date (If Any)	Type Agreement	Date Approved
State - contd				
University of North Carolina, Chapel Hill	3- 9-71		Submitted Environmental Report	
	2- 9-71		Research on Aquatic Ecosystem Contract	2-11-71
	3-17-71		Submitted Environmental Report	
Local				
Mecklenburg County Health Department	9-18-70		Submitted PSAR	
	3- 9-71		Submitted Environmental Report	
	6-10-71		Permit for McGuire Nuclear Station construction jobsite sewage facilities)	
	7- 6-71		Permit for McGuire Nuclear Station construction jobsite Aerobic Digestion sewage facilities)	10- 8-71
	8-16-71		Permit for McGuire Nuclear Station construction jobsite trailer camp sewage facilities)	
Mecklenburg County, County Manager	9-18-70		Submitted PSAR	
	3- 9-71		Submitted Environmental Report	
Charlotte Water Department	3-17-71		Submitted Environmental Report	
Central Piedmont Regional Council of Local Government	6- 1-71		Submitted Environmental Report	
Mecklenburg County Board of Commissioners	8- 2-71		Resolution to close a portion of SR 2182 at McGuire	9- 7-71
Mecklenburg County Building Inspector Division	9-18-70		Submitted PSAR	
	May 1971		Building Permit for construction of Site H 230 Kv Switch Station Relay House (Zone 1-2)	6-16-71
1. Charlotte Memorial Hospital	3-27-72		Agreement to cooperate with Duke in developing a program of treatment for any possible radiation injuries at McGuire	3-27-72 1.

STATE OF NORTH CAROLINA

DEPARTMENT OF WATER AND AIR RESOURCES

ROBERT W. SCOTT
GOVERNOR

P. D. DAVIS
J. NELSON GIBSON, JR.
WAYNE MABRY
HUGH L. MERRITT
LEE L. POWERS
J. AARON PREVOST
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GEORGE E. PICKETT, DIRECTOR
TELEPHONE 829-3003
E. C. HUBBARD, ASST. DIRECTOR
TELEPHONE 829-3006
RALEIGH, N. C. 27611
P. O. BOX 27048

IN REPLYING REFER TO:
WQ 70 LPB

March 4, 1971

Mr. W. S. Lee
Vice President, Engineering
Duke Power Company
422 South Church Street
Charlotte, North Carolina 28201

Subject: Certification to Meet Requirements
Public Law 91-224 Section 21 (b) (1)
Duke Power Company
McGuire Nuclear Station
Mecklenburg County, North Carolina

Dear Mr. Lee:

In accordance with your application dated December 18, 1970, and after advertising as required by the Board of Water and Air Resources, a certification required by Public Law 91-224 Section 21 (b) (1) has been issued. Two copies of Certificate 6-A are enclosed for your use.

If I or members of my staff can be of assistance to you, please advise.

Sincerely yours,

George E. Pickett

George E. Pickett
Director

Enclosure
cc: Mr. E. C. Hubbard
Mr. Tom Rosser
Mr. Frank R. Blaisdell
Dr. Jacob Koomen
Mr. Roy G. Sowers
Colonel Clyde P. Patton
Colonel Paul S. Denison
Dr. Peter Morris

NORTH CAROLINA
Wake County

CERTIFICATE

THIS CERTIFICATE is issued in conformity with the requirements of Public Law 91-224 of the United States and subject to the rules of the North Carolina Board of Water and Air Resources to Duke Power Company, Charlotte, North Carolina, pursuant to application filed on the 18th day of December, 1970, to discharge into the surface waters of Mecklenburg County, North Carolina, as a result of condenser cooling at Duke Power Company's McGuire Nuclear Station.

After publication of notice of the application in The Charlotte Observer on the 31st day of December, 1970, and determination that no public hearing upon said application is necessary, the North Carolina Board of Water and Air Resources hereby certifies, subject to any conditions hereinafter set forth, that there is reasonable assurance that the proposed activity of the applicant will be conducted in a manner which will not violate applicable water quality standards.

Conditions of Certificate: Applicable project construction and operation is to be done in accordance with plans and specifications made a part of the North Carolina Board of Water and Air Resources Permit No. 1977. Terms and conditions set forth in Permit No. 1977 are by reference incorporated in and made a part of this Certificate.

Violation of any of the conditions herein set forth shall result in revocation of this Certificate.

This the 4th day of March, 1971.

NORTH CAROLINA BOARD OF WATER AND AIR RESOURCES

BY George E. Pickett
George E. Pickett, Director

Certificate 6-A

STATE OF NORTH CAROLINA
DEPARTMENT OF WATER AND AIR RESOURCES

ROBERT W. SCOTT
GOVERNOR

P. D. DAVIS
J. NELSON GIBSON, JR.
WAYNE MABRY
HUGH L. MERRITT
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TELEPHONE 829-3003
E. C. HUBBARD, ASST. DIRECTOR
TELEPHONE 829-3006
RALEIGH, N. C. 27611
P. O. BOX 27048

IN REPLYING REFER TO:
WQ71CAW

March 4, 1971

Mr. W. S. Lee, Vice President
Engineering
Duke Power Company
P. O. Box 2178
Charlotte, North Carolina 28201

SUBJECT: Permit No. 1977
Duke Power Company
McGuire Nuclear Station
Cowans Ford, North Carolina
Mecklenburg County

Dear Mr. Lee:

In accordance with your application dated October 9, 1970, we are forwarding herewith Permit No. 1977, dated March 4, 1971, to Duke Power Company, McGuire Nuclear Station, Cowans Ford, North Carolina, for the construction and operation of a 2.84 B.G.D. cooling water system, consisting of three (3) low level water intakes at Cowans Ford Dam with pumps to pipe water to an intermediate level lake intake structure complete with trash racks, pumps, controls, etc., and a warm water discharge through an effluent canal into Lake Norman on the Catawba River.

This permit shall be effective from the date of its issuance until December 31, 1980, and shall be subject to the conditions and limitations as specified therein.

Also, enclosed is a copy of WPC Form #50 "Cost of Wastewater Treatment Works." This form is to be completed and returned to this office within thirty (30) days after the project is completed.

One (1) set of the approved plans and specifications is being returned to you.

Sincerely yours,

E. C. Hubbard

E. C. Hubbard
Assistant Director

Enclosures
cc: Mr. Charles Dewey
State Board of Health
Mr. L. P. Benton, Jr.

NORTH CAROLINA

BOARD OF WATER AND AIR RESOURCES

RALEIGH

P E R M I T

For the Discharge of Sewage, Industrial Wastes, or Other Wastes

---

In accordance with the provisions of Article 21 of Chapter 143, General Statutes of North Carolina as amended, and other applicable Laws, Rules and Regulations,

PERMISSION IS HEREBY GRANTED TO

Duke Power Company
McGuire Nuclear Station
Cowans Ford, North Carolina

FOR THE

construction and operation of a 2.84 B.G.D. cooling water system, consisting of three (3) low level water intakes at Cowans Ford Dam with pumps to pipe water to an intermediate level lake intake structure complete with trash racks, pumps, controls, etc., and a warm water discharge through an effluent canal into Lake Norman on the Catawba River,

in accordance with the application dated October 9, 1971, and in conformity with the plans, specifications and other supporting data, all of which are filed with the Department of Water and Air Resources and are considered a part of this Permit.

This Permit shall be effective from the date of its issuance until December 31, 1980, and shall be subject to the following specified conditions and limitations:

1. This permit shall become void unless the facilities are constructed in accordance with the approved plans and specifications and other supporting data and are completed and placed in operation on or before May 1, 1976, or as this date may be amended.

2. This permit is effective only with respect to the nature and volume of wastes described in the application, and other supporting data.

3. The facilities shall be effectively maintained and operated at all times so as to meet the temperature standards of 5°F increase above natural water temperature and a maximum of 90°F, measured as a daily average one foot below the water surface except within a mixing zone containing an area of not more than 3,500 acres and lying south of a line originating on the west bank at N. C. Coordinates E-1, 416, 900, and N-633, 600 and extending south 70°-00' east intersecting the point of land on the eastern shore, but at no time shall the heated waste discharge increase the temperature of the waters at any point within the Lake in excess of 95°F, as a monthly average.

4. The Company shall conduct both biological and physical studies necessary to establish the effect of temperature on the environment and shall include bioassays, conducted according to established procedures, to determine the 96-hour TLM temperature value for the most susceptible local aquatic species and life stages. The data obtained from such environmental studies shall be submitted annually to the North Carolina Department of Water and Air Resources to be used in the evaluation of the facility. Only after such evaluation will action be taken on extension of the expiration date contained in this permit.

5. In the event there are significant damages to aquatic life or other beneficial water uses within or outside the mixing zone, the Company shall immediately provide additional facilities as necessary to protect the designated water uses.

6. That any or all corrosion inhibitors, scale preventatives, or other chemicals used to treat make-up or cooling water, or contained in the blowdown be adequately treated prior to release.

Permit issued this the 4TH day of MARCH, 1971.

By E. C. Hubbard
E. C. Hubbard, Assistant Director
Department of Water and Air Resources

Permit No. 1977

NORTH CAROLINA

BOARD OF WATER AND AIR RESOURCES

RALEIGH

RECEIVED
OCT 1 1970
WATER AND AIR
POLLUTION CONTROL

APPLICATION FOR THE APPROVAL OF PLANS AND SPECIFICATIONS FOR

WASTEWATER COLLECTION AND/OR TREATMENT FACILITIES

AND THE

ISSUANCE OF ~~"CERTIFICATE OF APPROVAL" OR~~ "PERMIT" FOR THE

DISCHARGE OF TREATED SEWAGE, INDUSTRIAL WASTES OR

OTHER WASTES INTO THE WATERS OF THE STATE

Filed By: Duke Power Company
(Name)

Post Office Box 2178
(Address)

Charlotte, North Carolina 28201

APPROVED
NORTH CAROLINA BOARD
OF WATER AND AIR RESOURCES
Date 2-4 1971
Cert. or Permit No. 1977

WPC No. 1-5M-6-1-68

October 9, 19 70

TO: North Carolina Board of Water and Air Resources
Raleigh, North Carolina

Gentlemen:

In accordance with the provisions of Article 21 of Chapter 143, General Statutes of North Carolina as amended, application is hereby made by Duke Power Company (Name of board, individual or others) of the Charlotte (Name of city, village, town, sanitary district or establishment), in the county of Mecklenburg (Name of county), to the North Carolina Board of Water and Air Resources for the approval of the accompanying plans, specifications, and other data submitted herewith covering the construction of a Cooling water Discharge Structure to serve McGuire Nuclear Station

and for a "Certificate of Approval" and/or "Permit" for the discharge of warm water sewage, (industrial waste or other wastes) from the condensers (sewers or treatment plant) serving McGuire Nuclear Station (Name of municipality, institution, or industry, etc.) into (Name of treatment plant) or surface (surface or ground waters) waters of Lake Norman (Name of water course if surface waters; if ground waters, state water course to which they are tributary) at N618,700' E1,419,650 N. C. Grid Coordinates (Exact location of *point of discharge*).

The plans for the proposed works have been prepared by Duke Power Company (Engineering Firm) of Charlotte, North Carolina (Address). It is estimated that treatment works will provide adequate capacity to serve the McGuire Nuclear Station for a period of 40 years, at which time it is estimated the average daily sewage or waste flow will not exceed 2.84 billion gallons. It is further expected that the treatment works will effect overall reductions in pollution as follows: B.O.D. (5-day 20°C NA %, suspended solids NA %, total solids NA % coliform bacteria NA %, and toxic materials * NA %. The cost of the proposed works is estimated to be: sewers $ NA, pumping stations $ NA, treatment plant $ NA, others $____. The works will be completed and in operation on or before May 19 76

NA = Not Applicable

The applicant hereby agrees that the proposed works will be constructed in strict accordance with the approved plans and specifications or subsequently approved changes therein and further agrees to place its operation under the care of a competent person and to maintain and operate the plant according to the best accepted practice and in accordance with the plans and specifications approved by the Board.

Signature W S Lee /By L C Dail
Duke Power Company

Title Vice President, Engineering

Mailing Address Post Office Box 2178
Charlotte, North Carolina 28201

* Specify percentage reduction for each toxic substance, using additional sheet, if necessary.

STATE OF NORTH CAROLINA

DEPARTMENT OF WATER AND AIR RESOURCES

ROBERT W. SCOTT
GOVERNOR

P. D. DAVIS
J. NELSON GIBSON, JR.
WAYNE MABRY
HUGH L. MERRITT
LEE L. POWERS
J. AARON PREVOST
W. GRADY STEVENS

S. VERNON STEVENS, JR.
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P. GREER JOHNSON
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GLENN M. TUCKER
H. W. WHITLEY

GEORGE E. PICKETT, DIRECTOR
TELEPHONE 829-3003
E. C. HUBBARD, ASST. DIRECTOR
TELEPHONE 829-3006
RALEIGH, N. C. 27611
P. O. BOX 27048

IN REPLYING REFER TO:
WQ71CAW

March 4, 1971

Mr. W. S. Lee, Vice-President
Engineering
Duke Power Company
P. O. Box 2178
Charlotte, North Carolina 28201

SUBJECT: Permit No. 1982
Duke Power Company
McGuire Nuclear Station
Cowans Ford, North Carolina

Dear Mr. Lee:

In accordance with your application dated October 9, 1970, we are forwarding herewith Permit No. 1982, dated March 4, 1971, to Duke Power Company, McGuire Nuclear Station, Cowans Ford, North Carolina, for the construction and operation of an impounded 35-acre service water pond for emergency use only to shut down reactors in case Lake Norman water supply fails.

This permit shall be effective from the date of its issuance until December 31, 1980, and shall be subject to the conditions and limitations as specified therein.

Also, enclosed is a copy of WPC Form #50 "Cost of Wastewater Treatment works." This form is to be completed and returned to this office within thirty (30) days after the project is completed.

One (1) set of the approved plans and specifications is being returned to you.

Sincerely yours,

E. C. Hubbard
E. C. Hubbard
Assistant Director

Enclosures
cc: Mr. Charles Dewey
Mr. L. P. Benton, Jr.

NORTH CAROLINA

BOARD OF WATER AND AIR RESOURCES

RALEIGH

PERMIT

For the Discharge of Sewage, Industrial Wastes, or Other Wastes

---

In accordance with the provisions of Article 21 of Chapter 143, General Statutes of North Carolina as amended, and other applicable Laws, Rules and Regulations,

PERMISSION IS HEREBY GRANTED TO

Duke Power Company
McGuire Nuclear Station
Cowans Ford, North Carolina

FOR THE

construction and operation of an impounded 35-acre service water pond for emergency use only to shut down reactors in case Lake Norman water supply fails,

in accordance with the application dated October 9, 1970, and in conformity with the plans, specifications, and other supporting data, all of which are filed with the Department of Water and Air Resources and are considered a part of this Permit.

This Permit shall be effective from the date of its issuance until December 31, 1980, and shall be subject to the following specified conditions and limitations:

1. This permit shall become void unless the facilities are constructed in accordance with the approved plans, specifications, and other supporting data and are completed and placed in operation on or before May 1, 1976, or as this date may be amended.

2. This permit is effective only with respect to the nature of the operations described in the application and other supporting data.

3. The facilities shall be properly maintained at all times.

4. The Company, at least six months prior to the expiration of this permit, shall request its extension. Upon receipt of the request, the Board will review the adequacy of the facilities described herein and, if indicated, will extend the permit for such period of time and under such conditions and limitations as deemed proper.

Permit issued this the 4th day of MARCH, 1971.

By E. C. Hubbard

E. C. Hubbard, *Assistant Director*
Department of Water and Air Resources

Permit No. 1982

RECEIVED
OCT 1970
WATER AND AIR
POLLUTION CONTROL

NORTH CAROLINA

BOARD OF WATER AND AIR RESOURCES

RALEIGH

APPLICATION FOR THE APPROVAL OF PLANS AND SPECIFICATIONS FOR

WASTEWATER COLLECTION AND/OR TREATMENT FACILITIES

AND THE

ISSUANCE OF ~~"CERTIFICATE OF APPROVAL" OR~~ "PERMIT" FOR THE

DISCHARGE OF TREATED SEWAGE, INDUSTRIAL WASTES OR

OTHER WASTES INTO THE WATERS OF THE STATE

Filed By: Duke Power Company
(Name)

Post Office Box 2178
(Address)

Charlotte, North Carolina 28201

APPROVED
BOARD
WATER AND AIR RESOURCES
, 19
Cert. or Permit No.

WPC No. 1-5M-6-1-68

October 9, 19 70

TO: North Carolina Board of Water and Air Resources
Raleigh, North Carolina

Gentlemen:

In accordance with the provisions of Article 21 of Chapter 143, General Statutes of North Carolina as amended, application is hereby made by Duke Power Company (Name of board, individual or others) of the Charlotte (Name of city, village, town, sanitary district or establishment), in the county of Mecklenburg (Name of county), to the North Carolina Board of Water and Air Resources for the approval of the accompanying plans, specifications, and other data submitted herewith covering the construction of a dam to impound 35 acre Standby Nuclear Service Water Pond

and for a "Certificate of Approval" and/or "Permit" for the discharge of warm water sewage, (industrial waste or other wastes) from the closed heat exchangers (sewers or treatment plant) serving McGuire Nuclear Station (Name of municipality, institution, or industry, etc.) into (Name of treatment plant) or surface (surface or ground waters) waters of the above pond (Name of water course if surface waters; if ground waters, state water course to which they are tributary) (discharge from pond is to Catawba River) at N617,900; El, 420,450 N. C. Grid Coordinates (Exact location of *point of discharge*).

The plans for the proposed works have been prepared by Duke Power Company (Engineering Firm) of Charlotte, North Carolina (Address). It is estimated that treatment works will provide adequate capacity to serve the McGuire Nuclear Station for a period of 40 years, at which time it is estimated the average daily sewage or waste flow will not exceed negligible gallons. It is further expected that the treatment works will effect overall reductions in pollution as follows: B.O.D. (5-day 20°C NA %, suspended solids NA %, total solids NA % coliform bacteria NA %, and toxic materials * NA %. The cost of the proposed works is estimated to be: sewers $ NA, pumping stations $ NA, treatment plant $ NA, others $. The works will be completed and in operation on or before May -1- 19 76.

NA = Not Applicable

The applicant hereby agrees that the proposed works will be constructed in strict accordance with the approved plans and specifications or subsequently approved changes therein and further agrees to place its operation under the care of a competent person and to maintain and operate the plant according to the best accepted practice and in accordance with the plans and specifications approved by the Board.

Signature W. S. Lee / By L. C. Dail
Duke Power Company

Title Vice President, Engineering

Mailing Address Post Office Box 2178
Charlotte, North Carolina 28201

* Specify percentage reduction for each toxic substance, using additional sheet, if necessary.

DUKE POWER COMPANY

McGUIRE NUCLEAR STATION

UNITS 1-2

APPLICATION FOR LICENSES

DOCKETS 50-369 and 50-370

ENVIRONMENTAL REPORT SUPPLEMENT 2

May 1, 1972

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LIST OF FIGURES

1 INTRODUCTION

This Supplement 2 to the McGuire Nuclear Station Environmental Report filed March 9, 1971, is submitted to the Atomic Energy Commission as supplemental information in compliance with the Commission's letter of April 7, 1972. The following information specifically requested in the letter is included:

a. Plans and procedure proposed to be used to adequately establish the aquatic biota base line at the McGuire Site.

b. Steps proposed to establish the adequacy of the analytical model used for predicting the thermal plume at low lake levels.

c. Details of liquid radwaste model mentioned in the PSAR.

In addition, information and data developed since submission of Supplement 1 (November 24, 1971) is included.

2. DESCRIPTION OF McGUIRE NUCLEAR STATION

2.4 NATURAL ENVIRONMENT OF THE SITE

2.4.4 HYDROLOGY

As required by the Federal Power Commission, License No. 2232 the minimum continuous release from Cowans Ford Dam is 80 cubic feet per second.

3 LAKE NORMAN GENERATING COMPLEX AND ITS ENVIRONMENTAL FEATURES

3.3 RECREATION

The distance and direction from the site for the closest ten recreation areas is given in Table 3.3-1.

3.5 WILDLIFE

3.5.1 FLORA

The McGuire Nuclear Site environs consist of secondary and/or tertiary growths of plant communities. The area has been disturbed by recent logging operations and partial clearing for McGuire construction as well as by the construction of Cowans Ford Dam in the early 1960's. Nevertheless, as a whole, the less disturbed stands consist of a pine, oak, hickory, tulip poplar, and dogwood association.

There are three plant communities which are recognizable within the McGuire area. The dry ridges support almost pure stands of short-leaf and scrub pine, interspersed with red cedar. There is very little understory or ground cover in these areas.

The oak-hickory communities, mainly of the slopes, consist of oaks, hickorys, and tulip poplars. Understory trees are dogwood, red maple, and black cherry. The forest floor is partly covered with Japanese Honeysuckle, raindeer moss (*Cladonia*), and moss (*Leucobryum*). In the logged-over areas, the dogwoods are the dominant tree species.

The cove communities consist of tulip poplar, water oak, willow oak, cottonwood, and dogwood. Along the water's edge one can find black willow, serviceberry, black haw, and cat-tails. With the exception of a few cat-tails, the shoreline is void of submerged or semi-submerged aquatic plants.

The list of flora was obtained by an on-site investigation by Dr Herbert Heckenbleikner, Professor of Biology, University of North Carolina at Charlotte, North Carolina (Table 3.5-1).

3.5.2 FAUNA

Man has greatly influenced the vegetation of the McGuire Nuclear Station environs and consequently the fauna of the area has also undergone environmental changes. As a result of partial clearing for McGuire construction approximately 160 acres have been unavoidably removed from use as a possible habitat for native wildlife. The area has been developed, disturbed and logged over frequently in the past century. The impact of partial clearing upon the wildlife has been minimal since there were low populations of wildlife inhabiting the area.

A list of mammalian species was obtained from a search of the literature (Table 3.5-2).

3.6 WATER SUPPLY

Details of industrial and water supply intakes on Lake Norman and two downstream reservoirs, viz., Mtn. Island and Lake Wylie are given in Table 3.6-1. Average daily withdrawal and nature of use are included.

Table 3.3-1
10 Closest Recreation Areas

NAME	DISTANCE	QUADRANT
1. Bills Marina	1.7 Miles	NW
2. Outrigger Harbor	2.27 Miles	NE
3. Blacks Fish Camp & Marina	3.2 Miles	NW
4. Ranger Island Marina	3.2 Miles	NW
5. Joe's Marina	3.3 Miles	NE
6. Ramsey Creek Access	3.3 Miles	NE
7. Wer-Rena Marina	3.4 Miles	NE
8. Ye Old Camp Ground	3.4 Miles	NE
9. Beatty's Ford Access	3.4 Miles	NW
10. Holiday Land	3.4 Miles	NW

Table 3.5-1

List of Vascular Flora

OPHIOGLOSSACEAE (Adder's - Tongue Family)
Botrychium virginianum (L.) Swartz, Rattlesnake Fern

PTERIDACEAE (Bracken Fern Family)
Pteridium aquilinum (L.) Kuhn, Bracken Fern

PINACEAE (Pine Family)
Pinus echinata Miller, Short-leaf Pine
Pinus virginiana Miller, Scrub Pine

CUPRESSACEAE (Cypress Family)
Juniperus virginiana L.,Red Cedar

TYPHACEAE (Cat-tail Family)
Typha latifolia L., Common Cat-tail

LILIACEAE (Lily Family)
Smilax rotundifolia L., Greenbrier
Smilacino racemosa (L.) Desf, False Solomon's-seal
Polygonatum biflorum (Walter) ELL., Solomon's seal

IRIDACEAE (Iris Family)
Iris verna L., Dwarf Iris

SALICACEAE (Willow Family)
Salix nigra Marshall, Black Willow
Populus deltoides Marshall, Cottonwood

JUGLANDACEAE (Walnut Family)
Juglans nigra L., Black Walnut
Carya ovata (Miller) K. Koch, Shagbark Hickory
Carya tomentosa (Poiret) Nuttall, Mockernut
Carya glabra (Miller) Sweet, Pignut Hickory

FAGACEAE (Beech Family)
Fagus grandifolia Ehrhart, Beech
Quercus alba L., White Oak
Quercus stellata Wang, Post Oak
Quercus rubra L., Red Oak
Quercus rubra borealis (Michaux f.) Farwell, Northern Red Oak
Quercus coccinea Muenchh, Scarlet Oak
Quercus falcata Michaux, Southern Red Oak
Quercus nigra L., Water Oak
Quercus phellos L., Willow Oak

ULMACEAE (Elm Family)
Ulmus alata Michx., Winged Elm

Table 3.5-1 - Continued

ARISTOLOCHIACEAE (Birthwort Family)
Asarum canadense L., Wild Ginger

PHYTOLACCACEAE (Pokeweed Family)
Phytolacca americana L., Poke

BERBERIDACEAE (Barberry Family)
Podophyllum peltatum L., May Apple

MAGNOLIACEAE (Magnolia Family)
Liriodendron Tulipifera L., Tulip Tree

PAPAVERACEAE (Poppy Family)
Sanguinaria canadensis L. Bloodroot

HAMAMELIDACEAE (Witch-hazel Family)
Liquidambar styraciflua L. Sweet-gum

ROSACEAE (Rose Family)
Potentilla simplex Michx., Five-fingers
Rubus cuneifolius Pursh, Blackberry
Amelanchier arborea (Michx. f.) Fernald var. Arborea (Michx. f.) Serviceberry
Prunus americana Marshall, Wild Plum
Prunus serotina Ehrhart, Black Cherry

FABACEAE (Pea Family)
Gleditsia triacanthos L., Honey Locust

ANACARDIACEAE (Cashew Family)
Rhus radicans L., Poison Ivy
Rhus glabra L., Smooth Sumac

AQUIFOLIACEAE (Holly Family)
Ilex opaca Aiton, Holly

CELASTRACEAE (Staff-tree Family)
Euonymus americanus L., Strawberry Bush

ACERACEAE (Maple Family)
Acer rubrum L., Red Maple

VITACEAE (Vine Family)
Parthenocissus quinquefolia (L.) Planchon, Virginia Creeper
Vitis rotundifolia Michx., Muscadine

NYSSACEAE (Sour Gum Family)
Nyssa sylvatica Marshall, Black Gum

CORNACEAE (Dogwood Family)
Cornus florida L., Flowering Dogwood

ERICACEAE (Heath Family)
Rhododendrum nudiflorum (L.) Torrey, Wild Azalea

EBANACEAE (Ebony Family)
Diospyros virginiana L., persimmon

OLEACEAE (Olive Family)
Fraxinus pennsylvanica Marshall, Red Ash

LAMIACEAE (Mint Family)
Lamium amplexicaule L., Henbit

SCOPHULARIACEAE
Verbascum blattaria L. Mullein

RUBIACEAE (Madder Family)
Houstonia caerulea L., Bluets

CAPRIFOLIACEAE (Honeysuckle Family)
Lonicera japonica Thunberg, Japanese Honeysuckle
Viburnum prunifolium L., Black Haw

ASTERACEAE (Aster Family)
Krigia dandelion (L.) Dwarf Dandelion
Taxacum officinale Wiggers Common Dandelion
Antennaria solitaria Rydberg, Pussy-toes

Table 3.5-2

List of Probable Mammalian Species of Mecklenburg County

Common Name	Species	Relative Abundance	Habitat Preference
Oppossum	Didelphis marsupialis	Numerous	Low tangled woodlands along streams.
Southeastern Shrew	Sorex longirostris	Rare	Damp woods and swamps.
Short-tailed Shrew	Blarina brevicauda	Uncommon	Damp woods, upland fields.
Least Shrew	Cryptotis parva	Uncommon	Woody, old fields of abandoned farms.
Eastern Mole	Scalopus aquaticus	Common	Cultivated fields, gardens, pine woods and old fields.
Little Brown Myotis	Myotis lucifugus	Rare	Caves, tunnels, hollow trees.
Keen Myotis	Myotis keeni	Rare	Mine tunnels, caves, storm sewers.
Silver-haired Bat	Lasionycteris noctivagans	Uncommon	Forested areas along rivers and streams.
Eastern Pipistrelle	Pipistrellus subflavus	Common	Caves, wooded areas near water.
Big Brown Bat	Eptesicus fuscus	Rare	Caves, crevices, hollow trees, and abandoned houses..
Red Bat	Lasiurus borealis	Common	Trees and shrubs.
Hoary Bat	Lasiurus cinereus	Uncommon	Wooded areas.
Evening Bat	Nycticeus humeralis	Common	Buildings and hollow trees.

Table 3.5-2 Continued

Common Name	Species	Relative Abundance	Habitat Preference
Big-eared Bat	Plecotus rafinesquii	Rare	Trees, caves, and buildings.
Raccoon	Procyon lotor	Numerous	Wooded areas bordering streams or lakes.
Long-tailed Weasel	Mustela frenata	Rare	Burrows under woodland stumps along forest edges, sparse timbered areas.
Mink	Mustela vison	Common	Semi-aquatic along streams and lakes.
Striped Skunk	Mephitis mephitis	Uncommon	Open farmland or wasteland.
Red Fox	Vulpes fulva	Common	Woods to open fields.
Gray Fox	Urocyon cinereoargenteus	Common	Dense cover near water, woodlands.
Eastern Gray Squirrel	Sciurus carolinensis	Numerous	Hardwood forests, near human habita ons.
Southern Flying Squirrel	Glaucomys volans	Common	Open hardwood forests.
Rice Rat	Oryzomys palustris	Uncommon	Marshy areas, grasses, sedges.
Eastern Harvest Mouse	Reithrodontomys humulis	Uncommon	Old fields, wet meadows.
White-footed Mouse	Peromyscus leucopus	Common	Border of wooded or brushy areas.
Golden Mouse	Ochrotomys nuttalli	Common	Forests with dense undergrowth.

Table 3.5-2 Continued

Common Name	Species	Relative Abundance	Habitat Preference
Cotton Rat	*Sigmodon hispidus*	Common	Overgrown fields.
Meadow Vole	*Microtus pennsylvanicus*	Uncommon	Low moist areas, high grass lands.
Rock Vole	*Microtus chrotorrhinus*	Common	Mossy rocks and logs.
Pine Vole	*Microtus pinetorum*	Common	Semi-underground, open woods, and apple orchards.
Muskrat	*Ondatra zibethicus*	Numerous	Along ponds, lakes and streams.
Meadow Jumping Mouse	*Zapus hudsonius*	Uncommon	Open fields, dry meadows.
Eastern Cottontail	*Sylvilagus floridanus*	Numerous	Open fields and scrub land.
White-tailed Deer	*Odocoileus virginianus*	Uncommon	Open woods and brushy meadows.

References:

(1) Burt, W. H. and R. P. Grossenheider, A Field Guide to the Mammals, 2nd Ed., Sponsored by the National Audubon Society and National Wildlife Federation, 1964.
(2) Hall, E. R. and K. R. Kelson, 1959. Mammals of North America, Vol. 1 & 2, New York: Ronald Press.
(3) Miller, W. C. A Checklist of North Carolina Species. North Carolina Wildlife Resources Commission 1969.
(4) Hamilton, W. J. Jr. 1943. The Mammals of Eastern United States. Ithaca: Comstock Publ. Company, Inc.

Table 3.6-1
Municipalities and Industries Withdrawing Water From
Lake Norman, Mt. Island and Wylie Reservoirs on Catawba River

I. MUNICIPALITIES

	RESERVOIR	AVERAGE WITHDRAWAL MGD	PURPOSE
Davidson	Norman	0.22	City Supply
Huntersville	Norman	0.16	City Supply
Mooresville	Norman	2.0	City Supply
Charlotte	Mt. Island	34.0	City Supply
Belmont	Wylie	3.0	City Supply
Mt. Holly	Wylie	1.3	City Supply

II. INDUSTRIES

Southern Dye Stuff (Mt. Holly)	Wylie	1.5	Industrial Processing
American Efird Thread Plant (Mt. Holly)	Wylie	2.4	Industrial Processing
Superior Yarn Mills (Mt. Holly)	Wylie	0.03	Industrial Processing
Westinghouse (Charlotte)	Wylie	0.04	Industrial Processing

4. ENVIRONMENTAL EFFECTS OF McGUIRE NUCLEAR STATION

4.1 THERMAL EFFECTS

4.1.3 LAKE NORMAN MONITORING PROGRAM

The biological sampling program which will monitor the effects of McGuire on the biota in Lake Norman is outlined in Table 4.1-3.

4.1.5 DDESCRIPTION OF CONDENSER COOLING WATER SYSTEM

The residence times of entrained organisms in the condenser, discharge pipe and discharge canal are summarized below:

No. of Pumps	Time in Condensers	Time in Pipe	Time in Discharge Canal	
			Lake Elev. 760 Ft.	Lake Elev. 735 Ft.
2	10.0 sec.	56 sec.	1.37 hr.	0.39 hr.
3	7.5 sec.	41 sec.	1.02 hr.	0.28 hr.
4	6.5 sec.	36 sec.	0.88 hr.	0.24 hr.

4.1.6 EFFECT OF WARMED DISCHARGE ON LAKE NORMAN

The topography in the vicinity of McGuire is shown on Figure 4.1-8.

The analysis of the thermal influence of McGuire Nuclear Station on Lake Norman was divided into two parts. Part I of the analysis was the determination of the vertical temperature profiles (water depth vs water temperature) which will occur in Lake Norman with the influence of McGuire. From these profiles, the inlet temperatures to McGuire's condensers were determined and thus the expected discharge temperatures were also determined. In Part 2 of the analysis, the distriubtion of heated water on the surface of the lake was calculated.

Part I

Lake Norman's projected temperature profiles were based on profiles actually measured in the lake in front of Cowans Ford Dam, 1963 - May 1970. These were synoptic measurements taken with a frequency ranging from once a month to once a week. For every month of record, the extreme (warmest) measured profile was identified and the average of all the measured profiles was found. Computations for normal yearly conditions were based on the 12 warmest profiles. Thus, the extreme year is a "composite" year formed by the warmest January, the warmest February (probably from different years), etc. and this extreme year is a most conservative one.

McGuire will have intakes at two levels. The main intake will be a mid-depth one. For this study, its opening was assumed to be between elevations 720 ft and 735 ft (Lake Norman "full pond" elevation is 760 ft). The second intake was built during the construction of Cowans Ford Dam and its opening lies between elevations 655 ft and 670 ft. This deep intake will only be used during the months of the year when the water drawn into the upper intake is warmest. Under these condtions, the deep intake will provide some cool hypolimnetic water to "temper" the water from the main intake and thus reduce

McGuire's summer discharge temperatures. Water from the low intake will only be required during July, August and September. A minimum condenser temperature rise of 16 F was used.

The withdrawal of water from Lake Norman by McGuire will alter the temperature profiles since both the high and low level intakes are located beneath the lake's surface. The withdrawal of a given volume of water was represented graphically by removing that volume (measuring upward from the bottom of the intake structure) moving the overlying water temperatures down depths within the lake corresponding to the removed volume and returning the withdrawn water on top with a net residual temperature 1 F higher than the existing lake surface temperature. The residual temperature was an estimate based on cooling areas calculated by the methods proposed by Velz and Gannon.[1]

This procedure was followed for each of the 12 months of the year.

Figures 4.1-9 and 4.1-10 will help illustrate the method used. The figures represent the months of June and July respectively. In June, it is seen that withdrawal can be made from the higher intake only without exceeding 74 F average intake temperature (74 F + 16 FΔT = 90 F discharge). However, in July, it is necessary that a quantity of water be withdrawn from the low intake so that the discharge temperature will not exceed 90 F. The effect of the withdrawal at the 90 ft depth is easily seen. Also of interest in both figures is the fact that strict adherence to the described methodology sometimes leads to "unstable" profiles (cool water on top of warmer water) and these instabilities must be averaged out. This explains the occurrence at some depths of two lines, both labeled "next month's adjusted profile." The smoother of the two lines is the one finally used.

Computations for the normal year used monthly average surface elevations which had prevailed on Lake Norman since 1963. It was found that the supply of cool hypolimnetic water is sufficient to limit McGuire's normal monthly average discharge temperatures to 90 F. This meets the maximum temperature criteria set by the State of North Carolina. However, since these temperatures will still be more than 5 F above normal temperatures, a small mixing zone will be required to comply with the North Carolina regulation which restricts the temperature rise to 5 F.

For "extreme year" computations, the lake surface level was assumed to be 745 ft in July and August and 750 ft for the remaining months. The hypolimnetic supply was able to hold discharge temperatures to 95 F under these conditions, and a mixing zone would be required to meet both temperature criteria.

Part 2

Velz and Gannon have derived a mathematical expression for integrating heat loss as a function of temperature in order to calculate the amount of area needed to dissipate a quantity of heat. However, the equation does not account for the dilution of the warm plume with cooler water from the lake.

[1] "Forecasting Heat Loss in Ponds and Streams," C. J. Velz and J. J. Gannon Journal-Water Pollution Control Federation, Vol. 32 No. 4.

Temperature measurements which had been made around the Marshall Steam Station, also located on Lake Norman, showed that the rate of temperature loss could not be explained by surface heat transfer alone. There was substantial temperature reduction in a small area and this can best be explained by dilution which occurs near the discharge into the lake.

Accordingly, initial dilution at McGuire was assumed to correspond to the dilution experienced at Marshall. Then the heat transfer equation was applied to the new lower temperature and the required cooling areas were calculated. More cooling area is required in winter than in summer since evaporation is slower at lower ambient temperatures. Meteorological observations for a 30 year period (Charlotte National Weather Service Station) were examined and conditions were picked to represent the "worst" cooling occurring with a frequency of 1 in 10 years. The area required to cool within 5 F of normal temperature is about 3500 acres. The summer cooling area is expected to be only 1500 acres.

Conclusions

The influence of McGuire Nuclear Station on Lake Norman will be minimized in two ways. First, it will employ a condenser capable of restricting the temperature rise of the cooling water to 16 F. Second, judicious use of Lake Norman's cool hypolimnectic water resource will prevent McGuire's discharge temperatures from exceeding 90 F except in the most extreme year, and will assure that the discharge temperatures will not exceed 95 F even under most adverse conditions.

In order to comply with North Carolina temperature standards, the heated condenser cooling water must not be warmer than 90 F and must not be more than 5 F warmer than the ambient water temperatures, after having passed through a mixing zone. The latter criterion is the most difficult to meet and winter conditions prove more difficult than summer ones because heat transfer is slower in winter. A mixing zone area of 3500 acres will be sufficinet to meet all the temperature criteria nine years out of ten. In summer an area of only 1500 acres will be sufficient for meeting the criteria.

Isotherm areas and lake volumes beneath a 3500 acre plume are shown on Table 4.1-4.

Realizing that larger generating facilities mean greater involvement of water resources and require comprehensive long range planning, Duke Power in 1970 commissioned Alden Research Laboratories of Worcester Polytechnic Institute of Holden, Massachusetts to build a physical hydraulic model of the Lake Norman generating complex. Studies to be made at Alden will supplement Duke's comprehensive water research program, outlined in Section 4.1 of the McGuire Nuclear Station Environmental Report. The object of both programs is to further establish the performance of existing facilities and to produce design parameters for future development of generating facilities on Lake Norman

The projected impact of McGuire Nuclear Station on Lake Norman will be verified during the on-going model tests. Thus prior to operation in 1976, the McGuire design will receive a thorough review.

4.1.7 ECOLOGICAL EFFECTS

If the reproduction and growth of the principal species of fish in Lake Norman are protected, it seems reasonable that generally the associated aquatic biota will also be protected. There is a substantial amount of evidence that fish are frequently more sensitive to elevated temperatures than are most organisms lower in the food chain. Mount[1] stated that "Two functions which cannot be altered if we are to have a satisfactory crop of fish are reproduction and growth." Furthermore, he says that "If these are satisfactory, one would be hard pressed to justify any further restrictions on the addition of heat to a body of water, since the 'crop' is acceptable." These two criteria of reproduction and growth were certainly the ones used by the National Technical Advisory Committee[2] when they established their maximum temperatures recommended as compatible with the well-being of various species of fish and their associated biota.

From the data presented in Table 4.1-5, it can be seen that the final preferendum temperature of some of the principal fishes of Lake Norman is approximately 90 F and that their upper temperature tolerance limits are at least 93 F at the upper acclimation temperatures. The maximum temperatures recommended by the National Technical Advisory Committee as compatible with the well-being of various species of fish and their associated biota is 93 F for the growth of white bass, catfish, threadfin shad, gizzard shad, and 90 F for the growth of largemouth bass, bluegill, and crappie.

It was concluded in section 4.1.6 that "under probable, or average experienced conditions of record, the condenser cooling water discharge temperature will not exceed a monthly average of 90 F." Thus, the growth of the various fish species of the lake should be assured under the probable conditions. As noted in section 4.1.7 the spawning times of some fish species may be modified by variations in water temperatures between the discharge and ambient lake areas, but detrimental effects are not expected. In fact, successful spawning by three characteristic Lake Norman fish species, shad, largemouth bass, and yellow perch has been reported for the discharge area of Marshall Steam Station. Shad "eggs were observed to be most numerous near the point of discharge adhering to the discharge structure and to rocks and vegetation lining the discharge canal."[3] Largemouth bass spawned earlier in the region of the discharge cove than in the control coves with "numerous young-of-year largemouth bass (being observed) in the discharge canal and cove;" later examination showed discharge fish to be significantly larger both in length and weight than those caught from control coves.

[1]Mount, D.I., 1969. "Developing Thermal Requirements for Freshwater Fishes" in "Biological Aspects of Thermal Pollution." Vanderbilt University Press, page 143.

[2]National Technical Advisory Committee. 1968. Water Quality Criteria. Federal Water Pollution Control Administration, page 43.

[3]Adair, W.D. and D.J. DeMont. 1971. "Fish" in "An Interim Report on Environmental Responses to Thermal Discharges from Marshall Steam Station, Lake Norman, North Carolina," page 54.

Spawning of some species such as bluegills may be excluded from the discharge canal because of the water flow. However, no detrimental temperature effects upon spawning or growth of the various fish species under probable conditions should occur. Thus, protection of the spawning and growth of the fishes of Lake Norman should also afford general protection to the associated aquatic biota.

In the event that the extremely improbable adverse cooling conditions occur, a discharge of 95 F may occur. Under these conditions movement of many of the fish species into areas where the temperature is near optimum would be likely. The ability of a wide variety of fish species to discriminate between small temperature diffences has been demonstrated.[4] In experiments by Bull,[5] responses were obtained for temperature differences of 0.18 F and less and he concluded that "in the discriminatory perception of temperature a fish is provided with a sensory field which is so acutely sensitive as to be of obvious value in directive movements." As described in section 4.1.6 during the months that represent the extreme improbable adverse cooling conditions, the area of the mixing zone will be 3500 surface acres. The volume of water within the mixing zone will represent only approximately 12.5 percent of the lake volume beneath the 3500 acre surface area. In view of the fact that fishes can discriminate between various temperatures, their ability to avoid the discharge plume, if desired, seems obvious.

[4] Brett, J.R. 1956. "Some Principals in the Thermal Requirements of Fishes", Quart. Rev. Biol. 31 (2): 75-87.

[5] Bull, H.O. 1936. "Studies on Conditioned Responses in Fishes", J. Mar. Biol. Assoc. U.K. 21,1.

4.2 RADIOLOGICAL EFFECTS

4.2.2 RADIOACTIVE LIQUID RELEASES

The Average Additional Discharge Concentration shown in Tables 4.2-3a and 4.2-3b is found by diluting the annual release by the annual average condenser cooling water flow. The maximum instantaneous concentration shown in Table 4.2-4 is reactor coolant activity as diluted by the ratio of the minimum conderser cooling water flow to the waste monitor tank pump flow. Fractions of maximum permissible concentration (FMPC) are found by dividing a concentration by the legal limits shown in 10CFR20. The above calculations are based on an uncontaminated water intake to the condensers.

If the condenser cooling water contains activity, then the actual discharge concentration will be that predicted above plus the concentration of the intake. In order to predict the intake concentration, a model representing the lake as two control volumes was used. The first control volume, called the Pool, has only condenser cooling water discharge as an input. Its only output is an equivalent flow to the other control volume which is called the Channel. In addition to the flow from the pool, the Channel has as an input and output equal to the yearly average stream flow. The condenser cooling water intakes are also an output of the Channel. These relationships are shown in Figure 4.2-1.

The differential equations(1) describing this model are:

$$\frac{dNc}{dT} = \frac{Rcp}{Vp}Np - \left[\frac{Rcp + Rco}{Vc} + \lambda\right] Nc$$

$$\frac{dNp}{dT} = A + \frac{Rcp}{Vc} Nc - \left[\frac{Rcp}{Vp} + \lambda\right] Np$$

where: Nc = activity in channel; $\frac{Nc}{Vc}$ = Channel concentration

Np = activity in pool; $\frac{Np}{Vp}$ = Pool concentration

Vp = volume of pool

Vc = volume of channel

Rcp = condenser cooling water flow

Rco = flow across dam

A = activity addition by McGuire

λ = decay constant

In view of the fact that concentrations are averaged over a period of a year, in accordance with 10CFR20, equilibrium solutions are used. They are:

$$\frac{Nc}{Vc} = \frac{ARcp}{(Rcp + \lambda Vp)\ (Rcp + Rco + \lambda\ Vc) - (Rcp)\ (Rcp)}$$

(1) Similar to equations in North Anna PSAR Supplement Volume 2.

$$\frac{N_p}{V_p} = \frac{A(R_{cp} + R_{co} + \lambda V_c)}{(R_{cp} + \lambda V_p)(R_{cp} + R_{co} + \lambda V_c) - (R_{cp})(R_{cp})}$$

The V's in this model correspond to the volumes of the pool and channel and concentration is assumed to be constant over these volumes and zero elsewhere. The physical situation will not be quite this way. There will probably be some affected volume with some variable concentration as a function of position; however, in order to successfully apply our model to this situation, all this is needed is an appropriately chosen volume. It can be seen from the equations above that volume affects only decay. If λ is zero then concentration is independent of volume and when λ is not zero it is reduced. Therefore, the choice of a small volume is a conservative one.

A listing of assumptions and parameters is shown in Table 4.2-11.

For a conservative estimate of the dilution of the concentration of radioisotopes in the water discharged from Lake Norman, the following assumptions can be made:

1. Ignore decay (short transit times).

2. Assume that all additional dilution occurs just upstream of each hydro station.

The concentrations in the lakes indicated below can be expressed as a fraction of the maximum concentration in Lake Norman as follows:

Hydro Station	Average Stream Flow (CFS)
Cowans Ford	2670
Mountain Island	2700
Wylie	4100
Fishing Creek	4860
Great Falls	5150

Mountain Island = Lake Norman

Wylie = $\frac{(2670)}{(2700)}$ x Lake Norman

Fishing Creek = $\frac{(2670)}{(4100)}$ x Lake Norman

Great Falls = $\frac{(2670)}{(4860)}$ x Lake Norman

Below Great Falls = $\frac{(2670)}{(5150)}$ x Lake Norman

4.2.4 SOLID WASTE DISPOSAL

An estimated volume of 480 $ft.^3$ of demineralizer resins and 1000 $ft.^3$ of evaporator "bottoms" will be generated each year for 2 units. These wastes will range in activity from 0 to a maximum of 6×10^5 curies in the resins and 2×10^5 curies in the "bottoms" assuming 1 percent fuel defects in each unit.

4.3 OTHER WATER QUALITY EFFECTS

4.3.1 MECHANICAL CLEANING OF CONDENSER TUBES

The condenser cooling water tubes are stainless steel. Considering the high purity and nonaggressive nature of the cooling water, there should be no significant corrosion products released from the tubes to Lake Norman.

4.3.3 NONRADIOACTIVE WASTE WATER DISCHARGES

The following chemicals will be used in the primary and the secondary systems at McGuire:

1. Approximately eleven pounds of lithium hydroxide will be used per unit per year. The lithium will be removed by demineralizers and the resin will be drummed as solid waste.

2. Approximately 18,000 pounds of boric acid will be used per unit per year. It will be disposed of by concentration by evaporation and then drummed as solid waste.

3. Approximately 2,000 pounds of hydrazine will be used per unit per year. The hydrazine reacts chemically with oxygen in the system to form nitrogen and water, with a small portion of the hydrazine decomposing to form ammonia.

4. Approximately 26,000 gallons of 30 percent aqua ammonia will be used per unit per year. This is used for pH control of steam generator feedwater and small amounts will be disposed of through the steam generator blowdown.

5. The corrosion inhibitor in the secondary recirculating cooling water system will be sodium nitrite and borax. Approximately 1,200 pounds will be used per unit per year. This is a closed system with no blowdown.

6. Approximately 800 gallons of commercial liquid detergents will be used annually by the station for normal plant maintenance and cleanup. Any waste from this operation will be processed through the plant sewage treatment system. Powdered detergents used for the decontamination of clothing, equipment, laundries and laboratory articles may be used in quantities up to 3,200 pounds per year for two units. The laundry waste water will be processed through activated carbon filters for removal of organics and detergents.

7. Approximately five to 56 pounds of 100 percent hydrazine and approximately seven gallons of 30 percent aqua ammonia will be added per day per unit to the steam generator feedwater.

The blowdown system on each unit is designed for a maximum capacity of 600,000 pounds per day. There is the normal makeup capability of 475 gpm or 5,700,000 pounds per day for two units. The limiting concentrations of solids and chemicals in the boiler blowdown are given in Table 4.3-1.

4.3.4 DEMINERALIZED WATER SUPPLY

The two regenerable mixed bed makeup demineralizers, manufactured by Illinois Water Treatment Company, have a capacity of 475 gpm each. Approximately 137,000 pounds of 100 percent sodium hydroxide and 89,000 pounds of 66 F Baume sulfuric acid will be used per unit per year to regenerate the mixed bed demineralizers. After regeneration the spent acid and caustic will be mixed to assure neutralization. These reaction products are sodium sulfate and alkalinity. The average effluent from the waste water collection basin will contain approximately 45 ppm of sodium sulfate and 33 ppm of alkalinity expressed as $CaCo_3$. When this effluent from the waste water collection basin is diluted by the average flow of 2670 cfs through Cowans Ford Dam it would only contribute approximately 0.0002 ppm alkalinity as $CaCo_3$ and 0.0002 ppm of sodium sulfate to the Catawba River. When flow through Cowans Ford is at its minimum of 80 cfs, these effluents result in an increase of 0.6 ppm alkalinity and 0.8 ppm sodium sulfate in the river water.

4.4 LAND USE

4.4.1 McGUIRE NUCLEAR STATION

As mentioned in Section 4.4.1, the immediate vicinity of the site is relatively unpopulated and without commerce or industry of any importance. No industry employing more than 10 persons exists within one (1) mile of the site. Industries with 30 to 50 employees do not exist within a five (5) mile radius of the site. However, there are 12 major industries with more than 100 employees within ten (10) miles of the site (Table 4.4-1).

No major food processing industry exists within a ten (10) mile radius of the site.

The nearest farm is located about 0.8 mile from the site in the southeast quadrant.

4.4.2 NEARBY TRANSMISSION LINES

The length and width of transmission line rights of way between the switchyards and the plant are as follows:

	525 Kv Single Circuit Line	230 Kv Single Circuit Lines (Parallel) East Line	230 Kv Single Circuit Lines (Parallel) West Line
Length (Mile)	0.63	0.75	0.76
Width (Ft.)	200	270[(1)]	

Project uses of the above rights of way are:

	525 Kv Single Circuit Line	230 Kv Single Circuit Lines East Line	230 Kv Single Circuit Lines West Line
Farmland (Mile)	0.51	0.73	0.68
Works related to McGuire Powerhouse	0.12	0.02	0.08

(1) Combined width for the two parallel lines

4.7 McGUIRE NUCLEAR STATION AND THE ECONOMY

4.7.1 IMPACT OF CONSTRUCTION FORCES

Based on experience on similar Duke projects, it is estimated that about 75 percent of the work force will be drawn from the neighboring Mecklenburg, Lincoln, Gaston, Catawba and Iredell Counties; 13 percent will move into this area from other Duke jobs and the remaining 12 percent will live within commuting distance or will avail themselves of the bachelor quarters provided by Duke near the construction site. No family housing will be provided by Duke. Very few people are expected to move into the neighborhood to work on the project and as observed on other Duke projects, the completion of the project is unlikely to affect the neighboring countryside materially. No major construction, employing more than 500 workers, is in progress in this area.

Estimated manpower requirement and payroll during construction period is given in Table 4.7-1.

Table 4.1-3

The Biological Sampling Program For The Aquatic Environs Of McGuire Nuclear Station

The program as outlined is the basic plan to be periodically reviewed and revised as appropriate to achieve the program objectives.

A minimum of one full year of data will be collected prior to plant operation, plus operational monitoring.

The McGuire biological sampling program is to be coordinated with the work of other investigators and sampling programs at other relevant locations to achieve maximum multi-use of data.

Objectives:

1. To provide a basis for assessing the consequences of thermal discharges.

2. To provide baseline information which can be used for future comparison.

SAMPLING PROGRAM

PARAMETER	SAMPLING PLAN	FREQUENCY OF SAMPLING
1. Benthos	Sampling stations will be located in front of the intake and the discharge, and then at intervals North of the intake and Northeast of the discharge.	Seasonally, 4 times per year
2. Plankton a. Zooplankton b. Phytoplankton	Sampling stations will be located at the intake and the discharge, plus along two transects, one North of the intake, the other Northeast of the discharge into Ramsey Creek Cove.	Bimonthly, 6 times per year

PARAMETER	SAMPLING PLAN	FREQUENCY OF SAMPLING
3. Periphyton	Four stations will be maintained. Sampling at Cowans Ford Dam will be continued, plus new stations will be established in the discharge area.	Monthly
4. Fish*	a. Identify the spawning areas on Lake Norman with emphasis on Ramsey Creek Cove.	a. During spawning season
	b. Determine species composition, size class, and age composition of fish in Lake Norman with emphasis on Ramsey Creek Cove.	b. To be determined
5. Synoptic Water Quality	Sample necessary parameters (temperature,dissolved oxygen, etc.) to establish baseline water quality data and to provide supporting data for the benthos, plankton, periphyton and fish sampling programs.	As necessary
6. Continuous Water Temperature Monitoring	Besides continuing the temperature monitoring station at Cowans Ford Dam, several continuous temperature recording stations will be located in the vicinity of McGuire within the expected plume trajectory. (To supplement synoptic program.)	Continuous

* The fish study as outlined will be requested from the N. C. Wildlife Resources Commission. If this state agency cannot undertake such a project, other possibilities will be explored.

Table 4.1-4

Isotherm Areas
1 in 10 Recurrence Frequency

Winter: Ambient Water Temperature-40 F; Discharge Water Temperature-72 F;

Temperature	Area
55 F	800 acres
50 F	1800 acres
45 F	3400 acres

Summer: Ambient Water Temperature-84 F; Discharge Water Temperature-92 F;

Temperature	Area
91 F	400 acres
90 F	900 acres
89 F	1500 acres

Volume of Lake Norman Beneath a 3500-acre Plume from McGuire Nuclear Station

For Various Lake Levels

Lake Level	Volume Beneath 3500-Acre Area
760 ft above MSL (full)	117,800 acre-feet
755 ft above MSL -	116,300 acre-feet
750 ft above MSL -	113,500 acre-feet
745 ft above MSL -	112,900 acre-feet
735 ft above MSL -	111,200 acre-feet

Table 4.1-5

Median Heat-Tolerance Limits, Median Temperature Tolerance Limits and Final Preferendum Temperatures for Some of the Principal Fishes of Lake Norman

Species	Median Heat Tolerance Limits		Median Temperature Tolerance Limits			Final Preferendum Temperature
		Time (Hrs)	Acclimated to F	Upper Limit F	Time (Hrs)	
Gizzard shad	99.1[4]	-	77	93.2	48	-
Dorosoma cepedianum (La Sueur)			95	98.6	48	
Carp	96.3[1]	24	-	-	- -	89.6[7]
Cyprinus carpio Linnaeus						
Golden shiner	94.5[4]		68	89.6	66	
Notomigonus crysoleucas (Mitchill)		-	86	95.0	66	-
Channel catfish			59	86	24	
Ictalurus punctatus (Rafinesque)	-	-	77	93.2	24	-
Mosquitofish	99.1[4]		59	95	66	
Gambusia affinia (Baird and Girard)		-	95	98.6	66	-
Largemouth bass	97.5[4]	-	68	89.6	72	86 - 89.6[6]
Micropterus salmoides (Lacepede)	84.0[1]	24	86	93.2	72	
Bluegill	92.8[4]	-	50	82.4	24	90.1[3]
Lepomis macrochirus (Rafinesque)			86	96.9	24	
Yellow perch	90.1[4]	-	41	69.8	96	69.8[5]
Perca flarescens (Mitchill)	87.6[2]	12	77 (winter)	86	96	
	84.6[1]	24	77 (summer)	89.6	96	

Numbers indicate the reference cited.

References

(1) Black, E. C. 1953. "Upper Lethal Temperatures of Some British Columbia Fresh Water Fishes." Jour. Fish. Res. Bd. Can., Vol. 10, 196-210.

(2) Brett, J. R. 1944. "Some Lethal Temperature Relations of Algonquin Park Fishes." Univ. Toronto Stud. Biol. Ser. 52, Publ. Ont. Fish. Res. Lab., No. 63, 1-49.

(3) Fry, F. E. J., and B. Pearson, 1952. "Temperature Preference, Lethal Temperatures, Cruising Speed of the Bluegill." M.S.

(4) Hart, J. S. 1952. "Geographic Variations of Some Physiological and Morphological Characters in Certain Fresh Water Fishes." Univ. Toronto Stud. Biol., Ser. 60; Pub. Ont. Fish. Res. Lab., Nor. 72, 1-79.

(5) McCracken, F. D., and S. H. Strukman. 1948. "Preliminary Observations on the Preferred Temperature of the Perch." MS.

(6) Pennsylvania Department of Health. "Heated Discharges.. Their effects on Streams" Report by the Advisory Committee for the Control of Stream Temperatures to the Pennsylvania Water Board, Harrisburg, Pa. Pa. Dept. Health Pbl. No. 3, 108 pp.

(7) Pit, T. K., E. T. Garside, and R. L. Hepburn, 1956. "Temperature Selection of the Carp" (Cyprinus carpio Linn.). Can. J. Zool., Vol. 34, 555-557.

Table 4.2-11

Assumptions In The Lake Model

(1) Radioactive wastes remain with the water they are released with.

(2) Perfect mixing occurs where the waste is added to the condenser cooling water and where its equivalent flow joins the stream flow in the channel.

(3) Stream flow into the pool and evaporation are neglected.

Parameter	Value
Condenser cooling water flow	1.63×10^6 gpm
Flow past dam	2670 cfs
Volume of pool (Approx.)	10^8 ft^3
Volume of channel (Approx.)	3×10^8 ft^3
Waste monitor tank pump flow	200 gpm
Minimum Condenser cooling water flow	480,000 gpm

Table 4.3-1

Limiting Concentrations of Solids
And Chemicals in The Boiler Blowdown

pH	9.0 - 9.5
Total Dissolved Solids	125 ppm maximum
Suspended Solids	5 ppm maximum
Chlorides	75 ppm maximum
Silica	5 ppm maximum
Free Caustic	0
Iron and Copper	0.1 ppm total

Table 4.4-1
Major Industries Within 10 Miles With 100 Employees Or More[1]

	NAME	DISTANCE	QUADRANT	CATEGORY[2]
1.	J. P. Stevens, Stanley, N.C.	9.5 Miles	SW	5
2.	Talon Inc., Textile Fastner Division, Stanley, N.C.	9.5 Miles	SW	5
3.	American & Efird Thread Mills, Inc., Dyeing & Finishing	9.9 Miles	SW	4
4.	American & Efird Thread Mills, Inc., Rush Plant	9.9 Miles	SW	3
5.	American & Efird Thread Mills, Inc., Textured Yarn	9.9 Miles	SW	4
6.	Fieldcrest Mills, Inc., Mt. Holly Spinning Mill	9.9 Miles	SW	3
7.	Gaston County Dyeing Machine Co., Stanley, N.C.	9 Miles	SW	4
8.	Reeves Brothers Curon, Cornelius and Carolina Plant	6 Miles	NE	5
9.	Southern Dyestuff Co., Mt. Holly	9.9 Miles	SW	4
10.	Florida Steel Corp., Huntersville, N.C.	7.5 Miles	SE	4
11.	General Time, Davidson, N.C.	7.6 Miles	NE	5
12.	Magla Products, Huntersville, N.C.	6.5 Miles	SE	4

(1) Information collected from "North Carolina Directory for manufacturing Firms" (1968) prepared by Division of Statistics, N.C. Dept. of Labor.

(2) Employees in different categories:

Category 3 - 101-250
Category 4 - 251-500
Category 5 - 501-1000

Table 4.7-1
Estimated Manpower Requirement and Payroll During Construction

Year	(Average)	Payroll Amount (Dollars)
1972	850	5,913,000
1973	1537	14,516,000
1974	1810	19,354,000
1975	1654	13,978,000
1976	950	8,065,000
1977	200	1,716,000

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McGUIRE NUCLEAR STATION
AREA TOPOGRAPHY
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DUKE POWER

McGUIRE NUCLEAR STATION
Figure 4.1 - 8

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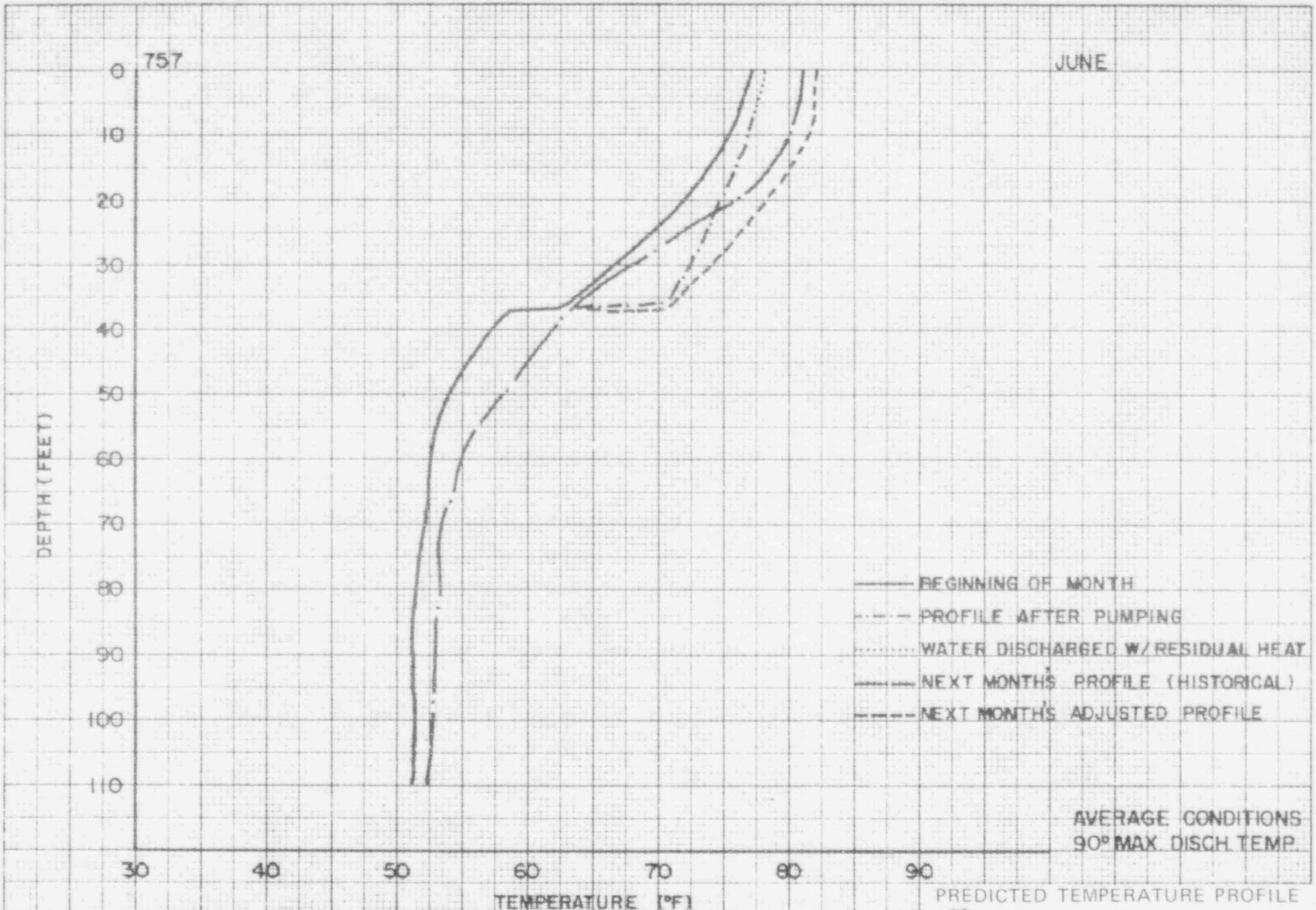
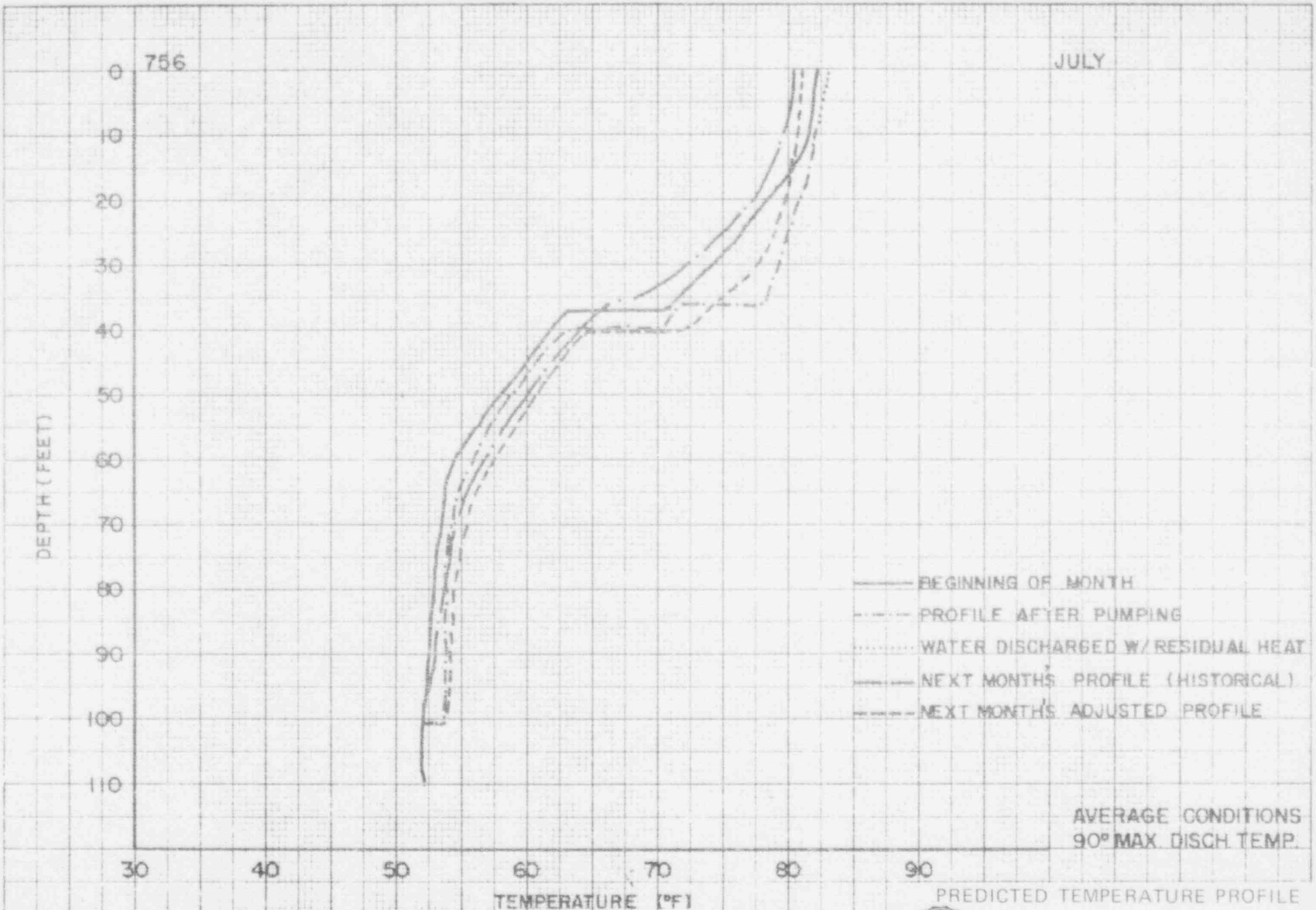


PREDICTED TEMPERATURE PROFILE

McGUIRE NUCLEAR STATION

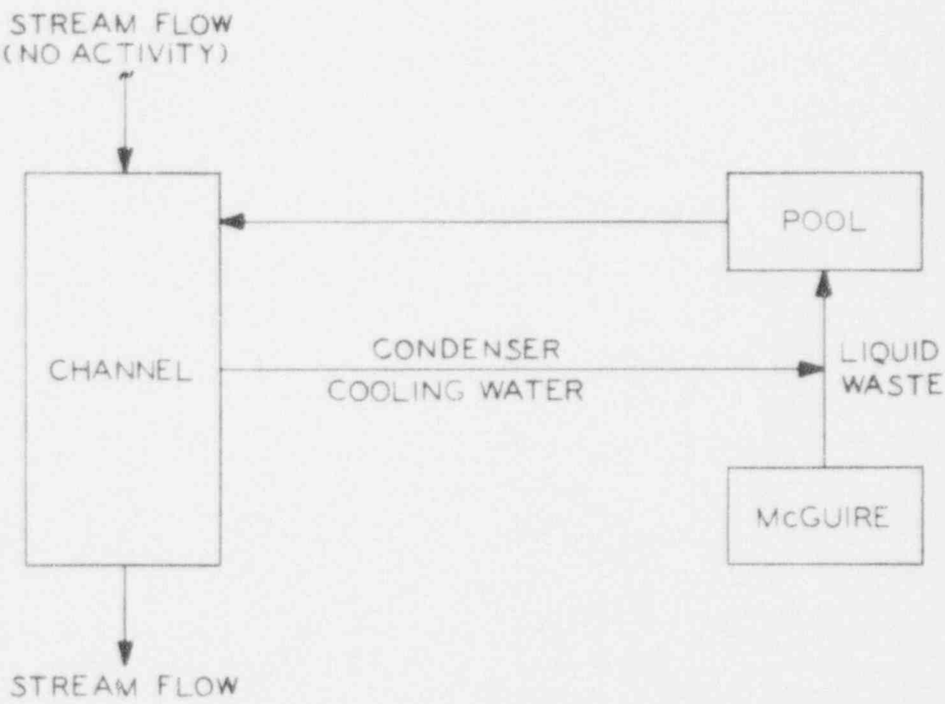
Figure 4.1-9



PREDICTED TEMPERATURE PROFILE

McGUIRE NUCLEAR STATION

Figure 4.1-10



RADWASTE LAKE MODEL
McGUIRE NUCLEAR STATION
Figure 4.2-1

7.5 ALTERNATE OF COOLING TOWER TO LAKE NORMAN COOLING

7.5.1 COMPARISON OF MECHANICAL DRAFT AND NATURAL DRAFT COOLING TOWERS

In comparing lake cooling to the alternative of evaporating cooling towers at this site in Table 7.2-1, conventional Mechanical Draft cooling towers were considered. The possibility of installing Natural Draft cooling towers instead of the conventional Mechanical Draft type has also been examined. The economic and environmental impacts of these two types have been compared in Table 7.5-1. Factors common to both the alternatives have been excluded in this comparison.

7.5.2 SUMMARY

It is evident from the comparison of the two types of cooling towers that Mechanical Draft cooling towers would be a better choice for this site. However, the alternative of surface cooling by Lake Norman is the most economical of the three alternatives and also has distinct environmental advantages over the two other alternatives.

Table 7.5-1
Comparison Of Mechanical Draft and
Natural Draft Cooling Towers
(Once-Through System)

Particulars	Mech. Draft	Natural Draft
A. TECHNICAL DATA[1]		
1. Rejected Heat (BTU/Hour)	15.8×10^{9}	15.8×10^{9}
2. Range (°F)	24	24
3. Approach (°F)	12	18
4. Wet Bulb Temperature (°F)	77[2]	76
5. Condenser Temperature Difference TD (°F)	6	6
6. Turbine Absolute Back Pressure (in of Hg)	3.35	3.85
7. Condenser Cooling Water Flow (GPM)	1.32×10^{6}	1.32×10^{6}
B. ECONOMICS		
1. Capital Cost ($)	8,780,000[3]	21,800,000[4]
2. Fan Capacity Cost	1,380,000[5]	-
3. Pump Capacity Cost	3,000,000[6]	3,000,000[6]
4. Fan Operating Cost Incl. Maintenance	950,000[7]	-
5. Pump Operating Cost Incl. Maintenance	3,080,000[8]	3,080,000[8]
6. Capacity Penalty Due To Higher Back Pressure	-	4,118,000[9]
7. Fuel Penalty Due To Higher Back Pressure	-	448,000[10]
Total	17,190,000	32,446,000

FOOTNOTES

(1) Assumes Once-Through Cooling Towers
(2) 1°F above that for Natural Draft to allow for recirculation
(3) Based on Dickey and Cates estimate + 15 percent for variation (Marley Company, Kansas City, Mo.)
(4) Assumed 50 percent Relative Humidity for design - based on Dickey and Cates estimate + 15 percent for variation
(5) Capacity at $125 per Kw
(6) Pump BHP for 75 feet head, and 78 percent overall efficiency, capacity at $125 per Kw
(7) Fuel cost at $80 per Kw per year, 80 percent plant factor, 67 percent Fan use. Includes operation and maintenance at 100 percent of fuel cost.
(8) Fuel cost at $80 per Kw per year, 80 percent plant factor. Includes operation and maintenance at 100 percent fuel cost
(9) Capacity penalty at $125/Kw
(10) Assumes maximum heat rate for 2 months in a year - capitalized cost of fuel

Table 7.5-1 - continued
Comparison of Mechanical Draft and
Natural Draft Cooling Towers
(Once-Through System)

Particulars	Mech. Draft	Natural Draft
C. ENVIRONMENTAL IMPACT		
1. Thermal Effect Highest Cold Water Temperature During Summer Months (°F)	89	94 (Larger Mixing Zone)
2. Land Use Approximate Area Required (Acres)	65	30
3. Consumptive Loss (GPM)	23,800	23,800
4. Icing and Fogging in the Local Area	Distinct possibility on cold, humid day	Less possibility due to plume released at high elevations
5. Aesthetics	Cover substantial area but low structures and can be treated architecturally to mitigate adverse aesthetic effects on the countryside	Tall (400 ft.+) conspicuous structures are generally not pleasing in appearance

DUKE POWER COMPANY
POWER BUILDING, BOX 2178, CHARLOTTE, N. C. 28201

W. H. OWEN
VICE PRESIDENT,
DESIGN ENGINEERING

RECEIVED
MAY 22 1972
U.S. ATOMIC ENERGY COMMISSION
Regulatory Mail Section

May 22, 1972

Mr R C DeYoung
Assistant Director for
Pressurized Water Reactors
Division of Reactor Licensing
Atomic Energy Commission
Washington, D C 20545

Re: McGuire Nuclear Station
Docket No. 50-369 and 50-370
Environmental Report - Construction Permit Stage
Supplement 3

Dear Mr DeYoung:

In reply to your letter of May 3, 1972, we are enclosing three signed originals and 297 copies of Supplement 3 to the McGuire Nuclear Station Environmental Report. The Supplement should be inserted at the back of the binder after Supplement 2. In addition to the specific information requested in your letter, Supplement 3 contains additional background data on the site and information developed since submission of Supplement 2 (May 1, 1972).

Also enclosed are three signed originals and 297 copies of Revision 2. The revised sheets should be inserted in the Environmental Report as explained in "Changes and Corrections."

Very truly yours,

s/W H Owen

W H Owen

WHO/w
Enclosures

cc Mr Glenn C Blaisdell, County Manager
Mecklenburg County
720 East Fourth Street
Charlotte, North Carolina 28202
(with one copy of enclosures)

2755

McGUIRE NUCLEAR STATION
ENVIRONMENTAL REPORT
DOCKET NOS. 50-369 and 50-370
REVISION NO. 2

May 22, 1972

Changes and Corrections

The following pages are to be inserted as replacements for existing pages.

Please note that vertical lines and revision numbers in each margin identify portions revised unless otherwise noted at bottom of page.

Front	Back
2-1	2-2
2-7	2-8

Duke Power Company
Charlotte, North Carolina

2. DESCRIPTION OF McGUIRE NUCLEAR STATION

2.1 STATION AND CYCLE DESCRIPTION

The McGuire Nuclear Station will have two units each with electrical output of about 1150 Mw (1 Mw=1000 kw). The Westinghouse Electric Corporation will furnish the nuclear steam systems, some of the engineered safety features and most of the waste disposal equipment for the station. The nuclear steam systems are of the four-loop pressurized water design similar to twelve other four-loop plants which precede McGuire. The waste disposal equipment will be the very latest and most efficient available. A description of the radioactive waste disposal system's performance can be found in Section 4.2 of this report.

In the pressurized water design (see Figure 2.2-1), a closed system of water, known as the Primary Coolant is circulated through the fuel elements in the reactor vessel. This water picks up heat produced by the nuclear reaction but is kept under sufficient pressure that, even though it rises to about 600°F it does not boil but remains liquid.

This hot water is then pumped into adjacent "steam generators." There the water flows through thousands of U shaped tubes and gives up its heat to another, entirely separate water system, called the Secondary Coolant. The Primary Coolant is then pumped back into the reactor vessel where it is used over and over.

The Secondary Coolant flows around the tubes carrying the hot Primary Coolant in the Steam Generator, picking up the heat from the Primary Coolant. The secondary Coolant boils and produces steam to drive the turbine.

After doing its work in the turbine, this steam is condensed into water and pumped back into the Steam Generator, forming the second closed cycle. The waters of these two systems do not contact each other.

A third water system is used to condense the Secondary Coolant steam back into water as it leaves the turbine. This cooling water is taken from Lake Norman and is discharged back to the lake. This system is separated from the reactor by the two closed cycles, the Primary and Secondary Coolant systems.

The electrical output of the McGuire units will be delivered thru 230 Kv and
1. 525 Kv transformers to the switching station, south of N. C. Highway 73.
Construction of this switching station began in 1970 to serve system 1.
transmission needs during the 1971-1975 period prior to operation of McGuire. In connection with construction of McGuire, the switching station will be expanded to receive and transmit the nuclear station's output.

The two units to be installed at McGuire are estimated to cost $440,964,000
1. exclusive of fuel. The cost of initial fuel cores is estimated to be $64,550,000
for a total station cost of over $505 million. The significant economic impact 1.
2. of this investment in Mecklenburg County is discussed in Section 4.7 of this 2.
report.

2.2 SITE DESCRIPTION

The McGuire Nuclear Station will be located in Mecklenburg County, North Carolina, near the Cowans Ford Dam approximately 17 miles northwest of Charlotte. The plant site is on the shore of Lake Norman about 1000 yards east of the Catawba River Channel as shown on Figure 2.2-1.

The plant site is bounded on the west by the Catawba River channel immediately downstream of Duke Power Company's Cowans Ford Hydroelectric Station, on the north by Lake Norman impounded by Cowans Ford Dam, on the east by private property and Lake Norman, and on the south by N. C. Highway 73. The intersection of the centerline of the two reactor buildings and the centerline between the reactor buildings is located at Latitude 35°-25'-59" north and Longitude 80°-56'-55" west.

The Exclusion Area is that area within a 2500-foot radius centered at the intersection of the two centerlines mentioned above.[1] The Low Population Zone as that area within five and one-half miles of the plant.[1] There are 26 population centers within 100 miles of the site. The largest of these are as follows:

Population Center	1970 Population	Distance From Site	Direction from Site
Charlotte, N. C.	239,049	17 miles	South-Southeast
Winston-Salem, N. C.	133,820	59 miles	North-Northeast
Greensboro, N. C.	140,660	78 miles	Northeast
Columbia, S. C.	111,706	98 miles	South

The Exclusion Area will be posted. A security fence will be erected around the immediate site area. A plot plan showing major plant features in the Exclusion Area, the site boundary and the controlled access areas within the site boundary are shown on Figure 2.2-2. Transmission lines and right-of-ways in the site area are discussed in Section 4.4.2.

(1) As defined by Code of Federal Regulations, Title 10, Part 100.

types. The four major rock types found include dark green meta-gabbro, light gray fine and medium grained granite, black and white fine grained diorite and black and white coarse grained diorite. Though the geologic structure at the site is very complex and old, there were no features in evidence which would present any problems in the design, construction and future operation or safety of the plant.

2.4.3 SEISMOLOGY

The regional ancient faults and geologic structures have not been active during the past 180 million years. The historical record of earthquakes in the southeast indicates that there is no known relationship between known faults and historic earthquakes.

Detailed studies of the larger earthquakes near the site have been made using newspaper accounts, interviews with older residents, examination of damage which is still visible and a study of local geologic conditions. These studies indicate that the greatest seismic intensity the site has experienced due to these larger earthquakes has been VII, Modified Mercalli Scale, from the Charleston earthquake, August 31, 1886, located 185 miles southeast of the site.

Three earthquake epicenters have been reported within 50 miles of the site. All three of these earthquakes are reported to have produced an epicentral intensity of V, Modified Mercalli Scale.

No identifiable active faults that could be expected to produce surface displacement have been recognized within 200 miles of the site or anywhere within the Piedmont Geologic Region of the site.

The foundations of the Reactor and Auxiliary Buildings will be located on rock which has excellent strength properties and small amplification of ground motion resulting from an earthquake. The operating basis earthquake[1] has been given a value of acceleration of eight percent of gravity at the top of rock
2. and the design basis earthquake[2] has been given a value of acceleration of 2.
fifteen percent of gravity at the top of rock.

Seismologically the site is well suited for a nuclear station.

2.4.4 HYDROLOGY

Hydrology studies for site suitability included characteristics of vicinity streams and their associated drainage areas, Catawba River flood studies and site groundwater.

The principal stream which drains the site is the Catawba River. The Catawba River begins at the Blue Ridge Divide near Old Fort, North Carolina, and flows in an easterly direction to a point near Millersville, North Carolina. It then flows in a southerly direction and becomes the Wateree River near Camden, South Carolina. The Catawba upstream of Wateree Dam has a length of approximately 240 miles and a drainage area of approximately 4,750 square miles.

(1) Plant designed for continuous operation during operating basis earthquake
(2) Plant designed for safe shutdown during design basis earthquake

Lake Norman and Cowans Ford Dam are a part of Duke's Catawba River hydroelectric system containing eleven hydroelectric reservoirs and dams, and extending along approximately 221 miles of the Catawba River. Lake Norman forms the tailwater of Lookout Shoals Dam, located 34 miles upstream from Cowans Ford, and Mountain Island Lake forms the tailwater for Cowans Ford. Mountain Island Dam is located 15 miles downstream from Cowans Ford. Refer to Figure 2.4-2, Plan and Profile of the Catawba River.

A United States Geological Survey Gaging Station was located 30 miles upstream from the present location of Cowans Ford Dam near Catawba, North Carolina, until it was inundated by the waters of Lake Norman in 1962. The average discharge past this point for a period of record of 30 years and a drainage area of 1,535 square miles was 2,337 cubic feet per second (cfs). The maximum flow recorded at this point was 177,000 cfs on August 14, 1940, and the minimum flow was 85 cfs occurring on September 15, 1957. The average flow at the Cowans Ford site is approximately 2,670 cfs. On July 16, 1916, the river reached a known flood stage of 44.1 feet at the USGS gage near Catawba, N. C. It has been estimated that this storm produced a flow of 199,500 cfs at the McGuire site on July 17, 1916.

Lake Norman has a surface area of 32,510 acres and a volume of 1,093,600 acre-feet at a surface elevation of 760 feet above mean sea level (MSL). Cowans Ford Dam's spillway is equipped with eleven gates with a total spillway capacity of 210,650 cubic feet per second with upstream water surface elevation at elevation 760.

The proposed site lies within the Piedmont Groundwater Province. All groundwater in this area is derived from precipitation. The depth to the water table depends primarily on topography and rock weathering. The level of the water table varies from the ground surface in the valleys to more than 100 feet below the surface on sharply rising hills.

The level of Lake Norman is the primary factor which governs the location and movement of the groundwater at the site. The elevation of groundwater coincides with the elevation of Lake Norman along the northern boundary of the site, and the groundwater moves downward in a south and southwesterly direction until it intersects the Catawba River and a small stream which drains into the Catawba.

There is no potential for harmful radioactive contamination of well water supplies via introduction of Lake Norman waters into groundwater. The concentration of radioactivity in Lake Norman is shown in Section 4.2 to be a small fraction of the limits imposed by AEC regulations. These concentrations would be further reduced by the ion exchange action of the soil through which the groundwater flows. Chemical analyses were made to determine the cation exchange capacity of the soils at the site. The results of these analyses have shown that any radioactive contaminant will move less rapidly through the soil than the groundwater (by a factor of 45 to 1 for strontium) because of the absorption of the contaminant by the soil particles.

Groundwater studies indicate that the groundwater conditions, including local wells used for water supply, will not be adversely affected by the construction of McGuire Nuclear Station.

DUKE POWER COMPANY

McGUIRE NUCLEAR STATION

UNITS 1-2

APPLICATION FOR LICENSES

DOCKETS 50-369 and 50-370

ENVIRONMENTAL REPORT SUPPLEMENT 3

May 22, 1972

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1 INTRODUCTION

This Supplement 3 to the McGuire Nuclear Station Environmental Report filed March 9, 1971, is submitted to Atomic Energy Commission as supplemental information in compliance with the Commission's letter of May 3, 1972. It contains information concerning the effects of early overturn of Lake Norman, as requested in the letter. Also included is additional background data on the McGuire site and information developed since submission of Supplement 2 on May 1, 1972.

2. DESCRIPTION OF McGUIRE NUCLEAR STATION

2.4 NATURAL ENVIRONMENT OF THE SITE

2.4.1 METEOROLOGY

The wind distribution at the McGuire site is graphically shown on Figure 2.4-3 and tabulated in Table 2.4-1.

TABLE

MCGUIRE METEOROLOGICAL SURVEY TOWER DATA FOR PERIOD OF DEC. 1,1969 THRU NOV. 30,1970

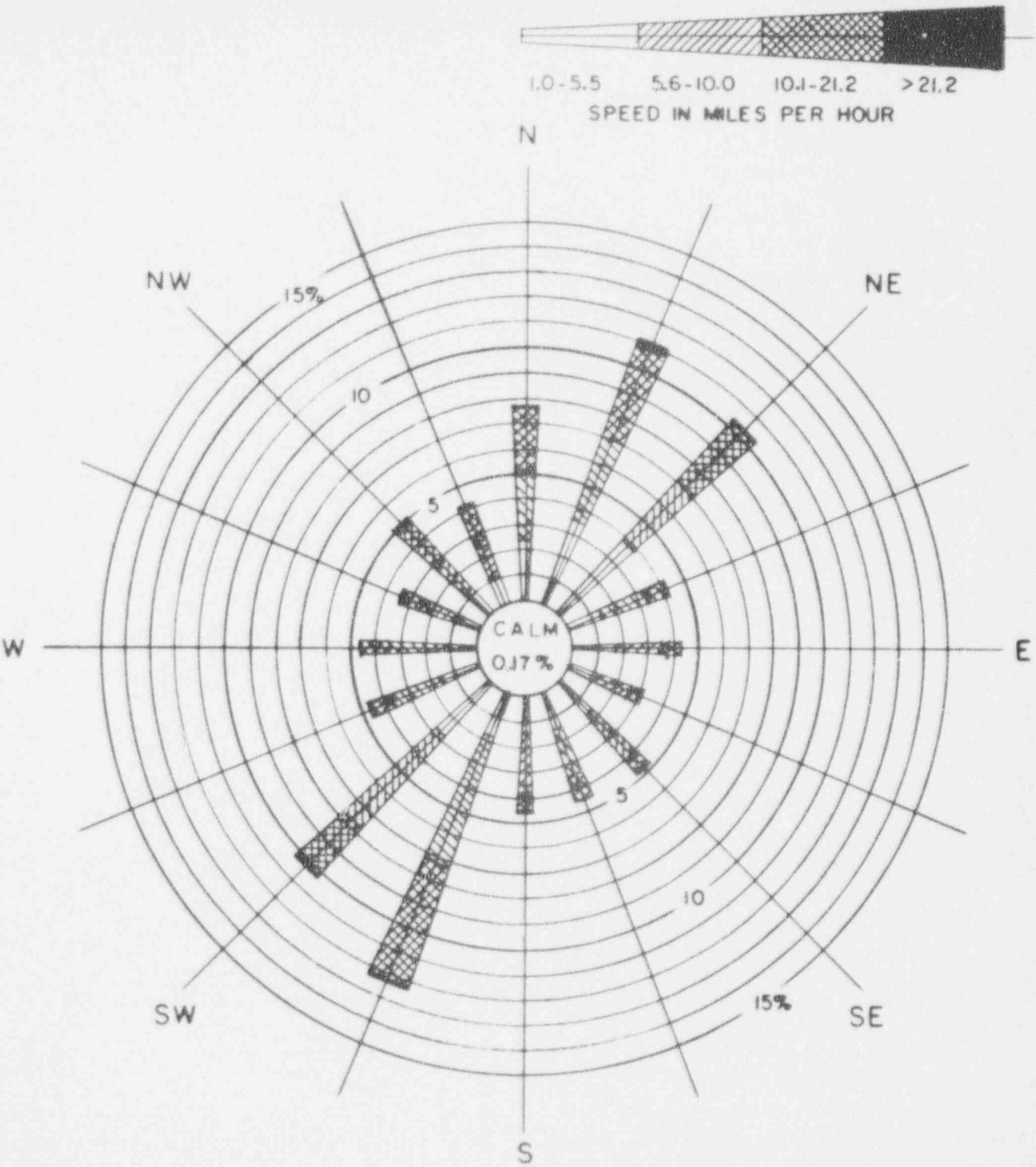
SUMMARY OF PASQUILL A+C+D+E+F+G+H WIND OCCURRENCES BY SECTOR + SPEED CLASS (NO. OCCURR,PERCENT)

DATE OF REPORT 2-24-71

WIND SECTOR	ITEM	SECTOR TOTAL	1.0-3.2 .45-1.49	3.3-5.5 1.5-2.49	5.6-7.8 2.5-3.49	7.9-10.0 3.5-4.49	10.1-12.3 4.5-5.49	12.4-14.5 5.5-6.49	14.6-16.7 6.5-7.49	16.8-19.0 7.5-8.49	19.1-21.2 8.5-9.49	>21.2 MPH >=9.5 M/S
360.0	NO	637	62	129	130	96	76	50	41	30	11	12
-N-	PCT	7.82	0.76	1.58	1.60	1.18	0.93	0.61	0.50	0.37	0.13	0.15
22.5	NO	911	84	198	161	127	93	99	73	39	19	18
-NNE-	PCT	11.19	1.03	2.43	1.98	1.56	1.14	1.21	0.90	0.48	0.23	0.22
45.0	NO	833	90	233	136	115	98	91	38	19	11	2
-NE-	PCT	10.23	1.10	2.86	1.67	1.41	1.20	1.12	0.47	0.23	0.13	0.02
67.5	NO	342	42	95	76	56	48	19	4	2	0	0
-ENE-	PCT	4.20	0.52	1.17	0.93	0.69	0.59	0.23	0.05	0.02	0.00	0.00
90.0	NO	350	41	99	80	64	41	21	3	0	1	0
-E-	PCT	4.30	0.50	1.21	0.98	0.79	0.50	0.26	0.04	0.00	0.01	0.00
112.5	NO	259	38	56	63	51	24	23	3	1	0	0
-ESE-	PCT	3.18	0.47	0.69	0.77	0.63	0.29	0.28	0.04	0.01	0.00	0.00
135.0	NO	385	40	100	88	109	31	8	4	4	0	1
-SE-	PCT	4.73	0.49	1.23	1.08	1.34	0.38	0.10	0.05	0.05	0.00	0.01
157.5	NO	373	30	87	104	75	46	20	8	0	3	0
-SSE-	PCT	4.58	0.37	1.07	1.28	0.92	0.56	0.24	0.10	0.00	0.04	0.00
180.0	NO	373	39	77	96	74	46	25	8	2	3	3
-S-	PCT	4.58	0.48	0.94	1.18	0.91	0.56	0.31	0.10	0.02	0.04	0.04
202.5	NO	1015	28	119	208	234	204	111	46	31	11	23
-SSW-	PCT	12.46	0.34	1.46	2.55	2.87	2.50	1.36	0.56	0.38	0.13	0.28
225.0	NO	840	53	182	196	199	99	58	26	13	6	8
-SW-	PCT	10.31	0.65	2.23	2.41	2.44	1.21	0.71	0.32	0.16	0.07	0.10
247.5	NO	385	35	88	103	82	35	27	9	2	2	2
-WSW-	PCT	4.73	0.43	1.08	1.26	1.01	0.43	0.33	0.11	0.02	0.02	0.02
270.0	NO	382	26	76	110	77	43	29	12	4	2	3
-W-	PCT	4.69	0.32	0.93	1.35	0.94	0.53	0.36	0.15	0.05	0.02	0.04
292.5	NO	287	28	41	62	60	41	29	13	4	5	4
-WNW-	PCT	3.52	0.34	0.50	0.76	0.74	0.50	[illegible]	0.16	0.05	0.06	0.05
315.0	NO	414	37	67	56	71	63	45	31	32	5	7
-NW-	PCT	5.08	0.45	0.82	0.69	0.87	0.77	0.55	0.38	0.39	0.06	0.09
337.5	NO	343	36	54	49	54	58	35	29	16	3	9
-NNW-	PCT	4.21	0.44	0.66	0.60	0.66	0.71	0.43	0.36	0.20	0.04	0.11
CALM	NO	14										
	PCT	0.17										
TOTAL	NO	8129	709	1701	1718	1544	1046	690	348	199	82	92
	PCT	99.83	8.71	20.89	21.10	18.96	12.84	8.47	4.27	2.44	1.01	1.13

TOTAL VALID OBSERVATIONS 8143

TOTAL OBSERVATIONS 8760



Note:

Representative
of Meteorological
Data Filed
In PSAR
(Elevation Above Grade 131 Feet)

SURFACE WIND ROSE

McGUIRE NUCLEAR STATION
Figure 2.4-3

4 ENVIRONMENTAL EFFECTS OF McGUIRE NUCLEAR STATION

4.1 THERMAL EFFECTS

4.1.3 LAKE NORMAN MONITORING PROGRAM

Average, warmest and coolest temperatures measured in front of Cowans Ford Dam are shown in Tables 4.1-6, 4.1-7 and 4.1-8 respectively. Dissolved oxygen concentrations at the same location are listed in Table 4.1-9.

4.1.6 EFFECT OF WARMED DISCHARGE ON LAKE WATERS

Table 4.1-10 shows the expected monthly average, maximum daily average, and maximum instantaneous discharge temperatures from McGuire and the expected monthly average and maximum daily average ambient surface temperatures in Lake Norman for normal and extreme conditions.

The expected vertical temperature profiles at the mouth of McGuire's discharge canal for each month of the year (normal climatic conditions) are shown on Figure 4.1-11. The vertical temperature profiles expected in front of Cowans Ford Dam while McGuire is operating at full load are shown on Figure 4.1-12 and Figure 4.1-13 shows the temperature profiles expected near the northern and eastern edges of the mixing zone. Figures 4.1-14, 4.1-15 and 4.1-16 give the same information for extreme climatic conditions.

In July under extreme conditions the cooling water discharge will have a dissolved oxygen concentration of 3 mg/l. About 1800 acres will be required to aerate this discharge to a concentration of 4 mg/l, and 3900 acres of the lake will have concentrations less than 5 mg/l. In August the discharge concentration will be 2 mg/l. Five hundred acres will have a concentration less than 3 mg/l, 2300 acres will have concentration less than 4 mg/l, and 4400 acres will have less than 5 mg/l. The discharge dissolved oxygen concentration in September will exceed 5 mg/l.

4.1.7 ECOLOGICAL EFFECTS

The studies described in 4.1.6 showed that even in the extreme composite year, sufficient cool water will be available to prevent monthly average discharge temperatures from exceeding 95 F (Table 4.1-1), and that the discharge will meet North Carolina water quality standards at the boundary of its prescribed mixing zone. Under normal conditions, studies show that McGuire could avoid using its lower intake, and still not produce discharge temperatures in excess of 95 F. By using the cool water under normal conditions, it is possible to restrict the discharge temperatures to 90 F (Table 4.1-2).

Unless altered by artificial means, the natural characteristic thermal stratification sequences of the mesotrophic and eutrophic impoundments of the Piedmont of North and South Carolina, result in rapid generation of hypolimnetic oxygen deficits. In some instances, the water layer above the bottom of the reservoir is depleted of oxygen by mid-May or even earlier, and in nearly all instances a zero value is attained by late August. These oxygen deficit conditions initially found just above the bottom spread throughout the hypolimnion producing a substantial water mass that is anaerobic and ecologically hostile to fish and benthic organisms that require dissolved oxygen. Associated with the absence of oxygen in the natural hypolimnion is generally found an increase in the concentrations of reduced iron and manganese. The higher solubility levels of these two elements under anaerobic conditions permits solution from the sediments of the iron and manganese rich soils of this area. Also, associated with the oxygen deficit of the hypolimnion is an increase in iron phosphate complexes, also, solubilizing from the bottom sediments.

The normal or natural overturn pattern of the reservoirs of this area, is generally found to follow a gradual mixing process from the surface down as the surface waters cool, until finally, the overlying water has attained the same temperature as that of the deepest levels. Under this unstable condition, the final overturn proceeds, usually, overnight under cold and windy conditions. This final overturn generally occurs in October or November. During a natural overturn a temporary condition of a marginal oxygen concentration may occur throughout the reservoir. This undersaturated condition with respect to dissolved oxygen will persist until reareation of surface waters overcomes the comsumption of oxygen due to inorganic oxygen demand (oxidation of reduced iron and manganese) and biochemical oxygen demand (aerobic decomposition). Thus, the normal sequence of stratification and generation of oxygen deficits in the hypolimnion with an Autumn overturn, in the reservoirs of the Piedmont, is basically a natural phenomenon.

Reservoirs built by Duke on the Catawba River do not follow the natural pattern of stratification outlined above. The hydroelectric impoundments on the Catawba River, except Lake Norman with its upstream under-water weir, all operate with deep intakes for power generation. Characteristic of these is Lake Wylie where the hydropower operating schedule of the impoundment has established a rate of withdrawal resulting in practical exhaustion of hypolimnetic waters and consequently a gradual overturn by late summer. In Lake Norman, withdrawal of hypolimnetic waters by thermal stations produces a similar effect. Associated with the gradual overturn is an increase in dissolved oxygen for the total depth of the lake and reprecipitation of the iron and manganese to the bottom sediments.

It might also be noted that the concept of early overturn, or destratification by artificial means, to prevent the formation of hypolimnetic waters with low oxygen content is a procedure that is becoming more widely used to optimize water quality. "The first attempt at mixing large bodies of water was reported by Hooper, Ball and Tanner[1] in 1952 in their article entitled 'An Experiment in the Artificial Circulation of a Small Michigan Lake.' In the years between then and now (1964), at least 18 destratification attempts have been made. Most of these have caused an improvement in the water quality of the impoundment or lake."[2]

[1] Hooper, F.F., R.C. Ball, and H.A. Tanner, "An Experiment in the Artificial Circulation of a Small Michigan Lake". Trans. Am. Fisheries Soc. 82: 222-41. July 1952.

[2] Symons, J.M., S.R. Weibel, and G.G. Robeck, "Influence of Impoundments on Water Quality-A Review of Literature and Statement of Research Needs." PHS Publ. No. 999-WP-18, Ocotber 1964, Revised 1966. 78pp.

Therefore, it might be postulated that from evidence already established on lakes throughout the country, hypolimnetic withdrawal has no detrimental effect, but, most probably, tends to improve ecological conditions. According to Symons Weibel and Robeck (1966) "mixing would prevent: (1) low dissolved oxygen concentrations; (2) increased iron and manganese concentrations: (3) production of hydrogen sulfide and (4) increase in color, in the hypolimnion. Mixing would, however, prevent the accumulation of cool waters in the impoundment bottom and might increase overall productivity of the lake by recycling back into the euphotic zone nutrients released during organism decomposition."[2] The projected use of hypolimnetic water in Lake Norman, which could result in an early overturn, will actually be to the ecological benefit of this reservoir.

The record of hypolimnetic oxygen deficit in Lake Norman, since its formation is shown on the accompanying table. The dates describe the earliest date at which the deepest sample at the Cowans-Ford water sampling station fell below 1.0 mg/l. The second date is the last sampling date on which zero values in the deepest water were also recorded. The precise date of overturn cannot be established exactly, since sampling dates were at a monthly interval and the overturn occurred between the dates shown. Based on the data below, in the event of an August overturn, there would be a period of approximately three months in each year which would remain with an oxygen credit, rather than an oxygen debit, in the hypolimnion.

Period of Oxygen Deficit in Lake Norman Station 109.0
Cowans Ford Dam

Year	A	B	C
1963	Aug. 5	Nov. 18	Dec. 9
1964	Aug. 25	Nov. 16	Dec. 10
1965	Aug. 18	Nov. 4	Dec. 13
1966	Sept. 9	Oct. 27	Nov. 23
1967	Sept. 1	Nov. 3	Dec. 3
1968	Sept. 1	-	Dec. 3
1969	Nov. 11	-	Dec. 11
1970	Aug. 18	Nov. 23	Dec. 1
1971	Aug. 19	Nov. 10	Dec. 2

A - First Sampling Date when DO was 1.0 in sample collected at the bottom.

B - Last Sampling Date when DO was 1.0 in sample collected at the bottom.

C - Sampling Date following B, which showed a well mixed Lake.

We conclude, therefore, that hypolimnetic pumping in Lake Norman will prove beneficial to the aquatic biota.

[2]Symons, J.M., S.R. Weibel, and G.G. Robeck, "Influence of Impoundments on Water Quality-A Review of Literature and Statement of Research Needs." PHS Publ. No. 999-WP-18, October 1964, Revised 1966. 78pp.

Table 4.1-6

Average Temperatures Measured In Front of Cowans Ford Dam, 1963-1970

Depth (Feet)	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	44.3	42.3	46.1	58.2	65.1	76.3	80.9	80.2	75.5	68.6	59.0	49.9
5	-	-	-	-	-	75.6	80.5	80.0	75.4	-	-	-
10	44.2	42.3	45.5	56.7	63.8	74.4	80.1	79.5	75.1	68.4	58.9	49.9
15	-	-	-	-	-	71.8	78.4	78.7	75.1	-	-	-
20	44.1	42.2	45.1	55.3	61.4	69.7	76.0	77.3	74.7	68.2	58.8	49.8
25	-	-	-	-	-	67.1	72.0	74.6	74.6	-	-	-
30	44.0	42.2	44.6	53.1	58.3	63.7	68.5	71.3	72.8	68.0	58.7	49.7
35	-	-	-	-	-	60.7	64.1	68.1	72.3	-	-	-
40	44.0	42.1	44.4	51.1	54.4	57.8	61.9	64.7	68.3	66.7	58.6	49.8
50	43.9	42.1	44.2	50.4	51.9	54.2	57.8	59.4	61.8	64.8	58.2	49.8
60	43.9	42.1	44.1	49.4	50.7	52.6	54.7	56.5	57.5	61.4	57.7	49.7
70	43.9	42.1	44.1	49.1	50.3	52.0	53.6	54.7	55.6	57.3	56.8	49.7
80	43.8	42.1	43.9	48.7	50.0	51.6	53.1	53.8	54.4	55.4	55.3	49.7
90	43.8	42.1	43.8	47.9	49.7	51.2	52.6	53.1	53.5	54.1	54.1	49.6
100	43.8	42.1	43.7	47.9	49.6	50.9	52.1	52.7	52.9	53.7	53.8	49.6
110	43.9	42.1	43.6	47.8	49.3	50.7	51.8	52.0	52.5	49.8	53.2	49.7
120	-	-	-	-	-	-	-	-	-	52.6	-	-

Table 4.1-7

Warmest Temperatures Measured In Front of Cowans Ford Dam, 1963-1970

Depth (Feet)	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	48.5	45.5	52.5	69.0	76.0	86.8	86.0	86.4	79.0	72.0	63.5	53.2
5	48.5	45.1	51.0	69.0	74.5	83.8	85.5	86.0	79.0	71.9	63.5	53.2
10	48.5	45.6	49.9	69.0	74.2	80.2	84.7	85.9	79.0	71.9	63.2	53.2
15	48.5	44.9	48.5	68.5	74.0	77.0	82.5	85.0	79.0	71.9	63.2	53.2
20	48.5	45.8	49.2	68.5	73.1	74.5	81.0	80.9	78.8	71.9	63.1	53.2
25	48.5	44.9	48.9	64.5	71.8	74.5	77.9	80.6	78.0	71.9	63.0	53.2
30	48.5	45.7	48.1	64.5	64.5	68.0	77.0	80.6	78.1	71.8	63.0	53.2
35	48.5	44.8	48.1	64.5	64.2	67.0	68.2	80.5	76.9	71.5	62.9	53.2
40	48.5	45.2	48.1	64.5	64.1	63.5	66.2	79.5	75.0	71.2	62.9	53.2
50	48.5	45.[illegible]	48.1	64.5	63.5	60.2	61.5	70.5	74.0	71.0	62.9	53.2
60	48.5	45.[illegible]	48.1	55.0	53.8	55.4	59.0	67.0	70.0	69.9	62.1	53.2
70	48.5	45.0	48.1	54.9	53.7	55.0	59.0	61.9	67.1	66.0	61.9	53.2
80	48.5	45.0	48.0	54.1	53.3	54.8	59.0	58.8	61.2	60.0	59.8	53.2
90	48.5	44.9	48.0	54.0	53.3	54.2	58.2	58.6	59.4	56.7	55.3	53.2
100	48.5	44.9	48.0	53.9	53.3	54.0	56.0	58.4	58.2	56.0	55.3	53.2
110	48.5	44.9	48.0	53.9	53.3	53.8	55.8	58.4	55.5	56.0	55.3	53.2
120	-	41.2	45.2	-	49.8	53.3	51.8	51.1	52.5	54.2	54.0	49.8

Table 4.1-9

Dissolved Oxygen Concentrations Measured In Front of Cowans Ford Dam

1967

Depth	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
(Feet) 1								7.8	7.3	7.7	8.0	9.3
5								7.9	7.6	7.4	-	-
10								8.1	7.6	7.4	7.7	9.0
15								7.5	7.6	7.4	-	-
20								6.6	7.6	7.4	7.7	9.5
25								2.6	7.6	7.4	-	-
30								2.1	7.6	7.3	7.5	9.2
35								1.4	7.6	7.3	-	-
40								1.4	7.2	7.1	7.5	9.3
50								1.5	7.0	6.4	7.5	8.9
60								1.5	0.1	0.4	7.4	9.2
70								1.6	0.1	0.3	6.7	9.2
80								2.1	0.1	0.3	0.2	8.7
90								2.3	0.2	0.3	0.3	8.7
100								1.4	0.2	0.2	0.4	8.6
105								0.4	-	-	-	-
110									0.1	0.2	1.0	7.9

Table 4.1-8

Coolest Temperatures Measured In Front of Cowans Ford Dam, 1963-1970

Depth (Feet)	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	40.7	40.5	41.0	49.8	54.5	68.1	76.6	74.2	71.5	62.1	55.0	44.2
5	40.5	41.0	41.0	49.2	60.9	67.8	76.3	76.1	71.5	62.1	55.0	44.2
10	40.2	39.9	41.0	48.0	53.0	66.5	76.1	75.3	71.5	62.1	55.0	44.3
15	40.2	41.0	40.9	47.8	60.1	65.5	74.0	74.0	71.3	62.1	55.0	44.3
20	40.2	39.5	40.9	47.5	52.7	65.0	69.8	72.5	71.2	62.1	55.0	44.2
25	40.2	41.0	40.9	47.5	55.8	61.5	61.2	68.0	71.0	62.0	55.0	44.2
30	40.2	39.5	40.9	47.5	51.5	56.0	57.6	57.4	63.0	62.0	55.0	44.2
35	40.2	41.0	40.9	47.0	50.1	54.0	55.2	57.4	61.0	62.0	55.0	44.2
40	40.2	39.5	40.9	46.8	49.9	52.2	54.0	54.9	56.0	60.6	55.0	44.2
50	40.2	39.5	41.0	46.2	49.0	51.0	52.2	51.8	51.5	56.6	55.0	44.2
60	40.2	39.5	41.0	45.9	48.9	50.2	51.0	51.0	51.0	53.1	54.1	44.2
70	40.2	39.5	41.0	45.5	48.0	50.0	50.5	50.8	50.8	53.0	54.0	44.2
80	40.2	39.8	41.0	45.2	47.3	49.8	50.1	50.1	50.1	52.0	53.4	44.2
90	40.2	39.8	41.0	45.2	46.9	48.2	50.0	50.0	50.1	52.0	52.2	44.2
100	40.1	39.5	41.0	45.1	46.5	48.0	49.9	50.0	50.1	52.0	51.8	44.3
110	40.0	40.9	41.0	45.0	46.2	47.9	49.8	49.8	50.1	51.3	51.2	46.0
120	-	41.2	42.2	-	46.1	47.9	49.9	50.8	51.8	51.1	52.5	46.8

Table 4.1-9 Continued

Dissolved Oxygen Concentrations Measured In Front of Cowans Ford Dam

1968

Depth	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
(Feet) 1	11.6	11.8	12.1	9.8	8.8	8.4	7.7	6.3	7.2	7.8		9.6
5	-	-	-	-	8.9	8.4	5.7	6.5	7.5	-		-
10	11.5	12.1	12.6	9.6	8.7	8.5	8.0	6.6	7.8	7.7		9.5
15	-	-	-	-	-	8.5	7.6	5.7	6.3	-		-
20	11.5	11.7	12.4	9.4	8.5	7.7	7.9	3.5	6.7	7.7		9.6
25	-	-	-	-	-	7.2	7.6	0.8	7.2	-		-
30	11.4	12.0	12.0	9.0	7.6	7.0	4.6	0.5	6.9	7.9		9.6
35	-	-	-	-	-	6.3	2.8	0.5	3.7	-		-
40	11.1	11.4	7.8	9.3	7.6	5.2	3.1	0.4	1.0	5.5		9.5
50	11.1	11.4	11.8	9.2	7.6	5.2	3.2	0.6	0.0	7.9	Not Available	9.4
60	11.1	11.6	11.5	9.1	7.6	5.5	3.4	0.8	0.1	7.4		9.6
70	11.4	11.6	11.5	9.1	7.6	5.7	3.6	1.5	0.2	0.4		9.2
80	11.3	11.5	11.2	8.7	7.7	5.7	3.8	1.5	0.4	0.4		9.2
90	11.3	11.0	11.5	8.8	7.8	5.9	4.1	1.3	0.2	0.4		9.2
100	11.3	11.3	11.4	6.0	7.4	5.7	4.2	1.6	0.1	0.6		9.0
105	-	-	-	-	-	-	-	-	-	-		-
110	10.7	11.3	11.4	7.5	7.4	4.3	3.6	1.3	-	-		8.2

Table 4.1-9 Continued

Dissolved Oxygen Concentrations Measured In Front of Cowans Ford Dam

1969

Depth (Feet)	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	11.0	11.6	11.7	10.8	9.7	8.4	7.6	7.3	6.8	7.9	8.4	9.8
5	-	-	-	-	9.8	8.3	7.6	7.2	6.9	-	-	
10	11.0	11.7	11.7	10.1	9.8	8.3	7.3	7.1	5.8	7.9	8.2	9.8
15	-	-	-	-	12.5	8.3	4.9	7.1	6.5	-	-	
20	10.7	11.7	11.6	10.0	9.2	8.4	4.3	7.0	6.7	7.9	8.3	9.8
25	-	-	-	-	9.5	7.8	2.8	6.8	6.6	-	-	
30	11.0	11.7	11.8	10.0	9.3	6.9	-	5.9	6.7	7.7	8.2	9.6
35	-	-	-	-	8.9	6.6	2.6	0.2	6.3	-	-	
40	11.0	11.5	11.6	10.1	8.9	6.1	2.7	0.3	1.8	7.7	8.3	9.9
50	11.0	11.5	11.5	10.1	9.5	6.3	2.8	0.6	2.1	7.5	7.3	10.0
60	10.9	11.5	11.4	10.1	8.9	7.0	4.1	1.9	2.0	7.6	6.9	9.9
70	11.1	11.4	11.7	9.7	9.6	6.7	4.4	2.8	2.0	7.7	6.8	10.0
80	10.8	11.3	11.4	9.6	9.1	6.8	4.3	3.1	2.4	7.4	6.4	9.8
90	10.6	11.3	11.5	9.7	9.1	7.1	4.3	3.2	2.4	0.2	5.1	10.1
100	10.8	11.2	11.4	9.8	8.3	6.5	4.2	2.9	2.3	0.4	0.1	9.4
105	-	-	-	-	-	-	-	-	-	-	-	-
110	11.1	11.6	11.5	9.8	8.9	6.3	3.5	1.3	2.6	0.1	1.1	8.9
120	-	-	11.8	-	-	6.3	3.4	-	-	-	-	-

Table 4.1-9 Continued

Dissolved Oxygen Concentrations Measured In Front of Cowans Ford Dam

1970

Depth (Feet)	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	11.6	11.7	12.8	10.4	7.9	8.1	7.6	6.2		7.6	7.7	9.8
5	-	-	-	-	-	8.2	7.5	6.2		-	-	-
10	11.6	11.9	11.4	10.4	8.2	8.2	7.6	6.3		7.4	7.9	9.6
15	-	-	-	-	-	8.0	6.1	5.7		-	-	
20	11.6	11.8	11.4	10.4	8.0	7.6	5.2	5.3		7.4	7.7	8.9
25	-	-	-	-	-	7.4	5.2	4.7		-	-	
30	11.6	11.6	11.3	10.2	7.1	5.1	4.2	4.2		7.2	7.7	8.6
35	-	-	-	-	-	4.9	4.0	2.6		-	-	
40	11.6	11.5	11.1	10.1	7.0	5.4	4.5	2.2		7.2	7.7	8.9
50	11.6	11.5	11.4	10.0	7.2	5.3	4.6	0.7	Not Available	6.9	7.8	9.2
60	11.6	11.6	11.4	10.0	7.1	5.7	4.5	0.2		6.4	7.7	9.6
70	11.6	11.8	11.4	9.6	7.1	5.7	4.6	0.4		3.1	7.3	8.9
80	11.6	11.7	11.3	9.6	6.9	5.6	4.6	1.3		0.1	7.1	9.0
90	11.6	11.6	11.0	9.4	6.8	5.1	4.4	1.3		0.1	5.0	9.1
100	11.6	11.5	10.7	9.1	5.6	3.0	3.9	0.8		0.0	0.0	9.2
105	-	-	-	-	-	-	-	-		-	-	
110	11.6	11.3	10.0	8.8	5.3	3.2	2.0	0.4		0.0	0.0	8.5

(1) Data reported for July were taken 6-30-70

Table 4.1-9 Continued

Dissolved Oxygen Concentrations Measured In Front of Cowans Ford Dam

1971

Depth (Feet)	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	Not Available	12.1	Not Available	10.3	8.2	6.1	6.5	7.4	Not Available	7.8	8.2	8.9
5		-		-	8.4	7.0	5.2	6.5		-		-
10		12.1		10.5	8.7	6.8	4.1	6.2		7.7	8.1	-
15		-		-	8.6	6.9	4.1	6.1		-		-
20		12.1		10.2	8.5	7.8	4.0	6.0		7.7	8.0	-
25		-		-	7.8	7.5	2.5	5.7		-		-
30		12.1		11.0	8.3	5.4	2.5	5.7		7.8	8.0	-
35		-		-	8.3	5.0	3.1	5.2		-	8.0	-
40		12.1		10.5	8.7	5.6	3.0	4.9		7.7	7.4	-
50		12.1		7.1	8.1	6.0	3.1	0.2		7.7	6.5	8.6
60		12.1		11.0	8.1	5.9	3.5	0.4		6.4	5.0	-
70		12.1		10.5	8.4	5.7	4.0	1.3		5.7	4.0	-
80		12.0		10.5	7.8	4.8	4.0	1.9		5.9	3.2	-
90		12.0		10.3	7.5	4.9	4.3	1.8		5.8	1.1	-
100		12.0		9.9	7.2	4.0	3.2	0.3		6.0	0.2	-
105		-		-	-	-	-	-		-	-	-
110		12.0		9.9	7.2	3.7	1.0	0.2		5.0	0.2	8.8

Table 4.1-10

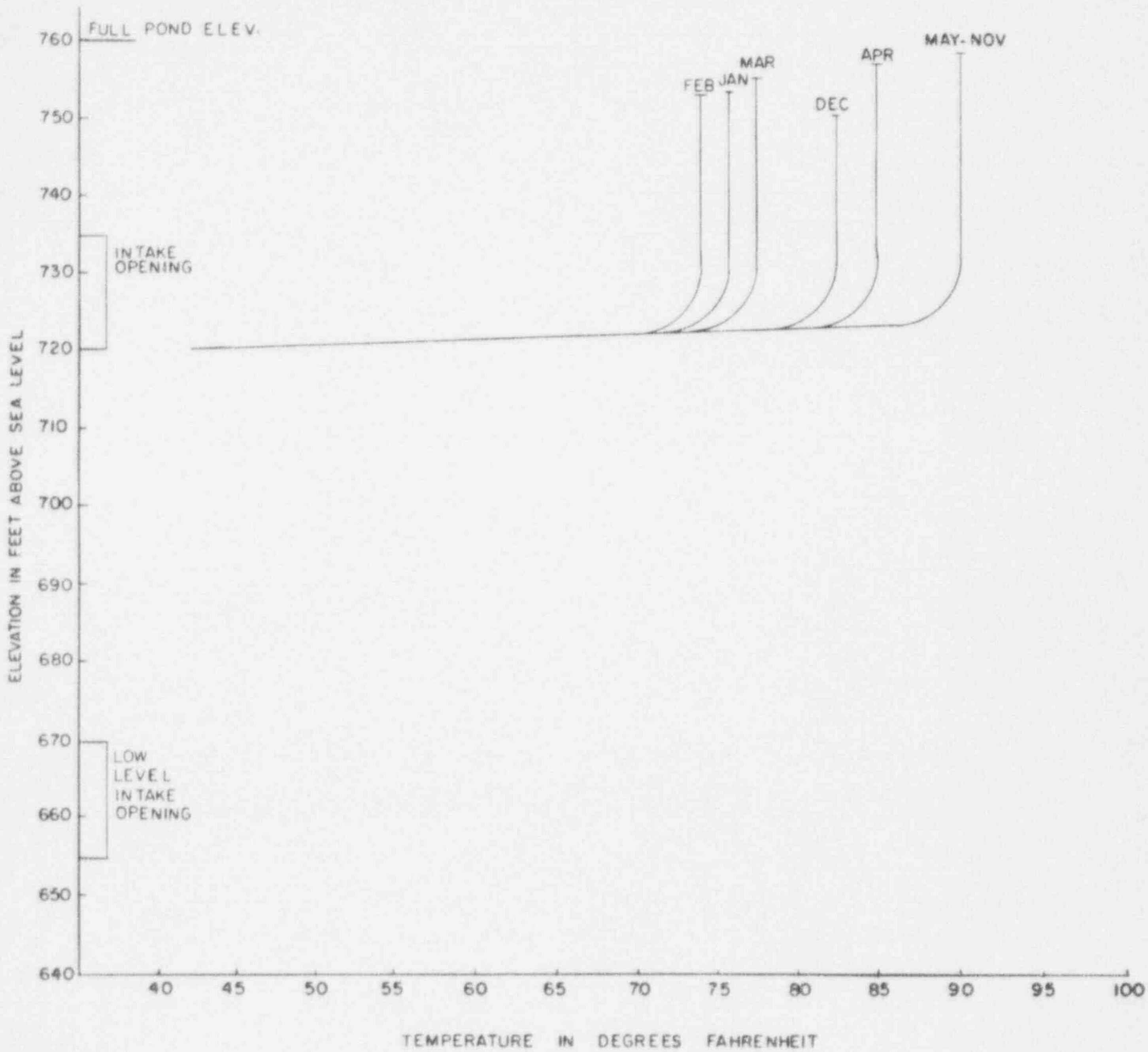
EXPECTED TEMPERATURES IN LAKE NORMAN WITH McGUIRE

UNITS 1 & 2 OPERATING AT 100% LOAD

	Monthly Average Discharge Temp. (°F)	Maximum Daily Average Discharge Temp. (°F)	Maximum Instantaneous Discharge Temp. (°F)	Monthly Average Ambient Surface Temp. (°)	Maximum Daily Average Ambient Surface Temp. (°F)
1 Jan.	76.0	79.0	81.0	44.0	47.0
Feb.	74.0	77.0	80.0	43.0	45.0
March.	77.0	81.0	83.0	47.0	51.0
April	85.5	88.5	92.0	59.0	69.0
May	90.0	90.0	92.0	66.0	78.0
June	90.0	90.0	92.0	77.0	84.0
July	90.0	90.0	92.0	82.0	86.0
Aug.	90.0	90.0	92.0	81.0	86.0
Sept.	90.0	90.0	92.0	76.5	89.5
Oct.	90.0	90.0	92.0	69.5	76.5
Nov.	90.0	90.0	92.0	60.0	65.0
Dec.	82.0	86.0	88.0	51.0	56.0
2 Jan.	80.5	83.5	85.5	48.5	51.5
Feb.	78.0	81.0	84.0	46.5	49.0
March.	80.5	84.5	86.5	53.5	57.5
April	95.0	95.0	97.0	70.5	80.5
May	95.0	95.0	97.0	72.5	84.5
June	95.0	95.0	97.0	88.0	95.0
July	95.0	95.0	97.0	86.5	90.5
Aug.	95.0	95.0	97.0	87.5	92.5
Sept.	95.0	95.0	97.0	80.5	83.5
Oct.	95.0	95.0	97.0	81.0	88.0
Nov.	95.0	95.0	97.0	65.0	70.0
Dec.	85.0	89.0	91.0	54.0	59.0

[1] Normal Climatic Conditions

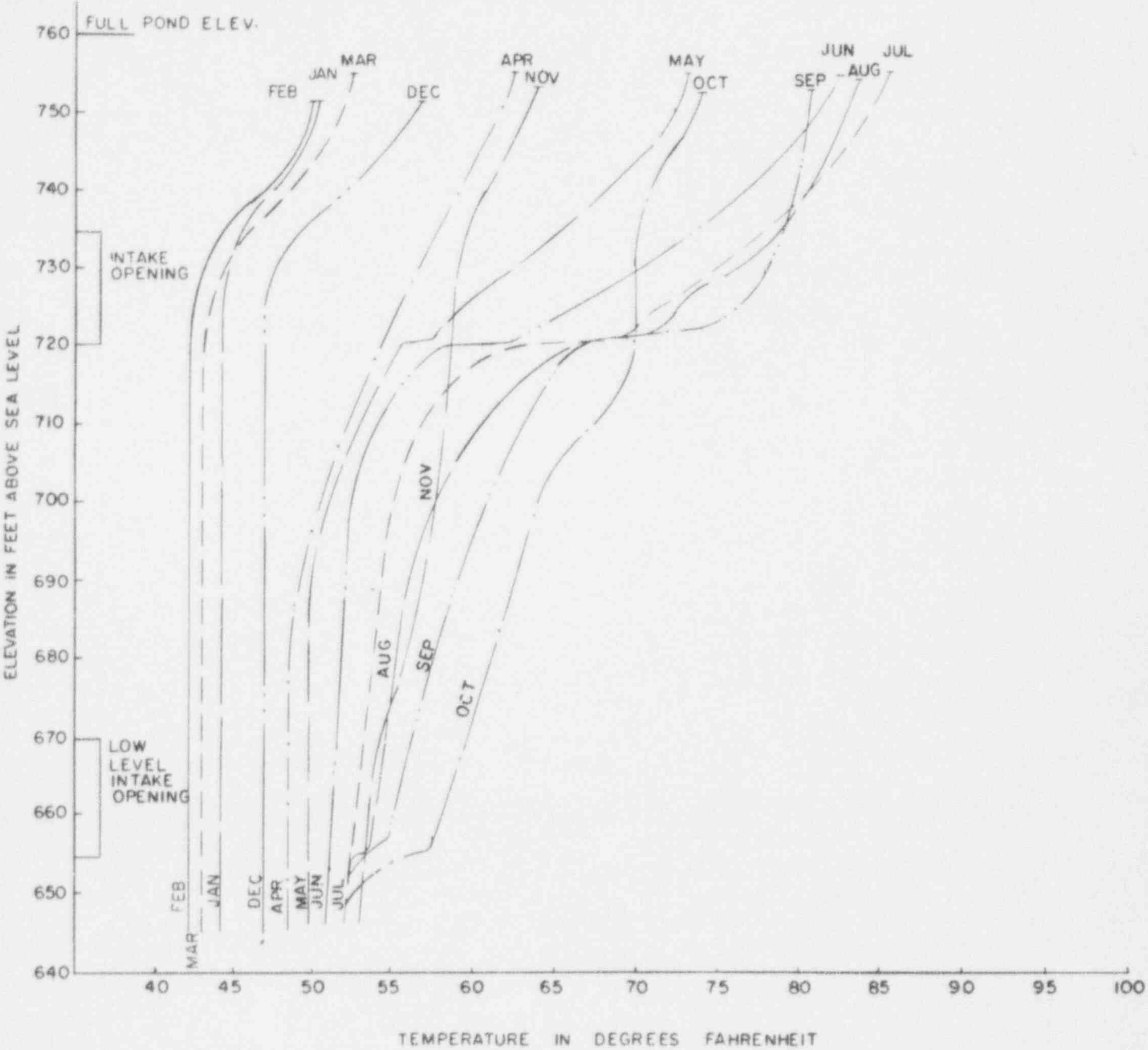
[2] Extreme (Warmest) Climatic Conditions



EXPECTED VERTICAL TEMPERATURE PROFILES AT THE MOUTH OF THE DISCHARGE CANAL NORMAL CONDITIONS

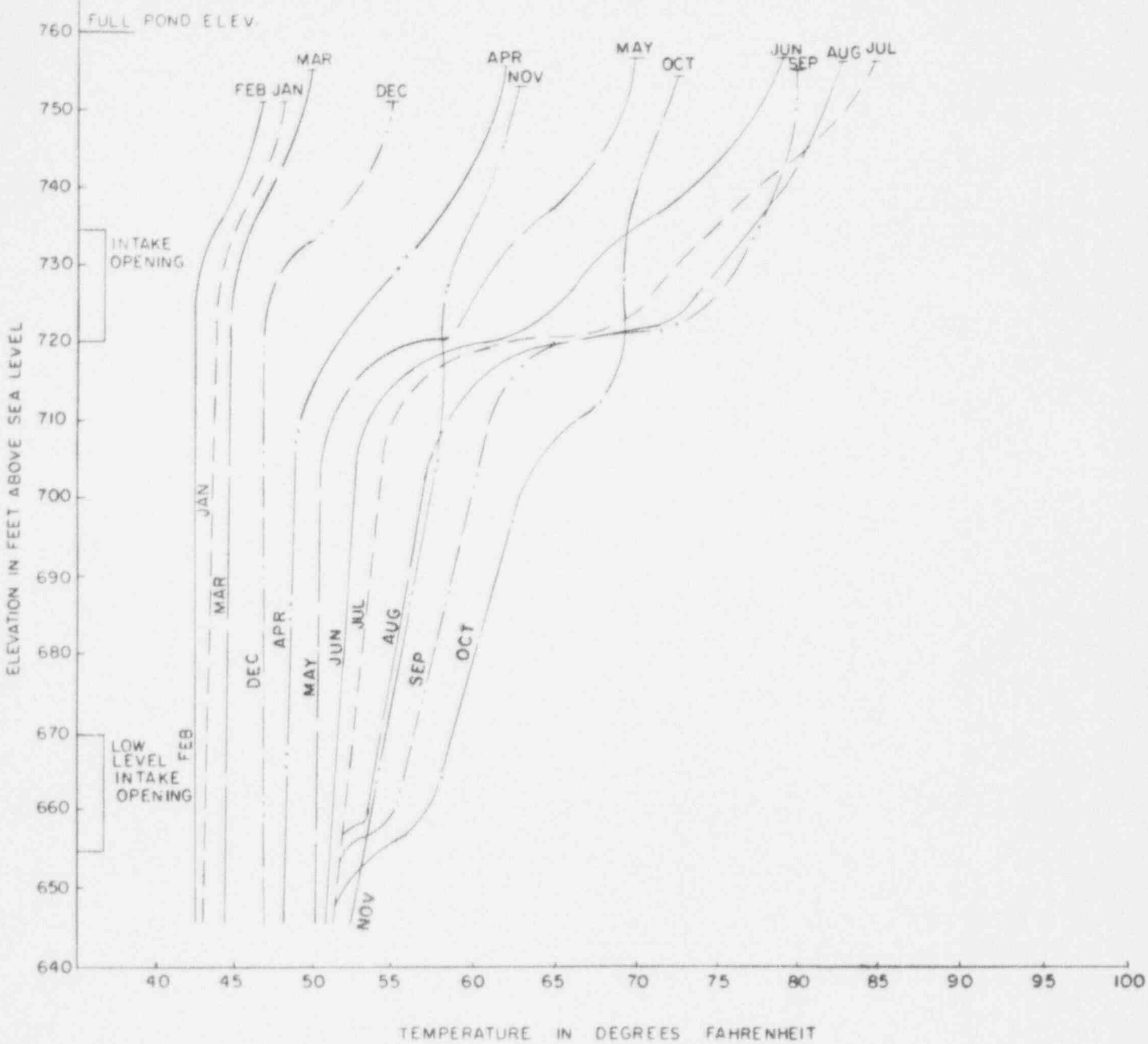
McGUIRE NUCLEAR STATION

Figure 4.1 - 11



EXPECTED VERTICAL TEMPERATURE PROFILES IN FRONT OF COWANS FORD DAM NORMAL CONDITIONS

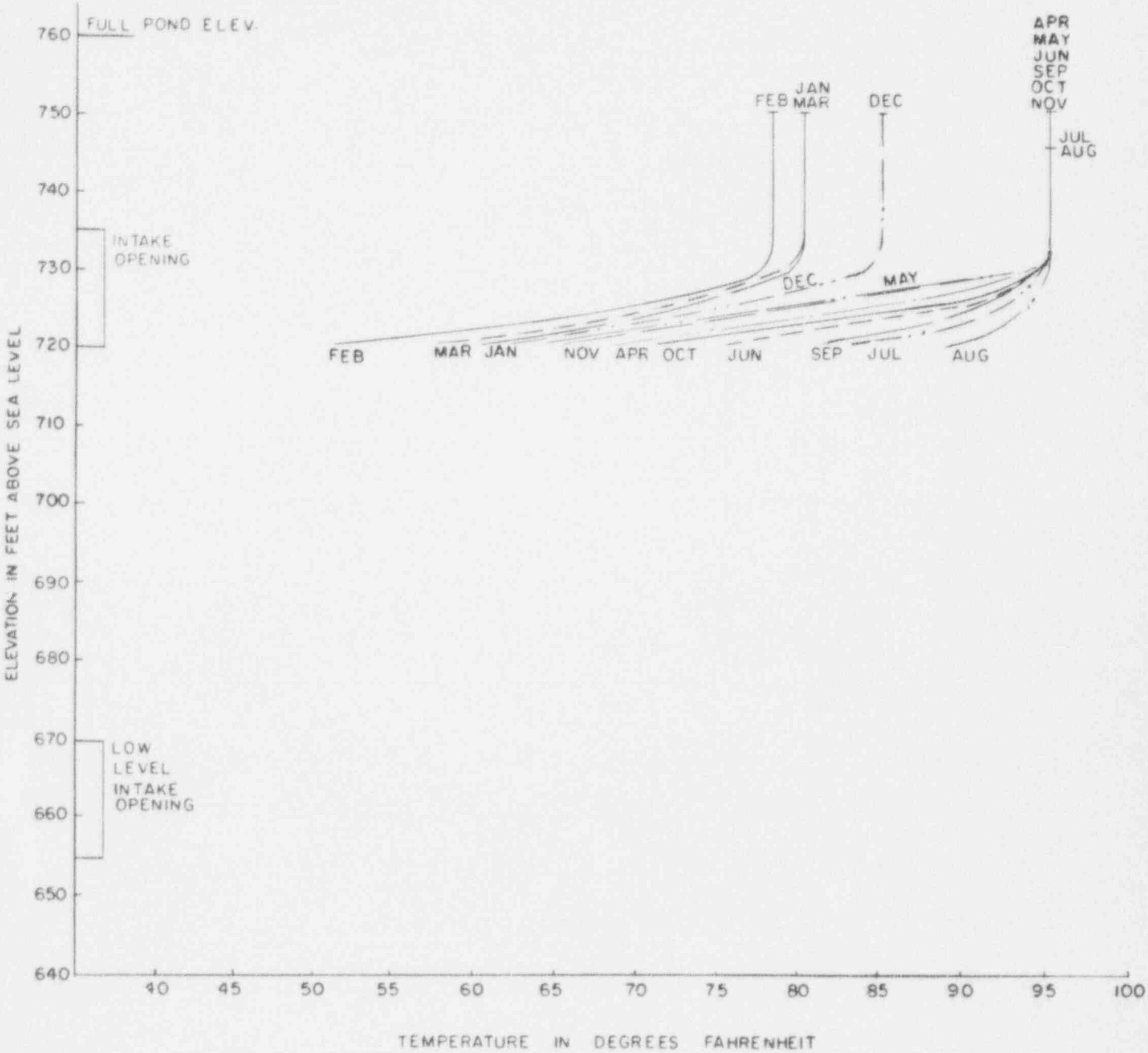
McGUIRE NUCLEAR STATION
Figure 4.1 - 12



EXPECTED VERTICAL TEMPERATURE PROFILES AT THE NORTH AND EAST EDGES OF MIXING ZONE NORMAL CONDITIONS

McGUIRE NUCLEAR STATION

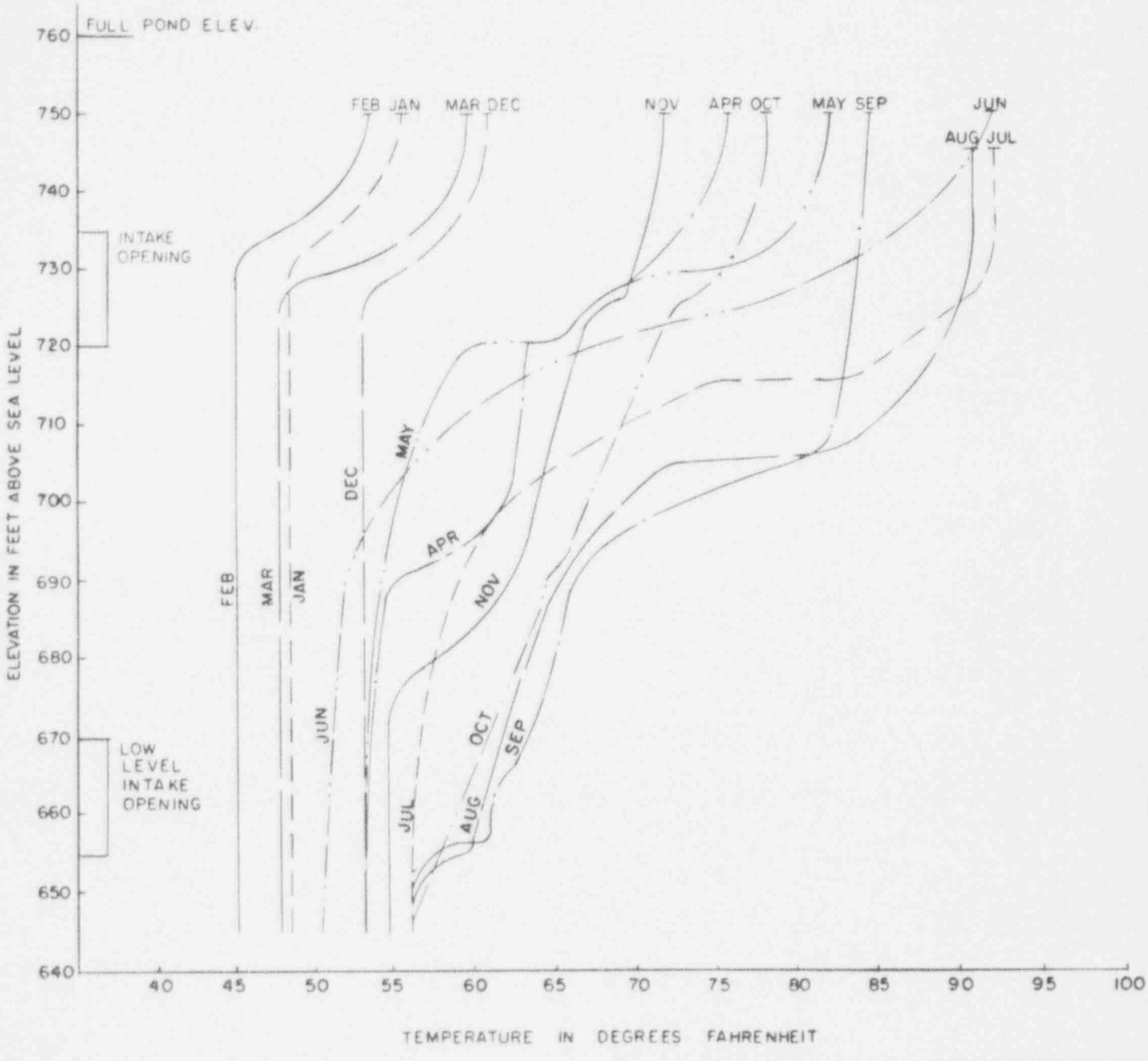
Figure 4.1 - 13



EXPECTED VERTICAL TEMPERATURE PROFILES AT THE MOUTH OF THE DISCHARGE CANAL EXTREME CONDITIONS

McGUIRE NUCLEAR STATION

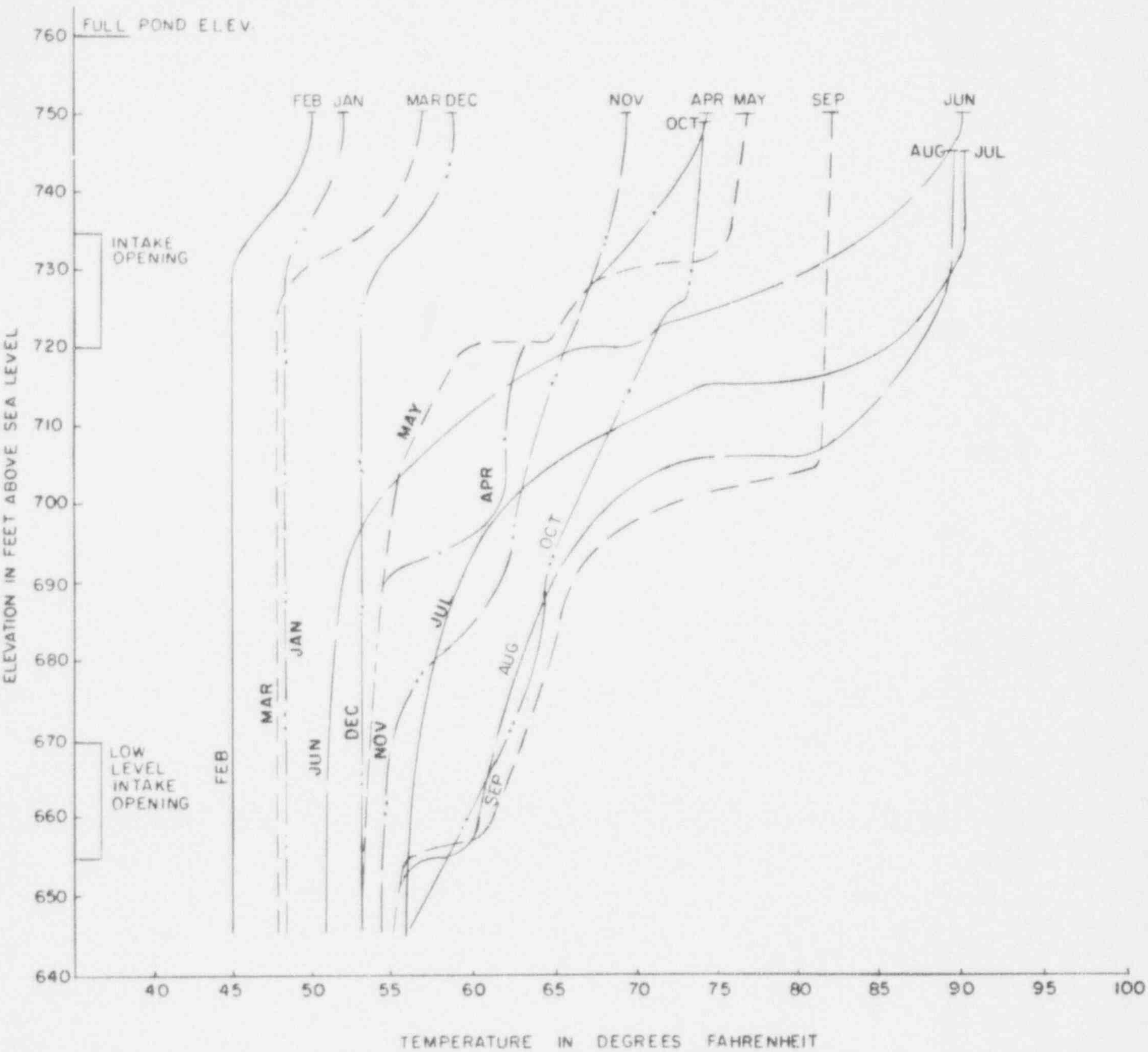
Figure 4.1 - 14



EXPECTED VERTICAL TEMPERATURE
PROFILES IN FRONT OF
COWANS FORD DAM
EXTREME CONDITIONS

McGUIRE NUCLEAR STATION

Figure 4.1 - 15



EXPECTED VERTICAL TEMPERATURE PROFILES AT THE NORTH AND EAST EDGES OF MIXING ZONE EXTREME CONDITIONS

McGUIRE NUCLEAR STATION

Figure 4.1 - 16

7 BENEFIT-COST ANALYSES

7.2 LAKE NORMAN GENERATING COMPLEX VS ALTERNATIVE

7.2.1 QUANTIFIABLE BENEFITS AND COSTS

For an economic comparison of hydroelectric generation for peaking purposes with the alternative mode of generation by combustion turbines, (Table 7.2-1) average useful life of each type of plant is assumed as follows:

Type of Plant	Average Useful Life
Hydroelectric plant, conventional and/or pumped storage	66 2/3 years
Combustion turbines	14 years

7.4 McGUIRE PLANT - NUCLEAR VS COAL ALTERNATIVE

7.4.1 INTRODUCTION

The comparison of generation cost between nuclear fuel and coal at McGuire site (Table 7.4-1) assumes the useful plant life for both alternatives to be 28 years.

Req II

Long
Cochran
Sutherland
Avery

U. S. A. E. C.
COMPLIANCE II
ATLANTA

DUKE POWER COMPANY

POWER BUILDING, BOX 2178, CHARLOTTE, N. C. 28201

W. H. OWEN
VICE PRESIDENT,
DESIGN ENGINEERING

June 20, 1972

JUN 2 0 1972

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

Re: McGuire Nuclear Station
Docket Nos. 50-369 and 50-370
Environmental Report

Dear Mr. Muller:

Please refer to your letter of June 7, 1972 requesting additional information for preparation of the draft environmental statement of the subject nuclear station. Accordingly, we are submitting three signed originals and 297 additional copies of Supplement 4 to the McGuire Nuclear Station Environmental Report. The Supplement should be placed at the end of the Environmental Report folder and the revised sheets inserted at appropriate places.

You will notice that items 1 through 17 of the "Request for Additional Information" attached with your letter have been fully covered by the enclosed Supplement and Revision. We regret we are presently unable to furnish a recent aerial photograph of the site requested in item 18. However, we expect to have available the aerial photograph within the next 4 to 6 weeks. We trust that this information will enable the staff to complete the licensing review of this project.

For your convenience we are also enclosing a check list showing the sections in which the additional information requested is found.

If you require additional information, please advise us.

Yours very truly,

W H Owen

W. H. Owen

WHO-lg

Enclosure

cc: Mr. Glenn C. Blaisdell, County Manager
Mecklenburg County
720 East Fourth Street
Charlotte, North Carolina 28202
(With one copy of Enclosures)

3326

DUKE POWER COMPANY
POWER BUILDING, BOX 2178, CHARLOTTE, N. C. 28201

W. H. OWEN
VICE PRESIDENT,
DESIGN ENGINEERING

June 20, 1972

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cc: Mr. Glenn C. Blaisdell, County Manager
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720 East Fourth Street
Charlotte, North Carolina 28202
(With one copy of Enclosures)

McGuire Nuclear Station
Check List of Additional Information Required
Environmental Impact Review
Docket Nos. 50-369 and 50-370

Item	Supplement 4 Section
1. Discuss basis of reported annual property tax of $4 million.	7.2.1.1
2. Discuss the training program for construction employees at Oconee Nuclear Station as it relates to the construction work force at McGuire Nuclear Station.	4.5.1
3. Provide a list of the cities drawing water from Lake Norman and the Catawba River and within a 50 mile radius of the site. Of special interest is information on the water supply for Cornelius, North Carolina.	3.6
4. Provide a description of the crop distribution within a radius of 50 miles along with the locations of dairy farms, farms and permanent residences within two miles of the site. Identify the nearest school, hospital and dairy farm.	4.4.1
5. Provide statistics on Duke's load and capacity growth for the period 1961-1970.	2.3
6. Discuss Duke's power pool obligations, if any, and the criteria used by Duke in establishing its reserve capacity.	2.3.1
7. Discuss the site selection criteria used by Duke in the selection of the McGuire site.	5.2
8. Provide information on Duke owned land around the site and Lake Norman with particular attention to any possible areas being considered as potential future sites for electric generating stations. A description of the intake and discharge features of such sites should be included.	2.2
9. Provide plans for the disposal of construction spoils and earth work quantities involved in the construction of McGuire. Identify the construction buildings that will be removed after completion of the construction phase.	4.5
10. Clarify the status of the wildlife management area below Cowans Ford Dam.	3.5.2
11. Provide the volume and acreage of the waste water collection basin along with detailed information on the sewage plant for McGuire Station.	4.3.3
12. Provide distances of transmission lines associated with the Lake Wylie and South Carolina sites.	7.3

Item		Supplement 4 Section
13.	Provide data on water storage for the Catawba River reservoirs.	4.2.2
14.	Provide details of the cooling water condensers as well as details of the discharge canal.	4.1.5
15.	Provide the appraised value of the one house (structure only) located within the exclusion area.	7.2.1.5
16.	Provide the current construction schedule for McGuire Nuclear Station.	2.3*
17.	Provide the elevation of the vent above the ground for the release of radioactive gas.	4.2.3
18.	If possible, provide a current (within the last six months) aerial photograph which shows the area within two miles of the site.	

*Supplement 1, Revision 3, June 20, 1972

McGUIRE NUCLEAR STATION
ENVIRONMENTAL REPORT
DOCKET NOS. 50-369 AND 50-370
REVISION No. 3

June 20, 1972

Changes and Corrections

The following pages are to be inserted as replacements for existing pages.

Please note that vertical lines and revision numbers in each margin identify portions revised unless otherwise noted at bottom of page.

Front	Back
ER Supplement 1, Page 2-3	-
ER Supplement 2, Page 4-10	ER Supplement 2, Page 4-11 - Deleted
Table 3.6-1, ER Supplement 2	-
ER Supplement 3, Page 4-3	-

Duke Power Company
Charlotte, North Carolina

2.3 BASIS OF NEED

Schedule highlights are tabulated below:

Unit 1	Unit 2	
May, 1971	With Unit 1	Break ground and start pre-construction earthmoving
December, 1971	With Unit 1	Receive exemption to construct Reactor and Auxiliary buildings and to erect equipment below yard grade
May, 1972	With Unit 1	Start concrete foundation
October, 1972	With Unit 1	Receive construction permit
October, 1973	July, 1974	Set reactor vessel
July, 1974	August, 1975	Start turbine-generator erection
August, 1975	August, 1976	Start precritical testing
November, 1975	November, 1976	Load fuel
March, 1976	March, 1977	Begin commercial operation

3. 3.

4.3.3 NONRADIOACTIVE WASTE WATER DISCHARGES

The following chemicals will be used in the primary and the secondary systems at McGuire:

1. Approximately eleven pounds of lithium hydroxide will be used per unit per year. The lithium will be removed by demineralizers and the resin will be drummed as solid waste.

2. Approximately 18,000 pounds of boric acid will be used per unit per year. It will be disposed of by concentration by evaporation and then drummed as solid waste.

3. Approximately 2,000 pounds of hydrazine will be used per unit per year. The hydrazine reacts chemically with oxygen in the system to form nitrogen and water, with a small portion of the hydrazine decomposing to form ammonia.

4. Approximately 2,600 gallons of 30 percent aqua ammonia will be used per
3. unit per year. This is used for pH control of steam generator feedwater 3.
and small amounts will be disposed of through the steam generator blowdown.

5. The corrosion inhibitor in the secondary recirculating cooling water system will be sodium nitrite and borax. Approximately 1,200 pounds will be used per unit per year. This is a closed system with no blowdown.

6. Approximately 800 gallons of commercial liquid detergents will be used annually by the station for normal plant maintenance and cleanup. Any waste from this operation will be processed through the plant sewage treatment system. Powdered detergents used for the decontamination of clothing, equipment, laundries and laboratory articles may be used in quantities up to 3,200 pounds per year for two units. The laundry waste water will be processed through activated carbon filters for removal of organics and
3. detergents. 3.

The blowdown system on each unit is designed for a maximum capacity of 600,000 pounds per day. There is the normal makeup capability of 475 gpm or 5,700,000 pounds per day for two units.

4.3.4 DEMINERALIZED WATER SUPPLY

The two regenerable mixed bed makeup demineralizers have a capacity of 475 gpm each. Approximately 137,000 pounds of 100 percent sodium hydroxide and 89,000 pounds of 66° Baume sulfuric acid will be used per unit per year to regenerate the mixed bed demineralizers. After regeneration the spent acid and caustic will be mixed to assure neutralization. These reaction products are sodium sulfate and alkalinity. The average effluent from the waste water collection basin will contain approximately 45 ppm of sodium sulfate and 33 ppm of alkalinity expressed as $CaCO_3$. When this effluent from the waste water collection basin is diluted by the average flow of 2670 cfs through Cowans Ford Dam it would only contribute approximately 0.0002 ppm alkalinity as $CaCO_3$ and 0.0002 ppm of sodium sulfate to the Catawba River. When flow through Cowans Ford is at its minimum of 80 cfs, these effluents result in an increase of 0.6 ppm alkalinity and 0.8 ppm sodium sulfate in the river water.

3. 3.

Table 3.6-1
Municipalities and Industries Withdrawing Water From
Lake Norman and Catawba River Within 50 Miles

I. MUNICIPALITIES

NORTH CAROLINA	RESERVOIR	AVERAGE WITHDRAWAL MGD	PURPOSE
Hickory	Oxford	5.52	City Supply
Longview	Oxford	1.52	City Supply
Davidson	Norman	0.22	City Supply
Huntersville	Norman	0.16	City Supply
Mooresville	Norman	2.00	City Supply
Charlotte	Mt. Island	34.00	City Supply
Belmont	Wylie	3.00	City Supply
Mt. Holly	Wylie	1.30	City Supply
SOUTH CAROLINA			
Rock Hill	Catawba River	4.00	City Supply
Fort Mill-Springs Mill	Catawba River	0.70	City Supply

II. INDUSTRIES

NORTH CAROLINA			
Southern Dye Stuff (Mt. Holly)	Wylie	1.50	Industrial Processing
American Efird Thread (Mt. Holly)	Wylie	2.40	Industrial Processing
Superior Yarn Mills (Mt. Holly)	Wylie	0.03	Industrial Processing
Westinghouse (Charlotte)	Wylie	0.04	Industrial Processing
SOUTH CAROLINA			
Rock Hill Printing & Finishing Company (Rock Hill)	Catawba River	12.00	Industrial Processing
J. P. Stevens (Rock Hill)	Catawba River	0.06	Industrial Processing

Therefore, it might be postulated that from evidence already established on lakes throughout the country, hypolimnetic withdrawal has no detrimental effect, but, most probably, tends to improve ecological conditions. According to Symons Weibel and Robeck (1966) "mixing would prevent: (1) low dissolved oxygen concentrations; (2) increased iron and manganese concentrations: (3) production of hydrogen sulfide and (4) increase in color, in the hypolimnion. Mixing would, however, prevent the accumulation of cool waters in the impoundment bottom and might increase overall productivity of the lake by recycling back into the euphotic zone nutrients released during organism decomposition."[2] The projected use of hypolimnetic water in Lake Norman, which could result in an early overturn, will actually be to the ecological benefit of this reservoir.

The record of hypolimnetic oxygen deficit in Lake Norman, since its formation is shown on the accompanying table. The dates describe the earliest date at which the deepest sample at the Cowans-Ford water sampling station fell below 1.0 mg/l. The second date is the last sampling date on which zero values in the deepest water were also recorded. The precise date of overturn cannot be established exactly, since sampling dates were at a monthly interval and the overturn occurred between the dates shown. Based on the data below, in the event of an August overturn, there would be a period of approximately three months in each year which would remain with an oxygen credit, rather than an oxygen debit, in the hypolimnion.

Period of Oxygen Deficit in Lake Norman Station 109.0
Cowans Ford Dam

Year	A	B	C
1963	Aug. 5	Nov. 18	Dec. 9
1964	Aug. 25	Nov. 16	Dec. 10
1965	Aug. 18	Nov. 4	Dec. 13
1966	Sept. 9	Oct. 27	Nov. 23
1967	Sept. 1	Nov. 3	Dec. 3
1968	Sept. 1	-	Dec. 3
1969	Nov. 11	-	Dec. 11
1970	Aug. 18	Nov. 23	Dec. 1
1971	Aug. 19	Nov. 10	Dec. 2

A - First Sampling Date when DO was <1.0 in sample collected at the bottom.

3 B - Last Sampling Date when DO was <1.0 in sample collected at the bottom. 3

C - Sampling Date following B, which showed a well mixed Lake.

We conclude, therefore, that hypolimnetic pumping in Lake Norman will prove beneficial to the aquatic biota.

[2] Symons, J.M., S.R. Weibel, and G.G. Robeck, "Influence of Impoundments on Water Quality-A Review of Literature and Statement of Research Needs." PHS Publ. No. 999-WP-18, October 1964, Revised 1966. 78pp.

DUKE POWER COMPANY

McGUIRE NUCLEAR STATION

UNITS 1-2

APPLICATION FOR LICENSES

DOCKETS 50-369 and 50-370

ENVIRONMENTAL REPORT SUPPLEMENT 4

June 20, 1972

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TABLE OF CONTENTS - (Continued)

LIST OF TABLES

LIST OF FIGURES

1 INTRODUCTION

This Supplement 4 to the McGuire Nuclear Station Environmental Report filed March 9, 1971 contains supplemental information requested by the Commission in their letter of June 7, 1972 for prepa ation of the draft Environmental Statement.

2 DESCRIPTION OF McGUIRE NUCLEAR STATION

2.2 SITE DESCRIPTION

Figure 2.2-3 shows the land owned by Duke around the site and Lake Norman within the low population zone. Two potential sites for steam generation plants, Sites D and E are also shown. Site D is about 3.5 miles northeast of the McGuire site and Site E is about seven miles north of the McGuire site.

In the future development of thermal stations at specified sites on Lake Norman, the exact layout and design of the cooling water intake and discharge structures will be a product of extensive field studies combined with physical and analytical modeling of the Lake Norman Generating Complex. It is not realistic to project the design features of future stations until such studies which must include the impact of McGuire Nuclear Station, have been made.

2.3 BASIS OF NEED

The generation capacity and peak load on Duke system for each year from 1961 through 1970 are tabulated in Table 2.3-1.

2.3.1 CRITERIA FOR RESERVE CAPACITY

The following factors determine the requirement of reserve capacity for Duke system:

a) Additional load due to inclement weather, about 5 percent of the expected peak load;

b) Size of largest unit;

c) Other outages and reduction to the extent of about 5 percent of expected peak load;

d) Forecast errors or severe outage based on previous experience;

e) Outage due to nuclear refueling.

2.3.2 POWER POOL OBLIGATIONS

Duke is not a member of any formal power pool and consequently McGuire is needed to meet Duke's system needs in 1976 and subsequent years.

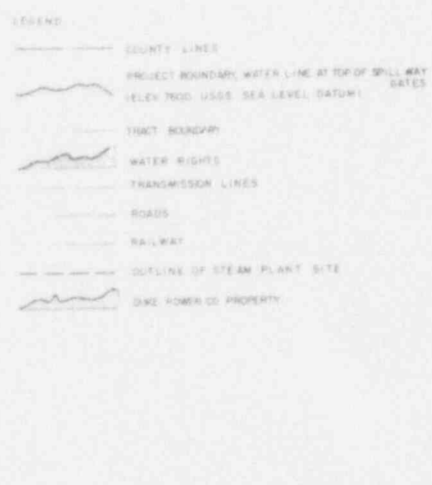
Duke is one of the members of the Southeast Reliability Council.

TABLE 2.3-1

Generation Capacity and Peak Load on Duke System 1961 Through 1970

Year	Maximum Generation Capacity Mw	Peak Load Mw
1961	3602	2837
1962	3602	3192
1963	3872	3370
1964	3872	3522
1965	4222	3826
1966	4603	4440
1967	4716	4579
1968	4837	5364
1969	5670	5614
1970	6463	6284


DENVER
TRIANGLE
COWANS FORD
McGUIRE NUCLEAR STATION
N
GASTON COUNTY
MECKLENBURG



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DUKE OWNED LAND WITHIN LOW POPULATION ZONE

McGUIRE NUCLEAR STATION

Figure 2.2-3

3.5 WILDLIFE

3.5.2 Fauna

In 1958 a group of Piedmont sportsmen (Catawba Waterfowl, Inc) proposed that a waterfowl refuge area be set aside to attract ducks and geese to this area. Duke Power agreed to lease up to 4000 acres of land at a minimal cost to the North Carolina Wildlife Resources Commission, provided the Commission would manage the refuge. In 1962 all parties concerned agreed and the Catawba Waterfowl, Inc Refuge was established on Mountain Island Lake just below Lake Norman and Cowans Ford Dam. The refuge proper consists of 1065 acres plus an additional 1070 acres which has been set aside as a protection strip along the Catawba River from Cowans Frod Dam downstream to the refuge proper. No hunting is allowed within one-half mile of the refuge boundary.

In the last ten years the number of waterfowl using the refuge has steadily increased. During the winter of 1971-72 as many as 2000 ducks were counted on the refuge at one time. Most of these ducks are migrants, however, some species winter in the area. Two hundred twenty Canada Geese were counted on the refuge at one time during the winter of 1971-72. The use of artificial nests has provided suitable nesting habitat for three Canadian Geese this spring. Three types of nests are being used, three floating nests, four platform nests in the water and four platform nests on land. The three geese presently nesting are using all three types.

Several resting ponds have been created on the refuge. Twenty-five acres have been planted in food crops such as wheat, barley, fesque, rye grass and clover. Corn is purchased from local sources and a resident of the area has been employed to spread the grain on a periodic basis.

Following is a listing of waterfowl which used the refuge during the winter of 1971-72.[1] Other pertinent data has been included.

Mallard (Anas platyrhynchos)- Approximately 80 percent of the duck population, a winter resident.

Black Duck (Anas rubripes)- 15 percent of duck population, a winter resident.

Pintail (Anas acuta)- Uncommon winter resident.

Blue-Winged Teal (Anas discors)- Occasional visitor, a transient.

American Widgeon (Mareca americana)- Occasional visitor, a transient.

American Coot (Fulica americana)- Occasional winter resident.

Wood Duck (Alix sponsa)- Uncommon resident.

Canada Goose (Branta canadensis)-A winter resident, occasionally nests in this area.

[1] Information provided by Mr Richard L Allison, President of Catawba Waterfowl, Inc, Charlotte, North Carolina.

3.6 WATER SUPPLY

Cities and industries drawing water from Lake Norman and Catawba River within a 50 mile radius of the site are listed in Table 3.6-1, revised June 20, 1972. Average daily withdrawals are also included. The withdrawal by Davidson, North Carolina includes water consumed in the neighboring town, Cornelius, North Carolina, that has progressively abandoned its water supply wells and is buying water from Davidson.

4 ENVIRONMENTAL EFFECTS OF McGUIRE STATION

4.1 THERMAL EFFECTS

4.1.5 DESCRIPTION OF CONDENSER COOLING WATER SYSTEM

The details of condensers for McGuire turbines are given in Appendix 4D. Discharge canal is detailed in Figure 4.5-2.

4.2 RADIOLOGICAL EFFECTS

4.2.2 RADIOACTIVE LIQUID RELEASES

The storage volume at full pond and maximum drawdown elevations of each reservoir on Catawba River are given in Table 4.2-12.

4.2.3 RADIOACTIVE GASEOUS RELEASES

The station vent for the release of radioactive gases is at elevation 902.02 msl, 142.02 feet above the yard elevation 760 msl as shown in Figure 2.3-1, PSAR.

4.3 OTHER WATER QUALITY EFFECTS

4.3.3 NON-RADIOACTIVE WASTE WATER DISCHARGES

Volume and area of the waste water collection basin are as follows:

	Area (Acres)	Volume (Acre Feet)
Maximum elevation 690	11.5	125
Minimum elevation 687	10.7	90

Details of sewage facilities at the plant site are presented in Table 4.3-2.

4.4 LAND USE

4.4.1 McGUIRE NUCLEAR STATION

The approximate crop distribution of harvested land within a 50 mile radius of the site is as follows:

Percent	Crop
43.7	Corn, soybeans, peanuts and wheat
6.4	Cotton
2.3	Tobacco
47.6	All hay and other crops
100.0	

Locations of dairy farms, farms and permanent residences within two miles of the site as a result of actual count made in June 1972, are presented in Figure 4.4-8. Nearest schools, hospitals and dairy farms are shown in Figure 4.4-7.

Population distribution within one mile radius of the site, shown in Figure 4.4-2, revised November 24, 1971, was based on a recount of houses in this area in October 1971.

4.5 CONSTRUCTION EFFECTS

Plan for disposal of construction spoils is given in Figure 4.5-1.

In constructing the discharge canal at McGuire 477,000 cubic yards of earth and 58,700 cubic yards of rock will be moved. An additional 180,000 cubic yards of earth and 77,000 cubic yards of rock will be used to construct dikes as the discharge canal will cut through several small coves before emptying into Ramsey Creek Cove. The intake canal will require the removal of 160,000 cubic yards of earth. Figure 4.5-2 shows the grading plan of the discharge canal and intake channel.

In deploying all of this earth and rock material, earth moving equipment will push the material into position in the lake, so that only a small fraction of the materials actually come into contact with the water, thus segregation of materials is held to a minimum and only a slight increase in local turbidity is realized.

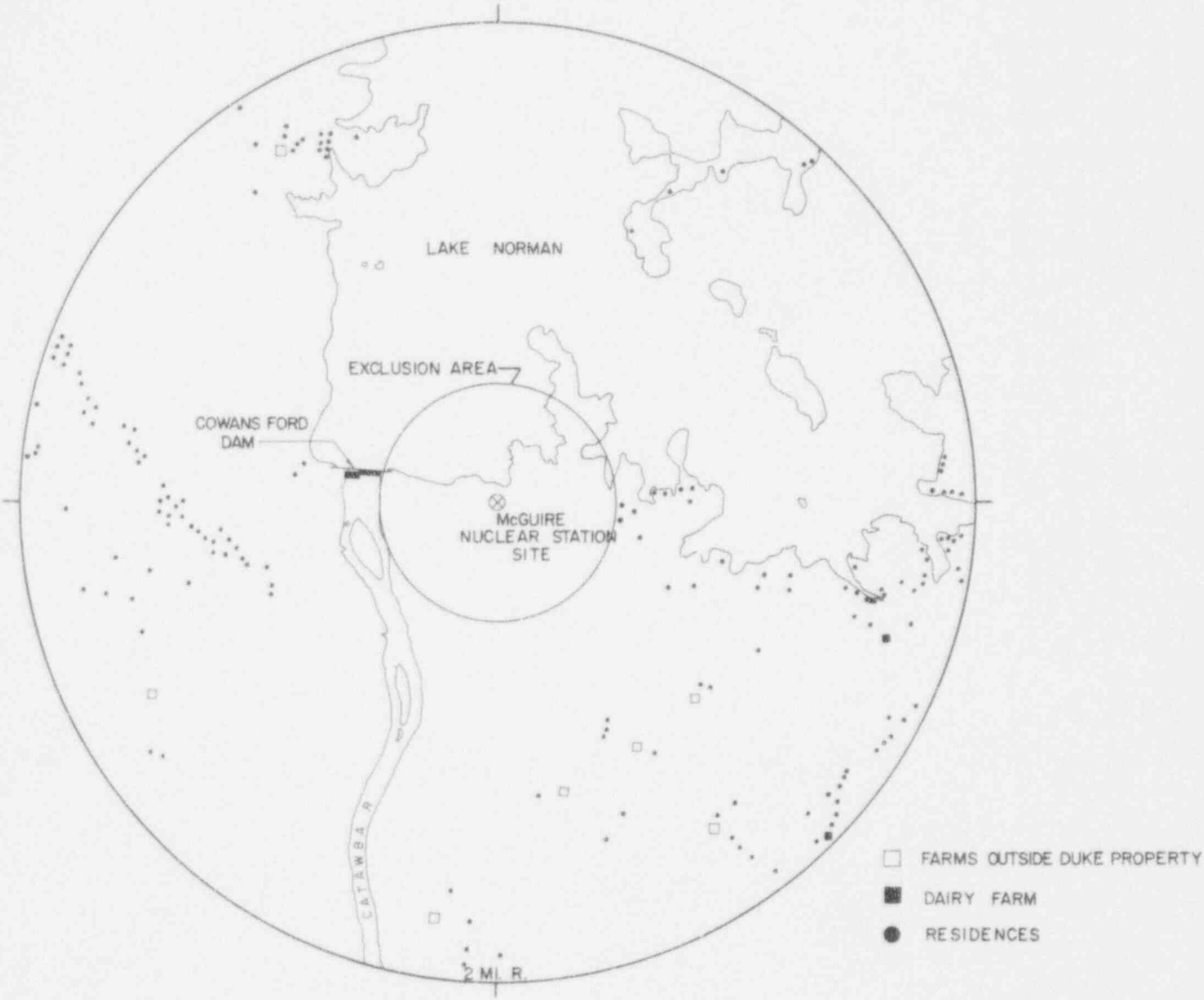
The construction buildings that will be removed after completion of the construction phase are shown in Figure 4.5-3.

4.5.1 CONSTRUCTION WORK FORCE

Duke's construction experience of Oconee Nuclear Station in South Carolina indicates that about 75 percent of the work force at McGuire will be drawn from the neighboring Mecklenburg, Lincoln, Gaston, Catawba and Iredell counties; about 13 percent will move in this area from other Duke jobs and the remaining 12 percent will live within commuting distance. Since a relatively small percentage of the work force will move into the project area from outside, the completion of the project is unlikely to affect the area economically.

A major proporation of the skilled labor force at McGuire will be drawn from the unskilled laborers hired locally and trained under the Duke in-house training program. At Oconee about 44 percent of the skilled labor force was hired locally as laborers and were subsequently trained and promoted to the skilled ranks.

It is expected that more than half of the peak skilled work force of 1300 at McGuire will be drawn from the local area and trained at the project site. Moreover, fewer construction workers are now willing to commute or move to new project sites.



LOCATION OF FARMS, DAIRYFARMS
& PERMANENT RESIDENCES, 0 - 2 MILES

McGUIRE NUCLEAR STATION

Figure 4.4-8

Table 4.2-12

Storage in Catawba River Reservoirs

	Full Pond Elevation Ft	Volume at Full Pond Billions Cu Ft	Maximum Drawdown Elevation Ft	Volume at Maximum Drawdown Billions Cu Ft
Bridgewater	1200.0	12.580	1165.0	5.086
Rhodhiss	995.1	2.945	980.1	1.228
Oxford	935.0	5.554	920.0	3.276
Lookout	838.1	1.169	833.1	0.961
Cowans Ford	760.0	47.637	735.0	20.727
Mtn Island	647.5	2.496	640.5	1.651
Wylie	569.4	12.280	554.4	5.738
Fishing Creek	417.2	2.614	402.2	0.984
Great Falls-Dearborn	355.8	0.089	350.8	0.055
Rocky Creek-Cedar Creek	284.4	0.419	282.4	0.352
Wateree	225.5	13.238	209.5	5.612

Table 4.3-2
McGuire 1 & 2
Sewage Treatment Facilities

I TEMPORARY CONSTRUCTION FACILITIES

Plant No.	Service	Capacity GPD	Permit No. N.C. Dept. of Water & Air Resources	Discharge Routing	Effluent Chlorine #/Day
1	Construction Mess Hall & Office	4000	2104	(Discharge to NSW Pond overflowing to Waste Water Collection Basin and then	0.2
2	Construction Toilets	5000	2104	(Overflows into Catawba River	0.25
3	Construction Trailer Camp	6000	2165	Discharge to 7 day (41,000 gal. min.) holding pond then to Catawba River	0.3

II PERMANENT SEWAGE FACILITIES

Plant No.	Service	Capacity GPD	Permit No. N.C. Dept. of Water & Air Resources	Discharge Routing	Effluent Chlorine #/Day
	Plant Sanitary Sewage	4500	N/A	Discharge to NSW Pond overflowing to Waste Water Collection Basin and then overflowing to Catawba River	0.225


N
Intake Canal Spoil Area (if dredged)
LAKE NORMAN
Earth or Rock Excavation may be spoiled here to increase width of barrier dams
General Spoil Area
Access Road

ANSTEC
APERTURE
CARD

Also Available on
Aperture Card

9406090191-13

NOTES ON CLEARING

1. Clear all excavation and fill areas and a strip 10 ft wide contiguous to all sides of these areas.

2. Clear Standby Nuclear Service Water Pond to El 743 ± with a 10' max from El 740.

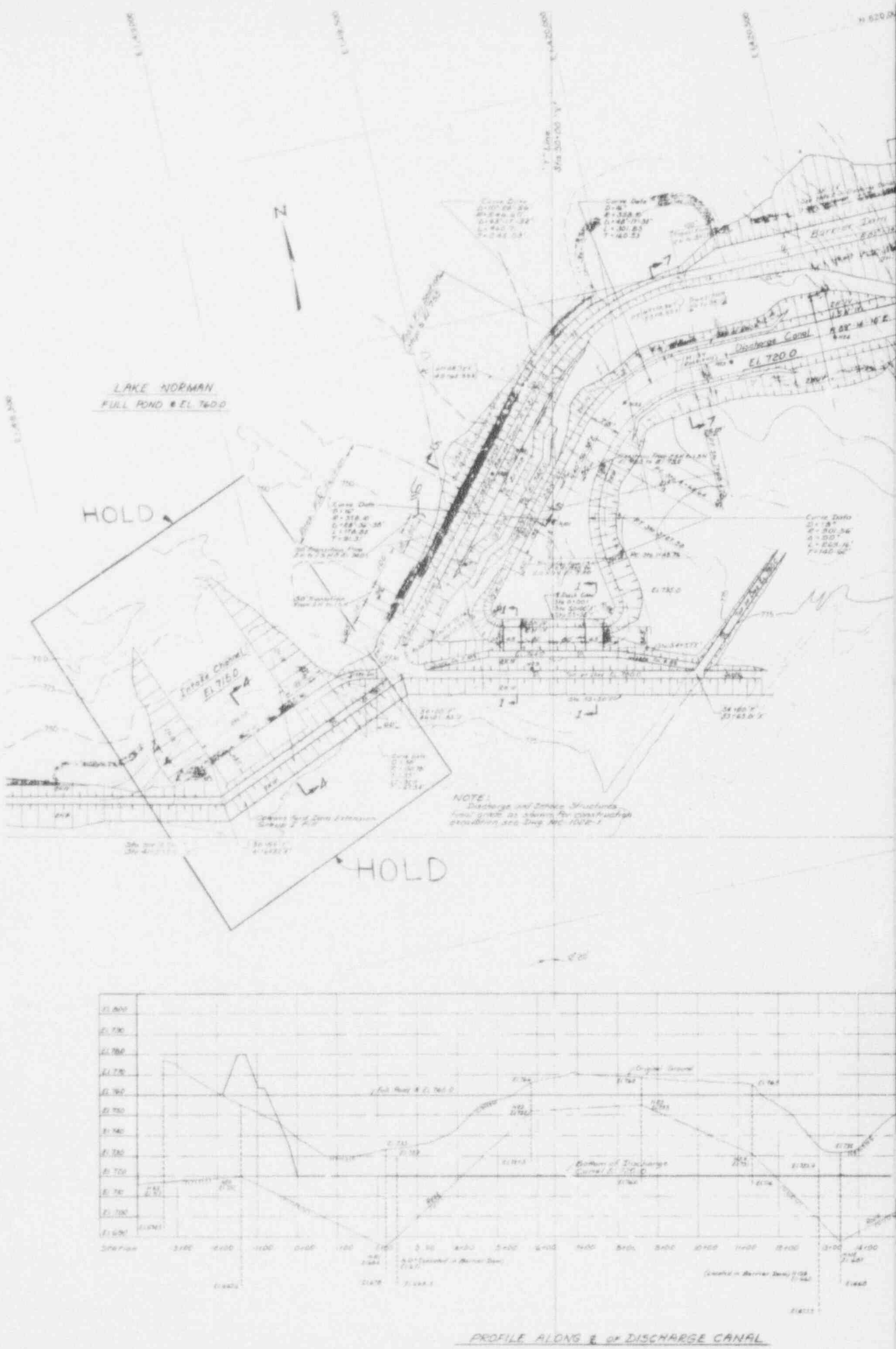
3. Clear Waste Water Collection Basin to El 693 ±.

4. Crossed hatched areas are not to be cleared by grading contractor. They will be cleared by bridge contractor.

5. Wooded Area - Trees in these shaded areas are not to be removed. These areas are to be marked appropriately in the field to insure preservation of trees in these areas.

CLEARING PLAN
SPOIL & BORROW AREA

McGUIRE NUCLEAR STATION
Figure 4.5-1



LAKE NORMAN
FULL POND @ EL 760.0
HOLD
Intake Channel
EL 715.0
Discharge Canal
EL 720.0
NOTE:
Discharge and Intake Structures final grade as shown. For construction excavation see Dwg MC-1028-1
HOLD
Full Pond @ El 760.0
Original Ground
Bottom of Discharge Canal El 720.0
PROFILE ALONG ℄ OF DISCHARGE CANAL

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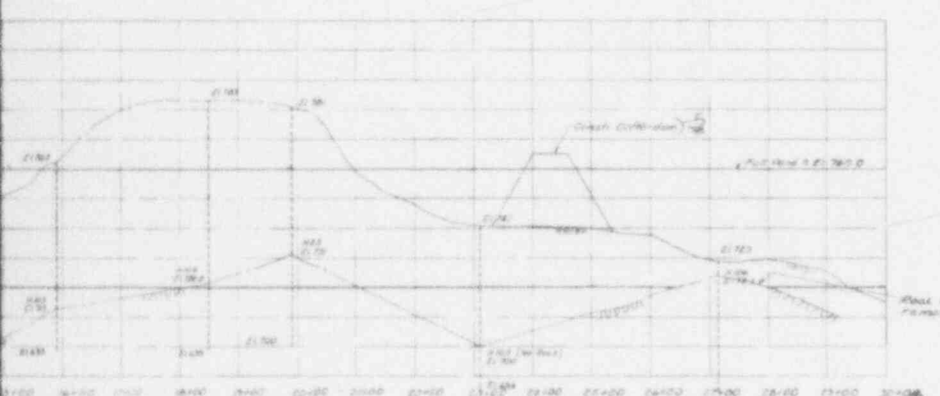

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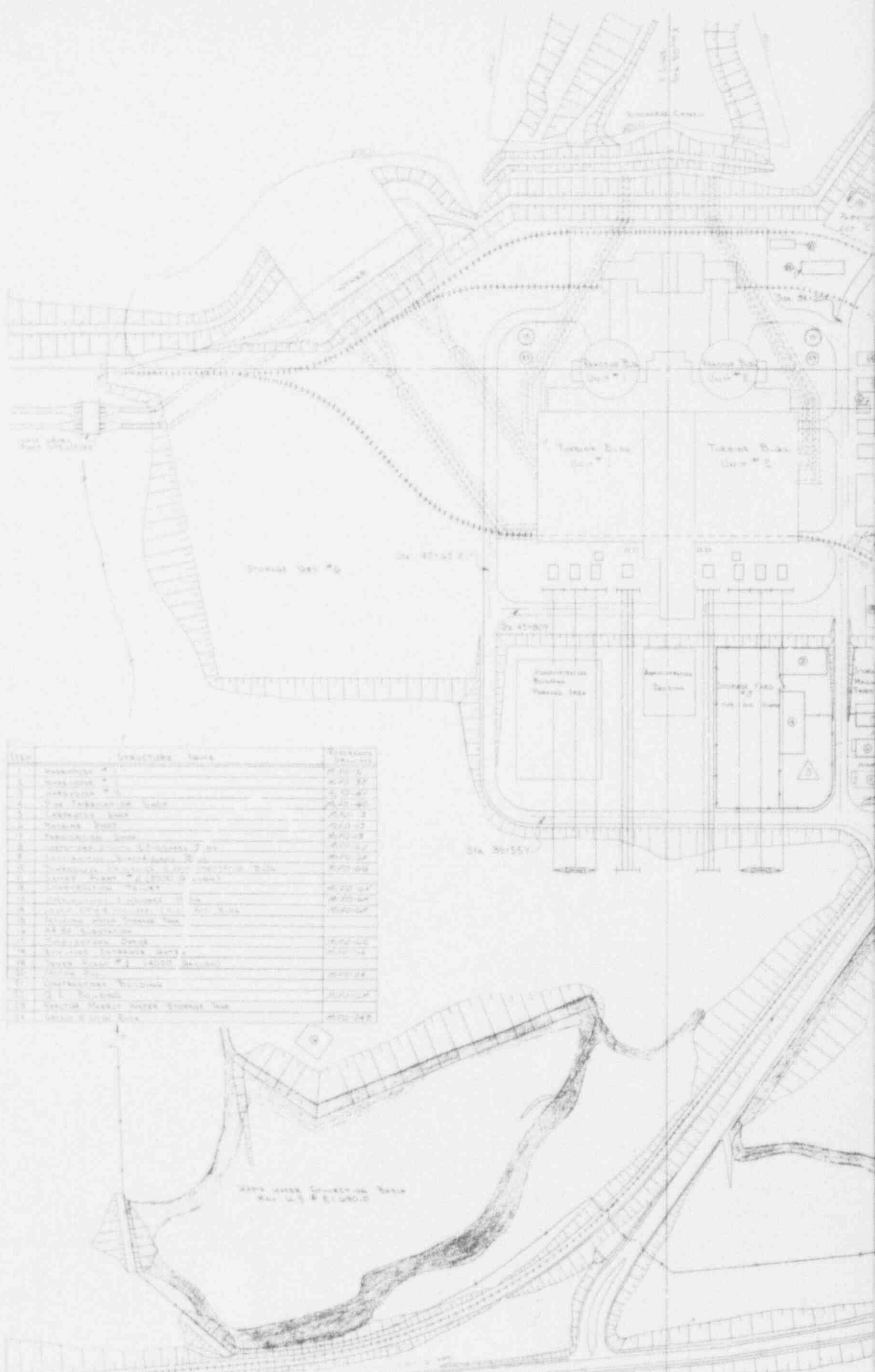
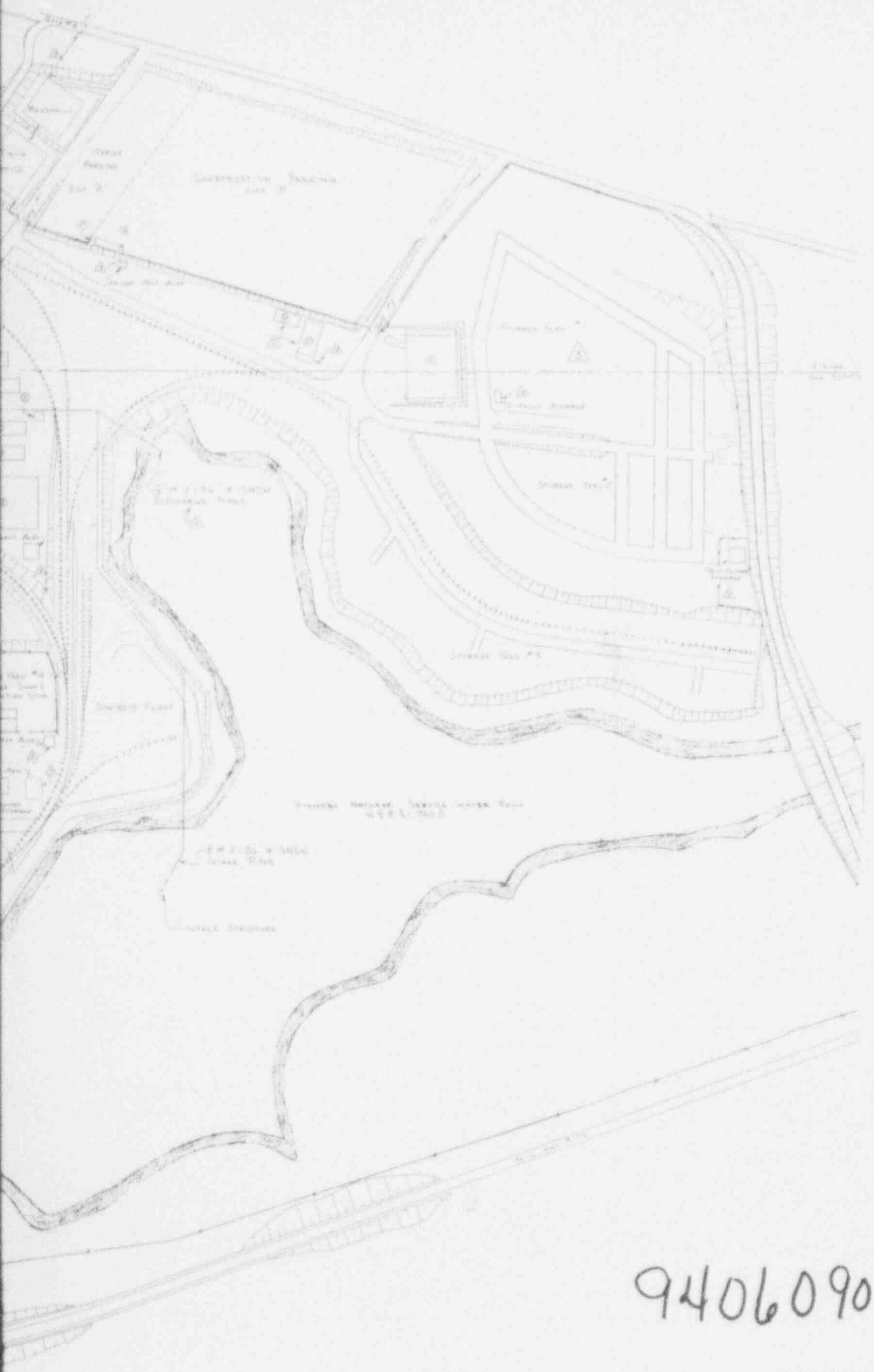
GRADING PLAN
DISCHARGE CANAL & INTAKE CHANNEL

McGUIRE NUCLEAR STATION
Figure 4.5-2



Reactor Bldg Unit #1
Reactor Bldg Unit #2
Turbine Bldg Unit #1
Turbine Bldg Unit #2
Storage Yard #2
Storage Yard #3
Sta. 45+80



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Aperture Card

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CONSTRUCTION PLANT LAYOUT

McGUIRE NUCLEAR STATION

Figure 4.5-3

5 ALTERNATIVES TO McGUIRE NUCLEAR STATION

5.2 ALTERNATIVE SITES FOR NEW CAPACITY

Criteria used for selection of McGuire site for a nuclear steam generating station are as follows:

a. Adequate source of cooling water;

b. Proximity to load center;

c. Proximity to transmission lines;

d. Suitable foundation and seismological conditions;

e. Favorable meteorology.

7.2 LAKE NORMAN GENERATING COMPLEX VS ALTERNATIVE

7.2.1 QUANTIFIABLE BENEFITS AND COSTS

7.2.1.1 Economic Development

McGuire Nuclear Station is located in Mecklenburg County. In 1970, property tax at the rate of $18.50 per $1000 of the assessed value was imposed in Mecklenburg County, and the assessed value was 60 percent of the actual cost of the property. For the revised estimated cost of $385,461,000 excluding interest during construction, the annual property tax on 1970 rates is about $4,300,000.

7.2.1.5 Land Use

Only one house existed within the exclusion area which was acquired by Duke along with 14.7 acres of land. This structure was valued at $7,400.

7.3 McGUIRE AT LAKE NORMAN SITE VS OTHER SITES

The length of transmission lines included in the cost estimate for alternative sites in Table 7.3-1 is as follows:

Site on existing Lake Wylie - 37.3 miles

Site in South Carolina on lake to be developed - 165 miles

APPENDIX 4D

McGUIRE 1-2

SURFACE CONDENSER EQUIPMENT FOR THE MAIN TURBINE

APPENDIX 4D

SPECIFICATION MCS-1202.00
July 15, 1971
Addendum #1

DUKE POWER COMPANY
McGUIRE UNIT 1-2

SURFACE CONDENSER EQUIPMENT FOR THE MAIN TURBINE

ADDENDUM #1

This Addendum changes the delivery specified in Paragraph 6, Page 6 as follows:

Delivery of Unit 1 equipment shall be December 1, 1973.

Delivery of Unit 2 equipment shall be April 1, 1975.

TPL/JSM/cf

SPECIFICATION MC-1202.0
November 27, 1970

DUKE POWER COMPANY
McGUIRE NUCLEAR STATION UNITS 1 & 2

SURFACE CONDENSER EQUIPMENT FOR MAIN TURBINE

1. GENERAL

This specification covers the furnishing, delivery and supervision of erection for two surface condensers to serve two turbogenerator units each with a name-plate capacity of 1220 MW. The condensers shall be furnished complete with air removal equipment, and all other auxiliary equipment and appurtenances which are directly a part of and are necessary for the successful continuous operation of the condenser equipment.

The equipment shall be furnished in accordance with attached "General Conditions of Contract" revised October 31, 1968.

The condenser equipment shall be designed and built in accordance with the "Standards for Steam Surface Condensers" as published by the Heat Exchange Institute.

2. CONDENSER INSTALLATION CONDITIONS

Each main condenser will serve a turbine of the tandem compound, six flow, single reheat type operating at 1800 rpm. The primary steam conditions to the turbine will be 975 psia - 541.5°F at the throttle, and the steam will pass through the HP turbine and then be reheated to 514.3°F. Seven stage bleeding will be used for heating feedwater.

2.1 Condenser Operating Conditions

The bid for each of the two main condensers shall be based on a circulating water inlet design temperature of 60.0°F and vacuum conditions of 1.46" HgABP, at the 60°F entering water temperature.

2.2 Condenser Space Limitations

The proposed arrangement of the condenser is shown on attached prints of preliminary drawings as follows:

PMC 111 Turbine Bldg Foundation - Gen Arr - Plans
PMC 112 Turbine Generator Foundation - Gen Arr - Sections

2.3 Condenser Performance

The proposal shall cover the furnishing of three single pass main condenser shells per unit arranged in parallel capable of condensing service as follows:

Main Condenser:	Flow (lb/hr)	Enthalpy (Btu/lb)
1) Flows to Condenser		
(a) Exhaust from Turbine to Condenser	8,108,287	1001.3
(b) Main Turbine Last Stage Drain	141,813	111.3 (liquid)
	62,273	1051.5 (Vapor)
(c) SJAE Drain	3,000	191.3
(d) Gland Steam (HP Turbine)	990	1090.8
Turbine Drain (LP Turbine)	5,015	1191.3
Condenser Duty (from items a,b,c,d) =	$7,676,815.6 \times 10^3$ Btu/hr	
(e) Aux Condenser Drain	173,946	63.8
2) Effective tube length	44'-9"	
3) Maximum free oxygen in condensate leaving the condenser hotwell, guar	.005 cc/liter	
4) Hotwell storage capacity at normal level (total - 3 shells)	170,000 gallons	
5) Circulating water inlet design temp, design flow	60°F, 959,602 gpm	
6) Cleanliness factor	.95	
7) Number of passes	One	
8) Circulating water velocity through tubes	7.0 ft/sec	
9) Condenser tubing quantity, size, and material	62,826, 1" OD, 22 BWG, 304 SS	
10) Effective surface	736,041 ft^2	
11) Guaranteed backpressure	1.46" HgA	
12) Turbine Bypass Dump Steam to Cond	6,340,878 lb/hr @ 972 psia, 541.1°F, 1191.3 Btu/lb	

3. EQUIPMENT TO BE FURNISHED

The condenser equipment shall be furnished complete with air removal equipment, and auxiliary equipment required for intended operation.

3.1 Main Condenser

Each unit shall consist of a three shell, parallel flow, single pass, deaerating condenser of the horizontal, divided waterbox type and shall be provided with an efficient inlet for the admission of steam and for the uniform distribution of same. Diagonal as well as longitudinal and transverse bracing shall be provided at the top of the condenser neck to stiffen it against vibration. The design of the internal bracing in the condenser neck is to be coordinated with the turbine manufacturer and is to be compatible with the turbine exhaust nozzle to give minimum exhaust losses. The tube spacing shall be arranged so that the steam will have free access to the entire tube surface and shall flow without any abrupt changes in either direction or velocity. The pressure drop across the condenser, the depression between the temperature of the condensate and that of the vacuum, and the temperature difference between vacuum and the condenser circulating water discharge shall be kept to a minimum. The condenser shall be of the deaerating type capable of deaerating the turbine exhaust, turbine drains, the drain from turbine steam seal system, and the normal make-up (up to 8500 gpm) from the upper surge tank. The condensate leaving the hotwell shall have a guaranteed oxygen content no greater than .005 cc/liter maximum. The condenser shall be arranged for dump steam from the turbine bypass system. The quantity of this dump steam is given in Section 2.3. The condenser will be located below the low pressure elements of the turbine with the tubes oriented transversely to the turbine generator axis. The condenser design shall permit turbine operation with one-half of a condenser shell out-of-service.

The condenser shell shall be of all welded construction and shall be suitably reinforced with ribs. The condenser shell shall be designed to withstand safely the pressure differentials of 15 psi external or 15 psi internal steam pressure measured at the centerline of the shell. It shall also withstand indefinitely successive changes of temperature between 32°F and 240°F. A suitable flange shall be provided on inlet filler piece between expansion joint and turbine exhaust nozzle, for welded connection to turbine exhaust nozzle. The hotwells shall have a total active storage capacity at the normal water level of 170,000 gallons. The hotwells shall be furnished with a complete gage glass and fittings and provision for socket weld connections for level controller and thermometers. Holes shall be provided in the condenser shell for low pressure bleed piping and steam seal piping for low pressure turbine as required. The condenser shall also have openings for two low pressure feedwater heaters in each shell neck. Provision shall be made for heater support with provisions for expansion. Heater final dimensions, weights, and all necessary design data will be provided to the successful bidder at a later date.

The waterboxes shall be of ample size for efficient distribution of water to the tubes. The waterboxes shall be designed for 15 psi external pressure and 30 psi internal pressure. The inlet box shall consist of two separate sections. The interior of the boxes shall be kept free of ribs and braces which would cause turbulence of flow. A suitable number of doors shall be provided to afford access to all the tubes. Adequate rungs for temporary interior scaffolding and hand grab bars at the doors shall be provided. A man door shall be provided in the hotwell and in the condenser shell for access. The waterboxes shall have bottom inlets and outlets. The waterboxes shall be of the weld-on type and the inlet connection arrangement and depth of waterboxes shall be such as to assure proper distribution of water and uniform entrance velocities against the tube-sheet. All necessary connections for circulating water pipes, waterbox drains, condensate, vents, and priming shall be provided and shall be furnished with weld ends. The waterbox inlet and outlet connections shall be 84" ID and shall have safety bars across the openings.

The number, size, shape and location of nozzles and holes shall be subject to Owner's approval. Tubesheets shall be of ample thickness properly reinforced against deflection or warping. Tube supports shall have wide bearing surface for tubes and shall be arranged so that tubes will be completely drained when condenser is not in operation. Drilling of tubesheets and supports shall be accurately aligned. The shell, the hotwell, the tubesheets, the tube support plates and the steam inlet neck shall be completely assembled, aligned, matched, marked and checked before shipment.

Tubes will be furnished by Owner and shall be 1" OD, 22 gage (average wall) seam welded Type 304 stainless steel to ASTM A-249. Tubes shall be rolled into the tubesheets and flared on the inlet end. Tubes will be replaced from the circulating water inlet end of the shells for Unit #1 and the outlet end for Unit #2. The interior of the waterboxes shall be coated with Debecote, or equal, after erection in the field. Surfaces to be coated shall be prepared by the condenser contractor in accordance with the specifications of the coating manufacturer.

Condenser shell, tubesheets, baffle plates and support plates shall be constructed of welded flange quality steel plate, ASTM A-285, Grade C. Waterboxes shall be of welded steel construction. A 1/8" thickness allowance shall be made for corrosion of waterboxes and shells.

Thrust blocks shall be provided for the condenser to support the weight of the condenser and for keying the condenser to prevent torsional twist on the expansion joint. Owner will furnish concrete support piers including anchor bolts and plates. Contractor shall furnish all required keys and lubricated plates.

3.2 Air Removal Equipment

Three full capacity, twin element, two stage, steam jet air ejectors shall be furnished with each condenser. One two stage element per unit shall be capable of maintaining guaranteed vacuums in one condenser shell and one auxiliary condenser with normal condenser air leakage. Steam for ejectors will be available at 1000 psig, saturated or any lower pressure and temperature required. Contractor shall furnish and install on each ejector unit a separator to remove moisture in steam supply line.

A common inner-and after-condenser of the surface type shall be furnished for each air ejector unit. Condensate will be used for circulating water. The tube design pressure shall be 300 psig. Condenser shall be furnished with Type 304 seam welded stainless steel tubes to ASTM A-249 Type 304 and flange quality steel plate, ASTM A-285, Grade C tubesheets. Siphon loops for tube jet condenser drains shall be furnished by Owner complete with piping and valves to condenser. Contractor shall furnish steam shutoff valves and strainers for ejectors complete with piping connections to ejectors. A diaphragm operated steam throttle valve will be furnished by Owner. Motor operated vacuum pumps will be furnished by Owner and will be used for evacuating the condenser to 20" Hg Vacuum, when starting the unit, and before steam is available at sufficient pressure for the steam jet ejectors. These vacuum pumps will also be used for evacuating waterboxes and for priming circulating pumps. The vacuum pump will be capable of evacuating the turbine and condenser volume to 20" Hg vacuum, in not more than 30 minutes.

3.3 Auxiliary Equipment

Contractor shall furnish for each unit with the three main condensers, the following:

a) Welding end nozzles for condensate discharge from condenser hotwell, for air piping offtakes, and all other connections as required by Owner.

b) Drains on the waterboxes and hotwell.

c) Dog bone type Rubber Belt Expansion Joint including stainless steel water seal arrangement for connection to turbine exhaust nozzle.

d) Gage glasses and fittings on hotwells.

e) Necessary steam strainers, steam separators, drain controls, test orifices, and air meters with necessary connections, for steam jet air exhausters.

f) All valves, gages, etc, to be subject to Owner's approval.

3.4 Circulating Pumps

The Owner will furnish circulating pumps.

4. GENERAL DESIGN REQUIREMENTS

The workmanship of all equipment shall be of high quality in every respect and shall be especially adapted for the safe and successful continuous operation of the condensing units.

Condenser shells and waterboxes shall be shop assembled and matchmarked before shipment.

No parts, materials, or equipment shall be of manufacture outside the United States, without prior approval of the Owner.

Bidder shall identify in his proposal any parts, materials, or equipment contemplated for manufacture outside of the United States.

5. REFERENCE DRAWINGS

The following attached preliminary drawings dated November 4, 1970 and status report are a part of this specification.

PBC-111 Turbine-generator Foundation - Gen Arr Plans
PBC-112 Turbine-generator Foundation - Gen Arr Sections
Equipment Status Report

6. DELIVERY

Delivery of the complete condenser and accessories for Unit 1 is required on November 1, 1973.

Delivery of the complete condenser and accessories for Unit 2 is required on November 1, 1974.

7. DRAWINGS

7.1 Two prints each of preliminary outline drawings of main condensers including field assembly joints and steam jet ejectors showing overall dimensions are to be included with proposals.

7.2 Four prints each of complete outline drawings of condensers and auxiliary equipment for Unit 1 shall be submitted to Mr W H Owen, Principal Mechanical Engineer, Duke Power Company, P O Box 2178, Charlotte, North Carolina 28201 for approval by February 1, 1971. Drawing approval is required before equipment is fabricated.

Eight additional prints each of these drawings shall be submitted for record after approval of initial issue.

7.3 A separate and complete set of twelve prints each of outline drawings covering all equipment furnished for Unit 2 shall be submitted to same as above before equipment is shipped.

7.4 Two prints of a detail drawing showing tubesheet layout shall be submitted to same address previously mentioned before condenser is shipped.

8. INSTRUCTION MANUALS

Ten copies of complete Operating & Maintenance Instructions for Unit 1 are to be submitted to Mr W H Owen, Principal Mechanical Engineer, Duke Power Company, P O Box 2178, Charlotte, North Carolina 28201, before equipment is shipped.

Ten copies of complete Operating & Maintenance Instructions for Unit 2 are to be submitted to the same address before equipment is shipped.

9. TESTS, REPORTS, INSPECTIONS AND PROCEDURES

9.1 The Owner shall have full access to the equipment during the process of its manufacture and shop testing. The Owner shall be notified when manufacturing schedule is arranged. Should any work, fabrication or material be supplied by a subcontractor or outside vendor, the Owner shall be notified in writing prior to release to the vendor. The Owner reserves the right of approval of any subcontractor and also the right to inspect work, fabrication or material being subcontracted at the subcontractor's location. The Owner shall be kept informed during manufacture of any major problems or rework of material and be informed of any major repair procedures. The manufacturer shall obtain approval from Owner prior to proceeding with any major repair procedures or material rework.

9.2 Bidder shall submit written outline giving extent of testing and inspection of each manufacturing operation.

9.3 Bidder shall submit by February 1, 1971, the following information for use by Owner or his authorized inspector.

9.3.1 Specification sheets for each condenser listing all parts and complete ASTM material specification of each part.

9.3.2 One set of outline dimension drawings and auxiliary connection list.

9.4 Contractor shall have traceable mill test reports available for Owner's inspection on all steel plate used in construction of condenser.

10. QUALITY ASSURANCE

These specifications cover condensers and accessories important to operation on a continuous basis. It is essential that they meet the quality standards of these specifications and referenced standards, and that this quality be proven. With the proposal, each bidder shall submit a description of the quality assurance procedures he proposes to use; outline his quality assurance organization showing lines of authority; a description of the documentation that will be developed during manufacture and that will be available to the Owner. Evaluation of proposals will include analysis of information submitted and rendering of a judgment with respect to each bidder's qualification to provide and document the quality required by these specifications. After award, the contractor shall submit complete written quality assurance procedures for Owner's review and approval.

11. SPARE PARTS

A complete list shall be included with quotation showing the spare parts recommended by bidder for auxiliary equipment. The list shall be complete with parts numbers and prices for each item.

12. INFORMATION TO BE FURNISHED

12.1 Specifications

Bidder shall submit complete and detailed specifications covering design, construction, materials, and workmanship of all equipment proposed. Bidder shall return with his proposal a copy of Sections 12.1, 12.2 and 12.3 of this specification marked to show the page number in his proposal on which each item of the following information is shown. This data shall include, but is not limited to, the following items:

Main Condenser:

a) Material, thickness, design pressure and method of construction of the condenser shell, hotwell and waterboxes. Material, thickness, and drilling of tubesheets. Materials and thickness of support plates and baffles.

b) Tube layout, arrangement of hotwell and provision of air off-takes.

c) Confirmation of effective square feet of cooling surface. Confirmation of number and overall length of tubes to be furnished by Owner and details of connection at tubesheets.

d) Confirmation of required circulating water flow at 60°F entering temperature to maintain 1.46" Hg ABP.

Air Removal Equipment & Accessories:

a) Design, construction and capacity of air removal equipment.

b) Steam design pressure and steam flow required for steam jet ejectors.

c) Head loss, in feet, for condensate flows of 5690 gpm and 8500 gpm per ejector.

d) Effective surface, sq ft, of inner and after-condensers and number of tubes in steam jet ejectors.

e) Volume of condensers to be evacuated by vacuum pump.

f) Description of accessories furnished.

12.2 Performance Data

Main Condensers:

a) Guaranteed vacuum in inches absolute, outlet water temperature, terminal difference and rate of heat transfer for the following conditions:

Steam to Condenser	See Section 2.3
Circulating Water Temp (with flow from 12.1 (d))	40°F to 80°F
Condition of tubes	95% and 100% clean

b) Vacuum drop between steam inlet and air off-take when condensing flow specified in Section 2.3 at 1.46" Hg ABP.

c) Maximum velocity of water through tubes and friction head loss through condenser at design.

d) Curves showing friction head loss vs flow.

e) Maximum oxygen content of condensate.

f) Temperature difference between condensate and steam at turbine exhaust when condensing flow specified in Section 2.3 at 1.46" Hg ABP.

Air Removal Equipment:

a) Performance curves for air removal apparatus giving air removal capacity and steam consumption for different vacua.

12.3 General Information

a) Two preliminary prints of outline drawings showing general dimensions, typical construction details, including provisions for tube expansion, removal clearances for condensers, condenser supports, and details of expansion joint connection to turbine exhaust flange.

b) Weight of unit, including weight of shell, waterboxes, tubes, tubesheets, and ejectors and total weight of condenser and all auxiliaries. Also weight of condenser full of water.

c) Bidder to submit complete description and estimate of size and weight of largest sub-assemblies of condenser shell, hotwell, dome, neck, tubesheets and support plates that will be shipped.

d) Although Owner will erect the condensers, bidder shall state estimated manhours required for erection of each condenser.

e) Condenser vacuum below which Owner should expect to incur excessive condenser tube vibration.

f) Bidder to complete and return with quotation one copy of attached "Equipment Status Report". The following items are to be completed by bidder: No 7, 9, 10, 11, 12, 13, 15, 17, 19, 20, 21, 22, and 24.

g) This equipment will be in storage or sitting in place for 24 months prior to startup of the plant. Bidder shall submit the following information:

1) Procedure for final cleaning in factory.
2) Protective coating applied in the factory.
3) Method of storage.
4) Recommended field storage and field cleaning procedure.

13. CONFORMANCE WITH SPECIFICATIONS

The Bidder must submit with his proposal a list of all major and minor exceptions to these specifications and obtain written approval from Owner of such exception prior to award of order. If there are no exceptions, it must be so stated in writing. It is particularly emphasized that any unapproved non-conformity with the specification must be changed to complete conformity at the manufacturer's expense, and this expense will include the cost of all labor and materials, and all other related expenses by the Owner or manufacturer.

14. ERECTION ENGINEER

All condenser equipment will be erected by Owner. Contractor shall furnish the services of an erection superintendent to supervise the installation and the placing of the equipment in operation.

The condensers shall be welded in shop, as much as possible. Condenser to be completely shop assembled and shipped to jobsite in maximum size complete sub-assemblies. Any welding which has to be done in the field shall be supervised by the contractor's erection superintendent. The Owner will weld the condenser neck to turbine exhaust nozzle under the supervision of the erection superintendents of both the turbine and the condenser, and each contractor shall assume responsibility for the effect of the weld on his equipment.

15. SUBMISSION OF PROPOSALS AND PRICES

Four copies of initial issue of proposals, without prices, and information as requested shall be submitted to Mill Power Supply Company, Attn: Mr R F Smith, Manager of Purchases, Plant Construction, P O Box 1339, Charlotte, North Carolina 28201, as soon as possible. Any late or incomplete proposals without prior approval by the Owner may not be considered in the award of the order. Extension of the above date will be granted only for valid and sufficient reasons of the bidder and provided such request does not delay or interfere with the work of the Owner. The Owner reserves the right to reject any or all bids.

A separate price letter shall be submitted to Mill Power Supply Company, Attn: Mr T J Garrett, President, P O Box 1339, Charlotte, North Carolina 28201 as soon as possible to include complete commercial information such as terms of payment, escalation policy and shipping schedule for delivery FOB Mt Holly, North Carolina.

15.1 Separate prices shall be submitted to Mr Garrett for the following equipment itemized under 3. EQUIPMENT TO BE FURNISHED.

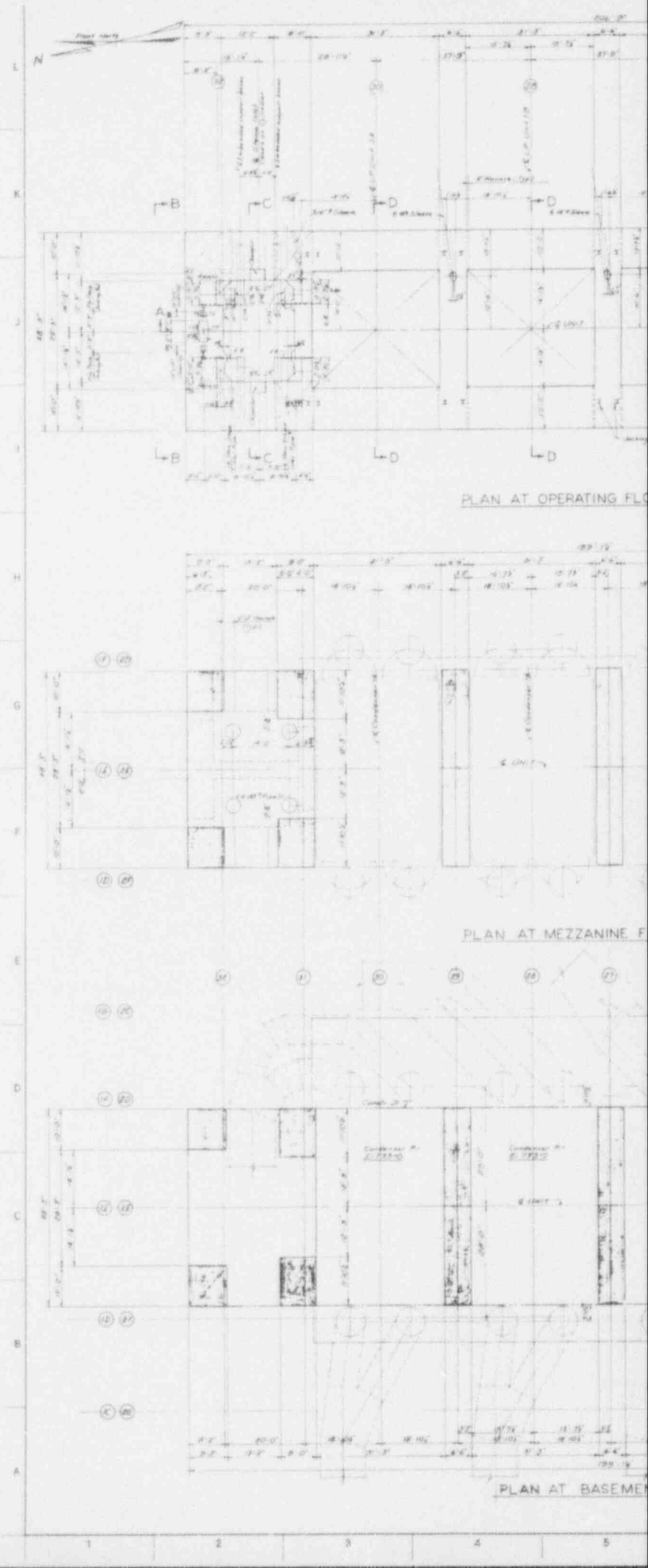
15.1.1 Main Condenser - maximum shop fabricated and assembled

15.1.2 Air Removal Equipment

15.1.3 Auxiliary Equipment

For any technical information required to prepare his proposal, the Bidder may contact by telephone, T P Lanning (704-374-4405) or J S McConnell (704-374-4599).

TPL/JSM/cf
11-30-70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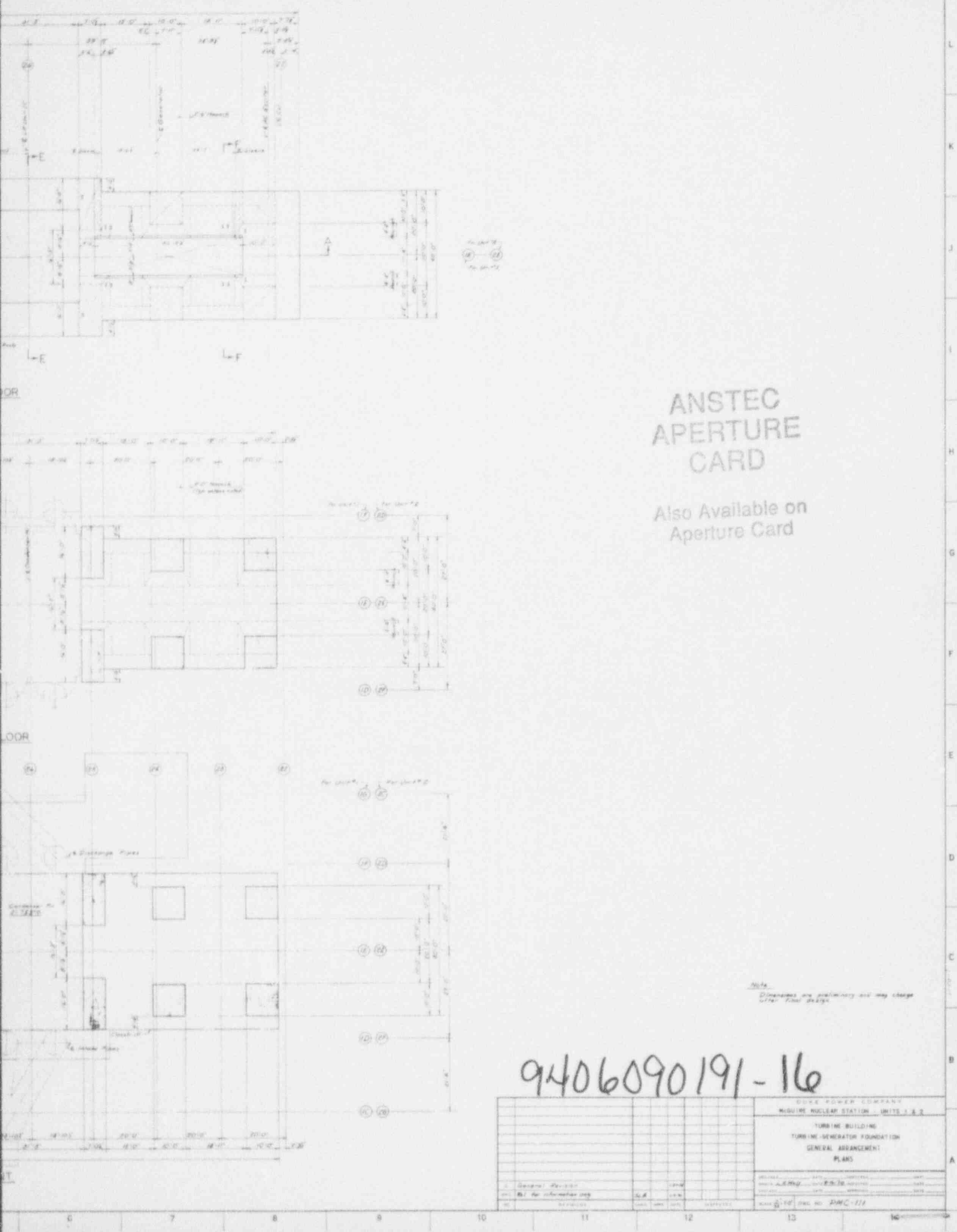
PLAN AT BASEMEN



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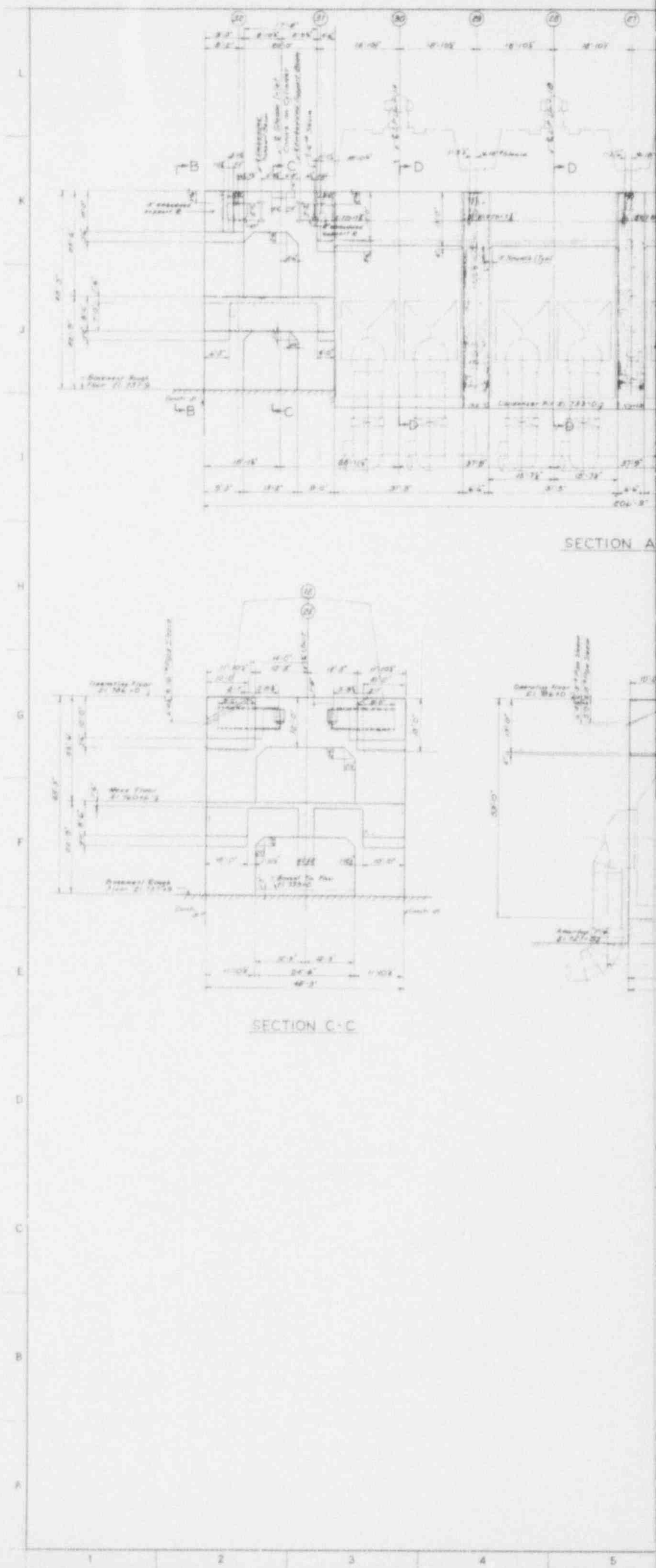
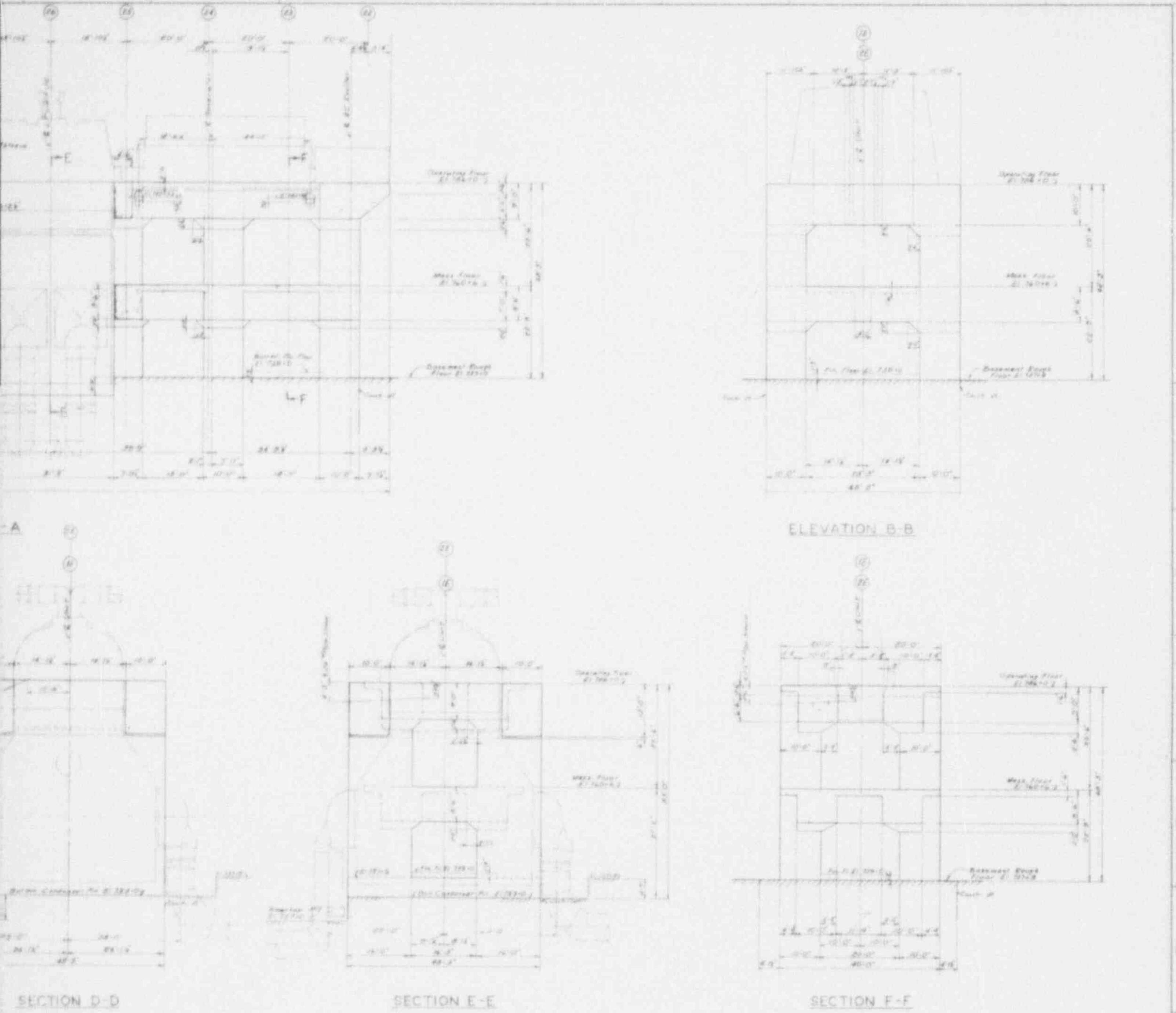
DUKE POWER COMPANY
McGUIRE NUCLEAR STATION - UNITS 1 & 2

TURBINE BUILDING
TURBINE-GENERATOR FOUNDATION
GENERAL ARRANGEMENT
PLANS

DWG. NO. PMC-111



SECTION A
SECTION C-C



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DUKE POWER COMPANY
McGUIRE NUCLEAR STATION - UNITS 1 & 2

TURBINE BUILDING
TURBINE-GENERATOR FOUNDATION
GENERAL ARRANGEMENT
SECTIONS

1	General Revision
Orig.	Rel. for information only

DWG. NO. FMC-112

USAEC REG 50-369 7 12 72 3809

Long
Cochran
Satterfield
Bebug

DUKE POWER COMPANY

POWER BUILDING, BOX 2178, CHARLOTTE, N. C. 28201

W. H. OWEN
VICE PRESIDENT,
DESIGN ENGINEERING

July 11, 1972

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

Re: McGuire 1 - 2
Environmental Report
Supplement 5
Docket No(s). 50-369 and 50-370

Dear Mr. Muller:

Please refer to your letter of June 28, 1972, requesting additional information for the preparation of benefit-cost analysis by the Commission Staff for the subject project and my return letter of June 30, 1972 enclosing three signed copies of Supplement 5 to the McGuire Nuclear Station Environmental Report filed March 9, 1971.

Accordingly, we are forwarding by Air Express Mail, the additional 297 copies.

Yours very truly,

W H Owen

W. H. Owen

WHO/dpw

Enclosures

NEPA

II

TABLE OF CONTENTS

LIST OF TABLES

2 DESCRIPTION OF McGUIRE NUCLEAR STATION

2.3 BASIS OF NEED

Table 2.3-2 gives the estimated cost of buying replacement power from neighboring utilities for one, two, three and four years, based on the 1972 cost for small blocks of capacity and energy. This estimate is based on the highly unlikely assumption that neighboring utilities would have enough generating capability available. In reality, there is no reason to believe that neighboring utilities would be in any better position than Duke to meet the requirements of their customers during this period, and it is, therefore, extremely doubtful that they would have capacity and energy available to sell Duke.

Table 2.3-2

Estimated Cost of Replacement Power
(At 1972 Costs) 1976 Through 1979

Period	Replacement Cost = $62.59 Per Kw Per Year At 70% LF		
	Unit 1	Unit 2	Total
3-1-76 Thru 12-1-76	$61,546,833	-	$ 61,546,833
1-1-77 Thru 12-1-77	$73,856,200	$61,546,833[1]	$135,403,033
1-1-78 Thru 12-1-78	$73,856,200	$73,856,200	$147,712,400
1-1-79 Thru 12-1-79	$73,856,200	$73,856,200	$147,712,400
		Total	$492,374,666

[1]Commercial Operation March 1977.

4 ENVIRONMENTAL EFFECTS OF McGUIRE NUCLEAR STATION

4.1 THERMAL EFFECTS

4.1.6 EFFECT OF WARMED DISCHARGE ON LAKE WATERS

As mentioned in Section 4.1.6 of Supplement 2 of the McGuire Nuclear Station Environmental Report, Duke commissioned Alden Research Laboratories to construct a hydro-thermal model of the Lake Norman Power Generating Complex. One of the objectives of this model is to determine if the present intake design permits recirculation of cooling water, and if so, provide design parameters to prevent recirculation during various operating modes. Therefore, any potential recirculation problems will be identified, and resolved, well in advance of McGuire's operation.

The supply of cool low-level water in Lake Norman has been shown to be adequate for use during July, August and September even for a "worst case" composite year developed from an array of individual extreme monthly conditions.[1] If, however, it is hypothetically assumed that no hypolimnetic water is available after the middle of August, then the cooling water supply would come from the upper intake at a temperature of 86 F and the discharge temperature would be 102 F. To provide for this hypothetical and unlikely contingency, one of the following two alternatives could be adopted:

a. Install conventional mechanical draft cooling towers, capable of lowering the temperature of the condenser cooling water from 102 F to 95 F. Heated condenser cooling water would be pumped from an area at the west end of the discharge canal, created by a gated regulator, to the cooling towers, which would be installed south of the discharge canal. Cooled water 95 F of less would be discharged back into Lake Norman downstream of the discharge canal regulator structure. When cooling towers were not in use, the regulator gates would be fully open to permit unobstructed flow of condenser cooling water in the discharge canal. The estimated cost of these mechanical draft cooling towers including attendant capacity and fuel penalties, operating expense, cost of regulator and additional piping is $18.0 million at current (1972) price levels. Of course, the environmental impact of such cooling towers would have to be fully assessed.

b. Use floating spray modules (spargers) in the discharge canal and Ramsey Creek cove to lower the condenser cooling water temperature. This concept is still in its developmental stage and has not been tested on a steam generating plant of this size; therefore, its reliability is still unproven. This would involve use of about 280 sparger units. Using two units per pass, about 20,000 feet of canal would be required, which would have to be created in Lake Norman in continuation of the discharge canal. The estimated cost of this alternative including capacity and fuel penalties and operating and maintenance at current price levels is $10 million. However, before this alternative could be adopted, a thorough study of the sparger arrangements and the effect of the large area of water spray on the environment, including public recreational use of the lake, would be necessary.

[1] In our opinion, such a "worst case" year is statistically impossible.

7 BENEFIT-COST ANALYSES

7.3 McGUIRE AT LAKE NORMAN SITE VS OTHER SITES

The estimate of costs that would be accrued if the present McGuire site were to be relocated is as follows:

a.	Site Preparation	$1,581,000
b.	Nuclear Plant Construction for Which Construction Permit or Exemption Was Not Required	7,110,000
c.	Construction Performed Under Existing Exemptions (Through March 21, 1972)	2,362,000
d.	Additional Projected Cost for Period March 21, 1972 through October 1, 1972	13,659,000
e.	Cost for Abandonment and Redress of Site	2,011,000
	Total Estimated Cost	$26,723,000

These costs apply only to abandonment of McGuire Site as of October 1, 1972. They do not include an allowance for engineering, licensing and site investigation costs. Nor do they include any allowance for increase in cost, due to inflation, to reach the same stage at an alternate site.