VIRGIL C. SUMMER

NUCLEAR STATION
UNIT I

ENVIRONMENTAL REPORT

SOUTH CAROLINA ELECTRIC & GAS COMPANY

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SUMMARY

General

The South Carolina Electric & Gas Company (SCE&G) proposes to construct a nuclear generating station, the Virgil C. Summer Nuclear Station (Summer Station), in Fairfield County, South Carolina, about 26 miles northwest of Columbia, to increase SCE&G's capacity to meet anticipated demands for electric power within its service territory. SCE&G's transmission system is part of an interconnected grid which extends over a large part of the east-central portion of the nation. In the 1965-1970 period, SCE&G's system territorial peak load increased an average of 11.6% per year. The forecasted system territorial peak load for the next decade (1971-1981) is based upon an annual growth of 11.3%. Completion of the proposed Summer Station will help to assure adequate capacity, including reserves to maintain system reliability.

The proposed Virgil C. Summer Station is part of an integrated complex consisting of a nuclear station, a pumped storage facility and two water reservoirs. The nuclear station's pressurized water reactor (PWR) will have a generating capacity of approximately 900 MWe; the pumped storage hydro electric plant has a planned total capacity of about 480 MWe. These facilities will be constructed adjacent to the existing Parr Reservoir on the Broad River which will be used as the lower reservoir for the pumped storage part of the complex. An upper reservoir (Lake Monticello) will be created by constructing Fairfield Dam across Frees Creek, a tributary of the Broad River. Lake Monticello will also provide cooling water for the nuclear station. Because of interaction between facilities of the complex, the discussion in this Report has been expanded to include all significant features, even though some of those features are not integral to the Summer Station.

Site preparation and construction will begin in 1972 and continue into 1977 for the Summer Station.

Environmental Impact of the Proposed Facility

The proposed Summer Station will be located in a sparsely populated area which is about 86% forested. About 700 acres of farm land, chiefly pasture, 6,000 acres of pine forest land and 2,800 acres of hardwood forest land will be taken out of production for the life of the Station. From four to eight dwellings, portions of Route 99, and a transmission line will have to be relocated. The residents and property owners displaced will be compensated. No existing long-range land use plans will be interfered with in the development of this project and no significant effects on the life styles of the human population are expected to result. Any discharges to the Lake Monticello-Parr Reservoir system which affect water quality will be processed to meet applicable water quality standards. Aesthetically, the plant facilities will be designed and constructed in a manner to minimize its visual impact. Certain features such as Lake Monticello are expected to improve the scenic quality of the area. Recreational opportunities will be developed on lands controlled by the Company where such use is practicable and consistent with project requirements and safety.

A land management program will be undertaken to alleviate any potential adverse effects of the facility construction on the natural environment and to enhance or preserve the existing environment where possible. This program will include erosion control, improvement of wildlife habitat, timber management, and beautification through landscaping. The land management program will be integrated with ecological studies and monitoring programs. The latter have been designed to measure environmental effects and provide the basic information needed in determining further precautions that may be necessary to protect the environment.

Any Adverse Environmental Effects Which Cannot be Avoided, Should the Proposal be Implemented

There will be a temporary adverse effect on the aesthetics of the environment due to the disturbance of the landscape by activity associated with construction of the facility. The physical presence of the facility itself might be construed to affect the visual beauty of the area, although little of the Station will be observable due to the inaccessability of the site. There will be some local wildlife and fishing resources adversely affected, primarily due to the removal of bottomland hardwood habitat and water level fluctuations in the enlarged Parr Reservoir. Four to eight families will be relocated. In most cases, these residents do not depend on their land for subsistance and relocation will not seriously alter their life style. Residents and property owners will be compensated.

It has been generally concluded from the analysis of the environmental impact that the substantial benefits from power production outweigh adverse effects, and that the proposed commitments in land and material represent a wise use of resources for man's benefit.

By implementation of the Land Management Program, many of the adverse effects that may be associated with the development of the proposed facility will be minimized.

Alternatives to the Proposed Action

The alternatives related to building the proposed Summer Station are (1) not providing the power, (2) importing power, (3) alternative forms of generation, (4) alternative sites and (5) alternate methods of cooling. Neither of the first two alternatives are possible because of the growing demand in SCE&G's service area and also in the cooperative regional grid territory service area, the latter fact making the second alternative unfeasible.

Alternate forms of generation such as fossil-fuel steam electric plants, gas-turbine units, conventional hydro electric plants, and pumped storage facilities were considered. Conventional hydro plants do not provide a suitable alternative to Summer Station due to the lack of available sites in the major load areas. Pumped storage facilities are suitable only for peaking power and are not a suitable alternative to a base load plant. Similarly, gas turbine units are also best suited for peaking power, due to their high fuel and maintenance costs. Fossil fuel plants were not selected due to the increasing difficulty in obtaining fuels. Nuclear units are not subject to foreseeable fuel restrictions and the addition of nuclear generating capacity is felt to add to the overall system reliability by providing a mix of different fuel usages.

In 1967 a system study was conducted to identify areas where electric generation facilities would be required in the near future. A preliminary evaluation of the suitability of these areas for nuclear station siting was made. The Parr area combines the features of suitable nuclear siting characteristics and a history of nuclear generation. The present site provides a remote minimum impact location near the Company's transmission grid which allows the construction of the integrated power complex covered by this Report.

The Relationship Between Local Short-Term Uses of Man's Environment and the Maintenance and Enhancement of Long-Term Productivity

"Short-term" is taken to represent that period of time from the initiation of construction to the ultimate decommissioning of the nuclear unit. The presently anticipated operating period for the nuclear unit is 40 years.

The short-term use of man's environment will include several disruptive undertakings. The major ones are the construction of roads and structures, the creation of a man-made lake, the enlargement of an existing reservoir, construction of transmission lines, and the discharge of chemical, nuclear and sanitary wastes. These activities are discussed in appropriate sections of the Report, along with the minimizing or offsetting measures that the Company proposes to undertake.

The impact of these short-term uses of the existing environment has been weighed against the potential maintenance and enhancement of long-term productivity of the proposed action in the form of the provision of electrical power. Overall economic and sociological advantages which accrue from the electricity produced are difficult to equate with the local and short-term losses which may be involved in the facility's construction and operation. In viewing all of the issues identified and discussed in this Report, however, it is SCE&G's opinion that the negative aspects of the short-term uses of man's environment do not cumulatively override the benefits of the long-term productivity offered by the proposed facility.

Irreversible and Irretrievable Commitments of Resources Which Would be Involved in the Proposed Action, Should it be Implemented

Numerous resources are included in the construction and operation of the Station including land, materials and supplies used to construct and operate the facility, water from the river, and human talent, skill and labor as well as capital. Some of these resource commitments are irreversible and irretrievable such as the nuclear fuel, and materials and supplies which cannot be salvaged after their use. Others are temporary commitments such as the use of land for the nuclear site which can be returned to other uses if the facilities are decommissioned. When the lifetime of the project is completed, it would be possible to remove structures, drain Lake Monticello, lower Parr Dam, and replant trees. While this would essentially return the area to its original pre-construction condition, it is doubtful that this will ever be done. Thus, for all practical purposes the elimination of forest land, particularly the hardwood forest lands and its associated wildlife habitat which will be flooded by Parr Reservoir, will represent an irretrievable commitment of resources. Nuclear fuel consumed in the fission process is also an irretrievable commitment of resources. This consumption is very small, however, particularly when compared to the fuel used by fossil fired plants.

1.0 INTRODUCTION

The South Carolina Electric and Gas Company (SCE&G) proposes to construct and operate a nuclear generating station, the Virgil C. Summer Nuclear Station (Summer Station) in Fairfield County, South Carolina, about 26 miles northwest of Columbia, the state capital. This report provides a comprehensive discussion of the environmental impact associated with the construction and operation of the Summer Station Unit No. 1 in compliance with the Atomic Energy Commission's regulations 10 CFR 50, Appendix D, which requires submittal of an Environmental Report discussing those items set forth in the National Policy Act of 1969.

The proposed Summer Station is an integral part of a planned electric power generating complex which also includes a pumped storage hydroelectric facility. Because of interaction between facilities of the complex, the discussion in this Report has been expanded to include all significant features, even though some of these features are not integral to the Summer Station. Consequently, the environmental considerations discussed include some items that are not normally required by the Atomic Energy Commission but are submitted in the spirit of providing complete information.

Specifically, this report provides information concerning the following environmental considerations:

1. The environmental impact of the proposed action
2. Any adverse environmental effects which cannot be avoided should the proposal be implemented

3. Alternatives to the proposed action

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

5. Any irreversible and irretrievable commitments of resources which would be involved in the proposed action, should it be implemented

SCE&G owns and operates an integrated electric generation, transmission and distribution system which serves approximately 270,000 customers in a 12,000 square mile service area. This area, stretching from the central region of the state to the coastal plains, includes Columbia, the State capital, and Charleston, South Carolina's principal seaport.

From 1965 to 1970, SCE&G's system territorial peak load increased an average of 11.6% per year. The forecast system territorial peak load for 1971 to 1981 is based upon a projected annual growth of 11.3%. The Virgil C. Summer Nuclear Station and other major new and projected generating stations will assure adequate electrical capacity and will provide reserves to maintain system reliability.

The Summer Station includes a single-unit pressurized water reactor (PWR) nuclear steam system, furnished by Westinghouse Electric Corporation, with a rating of approximately 900 MWe. The Summer Station is scheduled for operation in 1977. Gilbert Associates, Inc. are the Architect-Engineers.

SCE&G was assisted in the preparation of this Report by Dames & Moore, Consulting Engineers in Applied Earth Sciences. Model studies are being conducted by Alden Research Laboratories to assess thermal characteristics associated with the dissipation of heat from the condensers of the Summer Station.

Though this Report primarily discusses the presently planned Unit No. 1, the Company's long-range plans include the utilization of this site and Lake Monticello for future nuclear units. The heat dissipation studies have been based on operation of Lake Monticello as the source of condenser cooling water for two nuclear units.

2.0 ENVIRONMENTAL REPORT -- CONSTRUCTION PERMIT STAGE

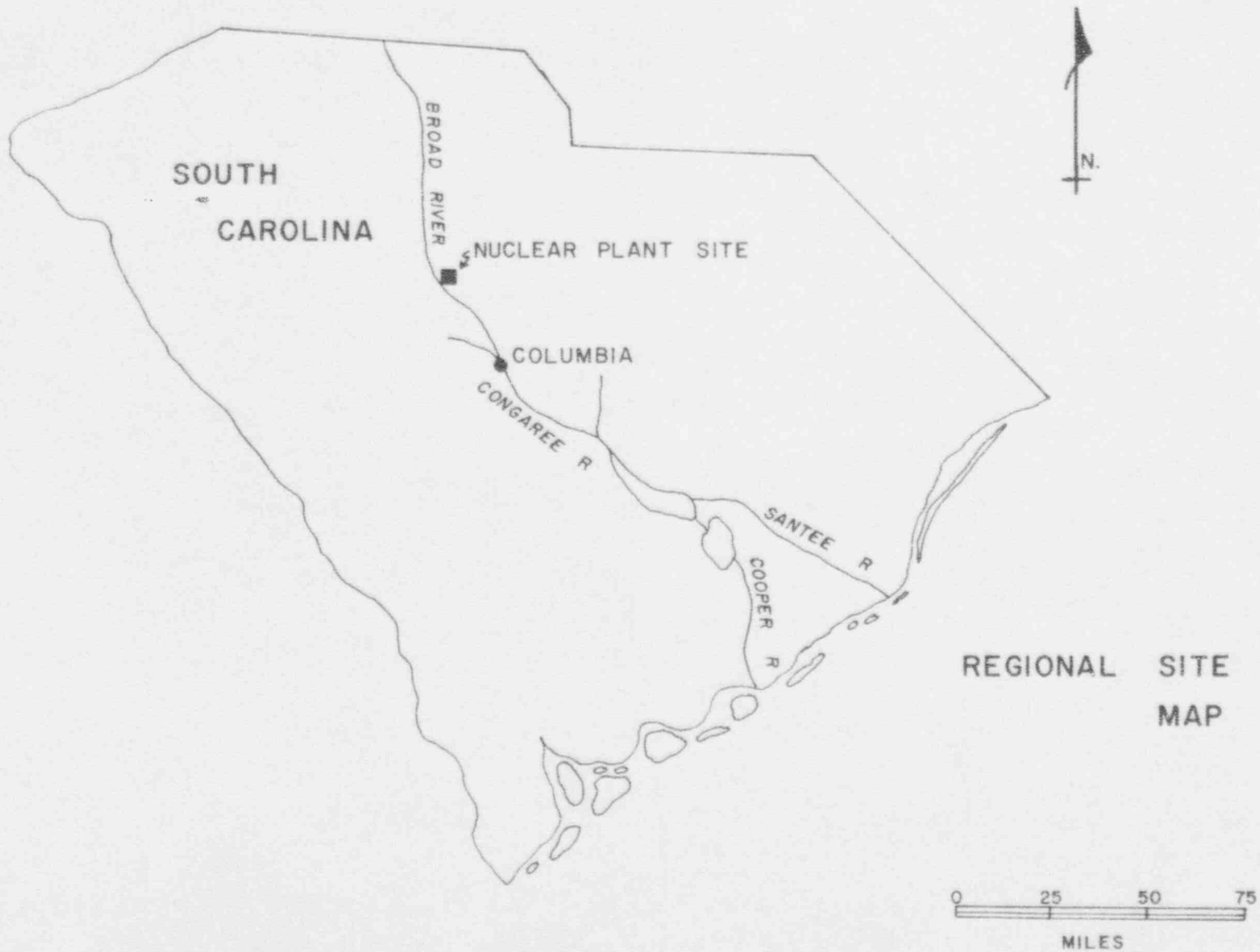
2.1 GENERAL

2.1.1 Location

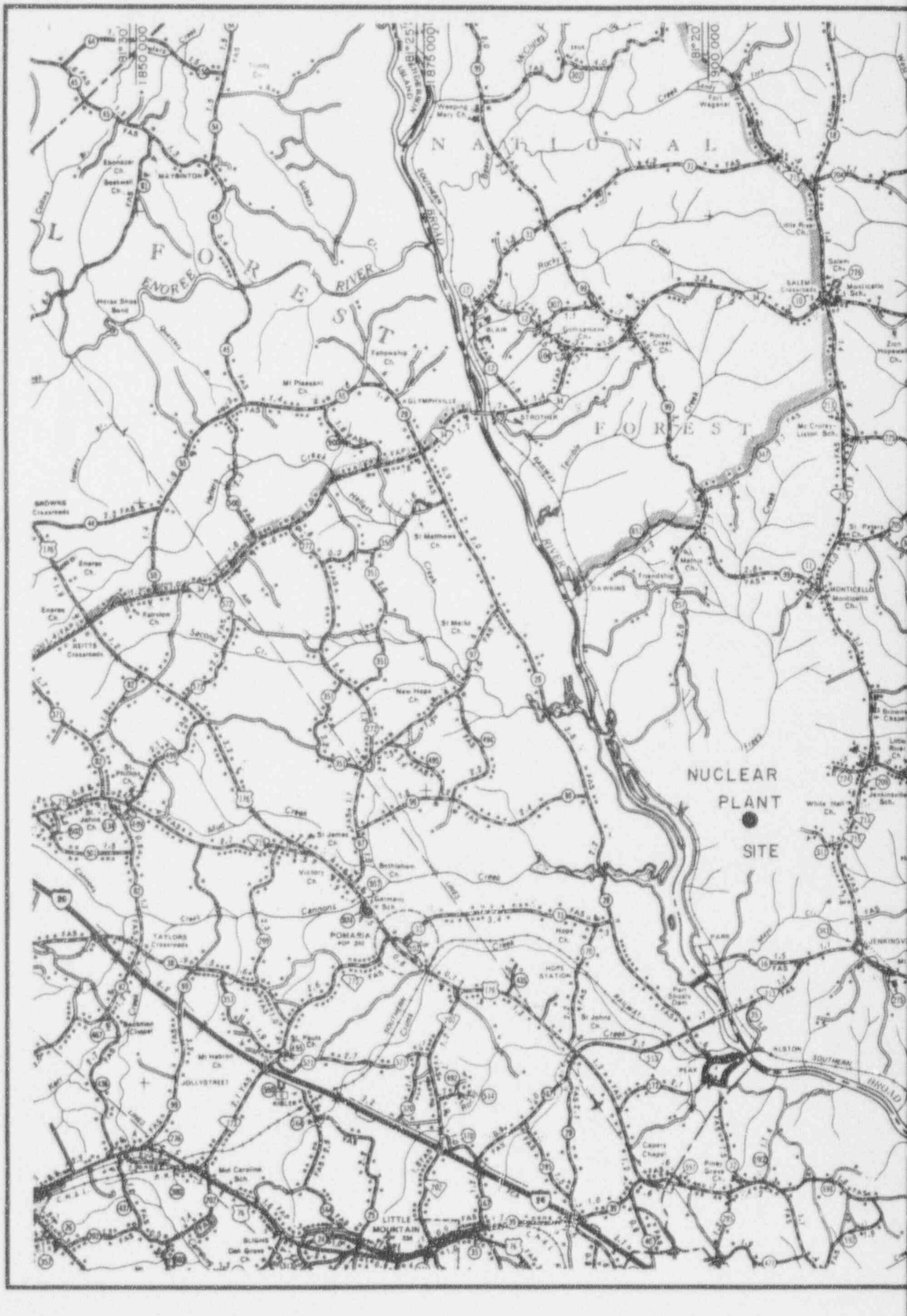
The proposed Virgil C. Summer Nuclear Station will be located in Fairfield County, South Carolina, at approximately latitude 34° 18' North and longitude 81° 19' West. Columbia, the state capital, is located about 26 miles to the southeast as shown on Plate 1. Nearby roads, highways and villages are shown on Plate 2. The site lies about one mile east of the Broad River and is about three miles northeast of existing conventional fossil fuel, gas turbine, and hydro plants at Parr. This particular area has a history of nuclear power. The decommissioned Carolinas Virginia Tube Reactor (CVTR), a demonstration prototype nuclear power plant, was operational at Parr from 1963 to 1967. Operation of the CVTR provided baseline data on radiological and meteorological conditions pertinent to the proposed project.

2.1.2. Overview

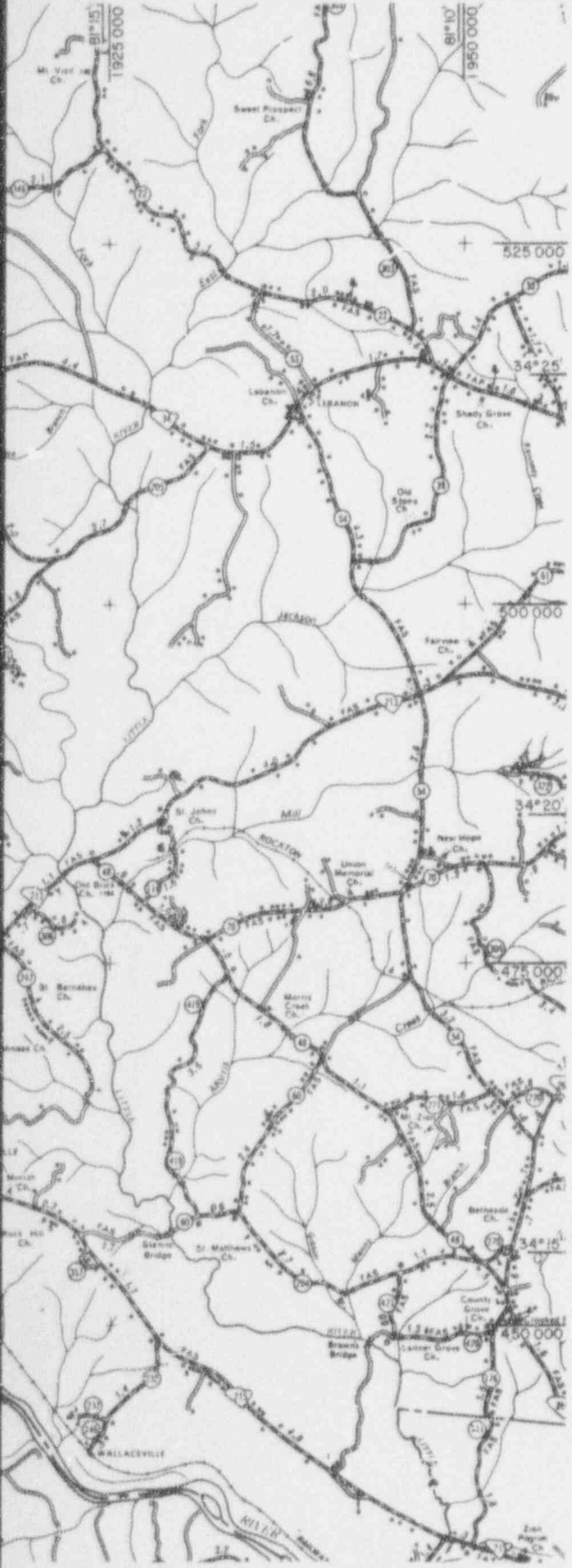
Summer Station is an integral part of a planned electric power generating complex which also includes a pumped storage hydroelectric facility (Fairfield Pumped Storage). Electricity will be generated from a single pressurized water reactor (PWR) nuclear unit with a capacity of about 900 MWe. The Summer Station will be constructed adjacent to an approximately 7,000 acre reservoir (Lake Monticello) which will be created by constructing a series of dams across Frees Creek, a tributary of the Broad River. Lake Monticello will provide cooling water for the Summer Station and generating water for the 480 MWe pumped storage facility. The level of the existing Parr Reservoir in the Broad River will be raised about nine feet, and will

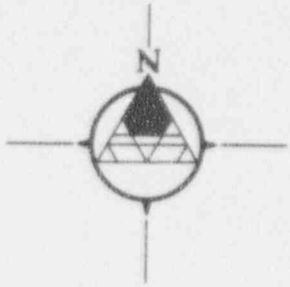


REGIONAL SITE LOCATION MAP



NATIONAL
FOREST
ENOREE RIVER
MAYBINTON
GLYMPHVILLE
STROTHER
BLAIR
DAWKINS
MONTICELLO
BROWNS Crossroads
KEITTS Crossroads
TAYLORS Crossroads
POMARIA
HOPE STATION
JOLLYSTREET
PEAK
ALSTON
LITTLE MOUNTAIN
NUCLEAR
PLANT
SITE





REFERENCE:

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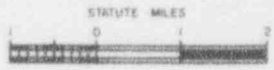


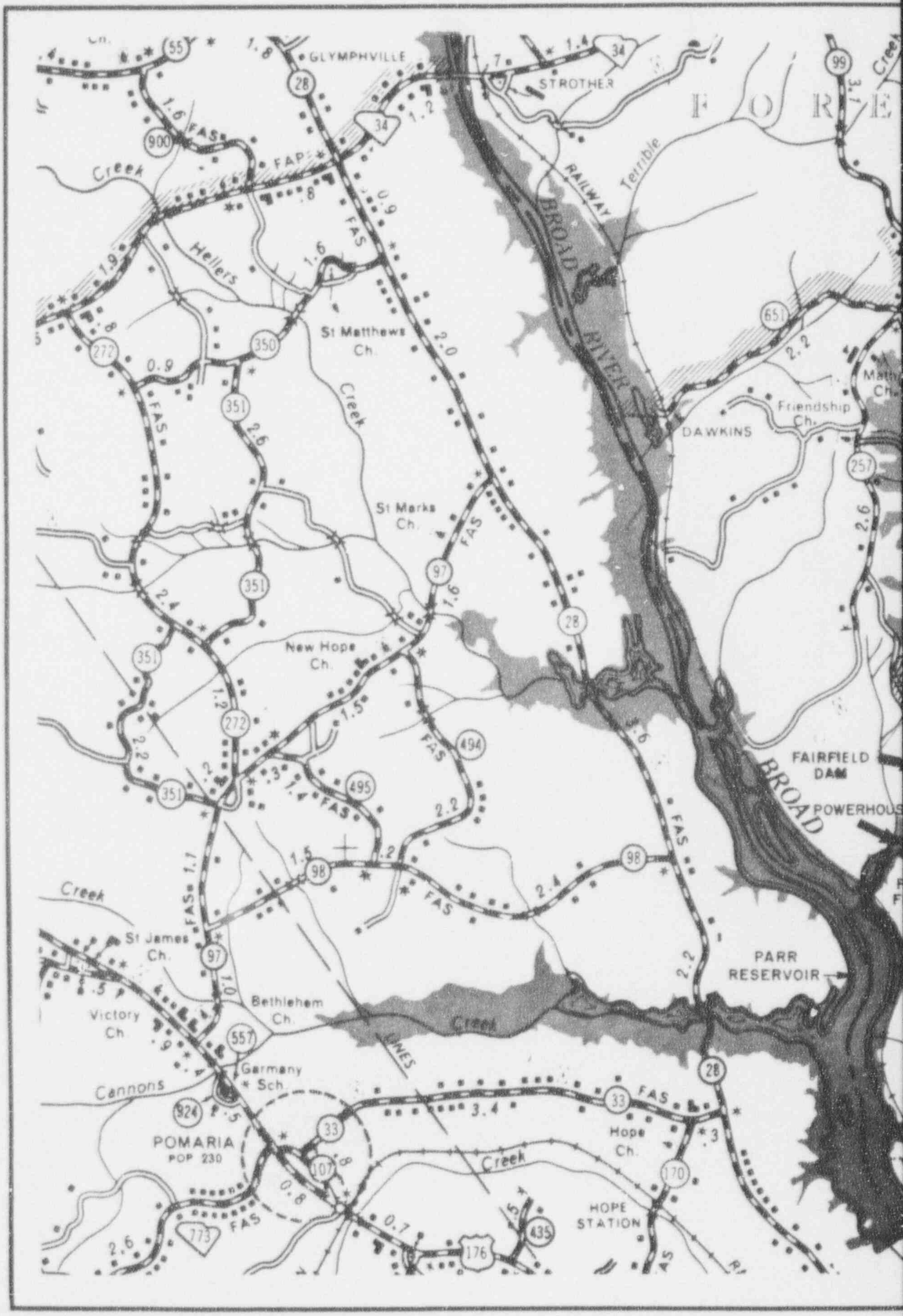
SITE VICINITY MAP

PLATE 2

9406090234 -01

be used in combination with the new Lake Monticello to operate the pumped storage facility.

The pumped storage facility will be used in the generating mode during periods of high electrical demand. At night, when the overall grid system load is generally reduced, a portion of the Summer Station's output will be used to provide the power necessary to return the water used during operation of the pumped storage facility, from Parr Reservoir to Lake Monticello. This cycle will normally be repeated daily and will assist the Summer Station to be operated with a high plant factor (ratio of the average power load of an electric power plant to its rated capacity). The location of the Summer Station with respect to Lake Monticello and other features of the power complex is shown on Plate 3.


GLYMPHVILLE
STROTHER
F O R E
Creek
Hellers
BROAD RIVER
RAILWAY
Terrible
St Matthews Ch.
St Marks Ch.
New Hope Ch.
DAWKINS
Friendship Ch.
FAIRFIELD DAM
POWERHOUS
PARR RESERVOIR
St James Ch.
Victory Ch.
Bethlehem Ch.
Cannons
Germany Sch.
POMARIA
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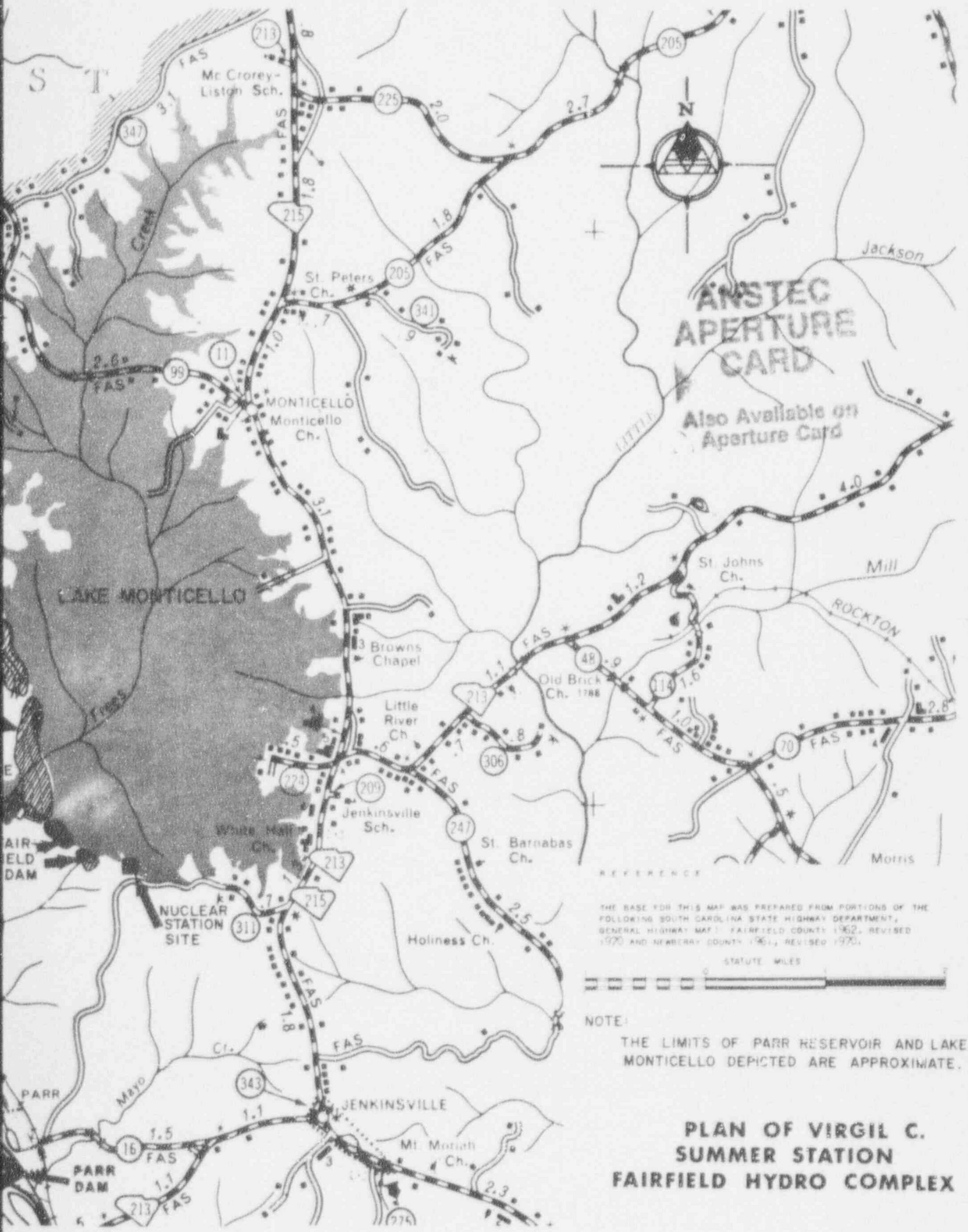
Hope Ch.
HOPE STATION
LINES



REFERENCE

THE BASE FOR THIS MAP WAS PREPARED FROM PORTIONS OF THE FOLLOWING SOUTH CAROLINA STATE HIGHWAY DEPARTMENT, GENERAL HIGHWAY MAP: FAIRFIELD COUNTY 1962, REVISED 1970 AND NEWBERRY COUNTY 1961, REVISED 1970.

STATUTE MILES

NOTE:

THE LIMITS OF PARR RESERVOIR AND LAKE MONTICELLO DEPICTED ARE APPROXIMATE.

PLAN OF VIRGIL C. SUMMER STATION FAIRFIELD HYDRO COMPLEX

PLATE 3

9406090234-02

2.1.3 Components of the Virgil C. Summer Nuclear Station

2.1.3.1 Major Structures

The major surface structures of the Virgil C. Summer Nuclear Station will include the following:

(1) Reactor Building (houses the reactor vessel, the reactor coolant pumps and primary piping, the pressurizer, the steam generators, and other equipment).

(2) Turbine-Generator Building (houses the turbine generator).

(3) Auxiliary Building (houses the Radwaste System and auxiliary equipment for reactor operations).

(4) Service Building (houses offices and machine shop).

(5) Fuel Handling Building (houses the new fuel and used fuel storage areas).

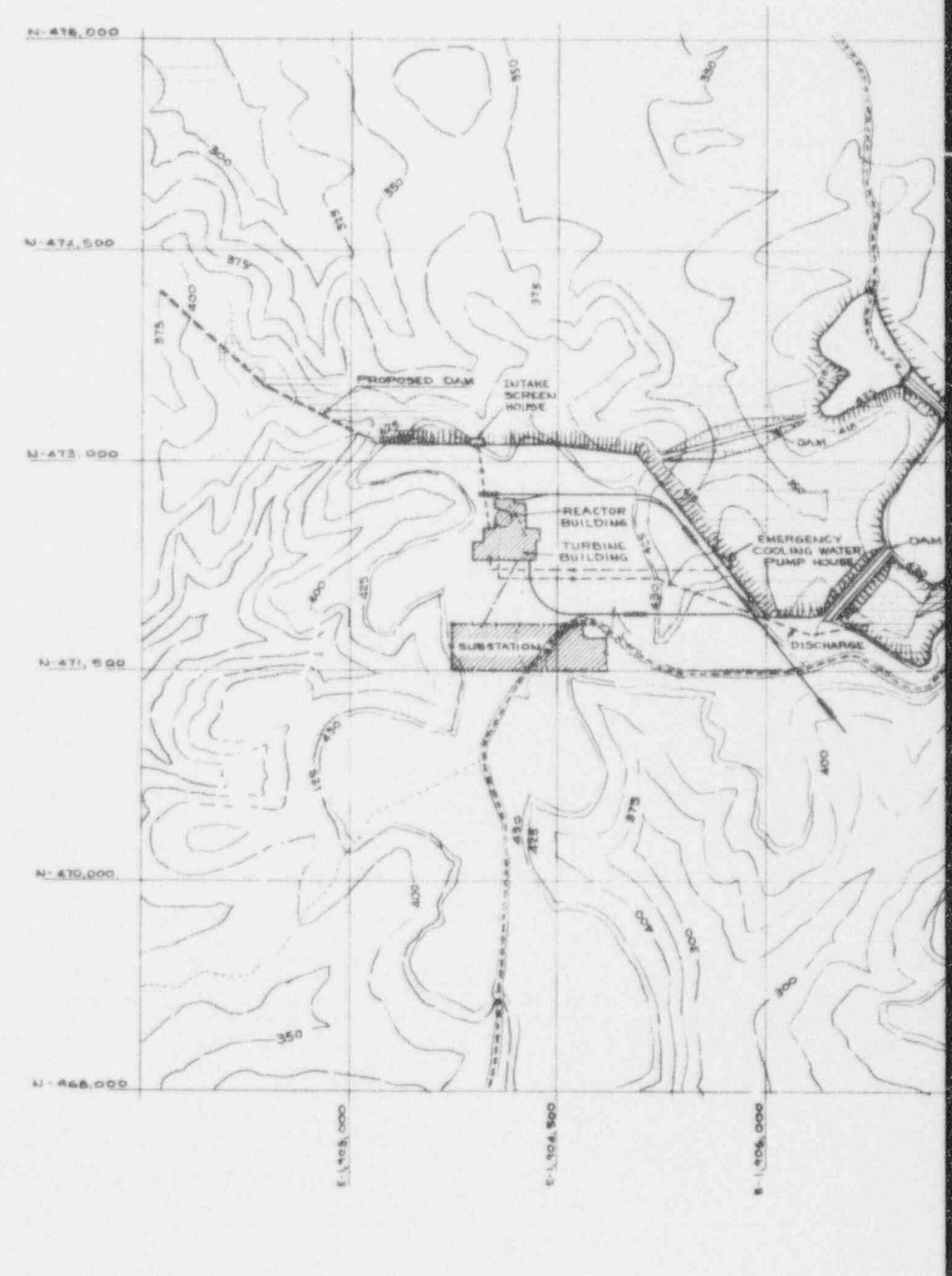
(6) Intermediate Building (houses the battery room, containment purge equipment, Component Cooling System equipment, control rod drive switch gear and other equipment).

(7) Control Tower (houses the control room, central access area, and relay room).

(8) Diesel-Generator Building (houses the two emergency diesel generators).

The main interaction of these structures with the environment will be with aesthetics and the impact of construction. These considerations are discussed in Sections 2.3.1 and 2.3.8 of this Report, respectively.

The planned layout of the Summer Station is shown on Plate 4.


N-476,000
N-474,500
N-473,000
N-471,500
N-470,000
N-468,000
PROPOSED DAM
INTAKE SCREEN HOUSE
REACTOR BUILDING
TURBINE BUILDING
SUBSTATION
DAM
EMERGENCY COOLING WATER PUMP HOUSE
DISCHARGE

LAYOUT OF SUMMER STATION

PLATE 4

9406090234-03

2.1.3.2 Major Systems

The major systems which will interact with the environment are summarized below. Additional descriptions are presented in Section 2.3, in relation to their specific environmental impact.

Condenser and Condenser Circulating Water System

Cooling water for the main condenser will be provided by the circulating water system at a rate of approximately 485,000 gpm. The circulating water will be supplied from an intake structure located on the bank of Lake Monticello and will be released by a discharge structure after passing through the tube side of the condenser. The temperature rise across the condenser during normal full power operation will be approximately 25°F. As a result, approximately 6.6×10^9 BTU/hr of waste heat will be removed.

Traveling screens will be provided to minimize the passage of fish and debris through the condenser. A mechanical cleaning device will be provided to reduce fouling of the condenser tubes.

A twin-shell, single-pass, dual pressure divided water box main condenser will be provided. The condenser is of conventional design with expansion joints in the neck, impingement baffles to protect tubes, and partitioned hotwells. There will be a duplex feedwater heater located in the condenser neck.

Vents and drains will be arranged in the same manner as those in fossil-fueled station. Vent gases from the main condenser are normally discharged to the atmosphere through a radiation monitor. In the event of a steam generator tube leak, with subsequent contamination of the steam, reactor grade non-condensable gases collecting in the condenser will be detected by a radiation monitor located in the vacuum pump effluent line and an alarm will be given.

The Radioactive Waste Processing System

Nuclear power stations produce radioactive materials that are waste products of an operating reactor. Only a small amount of these residual materials are discharged to the biosphere. The quantities and kinds of wastes discharged vary depending on the engineering design and waste management practices. SCE&G will utilize the Westinghouse Environmental Assurance System which is expected to reduce the release of radioactivity from the Summer Station to extremely low levels.

The Radioactive Waste Processing System is designed to provide the controlled treatment of radioactive liquid, gaseous and solid wastes. The Liquid Waste Processing System will collect, process and recycle reactor grade water, remove or concentrate radioactive constituents and process them until suitable for release and/or shipment off-site. The Gaseous Waste Processing System will function to remove fission product gases from the reactor coolant and contain these gases during normal station operation. Provisions will be made for controlled releases of decayed gases through the plant vent and/or eventual shipment off-site of decayed gases. The system also collects the gases generated from the boron recycle evaporator. The Solid Waste Disposal System will provide the capability to package solid wastes for shipment in a variety of containers to a government licensed, off-site disposal facility.

A more detailed description and potential impact of the Radioactive Waste Processing System is presented in Section 2.3.7.

Other Systems

Design details of the chemical treatment system and the domestic and sanitary water system have not been finalized. The systems will be designed to meet the South Carolina State Board of Health and South Carolina Pollution Control Authority requirements.

2.1.3.3 Other Summer Station Elements

Other elements of the Summer Station will include substations, transmission lines, a Component Cooling System, an emergency cooling reservoir, a Domestic and a Sanitary Water System, water wells, railroad spurs, roadways, and parking facilities.

2.1.3.4 Upper Reservoir (Lake Monticello)

Lake Monticello will provide cooling water for the Summer Station and store water for the pumped storage facility. The lake will have a surface area of about 7,000 acres and contain approximately 400,000 acre-feet of water. The average water depth will be about 57 feet. The lake will be created by constructing a series of earthen dams across Frees Creek. The normal daily fluctuation in water level in Lake Monticello resulting from operation of the pumped storage facility will be approximately four feet.

Filling operations for Lake Monticello are scheduled to begin the winter of 1975-1976. Initially one pumped storage facility pump will be used and the pumping rate will be limited to 4,000-5,000 cubic feet per second (cfs) until the water being added reaches the invert level of the intake structure at about elevation 365 feet (Mean Sea Level). The purpose of limiting the pumping rate during the early stages of filling is to reduce erosion of the lakeside embankment and to avoid undercutting of the pumped storage intake structure. After the invert level is reached, the rate of filling will be increased and maintained until the level of the newly created Lake Monticello reaches about elevation 425 feet. The estimated time to fill the Lake is six months.

The impact of Lake Monticello on the environment is discussed in Section 2.3.

2.1.4 Operation of Summer Station

The nuclear power station is a steam power plant in which a nuclear reactor takes the place of an ordinary steam boiler. The electrical portion of the plant (turbine-generator) is essentially the same and the product, electricity, is identical.

The heart of the nuclear station is the Nuclear Steam Supply System which consists of the reactor, the Reactor Coolant System, and associated auxiliary fluid systems. For the Summer Station, a pressurized water reactor (PWR) will be used and a Reactor Coolant System will be arranged as three closed reactor coolant loops connected in parallel to the reactor vessel, each containing a reactor coolant pump and steam generator. An electrically heated pressurizer will be connected to the hot leg of one reactor coolant loop to maintain the required high system pressure.

The core fuel will be uranium, enriched in the uranium-235 isotope. It will be loaded in three regions, with new fuel introduced into the outer regions, moved inward into a checkerboard pattern at successive refuelings and discharged from the inner region to the spent fuel storage area.

Fissioning of the uranium-235 fuel in the reactor core will generate heat which, in turn, will be transferred to the reactor coolant. The amount of heat generated (thermal power level) will be controlled by a coordinated combination of soluble neutron absorbers (borated water) and the mechanical control rods (stainless steel clad silver-indium-cadmium). Under full power operating conditions, approximately 2,775 MW of heat will be produced by fission. The primary water does not boil because of the high pressure in the system. It will pass through the steam generators (heat exchangers) where it will convert secondary loop water into steam. It is this steam which will turn the turbine-generator to produce electricity. After the water from the reactor completes its function in the heat exchangers, it will be returned to the reactor where the process begins again. Steam in the secondary loop will be condensed to water as it leaves the turbine in a condenser. The condensate will be collected in the hot well and will be returned as feedwater to the steam generators to go through its cycle again. Since both primary and secondary loop water are completely enclosed and separated, they will have no physical contact and the condenser will have no direct contact with radioactive nuclides in the reactor coolant.

The electricity produced will be stepped up in voltage to 230 KV by transformers. It will then join SCE&G's grid, adding approximately 900 MWe.

Auxiliary systems associated with the Nuclear Steam Supply System are provided to charge the Reactor Coolant System and to add makeup water, purify reactor coolant water, provide chemicals for reactor control, remove residual heat when the reactor is shut down, provide for emergency safety injection and to provide venting and draining of the Reactor Coolant System.

2.1.5 Other Facilities of the Electric Power Generating Complex

2.1.5.1 General

Other major features of the planned electric power generating complex will include Fairfield Pumped Storage and the enlargement of Parr Reservoir, which will be the lower reservoir for the pumped storage facility. Although the operation of Summer Station is independent of these facilities, there is sufficient interaction, from an environmental standpoint, to warrant discussion of these other facilities of the electric power generating complex.

2.1.5.2 Fairfield Pumped Storage

Lake Monticello will be created by constructing a series of earthen dams including an approximately 5,000 foot long dam on Frees Creek and three smaller saddle dams. This combination of dams is referred to as the Fairfield Dam.

In the south abutment of the main dam, an intake canal about 500 feet wide and 600 feet long will terminate as a gated intake structure (invert elevation 365 feet). Eight surface penstocks, each 18 feet in diameter and 950 feet long will connect the intake structure with the powerhouse.

The semi-outdoor-type powerhouse will contain eight 60 MWe reversible pump-turbines. The reversible feature means that during periods of high demand the pump-turbines are used to generate electricity, while during periods of low demand the pump turbines will be reversed and function as pumps to move water from Parr Reservoir to Lake Monticello.

Approximately 29,000 acre-feet of water will be withdrawn from Lake Monticello during a typical daily operation. This amount of water will generate approximately 3,800 MW-hours of electricity and will provide about eight hours of power generation. To return 29,000 acre-feet to Lake Monticello will require about ten hours pump-up operation.

2.1.5.3. Lower Reservoir (Parr Reservoir)

The existing 2,925 acre Parr Reservoir will be enlarged by about 2,800 acres in order to serve as the proper sized receiving reservoir for the power generation cycle of the pumped storage operation. The total surface area of the enlarged Parr Reservoir will thus be 5,725 acres and will be accomplished by raising the existing Parr Dam across the Broad River by about nine feet to elevation 266 feet. Bascule Gates will be erected across the entire 2,000 foot spillway crest.

The existing Parr Reservoir was created in 1914 for the operation of a conventional hydro plant. It will continue to supply cooling water to the Parr Steam Plant built in 1925 adjacent to the present conventional hydro facility.

The normal daily fluctuation in water level in the enlarged Parr Reservoir resulting from pumped storage operation will be about nine feet.

2.2 ENVIRONMENTAL APPROVALS AND CONSULTATION

The following is a list of agencies which South Carolina Electric & Gas Company has contacted or will contact. These contacts will be made so that information can pass between the agencies and South Carolina Electric & Gas Company at an early stage in the project planning and design. Questions and answers from each party will be addressed at the time of the meetings.

1. South Carolina Highway Department
2. South Carolina Wildlife Resources Department
3. South Carolina Department of Parks, Recreation, and Tourism
4. State Development Board - Geology Department
5. University of South Carolina Departments of Biology, Archeology, and Engineering
6. South Carolina Water Resources Commission
7. South Carolina Public Service Commission
8. South Carolina Pollution Control Authority
9. South Carolina State Board of Health
10. South Carolina Aeronautics Commission
11. United States Geological Survey - Water Resources Division (in Columbia)
12. United States Soil Conservation Service
13. United States Department of Agriculture
14. United States Bureau of Outdoor Recreation
15. United States Fish and Wildlife Service
16. United States Southeastern Parks Recreation Service
17. United States Weather Bureau
18. United States Forest Service
19. United States Department of Interior

20. United States Environmental Protection Agency

21. United States Army Corps of Engineers

22. Federal Aviation Agency

2.3 ENVIRONMENTAL IMPACT OF THE PROPOSED FACILITY

2.3.1 Land Use Compatibility

2.3.1.1 General

Topography

The Summer Station site is located in a forested area. Maximum relief in the general site area ranges from an elevation of 257 feet at the Broad River to a high of about 500 feet at the site and nearby ridges. Topography in the site vicinity is characterized by gently to steeply rolling hills, with narrow to broad ridge tops, and generally well-drained mature valleys

The Summer Station site is located on the north flank of an irregularly shaped relatively narrow ridge and ranges in elevation from 450 feet to 500 feet. Ground surface on the ridge at the site slopes irregularly downward in a general northeast direction. Construction of the Summer Station will involve excavation to a site grade of about elevation 435 to 440 feet.

Except on the broadest ridge tops, and to a minor degree on stream bottomlands, few level areas occur in the vicinity that are suitable for the cultivation of intertilled crops. Similarly, there are few relatively flat areas where building construction can take place without considerable cutting and filling and without taking precautions against erosion.

History

The region surrounding the Summer Station site was inhabited long before it was settled by Europeans. The lower settlement of the Great Cherokee Nation extended to the Broad River, and the area between the Broad River and the Catawba River was a prized hunting ground for both the Cherokees and the Catawba Indians.

Since initial settlement by European immigrants, area inhabitants have engaged principally in forestry, agriculture, and related activities.

The economy and population of Newberry and Fairfield Counties in the site vicinity are typical of rural South Carolina. Agriculture has declined substantially in economic importance and undergone significant changes since 1930. Farms have become larger, but the amount of harvested cropland has declined drastically as emphasis has changed from field crops to the production of livestock and livestock products. Declines in population have accompanied the decline in agriculture, but have been offset somewhat by a rise in the economic importance of low skill industries, primarily textile mills. These industries are located outside the site vicinity and, as a result, migration from the rural areas of the two counties to urban centers has continued for the past three decades.

Members of the State and local historical societies were interviewed regarding the historic resources of the area. Mr. Terry Liscomb of the South Carolina State Archives stated that there are no significant historic sites near the proposed site. Also, no sites are listed for the vicinity in the National Register of Historic Places.

Dr. Robert Stephenson, State Archeologist, indicated that there are four recorded archeological sites within the boundary of the proposed project (see Appendix A). This concentration of archeological sites within a small area suggests that others may be present, and Dr. Stephenson recommended that two of the sites be excavated and that prior to construction a detailed survey be made of the area to discover if additional sites exist. SCE&G will support and finance such a study to be conducted by the University of South Carolina Institute of Archeology and Anthropology.

2.3.1.2 Physical Characteristics

Geology

The Summer Station site is located in the Piedmont Physiographic Province, which is underlain by a complex sequence of deformed crystalline rocks. Most metamorphic rocks in the Piedmont Province of South Carolina were originally deposited as a thick sequence of sediments between 250 and 600 million years ago. Regional deformation during and at the end of the Paleozoic Era, accompanied by periods of igneous intrusion, resulted in consolidation, folding, faulting, and metamorphism of the rocks. Progressive uplift of the earth's crust and downward erosion of the land surface have exposed igneous and metamorphic rocks. Most of the uplift and erosion occurred after the deformation that produced the Appalachian mountains. During the last period of uplift, radiologically dated to be about 200 million years ago, late or post-Triassic diabase dikes were intruded. No younger tectonism has been identified in the Piedmont Province. The inplace residual soil now present in the Piedmont results from the intense chemical weathering of the metamorphic rocks over the last several million years.

The Summer Station site overlies complex zones of igneous, metamorphic and migmatitic rock types. These rocks are blanketed by 40 to 85 feet of residual soils. The rock and soils at the site will provide good support for the Summer Station facilities.

Field evidence suggests that a fault exists in the Parr area, approximately three miles southwest of the site. Displacement along this fault seems to be small and there are no indications of geologically recent movement. Based on extensive field studies, it is postulated that this fault is more than 200 million years old. No other substantial evidence of faulting within ten miles of the Summer Station site has been observed.

Mineral Resources

According to Mr. Norman Olsen, the South Carolina State Geologist, the only known economic mineral resources in the vicinity are sand and gravel deposits in the Broad River flood plain. Commercial dredging of these materials has been conducted a few miles upstream from the Parr Reservoir until recently. Within 10 to 15 miles of the site there is a non-commercial kyanite deposit at Little Mountain; a proposed granite quarry operation is located downstream on the Broad River.

It appears that no economic mineral resources underlie the site and loss of mineral resources due to construction and operation of the Summer Station will, therefore, be negligible.

Seismology

The site is within a region which has experienced a moderate amount of earthquake activity, but is well removed from areas which have experienced recurring shocks. Occasional earthquakes, however, have occurred in the Piedmont Province in which the site is located. These shocks have generally been associated with well defined local geological features which follow the regional northeast-southwest structural trend. Based on the seismic history of the region, there is a possibility of moderate earthquake motion at the site during the economic life of the Summer Station. This has been carefully studied and the Summer Station facilities will be conservatively designed to resist the effects of possible earthquake motion.

The foundation conditions at the site are satisfactory from the standpoint of earthquake-resistant design. All significant facilities will be supported either on rock or compact residual soils which would not be adversely affected by earthquake motion.

Soils

The soils in the site vicinity are derived from the weathering of igneous, metamorphic and migmatitic rocks, generally granodiorite and gneiss of complex lithology. Chemical weathering of rock has progressed to depths of 25 feet or more. The degree of weathering, however, is variable and depth to rock varies considerably. In some places, bedrock may crop out or exist at very shallow depths.

Alluvial soils occur along the stream bottoms and colluvial soils on the footslopes. The predominant surface soils in the site vicinity consist of silts and relatively impermeable silty clays. Sandy soils or friable sandy clays also occur in areas where the parent rock materials were high in quartz content. The soils are generally acidic with low to moderate cation exchange capacity and low organic matter content.

From an agricultural standpoint, the major soil associations in the site vicinity are:

1. Cecil-Davidson-Appling Association -- Deep, well drained soils with red to brownish-red firm subsoils. This association comprises the soils occurring on the principal ridge tops. Except for the steeper slopes, most of these soils have been cleared and cultivated. They are subject to erosion and under cultivation have sustained serious soil losses. Generally, these soils are best suited for pasture.
2. Cecil-Davidson-Wilkes Association -- Deep to shallow, well drained, firm upland soils. This association includes the Broad River bottoms and the side slopes adjacent to the main drainageways. The Cecil and Davidson soils are on the more gentle side slopes and ridge tops and the Wilkes soils are on more uneven terrain and steep side slopes. Except for the more gentle slopes and ridge tops with lower erosion hazards, these soils are best suited for forest.

In general, the soils are poorly suited to agricultural use, particularly cultivated crops, owing to the erosion hazard and low natural fertility.

2.3.1.3 Land Use

The Summer Station will be developed near a location which has a history of electrical power generation. There are existing conventional fossil fuel, gas turbine and hydro-electric generating facilities at Parr, as well as the decommissioned Carolinas Virginia Tube Reactor (CVTR), a demonstration prototype nuclear power plant which was operational from 1963 to 1967. The meteorological and radiological conditions surrounding the CVTR operation were continuously monitored from the inception of that project until its termination. As a result, a wealth of data have been collected regarding the radiological and meteorological conditions at Parr. These data have provided considerable insight into the feasibility of using the proposed lands for the Summer Station.

The effects of the proposed action on land use will be twofold: first, effects on the actual land area that will be acquired or controlled by SCE&G for the construction and operation of the Summer Station and associated pumped storage facility and second, effects which may be directly or indirectly imposed upon adjacent land uses. Each of these is considered in regard to its permanency or transiency on future use of the lands affected.

Existing and Future Land Use Within the Project Area

The total land area which will be acquired or controlled by SCE&G for purposes of both the Summer Station and pumped storage facility amounts to about 11,000 acres. The largest land requirements are about 7,000 acres to be occupied by Lake Monticello and about 2,800 acres which will be inundated by raising the level of Parr Reservoir. The remaining area will consist of land to be occupied by buildings, access roads, and other project elements, land in the Summer Station exclusion area and the peripheral land surrounding Lake Monticello.

Impoundment of Lake Monticello will require the relocation of portions of Route 99 where it crosses the upper part of the Lake, a portion of the right-of-way of a 110 KV Duke Power Company transmission line, from four to eight dwellings, and five small abandoned cemeteries. Steps will be taken to remove the existing cemeteries in a socially accepted manner. About 700 acres of cleared land, largely idle or used only as pasture, will be inundated. The remainder of the area to be inundated by both reservoirs is forested.

Land not covered by water or used for construction of facilities will be maintained essentially in its present state. Wooded areas will remain and cleared areas that exist will be managed for wildlife and recreation as part of the Land Management Program described in Section 2.3.6.3.

Existing and Future Land Use in Vicinity and Region

Land use characteristics in the vicinity (lands within 10 miles of the site) and region (within 50 miles of the site) are generally uniform with forestry by far the most dominant. Forests occur on 50 to 80% of the land in the twelve counties that are wholly or partly within the region. Tables 1 and 2 illustrate the vicinity and regional land use characteristics.

Vicinity lands are located principally within two counties: about 2/3 in Fairfield County, and about 1/3 in Newberry County. The Summer Station will be constructed in Fairfield County, which is presently about 80% forested, 13% agricultural, 3% urban and suburban, and the remaining 4% in other uses. A forty-year land use projection for the site vicinity (based on population and land use trends indicated by census data, planning studies and other statistics available for

TABLE 1

LAND USE IN VICINITY[1, 2]

Land Use	Fairfield County			Newberry County			Two-County Averages	
	1958	1967	Change 1958-1967	1958	1967	Change 1958-1967	1967	Change 1958-1967
	%	%	%	%	%	%	%	%
Federal Land	2.7	2.7	0	13.6	13.6	0	8.2	0
Urban and Built-Up	1.3	2.8	+1.5	4.4	4.5	+0.1	3.6	+0.8
Cropland	11.2	6.0	-5.2	19.8	12.4	-7.4	9.2	-6.3
Pasture	7.5	7.1	-0.4	4.3	8.8	+4.5	7.9	+2.0
Agricultural (Cropland Plus Pasture)	18.7	13.1	-5.6	24.1	21.2	-2.9	17.1	-4.3
Forest Land	75.5	80.0	+4.5	55.1	58.3	+3.2	69.1	+3.8
Other Land	1.7	0.9	-0.8	2.5	2.1	-0.4	1.5	-0.6

NOTES:

1. The area within 10 miles of the site is principally located within two counties: about two-thirds in Fairfield County, one-third in Newberry County.

2. Reference: "South Carolina Soil and Water Conservation Needs Inventory," May, 1970.

TABLE 2

LAND USE IN REGION[1, 2]

		Chester	Fairfield	Greenwood	Kershaw	Lancaster	Laurens	Average 12-County Area
Total County Land (Acres)		374,000	447,000	286,000	503,000	323,000	449,000	
Federal Land (%)	1958	3.2	2.7	3.5	0	0	4.5	3.9
	1967	3.2	2.7	3.5	0	0	4.5	3.9
						Percent Change		0
Urban and Suburban (%)	1958	4.3	1.3	5.2	2.1	2.3	3.9	4.2
	1967	4.2	2.8	6.3	2.9	9.3	5.4	6.4
						Percent Change		+2.2
Cropland (%)	1958	15.2	11.2	17.9	19.1	16.9	24.2	18.4
	1967	13.0	6.0	11.2	13.0	10.0	15.0	13.1
						Percent Change		-5.3
Pasture (%)	1958	12.1	7.5	10.8	2.0	5.4	9.4	7.2
	1967	11.2	7.1	14.1	3.2	6.6	11.1	8.9
						Percent Change		+1.7
Agricultural (Cropland plus Pasture) (%)	1958	17.6	18.7	28.7	21.1	25.3	23.6	24.2
	1967	24.2	13.1	25.3	16.2	16.6	26.1	22.0
						Percent Change		-2.2
Forest (%)	1958	61.7	75.5	60.0	72.8	66.9	54.7	61.3
	1967	66.5	80.0	65.0	79.5	69.3	61.2	64.2
						Percent Change		+2.9
Other Land (%)	1958	3.5	1.7	2.1	3.9	7.4	3.1	3.6
	1967	1.8	0.9	1.4	2.9	3.7	2.4	2.2
						Percent Change		-1.4

TABLE 2 (cont.)

LAND USE IN REGION, cont.

		Lexington	Newberry	Richland	Saluda	Union	York	Average 12-County Area
Total County Land (Acres)		455,040	405,120	479,000	283,000	330,000	438,000	
Federal Land (%)	1958	0	13.6	11.5	1.4	17.0	0.7	3.9
	1967	0	13.6	11.5	1.7	17.0	0.7	3.9
						Percent Change		0
Urban and Built-Up (%)	1958	6.9	4.4	10.2	0.8	2.7	6.0	4.2
	1967	10.5	4.5	17.6	1.2	3.2	9.2	6.4
						Percent Change		+2.2
Cropland (%)	1958	22.6	19.8	15.6	25.2	12.0	21.2	18.4
	1967	21.1	12.4	13.1	19.5	7.6	15.3	13.1
						Percent Change		-5.3
Pasture (%)	1958	2.7	4.3	3.5	11.8	6.5	10.4	7.2
	1967	3.5	8.8	2.9	17.3	9.4	11.8	8.9
						Percent Change		+1.7
Agricultural (Cropland plus Pasture) (%)	1958	25.3	24.1	19.1	37.0	18.5	31.6	24.2
	1967	24.6	21.2	16.0	36.8	17.0	27.1	22.0
						Percent Change		-2.2
Forest (%)	1958	64.3	55.1	56.1	57.6	55.6	55.7	61.3
	1967	61.8	58.3	52.7	57.0	61.2	58.0	64.2
						Percent Change		+2.9
Other Land (%)	1958	2.8	2.5	2.7	2.8	6.1	4.8	3.6
	1967	2.4	2.1	0.7	2.8	1.5	3.5	2.2
						Percent Change		-1.4

NOTES:

1. The area within 50 miles of the site takes in all or parts of the twelve counties listed in this Table.
2. Reference: "South Carolina Soil and Water Conservation Needs Inventory," May, 1970.

Newberry and Fairfield Counties) estimates that 85% of the land will be used for forestry (including recreation), 10% urban and built-up land, and 5% agricultural and other uses. This projection also includes judgments regarding the probable influence of local factors such as soils, topography, and geographic location. Based on these projections, it appears that projected land uses should not be significantly affected by the construction and operation of the proposed facilities.

Long-Range Planning

According to Regional and State Planning authorities, no long-range comprehensive county-wide or regional land use programs have been developed which include the site vicinity. Certain general plans regarding water supply and recreation, however, have been developed. According to the Fairfield County Water and Sewerage Plan, for example, improvements in domestic water supplies and well utilization will soon be made in the Monticello-Jenkinsville area. Also, the U. S. Forest Service (USFS) has some long-range plans for further development of recreation in their Broad River management area. With the possible exception of their holdings on the Broad River about one mile upstream from Dawkins, which may be affected by the increased size of Parr Reservoir, there will be apparently no conflict with other USFS plans. Discussions have been held with the USFS concerning the Dawkins area.

Fairfield and Newberry Counties have at present no zoning regulations controlling land use in the site vicinity.

Industrial and residential development in the southern part of the site vicinity, near Interstate 26, is expected to increase. It is anticipated that construction and operation of the proposed facilities will not adversely affect this land use. If anything, the power generated should be of benefit.

Based on statements in reports prepared by planning groups for each of the counties regarding land use policies and development plans it is concluded that the proposed project will not significantly conflict with any anticipated long-range land use plans.

Population Characteristics

The Summer Station will be located in a sparsely populated rural area. The population figures, estimated from 1970 census figures and house counts in the vicinity, are as follows:

Radius (Miles from Summer Station)	Cumulative Total
1	9
2	144
3	365
4	738
5	1,211
10	6,350

Population densities in the various sectors extending out from the Summer Station site vary from zero inhabitants per square mile to a high of 73 per square mile in a one to two mile sector east of the site. Only three other nearby sectors have population densities of more than 50. These are due to residences along State Route 215. The average density for the ten mile zone is about 20 people per square mile. It is estimated that the total population in the site vicinity will not change appreciably in the next forty years.

Additional population data for nearby communities are given in Table 3.

Agriculture

Construction of the proposed Summer Station and pumped storage facility will not involve much land presently used for agriculture; only about 700 acres of cleared land will be inundated by Lake Monticello. This land is of poor agricultural value and is presently idle or used almost entirely as pasture. A few small tracts of cleared land along the Broad River bottoms will be affected by enlargement of Parr Reservoir. Owing to the low fertility and severe erosion hazards association with soils in the area this land has never been highly productive. Most farms in the area are not economically viable and are owned and operated by part-time farmers who work in non-agricultural services and industries outside the 10-mile zone. Thus, the impact on the local agricultural economy will be small.

Agriculture is not a major industry in the vicinity of the Summer Station as a land use or as a source of income. Only 17% of total lands in Fairfield and Newberry Counties are devoted to agriculture, with a decrease of about 4% in the past decade. Agriculture data for these two counties are presented in Table 4.

Besides the decline in farmland in the region, there has also been a substantial change in farm enterprises. There has been a shift away from intertilled crops such as cotton to livestock and poultry.

TABLE 3

1970 POPULATION OF ALL UNINCORPORATED COMMUNITIES WHICH HAVE 1000 OR MORE INHABITANTS AND ALL INCORPORATED COMMUNITES--WITHIN A 30-MILE RADIUS OF THE SITE

COMMUNITY	POPULATION	DISTANCE FROM SITE IN MILES	DIRECTION
Peak	87	4	S
Pomaria	264	6	W
Little Mountain	240	9	SW
Chapin	342	9	S
South Congaree	1,434	29	S
Summit	130	26	S
Gilbert	186	26	S
Leesville	1,907	28	S
Lexington	969	22	S
Batesburg	4,036	30	SW
Prosperity	762	14	SW
Newberry	9,218	17	W
Silverstreet	156	22	W
Joanna	1,631	30	W
Whitmire	2,226	22	NW
Winnsboro	2,312	15	E
Ridgeway	437	22	E
Irmo	517	16	SE
Columbia	113,542	26	SE
West Columbia	7,838	26	SE
Pineridge	633	29	SE
Cayce	9,967	27	SE
Springdale	2,638	27	SE
Arcadia Lakes	741	28	SE
Ardincaple	726	28	SE
Boyden Arbor	416	27	SE
Forest Acres	6,808	27	SE
Forest Lake	39	27	SE
Carlisle	670	22	N
Baldwin-Argon Mills	1,042	29	N
Chester	7,045	29	N
Eureka	1,524	29	N
Winnsboro	3,411	15	NE
Great Falls	2,727	30	NE

NOTE:

1. Reference: "1970 Census of Population, South Carolina Advance Report," U. S. Department of Commerce, Bureau of Census.

TABLE 4

AGRICULTURAL DATA

FARMS, ACREAGE AND VALUE - 1964[1]

ITEM	FAIRFIELD COUNTY	NEWBERRY COUNTY
Number of Farms	455	1,018
Average Size of Farms (Acres)	278	179
Average Value Per Acre (Dollars)	109	117

CASH RECEIPTS FROM FARM MARKETINGS - 1969[2]

(Percent of Total 1969 County Cash Receipts/Rank in State)

ITEM	FAIRFIELD COUNTY	NEWBERRY COUNTY
Cotton and Cotton Seed	1.3/40th in 46	0.4/38th in 46
Soybeans	-	4.6/24
Oats	-	0.4/9
Wheat	0.8/31	0.6/19
Other Crops[3]	4.0/38	1.7/25
Forest Products[4]	24.3/3	3.2/5
Dairy Products	16.4/29	29.0/2
Cattle and Calves	33.7/27	13.1/7
Hogs	4.8/45	5.6/18
Eggs	8.6/45	29.6/1
Other Livestock and Livestock Products[5]	6.1	11.8

TABLE 4, cont.

LIVESTOCK AND POULTRY STATISTICS - 1969[6]

SPECIES AND CLASS	FAIRFIELD COUNTY	NEWBERRY COUNTY
All Cattle	9,500 head	22,300 head
All Milk Cows[7]	750 head	6,200 head
All Beef Cattle	8,500 head	13,400 head
Beef Cows 2 yrs and Over	5,200 head	6,800 head
Hogs	900 head	9,000 head
All Chickens	27,000 head	470,000 head
Egg Production (1968)		
Avg. Number of Layers During Year	22,000 head	353,000 head
Total Eggs Produced	4,700,000	81,200,000
Milk Production (1968)		
Avg. Number of Cows Milked During Year	700	6,100
Total Milk Produced	4,000,000 lbs.	43,000,000 lbs.

NOTES:

1. Reference: 1964 United States Census of Agriculture
2. Reference: South Carolina - Cash Receipts From Farm Marketing, September, 1970.
3. Includes Nursery and Greenhouse Products, Peanuts, Hay Crops, Seed Crops, Other Miscellaneous Crops, Fruits and Nuts Except Peaches.
4. Relates Only to Sales From 1964 Census Defined Farms.
5. Includes Farm Chickens, Turkeys, Turkey Eggs, Other Poultry, Honey, Beeswax, Sheep, Lambs, Wool, Horses, Mules.
6. Reference: South Carolina - Livestock and Poultry Statistics, June, 1969.
7. Cows and Heifers Two Years Old and Over Kept for Milk. Includes Two-Year Old Heifers Not Yet Fresh.

Industry

Other than a small plastics processing plant in Jenkinsville, there are no industrial facilities in the site vicinity. Local residents find employment in industries located in the Columbia area, 26 miles to the southeast, and in Winnsboro, 15 miles to the northeast. The smaller communities in the vicinity have no industry, but there are some small retail businesses. There are no commercial fisheries.

Forestry is the only industry of commercial importance. It is discussed in the following section.

Forestry

In 1967, Fairfield County was reported to be the most heavily forested county in the State and was ranked first in many forestry categories. Approximately 76,200 acres within the county are owned by five major pulp and paper companies. Also, Sumter National Forest occupies about 12,100 acres in the northwest section of the county. Most of the forest land within the county, however, is owned by private individuals.

Several forestry-related industries operate in the county, including saw mills, planing mills, and pulpwood dealers. Since 1958, the size of the county's forest industry has increased considerably. The volume of softwoods, particularly pines, has shown substantial increases, but the volume of hardwood has decreased. Efforts are presently being made to encourage quality hardwood species in the limited suitable lands available.

The dominant trees in the area are pines on the uplands and mixed hardwoods on the stream bottomlands. The creation of Lake Monticello will inundate about 6,000 acres of pine forested land but should not seriously affect the total forest resources of the area. The enlargement of Parr Reservoir, however, will inundate about 2,800 acres of bottomlands and presently established hardwood stands. The loss of these hardwoods must be considered a loss of potential forestry resource. Its impact, however, is expected to be more biological than commercial and is discussed in Section 2.3.6.

Recreation

There are a number of parks and recreational areas within the general region. Within ten miles of the site, however, the only significant public land available for recreational use is the Enoree Division of the Sumter National Forest. This tract lies northwest of the site; a portion of it is within six miles of the site. The Fairfield County portion of these public lands east of the Broad River comprises 8,187 acres and the Newberry County portion contains more than 55,000 acres. These areas provide recreational activities including picnicking, hiking, hunting and limited boating and fishing. The Broad River Scenic Area near the Union County line, and Molly's Rock Recreation Area off U. S. Highway 176 offer public access to the general area.

Hunting is a major visitor use. In 1970, over 35,000 deer hunter-days were spent in the Enoree Division of the Sumter National Forest. There were 4,500 turkey hunter-days and 24,000 small game hunter-days. There are two successful private waterfowl hunting clubs owning covelands upstream. These clubs are cooperators in the Broad River Waterfowl Management Program. These lowlands may be affected by the increased water level of Parr Reservoir. Discussions will be held with these clubs concerning the possible effects of the project.

While the Broad River attracts some fishermen in the site vicinity, it is not a high-use fishery or recreational area. There is only one boat launching ramp located at Cannon Creek which serves the immediate vicinity. There are several major lakes within the Columbia area which are more recreationally desirable. Lake Murray, for example, about 20 miles south, is an important recreational and residential attraction near Interstate Highway 26.

Government Reservations and Installations

There are no government reservations or installations in the vicinity of the Summer Station. The closest installation is Ft. Jackson Army Base which is about 28 miles away, near Columbia. Two other installations are McEntire National Guard Air Base about 40 miles away, and Shaw Air Force Base about 55 miles away, near Sumter. All three of these bases are southeast of the Summer Station. No other reservations or installations are located within 100 miles. The distances involved preclude any forseeable interactions of the bases and the Summer Station.

Aesthetics

The area is largely forested, but forests have been severely altered from their virgin condition by man's activities. Some of the land now classed as forest supports regrowth vegetation on formerly cleared agricultural land.

Impoundment of Lake Monticello will result in a lake with an irregular shoreline, much of which will be wooded and free of visible effects of the construction activities. The Summer Station structures will be almost completely hidden from view.

Efforts will be made to achieve an aesthetically compatible installation through a judicious selection of design and color from available alternatives. The appearance of the Summer Station will be made compatible with the surroundings and non-degrading so far as practical. A Land Management Program described in Section 2.3.6 will be undertaken to minimize possible detrimental effects on the aesthetics and ecology in the site locale and to provide recreational opportunities compatible with the operation of the Summer Station.

Noise will be an unavoidable by-product of construction. Noises associated with the operation of the Summer Station and the Fairfield Pumped Storage Facility, such as noise of flowing water, the hum of generators, motors and pumps audible for only a few hundred feet, should not be objectionable.

References:

1. "Comprehensive Water and Sewerage Plan, Fairfield County, South Carolina," Fairfield County Planning and Development Commission, September, 1969.

2. "Economy and Population, Newberry County, South Carolina," South Carolina State Development Board, Division of Community Planning, February, 1969.

3. "1964 United States Census of Agriculture, Volume 1, Part 27, South Carolina," U. S. Department of Commerce, Bureau of Census.

4. "1970 Census of Population, South Carolina Advance Report," U. S. Department of Commerce, Bureau of Census.

5. "South Carolina Soil and Water Conservation Needs Inventory," U. S. Department of Agriculture, Soil Conservation Service, Columbia, South Carolina, May, 1970.

2.3.2. Water Use Compatibility

2.3.2.1. Surface Water Hydrology

Watershed Description

The regional watershed is typified by low relief, meandering streams, and dendritic tributary systems. Run-off is moderately high due to poor infiltration properties of the soil cover. Groundwater discharge is localized in seeps and springs along drainage courses.

The Broad River watershed, upstream from Parr Dam, covers some 4,500 square miles and extends northwest for about 30 miles into North Carolina. Frees Creek flows into Parr Reservoir above the dam. Lakes and streams in the area are not subjected to ice covers or tidal changes. Parr Reservoir is not subject to any damaging wave action.

About 70% of the Frees Creek watershed will be altered by the 7,000 acre Lake Monticello and associated facilities. It is anticipated that increases in run-off that would normally result from direct lake capture of precipitation, drainage from construction areas, and the loss of evapotranspiration by vegetation inundated by the proposed lake will be balanced by losses of run-off resulting from Lake Monticello evaporation and seepage to the groundwater system. Although run-off records for Frees Creek are not available, the impact of Lake Monticello on the Broad River watershed run-off is expected to be insignificant.

Evaporation rate for Parr Reservoir is expected to amount to no more than 10 cfs which is about 0.005 of the mean monthly flows during the drier summer months. The evaporation rate from Lake Monticello is estimated to be as much as 45 cfs. This estimated loss will be replenished from Frees Creek watershed run-off and/or pump back from the Broad River.

Streamflow

The Broad River has an average annual run-off of 4.3 million acre-feet at Parr Dam and is the principal stream in the site area. The largest flood of record was 228,000 cfs on October 3, 1929 (recorded at Richtex, the nearest gauging station, 11 miles downstream from Parr Dam). The largest storm, however, occurred in 1916, about 9 years before the installation of the Richtex gauging station. The lowest measured instantaneous flow during the record period was 105 cfs with the lowest mean daily flow being 149 cfs. Ninety-five percent of the time the seven-day low flow in the river exceeds 700 cfs. The average yearly flow in the Broad River is approximately 6,100 cfs.

Streamflow from Frees Creek into the Broad River has not been measured but since run-off can generally be assumed to be proportional to the relative size of the drainage basins, Frees Creek flow would have a ratio of 17 square miles to 4,500 square miles, or 0.004 of the total Broad River flow. Normal low flows from the Frees Creek watershed during dry weather periods may be too low to measure.

Significant flood flows occur principally during and after the frequent rainstorms. During flood conditions the flows from the small Frees Creek watershed will be masked by the much larger Broad River flow. A 45 cfs storage replenishment requirement would utilize only about 0.008 of the average yearly river flow past Parr Dam. During low flow periods, minimum flow in the Broad River will be maintained.

The Broad River flows into Parr Reservoir will be continuously monitored and the information relayed to Parr Dam to assure the controlled release of river flows. Consequently, the operation of the Summer Station and pumped storage facility will not significantly alter Broad River flows.

Municipal Utilization

In the Columbia area, approximately 26 miles downstream from the site, the Broad River is a source of municipal and industrial supply. Users in this area currently discharge untreated waste water into the river. Increased municipal and industrial use of river water is expected as the Columbia metropolitan area expands. There is no irrigation demand on surface water in the area. No other significant municipal use of the Broad River is foreseen.

Municipal utilization will not be adversly influenced by the proposed project, since all discharges will meet the appropriate water quality standards and Broad River low-flows will be maintained.

2.3.2.2. Groundwater Hydrology

Aquifer System

Groundwater in the region occurs in two types of formations: (1) in the more pervious lower zones of the residual soil overburden, and (2) in jointed and fractured crystalline bedrock. Recharge is by infiltration of precipitation on the upland areas. Infiltration into subsurface water bearing formations at depth is retarded because of low permeability of the upper soils. Some of the water infiltrating the surface soils evaporates, transpires from plants, or re-emerges at the surface downslope at short distances from points of infiltration. A small portion of the water percolates to perched water zones in the lower soils and into the water table in the underlying jointed bedrock.

Flow Characteristics and Potential

The principal water table at the Summer Station site is 50 to 90 feet below existing grade (Elevation 350 to 420 feet) in the jointed bedrock. Seepage areas along surface drainages indicate some lenses of perched water in the soils above the principal water table.

The surface soils, in general, are relatively impervious. Underlying silty sandy soils, in general, are relatively permeable. Bedrock is impervious, except along joints.

Gradients generally follow the surface topography; the present principal direction of flow at the site is toward the northeast into Frees Creek. Groundwater velocity is probably not more than one foot per day.

The impoundment of Lake Monticello to a water surface elevation of 425 feet MSL will affect the existing water table conditions. Groundwater gradients will be generally reversed from the northeast to the south and west, toward Broad River tributaries and will move at an estimated velocity of less than one foot per day. It is expected that the groundwater level at the site would rise from its present level. Several piezometers will be installed at the site to measure water levels and identify the gradient and direction of the groundwater flow after the lake is impounded.

Water Well Utilization

The low permeability of water bearing rocks and the relatively impervious surficial soils result in relatively low yields from water wells in the site vicinity. Water wells in the general area are commonly less than 200 feet deep, and water well yields generally do not exceed 10 gpm and average about 5 gpm. The only municipal use of the groundwater supply is a well field at Jenkinsville, approximately three miles southeast of the site. Since the expected population increase over the next 40 years is negligible the projected increased use of groundwater, through local water well development, will be correspondingly small. Construction and operation of the Summer Station will not affect local groundwater supplies.

2.3.3 Heat Dissipation

2.3.3.1 Condenser Cooling Water Supply System

Cooling water for the main condenser will be supplied at a rate of approximately ~~485,000~~ 530,000 gpm. The circulating water will be pumped from an intake structure located on the bank of Lake Monticello and will be released by a discharge structure after passing through the tube side of the condenser. The temperature rise across the condenser during normal full power operation will be approximately 25°F. As a result, approximately 6.6×10^9 BTU/hr* of waste heat per unit will be removed.

Traveling screens will be provided to minimize the passage of fish and debris through the condenser. A mechanical cleaning device will be provided to reduce fouling of the condenser tubes.

2.3.3.2 Lake Monticello

Heat rejected by the condensers will be dissipated to the atmosphere after discharge into Lake Monticello. A hydraulic model of the overall hydrologic system has been constructed by Alden Research Laboratories. The model simulates Lake Monticello, Parr Reservoir and Broad River inflows and outflows. Superimposed on the modelled physical system are the thermal and hydraulic characteristics of the proposed Summer Station, Fairfield Pumped Storage facility, Parr Steam Electric Station and Parr Hydro Station. The model is constructed to a 1:500 horizontal scale and 1:50 vertical scale. Twenty minutes of model operation simulate a 24-hour period of the proposed facility operation. Temperature characteristics in Lake Monticello and Parr Reservoir are measured by more

* [illegible] 10/21/74

than 200 thermistors and thermocouples located on the surface and at varying depths throughout the model. Flow rates through the model's structures are controlled and measured by flowmeters.

For purposes of modeling the heat dissipation characteristics of Lake Monticello, it has been assumed that two nuclear generating units would be in operation. Only one unit, however, is currently planned. As part of its long-range planning SCE&G has considered the possible addition of a second unit at the Summer Station site at some future date. Therefore, the model studies are directed toward insuring that the environmental impact of not only the short-term plan (one unit), but also the long-range plan (two units) will be minimized.

The model studies are still in progress and the results will regulate final design configuration. However, preliminary results indicate that a surface discharge of the heated effluent is most practical from both an engineering and environmental standpoint. Assuming two units, a total water flow of ~~970,000~~ 1.0×10^6+ gpm will be used for cooling. It is anticipated that this water will be discharged from the Summer Station between elevation 415 feet and the surface. Velocity through the discharge structure will be less than 1.0 foot per second (fps). Intake water will also be obtained from the upper few feet of the lake. Intake velocities are expected to be on the order of 2.0 fps. The intake structure will contain trash racks and fish screens. Tentative locations of these structures are shown on Plate 4. A baffle extending approximately 3,000 feet into the lake will minimize recirculation of the heated water.

1.06×10^6 GPM

Data from the model studies indicate that approximately 30 days are required for the hydrologic system to respond to temperature changes in Broad River inflow. Therefore, while some daily fluctuation in surface temperatures will occur, monthly mean temperature values should reflect the thermal condition of the system. An estimate, based on a mathematical model, of the monthly mean temperature of the Lake Monticello surface water prior to operation of Summer Station is presented in Table 5. These data were calculated using known meteorologic parameters. From Table 5, maximum estimated temperatures at the discharge point would be approximately 25°F higher than the July mean temperature, or about 110°F.

The surface discharge of the condenser water at low velocities will minimize mixing and allow a rapid dissipation of heat from the lake surface to the atmosphere through evaporation. Tests show that, under summer conditions, more than 80 percent of the heat is lost by the 50 percent of the lake surface closest to Summer Station. All of the heat is dissipated within the nearest 75 percent of the lake surface. Under winter conditions evaporation losses are less and a somewhat greater portion of the lake surface will be required to dissipate the heat. Simulation of winter conditions are part of the continuing model studies.

More than 80 percent of the heat added to the lake by Summer Station will be confined to the upper 10 to 15 feet of the reservoir. Water below this level will exhibit a temperature increase of between two and three degrees.

Small amounts of heat may be transferred from Lake Monticello to Parr

TABLE 5

MONTHLY AVERAGE TEMPERATURE OF SURFACE

WATER OF LAKE MONTICELLO

MONTH	ESTIMATED TEMPERATURE AT INTAKE* (°F)
Jan.	44.4
Feb.	49.6
Mar.	58.7
Apr.	69.6
May	79.4
June	85.9
July	87.7
Aug.	86.7
Sept.	80.6
Oct.	68.6
Nov.	53.4
Dec.	43.5

*From "Deveopment of Electric Power Resources, 1971-1981," South Carolina Electric & Gas Company, Climatological Data (Table), January, 1971.

...rage discharge point during winter months but will ... than three degrees. Essentially no temperature increase will ... during either summer or winter below Parr Dam. In any event, all ...able water quality standards regarding thermal discharges will be ... SCE&G in the operation of the Virgil C. Summer Nuclear Station.

...t of the heated effluent on aquatic organisms in Lake Monticello ... Parr Reservoir is expected to be confined principally to micro-...anisms that are passed over the condensers. A discussion of the ...logic impact of the condensers and the heated water is presented ... Section 2.3.6.

.3.3.3 Water Quality

SCE&G will meet all applicable water quality standards pertaining to any effluents released to the environment. This section of the Report discusses existing water quality as it relates to the cooling water system. Chemical and sanitary effluents are discussed in Sections 2.3.4 and 2.3.5, respectively.

Reservoir through the pumped storage facility during winter months. Model tests indicate that there will be essentially no heat transferred to Parr Reservoir during the summer, due to relatively high evaporative cooling rates. It is anticipated that some temperature rise may occur near the pumped storage discharge point during winter months but will be less than three degrees. Essentially no temperature increase will occur during either summer or winter below Parr Dam. In any event, all applicable water quality standards regarding thermal discharges will be met by SCE&G in the operation of the Virgil C. Summer Nuclear Station.

Impact of the heated effluent on aquatic organisms in Lake Monticello and Parr Reservoir is expected to be confined principally to micro-organisms that are passed over the condensers. A discussion of the biologic impact of the condensers and the heated water is presented in Section 2.3.6.

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Chemical Quality - The Broad River has been frequently sampled by the U. S. Geological Survey since 1946. The nearest stations are #2-1565 near Carlisle, South Carolina, about 25 miles above Parr Dam and #2-1615 near Richtex, South Carolina, about eleven miles below Parr Dam. Chemical analyses indicate that the river water is very low in dissolved solids and that there generally is little variability in water quality with discharge rate. The chemical analyses for two discharge rates, one considerably higher and one lower than the average river flow of 6,000 cfs are presented in Table 6. A Hydrologic Monitoring Program, described in Section 2.6.6.3, will be undertaken to record inflow and outflow water quality values.

The quality of water flowing into the Parr Reservoir from the Broad River could result in water of low quality being taken into Lake Monticello by the Fairfield Pumped Storage facility and released during a subsequent generating mode. For example, the South Carolina Water Pollution Control Authority has noted several upstream violations of the State standards with regard to pH and coliform. Violations occurred upstream from the site in September, 1962; March, 1963; October, 1964; October, 1968 and May, 1969. Broad River inflow will be monitored both upstream and downstream from the project area in order to clearly define any effluents attributable to the facility operation.

Thermal Stratification - The phenomenon of thermal stratification in large reservoirs is well known. Stratification can occur naturally or artificially. Under natural conditions stratification occurs during

TABLE 6

BROAD RIVER WATER QUALITY
Samples taken at Richtex

ITEMS ANALYZED	SAMPLED 10-22-58 @ 1970 cfs FLOW		SAMPLED 12-19-59 @ 17800 cfs FLOW	
SiO_2	15	ppm	11	ppm
Fe	.01	ppm	.01	ppm
Ca	5.6	ppm	3.0	ppm
Mg	.9	ppm	1.9	ppm
Na	10	ppm	4.0	ppm
K	1.6	ppm	2.0	ppm
HCO_3	40	ppm	22	ppm
SO_4	2.3	ppm	2.2	ppm
CI	5.5	ppm	3.5	ppm
F	0.0	ppm	0.2	ppm
NO_3	0.3	ppm	1.2	ppm
Dissolved Solids	62	ppm	47	ppm
Hardness (as $CaCO_3$)	18	ppm	15	ppm
pH	6.8		6.6	
Color	10		15	

the summer by heating of the reservoir surface. Where deep mixing does not occur, an upper warm layer of water called the epilimnion develops. This layer is usually more or less uniformly warm, circulating and fairly turbulent. The epilimnion is separated by a zone of rapidly decreasing temperature, called the thermocline, from the lower, cooler hypolimnion. The warmer water tends to act as a lid on the hypolimnion and prevents total reservoir mixing. A similar condition can exist when a thermal power plant discharges heated water; the epilimnion is artificially supplied by the heated discharge water.

The result of stratification may be to decrease the water quality downstream from a reservoir if water is withdrawn from the hypolimnion which usually is low in dissolved oxygen. In moderately productive waters the biochemical oxygen demand in the hypolimnion is sufficient to nearly deplete the dissolved oxygen content of this zone. Since the hypolimnion is insulated from the atmosphere by the epilimnion, it does not become replenished and an oxygen deficiency results.

Stratification is not expected to occur in Parr Reservoir due to the daily drawdown and to the mixing of the reservoir water with that from Lake Monticello through operation of the pumped storage facility. Lake Monticello, however, will be stratified by the surface discharge of heated effluent from Summer Station. Fairfield Pumped Storage facilities will take water from Lake Monticello and will be suitably designed to prevent water from being discharged into Parr Reservoir with oxygen content below saturation.

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Temperature - Broad River temperature data have been collected at Carlisle and Richtex. In addition, temperature measurements have been made at the Parr Steam Plant intake. These data indicate that minimum monthly mean temperatures in the low 40's (°F) occur in December and January. Maximum monthly mean temperatures in the low 80's (°F) occur in July and August. Instantaneous temperatures as high as 92°F have been recorded at the Parr Steam Plant intake. However, since recirculation occurs at the intake, the maximum temperature over most of Parr Reservoir is probably in the high 80's.

Model studies of the system indicate that little or no heat from Summer Station will be added to Parr Reservoir. The thermal characteristics of Lake Monticello are discussed in Section 2.3.3.2.

2.3.3.4 Applicable Thermal Discharge Standards and Status of Water Quality Certification

On April 3, 1970, the Water Quality Improvement Act was enacted. It ammends the Federal Water Pollution Control Act. Section 21 (b) of the amended Act requires that applicants for a construction permit or operating license for any nuclear power station which will discharge effluents into the navigable waters of the United States, provide the Atomic Energy Commission (AEC) with certification from the State or Interstate pollution agency or the Secretary of Interior as appropriate, that there is reasonable assurance that the plant will not violate applicable water quality standards. Under Reorganization Plan No. 3 of 1970, the functions and duties of the Secretary of the Interior under this Act have been transferred to the Administrator of the

Environmental Protection Agency (EPA).

Even though the Broad River, above Columbia, South Carolina, is presently not designated a navigable waterway, SCE&G will apply for a 21 (b) certificate from the South Carolina Pollution Control Authority. The State Water Quality Standards have not yet been accepted by the Federal government. A draft of these standards has been submitted to the EPA, Charlottesville, Virginia and is presently under review. After the standards are approved, the 21 (b) certification will be applied for.

The water quality standards of the State of South Carolina are the only standards that apply to the operation of the Summer Station, since the water quality of no other state will be affected.

2.3.3.5 Meteorology and Climatology

Description - The climate of the site vicinity is classed generally as continental but there are periods of warm, humid weather during the summer months. The average air temperatures vary from about 45°F during the winter to 80°F during the summer. The annual precipitation averages about 45 inches and monthly amounts vary from two and one-half inches in November to about six inches in July.

The types of severe weather which may affect the Station include: tornadoes, with a return period of about 1,440 years; hurricanes, with a frequency of about one every two years passing within 250 miles of the Station; and thunderstorms, with a frequency of about 54 thunderstorm days per year. The estimated fastest wind speed for a 100 year return period is 100 miles per hour, sustained for about a 30 to 40 second duration.

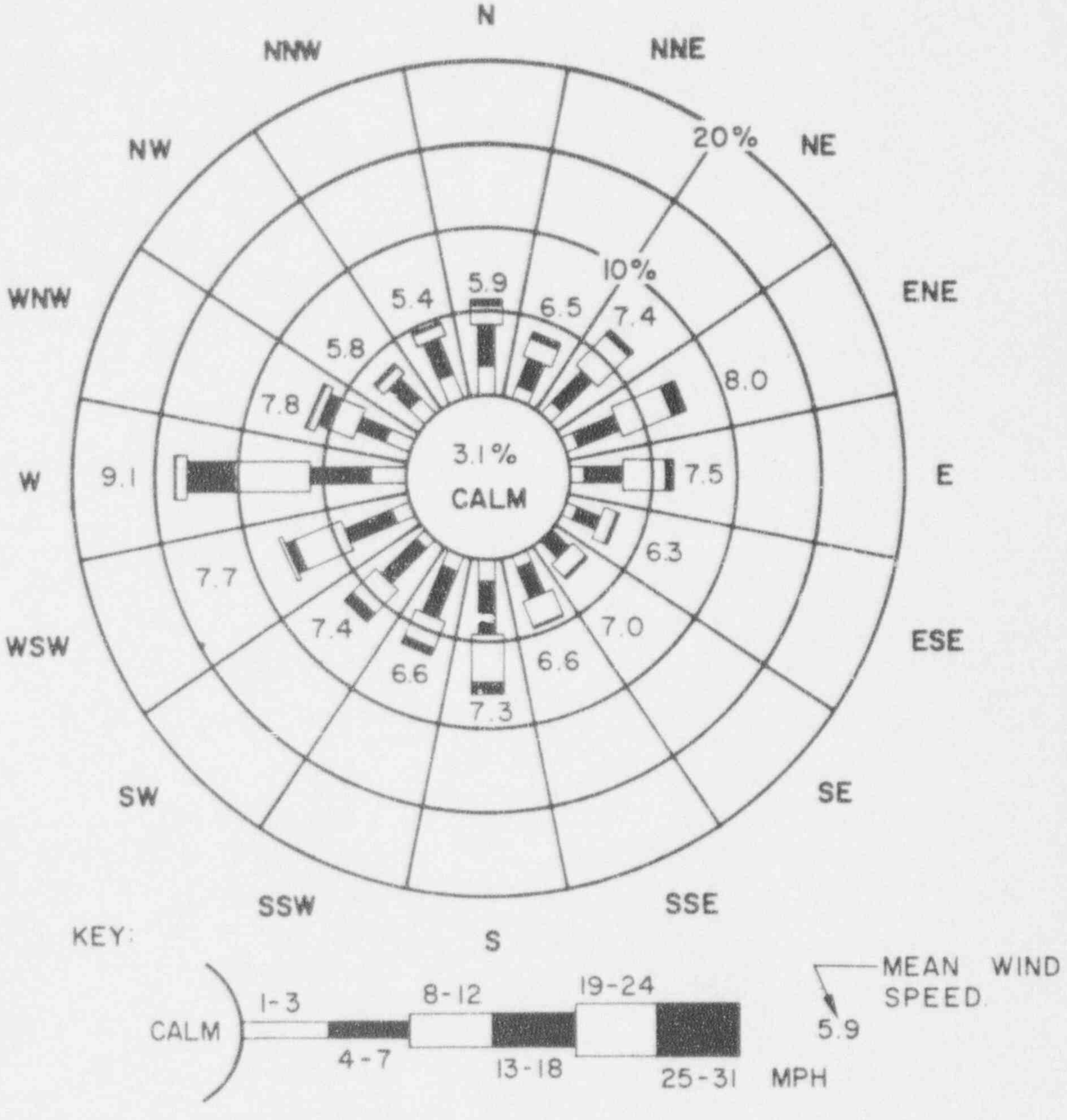
An approximation to the wind and stability conditions in the vicinity was obtained from an analysis of meteorological data measured at the CVTR meteorological tower. Winds averaged over a one hour period (speed, direction and range) and temperatures measured by instruments on a 200 foot meteorological tower for June 6, 1965 through June 5, 1966, were compiled into the Annual Wind Rose and the Stable Conditions Wind Rose presented on Plates 5 and 6 . The prevailing wind for both annual and stable conditions is from the west sector. This westerly prevailing wind is fairly typical for all seasons except fall when the prevailing wind shifts into the east-northeast sector. The average wind speed is 7.09 miles per hour annually and 6.0 miles per hour during stable conditions.

Stable conditions occurred at the CVTR tower about 57% of the time. From a comparison of the annual and stable condition winds, there is no evidence of a significant cool air drainage wind condition.

<u>Impact</u> - It is estimated that the increase in size of the Parr Reservoir will have no significant impact upon the atmospheric environment.

An evaluation of the impact of Lake Monticello upon the atmospheric environment is presented in Appendix B. The results of this evaluation are summarized below:

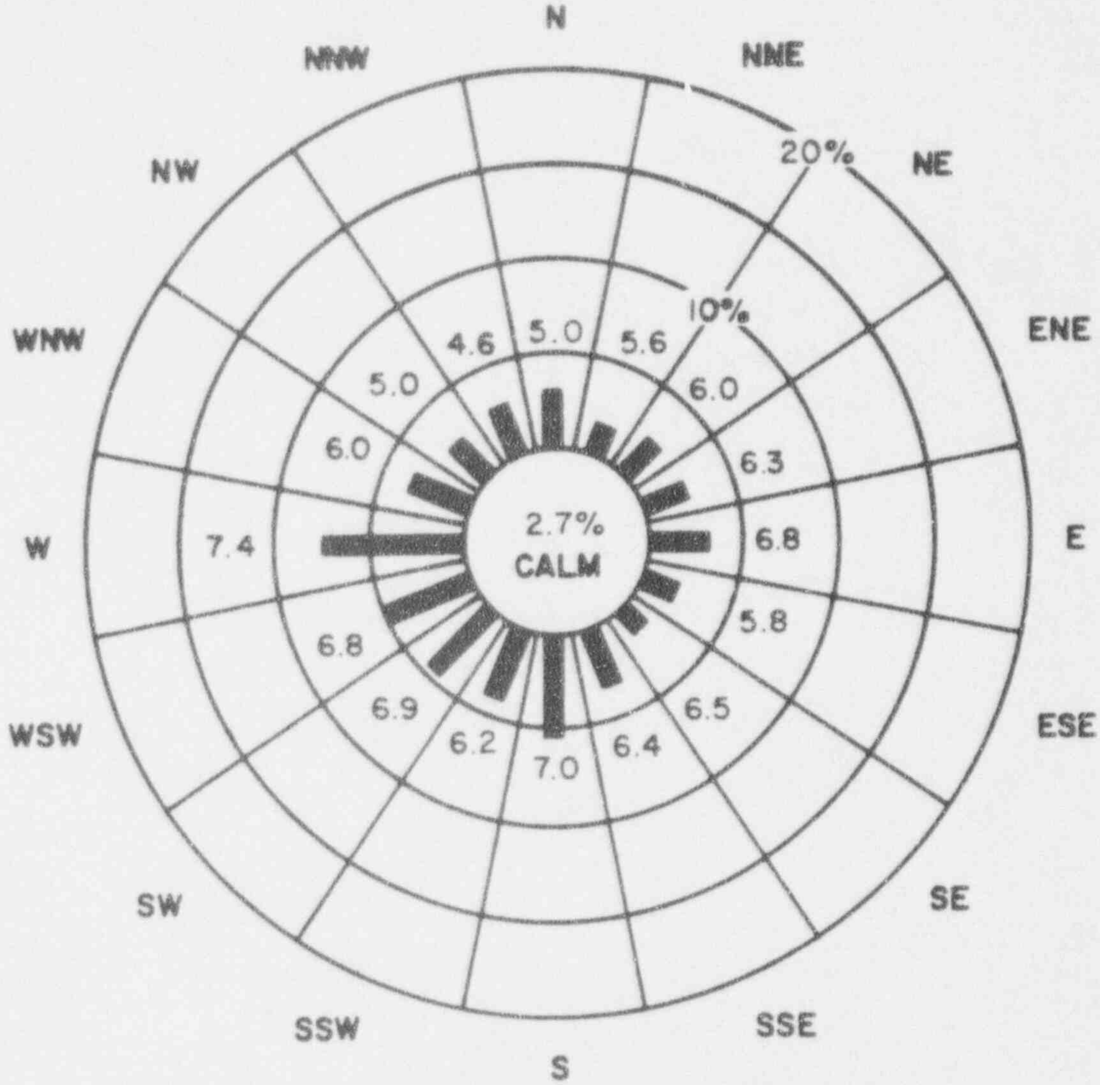
1. The existence of Lake Monticello will alter the frictional coefficients of the land surface; however, the impact of



FREQUENCY = 100 %
AVERAGE WIND SPEED = 7.09 MPH

DATA: 198-FOOT LEVEL WINDS
6/6/65 – 6/5/66
CVTR SITE

WIND ROSE – ANNUAL



BAR INDICATES FREQUENCY (%)
NUMBER INDICATES MEAN SPEED (MPH)

FREQUENCY = 57.19%

AVERAGE WIND SPEED = 6.03 MPH

DATA: 198 FOOT LEVEL WINDS
6/6/65 – 6/5/66
CVTR SITE

WIND ROSE
STABLE CONDITIONS

PLATE 6

this upon the wind speed, direction and directional variability will not be significant. Even though no evidence of a drainage wind was found in the analysis of the CVTR tower data, a meteorological monitoring program will be established to assess the impact upon climatic winds and possible drainage winds.

2. No significant changes in the amount of precipitation are anticipated in the area.

3. Lake Monticello could warm the air as much as 5°F for periods of calm air. This warming should only last for several hundred yards from the lake's shore before the warmed air mixes with the ambient air and returns to its original temperature.

4. The stability and diffusion characteristics of the atmosphere should be enhanced during the periods of atmospheric warming caused by Lake Monticello.

5. The increase in the frequency of fog was analyzed for advection and steam-type fog. For the more significant advection-type fog, the frequency increase was estimated to be greatest in the colder months; 3.6% was the greatest increase for those months considered. The summer months were estimated to have no change. Most of the increased fog frequency for advection fog was due to an earlier onset or a later dissipation (i.e., a longer duration) of an observed fog situation. Increases of up to 16% were estimated for the less significant, steam-type fog. The nature

of this type of fog, however, would limit its effects to the air immediately over Lake Monticello and only a few feet inland. From this analysis, it is estimated that there will be an increase in the frequency of fog; however, it will not constitute a significant impact upon the atmospheric environment.

2.3.4 Chemical Discharges

The systems for handling chemical discharges are in the early design stages and precise information on the design characteristics, types and quantities of materials to be handled, levels of treatment they will receive, the methods to be used for their release, and their effect on the environment is in the process of being developed. For other pressurized water reactors, sulfuric acid and caustic soda solutions are used in the water treatment plant for regeneration of ion exchange resins and various cleaning compounds. Chromates and borates are used at other locations throughout the plant. The Summer Nuclear Station equipment will include provisions for neutralizing and pH testing of the chemical discharges.

2.3.5 Sanitary Wastes

A sewage treatment plant will be installed to process all domestic wastes from the Station. The treatment plant will be designed in accordance with all applicable state and local regulations. Any discharges from the plant will meet state water quality standards.

During construction of the Station, portable sanitary facilities will be utilized. These facilities will be installed and serviced by a commercial supplier.

2.3.6. Biological Impact

2.3.6.1 Aquatic Ecosystem

General

Although the Broad River is "said" to be unpolluted, it does carry a high amount of suspended material as indicated by its brownish, turbid color. This turbidity places a limit on the river's carrying capacity (number of pounds of fish per acre) because the cloudy water restricts sunlight penetration; thus primary producers (mainly algae) do not build suitable populations to support large quantities of biomass.

A review of the available information on the Broad River has revealed that very little biological survey work has been done. Contacts were made with various State and Federal agencies who corroborated this finding. As a result, SCE&G has instituted an Aquatic Monitoring Program to determine and monitor the baseline inventory of aquatic organisms in the Broad River at Parr Reservoir. Details of the Program are discussed in Section 2.3.6.3. Results of the initial survey conducted in March, 1971, are discussed below. These results should be considered preliminary since they do not reflect seasonal variations and at least a full year of sampling will be required before specific conclusions can be reached regarding the baseline inventory.

Fish

Sixteen species of fish were found in the March sampling but because of seasonal effects on population changes and sampling conditions, a greater number of species is expected to be recorded in later samples. Previous studies, dating back to Catesby (Ref. 1) report a total of eighteen species for Richland County. Freeman (Ref. 2) recorded 49 species in the waters of Richland County. It should be pointed out that in addition to the Broad River, there are other watersheds within the county, thus some of these species were collected in quite different habitats from that of the Broad River. In Freeman's studies, only ten species were collected in the Broad River.

On the basis of this single spring sample, it is generalized that most fish species in the river are "rough fish;" however, several species such as the catfish, sunfish, crappies and largemouth bass are important in the fisherman's creel. Local fishermen report that catfish are the most sought after species. Other species collected were four species of sunfish, white catfish, yellow bullhead, white sucker, gizzard shad, longnose gar, golden shinner, carp, American eel and darter.

Plankton and Benthos

Plankton and benthos collections were made during March, 1971 from six sampling stations on the Broad River. The samples showed a river plankton dominated by diatoms, mainly Pennales. At least nine species made up the diatom community. Species present in greatest numbers were (1) Naviculate diatoms, (2) Synedra, (3) Melosira, and (4) Asterionella formosa. Other species observed were Scenedesmus, Ankistrodesmus and various unidentified green coccoid types, indicating a possible development of a chlorophycean assemblage as water temperatures rise with the spring season. An examination of net plankton indicated a very low population of zooplankton, probably an indication of the cold, early spring season and not representative of the river throughout the year. As river water temperatures increase copepods and cladocerans will probably make up a significant portion of the plankton during the summer season.

Benthic fauna was rather limited within the sampling area. Three of the species observed were pollution tolerant forms such as, (1) Tubixicidae, (2) Tentipedidae, and (3) Sphaeridae. While in themselves not indicative of a waste stress on the Broad River, they could reproduce extensively should sufficient organic matter enter the system.

Other species noted include Chaoborus (present in greatest numbers; range 33-52 per Ekman dredge) and the burrowing fly, Hexagenia. These organisms would indicate that the environment is well oxygenated. However, it should be pointed out that samples collected and examined for a single month of the year might represent an atypical picture of the river environment.

The biological characteristics of the river are influenced greatly by the high turbidity. The suspended inorganic soil particulates result in a grinding action on the plankton which shortens the survival of these organisms in the system. This, in turn, may produce effects on secondary production because of the resulting paucity of food for the grazers. Turbidity also reduces the penetration of solar radiation and proportionally causes a reduction of photosynthesis. This will affect both phytoplankton and submersed macrophytes.

Unique or Endangered Species

There are no known endangered species reported from the Broad River watershed.

However, significant changes in the flow, temperature, or chemical composition of the Broad River might possibly affect the spawning of striped bass in the Congaree River downstream. The striped bass, Roccus saxatilis, in the Santee-Cooper Reservoir Complex is the only well established landlocked population in the world. Studies by the South Carolina Wildlife Resources Department show that 96% of the spawning takes place in the Congaree River. Since the Broad River joins the Saluda River at Columbia to form the Congaree, studies will be conducted and appropriate measures taken to assure that the striped bass population will not be adversely affected by the operation of the Summer Nuclear Station.

Impact of Thermal Changes

To predict the effect of a change in the water temperature on the flora and fauna of an aquatic system, several factors must be considered simultaneously. For example, the effect of the temperature change could be evaluated relative to several different activities of fish, such as; reproduction, development, movement and activity, feeding, or growth. In turn, each of these variables is simultaneously affected by the:

1. Presence of chemical pollutants in the water (increased temperature generally increases the toxicity of various toxicants for fish).
2. Adjustment mechanisms of the species; that is, the ability of the organism to acclimate to an alteration in its environment; a factor that is predetermined by the genetics and physiology of the individual organism.
3. Other environmental factors in their habitat; such as dissolved oxygen, food supply, pH of the water, and stress of other species competing for the same ecological niche.

Most living organisms reach a steady state in response to temperatures which they naturally or experimentally experience in their immediate environments. The ability of the organism to survive new temperatures appears to be highly dependent on the difference between the new temperature and previous temperatures at which the organism existed. When organisms are confronted with uncomfortable temperature conditions, nervous centers effect a response in the organism to alter those conditions by:

1. Causing motile organisms to physically remove themselves from the situation.
2. Producing physiological adjustments to compensate for the temperature change.
3. Causing the organism to assume some protective position or behavior, or to develop dormant stages to resist the thermal stress.
4. Succumbing.

Persistent elevated temperatures may cause other behavioral displacement of species by:

1. Stratification of the water column, discouraging natural vertical movement of organisms.
2. Creation of thermal barriers to spawning and nursery grounds.
3. Seasonal changes in spawning and development.
4. Alteration in migration patterns.

Inherent changes in species behavior should not be misinterpreted as due to a single environmental factor because the same individual or species may react differently to the same factor (such as temperature change), depending on its age and the season of the year. Thermal tolerance, for example, may vary dramatically from one life stage to another (Plate 7) (Ref. 3). The breeding adult is the most sensitive of all life stages to all the thermal conditions. Non-breeding adults tolerate the greatest rate of change and frequency of exposure to temperature because of their ability to acclimate and/or compensate behaviorally. By contrast, young can maintain themselves over a wider temperature range than adults because of their metabolic simplicity. During the spawning season, fish will respond to their altered internal hormone balance and this could be misinterpreted as a response to changing temperature if data were collected and analyzed only at this time. Likewise, certain innate rhythmic mechanisms known as "biological clocks" have been shown to alter the normal metabolism of fish on a seasonal basis independent of the temperature at which the fish were kept.

All these factors must be considered for each species in a food web in attempting to predict the final impact of thermal changes on the aquatic environment.

A search of the literature reveals that very little is known of the ecology of cooling reservoirs. Several lakes designed for fossil-fueled plants are now being used and studied; however, adequate data are not yet available. There are no known nuclear power station reservoirs to date which have been functional for over one year. The projected environmental effects of thermal changes in Lake Monticello are therefore based on limited information.

THERMAL TOLERANCE FOR VARIOUS LIFE STAGES

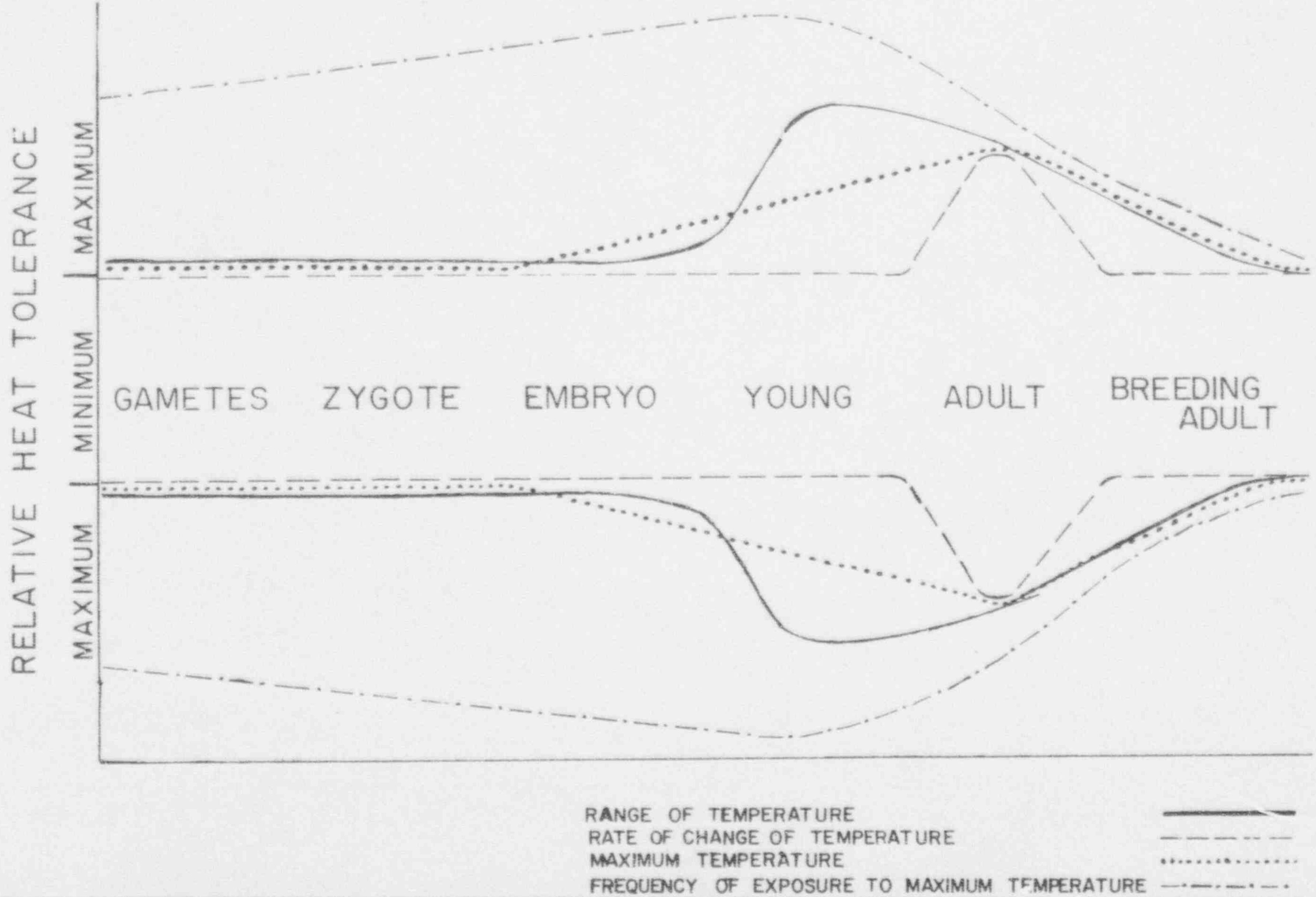


PLATE 7

The most important limiting factors to consider for cooling water are the altered oxygen and temperature conditions of this water after its use. These two factors are interrelated and are joint considerations in evaluating the requirements of aquatic organisms.

Water temperature is a critical factor because physical laws govern the amount of dissolved oxygen possible in water at any given temperature; higher temperatures result in a decrease in the available oxygen. The oxygen solubility in water at various temperatures is presented in Table 7.

For plants and animals, a rise in temperature causes an increase in metabolic rates up to a critical temperature (which may be different for each species) beyond which all metabolic activity stops and the organism dies. The practical results of temperature rises in an aquatic system are that oxygen-utilizing organisms (such as fish, invertebrates, and bacteria) require more oxygen and, at the same time, plants that produce oxygen by photosynthesis (such as aquatic weeds and algae) produce more oxygen. A critical point in evaluating the total effect of thermal changes on an ecosystem is how well this supply and demand factor is balanced. For example, the oxygen and temperature requirements of fish are quite variable and dependent upon such other factors as species, size, activity, physical condition, and age (Ref. 4). In water from 0°C (32°F) to 4°C (39°F), one or two ppm of oxygen is sufficient to sustain many game fish. However, from 15°C (59°F) to 20°C (68°F), less than 3 ppm may be lethal. Until just recently, fishery workers accepted the conclusion that good mixed fish faunas do not occur in waters in which the O_2 falls below 4 or 5 ppm.

TABLE 7

SOLUBILITY OF OXYGEN IN WATER

AT VARIOUS TEMPERATURES

Temperature (°F)	Dissolved Oxygen, ppm
32	14.6
41	12.8
59	10.2
77	8.4
86	7.6
95	7.1
104	6.6

Doudoroff and Shumway (Ref. 5) state that large numbers of fish species, including game fishes, have been collected in polluted waters where much lower O_2 concentration occurred regularly and even when concentrations not exceeding 4 ppm apparently had persisted for a long time. They concluded that although some species may be eliminated, most warm water fishes will evidently continue to inhabit O_2 deficient waters if the water quality is not otherwise too unfavorable.

As shown in Table 7 however, the oxygen content of the water is greater than 5 ppm at high temperature (95°F) and is therefore capable of supporting fish life as long as oxygen is being produced in the lake.

Developments at Par Pond (a cooling water lake developed for the AEC's Savannah River Plant, Augusta, Georgia) substantiate that a thriving population of game fish can exist at the expected warm temperatures of the proposed Lake Monticello. Par Pond receives over a billion gallons of water each day with temperatures up to 46°C (115°F). A visit to the Par Pond showed that the lake supported a fish population of exceptionally large bass. Many waterfowl and alligators were seen. Growth rates of the lake's fauna were reported to be above average (Ref. 5).

Eicker (Ref. 6) states that "a slight-to-moderate elevation of temperature above that normally found in representative lakes of the area may occur in a typical cooling lake. Unless unusual factors are involved, not attributed to temperature, there is no reason why a cooling lake should not produce fish at least as well as singular lakes of a district."

The temperature maximums compatible with the well-being of various fish species are presented in Table 8 (Ref. 7). This is not a complete list but it does illustrate the species differentiation and activity restrictions due to the influence of temperature.

TABLE 8

TEMP. MAXIMUMS COMPATIBLE WITH THE WELL BEING OF VARIOUS FISH SPECIES

34°C (93°F)	Growth of catfish, gar, white or yellow bass, spotted bass, buffalo, carpsucker, threadfin shad, and gizzard shad.
32°C (90°F)	Growth of largemouth bass, drum, bluegill and crappie.
29°C (84°F)	Growth of pike, perch, walleye, smallmouth bass and sauger.
27°C (80°F)	Spawning and egg development of catfish, buffalo, threadfin shad and gizzard shad.
24°C (75°F)	Spawning and egg development of largemouth bass, white, yellow and spotted bass

In addition, many aquatic organisms have the capacity to acclimate to extreme temperatures, both high and low. Most warm water game fish have this ability, although gradual temperature changes are tolerated much better than sharp ones.

Trembley (Ref. 8) reported temperatures lethal to 50% of the population of test fish (usually expressed as LD-50) that had been acclimated at several temperatures. Largemouth bass acclimated to 27°C (80°F) and had a LD-50 of 37-39°C (100-102°F). Bluegill sunfish acclimated to 26°C (79°F) and had a LD-50 of 39°C (103°F). Wurtz and Renn (Ref. 9) report that many aquatic organisms are able to acclimate to higher temperatures in relatively short times, a day or less, and that they lose this acclimation slowly. They also point out that the effects of sudden sharp rises in temperatures are especially difficult to assess, as sudden change is common in many aquatic environments. Tahatz (Ref. 10) subjected striped bass to temperature increases of 17°C (31°F) by changing from 7°C (45°F) to 24°C (76°F) without loss of fish. Rainbow trout, however, failed to stand the shock of an 11°C (20°F) rise after acclimation at 12°C (54°F), but did survive the shock of an 8°C (15°F) rise from an acclimation temperature of 11°C (51°F) (Ref. 11). It is generally accepted that most fish can live for short periods at abnormally high water temperatures, but they w[illegible] not reproduce if exposed to these conditions over long periods.

Smith (Ref. 12) in his thermal study of Wilkes Reservoir, Texas, found that fish survived temperatures of about 41°C (107°F). The catch results of placing gill nets in several temperature zones are shown in Table 9. It must be pointed out that fish caught in gill nets and held overnight are usually found dead so that the test only illustrates that more fish were

TABLE 9

SELECTED CATCH RESULTS - WILKES RESERVOIR, TEXAS

Station Number	Live Fish	Dead Fish	Temperature
1	9	34	42°C (107°F)
5	3	3	37°C (99°F)

Reference:

Threinen, C. W., 1958, "Cause of Mortality of a Mid-Summer Plant of Rainbow Trout in a Southern Wisconsin Lake with Notes on Acclimation and Lethal Temperature," Prog. Fish. Cult., 20(1):27.

present in the higher temperature zones than in the lower temperature zones. Smith also concluded that the fish in Wilkes Reservoir can move into waters of exceedingly high temperatures but possibly have trouble staying in these areas for extended periods of time. Wurtz and Renn (Ref. 9) indicate that largemouth bass feed and cruise more rapidly as temperatures rise to 22°C (71.6°F) with the optimum range falling between 22°C (71.6°F) and 29°C (84.2°F). Peak activity was noted at 25°C (77°F) and spawning was recorded at 24°C (75°F).

On the basis of the foregoing discussion, and from an analysis of Alden Laboratories model study results to date, it is apparent that certain zones within Lake Monticello will have temperatures which are compatible with the life cycle temperature requirements of typical warm water fishes. It is concluded therefore, that Lake Monticello will ultimately support a fish population compatible with its inherent carrying capacity. In the aquatic portion of the Biological Monitoring Program (discussed in Section 2.3.6.3). provisions have been made to monitor the natural development of this resource. This information will be used in the Land Management Program to develop fishery resources to their maximum, practical potential.

Impact of Condenser Passage on Biota

Ecologists have expressed concern regarding the effects on plankton and other marine and freshwater biota passing through the condenser systems of steam electric generating plants. With the advent of nuclear power facilities, awareness of this potential problem has become more acute. Questions have arisen regarding the long range ecological effect on a system acting as a reservoir for the large quantities of cooling water required for a nuclear power station. The following points have been raised: (1) What are the time-temperature relationships between plankton viability and inactivation in the condenser system, (2) What long term effects may be expected on the aquatic ecosystem if substantial quantities of plankton are inactivated by heat in condenser tubes, and (3) What ecological effects may be anticipated from addition of biocides to control growths of slimes or molluscs in condenser systems?

Until recently, effects of heat or biocide application on the plankton passing through a power plant were of no real interest or concern among aquatic scientists. Attention was usually directed toward the impact of heat on the receiving water. The effects on nursery areas and modifications in the physiology of aquatic organisms, especially fishes, were of great concern. Although the literature contains hundreds of papers relating to temperature effects on marine and freshwater organisms, only a few of these relate to effects on plankton and other small vertebrates and invertebrates as they pass through a cooling system of a power facility.

Much of the research in this country relating to condenser effects has been carried out at the Chesapeake Biological Laboratory. A report by

Morgan and Stross (Ref. 16) approximated a seasonal organic production loss of 424 tons in a study of the Potomac Electric facility at Chalk Point on the Patuxent River Estuary. Phytoplankton production was estimated by isotopic carbon techniques at different seasons during 1966 to 1967. The results of the study indicated that production could be expected to increase through condenser passage both in the early morning and when water temperatures were 16° C or cooler. Inhibition of photosynthesis was noted when ambient water temperatures reached 23° C or warmer. The addition of chlorine by plant personnel during the course of the experiment may have affected the results and, therefore, it is not clear whether or not the depression of primary production in Morgan and Stross' work is entirely from heat stress. The authors note this possibility, but were apparently unable to separate out effects of the two variables.

Hamilton, et al (Ref. 17) in a study on the same facility, showed some photosynthetic stimulation in heated intake water supporting the Morgan and Stross data. Unfortunately, no analyses were included of chlorine concentration. Some insight could have been gained into chlorine residual and phytoplankton response if this procedure had been carried out. (No chlorine or other biocide will be used for cleaning of the Summer Station condenser.)

A study of the York River at the Virginia Electric and Power Company plant at Yorktown showed increased primary production as ambient intake water was heated. Stimulation was observed at a Δ T of 8° C when water temperatures were between 0 and 5° C. Also, significant increases in production were found when water between 5 and 10° C was elevated to as much as 14° C. The work carried out by Warinner and Brehmer (Ref. 18) showed a reduction in photosynthesis when river water temperatures ranged from 10 to 15° C.

A report completed for the Edison Electric Institute by Johns Hopkins University (1970) (Ref. 3) shows that generally increased temperatures of James River water as it passes through the condensers increases photosynthesis. When the ambient temperature is greatest, such as was found in October and June, photosynthesis was depressed after a thermal stress in the condenser. The study suggests that below an ambient temperature of 19° C, temperature increases from the power plant increase photosynthetic rates and above 19° C temperature elevations decrease rates.

North (Ref. 19) working on the Pacific Coast found similar effects when phytoplankton were entrained in the intake water. With a rise in temperature, productivity increased during the cold season of the year.

Several studies have included effects of condenser passage on zooplankton. Results of some studies (North, Ref. 19) indicate a definite size-volume relationship to viability after thermal shocking. Generally, larger zooplankton are less resistant to heat stress than are smaller forms.

In a study at the Chalk Point, Patuxent River facility, Heinle (Ref. 20) examined effects of heat on eggs and larvae of copepods. Estimates of growth rate were also made on Acartia tonsa. Data were obtained on egg survival prior to the addition of heat so that mechanical disruption effects could be noted. The data show that heat affected eggs and nauplii more than adult forms, but chlorine addition to control fouling organisms had the most drastic effect on copepod survival and development.

Zooplankton survival by the Johns Hopkins study (Ref. 3) considered direct microscopic examination of organisms entrained in intake water. This study showed that nauplii have the greatest proportional loss of motility.

Rotifers and motile algal forms appeared to be less affected by the thermal elevations. Passage through condensers in the absence of heat does not appear to damage the microcrustacean population to any great extent.

Markowski (Ref. 21), reporting a study in the intake and outfall water of twelve power stations in England, noted relatively little effect on the biota from heat or chlorination. His study included a number of organisms representing the following groups: Protozoa, Coelenterata, Nematoda, Rotifera, Annelida, Crustacea, Insecta, Mollusca, Chaetognatha, and Tunicata.

The Lackey and Lackey study (Ref. 22) carried out at Turkey Point for the Florida Power and Light Company indicates some damage to the copepod populations through mechanical disruption and chlorination. This is the only report in the literature reviewed containing values on chlorine application, chlorine residuals and chlorine demand.

In general, the material in the literature discussed above does not lead to conclusions or findings which answer the questions raised at the beginning of this section and it appears therefore that the impact of condenser passage on biota is still largely unknown. Field studies will be included as part of the Biological Monitoring Program to evaluate the extent of the thermal effects on various forms of flora and fauna in the system.

Impact of Water Level Fluctuations

The operation of the pumped storage facility involves the exchanges of water between Lake Monticello and the Parr Reservoir. During the generation cycle the water level in Lake Monticello will be lowered up to four feet while the water level in Parr Reservoir will rise about nine feet. Although the water level fluctuations are not directly connected with operation of the Summer Station, discussion of its impact is warranted in this Report because of interaction and synergistic effects between the various facilities of the electric power generating complex.

While the water level rise in Parr Reservoir will result in 2,800 acres of new potential aquatic habitat, an increase in the amount of biomass will probably not be realized because of the possible influence of water fluctuation on the production of primary producers and on local spawning characteristics. However, there should be no significant downstream adverse biological effects as a result of these water level fluctuations. The effects of water level fluctuations in the enlargened Parr Reservoir and Lake Monticello are discussed in the following paragraphs.

Parr Reservoir - The primary production area of an aquatic habitat is the shallow water zone. In the turbid Broad River, this trophic zone is probably on the order of five feet and shallower. The food web begins here with the reproduction and growth of algae, aquatic insects and other important food sources. Of particular importance are the benthos since the carrying capacity of turbid type rivers is primarily dependent on these organisms rather than plankton. For the Broad River, benthos have been found to be rather limited in the existing Parr Reservoir area (this finding is based on only one sampling conducted in March, 1971, and is therefore preliminary) and it is therefore probable that its carrying capacity is correspondingly limited. When this aquatic habitat is subjected to daily water level changes of nine feet, the non-motile benthos will probably not be able to sustain themselves and, through their interaction with other elements of the food web, will probably cause the existing carrying capacity in the local area to be significantly reduced. As indicated in a literature search, the adaptability of aquatic ecosystems to this specific type and magnitude of stress is largely unknown and, consequently, the projected effect is felt to be conservative.

Since this section of the Broad River is not considered a high use fishery, the impact of reducing the river's carrying capacity is not felt to be extensive from a recreational standpoint. Nevertheless, SCE&G is taking steps to enhance the fishery resource in the complex area for the general benefit of the public. This is discussed in the Land Management Program.

The sport fishes in this type of river are nest builders and most spawning takes place in five feet or less. With daily drawdowns of up to nine feet there will be a dramatic effect on the spawning activities and associated egg and fry survival. Again, the adaptability of the aquatic ecosystems to respond to this type and magnitude of stress appears to be largely unknown. In other pumped storage projects with varying fluctuations over more extended periods of time, the aquatic ecosystems have adjusted to this kind of stress (Personal Communications with Dr. Edward Raney). A conservative approach is therefore to conclude that water fluctuations will severely affect the existing nest builder type of fishery. Results from the Biological Monitoring Program will be analyzed and a continuing search of the literature will be conducted to provide a data base from which the actual effects of water level fluctuations can be evaluated. Further, evaluation of the possibilities of alleviating this potential effect will be made. This information will also be used in the development of the planned public fishery resources.

Lake Monticello - For Lake Monticello, the impact of water level fluctuations must be considered within the context of what kind of aquatic ecosystem is likely to evolve and what influence thermal discharge and the exchange of biota between reservoirs will have on that ecosystem. However, there are no known studies of the biological characteristics of combined pumped-storage-cooling reservoir complexes and consequently the following discussion is based on generalized extrapolations of material in the literature which is considered reasonably applicable.

Cooling reservoirs and pumped storage reservoirs can provide a diversified aquatic habitat and can support a variety of aquatic species. Usually some form of aquatic life finds these artificial habitats suitable and even advantageous to its life cycle. Biological immigration takes place by organisms existing in the watershed and from those pumped in during fill-up operations. These two sources provide more than an adequate "stocking" of biota from large fish down to microorganisms.

During the first reproduction season, a rapid population growth can be expected to occur in Lake Monticello and the more habitat tolerant species will become dominant at that time. Eventually, the carrying capacity of the Lake will reach a dynamic equilibrium. This will probably take place within two years after impoundment.

Pre-operational generation tests including drawdowns and the addition of some heat may upset the dynamic balance of the newly developed biological system. Since the organisms will be living in a narrow tolerance range, stress may tend to eliminate some competition.

When the combined pumped storage and Summer Station complex begins full operation, the biological system will again become unbalanced and will have to adjust to the combined effects of thermal effluents, a continual input of biota from the Parr Reservoir, and water level fluctuations. At this point, organisms whose basic life requirements are most similar to that provided by the new environment will begin to dominate either in numbers or by weight until the system again becomes stable.

As discussed in Impact of Thermal Discharges, it seems likely that certain zones within Lake Monticello will have temperatures which are compatible with the life cycle temperature requirements of typical warm water fishes and therefore the evolved aquatic ecosystem in the Lake should be able to adjust to thermal stress.

As far as the continual input of biota from Parr Reservoir is concerned, preliminary data indicate that approximately 50% of the reservoir will be pumped into Lake Monticello every day. Due to the large flow rates through the pump-turbines, fish screens are not practical on the pumped storage intake structure because the larger fish would be drawn to the screens and crushed by the flow of water. Therefore, fish and various aquatic organisms will be exchanged between Lake Monticello and Parr Reservoir. In his work on the Smith Mountain Pumped Storage Reservoir, Reynolds concluded that movements of large masses of water through pumped storage reservoirs have a beneficial effect on the water quality, and in turn, its biology. Unfortunately this data has limited biologic application to Lake Monticello since Smith Mountain Pumped Storage Reservoir does not act as a cooling reservoir. Raney (Ref. 15) reports that at the Muddy Run Pumped Storage Plant, some larger fish were killed in passage by the pump turbine blades. He also found that fish eggs, dead larvae, phytoplankton, zooplankton and larval stages of bottom dwellers were pumped regularly into the reservoir. Passage mortality of some larger organisms can be expected in the pumped storage turbine to and from Lake Monticello. Although relatively little is presently known on the effect of passing aquatic organisms through pump-turbines, it seems reasonable to expect a continual exchange of biota between Lake Monticello and Parr Reservoir. It is commonly accepted by fishery scientists that yearly fall drawdowns on artificial impoundments are beneficial to fisheries by concentrating the total population, thus exposing the smaller forage fishes to predation. This aids in keeping the prey population in check and provides excellent fall growth and winter conditioning of the predator species. The effects of daily water fluctuations on the predator-prey relationships, however, are not presently known, but information collected during the Biological Monitoring Program (discussed in Section 2.3.6.3) will be used to evaluate relationships encountered in Lake Monticello.

The daily fluctuations of water levels in Lake Monticello will be approximately four feet and will probably have a significant effect on the spawning activities and associated egg and fry survival of the evolved fishery.

This created fishery may have a somewhat different response to the stress of water level fluctuation than the fishery in Parr Reservoir. The effects of the fluctuations will be monitored and evaluated as part of the Biological Monitoring Program.

2.3.6.2. Terrestrial Ecosystem

Vegetation Habitat

The proposed Station is located in an area dominated by pine plantations. Historically, this region was cleared of its native vegetation to allow the production of cotton on the uplands and corn and grain in the lowlands. The area suffered greatly with the advent of the boll weevil and during the depression years farmers largely abandoned the area.

In the early 1930's the Civilian Conservation Corps and the Works Progress Administration programs provided the manpower and the means to plant badly eroded areas with pines. The dominant pine species is loblolly pine and is found primarily on the slopes and uplands. Other associated upland species include white oak, red oak and hickory. Very little understory vegetation is present because of the shading effect of the deciduous trees. The pines provide some protection; however, they produce very little food for deer and other wildlife species.

The bottomlands are typically inhabited by cottonwood, sweetgum, nuttal oak, willow oak and white ash. Honeysuckle and greenbriar are important gound cover species. Bottomlands vegetation provides necessary nesting, roosting, shelter and food for many wildlife species. The honeysuckle, found almost exclusively in the lowlands, provides the primary food source for the deer population. According to South Carolina Game Biologists, the lush growth and nutrient value of honeysuckle has a direct influence on the excellent growth rates and physical condition of the deer. Acorns provide another major source of food for wildlife. Smartweed, an excellent waterfowl food, is also quite abundant in the bottomland.

A Terrestrial Monitoring Program has been initiated to establish a more complete baseline inventory. Field work began in June, 1971.

Wildlife

The upland pines and bottomland hardwoods provide an excellent turkey and deer habitat. Prior to the mid-50s these same species were not present but through the efforts of the South Carolina Wildlife Resources management programs, both species have become established and now have sustaining populations. The present populations provide a high quality game harvest. Hunter checking stations reported in 1970 that over 1,800 deer and more than 50 turkey were harvested in the management region near the Station area. The reported kills for both species have increased each year since their introduction. These two species are the primary game species of the site area.

In addition to the deer and turkey, the area also contains other game species, including rabbit, squirrel, quail, dove, grouse, fox, mink, musk-rats, oppossums, otter, racoons, skunks and bear. Other wildlife in the area include various mammals, birds, reptiles, amphibians, and numerous macro and micro-invertebrates. These organisms, although of apparently little direct sport or commercial value, form a necessary part of the ecological community through their participation in the cycling of nutrients and energy levels as a part of the food web.

Waterfowl have historically utilized the Broad River as a migratory flyway and nesting area. Many species are reported as transients. However, only wood ducks are considered resident species. The Broad River is one of the major wood duck production areas for the Piedmont System.

Because of the area's waterfowl potential, the South Carolina Wildlife Resources Department, in cooperation with the U. S. Forest Service, has developed a "Waterfowl Management Plan for the Broad River Composite." The objective of the program is to meet the increasing public demand for waterfowl hunting and viewing by restoring waterfowl resources in the area. The management plan report lists the "built-in" features of the area:

1. natural ponds and ox bows
2. open fields which can be utilized for game food production
3. greentree reservoir sites
4. suitable private lands already under Cooperative Agreement
5. hydro-electric reservoirs
6. a native wood duck population
7. suitable habitat in the Tyger and Enoree bottoms for future additional development.

The principal methods for attracting and holding waterfowl are:

1. planting food patches
2. flooding certain areas during the fall with the aid of control dams
3. providing several "refuge-type" resting and feeding areas.

Many of these practices have already been initiated on both private and public lands along the river.

The general geographic boundary of the program is a five-to-ten-mile-wide band bisected by the Broad River extending from the City of Lockhart south to the City of Dawkins. One major development of this program is located near Dawkins on Terrible Creek. This project includes 128 acres of open fields, 298 acres of bottomland hardwoods, and 619 acres of loblolly pine. The southern boundary adjoins the northern limits of the proposed Complex.

Impact on the Terrestrial Ecosystem

Probably the most significant impact on the terrestrial biota will result from the inundation of approximately 2,800 acres of bottomlands. These bottomlands up and down the river constitute an important food production area and serve as a primary food source for wildlife (primarily deer, turkey and wood ducks) both on and beyond the 2,800 acres. As a result, the loss of this food source will affect the wildlife resources in the surrounding locale. As these food source areas become unavailable, the motile forms will migrate to different areas. This migration of displaced wildlife will place a new stress on these invaded areas and disturb their dynamic equilibrium.

To adjust this disturbance to the terrestrial ecosystem, plans are being developed within the Land Management Program to create and improve wildlife habitat through selective planting of food and cover plants, the setting aside of appropriate areas as wildlife preserves and the development of a waterfowl management program. It should be noted that the flooding will result in additional protection and nesting for waterfowl.

According to preliminary data, the increased elevation of Parr Reservoir may flood certain properties of the U. S. Forest Service located upstream near Terrible Creek. Plans have been drawn for a waterfowl habitat area on Terrible Creek and development is expected soon. SCE&G has made contact with the U. S. Forest Service concerning the possible effects of the project on this development. Further discussions will be held as project plans are solidified.

The creation of Lake Monticello will involve the flooding of more pines than hardwoods and will result in the removal of about 7,000 acres of rather poor wildlife habitat. The removal of this poor habitat is not considered to be significant in its impact on wildlife in the area.

The decrease of waterfowl populations along the river in recent years has been attributed to the decline of the agricultural practices in the bottomlands. Although there are a few small farms, they do not supply grain food for the migrant flights. Experience has shown that large impoundments usually attract waterfowl during their spring and fall migrations. A waterfowl habitat improvement plan will be carried out around both reservoirs as part of the total Land Management Plan. Standard techniques will be utilized to provide food and additional nesting areas. This plan in all probability would be considered a significant contribution to the Broad River Waterfowl Plan. These areas are also compatible with good fish management procedures.

A review of the available information on the resident terrestrial wildlife indicates that no known unique or endangered species are present in this area.

2.3.6.3 Ecological Studies

To define the present characteristics of the project, an integrated program of study and evaluation involving a number of specific environmental monitoring and land management projects has been undertaken. The purpose of the monitoring programs is twofold: first, to establish baseline inventories and basic site characteristics and, second, to monitor these baseline inventories during construction and operation of the Summer Station in order to detect, and take corrective measures against, any unanticipated developments. The Land Management Program will make use of much of the data collected to insure that any adverse effects of construction and operation are minimized and that the natural environment is preserved and enhanced as much as practicable.

The environmental monitoring programs are discussed below and include:

1. Radiological Monitoring Program.
2. Meteorological Monitoring Program.
3. Biological Monitoring Program.
4. Hydrologic Monitoring Program.

These are followed by a discussion of the Land Management Program.

Radiological Monitoring Program - This program is designed to:

1. Determine the natural level of background radiation before Summer Station operation, against which all subsequent radiological data will be compared.
2. Verify the adequacy of Summer Station control of radioactive material.

3. Provide data for an evaluation of any radiological impact of the proposed facility on the human population and the biota.

4. Provide a source of data for public information.

Radionuclides exist in man's environment due to natural and man-made sources of radioactivity. Small amounts of radioactivity can be detected in all substances, organic or inorganic in origin. Extra-terrestrial radiation supplies another source of exposure to man, and since 1945, radioactive debris from the testing of nuclear weapons has been widely, but irregularly, distributed over the earth (fallout). Consequently, it is necessary to establish ambient levels of radio-activity, and the fluctuation of these levels, as well as to monitor the levels during Summer Station operation.

The radionuclides of primary concern are the fission products xenon-133, krypton-85, iodine-131, cesium-137, cerium-144, strontium-89, strontium-90, tritium and activation products consisting of cesium-134, isotopes of cobalt and tritium (cesium-134 is produced by fission product decay and neutron activation of stable cesium-133. Tritium is both a fission product and an activation product). The xenon and krypton are noble gases and will be found in the atmosphere. The remaining radionuclides may be found in the water and, to a lesser degree, in the atmosphere. Pathways by which these radionuclides may reach man are described in Section 2.3.7.3. These pathways have been considered in the design of the Radiological Monitoring Program.

The pre-operational program will begin two years before fuel loading of the Summer Station and will continue after start-up of the reactor.

Meteorological data will be evaluated together with demographic, hydrologic and topographic data to provide the necessary information for a determination of specific sampling sites.

Samples that will be collected and analyzed include surface water, fish and other aquatic biota, bottom sediments, airborne particulate, spring and well water, rainwater, crops and vegetation, milk, eggs and edible portions of poultry and wildlife. Integrated radiation doses from noble gases and natural background radiation will also be measured. The planned sampling program is summarized in Table 10. It may be modified as additional information becomes available concerning radionuclides released, concentration factors, and critical pathways to man.

Surface water will be collected monthly from Lake Monticello, Parr Reservoir and the Broad River above and below Parr Reservoir. A drinking water sample will be collected from the Columbia Water Works. These samples will be analyzed for gross beta and tritium. If gross beta exceeds 10 pCi/liter, the sample will be analyzed by gamma spectroscopy. Aquatic biota, including fish, will be collected semi-annually in the same general locations as water samples, except the Columbia Water Works. These samples will be analyzed by gamma spectroscopy. Fish samples ill also be analyzed for total radiostrontium and radiocesium.

It is known that aquatic organisms have the ability, either themselves or by means of their ingestion of other organisms, to concentrate certain stable elements, inorganic compounds, and radionuclides above the ambient concentrations in a fresh water environment. It can therefore be anticipated that a critical pathway eventually leading to man could exist through human consumption of edible fish from Lake Monticello, Parr

TABLE 10

ENVIRONMENTAL RADIATION MONITORING PROGRAM

Environmental Media	Description of Sampling Site(s)	Analysis and Frequency
Surface Water	1. Broad River near Blair (above Summer Station) 2. Broad River at Richtex (below Summer Station) 3. Broad River at the Columbia Water Works 4. Lake Monticello (near plant outfall) 5. Parr Reservoir	Gross beta and tritium monthly. Gamma isotopic analysis if gross beta exceeds 10 pCi/liter.
Aquatic Biota	1. Broad River at Blair 2. Broad River at Richtex 3. Lake Monticello 4. Parr Reservoir	Gamma isotopic analysis and Sr activity semi-annually. Cs activity semi-annually.
Bottom Sediment	Same as for Aquatic Biota	Gamma isotopic analysis and Sr-90 semi-annually.
Air Inhalation (low volume)	1. Nearby schools 2. East a. Site boundary b. Approximately 5 miles from release point c. Winnsboro 3. West a. Approximately 5 miles from release point b. Newberry 4. Columbia 5. Summer Station	Gross beta weekly. Gamma isotopic analysis if gross beta exceeds 1 pCi/m^3. I-131* monthly on charcoal cartridges.
(high volume)	Intermittent	As need indicates.
Air Immersion Dose (Radiation)	1. North, East, South and West at site boundary 2. At all low volume sampling locations	Integrated radiation dose - TLD badges exchanged quarterly.

* To begin three months before reactor start-up.

TABLE 10 (cont.)

ENVIRONMENTAL RADIATION MONITORING PROGRAM

Environmental Media	Description of Sampling Site(s)	Analysis and Frequency
Ground Water	1. From wells and springs selected from measurements of ground water conditions after filling of Lake Monticello. 2. One well west of Broad River	Gross beta annually. Gamma scans if gross beta exceeds 10 pCi/liter
Rainwater	At several low volume sampling locations	Tritium monthly.
Crops and Vegetation	From farms within 15 miles of site	Samples will be collected seasonally or at the time of harvest for gamma isotopic analysis, Sr-89 and Sr-90.
Milk	1. East - There are no dairy herds in this direction so a cow from a nearby farm will be selected. 2. North-Northeast - From dairy herds located approximately 10 miles from site. 3. West - From dairy herds located approximately 10 miles from site. 4. South-Southwest - From dairy herds approximately 8 miles from site in Newberry and Lexington Counties.	I-131* monthly. Sr-89, Sr-90 and total radiocesium on quarterly composites.
Animal	1. Rabbit - Within the exclusion area 2. Poultry Products - From Newberry County within 5-15 miles.	Meat and egg samples for Cs-137 semi-annually. Bone and egg samples for Sr-90 semi-annually.
Soil	Same as Crops and Vegetation	Sr-90, Cs-137 and Cs-134 annually.

* To begin three months before reactor start-up.

Reservoir or the Broad River. In order to estimate potential doses that could be received by an individual from ingestion of food containing trace quantities of radionuclides, a ratio of the concentration of a specific radionuclide in a given species to that in the ambient environment must be known. Much of the data that is available is based on stable nuclides in fish and water and these data have been used in evaluation of pathways to man. Additional information will be reviewed as it becomes available to obtain the most recent "concentration factor" data on selected radionuclides, especially cesium-137 which already exists in the Parr Reservior-Broad River environment as a result of world-wide fallout. If necessary, the evaluation of pathways will be revised based on data obtained in Parr Reservoir and the Broad River.

Bottom sediments will be collected semi-annually at the same locations as aquatic biota. These will be analyzed radiochemically for total radiostrontium and by gamma spectroscopy for cesium-137, cesium-134, cerium-144 and other gamma emitters.

Atmospheric monitoring will include the collection of airborne particulate material on filters designed to collect over 99% of all particles in the air that we breathe. These filters will be exchanged weekly and analyzed for gross beta radioactivity. If gross beta exceeds 1.0 pCi/m^3, the filter will be analyzed by gamma spectroscopy in an effort to identify major radionuclides present.

Charcoal cartridges will be added behind the particulate filters three months prior to reactor start-up. These cartridges will trap iodine-131, including methyl iodide. The cartridges will be replaced with new cartridges monthly.

Solid lithium fluoride thermoluminescent dosimeters (TLD) will be used to measure air immersion dose from gaseous releases. Each packet will contain five 1/8" x 1/8" x 0.035" TLD sealed in plastic, 35 mg/cm^2 thick. These will be exchanged quarterly for reading. Pre-operational data will be used to establish "background" levels at each location. Operational effects will be measured comparing readings after start-up of the reactor with pre-operational background levels. Additional comparison will include close in stations vs more distant stations.

Permeability of subsurface materials is low which results in slow movement of ground water. Samples of water from selected wells and springs will be obtained from sources lying in the path of this slow moving ground water flow (down gradient). Precise locations will be based on the results of measurements of ground water conditions after impoundment of Lake Monticello. These will be analyzed annually for gross beta. If gross beta exceeds 10 pCi/liter, the sample will be analyzed by gamma spectroscopy.

The primary purpose in collecting rainwater is to measure tritium in atmospheric moisture. If the concentration in moisture is known, the concentration in the air can be calculated from relative humidity and temperature readings. These samples will be collected monthly.

Small grain crops and pasture grass will be collected from agricultural areas near the site. These will be collected seasonally or at the time of harvest, as appropriate. The sample will be analyzed by gamma spectroscopy for iodine-131, cesium-137, cesium-134 and other gamma emitters then an aliquot will be analyzed by radiochemistry for strontium-89 and strontium-90.

Milk samples will be collected quarterly for determination of strontium-89, strontium-90 and total radiocesium (cesium-137 plus cesium-134). No attempt will be made to separate cesium-137 from cesium-134 unless unexpected high levels are measured which will permit identification of each isotope by gamma spectroscopy. Beginning three months before reactor start-up, the sampling schedule will be increased to monthly intervals for determination of iodine-131 and other gamma emitters.

A wild rabbit will be obtained semi-annually within the exclusion area. Poultry products will be collected semi-annually from Newberry County within 5-15 miles of the site. Flesh and egg samples will be analyzed for radiocesium with separate values for cesium-134 and cesium-137 reported if sufficient activity is present to permit identification. Egg and bone samples will also be analyzed for radiostrontium.

Meteorological Monitoring Program

An on-site monitoring program will be conducted to: provide meteorological data for the other environmental monitoring programs (radiological, biological and hydrological); evaluate the effects of Lake Monticello on the microclimatology; and to evaluate the diffusion characteristics of the atmosphere at the Summer Station site.

A meteorological tower approximately 200 feet high will be installed at the site. Instruments will be mounted on the tower at three levels. The upper level will be approximately 198 feet above the base of the tower; the middle and lower levels will be selected so that Lake Monticello effects and other influences on the diffusion climate are adequately monitored. Wind speeds, direction, directional deviation and temperature measurements will be taken at each level; dewpoint measurements will be taken at the upper and lower levels. A recording rain gauge will be installed near the base of the tower, and the water surface temperature of Lake Monticello will be measured in the vicinity of the tower. Instrumentation will include additional air temperature sensors at selected locations so that the stabilizing or destabilizing influences of Lake Monticello can be evaluated. A continuous record of data will be compiled, and periodic reports will be prepared summarizing and evaluating the data.

Biological Monitoring Program

A Biological Monitoring Program will be conducted in the Parr and Monticello Reservoirs to assess the ecological impact of construction and operation of the Summer Station and Fairfield Pumped Storage facilities. Although some aspects of the program apply to only one of the facilities, many aspects are common to both projects.

Primary emphasis will be placed on any species representing a unique group and on species important from a sport or commercial standpoint. Lower food chain organisms will also be studied. Specifically, the program is designed to:

(1) Document the present biological characteristics of site environs.

(2) Provide a basis for selecting measures which could minimize any projected adverse effects (including thermal, chemical, radiological, biological, hydrological and mechanical effects).

(3) Evaluate the effects of construction and operation of the proposed facilities on the biota.

The program will be conducted in two phases, pre-operational and operational. The principal objective of the pre-operational phase will be to provide baseline information on the various aquatic and terrestrial biota in the site environs. Objectives of the operational program will be to identify and evaluate changes in the baseline characteristics as a result of construction and operation of the facilities.

The aquatic portion of the pre-operational monitoring program is presently underway. The program consists of the following:

(1) Collection of fish samples at various points on the Broad River,

(2) Collection of samples of the various bottom types in the river (Benthos),

(3) Collection of plankton for identification and counting,

(4) Field and laboratory examination of species collected to aid in identification, estimation of age and growth rates, determining pertinent population parameters, and evaluating other taxonomic characteristics.

The pre-operational terrestrial biological monitoring program involves a habitat classification and wildlife survey. This program commenced in June, 1971. Habitat classification consists of mapping the various vegetative types in the site environs. Care is taken to note and evaluate any enhancement potential arising during the conduct of the study. Particular emphasis is placed on potential waterfowl habitat development. The wildlife survey will consider the more predominant forms of both vertebrate and invertebrates.

The operational biological monitoring program will involve Lake Monticello in addition to the Parr Reservoir sampling and taxonomic work similar to the pre-operational program and will include the following:

(1) Specific studies to evaluate the effects of the various facility operations on the aquatic organisms,

(2) Tagging and studying of key species in order to evaluate the impact of the project on the life history of these species,

(3) An evaluation of the changes in ecological conditions as compared to the baselines established in the pre-operational program.

Quarterly or seasonal (migration and spawning) wildlife and fish samples will be taken. The proposed aquatic sampling locations are shown on Plate 8. Sampling points may be relocated to conform with seasonal requirements as determined by the results of the program as it progresses.

Details of the Biological Monitoring Program are presented in Table 11, Biological Monitoring Plan. This table outlines the tentative frequency, number and location of sampling stations.

Hydrologic Monitoring Program

The Hydrologic Monitoring Program will include surface water and groundwater physical and chemical measurements.

The purposes of the surface water monitoring program will be to:

(1) Evaluate the baseline physical and chemical characteristics of Broad River and Frees Creek before and during construction,

(2) Monitor the quality of the water in Lake Monticello, Parr Reservoir and the Broad River after construction,

(3) Compare the quality of water in the lake, reservoir and river with applicable standards to assure compliance with regulations,

Hydrological

(4) Provide data for an evaluation of the impact of the project on the aquatic biota.

Both pre-operational and operational programs will be conducted. The pre-operational program will include two continuous recording stations which will be located so that information can be obtained from the same stations before and during construction and during operation. Tentatively, these stations will be located near the mouth of Frees Creek and approximately five miles upstream from Parr Dam on the Broad River. These stations will monitor temperature, dissolved oxygen, conductivity, pH and turbidity. The pre-operational program will also include six periodic sample locations. Bottle samples will be taken at all locations on a monthly basis to verify the recorder results and provide a more complete analysis. Radiological analyses will be performed on selected samples as discussed in the Radiological Monitoring Program. The sample locations will tentatively be located as follows:

Frees Creek - Two Samples: A station one mile upstream from the mouth of the creek and one approximately two miles upstream.

Broad River - Four Samples: One approximately one-half mile upstream, one approximately three miles upstream, one five miles upstream, and one approximately one mile downstream from Parr Dam.

Analyses to be performed on bottle samples are outlined in Table 12, Hydrologic Monitoring Program.

The operational program will comprise a continuation of the pre-operational program, with deletion of the Frees Creek stations and the addition of new stations to correspond to the project development. The program will be implemented in stages as the project progresses.

After Lake Monticello is filled, a continuous recording station will be installed in the vicinity of the pumped storage inlet which will monitor the quality of water in the lake and record temperature, dissolved oxygen, conductivity, pH and turbidity.

Three sampling stations, in addition to the continuous recording station, will be established in Lake Monticello. Monthly measurements of temperature and dissolved oxygen at 10 foot depth intervals will be taken at these stations.

Biological evolution will probably occur within Lake Monticello. In order to evaluate the trophic condition of the lake, quarterly analyses of selected bottle samples will be made for total nitrogen, ammonia nitrogen nitrate, nitrogen, total phosphorus, orthophosphate, and biochemical oxygen demand (BOD).

After construction of the Summer Station is complete, continuous recording stations will be installed near the condenser intake and discharge. These stations will provide data on the temperature and dissolved oxygen content of the water passing through the condensers.

The ground-water monitoring program will provide data on the physical and chemical properties of the ground-water in the site vicinity. Samples will be taken at various springs and wells in the vicinity of the project. The exact number and location of these samples will be determined in the field, but it is estimated that at least eight points will be sampled. Water quality samples will be collected and subjected to laboratory analyses; water level and spring flow measurements will be made quarterly.

Land Management Program

The purpose of the Land Management Program will be to alleviate any adverse effects of construction on the natural environment and to preserve or enhance the natural environment of the land controlled by SCE&G. The program will include improvement of the aesthetic qualities of the site and, to the extent practicable, provide for recreational development in those areas that are not restricted from public use. The Land Management Program will be fully integrated with overall facility planning, currently underway and planned monitoring programs, and ecological studies that may be undertaken as the result of SCE&G's continuing assessment of environmental considerations.

The SCE&G's Land Management Program will consist of several individual programs which include:

(1) Erosion Control - A program will be instituted by the site construction management involving the preservation of temporary or permanent ground cover or other techniques to control erosion during construction, and on land areas along access roads and

transmission lines. Control measures during construction will also include the scheduling of clearing and grading operations in order to minimize the period of time during which the soil surface is exposed and most susceptible to erosion. The procedures utilized will be integrated with the Wildlife Management and Landscape Programs so as to obtain the greatest enhancement benefits.

(2) Timber Management - A program will be conducted on SCE&G lands in order to develop and utilize the forest potential. This program will consider the multipurpose use of these lands for forestry, wildlife, and recreation. It will be integrated with the Wildlife Management and Recreational Programs. The options that SCE&G has with the present property owners reserve to them the right to remove the present timber within a stated period of time.

(3) Wildlife Management - This program will include the improvement of wildlife habitat through selective plantings of food and cover species in conjunction with conservation agencies, particularly in cleared and idle buffer areas. Suitable areas may be developed and set aside as wildlife refuges depending on the results of ecological studies.

(4) Recreational Potential - A study will be made to determine the recreational potential of the project area. Recreational facilities and activities compatible with the area needs, normal station operations, and public safety will be developed.

(5) Lake Management - Lake Monticello will be designed as a multipurpose reservoir so that its recreational potential may be realized. A portion of the lake will not be affected by the daily water level fluctuations, and will be suitable for natural fishery development.

(6) Landscaping - Environmental landscaping will be utilized to improve the aesthetic qualities of the area. This program will be integrated with the other Land Management programs to insure maximum benefit. Maximum utilization will be made of the native vegetation, with formal landscaping confined to the immediate Summer Station site area.

These programs will be designed and initiated where possible in cooperation with programs presently being conducted by various governmental conservation agencies.

TABLE 11

BIOLOGICAL MONITORING PROGRAM

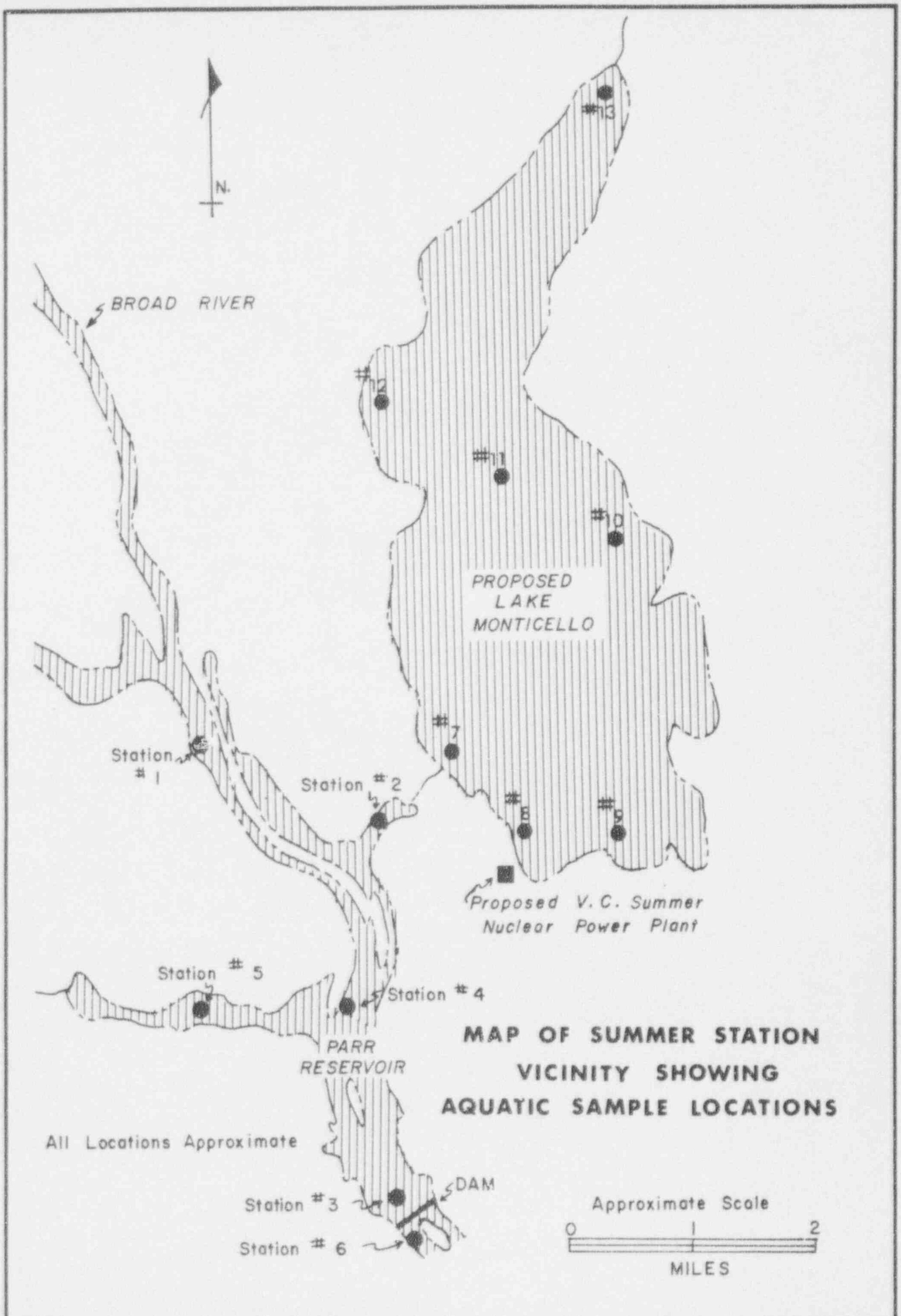
PROGRAM	VECTOR OR INDEX	FREQUENCY OF SAMPLING	ANALYSIS	LOCATION[1]
Aquatic	Fish	Quarterly	Species inventory, population composition, age growth rates, condition factors and life cycles of important game species.	Stations 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, and 13
	Plankton	Quarterly	Quantitative and qualitative analysis of phytoplankton and zooplankton. Development of food web relationships and indicator organisms.	Stations 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, and 13
	Benthos	Quarterly	Same as plankton	Same
Terrestrial	Habitat	Quarterly	Classification and mapping of vegetative types correlated with soil studies.	Project Area
	Wildlife	Quarterly	Species inventory, population trends, life cycle and home range of important game species.	Project Area

NOTE: 1. Refer to Plate 8 .

TABLE 12

HYDROLOGIC MONITORING PROGRAM

Frequency Of Sampling	Vector or Index	Analysis	Location
Continuous	Surface Water	Dissolved Oxygen Temperature Turbidity Conductivity pH	1. Near mouth of Frees Creek 2. Five miles upstream of Parr Dam 3. Lake Monticello near pumped storage intake
Continuous	Lake Monticello Water	Temperature Dissolved Oxygen	1. Summer Station intake and discharge
Monthly for pre-operational and for first year operational. This frequency may be reduced with time	Surface Water (laboratory analysis)	Temperature Carbon Dioxide (CO_2) pH Dissolved Oxygen (O_2) Total Dissolved Solids (TDS) Conductivity Total Alkalinity ($CaCO_3$) Total Hardness ($CaCO_3$) Chloride (Cl) Sulfate (SO_4) Silica (SiO_2) Iron (Fe) Calcium (Ca) Magnesium (Mg) Sodium (Na) Phosphate (PO_4) Ammonia (NH_3) Nitrate (NO_3) Nitrite (NO_2) Biochemical Oxygen Demand(BOD) Chemical Oxygen Demand (COD) Mercury (Hg)	1. Both continuous recording stations 2. 2 samples on Frees Creek (pre-operational), 1 & 2 miles upstream from Broad River 3. 4 samples on Broad River ½, 3 & 5 miles upstream & 1 mile downstream from Parr Dam 4. 3 stations in Lake Monticello (operational)
Quarterly	Ground-Water	Same as monthly surface water	Springs & wells, at least 8 locations; piezometers
	Lake Monticello	Total Nitrogen Ammonia Nitrogen Nitrate Nitrogen Total Phosphorus Orthophosphate BOD	3 stations in Lake Monticello



MAP OF SUMMER STATION VICINITY SHOWING AQUATIC SAMPLE LOCATIONS

PLATE 8

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SUMMER STATION DEVELOPMENT SCHEDULE

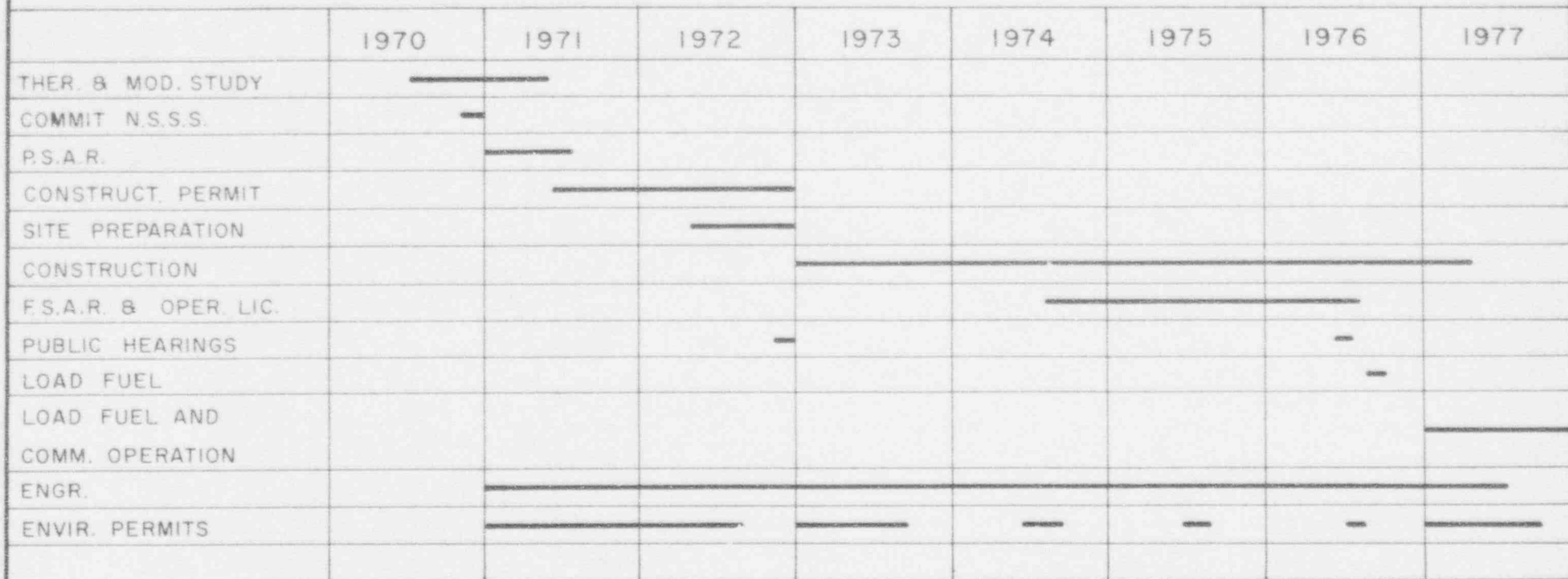


PLATE 15

2.3.7 Radioactive Discharges

2.3.7.1 Description of the Radioactive Waste Processing System

The Westinghouse Environmental Assurance System (EAS) will be used to process radioactive wastes and represents the most recent technology. As such, SCE&G believes that the EAS meets the criterion of "as low as practicable" as given in 10 CFR 50. The EAS is designed to assure that the quantities of radioactive releases from the Summer Station to the surrounding environment will not exceed a small fraction of the 10 CFR 20 limits. Two main systems of the EAS are the Liquid Waste Processing System and the Gaseous Waste Processing System. These are shown in Plates 9 through 14 and are discussed below along with the Station's Solid Waste Processing System.

Liquid Waste Processing System - The Liquid Waste Processing System will collect and process potential radioactive wastes for reuse or release. Provisions will be made to sample and analyze fluids before any discharges take place and based on the laboratory analysis, these wastes will be either retained for further processing or released under controlled conditions to the penstock of the Fairfield Dam. A permanent record of liquid releases will be provided by analyses of known volumes of waste. The system will be capable of processing wastes generated during operation of the reactor coolant system. The bulk of the radioactive liquids discharged from the reactor coolant system will be processed and retained by the Boron Recycle System. This will limit liquid input to the Liquid Waste Processing System and result in the processing of relatively small quantities of generally low-active level wastes.

The liquid Waste Processing System will be arranged to recycle as much reactor grade water entering the system as possible. This will be accomplished primarily by the segregation of equipment drains and waste streams which will prevent the intermixing of liquid wastes. The Liquid Waste Processing System will consist of two main sub-systems designated as Channel A and Channel B. Channel A will normally process all water which is to be discharged. A drain system will also be provided inside the containment to collect drains and leaks and transfer them to an appropriate tank.

Liquid releases to the environment are from either of the Waste Monitor Tanks or either of the Blowdown Monitor Tanks. Releases are sampled by a radiation monitor which will cause the closure of the discharge valve if the set point is exceeded. The released liquids are piped to the penstock of the Fairfield Dam where they are diluted by the water released through the dam during the generating portion of the pumped-hydro cycle. Planned liquid releases will be made only during the generating portion of the cycle. Releases are throughly mixed in the penstock and water wheels prior to entering the Parr Reservoir. Concentrations in the effluent from the penstock, assuming an annual average dilution flow of 3,380 cfs (21,900 cfs for eight hours per day, 169 days per year) of uncontaminated water are presented in Table 13 as "Initial Fraction MPC." During the pumping portion of the cycle, some of the fission and corrosion products released to the Parr Reservoir will be pumped up to the Monticello Reservoir. Continued operation of the cycle will cause concentrations in both reservoirs to increase over plant life. The theoretical maximum equilibrium concentration is the same as that concentration that would be obtained if liquid releases were diluted by a flow equivalent to the average flow of the Broad River. Thus, the column

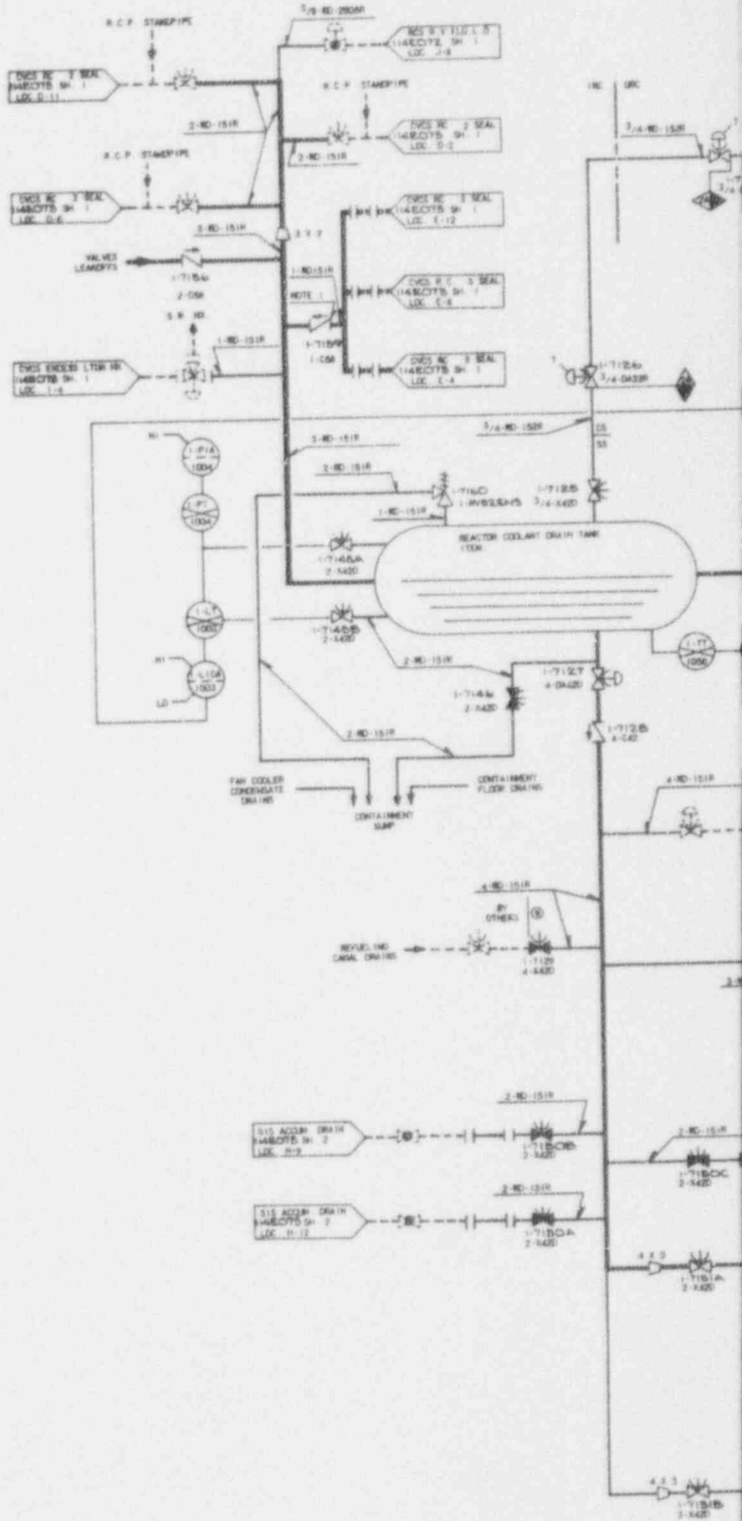
"Maximum Fraction MPC" in Table 13 was determined by assuming a dilution flow of 910 cfs.

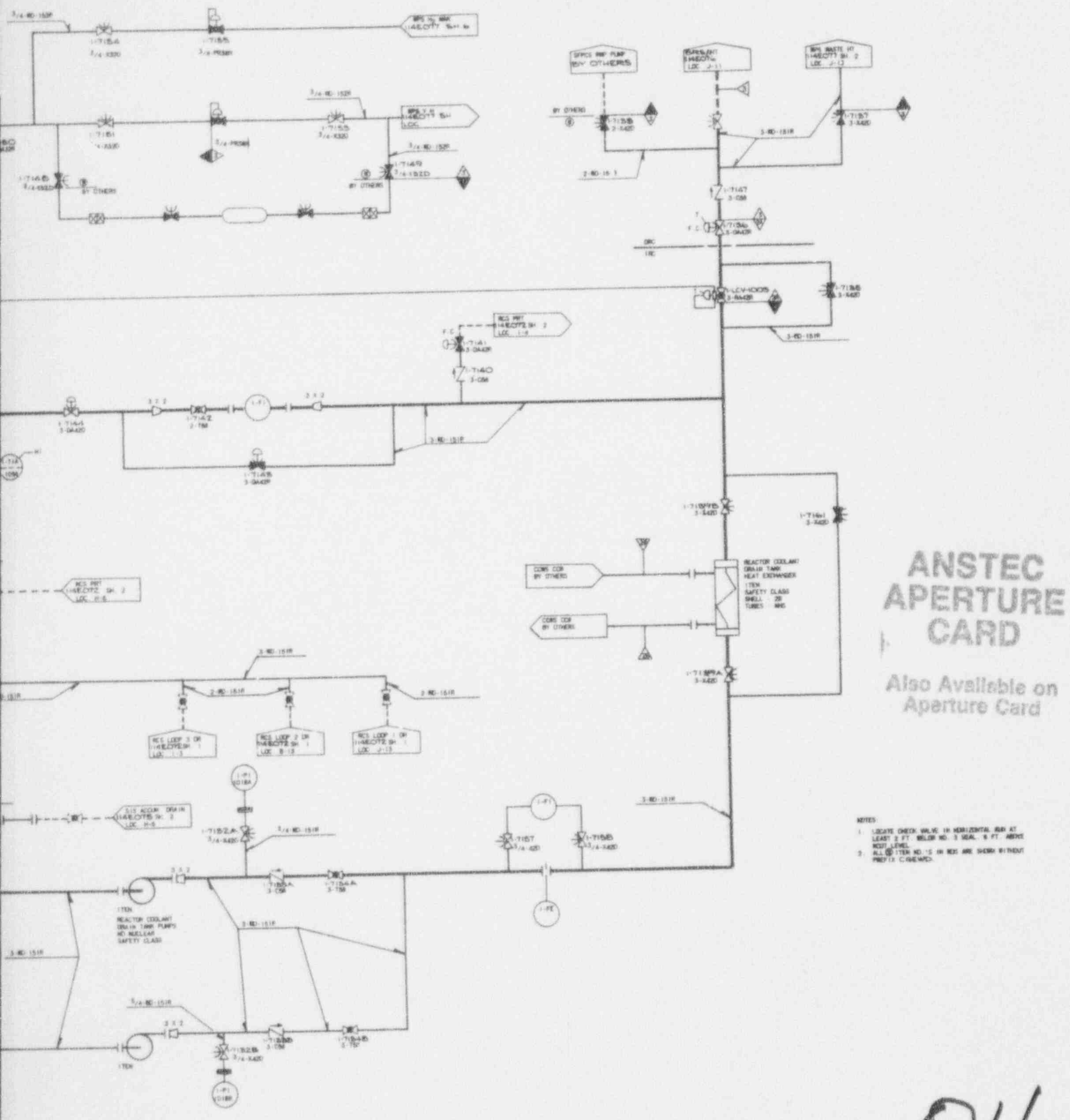
This flow is such that there is a 95 percent probability that the 30 day average flow in the Broad River will exceed it.

Alden Research Laboratories of the Worcester Polytechnic Institute will conduct a physical hydraulic model study of the Parr Reservoir-Monticello Reservoir - Broad River complex for South Carolina Electric and Gas Company to determine the dispersion and dilution characteristcs of the complex. Section 2.3.6.3 describes the environmental radiation monitoring program that will, among other things, determine the buildup of concentration in various segments of the complex and provide data to verify the model study as plant operation continues.

Channel A - Reactor Grade and Aerated Water Sources - Channel A will process all reactor grade water. This water will enter the Liquid Waste Processing System via equipment leaks and drains, valve leakoffs, pump seal leakoffs, tank overflows, and other tritiated and aerated water sources. Deaerated sources of tritiated water such as those from valve leakoffs will be collected in the reactor coolant drain tank and need not enter Channel A. These may be routed directly to the Boron Recycle System holdup tanks, part of the Chemical and Volume Control System.

The basic composition of the liquid collected in the waste holdup tank will be boric acid and water with some radioactivity. Liquid collected in this tank will be evaporated to remove radioisotopes, boron, and air from the water so that it may be reused in the reactor coolant system. Evaporator bottoms will be drummed unless found acceptable for boric


R.C.P. STANDPIPE
VALVES LEAKOFFS
REACTOR COOLANT DRAIN TANK
FAN COOLER CONDENSATE DRAINS
CONTAINMENT SUMP
CONTAINMENT FLOOR DRAINS
REFUELING CANAL DRAINS



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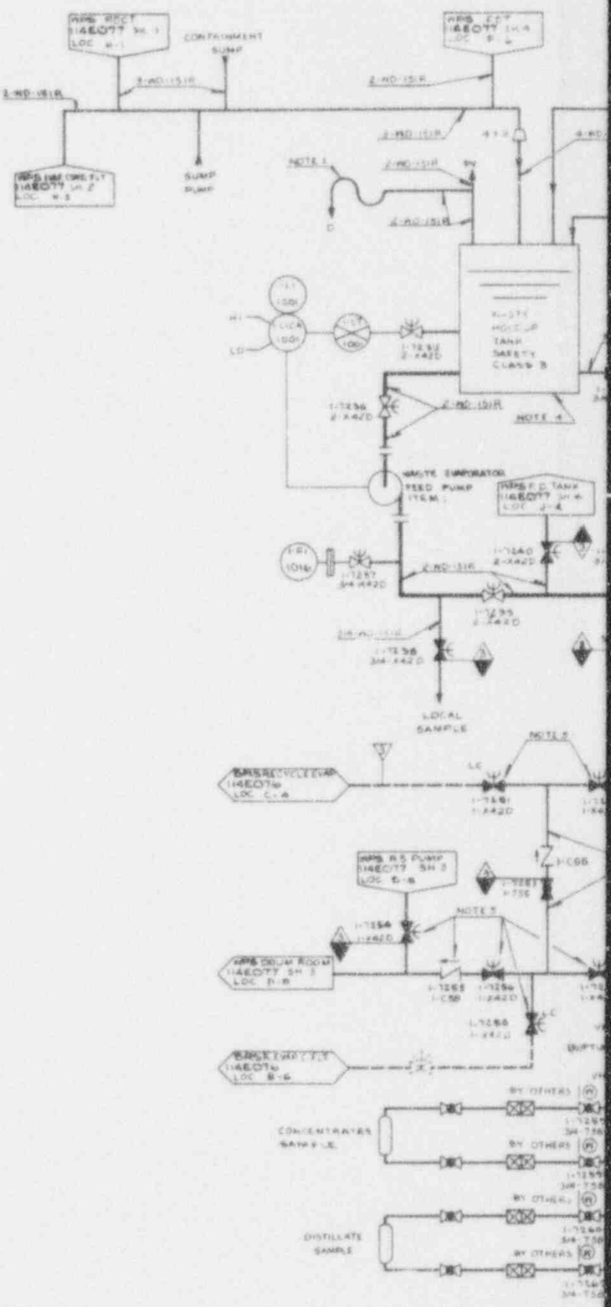
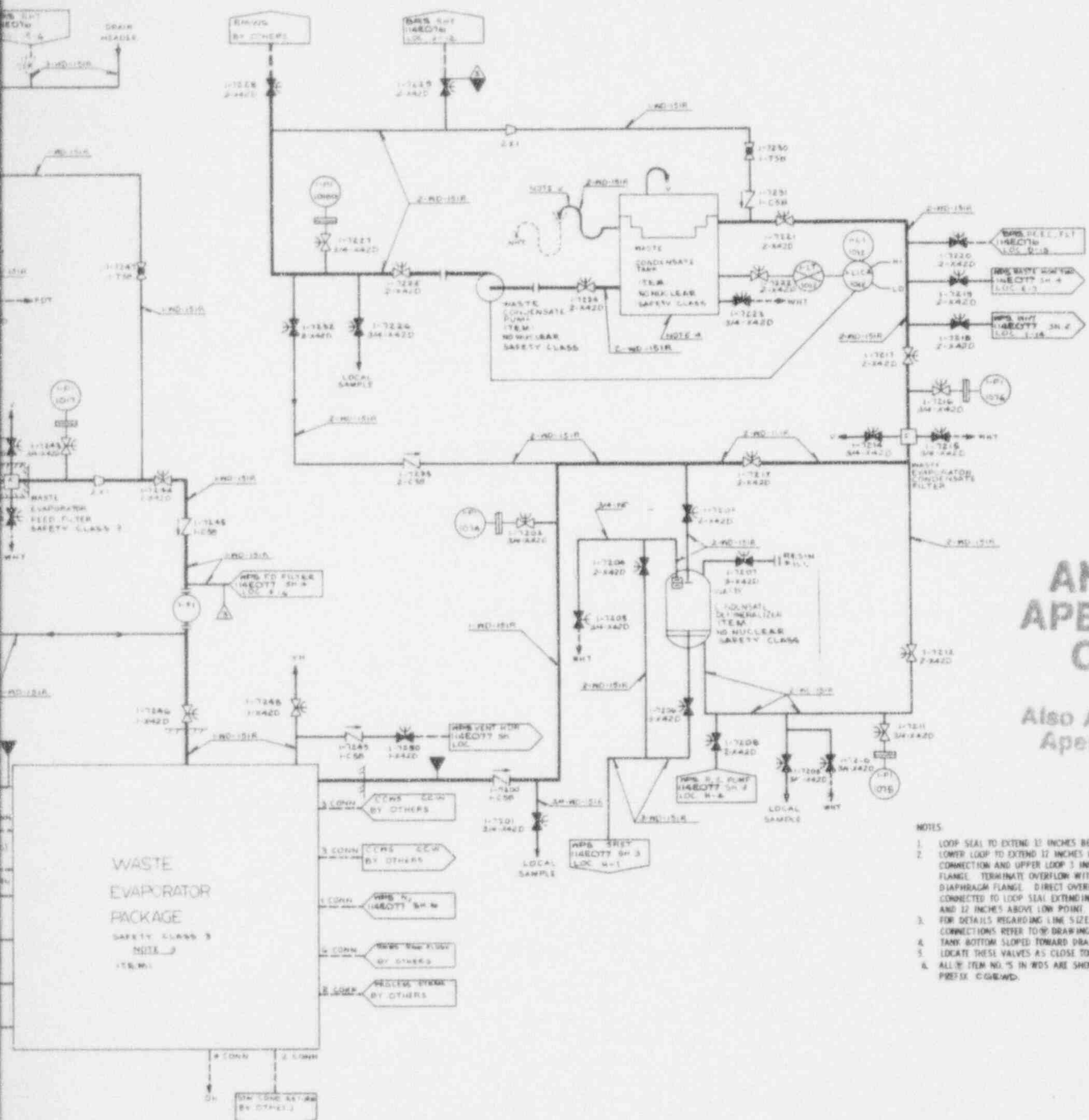
SUMMER NUCLEAR STATION
ENVIRONMENTAL ASSURANCE SYSTEM
PLATE 9


CONTAINMENT SUMP
SUMP PUMP
WASTE EVAPORATOR FEED PUMP
LOCAL SAMPLE
CONCENTRATES SAMPLE
DISTILLATE SAMPLE



NOTES:

1. LOOP SEAL TO EXTEND 12 INCHES BELOW & ABOVE PIPE.
2. LOWER LOOP TO EXTEND 12 INCHES BELOW OVERFLOW CONNECTION AND UPPER LOOP 3 INCHES BELOW DIAPHRAGM FLANGE. TERMINATE OVERFLOW WITHIN 12 INCHES OF DIAPHRAGM FLANGE. DIRECT OVERFLOW INTO FUNNEL CONNECTED TO LOOP SEAL EXTENDING 6 FEET BELOW FUNNEL AND 12 INCHES ABOVE LOW POINT.
3. FOR DETAILS REGARDING LINE SIZES AND NUMBER OF CONNECTIONS REFER TO DRAWING NOS. LATER & LATER.
4. TANK BOTTOM SLOPED TOWARD DRAIN.
5. LOCATE THESE VALVES AS CLOSE TOGETHER AS POSSIBLE.
6. ALL ITEM NO.'S IN WDS ARE SHOWN WITHOUT PREFIX CGEWD.

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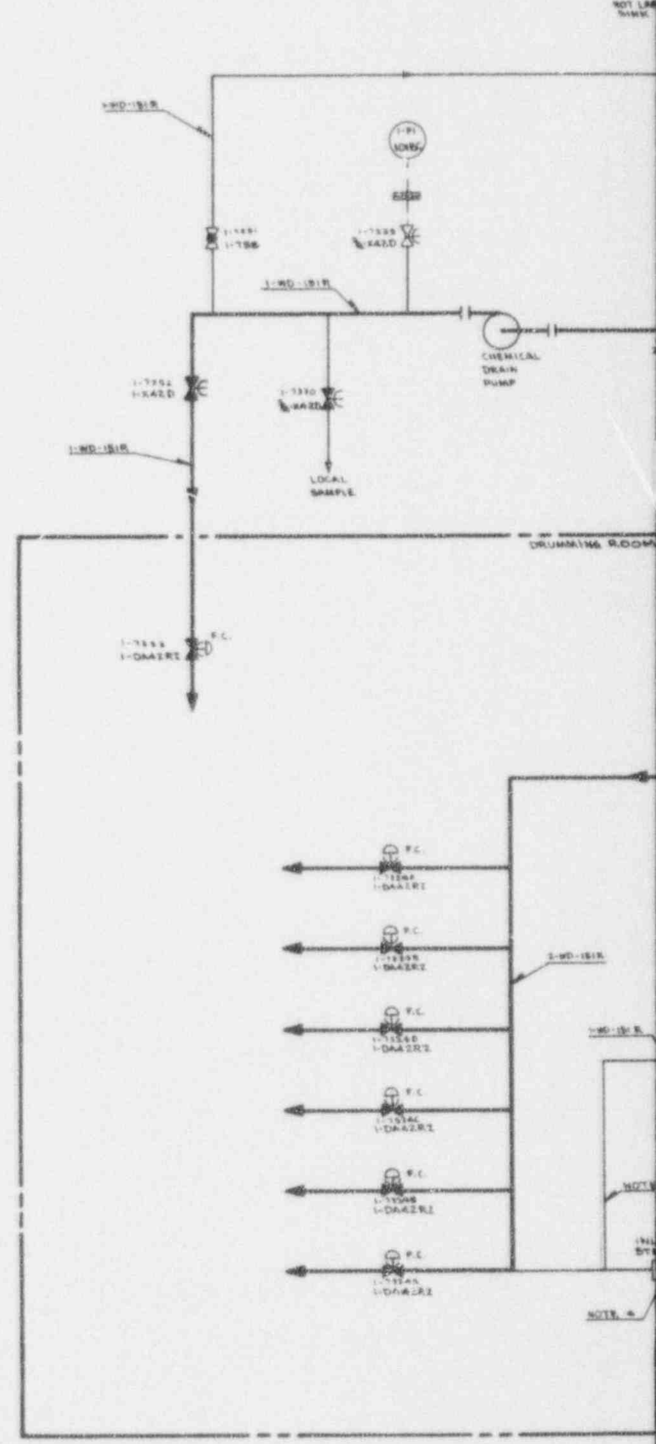
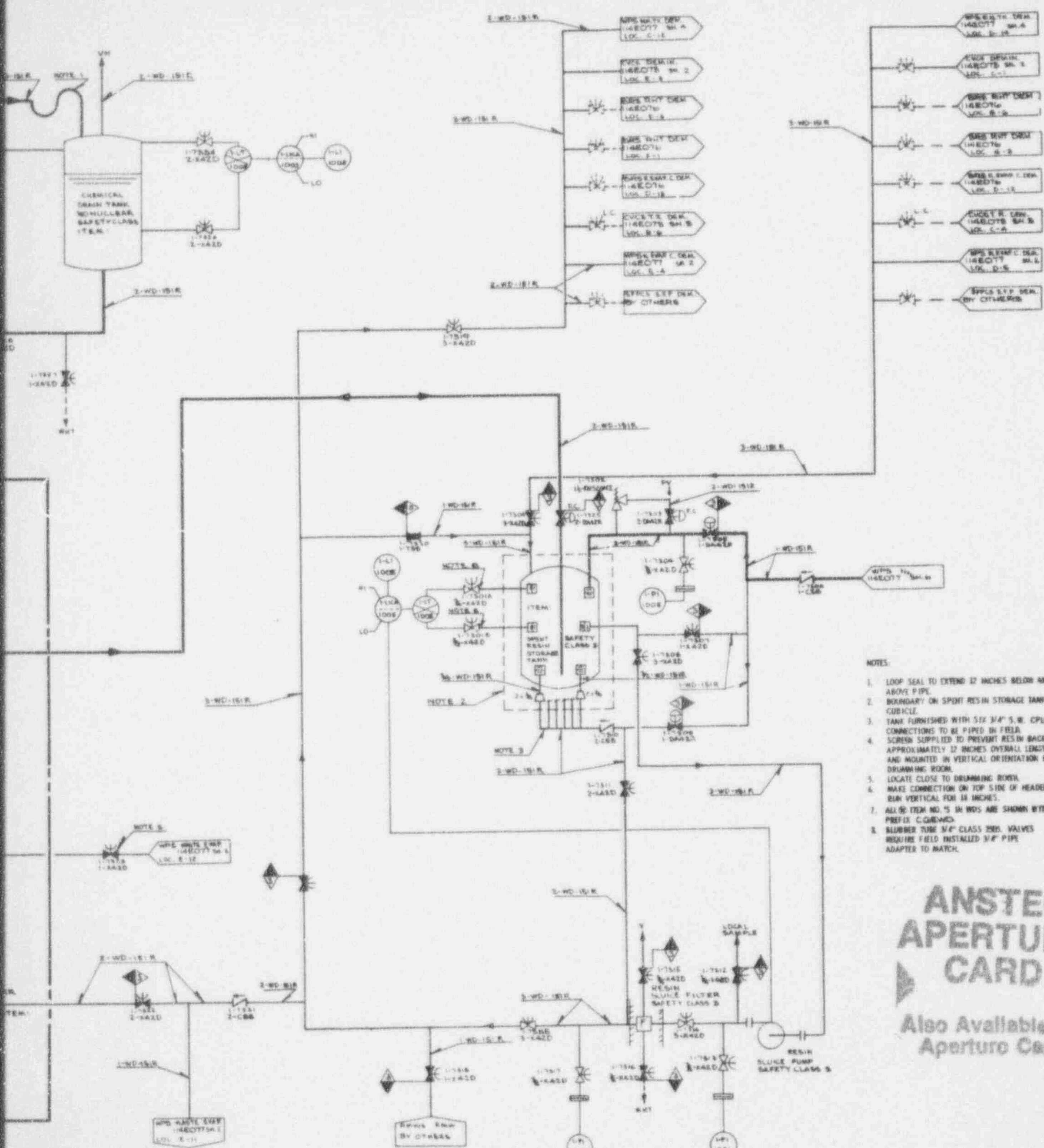
SUMMER NUCLEAR STATION
ENVIRONMENTAL ASSURANCE SYSTEM
PLATE 10


CHEMICAL DRAIN PUMP
LOCAL SAMPLE
DRUMMING ROOM



NOTES:

1. LOOP SEAL TO EXTEND 12 INCHES BELOW AND ABOVE PIPE.
2. BOUNDARY ON SPENT RESIN STORAGE TANK CUBICLE.
3. TANK FURNISHED WITH SIX 3/4" S.W. CPLG. SPARGER CONNECTIONS TO BE PIPED IN FIELD.
4. SCREEN SUPPLIED TO PREVENT RESIN BACK FLOW APPROXIMATELY 12 INCHES OVERALL LENGTH AND MOUNTED IN VERTICAL ORIENTATION INSIDE DRUMMING ROOM.
5. LOCATE CLOSE TO DRUMMING ROOM.
6. MAKE CONNECTION ON TOP SIDE OF HEADER, RUN VERTICAL FOR 18 INCHES.
7. ALL Ⓡ ITEM NO.'S IN WDS ARE SHOWN WITHOUT PREFIX C.G.E.WD.
8. BLUBBER TUBE 3/4" CLASS 2505. VALVES REQUIRE FIELD INSTALLED 3/4" PIPE ADAPTER TO MATCH.

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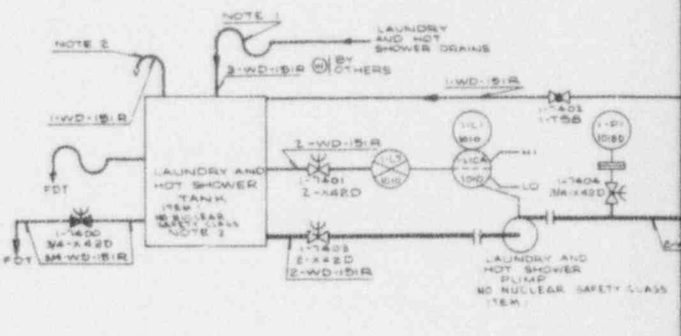
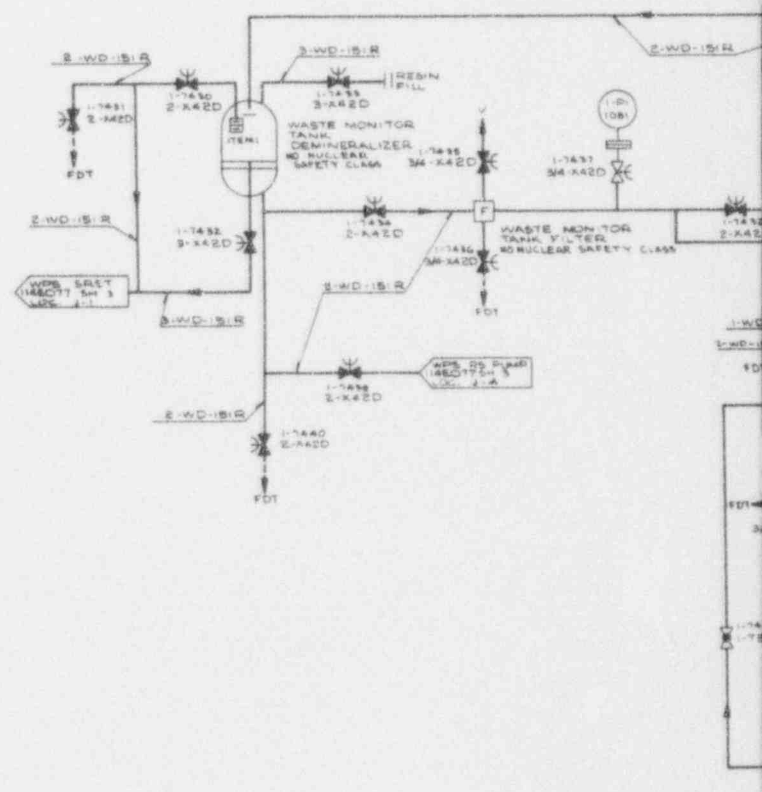
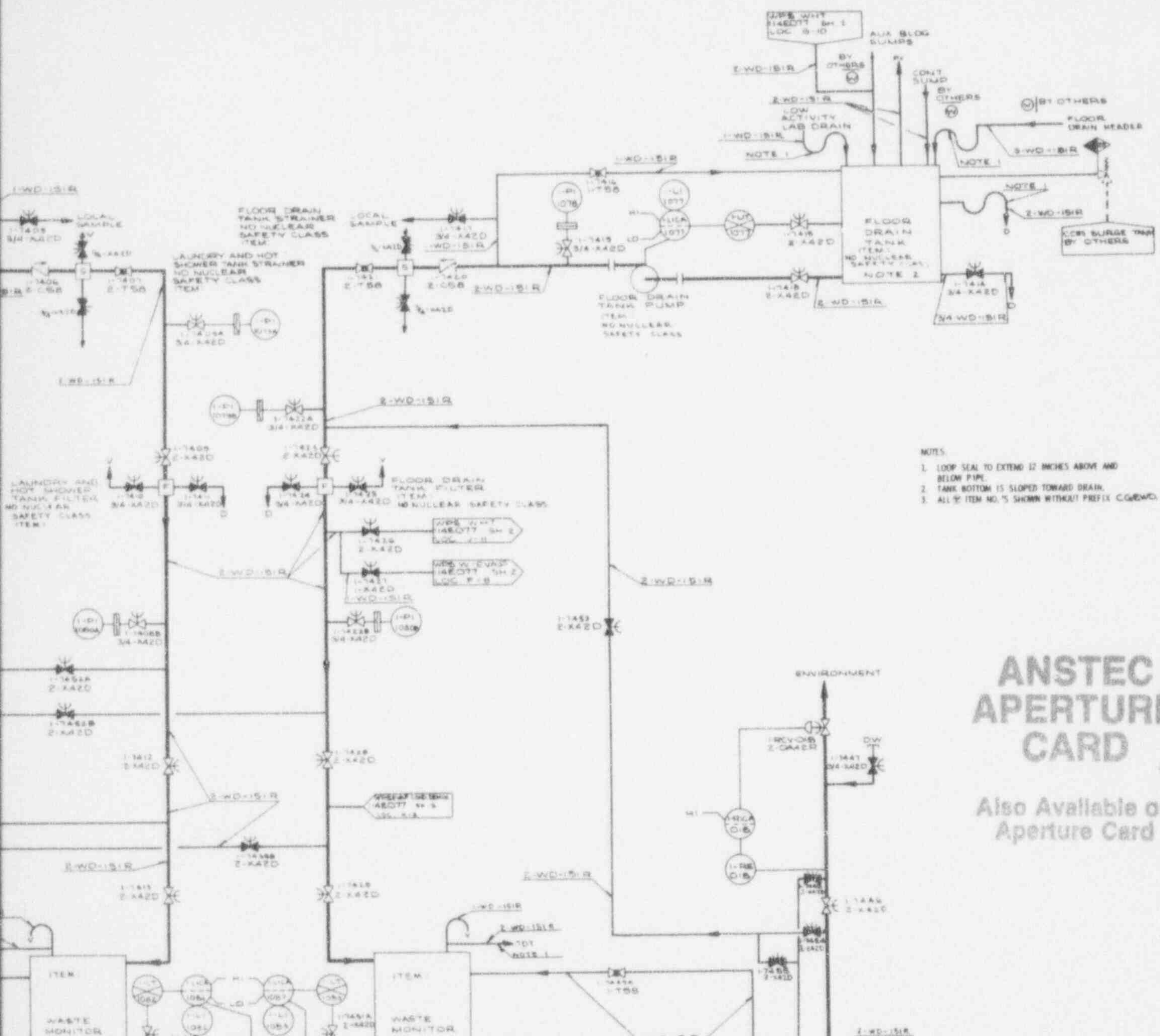
SUMMER NUCLEAR STATION
ENVIRONMENTAL ASSURANCE SYSTEM
PLATE 11


NOTE 1
NOTE 2
LAUNDRY AND HOT SHOWER DRAINS
3-WD-151R
BY OTHERS
1-WD-151R
1-WD-151R
FDT
LAUNDRY AND HOT SHOWER TANK
NOTE 2
1-7401
2-X42D
1-7404
3/4-X42D
1-7400
3/4-X42D
3/4-WD-151R
FDT
1-7403
2-X42D
2-WD-151R
LAUNDRY AND HOT SHOWER PUMP
NO NUCLEAR SAFETY CLASS
HI
LO


2-WD-151R
3-WD-151R
RESIN FILL
1-7430
2-X42D
1-7431
2-X42D
FDT
1-7433
3-X42D
WASTE MONITOR TANK DEMINERALIZER
NO NUCLEAR SAFETY CLASS
1-7435
3/4-X42D
1-7437
3/4-X42D
2-WD-151R
1-7432
3-X42D
1-7434
2-X42D
WASTE MONITOR TANK FILTER
NO NUCLEAR SAFETY CLASS
1-7436
3/4-X42D
FDT
3-WD-151R
2-WD-151R
1-7438
2-X42D
2-WD-151R
1-7440
2-X42D
FDT



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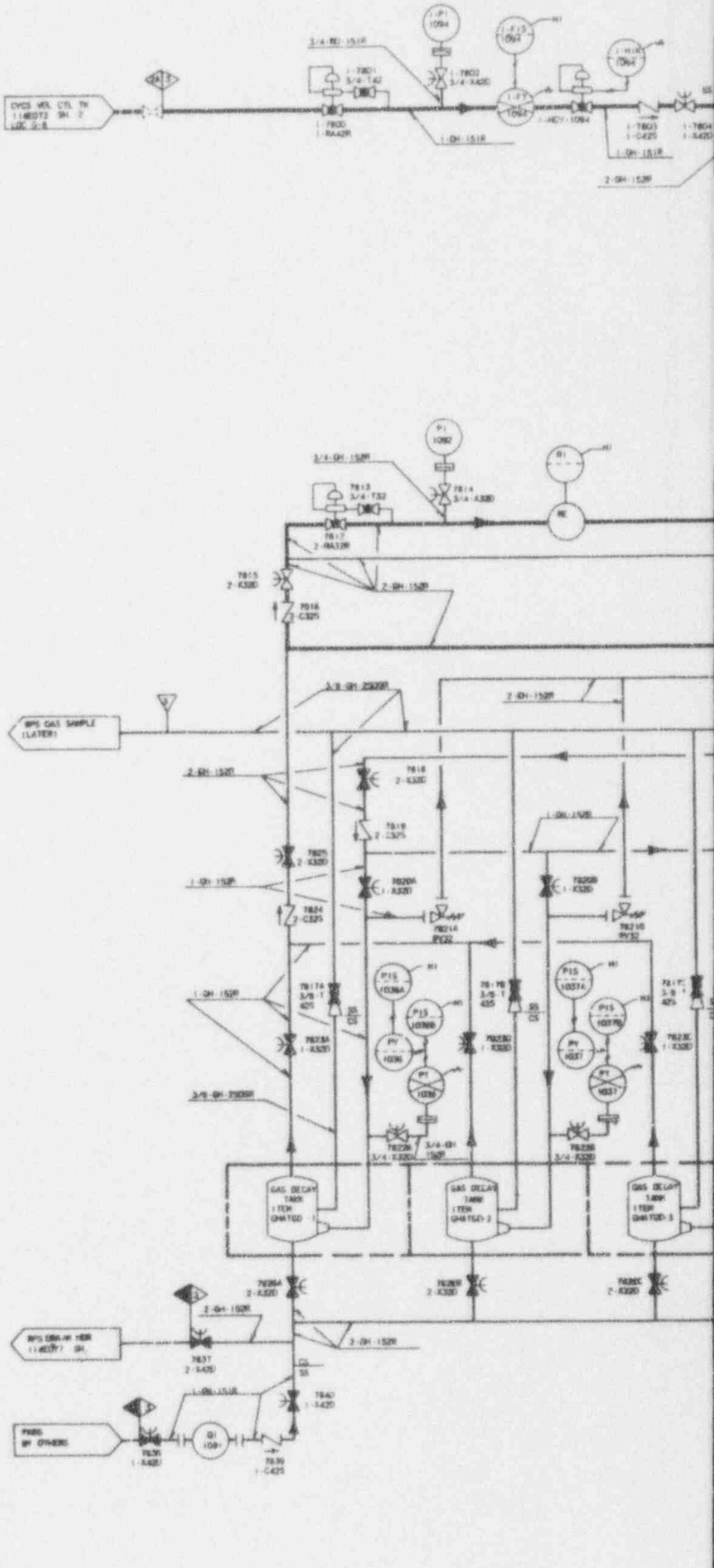
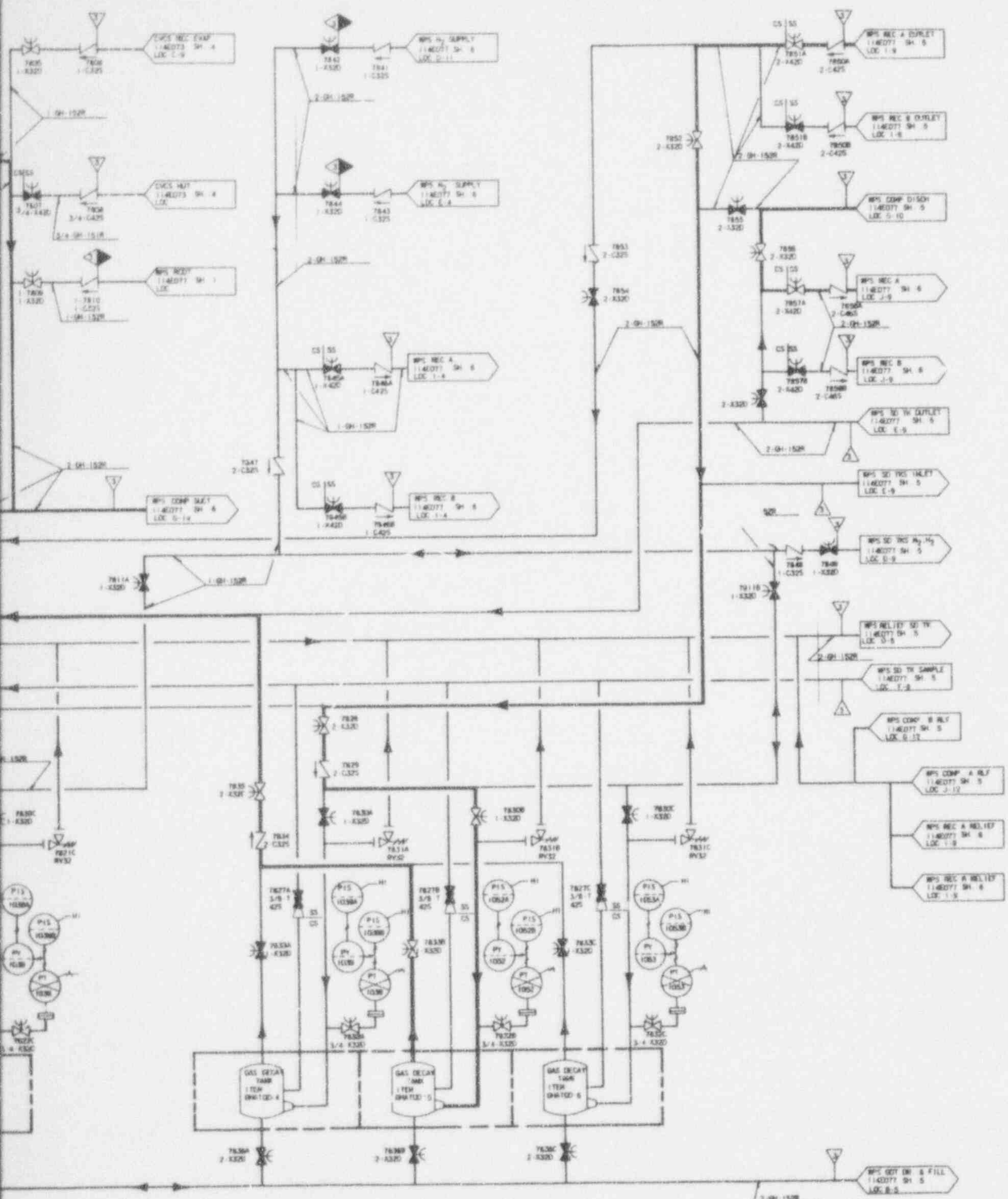
SUMMER NUCLEAR STATION
ENVIRONMENTAL ASSURANCE SYSTEM
PLATE 12



CVCS VOL CTL TK
BPS GAS SAMPLE (LATER)
GAS DECAY TANK
BPS DRAIN HDR
FROM BY OTHERS



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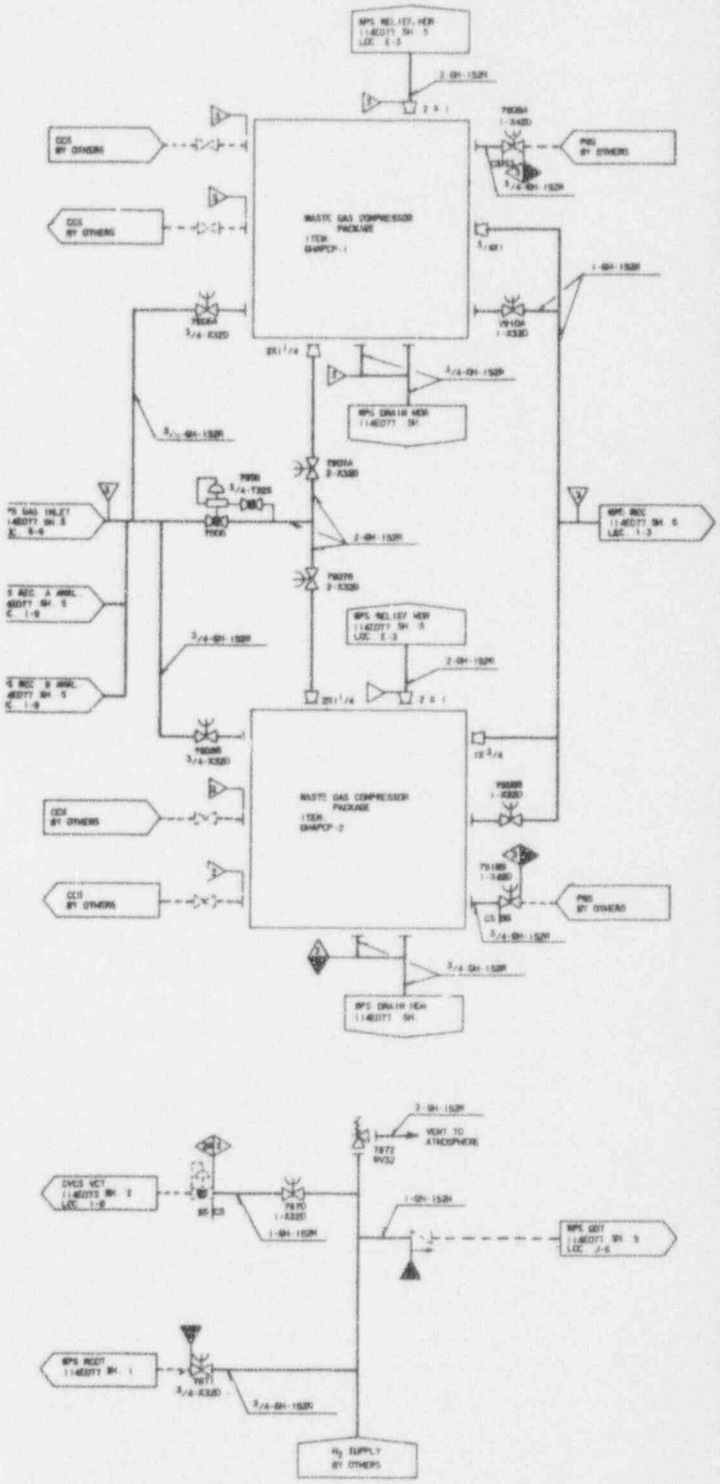
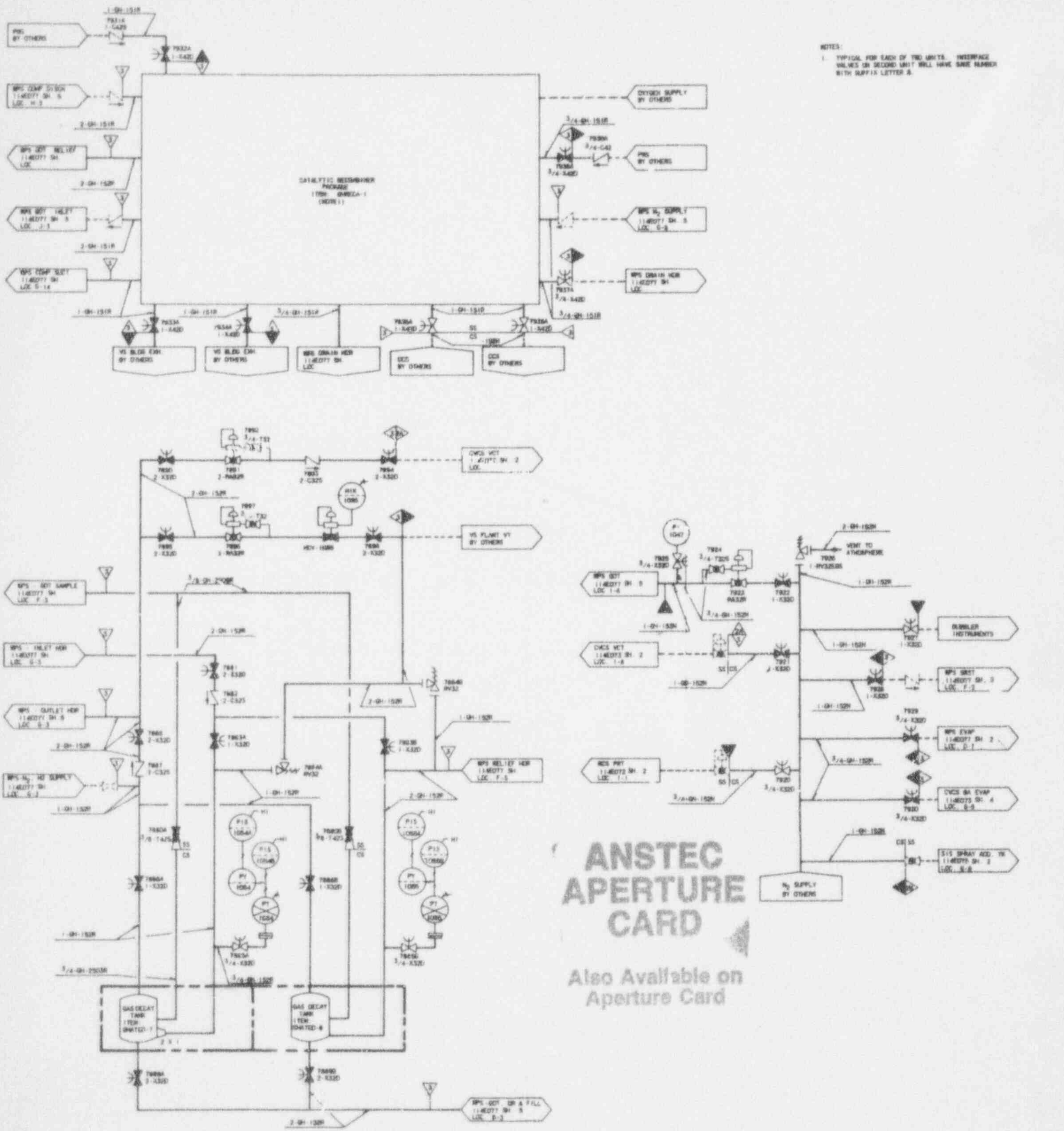
SUMMER NUCLEAR STATION
ENVIRONMENTAL ASSURANCE SYSTEM
PLATE 13


WASTE GAS COMPRESSOR PACKAGE
BY OTHERS
VENT TO ATMOSPHERE
H_2 SUPPLY
BY OTHERS



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SUMMER NUCLEAR STATION
ENVIRONMENTAL ASSURANCE SYSTEM
PLATE 14

acid recycle. The condensate leaving the waste evaporator may pass through the waste evaporator condensate demineralizer and then enter the condensate tank. When a sufficient quantity of water has collected in the condensate tank, it will normally be transferred to the reactor makeup water storage tank for reuse. Samples will be taken at sufficiently frequent intervals and analyzed to assure proper operation of the system to minimize the need for reprocessing. If a test sample indicates that further processing is required, the condensate may be passed through the waste evaporator condensate demineralizer or if necessary returned to the waste holdup tank for additional evaporation. The waste evaporator condensate tank will be supplied with a diaphragm to exclude air.

Channel B - Non-Reactor Grade Water Sources - Channel B will collect and process non-reactor grade liquid wastes from floor drains, equipment drains, sink drains, laundry and hot shower drains, and other non-reactor grade sources. Channel B equipment will include a floor drain tank and filter, a laundry and hot shower tank and filter, a waste monitor demineralizer and filter, and two waste monitor tanks.

The floor drain tank will collect floor drain wastes from the auxiliary building except for the hot shower drains. The containment sump contents will also be routed to the floor drain tank during normal operations. The liquids entering the floor drain tank will be from low volume, low activity sources. Normally, the activity of the floor drain tank contents will be well below permissible levels, and, following analysis to confirm these low levels, the tank contents will be discharged without further treatment via the waste monitor tanks. The discharge valve will be interlocked with a process radiation monitor and will close automatically when the radioactivity concentration in the liquid discharge line exceeds a preset limit. Liquid waste discharge flow volume will be recorded. However, should any spills, leaks or equipment failures cause radioactive water to enter the floor drain tank, this water will be processed.

Provisions will be made to process liquid from Channel B in the waste evaporator should this be necessary because of an unexpected high level of activity. If such a case should occur, the waste evaporator concentrate will be drummed and the condensate returned to Channel B for ultimate discharge.

Laundry and hot shower drains will be the largest source of liquid wastes in the Liquid Waste Processing System and normally will need no treatment for removal of radioactivity. This water will be transferred to one of the two waste monitor tanks via the laundry and hot shower filter. A sample will be taken and, after analysis, the results logged and the water discharged if the activity level is below acceptable limits.

Laboratory samples which are likely to be tritiated and/or which may contain chemicals required for analysis will not be discharged or recycled but will be drummed directly. These samples of relatively small volume will be discarded in a separate sink which will drain to the chemical drain tank. Low activity drains from the laboratory, such as rinse water, will be routed to the floor drain tank.

Instrumentation and controls necessary for the operation of the Liquid Waste Processing System will be located on an auxiliary control board near the equipment. Liquid wastes will be released to the penstock of the Fairfield Dam on a controlled basis only from the waste monitor tanks or blowdown monitor tanks.

Gaseous Waste Processing System - The Gaseous Waste Processing System will remove fission product gases from contaminated fluids and will have the capacity to contain them through the lifetime of the Summer Station. Since the system will also provide for the removal of fission product gases from the reactor coolant, it will function to reduce the escape of radioactive gases through unavoidable equipment leaks.

The Gaseous Waste Processing System will be a closed loop comprised of two waste gas compressors, two catalytic hydrogen recombiners, and eight gas decay tanks.

Two compressors will circulate gases around the system loop. The units will be water-sealed rotary positive displacement machines which are skid-mounted in a self contained package and will be constructed primarily of carbon steel. Mechanical seals will minimize the outleakage of seal water.

The eight welded steel gas decay tanks will be provided to contain waste gases, six for use during normal power generation and two for use during shutdown and startup operations. As indicated above, the tanks will be designed to permit the accumulation of fission gases for the entire design life of the Summer Station. However, it is the intent of South Carolina Electric and Gas Co. to operate this system by discharging the contents of one gas decay tank each quarter, during periods of favorable meteorology, after allowing the radioactive gases in the tank to decay for ninety days. The advantages of this method of operation are:

1. Disposal of the accumulated inventory at the end of plant life are minimized.
2. The dose to plant personnel due to gas leaks is reduced.

If, in the future, it is deemed more desirable to hold up the fission product gases without deliberate discharge, the capability of this manner of operation is designed into the system. The incremental increase in site boundary dose rates due to deliberate discharge versus holdup when averaged over the life of the plant is less than 1 mrem annually.

The operating procedure to be followed in implementing this plan for deliberate discharge of radioactive gases is to have four gas decay tanks alternately valved into the gaseous waste processing system. A fifth tank is isolated and in the decay mode. The sixth tank, which had been isolated for a minimum of ninety days, is discharged to the plant vent during periods of favorable meteorology. Because of the low pressure buildup in the tank, the tank contents are discharged by purging the tank with nitrogen. The contents of the tank are sampled prior to discharge and are sampled during discharge by a radiation monitor which will automatically terminate the discharge on high activity by closing the tank outlet valve.

Hydrogen recombiners will remove hydrogen from nitrogen-fission gas mistures by oxidation to water vapor which is then removed by condensation.

The units will be self contained, skid-mounted, catalytic systems designed for continuous operation.

Before Summer Station begins operation, the system will be flushed free of air and filled with nitrogen. During normal power operation, nitrogen gas will be continuously circulated around the loop by one of the two compressors. Fresh hydrogen gas will be charged to the volume control tank where it will be mixed with fission gases which are stripped from the reactor coolant into the tank gas space. The contaminated hydrogen gas will then be vented from the tank into the circulating nitrogen stream to transport the fission gases into the Gaseous Waste Processing System. The resulting mixture of nitrogen-hydrogen-fission gas will be pumped by the compressor to the recombiner where enough oxygen will be added to reduce the hydrogen to a low residual level by oxidation to water vapor on a catalytic surface. After the water vapor is removed, the resulting gas stream will be transferred from the recombiner into the gas decay tanks where the accumulated activity will be contained in six approximately equal parts. From the decay tanks the gas will flow back to the compressor suction to complete the loop circuit.

When the residual fission gases and the hydrogen contained in the reactor coolant must be removed in preparation for a cold shutdown, the Gaseous Waste Processing System operation will remain unchanged until after the reactor is shutdown. Then, with the four gas decay tanks still in service, operation of the system will continue as during normal power generation, until the coolant fission gas concentration is reduced to the desired level. At that time the four tanks will be valved out of operation, hydrogen purging will be stopped and one of the two shutdown tanks placed in service. This tank, however, will be placed in the process loop directly at the compressor discharge so that gas leaving the compressor will flow through the shutdown tank and then the recombiner before the mixture returns to the compressor suction to complete the loop. During the first reactor cold shutdown, fresh nitrogen will be charged to the volume control tank to strip hydrogen from the reactor coolant. The gas mixture will be vented to the compressor suction, flow through the shutdown decay tank to the recombiner where hydrogen is removed, and then return to the compressor suction. During the initial shutdown, there will be an accumulation of nitrogen in the shutdown tank which will be accommodated by allowing the tank pressure to increase. During subsequent shutdown, however, there will not be additional accumulation since the gas from the first shutdown will be re-used.

Solid Waste Processing System - The Solid Waste Processing System will facilitate the transport and packaging of all radioactive solid waste. The solid waste will be stored on-site prior to off-site shipping for disposal in accordance with applicable regulations. The system will be capable of processing four types of solid wastes:

1. Dry waste including rags, filters, clothing, paper, and equipment.
2. Evaporator concentrates.
3. Spent resins.
4. Spent filter cartridges.

The dry wastes will be compacted into drums by a waste press and the drums will be shielded and stored prior to off-site disposal. The spent filter cartridges will be packaged locally in a shielded drum for storage prior to off-site shipment. The evaporator concentrates and spent resins will be pumped into shielded holding tanks. Connections will be provided to discharge the waste to drums for solidification or directly to truck mounted casks for off-site shipment.

The solid wastes will be packed and shipped in containers which meet the Department of Transportation specifications. Throughout the shipping operations, protection of the public will be provided by the use of these containers and by transportation in specially designed and equipped vehicles driven by trained personnel.

2.3.7.2 Released Radioactivity

In the Summer Station there will be two sources of controlled radioactive releases; the Radioactive Waste Processing System and limited activities from the Plant Ventilating System (Noble Gases).

Releases from the Radioactive Waste Processing System

1. Liquid Releases: There are two sources of contaminated water, which is processed prior to release. One source will consist of the leakage of reactor coolant which cannot be recycled. This activity will consist of both fission and activation products and will include tritium.* Also, in order to control the buildup of tritium concentration in the plant liquid inventory, it is

*During fissioning of uranium fuel, tritium atoms are generated at the rate of approximately 8×10^5 atoms per ternary fission (1.05×10^{-2} curies/MWt-day). Other sources include neutron reactions with boron, lithium and naturally occurring deuterium in light water. Operating experience has indicated that the release of tritium into reactor coolants through Zircaloy fuel cladding is about one percent of the ternary produced tritium.

planned to discharge the equivalent of one reactor system volume of processed reactor coolant annually.

As shown in Table 13, the estimated annual average radioactivity concentration discharged via the liquid waste processing system is expected to be a small fraction of the 10 CFR 20 limits for identified mixtures.

Table 13 also indicates the expected isotopic fractions of MPC and total annual releases.

In addition to the radionuclides given in Table 13, operating experience has shown that trace amounts of Xe-133 ($< 10^{-4}$ uc/cc) remain in the distillate of the evaporator condensate. The expected noble gas release in the liquid discharge are:

Isotope	Release millicuries/yr	Initial Fraction* of MPC (Annual Average)	Maximum Fraction* of MPC (Annual Average)
Kr-85	1.39×10^{-1}	1.54×10^{-8}	5.7×10^{-8}
Xe-133	9.52×10^{-1}	1.05×10^{-7}	3.9×10^{-7}
Xe-133m	1.39×10^{-1}	1.54×10^{-8}	5.7×10^{-8}
Remaining Noble gases	Negligible	Negligible	Negligible

The MPC referred to above was taken from Appendix B to 10 CFR 20, page 74b. An MPC in water of 3×10^{-6} uc/cc is reported for radionuclides not individually listed and not decaying by alpha emission or spontaneous fission and having a radioactive half-life greater than 2 hours.

Defects in steam generator tubes may result in additional radioactive liquid discharge via the steam generator blowdown. The resulting discharge of radioactivity depends on the steam generator leak rate, duration of the leak, and the presence of fuel defects.

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*See Section 2.3.7.1 for explanation of terms.

TABLE 13

ESTIMATED ANNUAL LIQUID ISOTOPIC RELEASES AND FRACTION OF MPC*
IN THE DISCHARGE FROM THE FAIRFIELD DAM
PENSTOCK TO THE UNRESTRICTED AREA

Isotope	Release millicuries/yr	Initial** Fraction MPC (Annual Avg)	Maximum** Fraction MPC (Annual Avg)
Cr 51	.27264	4.6×10^{-11}	1.7×10^{-10}
Mn 54	.29283	1.0×10^{-9}	3.7×10^{-9}
Mn 56	.07101	2.4×10^{-10}	8.8×10^{-10}
Fe 55	.26108	1.1×10^{-10}	4.1×10^{-10}
Fe 59	.33506	1.9×10^{-9}	7.0×10^{-9}
Co 58	19.87655	6.8×10^{-8}	2.5×10^{-7}
Co 60	3.73429	2.5×10^{-8}	9.4×10^{-8}
Br 84	.00472	5.4×10^{-9}	2.0×10^{-8}
Rb 88	.22406	2.6×10^{-7}	9.4×10^{-7}
Rb 89	.00538	6.0×10^{-9}	2.2×10^{-8}
Sr 89	.24602	2.70×10^{-8}	1.0×10^{-7}
Sr 90	.01043	1.2×10^{-8}	4.4×10^{-8}
Sr 91	.00380	1.8×10^{-11}	6.8×10^{-11}
Sr 92	.00041	2.0×10^{-12}	7.4×10^{-12}
Y 90	.00201	3.52×10^{-11}	1.3×10^{-11}
Y 91	.41010	5.5×10^{-9}	1.7×10^{-8}
Y 92	.00059	3.4×10^{-12}	1.2×10^{-11}
Zr 95	1.11835	6.4×10^{-9}	2.4×10^{-8}

* Based on operation with cladding defects in fuel rods generating 0.2% of the rated core thermal power.

**See Section 2.3.7.1 for explanation of terms.

TABLE 13 (Cont'd)

Isotope	Releases millicuries/yr	Initial* Fraction MPC (Annual Avg)	Maximum** Fraction MPC (Annual Avg)
Nb 95	2.42087	8.2×10^{-9}	3.0×10^{-8}
Mo 99	68.82900	1.2×10^{-7}	4.4×10^{-7}
I 131	111.69742	1.2×10^{-4}	4.6×10^{-4}
I 132	.04129	1.2×10^{-8}	4.6×10^{-8}
I 133	16.34550	5.4×10^{-6}	2.0×10^{-5}
I 134	.10275	1.7×10^{-9}	6.4×10^{-9}
I 135	2.80800	2.44×10^{-7}	9.0×10^{-7}
Te 132	3.86100	4.32×10^{-8}	1.6×10^{-7}
Te 134	.00432	4.8×10^{-9}	1.8×10^{-8}
Cs 134	17.36810	6.4×10^{-7}	2.4×10^{-6}
Cs 136	7.16040	2.7×10^{-8}	1.0×10^{-7}
Cs 137	156.23386	2.64×10^{-6}	9.8×10^{-6}
Cs 138	.10541	1.2×10^{-7}	4.4×10^{-7}
Ba 140	.18352	2.0×10^{-10}	7.4×10^{-9}
La 140	.10538	1.8×10^{-10}	6.6×10^{-10}
Ce 141	3.26492	1.2×10^{-8}	4.4×10^{-8}
Ce 144	1.75497	6.0×10^{-8}	2.2×10^{-7}

$$\sum_i \frac{\text{Concentration}}{MPC_i}$$

	Released curies/yr	Initial	Maximum
Totals	0.419	1.30×10^{-4}	4.96×10^{-4}
Tritium	481	5.32×10^{-5}	1.97×10^{-4}

2. Gaseous Releases: The waste gas processing system as designed permits the storage of all fission gas generated during plant lifetime. If no waste gases are discharged, the system fission gas inventory will increase with time to a maximum inventory at the end of the 40 year plant life as presented in Table 14.

   Most of the accumulated activity will arise from short-lived nuclides which reach equilibrium in one month or less. The principal long-lived activity accumulation is Krypton-85. System design will assure that the accumulated fission gas presents no off-site problems by limiting a single gas decay tank to a maximum of 40,000 equivalent curies of xenon-133.

   In lieu of the on-site storage mode of operation described above South Carolina Electric and Gas Company intends to routinely discharge radioactive gases as discussed in Section 2.3.7.1. When discharging waste gas to the atmosphere, the system is controlled by a radiation monitor and an automatically operated valve to assure that releases are made within the design limits for the plant.

   An estimate of the release of gaseous radioactive wastes from this system is given in Table 15.

3. Solid Wastes: Solid wastes will have no effect on the immediate environs of the Summer Station since they will be consolidated and drummed for off-site disposal. The maximum amount of solids removed from the site each year is expected to be equivalent to that contained in 200 fifty-five gallon drums.

TABLE 14

Equivalent Curies of Xe-133*

	Zero Decay	30 Days	50 Days
Kr-85	13,240	13,240	13,240
All Others	18,120	362	25
Total:	31,360	13,602	13,265

*Based on continuous operation with 0.2% fuel defects.

Releases from the Plant Ventilation System - The releases from the Plant Ventilation System are made up of purging of the reactor building, volatile activity releases associated with coolant leakage of up to 20 gallons per day, and leakage and planned releases from the Gaseous Waste Processing System. Activity from the Plant Ventilation System will be released via the plant vent. These releases are essentially all noble gases and come from four sources:

1. Releases Associated with Containment Purging: During continuous operation of Summer Station, it is expected that the activity associated with a reactor coolant leak rate of 40 pounds per day will be dispersed throughout the reactor building atmosphere. The anticipated equilibrium radioactivity in the containment atmosphere is included in Table 15. The activities listed are available to be released to the environment prior to each refueling operation which normally occurs once each year. The Table also lists the activities expected to be discharged from the containment during purging operations accompanying refueling operations. These are the residual noble gases not stripped from the reactor.
2. Releases Associated with Coolant Leakage: The sources of these releases include non-reusable reactor coolant leakage in the auxiliary building and venting of reactor coolant samples withdrawn for coolant chemistry and radioactivity analysis. The expected activity releases are listed in Table 15.
3. Leakage from the Gaseous Waste Processing System: The estimated leakage from this system is 100 standard cubic feet per

TABLE 15

ESTIMATED GASEOUS RELEASES AND ATMOSPHERIC CONCENTRATIONS

	Kr-85m	Kr-85	Kr-87	Kr-88	Xe-133m	X-133	Xe-135	Xe-135
1) Releases, Associate With Containment Purging, Ci/yr								
a) Prior to Refueling	2.1(-3)*	1.78(-1)	3.4(-4)	2.3(-3)	1.9(-2)	2.28	1.18(-5)	1.18(-2)
b) During Refueling	-	0.027	-	-	-	15	-	-
2) Releases Associated With Coolant Leakage, Ci/yr	12.2	0.76	6.6	21	8.8	453	1.14	33
3) Releases Associated With Gaseous Waste Processing System Leakage, Ci/yr	2	15	0.2	2	10	604	7	17
4) Releases Associated With Planned Gas Decay Tank Discharge, Ci/yr	-	3410	-	-	-	0.2	-	-
Total Release, Ci/yr	14.2	683	6.8	23	18.8	1059	8.1	49.6
Total Release Converted To a Per Second Basis, Ci/sec	4.5(7)	2.22(-5)	2.16(-7)	7.3(-7)	5.96(-7)	3.36(-5)	2.58(-7)	1.57(-6)
Annual Average Concentration of Radionuclide at Nearest Site Boundary, uCi/ml	1.4(-12)	6.9(-11)	6.7(-13)	2.2(-12)	1.8(-13)	1.0(-10)	7.9(-13)	5.0(-12)
MPC of Radionuclide, uCi/ml	1.5(-8)	2.3(-7)	2.4(-9)	2.6(-9)	9.0(-8)	7.4(-8)	5.5(-9)	1.7(-8)
Fraction of MPC of Released Radionuclide**	1.4(-5)	2.3(-4)	3.4(-5)	1.1(-4)	6.0(-6)	3.5(-4)	2.6(-5)	5.0(-5)

*Exponent of ten shown in paranthesis; e.g., 2.96(-6) = 2.96×10^{-6}
**Total Fraction = 8.2(-4) = 0.08%

Note: The average annual relative dispersion factor is 3.10 (-6) seconds per cubic meter.
Plant operation with 0.2% fuel defects.

(5-31-72)

year. The radioactive gas release associated with this leakage is also included in Table 15.

4. Planned Releases from the Gaseous Waste Processing System: The planned release of the contents of one gas decay tank each quarter is discussed in section 2.3.7.1. The associated radioactive gas release is included in Table 15.

Total Radioactive Releases from the Plant Ventilation System - The expected average annual releases from each of the sources contributing to releases from the plant vent, as discussed above, have been summed and are included in Table 15.

2.3.7.3 Pathways to Man

The potential pathways of radiation exposure to man from operation of the Summer Station include: external exposure from release of gaseous waste from the facility; direct exposure from swimming and boating in Lake Monticello, Parr Reservoir and/or the Broad River; and, internal exposure via food chains involving fish, milk, food crops and drinking water.

While some estimates of the effects of the pathways to man can be made, reliance for detailed information on any patterns developing in this particular area must be placed on the Radiological Monitoring Program (see Section 2.3.6.3). In the pre-operational phase of the program, measurements will be made to establish the radiological characteristics of the area so that trends which might develop during the operating phase may be differentiated from normal background radiation.

External Exposure - Gaseous Wastes - The quantities and types of waste discharged to the atmosphere vary from nuclear station to station depending primarily on design characteristics of the facility and on waste management practices. SCE&G is using the latest technological advances in reactor design as incorporated in the Westinghouse Environmental Assurance System and will therefore be limiting radiation releases to levels "as low as practicable." If it is assumed that plant operation takes place with 0.2% failed fuel cladding, the annual average concentration of gaseous activity at the site boundary would be approximately 0.08% of the 10 CFR 20 limits (see Table 15 in Section 2.3.7.2).

This is equivalent to an annual dose of about 0.4 mrem which is only a small fraction of the additional radiation dose that a person would receive from living in a brick house instead of a wooden house. Population groups further than one mile from the reactor (that is, the immediate vicinity) would, of course, receive even lower doses. Based on this, external exposure from released gaseous wastes (in particular krypton-85 and xenon-133) is expected to be negligible.

Direct Exposure - Water - Direct external radiation exposure from activities such as boating and swimming in Lake Monticello, Parr Reservoir or the Broad River is expected to have a negligible effect on man. Furthermore, direct uptake by the respiratory tract, skin and gastro-intestinal tract is expected to be small, with no toxic effects on man. A comparison of direct exposure from activities in or near the water with ingestion of drinking-water or fish (discussed below) has indicated that the latter is the more limiting consideration.

Internal Exposure - The tendency of some elements and radionuclides to accumulate and concentrate through food webs is well known. The degree of concentration varies with (1) the trophic level of the organism under consideration, (2) the temperature of the environment (especially aquatic), (3) the content of stable elements in the system, and (4) the concentration of the radionuclides in the environment.

Since liquid effluents from the Summer Station will be discharged into the Broad River, aquatic food chains will be monitored as potential pathways to man. While fish might be swimming in water which contains very low concentrations of radionuclides, the radioactivity in the fish could be much higher due to reconcentration effects through the microorganism-small invertebrate-fish food chain. Since cesium acts like potassium in biological systems it is an important ion in the operation of cell membranes, particularly in muscles and nerves. Because of this relationship, therefore, the critical nuclides in fin fish are cesium-134 and cesium-137 because they are reconcentrated in edible fish muscle. Other radionuclides are also reconcentrated in fish (see Table 16), but their effects are not as significant as cesium-134 and cesium-137 from the standpoint of human population dose because they tend to concentrate in the non-edible portions of the fish (strontium in the bones, cobalt in the liver and kidney) (Ref. 2).

A calculation of the amount of fish that would have to be eaten daily by an individual to reach the MPC of cesium-134 plus cesium-137 for the general human population has been made using data in Table 16. A member of the general public would have to eat approximately 400 kg. (880 pounds) of fish every day of the year to ingest the maximum permissible dose of these radionuclides. This is greater than both the reported daily average intake by fishermen of 0.05 kg. (Ref. 3) to 0.1 kg. (Ref. 4) and the intake (0.23 kg/wk) used to estimate exposure via this pathway for the AEC Savannah River Plant (Ref. 5). Therefore, it is anticipated that the internal dose from consumption of fish caught in Lake Monticello, Parr Reservoir or the Broad River will be quite small. The total dose from all aquatic pathways is estimated to be 0.019% of the 10 CRF 20 equivalent limits (see Table 16).

The existence of some small commercial dairy and crop farms in areas of

TABLE 16

RADIONUCLIDES IN AQUATIC PATHWAYS TO MAN

Radionuclide	Co-58	Co-60	Sr-89	Sr-90	I-131	Cs-134	Cs-137
(MPC)w, uCi/ml	9(-5)*	3(-5)	3(-6)	3(-7)	3(-7)	9(-6)	2(-5)
$(MPC)_f$, uCi/g (See Note 1)	6(-3)	2(-3)	2(-4)	2(-5)	2(-5)	6(-4)	1(-3)
Concentration at Point of Release, uCi/ml (See Note 2)	6.1(-12)	7.5(-13)	8.2(-14)	3.6(-15)	3.8(-11)	5.6(-12)	5.2(-11)
Fraction of (MPC)w, f_1	6.8(-8)	2.5(-8)	2.7(-8)	1.18(-8)	1.24(-4)	6.4(-7)	2.64(-6)
C_f (See Note 3)	500	500	40	40	1	1000	1000
Fish Concentration, uCi/g	3.1(-9)	3.7(-10)	3.2(-12)	1.44(-13)	3.8(-11)	5.6(-9)	5.2(-8)
Fraction of $(MPC)_f$, f_2	5.1(-7)	1.9(-7)	1.64(-8)	7.2(-9)	1.86(-6)	9.2(-6)	5.2(-5)
% of MPC, $(f_1 + f_2)100$	5.8(-5)	2.1(-5)	4.4(-6)	1.94(-6)	1.24(-2)	1.0(-3)	5.6(-3)

Estimated dose from all aquatic pathways combined is 0.019% of the 10CFR20 equivalent limits.

* Exponent of ten shown in parenthesis: e.g., 9(-5) = 9×10^{-5}

Notes:

1. The maximum permissible concentration in fish $(MPC)_f$ is calculated from the maximum permissible concentration in water (MPC)w based on 15.4 kg. of water and 0.23 kg. of fish consumed by man per week (Ref. 5).
2. The concentration at the point of release is based on total curies/year and 900 cfs dilution.
3. The concentration factor, C_f, is the expected uCi/g in fish divided by uCi/ml in water. All values of C_f are based on a review of stable nuclide data for freshwater fish (Ref. 6).

Newberry and Fairfield Counties within a ten mile radius of the site indicates two possible routes to man in domesticated food chains for radionuclides in any effluents discharged to the atmosphere: (1) air-grass-milk-child and (2) air-soil-crop-food-man pathways. The critical radionuclides for the first route are iodine-131, strontium-89 and strontium-90, all of which are readily concentrated in milk. Cesium-134 and cesium-137 may also contribute to this pathway. For food crops, cesium-134, cesium-137, strontium-89 and strontium-90 are the critical nuclides. Strontium-89 and strontium-90 enter the food crop chain either through absorption by plant roots or direct plant surface contamination, while cesium-134 and cesium-137 enter the chain by direct plant surface contamination. However, as stated by Ref. 2, experience at operating pressurized water reactors which utilize gaseous waste treatment facilities has not indicated a measurable exposure hazard via these routes. This would, in turn, preclude significant contribution of radionuclides to the human population through the wild food chain of air-grass-animal-man since consumption of such foods is expected to be much less than man's milk and food crops intake.

The final pathway to man considered likely is from drinking water obtained from wells in the general area of the Summer Station. The Radiological Monitoring Program is designed to monitor the quantities of radionuclides appearing in local wells and to assure that the levels remain within drinking water standards recommended by the U. S. Public Health Service. Since surface waters will be below these limits, well water is also expected to be well below the limit for strontium-90 (10 pCi/liter) or other beta emitters (1000 pCi/liter).

In summary, it is concluded that the released radionuclides will have an insignificant effect on man, that is, the radioactivity levels anticipated from normal operation of Summer Station will be well below the 10 CFR 20 limits and so no acute toxicities or acute effects on man should result. A prototype nuclear power plant (CVTR) operated in the Parr area from 1963 to 1967 and had no significant impact on the surrounding environment (Ref. 1). The low level of release of radionuclides anticipated from the Westinghouse Environmental Assurance System, coupled with good dilution, is expected to result in a total dose from all pathways to man of only 0.4% of the 10 CFR 20 equivalent limits. Verification of these conclusions, which are based on calculations, will take place as the results of the pre-operational and operational monitoring programs become available. In addition, future reports of research in the field of both short and long-term effects of various radionuclides on different biological systems will be evaluated as they relate to the Virgil C. Summer Nuclear Station.

2.3.7.4 Radiological Effects on Important Species

As discussed in Section 2.3.7.2, the amount of activity released during plant operations is expected to be quite low, approximately 0.1% of the 10 CFR 20 limits. While it is true that radiation standards for safeguarding aquatic organisms and wildlife are more difficult to establish than those prescribed for man because of the many species involved, the following state ent was made by Dr. Raymond Johnson, Assistant Director, Bureau of Sports Fisheries and Wildlife, Department of the Interior:

> "However, in spite of this problem (numerous species involved), virtually all published data show that concentration of radio-

nuclides required to injure fish and wildlife are much higher than the maximum permissible concentrations prescribed in Title 10, part 20, of the Code of Federal Regulations."

Dr. Johnson went on to say that the cushion provided by the 10 CFR 20 limits appears to be adequate for acute toxicities or effects on aquatic organisms.

On the basis of the above, it is believed that the anticipated releases of radioactivity from the Summer Station will have a minimal radiological effect on the important species in the environs. Verification of this conclusion will be made when the results of the pre-operational and operational radiological monitoring programs become available.

References

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act of Construction

truction of the proposed Summer Station will commence in 1972 with
eparation and construction of access facilities. Major construction
anned to start in early 1973 and continue through 1976. The peak
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racticable.

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atment will be applied.

truction staging areas
ssible after grading.

2.3.8 Impact of Construction

The construction of the proposed Summer Station will commence in 1972 with site preparation and construction of access facilities. Major construction is planned to start in early 1973 and continue through 1976. The peak activity will occur in 1974 and 1975. This effort will be integrated with the construction activities associated with the Fairfield Pumped Storage facility.

During the construction of the Summer Station, SCE&G will require the contractor to employ specific construction practices at the station site, including those associated with minimizing environmental effects. Some of the measures that will be employed are:

1. Soil erosion protection procedures. These will include such features as reducing the area and duration of exposed soils to a minimum, retaining and protecting the natural vegetation wherever possible, and installation of conduits and settling basins. A storm water drainage system will be installed as soon as practicable.
2. Dust Control. Dust control measures, including water sprinkling or chemical treatment will be applied. Roads, parking lots and construction staging areas will be treated as soon as possible after grading.

Suitable facilities will be provided for the disposal of sanitary wastes in accordance with local and state standards. Similarly, the storage, handling and disposal of all cleaning materials, oils and wastes, will be in compliance with any locally applicable codes.

The construction activities will create noise, but because of the remote location and sparse population, the impact on the human environment should be minimal. There will, however, be some unavoidable disruption of the native wildlife in the construction area during the construction phase. As with any other large construction project, some combustion products will be released to the atmosphere by diesel powered machinery. [A fire protection system will be established to control any fire within the construction site. There will also be possible noise and traffic congestion entering and leaving the job site area, particularly at starting and quitting time, however, these effects should be confined to the immediate locale.

The impact of a large construction force on the local commercial and social patterns is dependent on numerous factors, many of which may be peculiar to a given area. While no known studies have been performed in the site area to assess this impact, no obvious conditions exist to indicate that the impact would be dissimilar from that associated with any large construction project in a sparsely populated area.

During the peak construction period, the work force will include about 1,800 persons, about two thirds of which will be employed on the Summer Station construction. The area immediately surrounding the site is deficient in skilled construction workers. Many workers will temporarily locate in the area. Some of the workers will commute from neighboring communities but it is probable that private interests will establish temporary housing such as trailer parks.

The local communities may be required to temporarily provide additional services such as schools, sewage facilities, domestic water supplies and it is possible that the local road network will be damaged somewhat by heavy construction machinery and traffic associated with the project.

The burden on these community facilities will probably exist for a few years and be offset in part by an increase in the economic base of the area due to the significant construction payroll and added tax base. During this time, expenditures by construction workers on housing, food, clothing and other necessities will contribute to the community's commercial growth and economic vitality. It is estimated that at peak activity, the monthly payroll will exceed $3,000,000. The added tax base will result in long-term benefits to local and county-wide communities and consequently serve as a positive influence on the development of this area.

The development schedule for the Summer Station is shown on Plate 15.

2.4 ANY ADVERSE ENVIRONMENTAL EFFECTS WHICH CANNOT BE AVOIDED SHOULD THE PROPOSAL BE IMPLEMENTED

2.4.1 General

The construction and operation of the Virgil C. Summer Nuclear Station can affect the environment in several ways. Building of the Summer Station structures and access roads and subsequent operation of the facility will have an impact on aesthetics, on the quality of air and water, and on wildlife and land resources. This section of the Report discusses those adverse effects which cannot be avoided.

Many people feel that an undisturbed natural landscape possesses beauty and, thus, is aesthetically pleasing. At the same time, most people are aware of the human comforts that are made available to them through the generation of electrical energy. Ultimately, compromises must be reached in which certain environmental effects, some of which are adverse, must be accepted as unavoidable in the provision of electrical energy. It is emphasized that all effects are not necessarily adverse; that those which are adverse will be minimized to the extent feasible. Many of the adverse effects on the environment which would result from the construction of the facility are not of a permanent nature. The duration of resource use, the irreversibility of certain actions and irretrievable commitments of resources associated with the proposed facility are discussed in Sections 2.6 and 2.7. Programs to monitor effects on the environment and steps which are to be taken in managing total land resources to minimize adverse impact and to improve existing resource conditions are outlined in Section 2.3.6.3.

2.4.2 Effect on Aesthetics

A temporary adverse effect on the environment will be the disturbance of the landscape by activity associated with construction of the facilities. Staging areas for the construction equipment and supplies will last for the period of construction. However, such areas will be attractively landscaped or restored to a natural pleasing appearance afterwards.

Emplacement of the Summer Station into the landscape will affect the existing aesthetics. The Station site area will be converted from a rural, pastoral scene dominated by land and trees to one of an industrial facility dominated by steel and concrete. However, the irregular shoreline of Lake Monticello and the general remoteness of the site will limit exposure of the Station. Landscaping will be designed to blend the facility into the existing scene as much as possible.

Some access roads and transmission lines will be unavoidable in the landscape. However, these facilities will also be designed to blend with the surroundings as much as possible.

The construction of Lake Monticello will change the site aesthetics from one of a predominately forested, hilly view to that of a broader lake view. This will have the result of creating a somewhat more expansive view due to the reflective character of the lake water surface. The shoreline will be irregular and wooded and should conceal the construction and structures from view over much of the lake.

Water level fluctuations in Parr Reservoir and Lake Monticello will periodically present some unsightly mud flats and barred shoals. The greatest water level fluctuations will occur in Parr Reservoir (about nine feet) and will expose a substantial amount of near-shore bottom land. The visual impact of these exposed areas will be mitigated somewhat by the fact that the lowest water levels will normally occur at night when the pumped storage facility is operating in the pumping mode. The impact of the exposed shoreline in Lake Monticello will be limited since the maximum water level lowering will be on the order of five feet.

2.4.3 Effects on Air, Water and Land Resources

There will be some release of effluents into the environment but the overall impact of these releases on the total environment is judged to be slight. All discharges to the air and aquatic environment will meet applicable quality standards.

There are a number of temporary or permanent unavoidable adverse effects on the land and wildlife resources in the Summer Station area. Local wildlife and fishery resources will be adversely affected by the removal of woodland habitat, and as a result of water level fluctuations in Lake Monticello and Parr Reservoir. The construction of Lake Monticello and the raising of Parr Dam will inundate merchantable timber. Salvage of the timber in the areas prior to flooding can be done, but the land can then no longer produce forest products for the life of the lakes.

Noise, dust, possible traffic congestion, added load to vicinity roads and highways and certain other disruptions to environment, particularly during construction, will have an unavoidable impact on the environment.

By following a land management program, many of the adverse effects that may be associated with the development of the proposed facility will be minimized. Further, SCE&G will be undertaking measures to enhance or improve upon the existing resources, where possible and compatible with the operation of the Summer Station.

2.4.4 Effects on Population

From four to eight dwellings will be relocated. While the impact of relocation on the persons living in these dwellings should not be minimized, the impact in comparison to other areas is small. The land in the site area is generally poorly suited to agriculture and is not extensively farmed. Many people in the area work in industries and services outside the site vicinity. Therefore, relocation of the dwellings should not seriously alter the life style of the inhabitants. All relocated residents and property owners will be fairly compensated.

2.5 ALTERNATIVES TO THE PROPOSED ACTION

Before deciding on the combined Summer Station and pumped storage project to provide for future base loads and peaking loads on the system, a thorough investigation was made of the alternatives for securing the power needed. The alternatives are discussed below.

2.5.1 Not Providing the Power

In the 1965-1970 period the SCE&G system territorial peak load increased an average of 11.6% per year, which is about 1/3 higher than the national average. The Company is a member of the Virginia-Carolinas Reliability Group whose other members are also experiencing load growths higher than the national average.

At the end of 1970 the peak load on the SCE&G system was 1,757 MW and this peak load is expected to increase to about 2,200 MW by 1973, about 3,000 MW by the end of 1975, 4,000 MW by the end of 1978, and over 6,000 MW by 1983.

The present generating capability of the SCE&G system (end 1970) is 1,875 MW and construction presently underway will bring the capability to 3,031 MW by 1975.

There is an urgent need for the additional installed generating capacity from the proposed Summer Station to enable SCE&G to meet the system demand within its franchised territory. SCE&G is obligated to provide a reliable electric supply to a 12,000 square mile service area which includes the two major load centers of Columbia, the State Capital; and Charleston, the principal seaport of South Carolina.

The peak loads and capacity forecasts through 1980 are given in Table 17, from which it can be seen that without the proposed additional generation, the Company's generating reserve will be less than 165 MWe by 1976.

As was noted above, existing capacity and plants presently under construction will barely meet the system peak load by 1975. In addition to supplying its own customers, SCE&G is obligated to meet certain commitments as a member of the Virginia-Carolinas Reliability Group of the Southeastern Reliability Council.

Therefore, not providing the power is not a feasible alternative.

2.5.2 Importing Power

SCE&G has system interconnections with Georgia Power Company, Duke Power Company, South Carolina Public Service Authority, and Carolina Power and Light Company. Two of the interconnections with Carolina Power and Light are 230 KV transmission lines while other interconnections are presently at 115 KV. Future 230 KV interconnections are planned with Duke Power (1971) and Georgia Power (1975/1976). These system interconnections are designed to improve the system reliability, but are not intended to transfer large blocks of power on a permanent basis, even if that power were available.

The whole southeastern region is experiencing above average load growth rates and there is not now, nor will there be in the foreseeable future, excess generating capacity in the region which could be purchased to meet SCE&G system needs.

Importing power is therefore not a feasible alternative.

TABLE 17

PEAK LOAD AND CAPACITY FORECAST

1975 - 1980

		1975	1976	1977	1978	1979	1980
(1)	Load-Peak Demand MWe						
	Terr. Peak	2563	2857	3186	3554	3960	4410
	Contract Sales	149	149	149	149	70	-
	Total Load	2712	3006	3335	3703	4034	4410
(2)	Capacity - MWe						
	Capacity Additions						
	Fossil	-	-	-	-	611	-
	Summer Nuclear	-	-	900	-	-	-
	Fairfield Pump Hydro	-	240	-	240	-	-
	Total Capacity						
	Fossil	2497	2497	2497	2497	3108	3108
	Hydro	243	243	243	243	243	243
	Com. Tur.	291	291	291	291	291	291
	Pump Hydro	-	240	240	480	480	480
	Nuclear	-	-	900	900	900	900
	Total	3031	3271	4171	4411	5022	5022
	Purchases	140	140	-	-	-	-
	Total Cap. Available	3171	3411	4171	4411	5022	5022
	Reserve	459	405	836	708	988	612

2.5.3 Alternative Forms of Generation

There are essentially two types of load demand: "base" where continued operation at maximum generator capacity is used to meet the minimum load demand and, "peaking" where operation is limited to a few hours to satisfy maximum load demand. Several types of generating facilities are available to meet either base or peaking load demands, but no one type is totally suitable for both base and peaking power generation. Alternate types of generation are discussed in this section.

2.5.3.1 Fossil Fuel Steam Generation

SCE&G's present base load generation capacity is largely fossil fuel steam plants and further fossil base load units are planned for 1973 and 1979. These plants are planned near the load center for the Charleston area to meet the future demands of that region. It should be noted that fossil-fuel plants are not particularly suited for peaking power generation due to mechanical factors.

Due to the exceptionally low cost of nuclear fuel the Summer Station will have an economic operating advantage for supplying base load power over fossil fuel plants, even though the initial investment is higher. Additionally, supplies of low sulfur coal, low sulfur residual fuel oil and natural gas are becoming increasingly difficult to obtain. Nuclear units are not subject to foreseeable fuel restrictions. Environmentally, nuclear generation involves the discharge of waste heat and minor amounts of radioactivity. Fossil-fuel plants also discharge waste heat and radioactivity, although to a lesser degree than nuclear stations. However, other effluents are released to the environment by fossil-fuels such as sulfur dioxide and particulate matter that are not associated with nuclear fuels. Also, a nuclear plant is generally considered to be more aesthetically pleasing.

It has been concluded that environmental impact of a nuclear station at the proposed site would be no greater than that posed by fossil-fueled plants. On the other hand, the economic advantage of nuclear generation and the system reliability that would result from a mixed fuel capacity must be considered positive attributes of the Summer Station. Therefore, it is the Company's opinion that the construction of a nuclear station at the site is a wiser use of the land and resources than a fossil-fueled plant.

2.5.3.2 Gas Turbine Units

The present SCE&G system includes 189 MWe of gas turbine capacity and a further 100 MWe is being constructed to provide additional reserve capacity.

Gas turbine units can use natural gas or kerosene and have low initial cost. However, fuel costs and maintenance costs are high if the units are operated for long periods of time. Hence, gas turbine units provide economical reserve capacity and very short duration peaking power. They are not suitable for supplying base load power, and therefore do not provide an alternative for the Summer Station.

2.5.3.3 Hydro-electric Units

The present SCE&G system includes 185 MWe of hydro capacity. A further 70 MWe are being added to the Saluda Hydro Station. Five MWe are planned to be added to the Parr Hydro Station.

Two types of hydro-electric facilities are in use: conventional or run-of-the-river plants, such as Parr Hydro Station, and pumped storage facilites, such as the proposed Fairfield Pumped Storage facility. These plants involve the building of dams and the impoundment of water. Power is generated by using the water head differential across the dam to turn turbine generators.

In general, both types of hydro-electric plants are best suited to providing peaking power, although some run-of-the-river plants may be capable of providing base load power if the flow of the river is sufficiently large. No sites within the Columbia-Charleston load centers are available that can support a base load hydro facility as an alternative to Summer Station.

Pumped storage facilities are suitable only for peaking power generation. These facilities utilize off peak, base load power from the system to pump the water used to generate power during peak demand periods back into the storage reservoir. Fairfield Pumped Storage facility at Lake Monticello will utilize power from Summer Station to pump back water from Parr Reservoir. Thus, this facility does not present an alternative to the nuclear station.

2.5.4 Alternative Sites

The selection of a power generating site requires an analysis of numerous factors. Such factors include: availability of suitable land from both a surface (topographic) and subsurface (soils, geology, seismology) standpoint; population and land use characteristics of the surrounding area; a sufficient water supply for cooling requirements; proximity to load centers, transmission lines, railroads and highways; location relative to items of historical and cultural significance; relative economics of site development; and the facility's impact on the environment.

SCE&G believes that the environmental impact of the facilities required to generate electric power can be minimized if the maximum use of a given site is realized. In general, disruption to the environment will be less for a single site containing several types of generating facilities than for several sites with only one facility. The number of roads, transmission lines and railroads required will be reduced. The number of families that would have to be relocated, and the impact of construction activities, would be generally lessened. Also, any adverse biologic effects would tend to be confined to a single localized area.

A 1967 system study identified Parr, Bushy Park (Charleston), and Wateree Station as areas near load centers where electrical generation facilities would be required in the near future. A preliminary evaluation of the suitability of these areas for nuclear station siting was made. The Parr area combines the features of suitable nuclear siting characteristics and a history of nuclear generation (CVTR). The Bushy Park area could pose special problems with regard to seismic design criteria since it is close to the Charleston earthquake area. SCE&G has decided upon fossil-fueled generation for the development of this site. The Wateree Station was most suitable for expansion of the existing fossil-fueled facilities to provide for rapid expansion of the Company's capacity.

The present site is in a remote location such that its utilization will have minimal environmental impact in terms of family relocation, land use changes, and ecologic considerations. It is convenient to existing railroads and highways and is adjacent to existing and planned transmission facilities. The integrated power complex provides for maximum utilization of the water resources both for cooling requirements and for power generation.

The present site represents, in the opinion of SCE&G, the best use of the available resources with a minimal environmental impact.

2.5.5 Alternate Radwaste Systems

The Radwaste System to be used in conjunction with the Virgil C. Summer Nuclear Station offers a significant improvement over other radwaste systems now being used or proposed for other nuclear facilities. The Westinghouse Environmental Assurance System (EAS) represents the latest state-of-the-art and as such, is felt to satisfy the "as low as practical" criteria for releases of radioactive effluents established by the AEC.

2.5.6 Alternate Methods of Cooling

A variety of cooling methods are available for dissipating waste heat from thermal power plants other than the artificial lake (Lake Monticello) that will be used at Summer Station. Other methods include cooling towers, spray ponds and once through cooling systems using river water directly.

Of the other methods available, wet cooling towers provide the only viable alternative at the proposed site. Dry cooling towers are not yet technically or economically practical. Spray ponds would also require construction of a reservoir, although smaller than Lake Monticello. A once through cooling system is not possible due to the lack of sufficient water flow in the Broad River.

Wet cooling towers, either natural or mechanical draft, could be used for Summer Station. However, the use of an artificial lake as the heat dissipation method is actually dictated by the project concept. This is because Lake Monticello will serve the dual purpose of providing cooling for the nuclear unit and also provide water for the pumped storage hydro plant. Thus, while the other methods of heat dissipation might be suitable for other facilities, a system has been chosen which best serves the overall needs of the proposed facility with the minimum environmental impact.

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

"Short-term" is taken to represent that period of time from the initiation of construction of the station to the ultimate decommissioning of the nuclear unit. The presently anticipated operating period for the nuclear unit is 40 years. Present thinking on the decommissioning of nuclear stations is that techniques can be developed which will remove radioactivity from the area to the extent that its utilization for other purposes will not be limited by radioactivity.

The short-term use of man's environment will include several disruptive undertakings. The major ones are the construction of roads and structures, the creation of a man-made lake, the enlargement of an existing reservoir, construction of transmission lines, the discharge of waste heat, the release of radioactive effluents, and the discharge of chemical and sanitary wastes. These activities have been discussed in previous sections of the Report, along with the minimizing or offsetting measures that SCE&G proposes to undertake.

Construction will result in the elimination of some of the existing wildlife habitat. This represents the most significant long-term adverse effect and would eliminate the growth of trees and vegetation for at least as long as Lake Monticello remains in existence.

On the other hand the use of Lake Monticello as an expanded recreational area may represent an enhancement of long-term productivity in terms of human enjoyment. In any event, it is felt that the benefits gained from the generation of electricity outweigh any potential short-term degrading effects on the environment at the proposed site.

2.7 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES WHICH WOULD BE INVOLVED IN THE PROPOSED ACTION SHOULD IT BE IMPLEMENTED

Numerous resources are included in the construction and operation of the Station including land, materials and supplies used to construct and operate the facility, water from the river, and human talent, skill and labor as well as capital. Some of these resource commitments are irreversible and irretrievable such as the nuclear fuel, materials and supplies which cannot be salvaged after their use. Others are only temporary commitments such as the use of land for the nuclear site which can be returned to other uses if the facilities are decommissioned. When the lifetime of the project is completed, it would be possible to remove structures, drain Lake Monticello, lower Parr Dam, and replant trees. While this would essentially return the area to its original pre-construction condition, it is doubtful that this will ever be done. Thus, for all practical purposes the elimination of forest land, particularly the hardwood forest lands and its associated wildlife habitat which will be flooded by Parr Reservoir, will represent an irretrievable commitment of resources. Nuclear fuel consumed in the fission process is also an irretrievable commitment of resources. This consumption is very small, however, particularly when compared to the fuel used by fossil fired plants.

APPENDIX A

ARCHEOLOGICAL STUDY

ARCHEOLOGICAL STUDY

In keeping with its intention of minimizing any adverse impact of the proposed facility on the environment, SCE&G has investigated the historic and archeological resources of the area. There are no significant historic sites near the proposed station. There are, however, four recorded archeological sites within the boundary of the proposed project.

Dr. Robert Stephenson, State Archeologist, has recommended that two of the archeological sites be excavated and analyzed, and that prior to construction a detailed survey of the area be conducted to determine whether additional sites of archeological interest exist, and if so, to determine whether detailed excavation and analysis are warranted. A copy of Dr. Stephenson's report and suggestions follows.

SCE&G will support and finance such a study which will be conducted by the University of South Carolina Institute of Archeology and Anthropology.

UNIVERSITY OF SOUTH CAROLINA
COLUMBIA, S. C. 29208

DIVISION OF ADVANCED STUDIES AND RESEARCH
Institute of Archaeology and Anthropology

March 12, 1971

Mr. Gary Doxtater
Route 5
Seymour, Indiana 47274

Dear Mr. Doxtater:

It was a pleasure to have a chance to visit with you on your recent trip to Columbia in connection with your study of the Parr Shoals area. I appreciate your concern with the archeology of this area as a part of the ecological study that you are making for Dames and Moore. This kind of approach is necessary in any such study of areas where the surface of the ground is to be disturbed.

We have checked our records for that particular area anticipated for development by the South Carolina Electric & Gas Company and have found that we have sites recorded there. The area has not been thoroughly searched and the recorded sites are only a part of the prehistoric and historic resources that appear to be present in the area. The attached resume indicates the extent of archeological research that has been done in the area and that will be required before development of the project.

I hope that this will be satisfactory for your purposes. I will look forward to seeing your report and recommendations as well as plans and time schedules for the project.

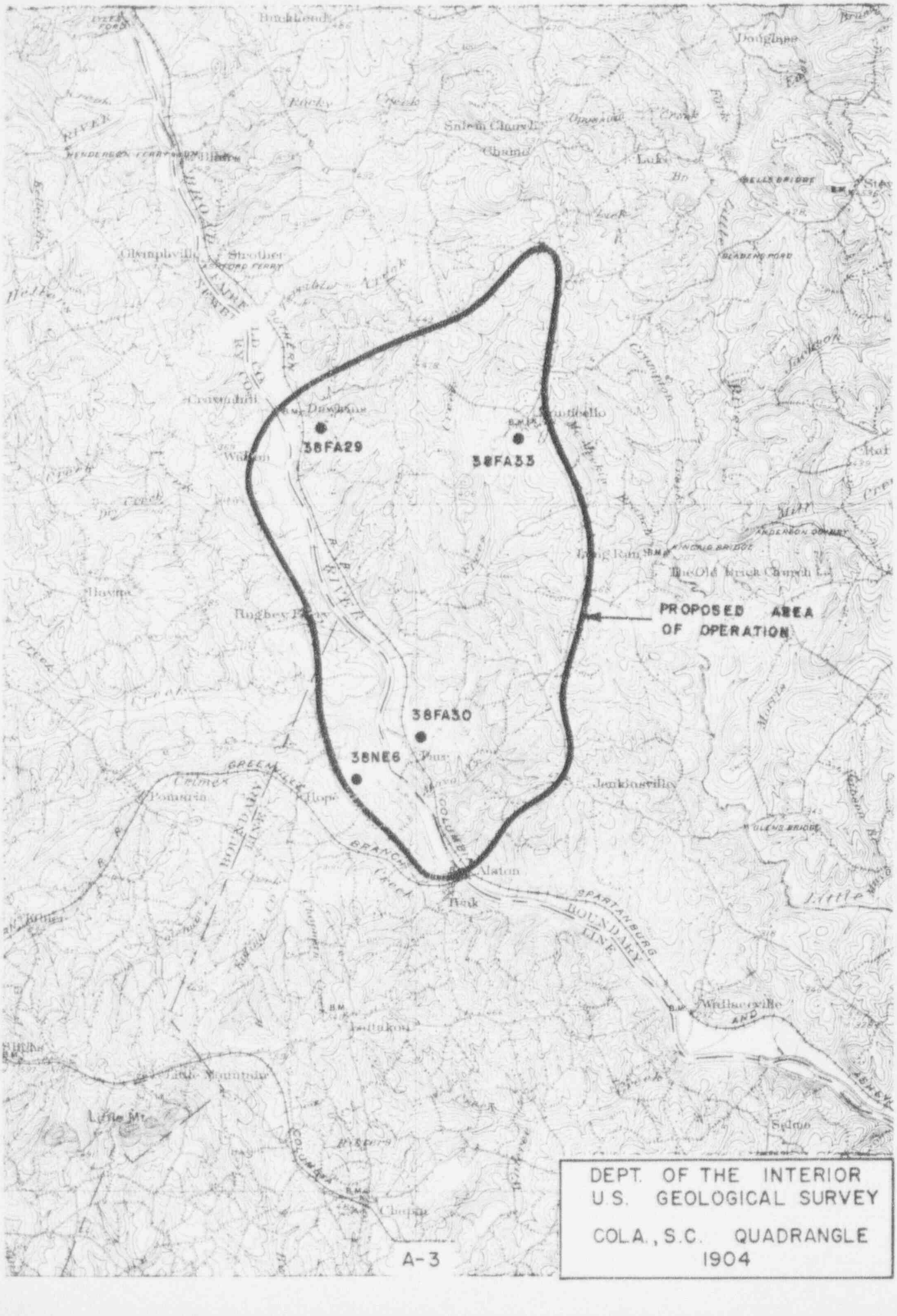
Sincerely,

Robert L. Stephenson

Robert L. Stephenson
Director and State Archeologist

Encl.

RLS:cr


38FA29
38FA33
38FA30
38NE6
PROPOSED AREA OF OPERATION
Monticello
Jenkinsville
Alston
Strother
Chapin
Little Mountain
Wallaceville
Salem Church
Douglass
Buckhead
DEPT. OF THE INTERIOR
U.S. GEOLOGICAL SURVEY
COLA., S.C. QUADRANGLE
1904

ARCHEOLOGICAL RESOURCES

PARR SHOALS AREA

NEWBERRY AND FAIRFIELD COUNTIES, SOUTH CAROLINA

At the request of Mr. Gary Doxtater of the firm of Dames and Moore, the Institute of Archeology and Anthropology made a check of the area near Parr Shoals on the Broad River to determine the archeological resources of that area. It is our understanding from Mr. Doxtater that the South Carolina Electric & Gas Company anticipates development of an area of approximately 8,000 acres here for an atomic power plant. This would include a dam and reservoir on a small stream known as Frees Creek and other developments such as roads, borrow pits, and buildings. Presumably all portions of the surface of the ground in this area would be disturbed. Therefore, any archeological resources in the area would have to be located and thoroughly excavated prior to construction on the project or they would be forever destroyed.

The Institute files show that four archeological sites are on record for this particular area. These are indicated on the attached map. These are as follows:

38FA29 - An Archaic campsite of the Guilford Complex (approximately 4,000-3,000 B.C.). Surface collections made in 1968 are modest. No testing or excavation has been done.

38FA30 - An Archaic campsite of the Guilford and Morrow Mountain Complexes (approximately 5,000-3,000 B.C.). Surface collections made in 1959 are modest. No testing or excavations have been done.

38FA33 - An Archaic and Woodland camp and village site of at least four occupations, Morrow Mountain (5,000-4,000 B.C.), Guilford (4,000-3,000 B.C.), Savannah River (3,000-0 B.C.), and Woodland (1,000 B.C.-1,000 A.D.). Surface collections made in 1970 are fairly extensive. No testing or excavations have been done. Projectile points, scrapers, pottery, and other artifacts have been collected here.

38NE6 - An Archaic and Woodland camp and village site of several occupations similar to those at 38FA33. Surface collections made in 1937-39 by Dr. Robert Wauchope are extensive. Projectile points, steatite bowls, netsinkers, a few fragments of pottery from the surface collections total almost 1,000 specimens. This appears to be one of the best sites to record the Archaic period (6,000-1,000 B.C.) in central South Carolina.

This many sites recorded in this small area would suggest that a systematic search of the area would reveal other sites. It is urged that before any construction be started, a detailed survey of the entire area be made to record all sites in the area, and that minor tests be made in each (including those already recorded) to determine the extent and value of these sites. It is also urged that site 38NE6 be completely excavated and that 38FA33 be partially excavated. Depending upon the results of the survey and testing operation, other sites may be found to require excavation, but this determination would have to await the results of the survey.

The survey and testing operation would require two men for two weeks in the field and four weeks of analysis and preparation of a report. The estimated cost of this survey and testing including preparation of the report is $2,500.

The excavation of 38NE6 and 38FA33 could be done concurrently by an archeologist and six men during a six week period in the field followed by the archeologist and one man doing the analysis and reporting for an additional six weeks. The estimated cost of this survey and testing including preparation of the report is $7,500. The cost of both these projects is expected to be borne by the developer, The South Carolina Electric & Gas Company. The work would be done by trained archeologists of the staff of the Institute of Archeology and Anthropology. Detailed reports of the work would be prepared and made available to the developer and could be used for public relations purposes.

This statement is prepared in the interests of the people of South Carolina as a means of preserving the prehistoric and historic record of this state and is submitted by:

Robert L. Stephenson
State Archeologist and
Director of the Institute of Archeology
and Anthropology
March 12, 1971

Table 10. (Continued)

Total Length (cm)	Frequency	% of Total, by Species	Average Weight (grams)	Condition[a] Factors
		(Gizzard shad)		
10	1	12.5	-	-
11	2	25.0	-	-
12	1	12.5	-	-
13	3	37.5	-	-
14	1	12.5	-	-
	8			
		(Largemouth bass)		
11	1	16.7	-	-
14	2	33.3	41	1.5
15	1	16.7	45	1.3
16	1	16.7	45	1.2
52	1	16.7	2495	1.8
	6			
		(Golden shiner)		
9	1	20.0	-	-
10	1	20.0	-	-
11	1	20.0	-	-
12	1	20.0	-	-
14	1	20.0	-	-
	5			

[a] $K_{(TL)} = 100W/L^3$

Table 11. Species Composition and Relative Abundance of Fishes Collected at Station 4, Broad River Study Area, Parr, South Carolina, March, 1971.

Common Name	Scientific Name	No.	% of Total
White sucker	Catostomus commersoni	13	50.0
Bluegill	Lepomis macrochirus	5	19.2
Carp	Cyprinus carpio	5	19.2
White catfish	Ictalurus catus	2	7.6
Longnose gar	Lepisosteum osseus	1	3.8
	Total	26	

Table 12. Length, Frequency, Weight and Condition Factor of Fishes Collected at Station 4, Broad River Study Area, Parr, South Carolina, March, 1971.

Total Length (cm)	Frequency	% of Total, by Species	Average Weight (grams)	Condition Factor[a]
		(Bluegill)		
15	2	40.0	54	1.7
17	1	20.0	91	1.8
19	1	20.0	136	1.9
20	1	20.0	150	1.8
	5			
		(White catfish)		
33	1	50.0	454	1.3
34	1	50.0	454	1.1
	2			

Other Species Collected

Species	Number	Size Range
White sucker	13	31-38 cm
Carp	5	36-51
Longnose gar	1	67

[a] $K_{(TL)} = 100W/L^3$

Table 13. Chemical Water Analysis of Broad River Study Area, Parr, South Carolina, March 4, 1971 (in ppm).

Tests	Station 2	Station 3	Station 4
Total Dissolved Solids, @105°C	47	45	45
Total Hardness, as $CaCO_3$	42	42	42
Calcium Hardness, as $CaCO_3$	24	30	18
Magnesium Hardness, as $CaCO_3$	18	12	24
Calcium, as Ca	9.6	12	7.2
Magnesium, as Mg	4.4	2.9	5.8
Alkalinity (Phenolphthalein), as $CaCO_3$	0	0	0
Alkalinity (Total), as $CaCO_3$	36	36	36
Carbonate Alkalinity, as $CaCO_3$	0	0	0
Bicarbonate Alkalinity, as $CaCO_3$	36	36	36
Hydroxides, as OH	0	0	0
Carbon Dioxide, as CO_2	-	18	54
Carbonates, as CO_3	0	0	0
Bicarbonates, as HCO_3	44	44	44
Chlorides, as Cl	0	0	0
Iron, as Fe	5.5	4.8	4.5
Manganese, as Mn	0	0	0
Sulfate, as SO_4	1	1	1
Fluorides, as F	0	0	0
Silica, as SiO_2	10	11	11
Copper, as Cu	0	0	0
Phosphate (Total), as PO_4	1.5	1.2	1.2
Color, Standard Platinum Cobalt Scale	45	40	40
Odor	0	0	0
pH (Laboratory)	4.8	6.6	6.1
Turbidity, Silica Scale	500	360	400

Table 13. (Continued)

Tests	Station 2	Station 3	Station 4
Total Nitrogen	2.73	2.50	2.57
Ammonia Nitrogen	1.00	0.82	0.82
Organic Nitrogen	1.73	1.68	1.75
NO_3 + NO_2 - Nitrogen	0.30	0.28	0.26
NO_2 - Nitrogen	0.10	0.05	0.05
NO_3 - Nitrogen	0.20	0.23	0.21
Total Phosphorus (PO_4-P)	0.27	0.27	0.25
Ortho Phosphorus (PO_4-P)	0.21	0.20	0.21
Total P - Filtered	-	-	-
Ortho P - Filtered	-	-	-
COD	15	21	21

Test results given in mg/l.

Table 14. Chemical Water Analysis of Broad River Study Area, Parr, South Carolina, March 21, 1971 (in ppm).

Test	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6
Total Nitrogen	0.35	0.85	0.15	0.15	0.25	0.15
Ammonia Nitrogen	0.24	0.28	0.12	0.12	0.22	0.07
Organic Nitrogen	0.11	0.57	0.03	0.03	0.03	0.08
NO_3 + NO - Nitrogen	0.254	0.186	0.251	0.257	0.194	0.270
NO_2 - Nitrogen	0.017	0.027	0.017	0.017	0.024	0.018
NO_3 - Nitrogen	0.237	0.159	0.234	0.240	0.170	0.252
Total P (PO_4-P)	0.25	0.38	0.28	0.25	0.31	0.29
Ortho P (PO_4-P)	0.18	0.19	0.23	0.23	0.23	0.29
COD	8	16	13	13	17	13
BOD	0.3	1.8	1.5	1.0	1.8	1.2
Total Dissolved Solids @ 105°C	40	36	60	No Data	No Data	No Data
Total Hardness, as $CaCO_3$	30	36	48	"	"	"
Calcium Hardness, as $CaCO_3$	18	18	36	"	"	"
Magnesium Hardness, as $CaCO_3$	12	18	12	"	"	"

Table 14. (Continued)

Test	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6
Fluorides, as F	0	0	0	No Data	No Data	No Data
Silica, as SiO_2	9	9	4	"	"	"
Copper, as Cu	0	0	0	"	"	"
Phosphate (Total), as PO_4	0.2	0.7	0.6	"	"	"
Color, Standard Platinum Cobalt Scale	45	250	90	"	"	"
Odor	0	0	0	"	"	"
pH (Laboratory)	7.5	7.2	7.2	"	"	"

Nitrogen and phosphorus represent water soluble fraction.

Test results in mg/l as applicable.

Table 14 (Continued)

Test	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6
Calcium, as Ca	7.2	7.2	14	No Data	No Data	No Data
Magnesium, as Mg	2.5	4.3	2.9	"	"	"
Alkalinity (Phenolphtalein), as $CaCO_3$	0	0	0	"	"	"
Alkalinity (Total), as $CaCO_3$	36	24	48	"	"	"
Carbonate Alkalinity, as $CaCO_3$	0	0	0	"	"	"
Bicarbonate Alkalinity, as $CaCO_3$	36	24	48	"	"	"
Hydroxides, as OH	0	0	0	"	"	"
Carbon Dioxide, as CO_2	-	3	6	"	"	"
Carbonates, as CO_3	0	0	0	"	"	"
Bicarbonates, as HCO_3	44	29	58	"	"	"
Chlorides, as Cl	0	0	0	"	"	"
Iron, as Fe	2.4	2.9	2.0	"	"	"
Manganese, as Mn	0	0	0	"	"	"
Sulfate, as SO_4	5	0	5	"	"	"

Table 15. Field Chemical and Physical Water Measurements Taken at Time of Sampling, Broad River Study Area, Parr, South Carolina, March 21, 1971.

	Station 1	Station 2	Station 3	Station 4	Station 5
TIME	1040	1225	1400	1520	1618
BOTTOM DEPTH (m)	6.70	2.74	2.13	2.95	3.65
AIR TEMPERATURE °C	70	70	68	67	66
SECCHI DISC (cm)	30.5	20.3	25.4	30.5	20.3
WATER TEMPERATURE °C					
Surface	12.0	15.5	12.5	12.0	14.0
Mid Depth	10.5	10.0	11.5	11.0	10.0
Bottom	10.5	10.0	11.5	11.0	8.0
DISSOLVED OXYGEN ppm					
Surface	9.2	10.5	12.0	10.5	10.2
Mid Depth	9.3	10.5	12.0	10.7	10.3
Bottom	9.2	10.2	11.5	10.5	10.0
pH					
Surface	7.50	7.24	7.17	7.30	7.14
Mid Depth	7.30	7.25	7.20	7.30	7.32
Bottom	7.35	7.16	7.00	7.33	7.60
VELOCITY (m/sec.)	0.609	0	0.289	0.54	0
(ft/sec.)	2.0	0	0.95	1.8	0

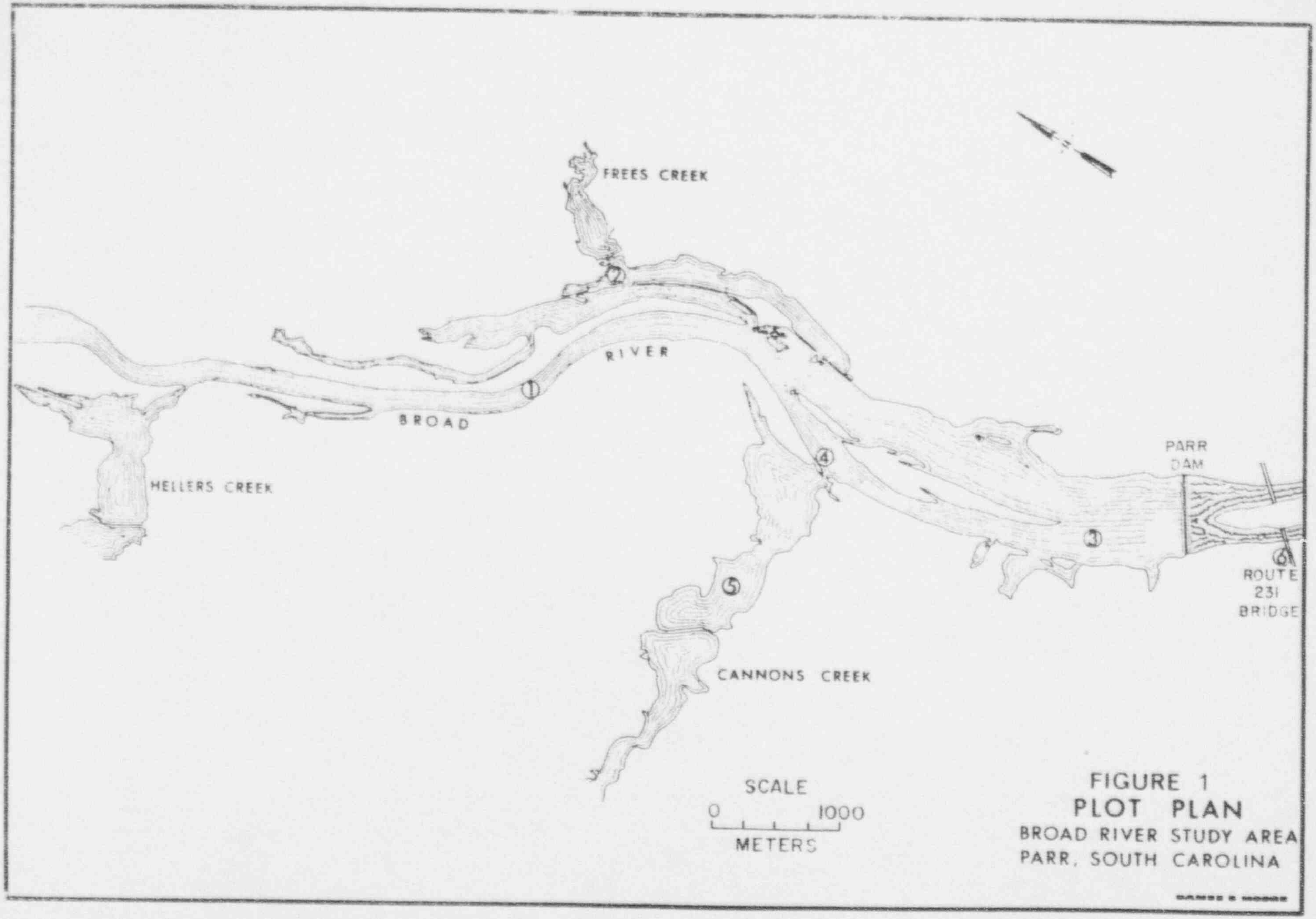


FIGURE 1
PLOT PLAN
BROAD RIVER STUDY AREA
PARR, SOUTH CAROLINA

APPENDIX B

EVALUATION OF THE CLIMATIC IMPACT OF LAKE MONTICELLO

EVALUATION OF THE CLIMATIC IMPACT OF LAKE MONTICELLO

B.1 INTRODUCTION

Heat generated by the Summer Station is the primary cause of effects on the atmosphere. Effects are anticipated first in the change in low level sensible temperature, then in the stability of the atmosphere over the cooling reservoir, and hence in the diffusion characteristics. With the addition of moisture to the atmosphere, the frequency of both advection and steam-type fog was examined.

Other effects which were examined but were not considered to be significant were the effects on the winds over the Lake surface and the effects of additional atmospheric moisture upon precipitation in the area.

The possible effects on the winds are changes in the wind speed, wind direction, and wind directional variability. The changes in the wind speed would occur because the surface frictional coefficient of the air-water interface would be different from that which is now existent at Elevation 425 feet. Small changes in the wind direction would also be caused by this change of the surface frictional coefficient. Also, a new thermodynamic regime would possibly be established with the impoundment of Lake Monticello, resulting in convective air currents and hence a modification of cool-air drainage winds over Frees Creek, if a significant one exists there. The wind directional variability could also be changed because of the change in the frictional coefficient over Lake Monticello. It is expected that any of these variations will not have a significant impact upon the atmospheric environment; however, to assess the variation in the winds and the diffusion characteristics in the area, a meteorological monitoring program will be established and computation of any variation will be made (See Section 2.3.6.3).

The addition of moisture to the atmosphere could result in a slight increase in the amount of precipitation. This slight increase in precipitation would be distributed over a large area, and its effects would not be significant.

B.2 IMPACT ON TEMPERATURE AND STABILITY

The effects of cooling ponds on temperatures in an area will be significant only when ventilation across the pond is at a minimum. The lack of ventilation will give air over the pond enough time to obtain the temperature of the surface water (Reference 1). In a study performed on the shore of Chesapeake Bay, it was found that low-level air in contact with the water for an hour or more had sufficient time to attain the temperature of the surface of the water. Considering this time interval and the shape of the pond, it is estimated that air moving with a speed of 3 mph or less would attain the surface water temperature. (It is realized that convective air currents generated by heated air over the Lake Monticello might modify this assumption, but 3 mph is a good approximation for analysis, and the on-site monitoring program, when initiated, will supply data for a more detailed analysis.)

The total change in the temperature of the air over Lake Monticello is a function of the surface water temperature. The surface water temperature is determined by adding the effects of the coolant water discharge from the Summer Station to the equilibrium surface temperature as determined in

Reference 2. The estimated monthly equilibrium surface water temperatures, based on a mathematical model, are provided in Table B-1.

Values for the change in surface temperature that are caused by the coolant water discharge are being evaluated by the Alden Research Laboratories. Preliminary results from this study are available and based on these data, a conservative 5° F average rise due to the coolant water discharge when the wind speed is less than or equal to 3 mph has been utilized in analysis. For any wind speed greater than 3 mph, the air would not remain in contact with the water for a sufficient amount of time to attain the surface water temperature.

TABLE B-1

EQUILIBRIUM LAKE MONTICELLO SURACE WATER TEMPERATURE

MONTH	EQUILIBRIUM TEMP. (°F)
Jan.	44.4
Feb.	49.6
Mar.	58.7
Apr.	69.6
May	79.4
June	85.9
July	87.7
Aug.	86.7
Sep.	80.6
Oct.	68.6
Nov.	53.4
Dec.	43.5

The most important consequence of the increased air temperature is not its effect upon the sensible heat, but its effect upon the change in the stability of the atmosphere. The stability of the atmosphere has a direct effect upon the diffusion characteristics at the site; thus, an estimate of the modified stability was made since it would alter the diffusion at the site. This estimate was accomplished by modifying the low-level temperatures for those winds which move either on-shore or off-shore at Summer Station with a speed less than or equal to 3 mph. Temperatures were not modified for winds with a direction from the sectors east through southeast and west through northwest, because the air would not remain in contact with the lake surface for a sufficient length of time to achieve isothermicity.

The change of thermal stability due to the impoundment of Lake Monticello is presented in Table B-2. The stabilities are presented as Pasquill class and with a literal description. The frequencies are presented as annual percentages. The first column of frequencies presents the best approximation to the frequency of stability classes that are existing in the site area (based upon CVTR tower data). The second column of frequencies presents an estimate of the stability considering only the equilibrium surface water temperature of Lake Monticello and the third column of frequencies presents the frequency and stability classifications considering the equilibrium surface water temperature and the effect of the coolant water discharge from the Summer Station. It is noted that the impoundment of Lake Monticello will cause a decrease in the frequency of the more stable classifications and an increase in the frequency of the more unstable classifications.

TABLE B.2

THERMAL STABILITY CHANGES DUE TO LAKE MONTICELLO

PASQUILL CLASS	STABILITY DESCRIPTION	STABILITY FREQUENCY		
		AT CVTR TOWER	WITH LAKE MONTICELLO'S EQUILIBRIUM SURFACE WATER TEMPERATURE	
			W/O COOLANT WATER DISCHARGE	W/ COOLANT WATER DISCHARGE
A	Extremely Unstable	9.79%	18.51%	19.47%
B	Unstable	4.05%	4.02%	4.05%
C	Slightly Unstable	6.30%	5.88%	5.98%
D	Neutral	22.68%	20.63%	20.80%
E	Slightly Stable	26.97%	23.99%	24.23%
F	Stable	13.05%	10.79%	10.68%
G	Extremely Stable	17.17%	16.18%	14.79%
E+F+G	All Stable Conditions	57.19%	50.96%	49.70%
	Relative Dispersion (seconds/cubic meter)	3.3×10^{-4}	2.35×10^{-4}	2.15×10^{-4}

The most significant change occurs in the "All Stable Conditions" in Table B-2 in which a decrease in frequency from 57 to 51 percent occurs due to the creation of Lake Monticello and a further decrease to about 50 percent occurs with the addition of the coolant water discharge from the Summer Station. This change in the frequency of stability classifications has a significant effect on the diffusion characteristics at the Summer Station site. This effect can be illustrated by using the relative concentration at the 95% level as a reference. The best approximation to the existing diffusion (relative concentration) in the site area (as determined by data from the CVTR tower) for the 95% level, is estimated to be 3.3×10^{-4} sec/cu meter. The change in the relative concentration due to the impoundment of Lake Monticello will result in a 95% level diffusion of 2.35×10^{-4} sec/cu meter. This would decrease to an estimated 2.15×10^{-4} sec/cu meter when the coolant water discharge from the Summer Station is considered. With this decrease in relative concentration values, it is noted that there will be a significant enhancement of the diffusion characteristics at the site due to the Lake Monticello functioning as a cooling reservoir.

Warming of the atmosphere, the change in the stability, and the change in the diffusion characteristics do not persist for a great distance from the lake. It is estimated that these changes would not prevail for more than several hundred yards downwind of the lake. For distances greater than this, the modified air would have had sufficient time to mix with the ambient air and return to the ambient temperature and stability conditions.

B.3 IMPACT UPON THE FREQUENCY OF FOG

The relative humidity of the air is an important factor in the creation of fog. Since Lake Monticello functions as a cooling reservoir by evaporating water vapor into the air, it should increase the humidity over the lake, thereby resulting in a change in the frequency of fog. The conditions for fog formation are a high relative humidity and a dewpoint temperature that would be greater than Lake Monticello's equilibrium surface water temperature. To effect these conditions and allow an estimation of the increased frequency of fog, two mechanisms for the creation of fog were examined. These mechanisms result in the phenomena of advection fog and steam fog.

B.3.1 Advection Fog

Advection fog results from the advection, or movement, of moist air over a colder surface. This condition for fog formation occurs when the dewpoint temperature is warmer than the surface water temperature and the winds are sufficiently light to allow the dewpoint temperature to approach the surface water temperature.

Data which form the basis for this estimation were measured at the Columbia Weather Station. These data were used because they contained simultaneous observations of temperature, dewpoint, wind speed, wind direction, and fog observations. Even though any particular fog occurrence may not be representative of the specific conditions at Lake Monticello, it is believed that the overall frequency increase in fog will closely approximate that over the lake.

The purpose of this study was to determine the increase in the frequency of fog. If fog already existed for the time period, then the data was not considered. Wind speed and direction criteria that would be compatible with air remaining over the lake for a sufficient time interval are as follows:

A. An observation was not considered if the wind speed was greater than seven mph.

B. If the wind speed was four to seven mph, then only observations with wind directions from the north-northwest through north-northeast or south-southeast through south-southwest were considered (thereby correlating wind directions to the long axis of the lake).

C. If the wind speed was less than or equal to three mph, all observations were considered.

In addition, it was assumed that fog occurred if the dewpoint was greater than or equal to the equilibrium surface water temperature (Table B-1).

The frequency increase due to advection type fog is presented in Table B-3 for a selected time period (concurrent with the data that was obtained and used in the diffusion analysis). Note from the Table that the fog frequencies for Columbia Weather Station varied from about seven percent in December, 1965, up to almost 20 percent in January, 1966. If these fog frequencies had been applicable over the lake, then the net increase due to advection type fog is estimated to be as presented in the third column of Table B-3. This net

TABLE B-3

PROJECTED IMPACT OF LAKE MONTICELLO ON FOG* FREQUENCY

MONTH	FOG FREQUENCY (%) AT COLUMBIA	NET FREQUENCY (%) INCREASE DUE TO: ADVECTION FOG	STEAM FOG
June, 1965	-	**	**
July, 1965	8.5	0	6.4
Aug., 1965	-	**	**
Sep., 1965	12.9	0	9.2
Oct., 1965	9.3	0	11.7
Nov., 1965	9.6	0.4	15.8
Dec., 1965	6.9	3.6	12.9
Jan., 1966	19.8	2.0	7.6
Feb., 1966	18.8	0.4	4.0
Mar., 1966	-	**	**
Apr., 1966	-	**	**
May, 1966	12.9	0	5.6

* Defined by visibilities less than or equal to six miles.

** Not Computed

increase would vary from no increase for the months of July, September, October, and May to as high as a 3.6 percent increase in December. The reason for an increase of fog frequency during these cooler months is that the reservoir surface temperature is low enough to cool air to its dewpoint on the warmer, more humid days of the cold season.

B.3.2 Steam Fog

Steam fog results from intensive evaporation of vapor from a warm water surface into a relatively cooler air mass. The occurrence of steam fog will be usually confined to the immediate area of Lake Monticello and would not be experienced more than few feet inland from the shoreline. A good example of steam fog that is familiar to many people is the steam rising off a hot road in the summer afternoon after a shower. It does not persist for a great height over the surface of the road and it is readily dissipated in a breeze.

Criteria used in the compilation of the increased fog frequency due to steam fog were:

A. No fog existed.

B. Wind speed must be less than or equal three mph.

C. When relative humidity is greater than or equal to 90 percent, the temperature spread between the air and water is greater than or equal to 5° F.

D. When the relative humidity is between 75 and 90 percent, the temperature spread between the air and water is greater than or equal to 10° F.

The frequency increase due to steam fog is presented in the fourth column of Table B-3. Net frequency increases vary from 4 percent in February up to about 16 percent in November. This frequency increase in November seems rather large; however, it does not present a significant impact upon visibilities in the area because of the nature of steam fog.

The meteorological monitoring program will be designed to acquire temperature, moisture and surface water temperature data in addition to wind speed and wind direction data adjacent to Lake Monticello. After a suitable amount of data has been acquired (approximately one year), a review of the variations in the wind, moisture and thermodynamic parameters will be made to verify the influence of Lake Monticello on fog frequency.

B.4 CONCLUSIONS

1. The existence of Lake Monticello will alter the frictional coefficients of the land surface; however, the impact of this upon the wind speed, direction and directional variability is not considered to be significant. Even though no evidence of a drainage wind was found in the analysis of the CVTR tower data, a meteorological monitoring program will be established to assess the impact upon climatic winds and possible drainage winds.

2. No significant changes in the amount of precipitation are anticipated in the area.

3. Lake Monticello could warm the air as much as 5° F for periods of calm air. This warming would only last for several hundred yards from the lake's shore before the warmed air mixes with

the ambient air and returns to its original temperature.

4. The stability and diffusion characteristics of the atmosphere would be enhanced during the periods of atmospheric warming caused by Lake Monticello. The meteorological monitoring program is designed to document these changes.

5. The increase in the frequency of fog was analyzed for advection and steam-type fogs. For the more significant advectión-type fog, the frequency increase was estimated to be greatest in the colder months; 3.6 percent was the greatest increase for those months considered. The summer months were estimated to have no change. Most of the increased fog frequency for advection fog was due to an earlier onset, or a later dissipation (i.e., a longer duration) of an observed fog situation. Increases of up to 16 percent were estimated for the less significant, steam-type fog. The nature of this type of fog, however, would limit its effects to the air immediately over Lake Monticello and only a few feet inland. From this analysis, it is estimated that there will be an increase in the frequency of fog; however, it will not constitute a significant impact upon the atmospheric environment.

REFERENCES

1. "Atmospheric Dispersion over Chesapeake Bay," Monthly Weather Review, 90 (6), pp 217-224, June 1962.

2. "Development of Electric Power Resources, 1971-1981," South Carolina Electric & Gas Company, January, 1971.

QUARTERLY REPORT ON THE BASELINE BIOTIC SURVEY,
BROAD RIVER STUDY AREA
PARR, SOUTH CAROLINA

FOR SOUTH CAROLINA ELECTRIC & GAS COMPANY
MARCH, 1971

Project No. 5182-013-09

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CABLE: DAMEMORE TELEX: 5-42611

South Carolina Electric & Gas Company
Post Office Box 764
Columbia, South Carolina 29202

Attn: Mr. Harold T. Babb and
Mr. W. E. Moore

Gentlemen:

Enclosed with this letter is a draft of our report entitled "Quarterly Report on the Baseline Biotic Survey, Broad River Study Area, Parr, South Carolina, for South Carolina Electric & Gas Company, March, 1971. This quarterly survey was the first in a series of surveys. The survey was undertaken in part to provide some baseline information for inclusion in the Environmental Report. An aquatic survey, only, was undertaken.

If you have any questions concerning this draft, please do not hesitate to contact us. As soon as we have received your comments we will prepare the report in final form.

Very truly yours,

DAMES & MOORE

Robert C. K. Au

William M. Greenslade

RCKA:WMG/gh
Enclosure

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1.0 INTRODUCTION

In connection with the proposed Fairfield Pumped-Storage Facility and Virgil C. Summer Nuclear Station Unit 1, to be constructed about three miles north of Parr, South Carolina, a survey of aquatic life was initiated in March, 1971. The survey was conducted in the Broad River (Parr Reservoir) in the vicinity of the proposed projects.

The purpose of the survey was to obtain an indication of the aquatic biota present in the project area. Sampling of fish, plankton and benthos was performed. Water samples for the determination of chemical and physical properties of the Broad River were taken.

The March sampling trip is the first of planned quarterly biological surveys which are being performed to establish a baseline of aquatic biota in the project area prior to construction of the proposed facilities. Data from these surveys will provide the basis for evaluating any changes brought about during construction and operation phases of the project and are part of a broad environmental monitoring program which will continue into the construction and operational phase of the planned projects to assess and evaluate the environmental impact of the proposed facilities.

2.0 METHODS AND MATERIALS

2.1 COLLECTION STATION DESCRIPTION

Collections were made between March 1 and March 21, 1971. Two site visits were made. The first visit made from March 1 to 4, 1971 coincided with a period of high run-off and made sampling of the aquatic biota impossible. Some water measurements were made. A second trip was made from March 15 through March 21, 1971, after the river had subsided, and a successful sampling of the biota was accomplished.

Five sampling areas were located and are shown on Figure 1. These areas were selected as representative of varying conditions within the present waterway and of conditions that are anticipated to exist when the facilities are completed. The stations are defined as follows:

Station 1, located upstream from the Frees Creek embayment in the Broad River channel, an area that would not be subject to strong current movements when the pumped-storage facility is operating.

Station 2, located near the mouth of the Frees Creek embayment in an area that would be subject to strong water movements during pumping and water release.

Station 3, located in the main body of Parr Reservoir, approximately 3,000 feet above Parr Dam.

Station 4, located near the outlet of the Cannons Creek embayment, a main channel on the west side of Parr Reservoir.

Station 5, located within the Cannons Creek embayment, a major embayment on the west side of the Broad River.

Station 6, located below Parr Dam, an area that would be indicative of the cumulative effects of changes in Parr Reservoir on downstream life.

2.2 AQUATIC COLLECTING PROCEDURES

2.2.1 Plankton

At each station 76 liters (20 gallons) of surface water were passed through a Wisconsin #25 plankton net and organisms were concentrated in 100 ml. 50 milliliters of this volume were then centrifuged and examined under a microscope. Examination for plankton followed the procedures outlined in the 12th edition of Standard Methods for the Examination of Water and Waste Water. Two passes were made with 40 power magnification and two passes were made with a 160 power magnification objective lens.

2.2.2 Benthic and Limnic Fauna

All samples were taken by a 15 cm x 15 cm Ekman dredge, and sediments were separated using a #30 sieve. Samples were collected at

Stations 2, 3 and 5.

2.2.3 Fish

Fish were collected by means of seines, traps, and an electroshocker. All fish were weighed to the nearest ounce and measured to the nearest 1/10 inch (total length). Data was later converted to the metric system. These data provided information to determine representative size classes and condition factors. Scale samples were also taken for later reading and determination of age groups. The fish were returned to the river after being marked for future identification. The right pectoral fin was clipped to provide a short-term method to determine recapture during later samples. More permanent markings may be utilized if needed for long-range studies.

The data from all fish were grouped in one centimeter increments. The total length of individuals were rounded to the nearest centimeter, i.e., individuals from 1.5 - 2.4 cm are included in the 2.0 centimeter group.

Condition factor (K) were calculated for each individual fish, and the average condition factor of all fish in each length grouping was determined. The formula $K_{(TL)} = 100W/L^3$ was used for all condition factor determinations. This formula, along with its application and limitations, is described in Bennett (1962). Condition factors were not calculated for very small fish because of inaccuracies associated with weighing in the field.

2.2.4 Physical and Chemical Analyses of Water

Water samples were collected in standard Kremmer water samplers, sealed in clean glass jars, and sent to a commercial laboratory for analysis. Samples from the surface, mid-water, and bottom were taken separately and then combined for one sample indicative of the entire water column.

3.0 FINDINGS

3.1 AQUATIC BIOTA

3.1.1 Plankton

Table 1 lists the phytoplankton collected and their relative abundance in numbers. Diatoms, primarily of the order Pennales were most abundent. Species showing the highest populations were: (1) Naviculate diatoms, (2) *Synedra* sp., (3) *Melosira* sp. and (4) *Asterionella formosa*. At least nine species made up the diatom community. Other phytoplankton observed were *Scenedesmus*, *Ankistrodesmus* and various unidentified green coccoid types indicating the possible development of a chlorophycean assemblage as water temperatures rise with the spring season. A very low population of zooplankton was found. The scarcity of zooplankton probably is a reflection of the cold, early spring season and is probably not representative of the river throughout the year. It would be expected that species of copepods and cladocerans would make up a significant portion of the plankton, and none of these were found.

3.1.2 Benthic and Limnic Fauna

Bottom samples were collected at Stations 2, 3 and 5. Table 2 lists the benthic invertebrates found and their abundance. Benthic fauna was limited, based on the samples taken. Only three types of organisms were present. These were the tubificids, commonly referred to as sludge worms, phantom midges (Chaoborus sp.) and some Chironomids. A few statoblasts of bryozoans were noted indicating the presence of these organisms in the river environment. No other invertebrates were identified, however, a number of tusks probably representing immature mayflies were seen.

3.1.3 Fish

A total of 16 species were recorded and include largemouth bass, white crappie, redear sunfish, pumpkinseed sunfish, warmouth sunfish, bluegill sunfish, redbreast sunfish, white catfish, yellow bullhead, white sucker, gizzard shad, longnose gar, golden shiner, carp, American eel, and a darter. A list of species collected by station and by types of collecting gear are presented in Table 3.

Table 4 presents the species composition and abundance of all fish collected during the sampling period. Of these, the bluegill sunfish was the most abundant species (48.9%). As a result of contacts made with local fishermen, catfish were reported to be the most sought after species. Because of selectivity of sampling gear to the scale fishes, means of sampling other than those employed during this sampling will be necessary to determine the significance of catfish in the river. Tables 5 through 12, present species composition, relative abundance, length, frequency, percent of total, average weight and condition factor for fish collected, by station.

3.1.4 Physical and Chemical Analyses of Water

Three sets of water quality data were obtained during the sampling period. One set of samples was collected during each site visit and subjected to laboratory analyses. In addition, field measurements were made at the time the fish were collected. Data from samples collected during the first site visit on March 4, 1971 are presented in Table 13. Samples were collected at Stations 2, 3 and 4 only; high water stage prevented the collection of samples at other stations. Data collected during the second site visit are presented in Table 14.

Generally the river has a high suspended solids content. This is evidenced by the fact that the river water usually has substantial turbidity.

Nutrients such as nitrogen and phosphorus are adequate to sustain a fairly high biomass of plant materials. Total nitrogen, for example, ranged from 2.57 mg/l to 2.73 mg/l in water collected in early March and from 0.15 mg/l to 0.85 mg/l at the end of the month. It is likely that the elevated levels during the first period are reflections of the heavy rainfall occurring during this time which washed nitrogenous substances from the land and atmosphere into the river.

Phosphorus concentrations range from 0.21 mg/l at Station 4 to 0.38 mg/l at Station 3. Therefore, plant growth would not appear to be limited by this nutrient. Since the water is relatively low in alkalinity (24 mg/l to 36 mg/l) some algal growth stimulation may occur from carbon.

Silica and calcium play significant roles in phytoplankton development. Silica is in abundant supply. Samples showed an average value of 9 mg/l. Calcium varied from 7.2 mg/l to 14 mg/l.

4.0 REFERENCES

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2. Lagler, Karl F., 1956, "Freshwater Fishery Biology," Wm. E. Brown Company, Dubuque, Iowa.

3. Ward, Henry B., and George C. Whipple, 1959, "Fresh-Water Biology," John Wiley & Sons, Inc., New York, London.

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Table 1. Unfiltered Samples of Phytoplankton Collected, Broad River Study Area, Parr, South Carolina, March 21, 1971, in No./ml.

CYANOPHYTA	CHLOROPHYTA	CHRYSOPHYTA		EUGLENOPHYTA	DINOFLAGELLATA
		Station No. 1			
	Scenedesmus sp. 1	Naviculate	20	3	
	Unidentified Green Coccoid 3	*Synedra* sp.	14		
		Melosira varians	4		
		Cocconeis placentula	1		
		Melosira sp.	5		
		Unidentified Pennate	2		
		Synedra accus	1		
		Stauroneis sp.	1		
		Cymbella	2		
		Fragilaria crotonensis	1		
		Station No. 2			
	Unidentified Green Coccoid 29	Unidentified Diatom	4	4	3
	Scenedesmus sp. 1	*Asterionella formosa*			
		Cells	14		
		Colonies	3		
		Synedra sp.	4		
		Naviculate	1		
		Dinobryon sp.	1		
		Synedra accus	1		
		Station No. 3			
	Unidentified Green Coccoid 5	*Synedra* sp.	8	5	
	Scenedesmus sp. 5	Naviculate	13		
		Asterionella formosa	15		
		Melosira sp.	10		
		Tabellaria fenestrata	5		

Table 1. (Continued)

Station No. 4

CYANOPHYTA	CHLOROPHYTA		CHRYSOPHYTA		EUGLENOPHYTA	DINOFLAGELLATA
	Unidentified Green Coccoid	6	*Synedra accus*	5		1
	Scenedesmus sp.	1	*Synedra* sp.	7		
			Stauroneis	3		
			Unidentified Pennate	1		
			Asterionella formosa			
			Cells	16		
			Colonies	4		
			Cymbella sp.	3		
			Fragilaria sp.	4		
			Naviculate	11		
			Melosira sp.	11		
			Unidentified	8		

Station No. 5

CYANOPHYTA		CHLOROPHYTA		CHRYSOPHYTA		EUGLENOPHYTA	DINOFLAGELLATA
Oscillatoria sp.	1	Ankistrodesmus	1	Naviculate	3	2	
		Unidentified Green Coccoid	1	*Synedra* sp.	4		
				Melosira sp.	1		

Station No. 6

CYANOPHYTA	CHLOROPHYTA		CHRYSOPHYTA		EUGLENOPHYTA	DINOFLAGELLATA
	Unidentified Green Coccoid	24	*Tabellaria fenestrata*	1		
	Scenedesmus sp.	4	*Synedra* sp.	15		
			Naviculate	8		
			Asterionella formosa			
			Cells	5		
			Colonies	1		
			Melosira varians	10		
			Unidentified	4		

Table 2. Benthos Collected from Station #2, 3 and 5, Broad River Study Area, Parr, South Carolina, March 21, 1971.

STATION 2

52 - Chaoborus sp.
3 - Tendipedidae
14 - 15 - Tubificidae
2 - Sphaeriidae
1 - Ephemeridae Hexagenia sp.

STATION 3

1 - Tendipendidae larva
1 - Chaborus sp.
1 - Sphaeriidae
1 - Unidentified submersed plant

STATION 5

33 - Chaoborus sp.
6 - Tendipedidae
15 - Tubificidae

Table 3. Fish Collected from Broad River Study Area, Parr, South Carolina, March 15, 1971.

	Common Name	Scientific Name	Station 5	Station 2	Station 3	Station 6
Shocker -	Largemouth Bass	Micropterus salmoides	x	x	x	
	Redear Sunfish	Lepomis microlophus	x	x	x	
	Pumpkinseed Sunfish	Lepomis gibbosus	x	x		
	Warmouth Sunfish	Chaenobryttus gulosus	x	x		
	Bluegill Sunfish	Lepomis macrochirus	x	x	x	x
	Redbreast	Lepomis auritis	x			
	White Crappie	Pomoxis annularis	x	x	x	
	Gizzard Shad	Dorosoma cepedianum	x	x	x	x
	Carp	Cyprinus carpio	x	x		x
	Darter sp.	Etheostoma sp.		x		
	Golden Shiner	Notemigonus crysoleucas			x	
	White Sucker	Catostomus commersoni				x
	White Catfish	Ictalurus catus				x
	Longnose Gar	Lepisosteus osseus				x
Traps -	Redear Sunfish	Lepomis microlophus	x			
	Pumpkinseed Sunfish	Lepomis gibbosus	x			
	Bluegill Sunfish	Lepomis macrochirus	x	x	x	x
	White Crappie	Pomoxis annularis	x			
	Golden Shinner	Notemigonus crysoleucas	x			
	Warmouth Sunfish	Lepomis Gulosus		x		
Seine -	Largemouth Bass	Micropterus salmoides			x	
	Bluegill Sunfish	Lepomis macrochirus			x	
	White Crappie	Pomoxis annularis			x	
	Gizzard Shad	Dorosoma cepedianum			x	
	Golden Shinner	Notemigonus crysoleucas			x	
Species Observed	Largemouth Bass	Micropterus salmoides				x
	White Crappie	Pomoxis annularis				x
	American Eel	Anguilla rostrata				x
	Yellow Bullhead	Ictalurus natalis				x

Table 4. Species Composition and Relative Abundance of All Fishes Collected in the Broad River Study Area, Parr, South Carolina, March, 1971.

Common Name	Scientific Name	No.	% of Total
Bluegill	*Lepomis macrochirus*	93	48.9
White crappie	*Pomoxis annularis*	20	10.5
Redear sunfish	*Lepomis microlophus*	18	9.5
Largemouth bass	*Micropterus salmoides*	13	6.8
White sucker	*Catostomus commersoni*	13	6.8
Carp	*Cyprinus carpio*	8	4.2
Gizzard shad	*Dorosoma cepedianum*	8	4.2
Golden shiner	*Notemigonus crysoleucas*	6	3.1
Pumpkinseed sunfish	*Lepomis gibbosus*	3	1.5
Warmouth sunfish	*Lepomis gulosus*	3	1.5
Longear sunfish	*Lepomis megalotis*	2	1.0
White catfish	*Ictalurus catus*	2	1.0
Longnose gar	*Lepisosteus osseus*	1	.5
	Total	190	

Table 5. Species Composition and Relative Abundance of Fishes Collected at Station 2, Broad River Study Area, Parr, South Carolina, March, 1971.

Common Name	Scientific Name	No.	% of Total
Bluegill	Lepomis macrochirus	28	62.2
Largemouth bass	Micropterus salmoides	4	8.8
White crappie	Pomoxis annularis	4	8.8
Redear sunfish	Lepomis microlophus	3	6.6
Pumpkinseed sunfish	Lepomis gibbosus	2	4.4
Warmouth sunfish	Lepomis gulosus	2	4.4
Carp	Cyprinus carpio	2	4.4
	Total	45	

Table 6. Length, Frequency, Weight and Condition Factor of Fishes Collected at Station 2, Broad River Study Area, Parr, South Carolina, March, 1971.

Total Length (cm)	Frequency	% of Total, by Species	Average Weight (grams)	Condition[a] Factor
		(Bluegill)		
4	1	3.7	-	-
4	1	3.7	-	-
6	3	11.1	-	-
7	5	18.5	-	-
8	3	11.1	9	1.8
9	2	7.4	14	1.7
10	6	22.2	23	1.9
11	2	7.4	32	2.2
12	2	7.4	32	1.8
13	2	7.4	45	2.1
	27			
		(Largemouth bass)		
16	1	25.0	54	1.4
17	1	25.0	68	1.3
34	1	25.0	613	1.6
40	1	25.0	1043	1.6
	4			
		(White crappie)		
24	1	25.0	181	1.3
30	1	25.0	408	1.6
31	2	50.0	488	1.6
	4			
		(Redear sunfish)		
6	1	33.3	-	-
16	1	33.3	86	2.1
27	1	33.3	318	1.6
	3			
		(Pumpkinseed sunfish)		
9	1	50.0	14	1.7
10	1	50.0	27	2.4
	2			

[a] $K_{(TL)} = 100W/L^3$

Table 6. (Continued,

Total Length (cm)	Frequency	% of Total, by Species	Average Weight (grams)	Condition[a] Factor
		(Warmouth sunfish)		
14	1	50.0	59	2.3
15	1	50.0	68	1.9
	2			
		(Carp)		
60	1	50.0	3062	1.4
78	1	50.0	6350	1.3
	2			

[a] $K_{(TL)} = 100W/L^3$

Table 7. Species Composition and Relative Abundance of Fishes Collected at Station 5, Broad River Study Area, Parr, South Carolina, March, 1971.

Common Name	Scientific Name	No.	% of Total
Redear sunfish	Lepomis microlophus	6	25.0
Bluegill	Lepomis macrochirus	5	20.8
White crappie	Pomoxis annularis	4	16.6
Largemouth bass	Micropterus salmoides	3	12.5
Longear sunfish	Lepomis megalotis	2	8.3
Pumpkinseed sunfish	Lepomis gibbosus	1	4.1
Warmouth sunfish	Lepomis gulosus	1	4.1
Carp	Cyprinus carpio	1	4.1
Golden shiner	Notemigonus crysoleucas	1	4.1
	Total	24	

Table 8. Length, Frequency, Weight and Condition Factor of Fishes Collected at Station 5, Broad River Study Area, Parr, South Carolina, March, 1971.

Total Length (cm)	Frequency	% of Total, by Species	Average Weight (grams)	Condition Factor[a]
		(Redear Sunfish)		
6	1	16.7	-	-
13	1	16.7	45	2.2
19	1	16.7	113	1.6
21	1	16.7	159	1.8
22	1	16.7	181	1.7
26	1	16.7	272	1.6
	6			
		(Bluegill)		
6	1	20.0	18	-
10	2	40.0	23	1.7
11	1	20.0	32	2.2
16	1	20.0	77	1.8
	5			
		(White crappie)		
12	1	25.0	23	1.4
20	1	25.0	113	1.5
21	1	25.0	136	1.4
33	1	25.0	499	1.5
	4			
		(Largemouth bass)		
21	1	33.3	113	1.2
23	1	33.3	136	1.2
31	1	33.3	445	1.5
	3			
		(Longear sunfish)		
10	1	50.0	18	1.6
14	1	50.0	45	1.8
	2			
		(Pumpkinseed sunfish)		
15	1	100.0	68	1.9
		(Warmouth sunfish)		
10	1	100.0	23	2.0

[a] $K_{(TL)} = 100W/L^3$

Table 8. (Continued)

Total Length (cm)	Frequency	% of Total, by Species	Average Weight (grams)	Condition[a] Factor
		(Carp)		
55	1	100.0	2835	1.7
		(Golden shiner)		
14	1	100.0	32	1.3

[a] $K_{(TL)} = 100W/L^3$

Table 9. Species Composition and Relative Abundance of Fishes Collected at Station 3, Broad River Study Area, Parr, South Carolina, March, 1971.

Common Name	Scientific Name	No.	% of Total
Bluegill	*Lepomis macrochirus*	55	57.8
White crappie	*Pomoxis annularis*	12	12.6
Redear sunfish	*Lepomis microlophus*	9	9.4
Gizzard shad	*Dorosoma cepedianum*	8	8.4
Largemouth bass	*Micropterus salmoides*	6	6.3
Golden shiner	*Notemigonus crysoleucas*	5	5.2
	Total	95	

Table 10. Length, Frequency, Weight and Condition Factor of Fishes Collected at Station 3, Broad River Study Area, Parr, South Carolina, March, 1971.

Total Length (cm)	Frequency	% of Total, by Species	Average Weight (grams)	Condition[a] Factor
		(Bluegill)		
6	1	1.8	-	-
7	3	5.4	-	-
8	2	3.6	-	-
9	8	14.5	-	-
10	7	12.7	-	-
11	7	12.7	-	-
12	5	9.1	-	-
13	6	10.9	-	-
14	9	16.4	54	2.0
15	3	5.5	67	2.1
16	2	3.6	88	2.2
17	1	1.8	91	1.9
18	1	1.8	127	2.4
	55			
		(White crappie)		
9	1	8.3	9	1.2
10	2	16.7	9	1.0
11	1	8.3	14	1.1
13	1	8.3	23	1.1
14	3	25.0	41	1.6
15	1	8.3	45	1.4
20	1	8.3	127	1.5
23	2	16.7	161	1.3
	12			
		(Redear sunfish)		
6	1	11.1	5	1.9
7	1	11.1	5	1.4
8	1	11.1	9	1.7
13	1	11.1	45	2.2
16	1	11.1	82	1.9
20	2	22.2	180	2.1
23	1	11.1	263	2.2
24	1	11.1	295	1.8
	9			

[a] $K_{(TL)} = 100W/L^3$

QUARTERLY REPORT ON THE BASELINE BIOTIC SURVEY,
BROAD RIVER STUDY AREA
PARR, SOUTH CAROLINA

FOR SOUTH CAROLINA ELECTRIC & GAS COMPANY
JUNE, 1971

Project No. 5182-031-17

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1.0 INTRODUCTION

This report presents the results of the second quarterly sample taken in the area of the proposed Summer Nuclear Station and the Fairfield Pumped-Storage Facility near Parr, South Carolina. Data were collected during the weeks of June 21, 1971. The objective of the survey remained the same as for the initial survey: to provide baseline information on biological communities in the Parr Reservoir area of the Broad River. These data will be used as a means of evaluating potential effects from the construction or operation of the proposed project.

As a result of experience gained during the March sampling, some procedures were changed for this survey. The changes strengthen the program and are detailed under Methods and Materials. In addition, a terrestrial survey program was begun with the objectives of identifying important plant and animal species in the area surrounding Parr Reservoir and arriving at indications of their abundance.

2.0 AQUATIC SURVEY

The area encompassed by the aquatic survey is shown in Figure 1. Within the study area the Broad River is a slow moving, turbid stream. Secchi disc readings range from .15 to .70 meters. Water depth at Parr Dam was originally 30 feet when the dam was construction in 1914. Since that date heavy deposits of silt have reduced water depth to less than 10 feet at the dam and to a few feet or less in other parts of the reservoir. This has made boat travel difficult in some locations.

Within the reservoir many stumps, submerged or above water, remain from the initial flooding. In addition, islands have formed due to silt deposition. The shoreline is heavily vegetated with trees, which often overhang the water.

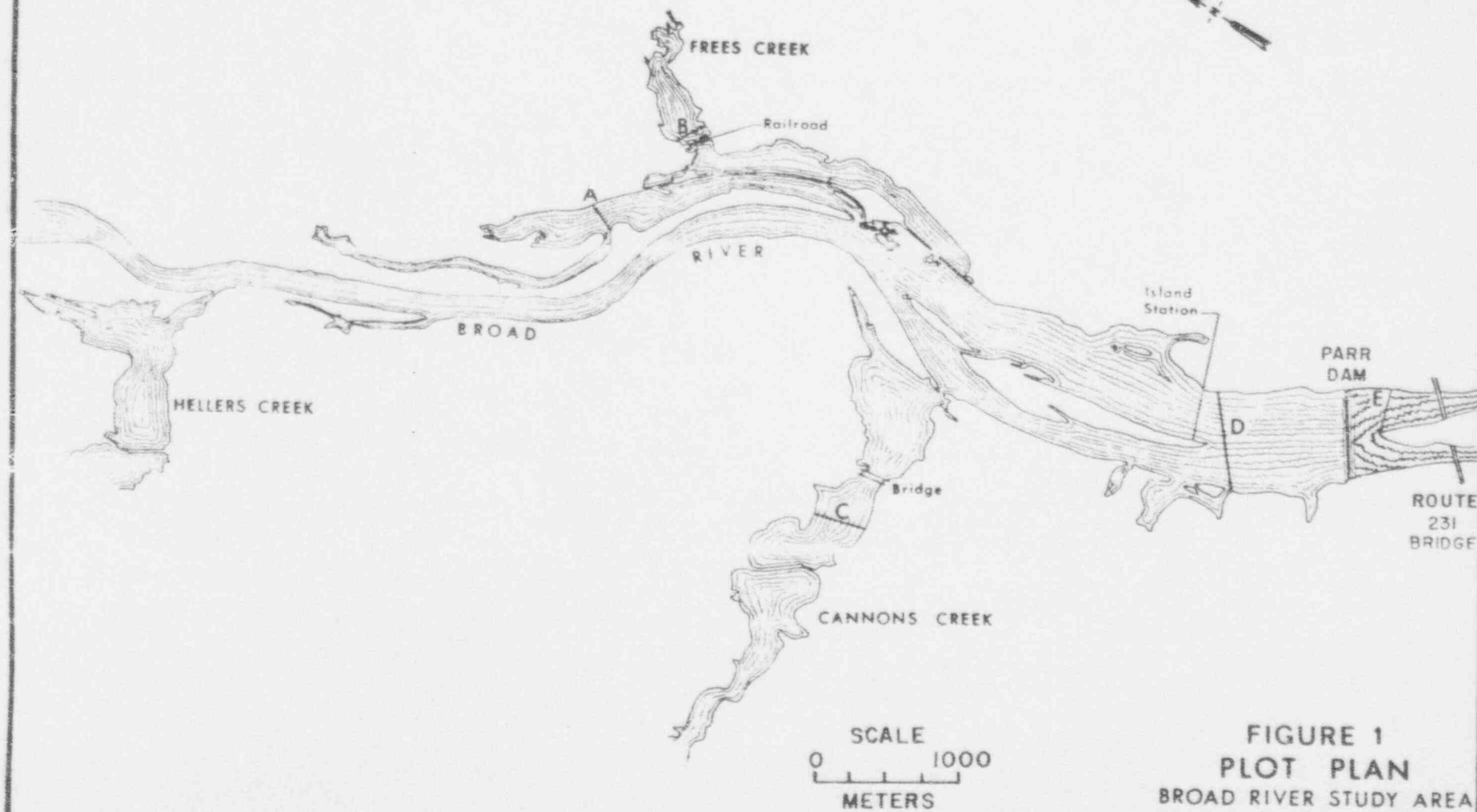


FIGURE 1
PLOT PLAN
BROAD RIVER STUDY AREA
PARR, SOUTH CAROLINA

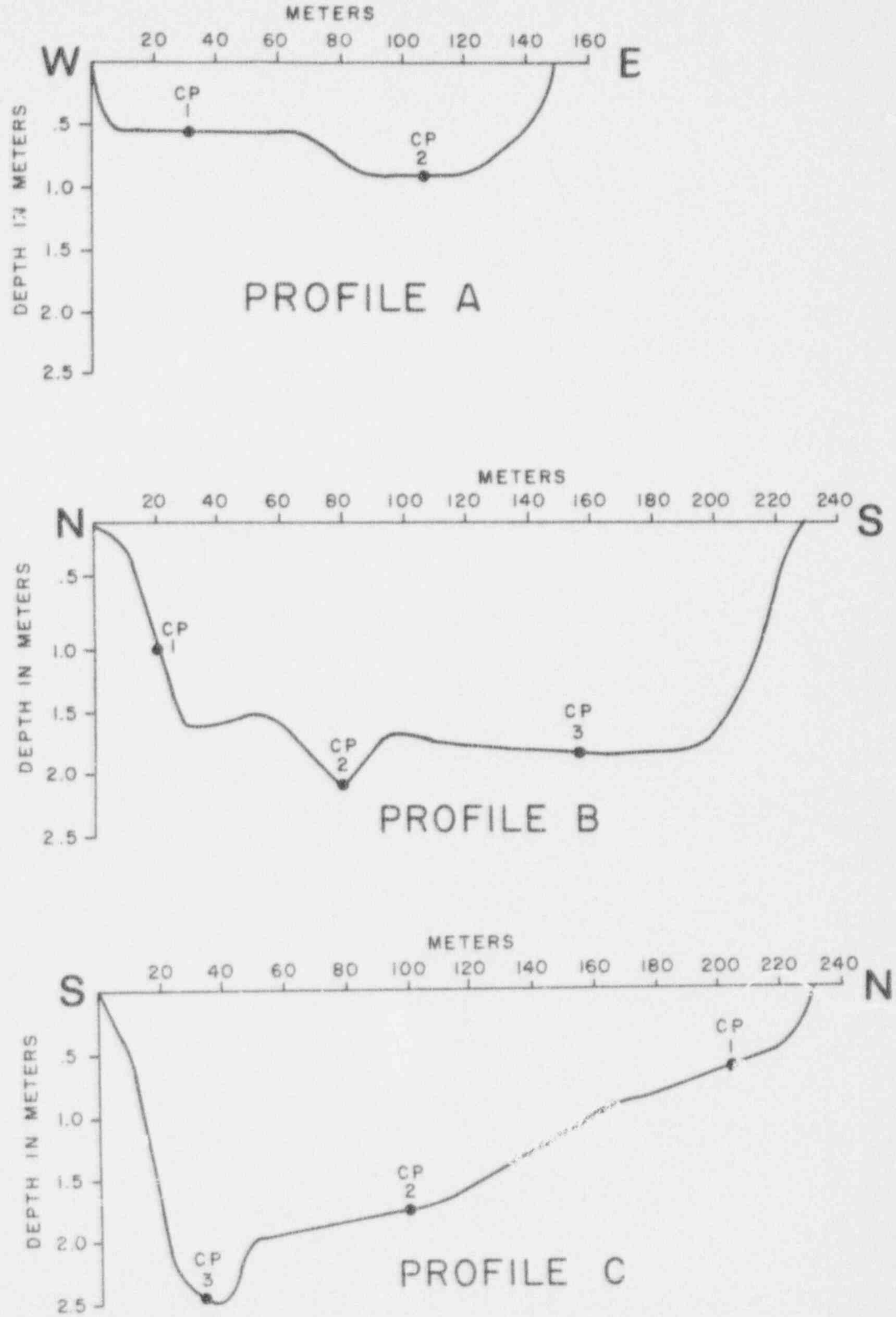
2.1 METHODS AND MATERIALS

2.1.1 Collection Station Description

Collections were made from five transects within the Broad River Study area. Four of these are within the reservoir and one is below Parr Dam as shown on Figure 1. Within these transects were several sampling points. Their locations on depth profiles are given in Figure 2. Because June sampling transects differ in some respects from sampling areas used in the initial March survey, they have been labeled A through E to distinguish them from the former stations labeled 1 through 6. Changes were made based on increased familiarity with the Broad River area.

Transect A is located approximately 610 meters upstream from the confluence of Frees Creek and the Broad River. This is a backwater region on the east bank of the reservoir that will be flooded when Parr Dam height is increased. The transect runs from shore to shore, a total length of 150 meters. Collecting points are located near either shore.

Transect B is located in the Frees Creek embayment. This area will be subject to strong water movements during pumping and water release. The transect is 75 meters upstream from the railroad and parallel to it. Transect B is 230 meters in length and has three collecting bridge points.



LEGEND

CP– LOCATION OF COLLECTING POINT

PROFILE A – REFERS TO LOCATION AS SHOWN ON PLOT P

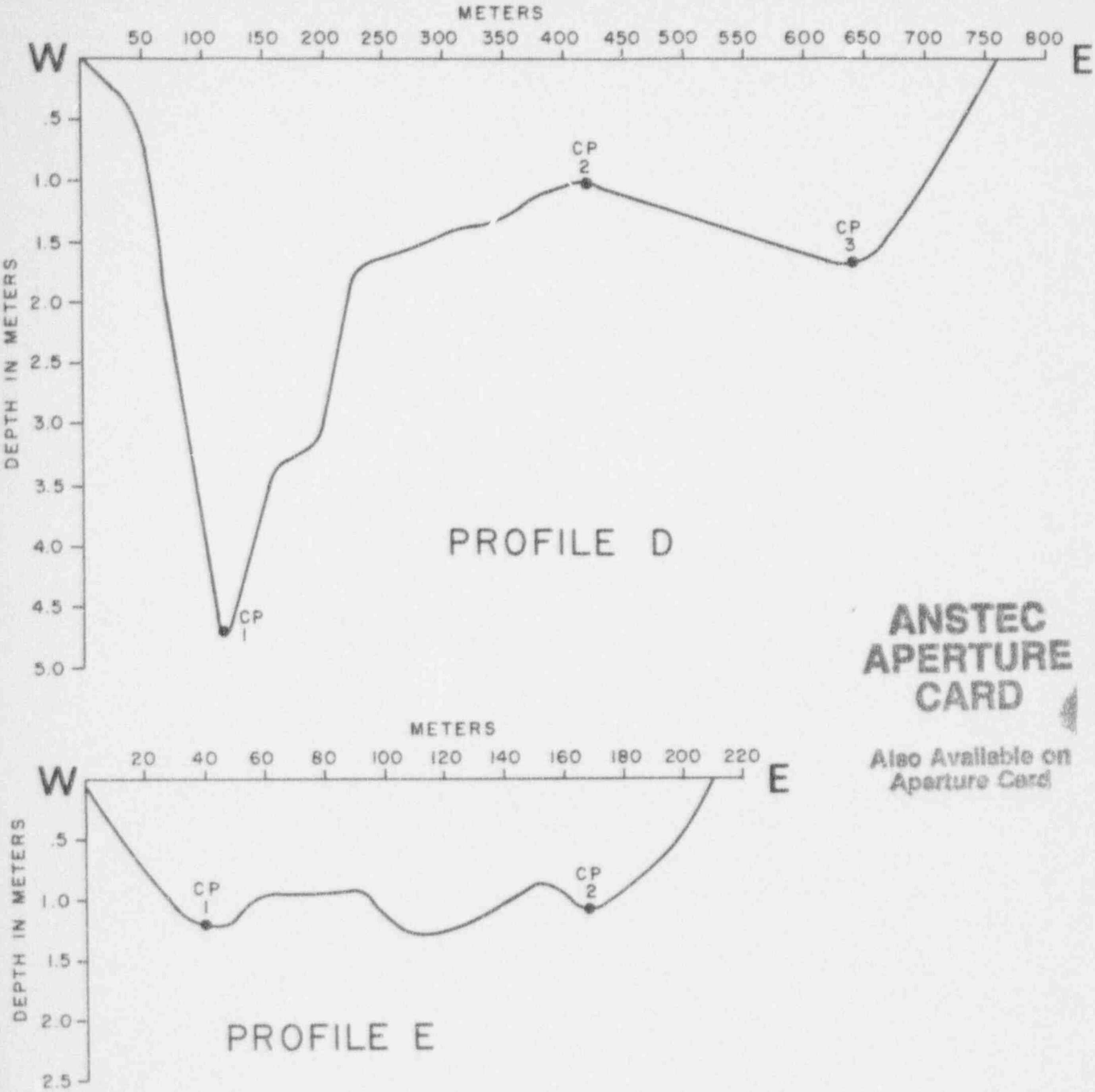


FIGURE 2

DEPTH PROFILES OF SAMPLING TRANSECTS

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DAMES & MOORE

Transect C is located 460 meters upstream from the Route 28 bridge in Cannons Creek embayment, a major embayment on the west side of the Broad River. Transect C is 230 meters in length and has three collecting points.

Transect D is located upstream from Parr Dam in the main body of Parr Reservoir. The west end of the transect is 305 meters and the east end is 535 meters upstream from the dam. Transect D is 760 meters in length and has three collecting points. Some samples were also taken from the east shore of the mid-river island just upstream of Transect D.

Transect E is located below Parr Dam in the east channel of the river. The length of this transect is 220 meters from the east bank to the tip of the island and has two collecting points.

Table 1 presents the depth and substrate type at the collecting points for the several transects. The configuration of the river bed along the transects is shown in Figure 2.

2.1.2 Collecting Procedures

2.1.2.1 Plankton

A modified Wisconsin tow net having a mouth diameter of 12.0 cm and a length of 55 cm was used for all plankton sampling. The net and

detachable bucket were constructed of #20 silk bolting cloth.

Plankton samples for quantitative and qualitative analyses were collected in two ways. The first method sampled surface waters to a depth of about 25 cm. One hundred liters of surface water was poured through the plankton net. Samples were collected at all but the shallowest stations using this method. The second method sampled the water column at each station. The plankton net was lowered into the water until first the bucket and then the bottom of the mouth touched the substrate. The net was recovered by using a steady retrieval rate of approximately 0.5 m per second. The inside of the net was washed with filtered water which concentrated all organisms in the bucket of the net. The plankton concentrate collected by the two methods outlined above was washed with filtered water into small jars. Care was taken to wash the bucket of the net free of all organisms. All samples were preserved in 10% formalin, labeled, and stored for identification and enumeration.

In the laboratory, all samples were brought to a 50 ml volume. A one ml aliquot was taken from each thoroughly mixed sample with a Hensen-Stemple pipette and placed in a Sedgwick-Rafter counting chamber. All organisms in the chamber were examined by microscope, identified, and enumerated. The total number of organisms in the sample was computed by multiplying the one ml aliquot by 50. Appropriate computations were made to convert the estimated total into organisms or cells per liter of water.

2.1.2.2 Benthic and Limnic Fauna

All quantitative benthic samples, with one exception noted below, were collected with an Ekman dredge (15 x 15 cm). The dredge was lowered into the water until it was firmly in contact with the bottom. A heavy messenger was then used to activate the tripping mechanism closing the jaws and collecting a sample of substrate. The dredge was retrieved rapidly, placed over a bucket lined with a plastic bag and its contents washed with filtered water until all of the substrate material was transferred to the bag. Two samples were taken from each sampling point.

Substrate samples were washed from bags into a wash bucket fitted with #30 wire cloth. The material remaining on the wire cloth was then thoroughly washed with a fine, soft spray of water and the organisms and other materials remaining were washed into small jars and preserved in 10% formalin for laboratory study. Because of the rocky bottom found at the transect below Parr Dam, a Surber square-foot sample was used for bottom sampling instead of the Ekman dredge. Rocks upstream from the sampler were agitated to dislodge organisms, and these were swept into the sampling net by the current.

Qualitative samples of benthic organisms and insects were taken in nets along the shoreline. Living benthic animals were separated from the bottom muck by hand and preserved in 80% ethanol for laboratory study. Insects were taken from the air by net and preserved for further study. In the laboratory these animals were examined under a stereoscopic microscope and identified.

Qualitative sampling is valuable because many animals are recovered by this method which are not obtained by dredging or other quantitative methods. Among these animals are the limnic insects, the immature stage of which form a large portion of the benthic population.

The combined quantitative and qualitative samples provide a more balanced and true view of the aquatic ecosystem than either one alone would show.

2.1.2.3 Fish

Fish were collected by electro-fishing equipment and modified hoop nets. The sampling effort included one twenty-four hour trap set and two hours of electro-fishing at each station. Experience from the March survey showed that beach seines were not suitable for the area.

All fish collected were measured to the nearest tenth of an inch and weighed to the nearest hundredth of a pound. These measures were later converted to centimeters and grams. Scale samples were taken from a representative number of fish in each size group and species for later use in determining age and rates of growth. A right pectoral fin clip was used on major species to provide a short-term method of identifying recaptures in later samples.

Condition factors (K) were calculated for each individual fish, and the average condition factor of all fish in each length grouping was determined. The formula $K_{(TL)} = 100W/L^3$ was used for all condition factor determinations (W = weight in grams, L = length in centimeters). This formula, along with its application and limitations, is described in Bennett (1962) and Carlander (1969).

Condition factors are valuable in detecting gross changes in availability of food organisms.

Age determinations are not included in this report, but will be presented in the Annual Report.

2.1.2.4 Water Quality

Water samples were collected with a 1.2 liter Kemmerer water sampler. Samples for dissolved oxygen analysis were withdrawn from the Kemmerer sampler by placing the rubber emptying tube at the bottom of a ground-glass stoppered bottle and allowing water to fill and overflow the bottle volume. Dissolved oxygen was measured to the nearest part per million with a Hatch Model OX-2-P test kit. A Hatch portable colorimetric pH test kit was used to measure pH to the nearest 0.1 unit.

A vertical series of temperatures were taken at each station using a Yellow Springs Instrument Company Telethermometer (Model 47). The thermistor probe was lowered to the bottom and the temperature indicator was allowed to stabilize prior to recording the temperature in degrees centigrade. Temperatures were then recorded at 0.25 m intervals to the nearest 0.5°C with the final reading at 1 cm below the surface.

A Secchi disc (20 cm diameter) was employed to measure turbidity of the water. The maximum water depth at which the disc was visible was determined to the nearest 0.05 m at each station.

2.2 FINDINGS

2.2.1 Plankton

Analysis of the plankton collection showed that Fragilaria crotenensis was the most abundant phytoplankton in the surface and vertical samples. This species was found to be present in numbers up to 4,971 per liter. Miscrospora sp. was the next most abundant species of phytoplankton with numbers up to 1,224 per liter. Tables 2 and 3 list the complete phytoplankton analysis of this survey.

The zooplankton were best represented by the rotifers with Asplanchna and Brachimus consistently the most numerous. Tables 4 and 5 list the species and abundance of zooplankton.

2.2.2 Benthic and Limnic Fauna

Quantitative samples were collected with an Eckman dredge. Benthic organisms were represented by a variety of invertebrate groups. The most abundant species was Chaoborus punctipennis with as many as 4,257 individuals per sample. Other abundant organisms are Hexagenia bilineata, Caenis sp., Pseudosida sp., Branchiura sowerbyi, Spaerium sp. and several species of chironomids. Table 6 presents a list of species and their abundance at the 6 sampling stations.

Table 7 gives the results of the qualitative sampling of littoral organisms and insects along the water's edge. The qualitative sampling revealed some species not found in the Ekman dredge samples. The abundance of Hexagenia limbata, and the presence of a greater variety of odonata were in contrast to data obtained from Ekman dredge samples.

2.2.3 Fish

A total of 205 fishes of 20 species were collected. Species collected, in order of relative abundance, were white crappie, bluegill, black crappie, gizzard shad, longnose gar, quillback carpsucker, yellow bullhead, redear sunfish, carp, white bass, largemouth bass, spotted sucker, hybrid sunfish, golden shiner, longear sunfish, spotfin shiner, warmouth sunfish, pumpkinseed sunfish and american eel. Table 8 shows the species composition and abundance of all fishes collected. Channel catfish and white catfish were observed in fishermen's creel but were not taken in the sample.

The June survey added seven species to the preliminary species composition list for the Parr Reservoir site established by the March survey (Table 9). Two of these are potentially important sport species, the black crappie and the white bass. Two species taken in the March survey, white sucker and white catfish, were not found in this sample. This demonstrates the importance of quarterly samples to account for the influence of seasonal effects on population densities and sampling efficiency. Tables 10 through 19 describe the species composition, relative abundance, length, frequency, weight and condition factor of fishes taken in the June survey.

2.2.4 Water Quality

Temperature profiles were taken at several collecting points on each station transect. Table 20 shows the depths and temperatures recorded in the study area.

Secchi disc, pH and dissolved oxygen tests were performed at the various stations and are recorded in Table 21.

3.0 TERRESTRIAL SURVEY

Objectives of the terrestrial survey were the setting up of traplines, stations, and observation points to collect data on important species of birds, mammals and vegetation in the area of the proposed Fairfield-Summer complex; to provide indices of abundance of these species, and to collect ancillary information on reptiles and amphibians.

3.1 METHODS AND MATERIALS

3.1.1 Wildlife Survey Route

One wildlife survey route and four permanent small mammal traplines were established. Their locations are shown on Figure 3.

3.1.1.1 Permanent Small Mammal Traplines

Trapline No. 1 is approximately 1-1/2 miles south of the town of Monticello. The primary vegetation of the area is second growth pine. The area will be flooded by the proposed Monticello Reservoir. Specific location instructions are as follows: beginning at Keller's Grocery on Route 215 between Monticello and Jenkinsville, go north 0.3 mile to first road on left, turn left (west) and go 0.7 mile to fork in road. The trapline is oriented north-south at right angles to the road just before fork in road. Trapping stations are marked by wooden stakes numbered 1 through 20.

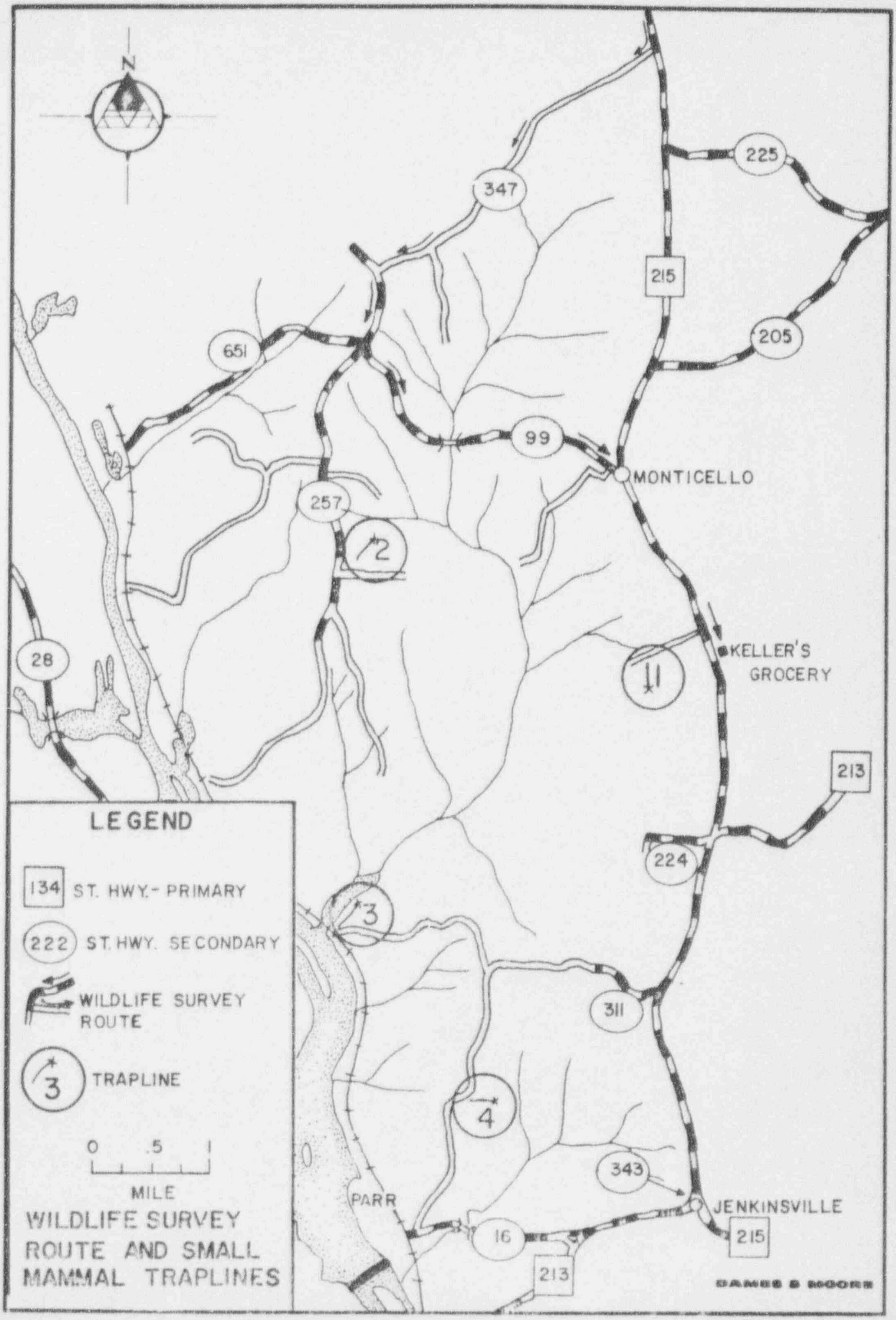
N
347
225
215
651
205
99
MONTICELLO
257
2
KELLER'S
GROCERY
1
28
213
LEGEND
134 ST. HWY.- PRIMARY
222 ST. HWY. SECONDARY
WILDLIFE SURVEY
ROUTE
3 TRAPLINE
224
3
311
4
0 .5 1
MILE
343
JENKINSVILLE
PARR
16
215
213
WILDLIFE SURVEY
ROUTE AND SMALL
MAMMAL TRAPLINES
DAMES & MOORE

FIGURE 3

Trapline No. 2 is approximately 2 miles east and 1/2 mile south of Monticello. The area was "clearcut" then replanted to pine circa 1967 and will not be flooded by the proposed reservoir. Specific location instructions are as follows: from the junction of Route 257 and Route 99, go south 2.2 miles on Route 257, turn left (south) toward proposed dam site on a dirt road, drive 0.2 mile from Route 257 staying left at the fork. Stake marked 2S on right side of road. The trapline begins 17 steps to right of the road and roughly parallels the road.

Trapline No. 3 is on the east side of the present Parr Reservoir and follows the Frees Creek embayment. The trapline runs through a mixed hardwood-conifer forest in an area that will be flooded by the proposed reservoir. Deciduous trees, though not present in pure stands, are most abundant in low areas near the water course. Specific locations instructions are as follows: beginning at Monticello, drive approximately 4 miles south on Route 215 to Route 311, a paved road which runs east-west, turn west (right) onto this road, drive 1.6 miles and turn right on "T" road, go 0.6 mile and take left fork, and drive 1.0 mile to end of road at Frees Creek. Trapline starts at end of road to right of walking path headed northeast (away from railroad trestle).

Trapline No. 4 is in a stand of conifers that will not be flooded by the proposed reservoir. It is located 1.7 miles north of the existing power plant at Parr, on the east side of the road leading to the proposed nuclear station site. Specific location instructions are as follows: beginning at Monticello, drive approximately 4 miles south on Route 215 to Route 311, a paved road which runs east-west. Turn west (right) onto this road and go 2.6 miles to 45 stake on left. The trap-line runs at right angles to the road.

3.1.2 Collecting Procedures

3.1.2.1 Insects and Other Anthropods

Insects were collected by hand with a standard light-weight insect net, asphixated, and stored in vials of 80% ethyl alcohol. The specimens were identified in the laboratory using a Wild M5 stereo-microscope (10x - 112x) and standard taxonomic keys (Borror and DeLong, 1964).

3.1.2.2 Amphibians and Reptiles

Amphibians and reptiles were collected when encountered in the field. Specimens were injected with 10% formalin (40% formalin for turtles), catalogued, tagged and immersed in 10% formalin. They are deposited in the Ball State University Herpetology Collection.

3.1.2.3 Birds

The Wildlife Survey Route was established to obtain an index of bird species and their abundance. Birds were not collected. Identification was made by sightings in conjunction with bird calls. A standard method was used which involved travelling the survey route by car and stopping for 3-minute observations at one mile intervals. This survey technique is well established in the literature (Bennitt, 1951, Reeves, 1954). Observations began at the time of official sunrise at the junction of routes 215 and 347 and ceased at one hour after sunrise near Keller's Grocery. Travel between observation points was at the rate of 20-30 mph. At each stop the number of calling bobwhite males was recorded (not the number of calls). The species and numbers of birds seen at each stop and during each mile of travel between stops were recorded. Weather conditions, including cloud cover and wind velocity, were recorded at the start of each count.

A list of birds observed on the area was compiled from bird sightings of both road kills and live birds on the survey route. Subsequent sightings during other field activities were added to the list of birds present.

3.1.2.4 Mammals

Four permanent small mammal traplines were established. Each trapline includes 20 trapping stations in a line with 15.0 m intervals between stations. Within 2 meters of each station three snaptraps (two mouse traps and one rat trap) were set and baited with peanut butter and/or dry rolled oats. Each trapline was visited every day for three to five successive days. Trapped mammals were identified to species, sexed, weighed, measured, examined for lactation and pregnancy, catalogued, and preserved in 10% formalin.

Mammals found road killed, observed along the Wildlife Survey Route, and seen during the course of other field work, were identified and recorded. Mammal signs such as tracks and scats were noted.

Bats were collected at dusk by using a .22 rifle and a .410 shotgun. The .22 shells contained #12 shot and the .410 shells contained #9 shot.

3.1.2.5 Vegetation

Plant specimens were collected and pressed for later identification and cataloging. Particular care was taken to collect plants growing along the permanent small mammal traplines. Quantitative vegetation data were gathered by using the Point-Centered Quarter Method of Sampling (Cottam and Curtis, 1956). This sampling technique gives total density (plants per hectare), relative density, absolute density, frequency and relative frequency. Sampling points were chosen along each small mammal trapline ten steps to the right of each trapping station and ten steps to the left of each trapping station for a total of 40 sampling points for each of the four mammal traplines. Each sampling point is considered the center of four quarters. At each point the closest tree to the point in each of the quarters is chosen. The species and diameter of each of these four trees is recorded and then the distance between the point and each of the four trees is measured.

3.2 FINDINGS

3.2.1 Insects and Other Anthropods

Very little collecting of terrestrial insects was done. Those which were collected and identified are listed below.

Frees Creek - Coleoptera

Staphylinidae

Habrocerus magnus Le Conte

Below Parr Dam

Psocoptera

Psocidae

Hymenoptera

Siricidae

Tremex columba L.

Diplopoda

Millipedes

Various insects were collected near the mammal traplines. These insects were mostly beetles and dipterans. The dipterans were primarily deer-flies, Chrysops sp.

3.2.2 Amphibians and Reptiles

Amphibians collected in the Broad River Study Area include:

American Toad	-	Bufo americanus americanus
Fowler's Toad	-	Bufo woodhousei fowleri

Reptiles collected on the Broad River Study Area include:

Eastern Mud Turtle	-	Kinosternon s. subrubrum
Eastern Box Turtle	-	Terrapene c. carolina
Eastern Painted Turtle	-	Chrysemys p. picta
Yellow-Bellied Turtle	-	Pseudemys s. scripta
River Cooter	-	Pseudemys c. condinna
Florida Cooter	-	Pseudemys f. floridana
Gulf Coast Softshell	-	Trionyx spinifer asper
Fence Lizard	-	Sceloporus undulatus
Six-Lined Racerunner	-	Cnemidophorus sexlineatus
Broad-Headed Skink	-	Eumeces laticeps
Brown Water Snake	-	Natrix taxispilota
Rough Green Snake	-	Opheodrys aestivus

3.2.3 Birds

Birds observed on the Broad River Study Area include (45 species):

Great Blue Heron - Ardea h. herodias (Linnaeus)

American Egret - Casmerodius albus egretta (Gmelin)

Little Blue Heron - Florida c. caerulea (Linnaeus)

Mallard - Anas p. platyrhynchos (Linnaeus)

Wood Duck - Aix sponsa (Linnaeus)

Turkey Vulture - Cathartes aura septentrionalis (Wied)

Black Vulture - Coragyps atratus (Meyer)

Broad-winged Hawk - Buteo p. platypterus (Vieillot)

Eastern Bobwhite - Colinus v. virginianus (Linnaeus)

Rock Dove - Columba livia (Gmelin)

Mourning Dove - Zenaidura macroura carolinensis (Linnaeus)

Yellow-billed Cuckoo - Coccyzus a. americanus (Linnaeus)

Black-billed Cuckoo - Coccyzus erythropthalmus (Wilson)

Chuck-Will's-Widow - Caprimulgus carolinensis (Gmelin)

Chimney Swift - Chaetura pelagica (Linnaeus)

Ruby-throated Hummingbird - Archilochus colubris (Linnaeus)

Southern Downy Woodpecker - Dendrocopos p. pubescens (Linnaeus)

Eastern Kingbird - Tyrannus tyrannus (Linnaeus)

Eastern Wood Pewee - Contopus virens (Linnaeus)

Barn Swallow - Hirundo rustica erythrogaster (Boddaert)

Purple Martin - Progne s. subis (Linnaeus)

Florida Blue Jay - Cyanocitta c. cristata (Linnaeus)

Southern Crow - Corvus brachyrhynchos paulus (Howell)

Tufted Titmouse - Parus bicolor (Linnaeus)

Brown-Headed Nuthatch - Sitta p. pusilla (Latham)

Carolina Wren - Thryothorus l. ludovicianus (Latham)

Eastern Mockingbird - Mimus p. polyglottos (Linnaeus)

Brown Thrasher - Toxostoma r. rufum (Linnaeus)

Southern Robin - Turdus migratorius achrusterus (Batchelder)

Wood Thrush - Hylocichla mustelina (Gmelin)

Eastern Bluebird - Sialia s. sialis (Linnaeus)

Loggerhead Shrike - Lanius l. ludovicianus (Linnaeus)

Starling - Sturnus v. vulgaris (Linnaeus)

Eastern Yellow Warbler - Dendroica petechia aestiva (Gmelin)

Yellow-Breasted Chat - Icteria v. virens (Linnaeus)

English Sparrow - Passer d. domesticus (Linnaeus)

Southern Meadowlark - Sturnella magna argutula (Bangs)

Eastern Red-wing - Agelaius p. phoeniceus (Linnaeus)

Florida Grackle - Quiscalus q. quiscula (Linnaeus)

Eastern Cowbird - Molothrus a. ater (Boddaert)

Summer Tanager - Piranga r. rubra (Linnaeus)

Eastern Cardinal - Richmondena c. cardinalis (Linnaeus)

Eastern Blue Brosbeak - Guiraca c. caerulea (Linnaeus)

Indigo Bunting - Passerina cyanea (Linnaeus)

Alabama Towhee - Pipilo erythrophthalmus canaster (Howell)

The Wildlife Survey Route was run for three consecutive mornings during the period June 23 through June 25. Numbers of birds both seen and heard varied from morning to morning because of weather conditions and other uncontrolled variables. The maximum number of each species seen and/or heard on any one morning is given below. These numbers serve as an index of the total population and can be used to estimate population trends when compared to future results of this survey.

- Calling Bobwhite - 17
- Chimney Swift - 2
- Eastern Kingbird - 8
- Barn Swallow - 8
- Purple Martin - 1
- Florida Blue Jay - 9
- Southern Robin - 1
- Eastern Bluebird - 1
- Loggerhead Shrike - 3
- Starling - 1
- Yellow-Breasted Chat - 1
- English Sparrow - 6
- Southern Meadowlark - 5
- Eastern Red-Wing - 5
- Summer Tanager - 2
- Eastern Cardinal - 5

Common names of birds and phylogenetic order of presentation are from Sprunt and Chamberlain (1970).

3.2.4 Mammals

The 60 snaptraps (3 traps at each 20 stations) set in each of the four permanent mammal traplines were operated for a total of 960 trapnights. A trapnight is defined as one trap set for 24 hours or less. A list of mammals is found in Table 22, Mammals Collected on the Fairfield-Summer Power Project Site, Fairfield County, South Carolina, June, 1971.

Permanent Small Mammal Trapline - Site 1 was set on June 22 and the traps were pulled on June 27 after 300 trapnights. Two *Peromyscus g. gossypinus*, cotton mice, (RDK#'s 1208 and 1239 - see Table 22) were trapped giving a trapping success of one cotton mouse per 150 trapnights at this site.

Permanent Small Mammal Trapline - Site 2 was set on June 23 and the traps were pulled on June 27 after 240 trapnights. Four *Mus musculus*, house mice, (RDK#'s 1217, 1227, 1236 and 1240 - see Table 22) and two *Sigmodon hispidus komareki*, cotton rats, (RDK#'s 1226 and 1235 - see Table 22) were trapped. Trapping success was one house mouse per 60 trapnights and one cotton rat per 120 trapnights.

Permanent Small Mammal Trapline - Site 3 was set on June 23 and the traps were pulled on June 27 after 240 trapnights. Four *Peromyscus*

g. gossypinus, cotton mice, (RDK#'s 1218, 1219, 1220 and 1234 - see Table 22) and one Blarina brevicanda carolinensis, short-tailed shrew, (RDK# 1228 - see Table 22) were collected in the trapline. Trapping success was one cotton mouse per 60 trapnights and one short-tailed shrew per 240 trapnights.

Permanent Small Mammal Trapline - Site 4 was set on June 24 and the traps were pulled on June 27 after 180 trapnights. Three Peromyscus g. gossypinus, cotton mice, (RDK#'s 1229, 1232 and 1233 - see Table 22) and two Ochrotomys nuttalli aureolus, golden mice, (RDK#'s 1230 and 1241 - see Table 22) were trapped. Trapping success was one cotton mouse per 60 trapnights and one golden mouse per 90 trapnights.

All mammal species collected on the traplines are relatively common in South Carolina but none have previously been reported from Fairfield County (Golley, 1966).

Mammals known to be on the Broad River Study Area include:

Short-tail Shrew	-	Blarina brevicauda
Seminole Bat	-	Lasiurus seminolus
Raccoon	-	Procyon lotor
Bobcat	-	Lynx rufus
Eastern Gray Squirrel	-	Sciurus carolinensis
Cotton Mouse	-	Peromyscus gossypinus
Golden Mouse	-	Peromyscus nuttalli
Hispid Cotton Rat	-	Sigmodon hispidus
House Mouse	-	Mus musculus
Eastern Cottontail	-	Sylvilagus floridanus

The only mammal seen on the Survey Route was one gray squirrel.

3.2.5 Vegetation

Approximately 65 plant species were collected on the Broad River Study Area during June, 1971. This total included 13 species that had not been previously collected in Fairfield County according to Radford et al (1968). These new records do not represent range extension, but merely indicate that Fairfield County has not been worked extensively by botanists.

The reservoir area floral survey was particularly intense near the Permanent Mammal Traplines (Sites 1 through 4). Common and scientific names are those given by Radford, Ahles and Bell (1968). Species not previously collected in Fairfield County according to Radford et al are marked with an *. Voucher specimens are deposited in the Ball State University Herbarium.

Site 1 Collections

Family Aspleniaceae

1. Asplenium platyneuron (L.) Oakes - Ebony Spleenwort.

Family Fabaceae

2. Lespedeza virginica (L.) Britton - Lespedeza.

Family Cornaceae

3. Cornus florida L. - Flowering Dogwood*

Family Ericaceae

4. Chimaphila maculata (L.) Pursh - Spotted Wintergreen.

Family Asclepiadaceae

5. _Asclepias tuberosa_ L. - Pleurisy Root

Family Convolvulaceae

6. _Convolvulus arvenais_ L. - Bindweed*

Family Bignoniaceae

7. _Campsis radicans_ (L.) Seemann - Trumpet Vine

Site 2 Collections

Family Pinaceae

1. _Pinus taeda_ L. - Loblolly Pine

Family Poaceae

2. _Alopecurus carolinianus_ Walter - Foxtail Grass*
3. _Sorghum holepense_ (L.) Persoon - Johnson Grass

Family Liliaceae

4. _Smilax glauca_ Walter - Greenbriar
5. _Allium canadense_ L. - Wild Onion

Family Phytolaccaceae

6. _Phytolacca americana_ L. - Poke

Family Caryophyllaceae

7. _Silene antirrhina_ L. - Sleepy catchfly

Family Rosaceae

8. _Rubus allegheniensis_ Porter - Blackberry*
9. _Rosa_ sp. - Rose
10. _Prunus americana_ Marshall - Wild Plum
11. _Prunus serotina_ Ehrhart - Black Cherry

Family Fabaceae

12. _Albizia julibrissin_ Durazzini - Mimosa
13. _Cercis canadensis_ L. - Redbud*
14. _Lespedeza repens_ (L.) Barton - Lespedeza
15. _Lespedeza stuevei_ Nuttall - Lespedeza*

Family Euphorbiaceae

16. _Euphorbia corollata_ L. - Flowering Spurge*

Family Aceraceae

17. _Acer rubrum_ L. - Red Maple*

Family Vitoceae

18. Parthenocissus quinquefolia (L.) Planchon - Virginia Creeper

19. Vitis rotundifolia Michaux - Muscadine

Family Passifloraceae

20. Passiflora incarnata L. - Maypops or Passion Flower

Family Nyssaceae

21. Nyssa sylvatica Marshall - Black Gum

Family Verbenaceae

22. Verbena sp. - Verbena

Family Lamiaceae

23. Prunella vulgaria L. - Selfheal

Family Solanaceae

24. Solanum carolinense L. - Nightshade

Family Plantaginaceae

25. Plantago lanceolata L. - English Plantain

26. Plantago aristata Michaux - Plantain

Family Caprifoliaceae

27. Lonicera japonica Thumberg - Japanese Honeysuckle

Family Asteraceae

28. Lactuca scariola L. - Prickly Lettuce

29. Pyrrhopappus carolinianus (Walter) DC. - False Dandelion*

30. Senecio vulgaris L. - Groundsel*

31. Eupatorium sp. - Thoroughwort

32. Helenium amarum (Raf.) H. Rock - Bitter Weed

Site 3 Collections

Family Aspidiaceae

1. Polystichum acrostichoides (Michaux) Schott - Christmas Fern

Family Aspleniaceae

2. Asplenium platyneuron (L.) Oakes - Ebony Spleenwort

Family Juglandaceae

3. Carya tomentosa (Poiret) Nuttall - Mockernut*

Family Betulaceae

4. Ostrya virginiana (Miller) K. Koch - Hop Hornbean

5. Carpinus caroliniana Walter - Ironwood

Family Fagaceae

6. *Quercus alba* L. - White Oak
7. *Quercus stellata* Wang. - Post Oak
8. *Quercus rubra* L. - Red Oak
9. *Quercus phellos* L. - Willow Oak

Family Aristolochiaceae

10. *Hexastylis arifolia* (Michaux) Small - Wild Ginger

Family Portulacaceae

11. *Claytonia virginica* L.-Spring Beauty*

Family Hamamelidaceae

12. *Liquidambar styraciflua* L. - Sweet Gum*
13. *Hamamelis virginiana* L. - Witch Hazel

Family Fabaceae

14. *Vicia caroliniana* Walter - Vetch*

Family Aceraceae

15. *Acer saccharum* Marshall - Sugar Maple

Family Tiliaceae

16. *Tilia* sp. - Basswood*

Family Acanthaceae

17. *Ruellia caroliniensis* (Walter) Stendel - Ruellia

Family Caprifloiaceae

18. *Lonicera japonica* Thumberg - Japanese Honeysuckle

Site 4 Collections

Family Fagaceae

1. *Quercus nigra* L. - Water Oak

Family Anacardiaceae

2. *Rhus copallira* L. - Winged Sumac

Family Oleaceae

3. *Fraxinus americana* L. - White Ash

Collections Not at Trapping Sites

Family Liliaceae

1. *Polygonatum biflorum* (Walter) Ell - Solomon's Seal

Family Fabaceae

2. *Lespedeza virginica* (L.) Britton - Lespedeza

Family Fabaceae (con't)

3. Leapedeza stuevei Nuttall - Lespedeza*

4. Pueraria lobata (Willd.) Ohwi - Kudzu

Family Aquifoliaceae

5. Flex opaca Aiton - Holly

Family Passifloraceae

6. Passiflora incarnata L. - Maypops or Passion Flower

Family Elaeagnaceae

7. Elaeagnus umbellata Thumbert - Silverberry

Family Asclepiadaceae

8. Asclepias tuberosa L. - Pleurisy Root

Family Caprifoliaceae

9. Lonicera japonica Thumberg - Japanese Honeysuckle

Family Asteraceae

10. Erigeron strigosus Muhl. ex Willd. - Daisy Fleabane

The Point-Centered Quarter Method was used to sample vegetation on Permanent Mammal Trapline Sites 1, 3 and 4. Site 2 was not sampled since it was recently clear-cut and sampling results, over time, will tend to merely demonstrate early plant succession. On Sites 1 and 4 four samples were taken ten steps (approximately 10 meters) to the right of each of the 20 trapping stations and ten steps to the left of each of the 20 trapping stations. On Site 3, Frees Creek is within three to ten meters along the NW (left) side of the trapline. On Site 3 four samples were taken three steps (approximately 3 meters) to the SE (right) of the midpoint between each trapping station (including 4 samples beyond Station 20).

Trees measuring 2.5 centimeters or more d.b.h.(diameter at breast height or at 1.37 meters) were the only vegetation sampled. Tables 23, 24 and 25 list the sampled species with their density and frequency. Tables 26, 27 and 28 give the numbers of sample trees in each diameter size class.

The greatest diversity or number of species was found on Site 3 (Table 24) where the 2,246 trees measured were intermediate in abundance between 1,932 trees on Site 4 (Table 25) and 2,424 trees on Site 1 (Table 23). Loblolly Pine is remarkable for its abundance on Site 4 where there are 1,568 loblollys per hectare and 81.3% of all sample trees are of this species (Table 25).

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Table 1. Depth and Substrate Type at Collecting Points on Broad River Study Area, June, 1971.

Transect	Location	Collecting Points	Collection Date	Depth (1) Meters	Substrate (2) Type
A	Above Frees	1	6/25	0.50	mk, st
	Creek	2	6/25	0.75	mk, st
B	Frees Creek	1	6/23	1.00	mk, st
		2	6/23	2.00	mk, st
		3	6/23	1.75	mk, st
C	Cannons Creek	1	6/22	0.50	mk, st
		2	6/22	2.00	mk, s
		3	6/22	2.00	mk, s
D	Above Parr	1	6/24	4.75	st, mk
	Dam	2	6/24	1.50	st, mk
		3	6/24	1.25	st, mk
E	Below Parr	1	6/26	1.00	md, mk
	Dam	2	6/26	1.00	cg

(1) Depth to nearest 0.25 meter.

(2) md = miscellaneous debris (detritus), st = silt, mk = muck, s = sand, cg = coarse gravel.

Table 2. Phytoplankton in Surface Samples Collected from Transects and Collecting Points on the Broad River Study Area, June, 1971.

Number 1/ per liter at transects and collecting points

Organism	Transect A Above Frees Creek		Transect B Frees Creek			Transect C Cannon's Creek			Transect D Above Parr Dam			Transect E Below Parr Dam	
	1	2	1	2	3	1	2	3	1	2	3	1	2
Chlorophyta													
Actinastrum	0.5	1.5	0.5	-	-	-	-	-	13.0	9.0	22.0	23.0	0.5
Ankistrodesmus	-	-	-	-	-	-	-	-	-	-	1.5	-	-
Closterium	-	-	-	-	-	-	-	-	-	-	0.5	-	1.0
Microspora (A)2/	119.5	332.0	31.0	127.5	14.0	-	-	-	172.5	183.0	75.0	131.5	150.5
Microspora (B)2/	24.5	49.5	-	9.0	-	-	-	-	25.5	23.5	5.5	35.0	84.5
Pediastrum	3.5	2.5	0.5	0.5	-	0.5	-	-	1.5	1.0	3.0	4.5	0.5
Scenedesmus	-	-	-	-	-	-	-	-	-	-	1.0	1.5	-
Sphaerocystis	0.5	5.5	-	-	-	-	-	-	1.5	2.5	4.0	13.0	3.0
Chrysophyta													
Asterionella	-	-	-	-	-	-	-	-	-	0.5	-	2.5	-
Dinobryon	-	-	0.5	-	-	-	-	-	-	-	-	-	-
Fragilaria - crotonensis	394.5	518.0	7.5	-	-	-	-	-	1670.5	1555.0	2726.5	3254.0	792.5
Navicula	-	-	-	-	-	-	-	-	0.5	-	0.5	0.5	0.5
Pleurosigma	-	-	-	-	-	-	-	-	-	-	-	0.5	-
Synedra	1.0	2.5	0.5	-	-	0.5	-	-	5.0	1.5	2.5	3.0	-
Tabellaria	5.0	-	-	-	-	-	-	-	1.0	3.0	-	30.5	-
Cyanophyta													
Anabaena 3/	1.0	4.5	-	4.5	2.0	-	-	-	-	1.5	0.5	-	1.5
Chroococcus	-	-	0.5	28.0	10.5	-	-	-	0.5	-	1.0	-	-
Microcystis	3.0	3.0	2.0	2.0	0.5	-	-	-	0.5	0.5	1.0	4.0	-
Oscillatoria (A) 2,3/	4.5	19.0	-	-	-	-	-	-	0.5	3.0	1.5	1.0	5.5
Oscillatoria (B) 2,3/	2.5	-	-	-	-	-	-	-	-	-	-	-	-
Spirulina	-	1.5	-	-	-	-	-	-	0.5	0.5	1.5	2.5	3.5

1/Number of cells unless otherwise noted.
2/(A) and (B) are probably two species; (A) is about 2-3 x smaller than (B).
3/Number of multiple-cell filaments.

Table 3. Phytoplankton in Vertical Plankton Net Tows Collected from Transects and Collecting Points on the Broad River Study Area, June, 1971.

Organism	Number [1] per liter at Transects and Collecting Points							
	Transect B			Transect C		Transect D		
	1	2	3	2	3	1	2	3
Chlorophyta								
Actinastrum	-	-	0.6	-	-	6.0	14.0	7.1
Closterium	-	-	-	-	-	-	0.7	-
Microspora (A) [2]	862.8	481.8	516.4	11.0	2.9	584.7	1224.0	107.7
Microspora (B) [2]	-	-	-	-	-	8.8	-	-
Pachycladon umbrinus	-	-	-	-	-	0.2	-	-
Pediastrum	-	0.6	-	-	-	1.0	-	2.9
Scenedesmus	-	-	-	-	-	0.7	-	0.9
Sphaerocystis	1.1	-	-	1.1	-	-	-	-
Chrysophyta								
Asterionella	-	-	-	-	-	0.2	-	3.5
Dinobryon	1.1	-	-	-	-	-	-	-
Fragilaria crotonensis	-	-	-	-	-	3873.0	4971.4	2478.7
Pleurosigma	-	-	-	-	-	-	-	-
Synedra	2.2	1.1	0.6	1.1	2.0	0.7	-	3.5
Tabellaria	-	-	-	-	-	2.1	-	3.5
Cyanophyta								
Anabaena	13.3	6.1	6.3	-	-	0.7	0.7	-
Chroococcus	-	-	-	-	-	-	-	-
Microcystis	-	0.6	-	-	-	-	-	-
Oscillatoria (A) [2,3]	5.5	1.1	-	-	-	3.3	5.2	4.4
Oscillatoria (B) [2,3]	-	-	-	-	-	0.5	-	-
Spirulina	-	-	-	-	-	2.1	2.2	0.9
Pyrrhophyta								
Ceratium	-	-	-	-	-	0.2	1.5	-

1/Number of cells unless otherwise noted.
2/(A) and (B) are probably two species; (A) is about 2-3x smaller than (B).
3/Number of multiple-cell filaments.

Table 4. Zooplankton in Surface Samples Collected from Transects and Collecting Points on the Broad River Study Area, June, 1971.

Organism	Number / liter at transects and collecting points												
	Transect A		Transect B			Transect C			Transect D			Transect E	
	1	2	1	2	3	1	2	3	1	2	3	1	2
Rotifera													
Asplanchna	0.5	10.5	-	-	-	-	-	-	-	-	-	-	-
Brachionus	-	3.0	8.5	10.5	4.0	5.5	4.0	7.0	-	-	5.5	0.5	-
Filinia	-	21.0	1.5	4.0	1.5	6.0	2.5	2.0	-	-	0.5	0.5	-
Keratella	0.5	-	1.5	-	-	0.5	0.5	-	-	-	5.0	-	-
Polyarthra	-	1.0	0.5	1.5	1.0	-	-	-	-	-	-	-	0.5
Crustacea													
Cladocera													
Pseudosida	0.5	1.5	1.5	0.5	-	-	1.0	-	-	-	0.5	-	1.0
Scaphaleberia	-	-	-	-	-	-	-	0.5	-	-	-	-	-
Copepoda													
Cyclops	-	-	-	-	-	-	0.5	-	-	-	-	-	-
Diaptomus	-	0.5	-	-	-	-	-	-	-	-	-	-	-
Nauplii	0.5	2.0	1.5	6.0	0.5	-	1.5	1.0	1.5	-	6.0	1.5	-

Table 5. Zooplankton in Vertical Plankton Net Tows Collected from Transects and Collecting Points on the Broad River Study Area, June, 1971.

Number / liter at transects and collecting points

Organism	Transect B			Transect C		Transect D		
	1	2	3	2	3	1	2	3
Rotifera								
Asplanchna	-	-	1.9	-	-	-	-	-
Brachionus	2.2	-	-	13.8	10.8	1.2	0.7	-
Filinia	-	0.6	0.6	0.6	-	-	-	-
Keratella	1.1	-	0.6	3.9	-	0.2	-	2.7
Polyarthra	-	1.7	-	2.2	-	0.2	-	-
Crustacea								
Cladorcera								
Pseudosida	1.1	-	-	-	1.5	-	-	-
Copepoda								
Cyclops	-	-	0.6	-	-	-	-	-
Diaptomus	1.1	-	-	-	-	-	-	-
Nauplii	2.2	1.7	1.9	7.2	4.9	0.2	-	1.8

Table 6. Benthic Organisms in Bottom Samples Collected from Transect and Collecting Points in the Broad River Study Area, June, 1971.

Organism	Life Stage[2]	Mean Number[1] / m² at transects and collecting points													
		Transect A		Transect B			Transect C			Transect D			Transect E		Island
		1	2	1	2	3	1	2	3	1	2	3	1	2	1
Insecta															
Coleoptera															
Elmidae															
Stenelmis sp.	L	-	-	-	-	-	-	-	-	-	-	-	38	43	-
	A														
Hydrophilidae															
Berosus sp.	L	-	-	-	-	-	-	-	-	-	-	-	-	22	-
Diptera															
Ceratopogonidae															
Palpomyia sp.	L	-	-	65	-	-	22	22	-	-	-	-	-	-	43
Chironomidae															
Ablabesmyia sp.	L	22	-	43	-	-	-	-	-	86	43	-	-	-	366
Chironomus attenuatus	L	172	43	43	22	22	-	-	22	151	43	-	-	22	-
Coclotanypus concinnus	L	387	409	86	-	-	43	65	22	65	43	65	-	-	744
Cryptochironomus digitatus	L-P	-	-	-	-	-	-	-	22-22	22	22	22	27	-	-
Glptotendipes senilis	L	-	-	-	-	-	-	-	-	-	-	-	11	22	43
Harnishia sp.	L	22	-	43	-	-	-	-	-	22	-	-	-	-	-
Paracladopelma nais	L	-	-	22	-	-	-	-	-	-	-	22	11	-	-
Pentaneura sp.	L	-	-	-	-	-	-	-	-	-	-	-	11	323	-
Polypedilum convictum	L	-	-	-	-	-	-	-	-	-	-	-	11	22	43
Polypedilum halterale	L	-	-	-	-	-	-	-	-	-	22	-	-	-	-
Procladius culciforms	L	-	-	86	22	-	-	43	22	-	-	43	-	-	-
Psectrocladius sp.	L	-	-	-	-	-	-	-	-	-	-	-	5	-	-
Pseudochironomus - fulviventris	L	-	-	22	-	-	-	-	-	-	43	-	-	-	-
Smittia ephemerae	L	-	-	-	-	-	-	-	-	-	-	-	5	-	215
Tanytarsus dissimilus	L	-	-	-	-	-	-	-	-	-	-	-	246	65	-
Tanytarsus guerla	L-P	-	-	366-43	-	-	-	-	22	-	-	-	-	-	-
Tanytarsus mancus	L	43	22	22	-	-	-	-	-	-	-	-	-	-	-
Unidentified	P	-	-	-	-	-	-	-	-	-	-	22	27	86	22
	A	-	-	-	-	-	-	-	-	43	-	-	11	-	-
Culicidae															
Chaoborus punctipennis	L	194	-	645	4257	1742	3741	5268	22	-	43	-	5	-	-
	P	-	-	22	86	151	645	258	22	-	-	-	-	-	-
	A	-	-	-	22	-	-	-	-	-	-	-	-	-	-
Ephemeroptera															
Baetidae															
Caenis sp.	N	-	-	-	-	-	-	-	-	-	22	-	128	1935	-
Ephemeridae															
Hexagenia limbata	N	-	22	43	-	-	-	22	903	516	86	-	-	22	516

Table 6. (Continued)

Organism	Life Stage[2/]	Mean number[1/] / m^2 at transects and collecting points													
		Transect A		Transect B			Transect C			Transect D			Transect E		Island
		1	2	1	2	3	1	2	3	1	2	3	1	2	1
Heptageniidae															
Stenonema sp.	N	-	-	-	-	-	-	-	-	-	-	-	150	43	-
Hemiptera															
Corinidae															
Unidentified	L	-	-	-	-	-	-	-	-	-	-	-	-	-	22
Notonestidae															
Notonecta sp.	L	-	-	-	-	-	-	-	22	-	-	-	-	-	-
Veliidae															
Unidentified	L	-	-	22	22	-	-	-	-	-	-	-	-	-	-
Neuroptera															
Silalidae															
Sialis sp.	L	-	-	151	-	-	-	-	22	-	-	-	-	22	-
Odonota															
Coenagrionidae															
Hyponeura sp.	N	-	-	-	-	-	-	-	22	-	-	-	-	22	-
Gomphidae															
Gomphus sp.	N	-	-	-	-	-	-	-	-	-	43	-	-	-	-
Trichoptera															
Hydropsychidae															
Hydropsyche sp.	L	-	-	65	-	-	-	-	-	-	-	-	21	43	-
Psychomiidae															
Phylocentropus sp.		-	-	-	-	-	-	-	-	-	-	-	-	-	129
Unidentified	L	-	-	-	-	-	-	-	22	-	-	-	-	22	-
Crustacea															
Isopoda															
Asellus sp.		-	-	-	-	-	-	-	-	-	-	-	-	22	-
Cladocera															
Pseudosida sp.		-	-	-	-	-	-	-	-	22	22	-	-	1097	-
Arachnoidea															
Hydracarina															
Unidentified		-	-	-	-	-	-	-	22	22	22	-	32	-	-
Annelida															
Hirudinea															
Unidentified		-	-	-	-	-	-	-	-	-	-	-	-	172	108

Table 6. (Continued)

Organism	Life Stage[2/]	Mean number[1/] / m² at transects and collecting points: Transect A 1	Transect A 2	Transect B 1	Transect B 2	Transect B 3	Transect C 1	Transect C 2	Transect C 3	Transect D 1	Transect D 2	Transect D 3	Transect E 1	Transect E 2	Island 1
Oligochaeta															
Branchiura sowerbyi		-	-	43	366	473	215	258	602	366	151	323	-	22	774
Unidentified		430	344	301	337	22	-	-	-	65	215	2043	-	172	710
Nematoda															
Unidentified		-	-	65	22	43	-	-	-	22	-	-	-	-	-
Mollusca															
Gastropoda															
Physidae															
Physa sp.		-	-	-	-	-	-	-	-	-	-	-	-	22	-
Planorbidae															
Gyraulis sp.		-	-	-	-	-	-	-	-	-	-	-	-	215	-
Pelecypoda															
Sphaeriidae															
Spaerium sp.		-	-	280	22	-	22	-	86	273	1269	2171	235	172	3204
Unionidae															
Elliptio sp.		-	-	-	-	-	-	-	-	-	22	-	-	-	-

1/ Computed from mean of two Ekman dredge (15 x 15 cm) samples except collecting point 1 of transect C which is computed from the mean of two Surber (30.5 x 30.5 cm) samples.
2/ A = Adult, L = larvae, N = nymph, P = pupae

Table 7. Results from Qualitative Sampling of Littoral & Terrestrial Invertebrates, Parr Reservoir, Parr, S.C., June 21-25, 1971.

Class Subclass	Order Suborder	Family Subfamily	Genus Species	Cannons Creek C	Frees Creek B	Mid-River Island D	Below Dam E
Insecta							
	Odonata						
	Anisoptera (Dragonflies)	Gomphidae	Erpetogomphus lampropeltis	1	-	2	-
		Libellulidae					
		Macromininae	Macromia alleghaniensis	1	-	1	-
			Macromia caderita	1	-	-	-
		Libellulinae	Miathyria marcella	1	-	-	-
			Ladona sp.	4	-	-	-
			Tramea carolina	1	-	-	-
			Dythemis velox Hagen	-	1	-	-
	Zygoptera (Damselflies)	Agrionidae	Neoneura sp.	2	-	-	-
			Nehalennia sp.	1	-	-	-
			Genus sp.1	2	2	-	-
			Genus sp.2	2	-	-	-
			Genus sp.3	1	1	-	-
	Coleoptera (Beetles)	Gyrinidae	Gyretes sp.	15	-	-	-
		Haliphidae	Peltodytes sp.	2	-	-	-
	Trichoptera (Caddisflies)	Leptoceridae	Leptocella sp. Banks	1	-	-	-
			Genus sp.	2	-	-	-
		Hydropsychidae	Macronemum sp. Burmeister	-	1	-	3
	Diptera (Flies)	Chironomidae		1	-	-	-
	Ephemeroptera (Mayflies)	Hexgenildae	Hexagenia limbata Serville	2	2	55	-
	Hemiptera (Bugs)	Gerridae	Metrobates sp.	-	15	-	-
Crustacea Malacostraca	Decapoda (Shrimp)		Palaemonetes paludosus	8	-	-	-
	Isopoda	Asellidae	Asellus sp. St. Hillaire	5	-	-	-

Table 7. (Continued)

Class Subclass	Order Suborder	Family Subfamily	Genus Species	Cannons Creek C	Frees Creek B	Mid-River Island D	Below Dam E
Pelecypoda (Clams)		Sphaeriidae					
		Sphaeriinae	*Musculim* sp.	8	-	22	-
		Anondontinae	*Anodonta* sp.	1	-	-	-
Gastropoda (Snails)		Vivaparidae	*Campeloma* sp.	14	-	-	-
		Planorbidae	*Gyraulus* sp.	1	-	-	-
Hirudinea (Leeches)		Glossiphoniidae	*Helobdella* sp.	2	-	-	-
			Glossiphonia heterolita	-	-	3	-
Pisces (Fish)		Centrarchidae	*Lepomis* sp. 1	1	-	-	-
			Lepomis sp. 2	1	-	-	-

Table 8. Species Composition and Relative Abundance of All Fishes Collected in the Broad River Study Area, June, 1971.

Common Name	Scientific Name	No.	%
White crappie	*Pomoxis annularis*	87	43.0
Bluegill	*Lepomis macrochirus*	25	12.0
Black crappie	*Pomoxis nigromaculatus*	20	10.0
Gizzard shad	*Dorosoma cepedianum*	19	9.0
Longnose gar	*Lepisosteus osseus*	15	7.0
Quillback carpsucker	*Carpiodes cyprinus*	7	3.0
Yellow bullhead	*Ictalurus natalis*	7	3.0
Redear	*Lepomis microlophus*	5	2.0
Carp	*Cyprinus carpio*	4	2.0
White bass	*Morone chrysops*	3	1.0
Largemouth bass	*Micropterus salmoides*	2	1.0
Spotted sucker	*Minytrema melanops*	2	1.0
Hybrid sunfish		2	1.0
Golden shiner	*Notemigonus crysoleucas*	2	1.0
Longear	*Lepomis megalotis*	1	.5
Spotfin shiner	*Notropis spilopterus*	1	.5
Warmouth	*Chaeniobrythus gulosus*	1	.5
Pumpkinseed	*Lepomis gibbosus*	1	.5
American eel	*Anguilla rostrata*	1	.5
	Total - - -	205	

Table 9. Summary of Species Composition and Relative Abundance of Fishes Collected in the Broad River Study Area, S. C., March and June, 1971.

Common Name	Scientific Name	March, 1971 No.	March, 1971 %	June, 1971 No.	June, 1971 %	Composite No.	Composite %
Bluegill	Lepomis macrochirus	93	48.90	25	12.20	118	29.80
White crappie	Pomoxis annularis	20	10.50	87	42.60	107	27.10
Redear	Lepomis microlophus	18	9.50	5	2.40	23	5.80
Largemouth bass	Micropterus salmoides	13	6.80	2	.98	15	3.70
Carp	Cyprinus carpio	8	4.20	4	1.90	12	3.00
White sucker	Castostomus commersoni	13	6.80	-	-	13	3.30
Gizzard shad	Dorosoma cepedianum	8	4.20	19	9.30	27	6.80
Golden shiner	Notemigonus crysoleucas	6	3.10	2	.98	8	2.00
Pumpkinseed	Lepomis gibbosus	3	1.50	1	.49	4	1.00
Warmouth	Lepomis gulosus	3	1.50	1	.49	4	1.00
Longear sunfish	Lepomis megalotis	2	1.00	1	.49	3	.75
White catfish	Ictalurus catus	2	1.00	-	-	2	.50
Longnose gar	Lepisosteus osseus	1	.50	15	7.40	16	4.00
Black crappie	Pomoxis nigromaculatus	-	-	20	9.80	20	5.00
Quillback carpsucker	Carpiodes cyprinus	-	-	7	3.40	7	2.00
Yellow bullhead	Ictalurus natalis	-	-	7	3.40	7	2.00
White bass	Morone chrysops	-	-	3	1.40	3	.25
Spotted sucker	Minytrema melanops	-	-	2	.98	2	.50
Hybrid sunfish		-	-	2	.98	2	.50
Spotfin shiner	Notropis spilopterus	-	-	1	.49	1	.25
American eel	Anguilla rostrata	-	-	1	.49	1	.25
		190		205		395	

Table 10. Species Composition and Relative Abundance of Fishes Collected at Transect A, Broad River Study Area, June, 1971.

Common Name	Scientific Name	No.	%
Gizzard shad	_Dorosoma cepedianum_	14	29.2
Longnose gar	_Lepisosteus osseus_	8	16.7
White crappie	_Pomoxis annularis_	7	14.6
Black crappie	_Pomoxis nigromaculatus_	6	12.5
Bluegill	_Lepomis macrochirus_	6	12.5
Redear	_Lepomis microlophus_	3	6.3
Yellow bullhead	_Ictalurus natalis_	3	6.3
Largemouth bass	_Micropterus salmoides_	1	2.3
	Total -	48	

Table 11. Length, Frequency, Weight and Condition Factor of Fishes Collected at Transect A, Broad River Study Area, June, 1971.

Size Groups	Number	Percentage	Average Weight	Condition Factor (k)
		(Gizzard shad)		
16 cm	1	7.1	36 grams	.9
18	1	7.1	50	.9
22	1	7.1	73	.7
25	1	7.1	136	.9
28	1	7.1	172	.8
33	1	7.1	281	.8
35	2	14.2	308	.8
36	1	7.1	336	.8
37	3	21.3	441	.9
39	1	7.1	435	.7
40	1	7.1	468	.7
	14			
		(Largemouth bass)		
33	1	100	77.1	2.1
		(Bluegill)		
6	1	16.7	5	1.9
8	1	16.7	5	.9
10	1	16.7	14	1.4
11	2	33.3	18	1.4
12	1	16.7	23	1.4
	6			
		(Redear sunfish)		
9	1	33.3	14	1.8
13	1	33.3	27	1.2
18	1	33.3	91	1.7
	3			
		(Black crappie)		
12	1	16.7	14	1.6
13	1	16.7	23	1.0
17	1	16.7	45	1.0
20	1	16.7	104	1.2
21	1	16.7	113	1.3
22	1	16.7	136	1.3
	6			
		(White crappie)		
11	4	57.2	12	.8
12	2	28.6	14	.8
18	1	14.3	59	1.1
	7			

(Continued)

Table 11. (Continued)

Size Groups	Number	Percentage	Average Weight	Condition Factor (k)
		(Longnose gar)		
45 cm.	1	12.5	113 grams	.1
61	1	12.5	454	.2
59	1	12.5	454	.2
66	1	12.5	680	.2
69	1	12.5	680	.2
73	1	12.5	1270	.3
83	1	12.5	1588	.3
84	1	12.5	1588	.3
	8			
		(Yellow bullhead)		
38	1	33.3	726	1.3
41	2	66.6	816	1.2
	3			

Table 12. Species Composition and Relative Abundance of Fishes Collected at Transect B, Broad River Study Area, June, 1971.

Common Name	Scientific Name	No.	%
White crappie	Pomoxis annularis	17	53.1
Bluegill	Lepomis macrochirus	7	21.9
Redear	Lepomis microlophus	2	6.2
Golden shiner	Notemigonus crysoleucas	2	6.2
Warmouth	Lepomis gulosus	1	3.1
Hybrid sunfish		1	3.1
Gizzard shad	Dorosoma cepedianum	1	3.1
Quillback carpsucker	Carpiodes cyprinus	1	3.1
		32	

Table 13. Length, Frequency, Weight and Condition Factor of Fishes Collected at Transect B, Broad River Study Area, June, 1971.

Size Groups	Number	Percentage	Average Weight	Condition Factor (k)
		(White crappie)		
9 cm.	1	5.9	9 grams	1.1
11	4	23.6	14	.9
12	9	53.1	18	1.1
15	1	5.9	32	1.0
17	1	5.9	50	1.1
19	1	5.9	73	1.1
	17			
		(Bluegill sunfish)		
8	1	14.3	9	1.8
9	2	28.6	11	1.1
11	2	28.6	25	1.6
13	1	14.3	45	2.2
14	1	14.3	46	1.8
	7			
		(Redear sunfish)		
9	1	50.0	14	2.0
14	1	50.0	41	1.6
	2			
		(Golden shiner)		
12	1	50.0	14	.8
15	1	50.0	27	.9
	2			
		(Gizzard shad)		
35	1		35	.8
		(Quillback carpsucker)		
43	1		998	1.2
		(Warmouth sunfish)		
22	1		23	1.4
		(Hybrid sunfish)		
13	1		32	1.5

Table 14. Species Composition and Relative Abundance of Fishes Collected at Transect C, Broad River Study Area, June, 1971.

Common Name	Scientific Name	No.	%
White crappie	*Pomoxis annularis*	57	86.3
Bluegill	*Lepomis macrochirus*	4	6.7
Gizzard shad	*Dorosoma cepedianum*	2	3.3
Quillback carpsucker	*Carpiodes cyprinus*	1	1.5
Yellow bullhead	*Ictalurus natalis*	1	1.5
Hybrid sunfish		1	1.5
		66	

Table 15. Length, Frequency, Weight and Condition Factor of Fishes Collected at Transect C, Broad River Study Area, June, 1971.

Size Groups	Numbers	Percentage	Average Weight	Condition Factor (k)
		(White crappie)		
10 cm.	1	1.8	14 grams	1.2
11	20	35.1	18	1.2
12	15	26.3	20	1.2
13	4	7.0	25	1.2
14	3	5.3	33	1.3
15	3	5.3	38	1.1
16	5	8.8	43	1.2
17	1	1.8	59	1.1
18	2	3.5	56	1.5
19	2	3.5	68	1.1
22	1	1.8	113	1.1
	57			
		(Bluegill)		
9	2	50.0	14	1.6
11	1	25.0	23	1.6
21	1	25.0	159	1.8
	4			
		(Gizzard shad)		
21	1	50.0	82	.9
22	1	50.0	86	.8
	2			
		(Quillback carpsucker)		
39	1		762	1.3
		(Yellow bullhead)		
18	1		64	1.1
		(Hybrid sunfish)		
9	1		14	1.6

Table 16. Species Composition and Relative Abundance of Fishes Collected at Transect D, Broad River Study Area, June, 1971.

Common Name	Scientific Name	No.	%
Black crappie	*Pomoxis nigromaculatus*	10	45.4
White crappie	*Pomoxis annularis*	5	22.7
Bluegill	*Lepomis macrochirus*	3	13.6
Largemouth bass	*Micropterus salmoides*	1	4.5
Pumpkinseed	*Lepomis gibbosus*	1	4.5
Longnose gar	*Lepisosteus osseus*	1	4.5
Carp	*Cyprinus carpio*	1	4.5
		22	

Table 17. Length, Frequency, Weight and Condition Factor of Fishes Collected at Transect D, Broad River Study Area, June, 1971.

Size Groups	Number	Percentage	Average Weight	Condition Factor (k)
		(Black crappie)		
11 cm.	2	20.0	20 grams	1.4
17	1	10.0	73	1.4
18	1	10.0	91	1.5
20	1	10.0	127	1.5
22	1	10.0	177	1.7
24	1	10.0	222	1.6
25	2	20.0	240	1.6
28	1	10.0	345	1.5
	10			
		(White crappie)		
11	1	20.0	18	1.3
17	2	40.0	63	1.3
22	1	20.0	150	1.3
25	1	20.0	222	1.4
	5			
		(Bluegill)		
13	1	33.3	50	2.3
16	1	33.3	82	2.2
17	1	33.3	109	2.4
	3			
		(Largemouth bass)		
6	1		5	2.8
		(Pumpkinseed sunfish)		
14	1		54	2.1
		(Carp)		
51	1		1814	1.4
		(Longnose gar)		
53	1		281	.2

Table 18. Species Composition and Relative Abundance of Fishes Collected at Transect E, Broad River Study Area, June, 1971.

Common Name	Scientific Name	No.	%
Longnose gar	*Lepisosteus osseus*	6	16.7
Bluegill	*Lepomis macrochirus*	5	13.9
Quillback carpsucker	*Carpiodes cyprinus*	5	13.9
Black crappie	*Pomoxis nigromaculatus*	4	11.1
White bass	*Morone chrysops*	3	8.3
Gizzard shad	*Dorosoma cepedianum*	2	5.6
Carp	*Cyprinus carpio*	2	5.6
Spotted sucker	*Minytrema melanops*	2	5.6
Longear	*Lepomis megalotis*	1	2.8
White crappie	*Pomoxis annularis*	1	2.8
Spotfin shiner	*Notropis spilopterus*	1	2.8
Yellow bullhead	*Ictalurus natalis*	3	8.3
American eel	*Anguilla rostrata*	1	2.8
		36	

Table 19. Length, Frequency, Weight and Condition Factor of Fishes Collected at Transect E, Broad River Study Area, June, 1971.

Size Groups	Number	Percentage	Average Weight	Condition Factor (k)
		(White bass)		
33 cm.	1	33.3	571 grams	1.6
34	1	33.3	567	1.4
39	1	33.3	907	1.6
	3			
		(Longnose gar)		
41	1	16.7	136	.2
43	1	16.7	113	.1
55	1	16.7	363	.2
56	1	16.7	499	.3
67	1	16.7	794	.3
86	1	16.7	1588	.2
	6			
		(Bluegill)		
10	1	20.0	18	1.7
11	1	20.0	23	1.6
17	1	20.0	104	2.3
18	2	40.0	122	2.1
	5			
		(Black crappie)		
11	1	25.0	14	1.0
12	1	25.0	18	1.0
15	1	25.0	36	1.2
17	1	25.0	64	1.3
	4			
		(Quillback carpsucker)		
29	1	20.0	340	1.4
33	1	20.0	495	1.4
34	3	60.0	551	1.4
	5			
		(Gizzard shad)		
29	1		227	1.0
31	1		249	.8
	2			
		(Carp)		
51	1	25.0	2155	1.6
56	2	75.0	2631	1.4
	3			
		(Spotted sucker)		
43	1		726	.9
44	1		771	.9
	2			

(Continued)

Table 19. (Continued)

Size Groups	Number	Percentage	Average Weight	Condition Factor (k)
		(Yellow bullhead)		
19 cm.	1	25.0	680 grams	1.0
22	2	75.0	104	1.0
	3			
		(Longear sunfish)		
14	111		54	1.9
		(White crappie)		
12	1		14	.8
		(Spotfin shiner)		
9	1		9	1.1

Table 20. Temperature Profile Data (by Date) from Transects and Collecting Points in the Broad River Study Area, June, 1971.

Temperatures in °C[1] at transects

Depth (m)	Transect A (6/25)		Transect B (6/23)			Transect C (6/22)			Transect D (6/24)			Transect E (6/26)	
Coll. Points	1	2	1	2	3	1	2	3	1	2	3	1	2
0.00[2]	31.5	32.5	29.5	30.0	28.5	31.0	30.0	30.0	27.0	29.0	26.0	28.5	28.5
0.25	27.0	27.0	26.5	27.0	24.0	29.5	29.0	28.0	26.0	27.5	26.0	28.5	28.5
0.50	27.0	27.0	25.5	25.0	24.0	29.5	28.5	26.0	26.0	27.0	26.0	28.5	28.5
0.75		27.0	24.5	23.5	23.0		27.0	25.0	26.0	27.0	26.0	28.5	28.5
1.00			24.0	23.0	22.0		26.0	24.5	26.0	26.5	26.0	28.5	28.5
1.25				22.0	22.0		25.0	24.0	26.0	26.0	26.0		
1.50				21.5	21.5		24.5	23.5	26.0	26.0			
1.75				21.0	21.5		24.0	23.0	26.0				
2.00				21.0			24.0	23.0	26.0				
2.25									26.0				
2.50									26.0				
2.75									26.0				
3.00									26.0				
3.25									26.0				
3.50									26.0				
3.75									26.0				
4.00									26.0				
4.25									26.0				
4.50									26.0				
4.75									26.0				

1/ Temperatures to nearest 0.5°C.
2/ Surface

Table 21. Selected Tests Performed at Transects and Collecting Points in the Broad River Study Area June, 1971.

Transects	Collecting Points	Date	Secchi[1/] (m)	pH surface	pH bottom	Dissolved Oxygen (ppm) surface	Dissolved Oxygen (ppm) bottom
A Above Frees Creek	1	6/25	0.20	7.5	7.0	10	8
	2	6/25	0.20				
B Frees Creek	1	6/23	0.20				
	2	6/23	0.25	7.7	6.9	11	6
	3	6/23	0.25				
C Cannons Creek	1	6/22	0.50				
	2	6/22	0.70	7.7	7.0	10	7
	3	6/22	0.60				
D Above Parr Dam	1	6/24	0.25	7.0	7.0	9	7
	2	6/24	0.25				
	3	6/24	0.25				
E Below Parr Dam	1	6/26	0.15	7.0	-	9	-
	2	6/26	0.15				

1/Read to nearest 0.05 m.

Table 22. Mammals Collected on the Fairfield-Summer Power Project Site, Fairfield County, South Carolina, June, 1971.

Species	Sex	Collection No. (RDK)*	Total Length	Tail Length	Hind Foot	Ear Length	Body Weight
Peromyscus gossypinus	F	1208	135 mm.	61 mm.	17 mm.	21 mm.	16.3g
" "	F	1218	155	65	23	16	29.1
" "	F	1219	169	64	22	12	26.8
" "	F	1220	?	?	?	?	?
" "	F	1229	152	62	18	15	18.1
" "	F	1232	151	65	19	?	17.4
" "	M	1233	153	62	?	?	18.2
" "	M	1234	169	78	22	19	28.9
" "	M	1239	138	61	19	16	16.0
Procyon lotor	?	1211	(skull only, found dead)				
Lasiurus seminolus	F	1213	115	48	10	12	14.4
" "	F	1214	102	41	9	10	10.2
" "	F	1225	?	?	?	?	10.4
Mus musculus	F	1217	150	75	18	13	19.0
" "	F	1227	161	81	17	?	21.6
" "	F	1236	170	81	18	13	23.1
" "	M	1240	153	78	19	12	17.3
Sigmodon hispidus	F	1226	198	87	29	19	57.8
" "	M	1235	267	106	29	?	126.0
Blarina brevicanda	M	1228	82	19	12	0	6.5
Ochrotomys nuttalli	M	1230	162	80	18	17	15.4
" "	F	1241	170	80	20	17	16.4

*RDK = Ralph D. Kirkpatric, Ph.D., Collector.

Table 23. Trees (2.5 centimeters or more d.b.h.*) on and near Permanent Small Mammal Trapline Site 1,-Fairfield County, South Carolina, June, 1971.

Species		Relative Density	Absolute Density (trees per hectare)	Relative Frequency
Pinus taeda, Loblolly Pine		69.4%	1,681	52.9%
Liquidambar styraciflua, Sweet Gum		18.0%	438	21.4%
Cornus florida, Flowering Dogwood		6.3%	153	11.4%
Juniperus virginiana, Red Cedar		3.1%	75	7.1%
Liriodendron tulipifera, Tulip Tree		1.3%	31	2.9%
Ostrya virginiana, Hop Hornbeam		1.3%	31	2.9%
Acer rubrum, Red Maple		0.6%	15	1.4%
	Totals	100%	2,424	100%

*d.b.h. = diameter of breast height or 1.37 meters

Table 24. Trees (2.5 centimeters or more d.b.h.) on and near Permanent Small Mammal Trapline Site 3, Fairfield County, South Carolina, June, 1971.

Species	Relative Density	Absolue Density (trees per hectare)	Relative Frequency
Juniperva virginiana, Red Cedar	19.2%	430	16.0%
Acer rubrum, Red Maple	14.8%	332	13.4%
Pinus taeda, Loblolly Pine	18.6%	417	16.0%
Quercus sp., White Oak Group	6.2%	139	7.6%
Fraximus sp., Ash	6.2%	139	8.4%
Cstrya virginiana, Hop Hornbeam	5.6%	124	7.6%
Carya sp., Hickory	4.7%	106	5.0%
Carya ovata, Shagbark Hickory	4.7%	106	5.9%
Carpinus caroliniana, Ironwood	4.7%	106	2.5%
Quercus sp., White Oak Group	3.8%	84	3.4%
Tilia sp., Basswood	3.8%	84	3.4%
Quercus sp., Oak	3.1%	68	4.2%
Quercus virginiana, Live Oak	1.8%	42	2.5%
Cornus florida, Flowering Dogwood	1.2%	28	1.7%
Cercis canadensia, Redbud	1.2%	28	1.7%
Quercus shellos, Willow	0.6%	13	0.7%
Totals	100%	2,246	100%

Table 25. Trees (2.5 centimeters or more d.b.h.) on and near Permanent Small Mammal Trapline Site 4, Fairfield County, South Carolina, June, 1971.

Species	Relative Density	Absolute Density (trees per hectare)	Relative Frequency
Pinus taeda, Loblolly Pine	81.3%	1,568	60.7%
Juniperus virginiana, Red Cedar	6.3%	122	12.2%
Flex opaca, Holly	3.1%	60	6.1%
Prunus serotina, Black Cherry	2.5%	48	4.5%
Quercus sp. White Oak Group	1.9%	37	4.5%
Acer rubrum, Red Maple	1.9%	37	4.5%
Quercus sp., Oak	0.6%	12	1.5%
Quercus phellos, Willow Oak	0.6%	12	1.5%
Ostrya virginiana, Hop Hornbeam	0.6%	12	1.5%
Quercus alba, White Oak	0.6%	12	1.5%
Liquidambar styraciflua, Sweet Gum	0.6%	12	1.5%
Totals	100%	1,932	100%

Table 26. Number of Each Tree Species (2.5 centimeters or more d.b.h.) in Each Size Class (by 5 centimeters increments) on and near Permanent Small Mammal Trapline Site 1, Fairfield County, South Carolina, June, 1971.

Species		Diameter Size Class Midpoints							
		5cm	10cm	15cm	20cm	25cm	30cm	35cm	Total
Pinus taeda		35	36	26	8	4	2	0	111
Liquidambar styraciflua		14	6	4	1	1	1	2	29
Cornus florida		7	3	0	0	0	0	0	10
Juniperus virginiana		3	2	0	0	0	0	0	5
Liriodendron tulipifera		1	1	0	0	0	0	0	2
Ostrya virginiana		2	0	0	0	0	0	0	2
Acer rubrum		1	0	0	0	0	0	0	1
	Totals	63	48	30	9	5	3	2	160

Table 27. Number of Each Tree Species (2.5 centimeters d.b.h.) in Each Size Class (by 5 centimeter increments) on and near Permanent Small Mammal Trapline Site 3, Fairfield County, South Carolina, June, 1971.

Species	Diameter Size Class Midpoints									
	5cm	10cm	15cm	20cm	25cm	30cm	35cm	40cm	45cm	Total
Juniperus virginianus	17	11	3	-	-	-	-	-	-	31
Acer rubrum	21	4	5	-	-	1	-	-	-	31
Pinus taeda	4	4	7	5	1	1	1	-	1	24
Quercus, sp. White Oak Group	3	4	3	-	-	-	-	-	-	10
Fraxinus, sp.	2	4	-	2	-	1	-	-	-	9
Ostrya virginiana	2	2	3	1	-	1	-	-	-	9
Carya, sp.	3	-	3	1	-	-	-	-	-	7
Carya ovata	2	1	-	2	2	-	-	-	-	7
Carpinus caroliniana	3	3	1	-	-	-	-	-	-	7
Quercus, sp. White Oak Group	1	1	2	2	-	-	-	-	-	6
Tilia, sp.	3	-	3	-	-	-	-	-	-	6
Quercus, sp.	3	1	-	1	-	1	-	-	-	6
Quercus virginiana	-	-	-	-	1	1	-	-	-	2
Cornus florida	2	-	-	-	-	-	-	-	-	2
Cercia canadensis	2	-	-	-	-	-	-	-	-	2
Quercus phellos	-	-	1	-	-	-	-	-	-	1
Totals	68	35	31	14	4	6	1	0	1	160

Table 28. Number of Each Tree Species (2.5 centimeters or more d.b.h.) in Each Size Class (by 5 centimeter increments) on and near Permanent Small Mammal Trapline Site 4, Fairfield County, South Carolina June, 1971.

Species	Diameter Size Class Midpoints							
	5cm	10cm	15cm	20cm	25cm	30cm	35cm	Total
Pinus taeda	57	35	17	8	4	6	3	130
Juniperus virginiana	5	3	2	-	-	-	-	10
Flex opaca	5	-	-	-	-	-	-	5
Prunus serotina	2	-	2	-	-	-	-	4
Quercus sp., White Oak Group	2	-	-	1	-	-	-	3
Acer rubrum	3	-	-	-	-	-	-	3
Quercus sp., Oak	1	-	-	-	-	-	-	1
Quercus phellos	1	-	-	-	-	-	-	1
Ostrya virginiana	-	1	-	-	-	-	-	1
Quercus alba	-	-	1	-	-	-	-	1
Liquidambar styraciflua	1	-	-	-	-	-	-	1
Totals	77	39	22	9	4	6	3	160

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PRESSURIZED WATER REACTORS

Basic Data for Source Term Calculation

INSTRUCTION SHEET

Insert after Appendix B1 of the Environmental Report