February 28, 1972

Joseph M. Farley Nuclear Plant
Amendment 1 to Supplementary Environmental Report

Attention: Recipients of Joseph M. Farley Nuclear Plant
Supplementary Environmental Report

Transmitted herewith is Amendment 1 to the Joseph M. Farley Nuclear Plant Supplementary Environmental Report. This Amendment consists of revised pages of the Supplementary Environmental Report, and Appendix A-Environmental Benefit-Cost Analysis.

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Yours very truly,

S. R. Hart, Jr.

S. R. Hart, Jr.

SRH:Fk

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Part 8
8.0 Irreversible and Irretrievable Commitments of Resources

APPENDIX A
Environmental Benefit-Cost Analysis

1.0 Basis for The Joseph M. Farley Nuclear Plant

Section 102(2)(c) of the National Environmental Policy Act requires a discussion of alternatives to the proposed action. The purpose of the construction of the Joseph M. Farley Nuclear Plant is to produce electric power to supply the increasing needs of the customers of Alabama Power Company.

At the time the decision to construct this plant was made in 1968, there were a number of practical alternatives available. Such alternatives were carefully weighed in the studies which led to the decision to construct a nuclear generating plant in Southeast Alabama. The alternatives available at the present time have changed considerably. The alternatives considered in arriving at the decision to construct the Farley Nuclear Plant and those still available today are discussed in detail in this Supplemental Environmental Report.

One drastic alternative to the construction of the Farley Nuclear Plant would be the failure of Alabama Power Company to provide any source for the additional electric power required to supply the increasing needs of its customers. Alabama Power Company does not consider this a feasible alternative and the effect of such choice is not discussed in this report. Alabama Power Company is under the jurisdiction of the Alabama Public Service Commission and has a legal obligation to provide adequate and reliable electric service. In addition, under Section 202 of the Federal Power Act, Congress has expressed as a national policy the goal of assuring adequate supplies of electric power.

The question is, therefore, narrowed to the determination of the amount, if any, of additional generating capacity required in the years

1975 and beyond, and the determination of the best type of, and location for, such generating capacity by a careful comparison of the possible alternatives.

1.1 Need for Power

Alabama Power Company's maximum territorial peak hour demand reached 4,341.9 megawatts on July 14, 1971. (This load does not include 78.1 megawatts of load supplied by Southeastern Power Administration and delivered to customers of Southeastern Power Administration over the transmission system of Alabama Power Company, nor does the capacity tabulation which follows include this amount of capacity.)

The Company's long term average annual compounded growth rate is approximately 8.2 percent. Based on studies of trends of past load growth, as well as studies of expected increases in sales of energy at load factors consistent with past experience, the maximum territorial peak hour demands in future years are estimated as follows:

1972...............4,784 megawatts

1973...............5,243 megawatts

1974...............5,661 megawatts

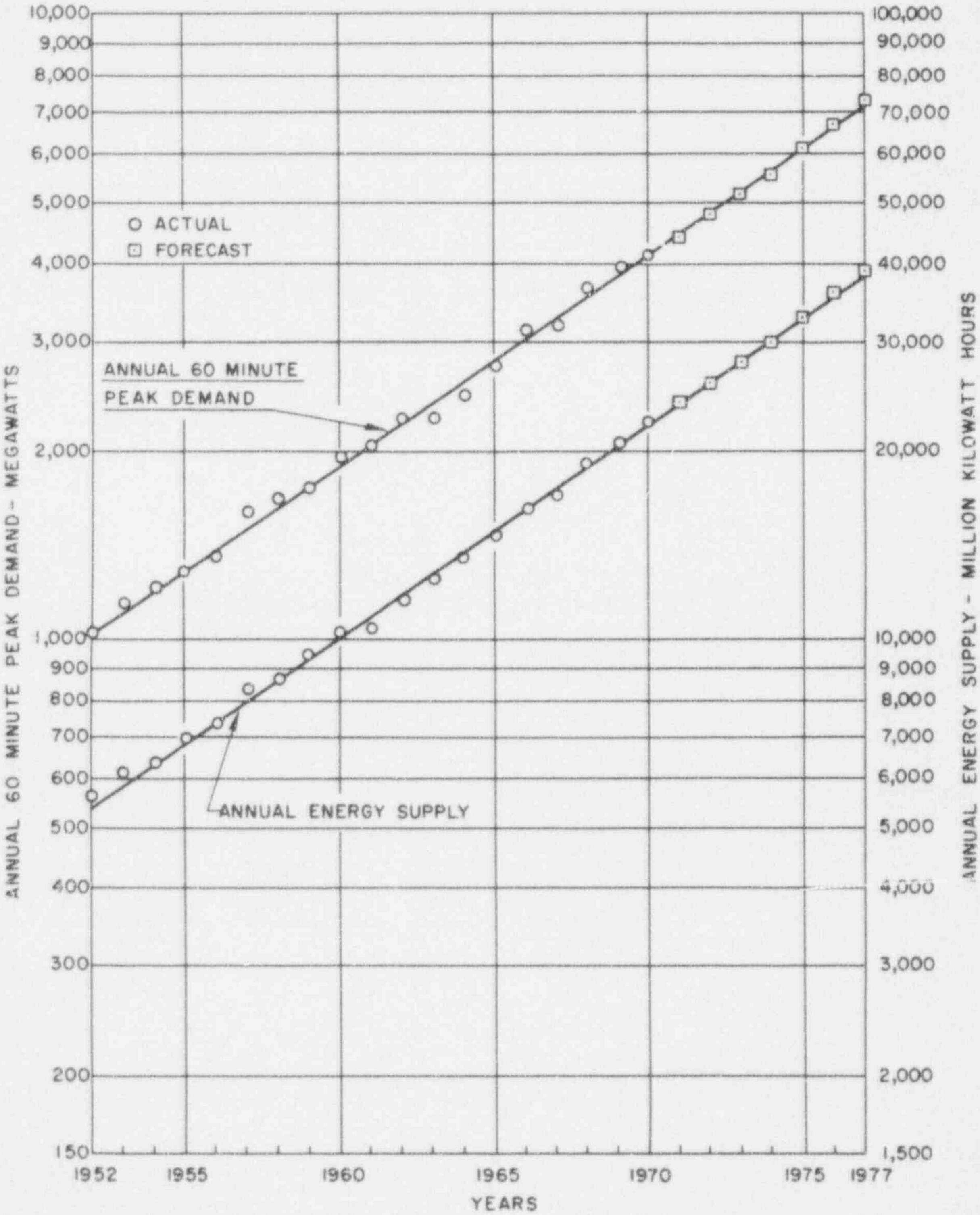
1975...............6,111 megawatts

1976...............6,704 megawatts

1977...............7,267 megawatts

The long term growth trends and future estimated loads are shown graphically on Figure 1-1.

The estimated future load growth is based on the most recent projections of the actual load growth experienced through the summer of 1971.



ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT

ANNUAL 60 MINUTE PEAK DEMAND AND ANNUAL ENERGY SUPPLY

FIGURE 1-1

This projected rate of load growth is consistent with the trend for the entire United States. Since 1965 the demand for electric power in the United States has increased at an annual average compounded rate of approximately 8 percent.[1] The Federal Power Commission in its National Power Survey[2], published in 1964, demonstrated a long term growth rate for the period 1920-1963 equivalent to an annual average compounded growth rate of 7.2 percent. A comprehensive article "Energy and Power" in the September, 1971 issue of Scientific American[3] presented similar data on growth of electrical energy as a part of the nation's total energy supply. These and other studies establish strong justification that the load growth experienced in the past will continue in future years.

In addition to the Farley Nuclear Plant, the Company presently has under construction a coal fueled generating plant with a capacity of 712 megawatts at Gorgas, Alabama, approximately 25 miles northwest of Birmingham, scheduled for operation prior to the summer peak load period of 1972 and a coal fueled generating plant with a capacity of 850 megawatts at Wilsonville, Alabama, approximately 25 miles southeast of Birmingham scheduled for operation prior to the summer peak load period of 1974.

With the completion of these generating units, the assignment of two older coal fueled units to standby service and adjustments in planned purchased power contracts, the Company's total generating capability in 1974 will be 6,708.3 megawatts.

In order to determine generating capacity requirements, it is necessary to add to the estimated peak hour demand 3 percent of this amount to account for load swings within the hour and 2 percent for operating margin. In 1975, this results in an estimated peak load of 6,416.5 megawatts.

To provide adequate reliability for the system, a reserve margin must be available during periods of forced outages of generating units. Alabama Power Company has determined that a minimum level of reserves is an amount equal to 3 percent of total hydroelectric capability and 10.5 percent of total thermal plant capability. It is apparent that the generating plant capability on the Alabama Power Company system at the end of 1974 will not be adequate to meet the 1975 load requirements with an acceptable level of reserves.

Alabama Power Company is a wholly owned subsidiary of The Southern Company and is closely interconnected with the other subsidiaries, Mississippi Power Company, Gulf Power Company and Georgia Power Company. For maximum economy in construction and operation, generating plant additions for any of the operating subsidiaries are planned in relation to the needs of all of the companies as an integrated system. Therefore, in determining the need for additional generating capacity on the Alabama Power Company system in 1975 and beyond, consideration was given to the needs of the entire Southern Company System.

The estimated peak hour demand on The Southern Company System in 1975 is estimated to be 19,219 megawatts. At the end of 1974 it is estimated that the total system generating capability will be 20,937.3 megawatts. In 1975 the estimated peak load plus minimum required reserves will be 22,317.4 megawatts based on an estimated peak hour demand of 19,219 megawatts. It is apparent that additional generating capacity will be required on The Southern Company System prior to the 1975 peak load period.

Beginning in 1967, detailed system studies were made which determined that additional generating capacity would be required on the Alabama Power Company system by 1975.

1. Electrical World, 22nd Annual Electrical Industry Forecast (September 15, 1971)

2. National Power Survey - Vol. I, U. S. Government Printing Office 1964, p 10

3. Chauncey Starr, Energy and Power, Scientific American, Vol. 225, No. 3 (September 1971)

1.2 Location of the Additional Generating Capacity

Once the determination had been made that additional generating capacity would be required, further detailed studies were made to determine the optimum location of the new plant. Such studies involved consideration of transmission line load flow, system reliability, fuel economics, availability of rail and water transportation, topography, geology, hydrology, population density and the availability of suitable property.

The southeastern portion of Alabama is the only area of substantial size within the Alabama Power Company service area in which the Company does not own and operate a generating plant. This has been due primarily to the relatively higher cost of coal in this area because of the longer distances from the coal fields in northern Alabama and the lack of a direct water transportation route. Further, because of the absence of large industrial customers and the relatively lower population density in this area, the electric power requirements were low enough to enable this Company to serve the loads over transmission lines from generating plants located at a considerable distance from the area.

Prior to 1954 the area was served over transmission lines operating at 115,000 volts. In 1954 a 230,000 volt transmission line was constructed into Southeast Alabama from the Barry Steam Plant north of Mobile to the Pinckard Substation in Southeast Alabama. By 1966 a second 230,000 volt transmission line to the area was required and was constructed from the Montgomery area, 100 miles to the northwest, where it connected to sources supplied by both steam electric and hydroelectric generating plants to the Pinckard Substation.

In the 1967 studies, it was predicted that the demand for power in the southeast Alabama area would reach 360 megawatts in 1975. At this load, considerations of transmission line loading and system reliability made it economically feasible to construct generating capacity in the southeast Alabama area.

While economic considerations had weighed heavily against this area as a location for generating capacity in the past because of the substantially higher coal costs in the area, additional factors were introduced in the 1967 evaluations.

The Company's requirements for coal, particularly when the 1972 and 1974 coal fueled units previously mentioned were considered, exceeded the amount of coal available at a competitive price from the Alabama coal fields. Consideration was given to the purchase of coal from states north of Alabama from which the coal could be barged down the Mississippi River system. Since the construction of Jim Woodruff Dam in 1957, the southeast Alabama area has had a navigable waterway on the Chattahoochee River connected by the Inter-Coastal Waterway to the Mississippi River, and the cost of coal delivered to Southeast Alabama has become more comparable with the cost of coal delivered to other possible generating plant sites in Alabama.

The Company had been closely following the development of nuclear power and concluded that nuclear technology had reached the point that nuclear plants should be considered on their economic merits. Since transportation costs represent a small percentage of the delivered cost of nuclear fuel, the economics of nuclear generating plants are relatively independent of location as long as rail and barge transportation is available, and other site requirements are met.

When all of these factors were considered, there was a clearly demonstrated advantage to building a generating plant in Southeast Alabama.

Fol' ing the decision to locate the plant in Southeast Alabama, a detailed ı was begun for the actual plant site.

The requirements for barge transportation of coal, if the plant were to be coal fueled, and the highly desirable provision for barge transportation of la mponents, if the plant were to be a nuclear plant, immediately limited the search to the area along the Chattahoochee River. A 50 mile stretch of the river was explored in detail and various alternative sites were compared, and one site was selected as the most acceptable from the standpoints of topography, geology and hydrology. These detailed studies are descrit n Section 1.5 of this report.

1.3 Type of Generating Plant

The load studies previously mentioned had indicated the need for additional generating capacity to meet both base load and peaking requirements. Combustion turbines, because of their relatively low capital costs but high fuel costs, and hydroelectric generating plants, because of the characteristics of stream flows in Alabama, are best suited for peaking purposes. Fossil fueled steam and nuclear generating plants are best suited for base load operation.

A decision was made to provide additional peaking capacity at Mitchell Dam on the Coosa River and to construct a new hydroelectric generating plant to be located near Crooked Creek on the Tallapoosa River, subject to approval of the Federal Power Commission. There are no feasible hydroelectric sites still undeveloped in the southeast Alabama area.

The remaining practical alternative was therefore limited to a choice between a fossil fueled or a nuclear generating plant in Southeast Alabama. Because of relatively higher costs of gas and oil and the unavailability of gas, the choice of fuel for the fossil plant was limited to coal.

The selection of a nuclear plant instead of a coal fueled plant was made primarily on a comparison of the long range costs of owning and operating each type of plant. On the basis of the best estimates available at that time on the construction costs and future fuel costs, the nuclear plant was found to have a clear, long range economic advantage. The decision was, therefore, made to construct a nuclear plant, subject to the approval of the Atomic Energy Commission and other regulatory agencies.

In retrospect, it appears that the decision to construct a nuclear plant in this area presented substantial environmental advantages. The plant site is located in an area of relatively low population density. The topography, geology and hydrology of the site are such that the plant and associated facilities will have minimal environmental impact.

The Federal Power Commission, in its comments on the earlier Environmental Report for the Joseph M. Farley Nuclear Plant, stated:

> "By selecting nuclear units and locating them in Southeast Alabama, which is devoid of generating facilities, the reliability of electric service for both the customers of Alabama Power Company and those of The Southern Company will be improved as generation will be placed near the loads and transmission loss will be reduced."

1.4 Comparison of Relative Environmental Effects of Alternate Sources of Power Generation

Although new sources of power generation are being investigated in many places throughout the world, the sources discussed below are the only ones feasible for consideration as alternatives for the Joseph M. Farley Plant. It should be noted that advancements are being made in the technology of coal fueled plants which will serve to reduce their environmental impact, particularly as it relates to air quality.

1.4.1 Types of Generating Plants and Their Environmental Effects

The following types of base load generating plants have been chosen for comparison in order to obtain an evaluation of the relative environmental effects of each during normal operations:

1. Nuclear fueled
2. Coal fueled
3. Oil fueled
4. Gas fueled

The environmental effects of each of these types of plants are compared with respect to the items listed below. The comparative numbers are based on available estimates made for a typical 1,000 megawatt generating plant.[1]

1. Air quality effects
2. Water quality effects
3. Noise levels
4. Asthetics
5. Land use

1.4.2 Air Quality Effects

A coal-fueled plant of 1,000 megawatt capacity consumes an estimated 2.3×10^6 tons per year of coal. It has been estimated that combustion of this quantity of coal results in the release annually of 306×10^6 lbs. of oxides of sulfur*, 46×10^6 lbs. of oxides of nitrogen, 1.15×10^6 lbs. of carbon monoxide, 0.46×10^6 lbs. of hydrocarbons, 0.12×10^6 lbs. of aldehydes and 9.9×10^6 lbs. of particulate matter (based on an assumed flyash removal efficiency of 97.5 percent)**[1] If it is assumed that a coal fueled plant with capacity equal to the two units of the Joseph M. Farley Plant (1658 megawatts) is used for comparison, emissions will be approximately 66% greater than those estimated for the 1,000 megawatt plant.

If electrostatic precipitators or other devices are installed, resulting in removal of about 99 percent of the flyash, the emissions of particulates from a 1000 megawatt coal fueled plant will be reduced to an estimated 4.0×10^6 lbs. per year. This is the degree of precipitator efficiency presently being specified by Alabama Power Company.

Compliance with the proposed standards of performance for new stationary sources, issued by the Environmental Protection Agency on August 17, 1971, will result in sulfur dioxide emissions from the 1,000 megawatt example plant of approximately 54.8×10^6 lbs. per year.

Combustion of coal will result in the emission of small quantities of radioactive nuclides, notably radium 226 (half life 1620 years) and radium 228 (half life 5.7 years).[1]

* Assuming 3.5 percent sulfur content, of which 15 percent remains in the ash.

**Assuming 9 percent ash content.

It has been estimated that in the United States emissions from all coal fueled steam electric plants now account for 42.7 percent of the sulfur oxides emissions, 10.5 percent of the particulates and 15.8 percent of the nitrogen oxides.[2] Technology being incorporated in newer plants, such as might be considered as alternatives to the Farley Plant units, will substantially reduce the incremental contribution per plant of these pollutants.

If an oil fueled steam electric plant is substituted for a coal fueled plant for purposes of comparison, the 1,000 megawatt plant would burn an estimated 460 x 10^6 barrels of oil annually.[1] Such a plant would discharge an estimated 116 x 10^6 lbs. of sulfur oxides each year, 48 x 10^6 lbs. of oxides of nitrogen, 1.47 x 10^6 lbs. of hydrocarbons and 1.6 x 10^6 lbs. of flyash.*[1] In addition, small quantities of aldehydes and carbon monoxide would be discharged. The combustion of oil would produce minute quantities of radioactive nuclides amounting to a small fraction of those indicated for a coal fueled plant.

A gas fueled steam electric plant with a capacity of 1,000 megawatts would require an estimated 6800 x 10^6 cubic feet of gas annually.[1] The combustion of this quantity of gas, <u>if available</u>, would result in the discharge of only 0.03 x 10^6 lbs. of sulfur oxides annually and 28 x 10^6 lbs. of oxides of nitrogen annually. Flyash emissions would be reduced to approximately 1.0 x 10^6 lbs. annually.** Nuclear plants will not produce releases of most of the air pollulants listed for the fossil fuel plants

* Assuming 0.05 percent ash content and 1.6 percent sulfur content by weight.

** Assuming the use of present commercial grade gas with possible prior treatment.

in the previous paragraphs. Minimal routine releases of non-radiological air pollutants result from the operation of a nuclear fueled plant. (See Section 5.2.1) Radiological releases are discussed in Part 4, which indicates no harmful environmental effects from such releases will occur.

1.4.3 Water Quality Effects

The principal consideration in water quality for any steam electric generating facility is the release of waste heat to the environment. In the Rankine cycle, which is the basis for almost all steam-electric power production, the maximum attainable efficiency as a practical matter is approximately 40 percent. Much of the rejected heat is dissipated in the condenser cooling water. If the temperature of the receiving water is raised to too high a level, the result will be damage to the aquatic biota. This problem is common to coal fueled, oil fueled, gas fueled and nuclear fueled plants. At this time, light-water nuclear plants are somewhat less efficient than fossil fueled plants, and therefore, the quantity of heat rejected per unit of generation is somewhat greater. Also, in fossil fueled plants, some of the waste heat is rejected through the stack, whereas, in a nuclear fueled plant, almost all of the waste heat is rejected to the condenser cooling water. Table 1-1, based on the "Federal Power Commission Staff Study Supporting the Commission's 1970 Power Survey", shows the heat budget for various types of steam electric generating plants.

In order to avoid damage to the aquatic environment at the Joseph M. Farley Nuclear Plant site, closed-cycle cooling tower systems are being installed. These are described in more detail in Section 3.3.3. Because evaporation of water is the principal means of dissipating waste heat, there will be an inevitable consumptive loss of water associated with the

Table 1-1

STEAM GENERATING PLANTS - HEAT BUDGET*

Type Steam Generating Plant	Heat Rate BTU/KWH	Unit of Generation** BTU/KWH	Misc. Losses BTU/KWH	Losses to Condenser BTU/KWH	Efficiency %
"Average" Fossil Plant	10,300	3,413	1,600	5,300	33
Modern Fossil Plant	8,600	3,413	1,300	3,900	40
Light Water Nuclear Plant	10,500	3,413	400	6,700	32.5
Possible Future Fossil Plant	8,000	3,413	1,200	3,400	43

* Based on Federal Power Commission Staff Study supporting Commission's 1970 National Power Survey.

** 1 Kilowatt Hour = 3,413 BTU.

operation of these cooling towers. This consumptive loss from evaporation and drift from cooling towers at the Joseph M. Farley Nuclear Plant will be 28,000 gallons of water per minute (14,000 gpm for each unit). Although this loss cannot be considered to be a serious degradation of the environment in this area where water is relatively plentiful, it must be recognized that its value may represent some loss to the environment. It can also be the basis for limited potential fogging and meteorological alterations in the immediate vicinity of the plant. Alabama Power Company is installing a similar cooling tower system at the Gaston #5 coal fueled unit now under construction at Wilsonville, Alabama. This plant will have a generating capacity of approximately 850 megawatts, and it is therefore possible to make a direct comparison of the consumptive loss of water for similar sized nuclear and coal fueled plants. At the Gaston Plant, there will be a consumptive loss of water in the cooling towers of approximately 8260 gpm. Therefore, on the basis of this comparison, a nuclear plant equipped with cooling towers consumes substantially more water than a similar sized fossil fueled plant in this general area.

Discharges from the ash ponds of fossil fueled plants may result in some degradation of water quality. Although this has never been identified as a serious problem on the Alabama Power Company system, it must be recognized as a possible cause of adverse environmental effects which is not shared by a nuclear plant. On the other hand, the operation of a nuclear plant will result in minimal controlled releases of radioactive nuclides to the water.

1.4.4 Noise Levels

The principal differences in noise levels between the various types of plants considered in this discussion would result from transportation and fuel handling. Operation of a coal fueled plant involves massive shipment of coal by rail, barge or truck, and fuel handling at the site inevitably produces one of the greatest sources of high noise levels. Oil fueled plants also require large fuel shipments but would be expected to produce considerably lower noise levels. Operation of a nuclear plant would be expected to result in relatively low noise levels associated with fuel transport and handling. Since fuel shipments to and from a nuclear plant will occur on an annual cycle, noise levels associated with fuel transport should be minimal. There should be no significant differences between noise levels of the various types of steam-electric plants produced by cooling tower operation, transformers and turbine generators.

1.4.5 Aesthetics

Coal fueled plants require large coal piles and ash ponds which are extremely difficult to blend unobtrusively into the landscape. All electric generating plants, of course, require construction of substations and transmission lines in order to transport electric power from the plant to the load centers, and there are no differences in aesthetics as far as these basic types of facilities are concerned.

Other possible adverse effects of coal fueled plants include alteration of scenery by strip mining, transportation, fuel storage facilities, stacks, and ash disposal areas.[3]

In addition, oil fueled plants may result in other adverse environmental effects, including alteration of scenery by pipe lines, storage tanks, stacks, and ash disposal areas. It is recognized that drilling and transport of oil can result in serious environmental problems in the event of accidental spills and fires. While regulation of such transportation has increased to prevent environmental consequences of such accidents, it has not received the detailed type of review associated with transportation of nuclear fuel.

Since nuclear plants require no ash ponds or massive fuel storage areas, it is reasonable to conclude that a nuclear plant can be made more aesthetically pleasing than the fossil fuel plants considered.

The Joseph M. Farley Nuclear Plant will be located in an area which may generally be characterized as agricultural. The site itself has been, until recently, partially cultivated. Although any structure would constitute a change from the rural scene, the Farley Plant will result in a minimal visual impact on the area.

Architectural features were carefully designed to provide an aesthetically pleasing appearance, and landscaping will assure that the plant will be an attractive addition to the countryside. An architectural sketch of the Joseph M. Farley Nuclear Plant is shown at the beginning of this report.

Alabama Power Company anticipates that many people will visit the plant's information center. The majority of the site will be left in or returned to a natural state to serve not only as a buffer from the agricultural area surrounding the plant, but also to permit wildlife to continue an unhampered existence in the area.

1.4.6 Land Use

Although the Joseph M. Farley Nuclear Plant will be located on an 1850 acre site, the plant itself will occupy but a small portion of the area.

This site will provide over 4,000 feet of exclusion distance between the reactors and the site boundary. Because no ash ponds, coal piles or large oil storage tanks will be required, it will be possible to use a much larger portion of the site for the preservation and growth of vegetation and use by native wildlife in the area.

1.4.7 Evaluation of Alternate Generating Plants

Consideration of the foregoing section leads to the conclusion that the construction of a nuclear fueled generating plant in Southeast Alabama at the Farley site will result in the minimum environmental impact.

[1] Terrill, J.G., E.D. Harward and I.P. Leggett, Environmental Aspects of Nuclear and Conventional Power Plants, Ind. Med. Surg., 36 (June 1967)pp 412-419

[2] Joint Committee on Atomic Energy, Environmental Effects of Producing Electric Power, Congress of the U.S., 91st Congress, Vol. 3, p 811.

[3] Hull, Andrew P., Radiation in Perspective: Some Comparisons of the Environmental Risks from Nuclear and Fossil-Fueled Power Plants, Nuclear Safety, Vol. 12, No. 3 (May-June 1971) p 185.

1.5 General Site Area Studies

The chief considerations which entered into the selection of potential plant sites were (1) location on a navigable river to provide water for a cooling system and to provide barge transportation for heavy equipment and fossil fuel if necessary, (2) a large site area available for exclusion purposes or for storage of fossil fuel and flyash disposal, (3) location in an area of low population density, (4) satisfactory foundation conditions, and (5) compliance with AEC requirements for geological and hydrological factors. A careful search was made in southeast Alabama to find a site that would fulfill all of the above requirements for either a fossil fueled or a nuclear fueled plant.

Since the Chattahoochee River is the only navigable waterway in Southeast Alabama, the site search was concentrated along a 50 mile stretch of the west river bank from the Alabama-Florida state line to near Eufaula, Alabama. The northern and southern portions of this area are directly underlain by soft limestones, sands or clays, and show evidence of sinkhole activity. Although the formations in this area might provide competent foundations for most structures, it was concluded that the large bearing loads imposed by a nuclear fueled plant and the need to prevent contamination of ground water aquifers in the unlikely event of liquid radioactive waste spillage would require aquicludes in combination with competent rock formations.

After the preliminary investigation, the site search was concentrated in an area from just south of Highway 84 near Gordon, Alabama, northward to near Haleburg, Alabama. This area is directly underlain by strata of the Moody's Branch, Lisbon and Tallahatta formations.

Numerous studies were conducted including: (1) geologic field reconnaissance, (2) an air photo study, (3) exploratory drilling, (4) geophysical logging, (5) geological literature review. The results of these studies are described in Section 2.4.3 of this report.

1.5.1 Studies of the Joseph M. Farley Plant Site

The site selected is outstanding and meets the AEC requirements in every respect. No other site investigated had characteristics as favorable for filling the needs of a nuclear fueled plant.

The plant site was investigated by geologic field mapping, aerial reconnaissance, air photo interpretation, geologic borings, laboratory tests of undisturbed samples, geophysical surveys, seismic studies, a piezometer observation program and other associated studies. Refer to Section 2.4.3 of this report for more detail.

Because of the remoteness of the site from large population centers, the site size and geologic and hydrological factors, Alabama Power Company submits that the site selected reduces substantially any potential adverse environmental effects.

1.5.2 Alternate Sites

Several other sites were considered and rejected for various reasons during the course of the area investigation. Those considered as being the most competitive to the selected site are:

(1) "Alaga Site". This area south of Highway 84 along the west bank of the Chattahoochee River fulfilled most of the criteria for a plant site. It was rejected due tc the cavernous limestone underlying the site and the large numer of

sinkholes in the area. It was concluded that this area would present difficult foundation problems. Also, there could be problems associated with accidental spillage of liquid radioactive wastes.

(2) "Cedar Creek Site". This site (about 3 miles south of the Farley Plant site) has many good features but it is near some sinkhole activity. It is also near the north edge of what was thought to be the "Chattahoochee Anticline". It also was considered to be too close to the Great Southern Paper Company Plant.

(3) "Foster Creek Site". This area, about 6 miles north of Columbia, Alabama, is north of the Lisbon formation outcrop. Although the Tallahatta formation underlying this area could provide a competent foundation, it is not considered to be as satisfactory as the foundation rock at the Farley site. Other detrimental factors were the difficulty of railroad access, a more rugged terrain that would present construction difficulties, and several inhabitants who would have had to be displaced from the site area.

(4) Three other sites in the same general area were considered but were rejected due to more obvious potential difficulties.

2.0 General Information

Part 2 presents general information on the location of the Farley Project, a summary description of the project facilities and a baseline inventory of the environment in the area. The purpose of this part is to provide a basis for consideration of the environmental impact of the facility and alternatives which are presented in subsequent sections.

2.1 Location Of The Joseph M. Farley Plant

The Joseph M. Farley Nuclear Plant is to be located in southeast Alabama on the west side of the Chattahoochee River, 5 miles south of the town of Columbia in Houston County, as shown on Figures 2-1 and 2-2. The site is about 5.5 miles north of Gordon, Alabama; 16.5 miles east of Dothan, Alabama; 100 miles southeast of Montgomery, Alabama; and 180 miles south-southwest of Atlanta, Georgia.

The plant buildings will be located about 4,400 feet west of the west bank of the Chattahoochee River (at river mile 43) as shown on Figure 2-3.

2.2 Plant Facilities

The Joseph M. Farley Nuclear Plant is located on an 1850 acre site adjoining the Chattahoochee River. Approximately 410 acres have been cleared for actual plant and construction use.

The Joseph M. Farley Nuclear Plant will consist of two units, each capable of a warranted power output of 2660 megawatts (thermal), corresponding to a gross output of 861 megawatts (electric), and a maximum calculated output of 2774 megawatts (thermal) and 898 megawatts (electric). Each unit will utilize a Westinghouse pressurized light water reactor and a Westinghouse turbine generator.

FARLEY NUCLEAR PLANT LOCATION

LEGEND

● POPULATION CENTERS OVER 20,000 WITHIN 100 MILES OF THE SITE

○ OTHER MAJOR POPULATION CENTERS IN PART OF ALABAMA, FLORIDA AND GEORGIA

26 0 26 52

SCALE IN MILES

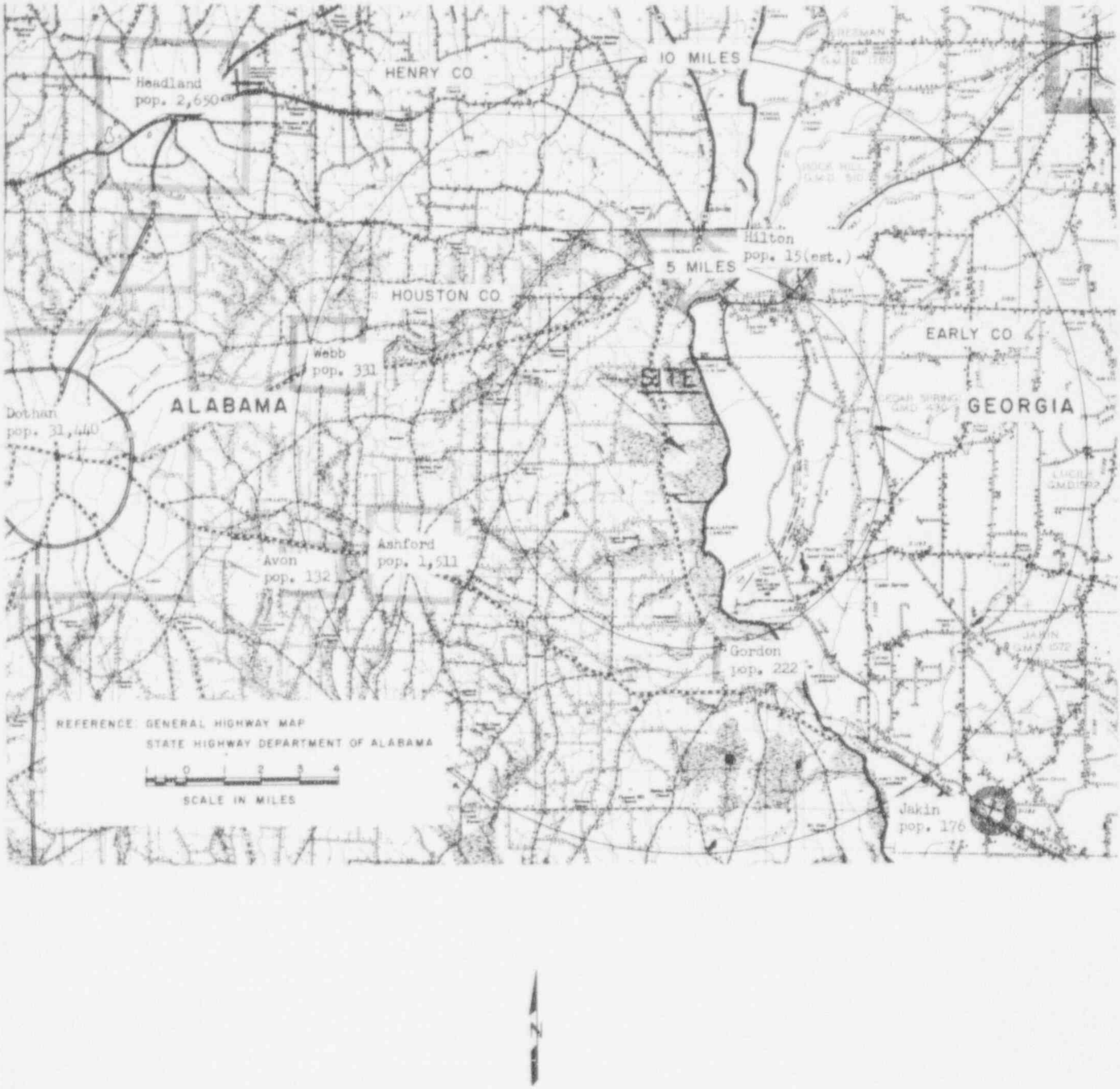
ADAPTED FROM: COUNTY AND CITY DATA BOOK - 1962
U.S. DEPT. OF COMMERCE
BUREAU OF THE CENSUS

ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT

FARLEY NUCLEAR PLANT LOCATION

FIGURE 2-1

FARLEY NUCLEAR PLANT SITE



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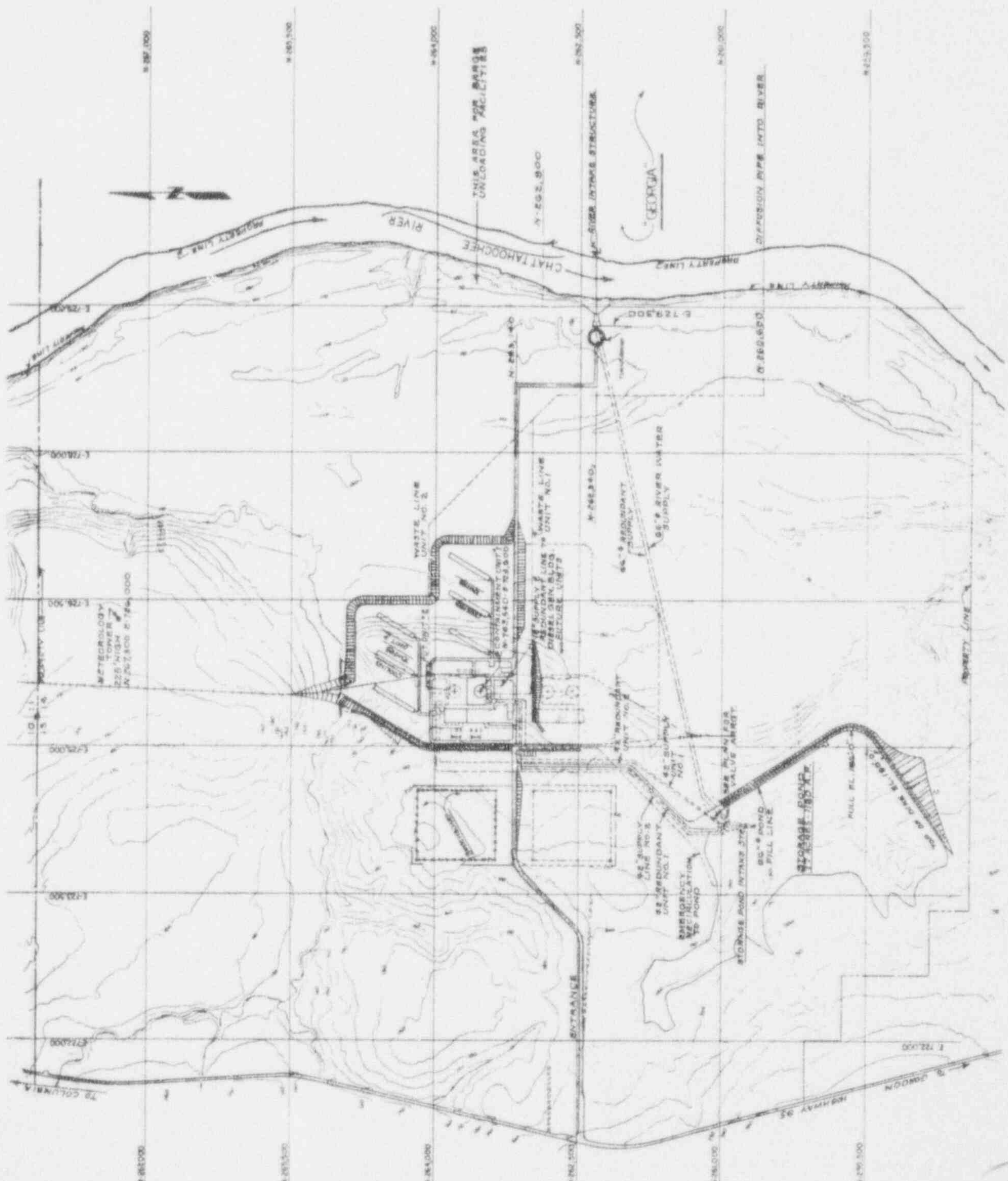
FARLEY NUCLEAR PLANT SITE

FIGURE 2-2



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SITE PLOT PLAN

FIGURE 2-3

The Site Plot Plan is shown in Figure 2-3, which indicates the arrangement and orientation of the plant buildings and structures.

Each unit will have a prestressed concrete containment which houses a Nuclear Steam Supply System, consisting of a reactor, steam generators, reactor coolant pumps, pressurizer, and some of the reactor auxiliaries.

Each unit will also have an auxiliary building and a turbine building. The auxiliary buildings will house the waste treatment facilities, engineered safeguards system components, heating and ventilation system components, switchgear, laboratories, offices, laundry, spent fuel pools, new fuel storage facilities, and the control room.

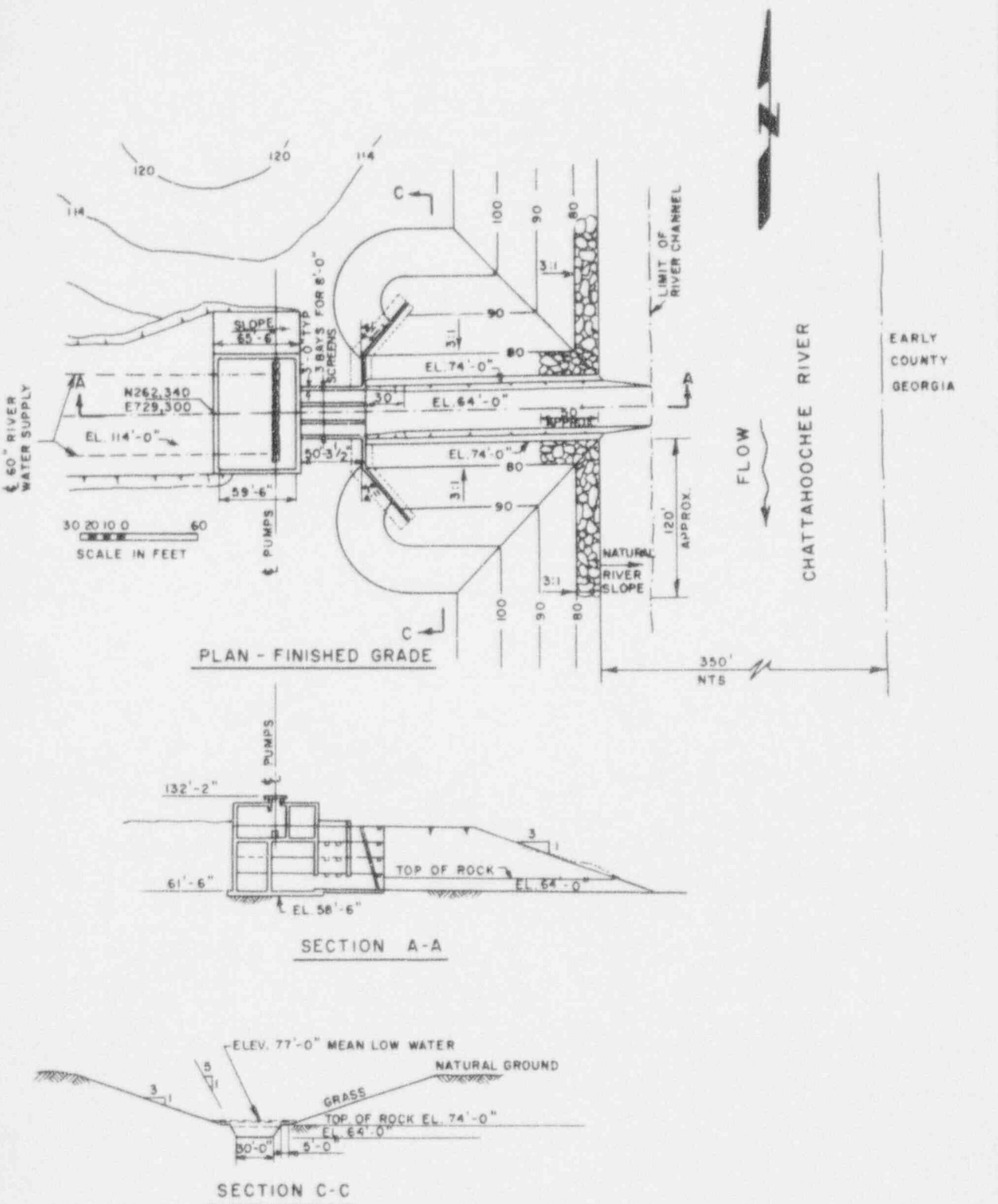
The turbine buildings house the turbine generators, condensers, feedwater heaters, condensate and feedwater pumps, turbine auxiliaries, and certain non-safety related switchgear.

The plant will have a diesel generator building, housing the emergency diesel generators; a service building containing offices, shops and warehouse space; a visitors' information center; a sanitary sewage treatment plant; a water treatment plant; various water storage tanks; and a fire protection pumphouse.

The above-mentioned structures are designed to be architecturally attractive.

Cooling water will be withdrawn from the Chattahoochee River and transferred to a storage pond. Ten pumps will be located in the river intake structure shown in Figure 2-4. They will have a maximum withdrawal capacity of approximately 100,000 gpm although only 78,000 gpm is the maximum expected to be required for two unit operation.

A storage pond will be formed by locating an earth dam across a



ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT

RIVER INTAKE STRUCTURE

FIGURE 2-4

shallow valley immediately south of the plant. The dam will form a reservoir of approximately 65 acres. The reservoir will inundate an existing dam and small pond and will be used to store water pumped from the river prior to its use in the plant circulating water system. The storage pond will provide a dependable, year-round source of fresh drinking water for wildlife in the area.

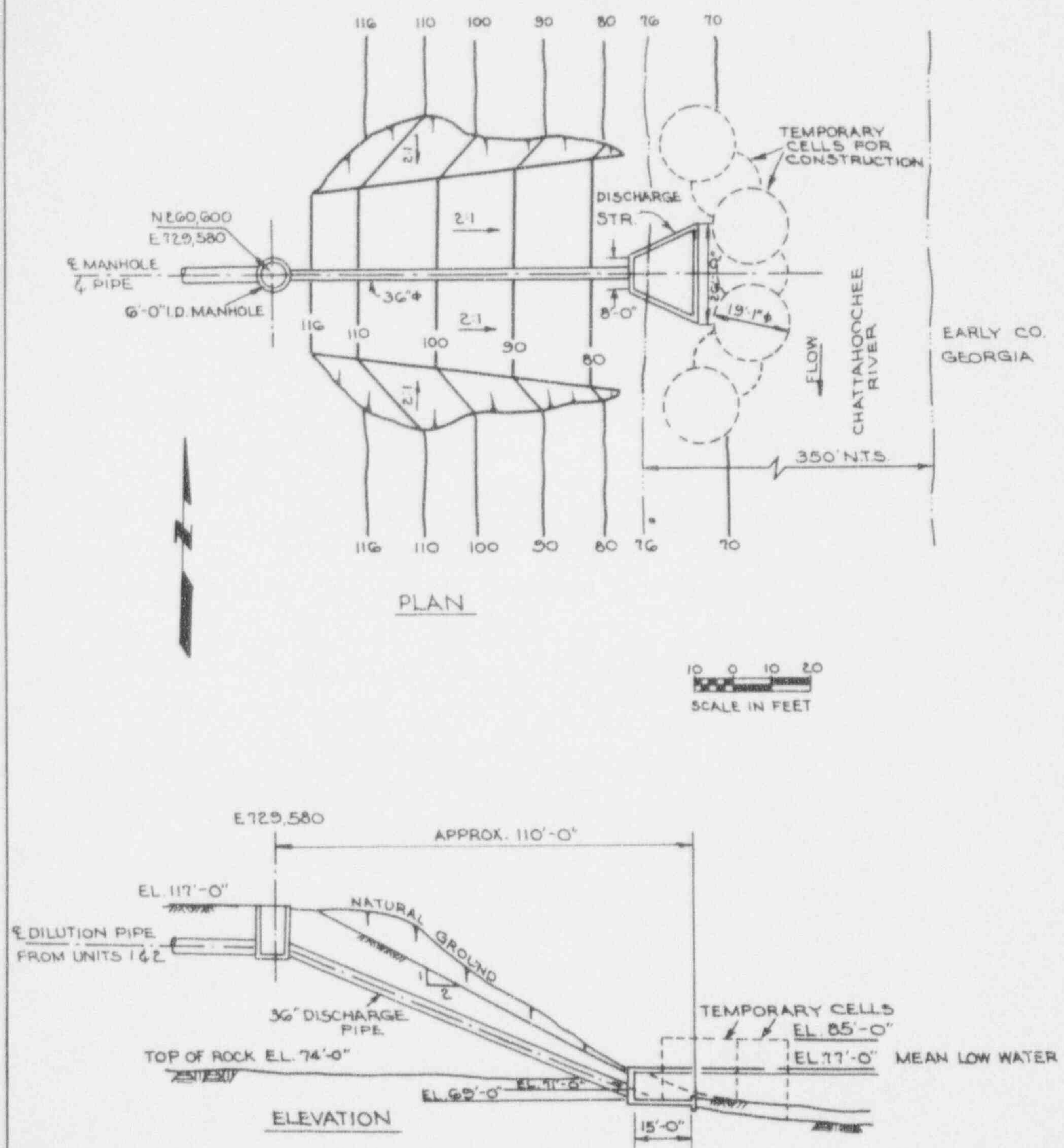
Water will be withdrawn from the pond for use in the plant and cooling tower. Ten pumps with a maximum capacity of 90,000 gpm will be located in the storage pond intake structure. A maximum of only 78,000 gpm is expected to be required.

A prominent feature of the plant will be the three mechanical draft cooling towers associated with the condenser cooling water system of each unit. Each tower will be 505 feet long by 62 feet wide by 59 feet high and will circulate approximately 200,000 gpm. Evaporation and drift losses from the six towers are expected to total 28,000 gpm. 1

A portion of the plant wastes will enter the dilution line and will be mixed with the tower blowdown prior to discharge to the river at the discharge structure shown in Figure 2-5.

A barge unloading facility will be constructed on the site to unload some of the heavy equipment and materials during the construction period. This facility is shown in Figure 2-6.

A railroad spur has been constructed to move some of the equipment and materials to the site during construction and possibly to transport nuclear fuel and other materials after the plant is placed in operation. The railroad will connect with the Central of Georgia Railroad at Columbia, some five miles to the north.



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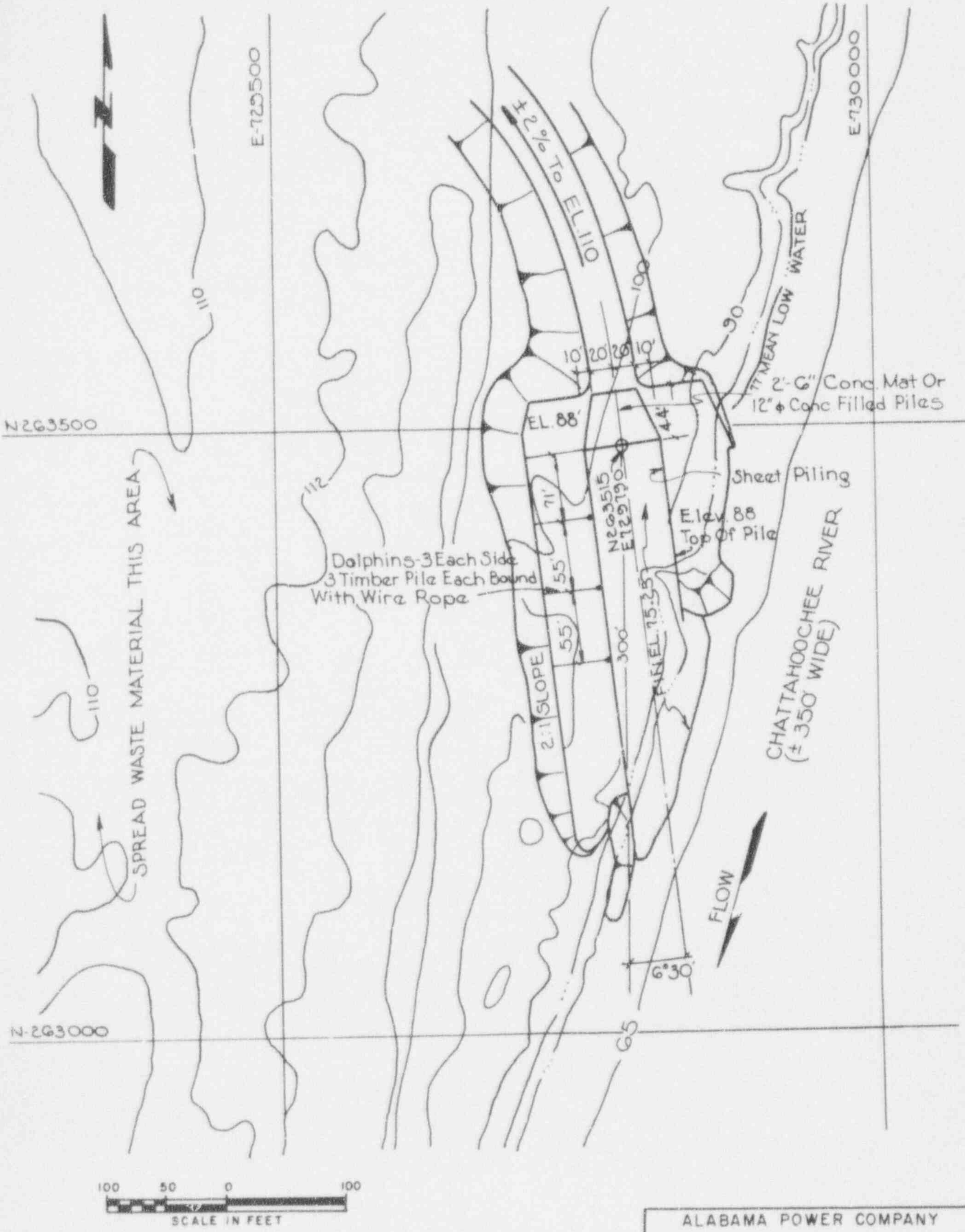
WATER DISCHARGE STRUCTURE

FIGURE 2-5



ALABAMA EAST COORDINATE SYSTEM
DATUM PLANE: MEAN SEA LEVEL

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ENVIRONMENTAL REPORT

BARGE UNLOADING FACILITY

FIGURE 2-6

Transmission of electricity will require construction of switchyards and transmission lines. The switchyards will lie west of the plant and will include a 230 KV switchyard for Unit 1 and a 500 KV switchyard for Unit 2. The plant will be linked to the interconnected system of The Southern Company by at least four high voltage transmission lines and a 500/230 KV auto transformer connection. The lines will approach the site on at least two separate rights-of-way.

A 225 foot high microwave/meteorological tower and an equipment building have been built on the north central protion of the site. The tower has been constructed to conform fully with regulations of the Federal Communications Commission and the Federal Aviation Administration. The tower will have no effect on public radio and television reception in the area, and weather data accumulated by the meteorological station will be made available to interested government agencies.

Entrance to the plant will be restricted to two paved roads from Highway 95 on the west boundary of the site. Other permanent roads required within the site boundary are roads from the plant proper to the storage pond intake structure, river intake structure, meteorological-microwave station and barge unloading facility. To restrict access to safety-related portions of the plant, a security fence will be constructed surrounding that area of the site occupied by principal buildings, and any other areas deemed necessary.

During construction, approximately 90,000 square feet of temporary warehouses, as well as shops, offices and sanitary facilities will be required. These facilities will be located in the general area of the permanent structures and will be removed when construction is completed.

In addition, approximately 3,000,000 square feet of laydown space for outdoor material storage will be required.

2.3 Transmission Lines

It is planned for electrical power generated at the Joseph M. Farley Nuclear Plant to be delivered to the interconnected transmission system of The Southern Company members over 230 KV and 500 KV transmission lines, The size, voltage levels, and routings of these lines were determined primarily on the basis of reliability of electrical service.

Studies for determining the transmission requirements for generation from the Farley Plant began in 1968 using the estimated peak hour power demand conditions with two generating units of 829 megawatts capacity at the Farley Plant in the period 1975-1977. The plan selected is:

(a) Unit #1 connected to a 230 KV substation bus.

(b) Unit #2 connected to a 500 KV substation bus. An auto-tie transformer will connect the 230 KV and 500 KV busses.

(c) Two 230 KV lines to Alabama Power Company Pinckard Substation.

(d) One 230 KV line to Georgia Power Company.

(e) One 500 KV line to Georgia Power Company. (Initial operation at 230 KV).

(f) One 500 KV line to Alabama Power Company Substation in Montgomery, Alabama.

Georgia Power Company will be responsible for the transmission connections from the Farley substations to the Georgia system which extends to the east side of the Chattahoochee River.

The advantages of this plan are:

(a) Unit #1 output will be delivered to the existing system at 230 KV with minimum additional transmission and step-down facilities and with reduced lead time for construction of the initial facilities.

(b) Existing 230 KV system will be coordinated with the proposed plant facilities and transmission.

(c) Unit #2 output will provide a potential total output at the plant of approximately 1600 MW. 500 KV transmission is justified for transmitting this amount of power over long distances with fewer transmission lines than at 230 KV.

(d) The need for substantial amounts of testing power in 1973 will be more easily met with the 230 KV portion of the plan by connecting to the existing 230 KV system at the Pinckard Transmission Substation.

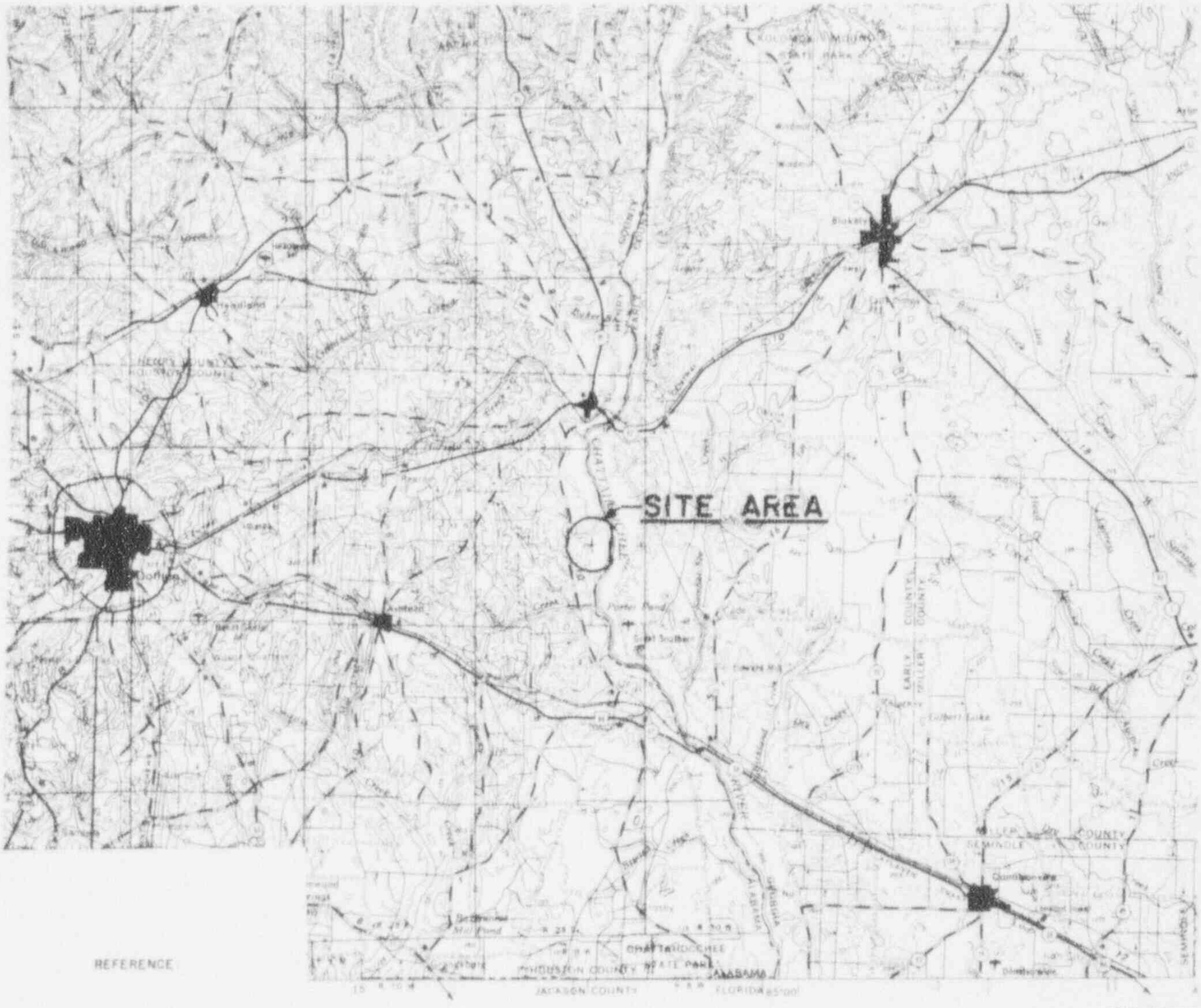
2.4 Base Line Inventory Of The Area Environment

2.4.1 Topography

The site area is in the southern Red Hills physiographic province in the East Gulf Coastal Plain of Alabama. It is a region of relatively flat to rolling terrain as indicated on Figure 2-7.

The Upland and the Chattahoochee River Valley constitute the two basic topographic features of the site as indicated on Figure 2-8. The Upland is gently undulating and ranges from about 150 to 210 feet MSL. Its surface generally slopes towards Rock Creek to the north and towards the river floodplain to the east. Some erosion has progressed from the lower elevations to etch irregularities into the upland surface.

REGIONAL TOPOGRAPHY



REFERENCE

ARMY MAP SERVICE
DOTHAN, ALABAMA NH 16-3
CONTOUR INTERVAL 50 FEET
SUPPLEMENT CONTOURS AT 25 FEET

5 0 5
SCALE IN FEET

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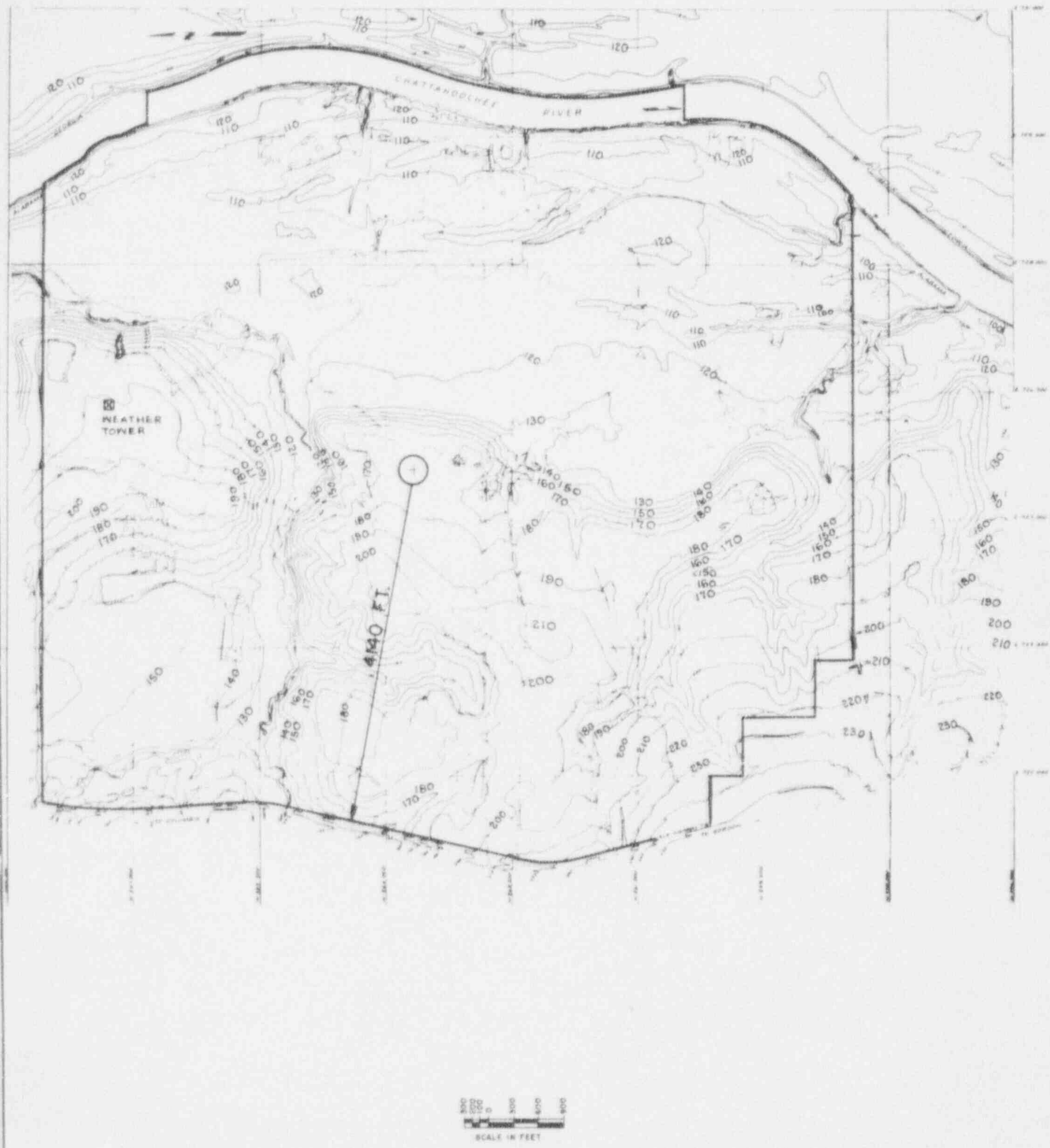
REGIONAL TOPOGRAPHY

FIGURE 2-7



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SITE TOPOGRAPHIC MAP

FIGURE 2-8

The eastern border of the Upland corresponds to the upper rim of the Chattahoochee Valley at about 170 feet MSL. Eastward the ground surface slopes gently toward the river until the slope flattens to form the main river terrace at an approximate elevation of 125 feet MSL. This terrace is 300 to 500 feet wide near the site, and widens to about 1500 feet just south of the main site area. Between this terrace and the Chattahoochee River is the essentially flat floodplain ranging from elevation 100 to 120 feet MSL. The width of the floodplain near the site ranges from about 2500 to 3000 feet. The river is 20 to 30 feet below the present floodplain.[1]

1. Copeland, C. W., Geology of the Alabama Coastal Plain, Geological Survey of Alabama, Circular 47.

2.4.2 History

Houston County was created by the Legislature on February 9, 1903. Its territory was taken from Dale, Geneva and Henry Counties and is the newest county in Alabama. It was named in honor of Governor George Smith Houston, who was elected Governor of the State of Alabama in 1874.

Dothan, the county seat of Houston, is a relatively young town being incorporated in 1886.

Columbia, about 5 miles north of the Joseph M. Farley Nuclear Plant site is one of the oldest towns in southeast Alabama, being started in 1822. It was the county seat of Henry County until 1833.

Many Indian relics, town sites and mounds are in Houston County along the Chattahoochee River and the Choctawhatchee River. Most of these have been identified as being of Seminole and Creek origin. In 1715, the Omussee Tribe of the Yamasee Indians settled in this area after being driven out of the Carolinas by the British. They affiliated with the Seminole and Creek Indians here until forced to move again in 1814. The Lower Creek Indian town of Yufala was located near the present town of Gordon, Alabama, until 1814.

Mr. Ralph H. Allen, Jr., Chief Game Management, Alabama Department of Conservation, who is a noted student and collector of Indian artifacts and Mr. A. D. Joiner, an active member of the Alabama Archaeological Society recently visited the Farley site looking for evidence of Indian mounds, village sites or items of historical interest. None were found.

No historical landmark or places of historical interest are located in the general vicinity of the site. The closest place of historical interest listed in the National Register of Historical Places - 1969, is "Kolomki Mounds". These Indian mounds are located 22 miles northeast of the site in Earley County, Georgia.

2.4.3 Geology And Subsurface Resources

Various studies relating to the geology of the plant site and its regional environs have been conducted. These studies included: (1) a geologic field reconnaissance along the Chattahoochee River to establish the local stratigraphic sequence and to explore exposed rock and soil units; (2) an air photo study of the area; (3) an investigation of the subsurface conditions over a broad area by drilling exploratory borings along a 12 mile reach of the Chattahoochee River; (4) geophysical logging of these borings by the Alabama Geological Survey to determine stratigraphic correlation; (5) a review of geological literature relative to the area.

The plant site was investigated by geologic field mapping, aerial reconnaissance, air photo interpretation, geologic borings, laboratory tests of undisturbed samples, geophysical surveys, and piezometer observations.

The Joseph M. Farley Nuclear Plant is located in the East Gulf Coastal Plain which is to the south of the Appalachian System. The East Gulf Coastal Plain is underlain by a series of sedimentary formations composed chiefly of sand, clay, marl, and limestones. These sediments range in age from late Jurassic to Recent. The upper Cretaceous deposits overlap the lower in Alabama and the younger sediments are exposed generally in successive belts toward the present Gulf of Mexico.

In southeast Alabama, southwest Georgia, and northern Florida, drilled wells have penetrated basement rock composed of unmetamorphosed Paleozoic sedimentary units. The total thickness of the overlying sedimentary units are more than 10,000 feet in Northern Florida. These sediments dip toward the Gulf of Mexico at a rate of 10 to 35 feet per mile with the amount of dip increasing with depth.

In southeastern Alabama and southwestern Georgia, the gentle south-dipping Paleocene through Oligocene sequence is thought to be influenced by only one major structural feature, the Chattahoochee Anticline. The axis of this northeast trending fold appears to cross the Chattahoochee River about four miles north of the Florida-Alabama boundary, (approximately 12 miles from the site) causing a reversal and flattening of dip for a distance of approximately nine miles to the northwest. There are no faults known to be associated with this structure. The tectonic inactivity of the basement rock in this area is further substantiated by the small volume of recorded seismic activity in the entire Southeastern Coastal Region.

There are no significant surface structures in southeastern Alabama. The attitude of the sediments are remarkably uniform with the beds dipping south towards the Gulf of Mexico. No major or active faults were found nor are believed to exist within the area studied and no evidence of surface displacement was observed during the field investigation.

The plant site is characterized by two topographic features: (1) the gently undulating Upland and (2) the Chattahoochee River Valley which includes the associated terraces, floodplain and the river channel itself.

The Quanternary terrace and floodplain deposits are varied and consist of alluvial gravelly sands to clay, and are loose to dense in consistency. These materials represent a thin veneer overlying the older sedimentary formations.

Beneath these alluvial deposits and forming the upper geologic units at the site are deposits of sand, gravel, clay, silt, siltstone, sandstone and limestone, all of Tertiary age. These Eocene units from oldest to youngest are: Tallahatta and Lisbon formations, Moody's Branch formation, and Ocala Limestone undifferentiated.

Overlying the Moody's Branch formation are Recent alluvial deposits and a Residuum deposit. The Residuum consists mainly of yellowish-orange medium to very coarse-grained gravelly sand and mottled sandy clay.

The Lisbon formation, which is a competent siltstone, sandstone, and extremely dense silty sand, is approximately 120 feet thick and is the significant foundation material for the plant structures. Below the Lisbon formation, the stresses imposed by the structures are so low that the foundation materials are not considered important in the foundation evaluation. Beneath the Lisbon are the Tallahatta, the Hatchetigbee, the Tuscahoma, the Nanafalia and the Clayton formations.

The physical characteristics and composition of the foundation materials were determined by laboratory tests. These tests include routine classification, consolidation and triaxial compression tests. The test procedures used were in accordance with current standard, acceptable methods presently in use.

The quality of the Lisbon formation as a foundation is demonstrated by the fact that Columbia Lock and Dam, 2-½ miles upstream, is founded on the Lisbon formation. This quality is well stated in the Geologic Conclusions of the Geology and Foundation, Design Memorandum No. 2, Columbia Lock and Dam, by the U. S. Corps of Engineers: "The coastal plain sediments present in the foundation and reservoir at the Columbia Dam site are uniform in character and have no apparent structural faults that would make the development of the proposed plan inadvisable from a geologic standpoint."

Underlying the Lisbon formation at about elevation - 20 feet MSL is the Tallahatta formation. This unit consists of sand and clay beds, sandy claystone, glauconitic quartz sand, and sandy fossiliferous limestone. The limestone grades upward into irregularly indurated calcareous sandstone. The sand beds are very argillaceous, medium to coarse-grained and poorly sorted. Total thickness of the Tallahatta formation in the site area is approximately 70 feet.

Dr. Walter B. Jones, for many years Alabama State Geologist, carefully investigated the plant site for surface and subsurface resources. His conclusions are: "There are no rocks or minerals of commercial value on Alabama Power Company's SEALA (Joseph M. Farley Nuclear Plant) steam plant site".[5]

1. Owens, Marie Bankhead, Our State-Alabama, the Alabama State Department of Archives and History, Historical and Patriotic Series No. 7.

2. Weaver, Charlotte S., The Story of Alabama-A History of the State, Alabama Almanac for 1965, Vol. 1, Alabama Republican State Executive Committee

3. Alabama Historical Association, Preliminary List Of Highway Marker Suggestions, April 1952

4. U. S. Department of the Interior, National Park Service, National Register Of Historical Places, 1969

5. Jones, Dr. Walter B., Report On The Possible Occurrence Of Rocks, Minerals, Oil Or Gas Of Commercial Value On Or Under A Tract Of Land In Houston County On Which The Alabama Power Company Plans To Build A Steam Plant, 1969

2.4.4 General Hydrology

The site is located between Cedar Creek and Rock Creek, 5 miles south of Columbia, Alabama, and 16.5 miles east of Dothan, Alabama, on the west bank of the southward-flowing Chattahoochee River which discharges into and forms a part of Lake Seminole, on the Georgia-Florida state line. The river is a navigable waterway with a 9 foot channel depth maintained by the U. S. Army Corps of Engineers.

The average annual rainfall for Houston County (site area) is 53 inches and is fairly evenly distributed throughout the year. Of this amount, average annual runoff is approximately 20 inches or 0.95 million gallons per square mile. This runoff includes direct surface runoff and discharge from springs.

Houston County is drained by the Chattahoochee River, the Choctawhatchee, and tributaries of the Apalachicola River in Florida. Surface and groundwater generally follow the dip of geologic structure which is in a southerly direction.

2.4.4.1 Groundwater

There are two major aquifers in Houston County. The major shallow aquifer consists of a system of sands and porous limestones and is composed of the Ocala, Moody's Branch, Lisbon, Tallahatta and Hatchetigbee formations. The base of the major shallow aquifer is at approximate elevation -125 feet MSL at the site. The major deep aquifer consists of sand and porous limestone in the Tuscahoma, Nanafalia, and Clayton formations. A boring located approximately 2 miles from the site indicates the base of the major deep aquifer to be at an elevation of -925 feet MSL in this area.

The recharge areas for both aquifers are in the northern parts of Houston County and other areas further north.

The major aquifers generally dip to the south from 15 feet to 40 feet per mile. However, local topography may affect their elevations in some localized areas.

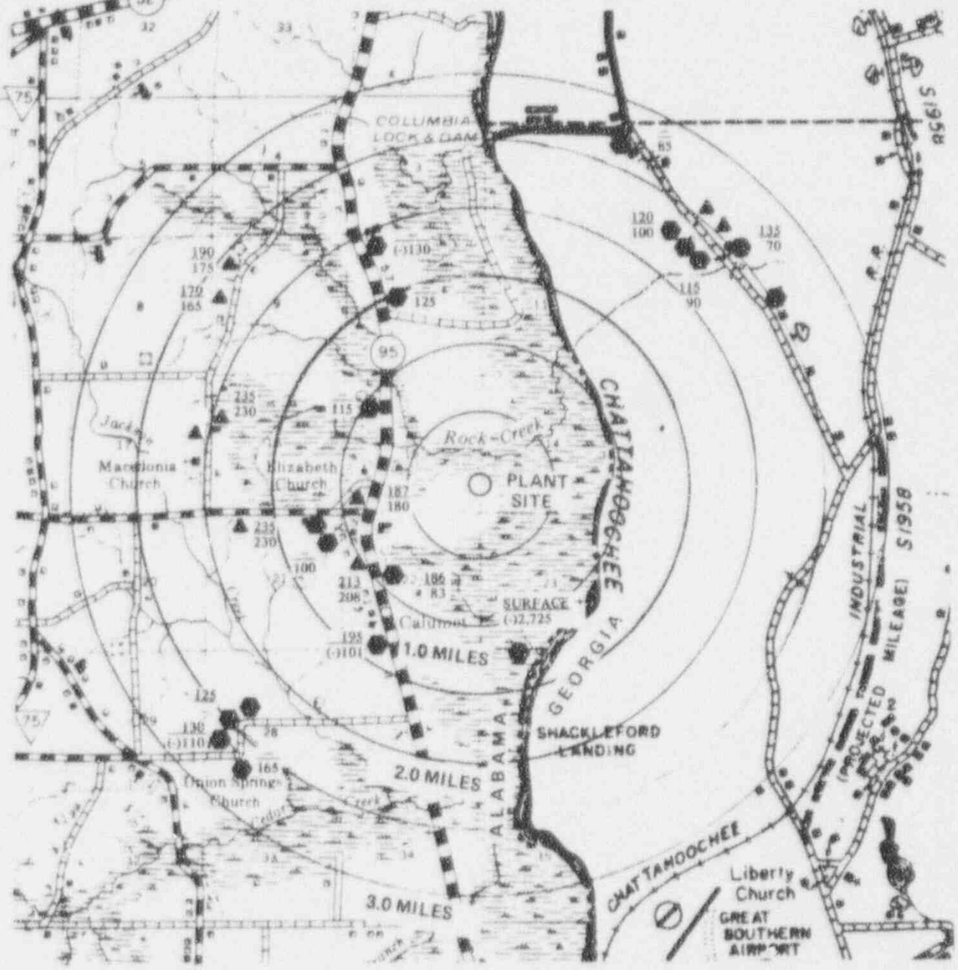
All water for home and industrial uses in the county comes from wells. City wells range from 115 to 684 feet in depth and from 4 to 24 inches in diameter. Yield from these wells ranges from 50 to 520 gallons per minute.

The water supply for Columbia, Alabama, comes from a well at elevation -349 feet MSL which is within the major deep aquifer. The water bearing units for this source are the Tuscahoma and Nanafalia formation.

The Tallahatta and Hatchetigbee formations are believed to be the water bearing units for the town of Gordon, 5.5 miles south of the plant site. The water for the town is obtained from an elevation of -198 feet MSL.

In order to determine the general groundwater environment surrounding the site, groundwater levels were established, generally within a two mile radius, in numerous domestic wells both in Alabama and Georgia. The results of the well survey are shown on Figure 2-9.

A number of sealed wells, both shallow and deep, were found. Where possible, local residents were interviewed regarding these wells. The majority of those interviewed could provide little specific information; therefore, well data, especially that pertaining to the major shallow aquifer, is lacking in many instances at individual well locations.



LEGEND

▲ EXISTING DUG WATER WELL

⬣ EXISTING DRILLED WATER WELL

230 ELEV. OF WATER LEVEL IN FEET
225 ELEV. OF BOTTOM OF WELL IN FEET

KEY PLAN

NOTES

1. WELL SURVEY CONDUCTED BY BECHTEL CORP. AND ALABAMA POWER CO. DURING JUNE, 1969.
2. WELL SURVEY DATA IS LACKING FROM MOST DRILLED WATER WELLS DUE TO SEALED DRILLED HOLES AND LACK OF KNOWLEDGE OF PROPERTY OWNERS OF PERTINENT WELL DATA.
3. TEMPERATURE OF WATER IN WELLS SURVEYED AVERAGED 68° F.
4. WELL ELEVATIONS ARE APPROXIMATE BECAUSE OF LACK OF PRECISE GROUND CONTROL.
5. MAP REFERENCES: GENERAL HIGHWAY MAPS, HOUSTON CO. ALABAMA AND EARLY COUNTY, GEORGIA.

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WATER WELL SURVEY

FIGURE 2-9

The survey data indicates that the shallow aquifer, perched within the overburden above the Lisbon formation and discussed in greater detail later in this section is controlled as one might expect, by topographic slopes, flowing toward the nearby surface creek, stream or river. The deep wells, although widely scattered and apparently terminating near the base of the major shallow aquifer, tend to verify the southward regional piezometric dip.

Water of good chemical quality, according to published reports, is found in the Chattahoochee River as well as in both of the major aquifers. Of the wells surveyed, none were noted where water treatment is being conducted. Temperature variation of well water measured ranged from 68 to 69 degrees Farenheit.

Shown in Table 2-1 are the surface water constituents reported in parts per million from the Chattahoochee River at Columbia, Alabama. Also tabulated are results of analyses from wells on the J. E. McNair Estate, immediately adjacent to the plant area. The U. S. Geological Survey, Water Resources Division, obtained the river water sample in August, 1960 and the groundwater samples in August, 1965.[2]

In order to determine local groundwater levels and to monitor their fluctuations a series of nine piezometer groups were installed in nests of 4 or 5 per location in 1969. Refer to Figure 2-10. Spacing between piezometer group positions averages one-half mile. Periodic readings are being made to provide groundwater elevation data. The formation locations of the piezometers are as follows:

Piezometer No.	Geologic Formation
P-1(a)	Undifferentiated Terrace and Residuum
P-1(b)	Recent Alluvium
P-2	Moody's Branch Sand Residuum
P-3	Upper Lisbon
P-4	Lower Lisbon
P-5	Tallahatta

Table 2-1

Water Analysis (ppm)

Sample Number	(1)	(2)	(3)
Silica (SiO_2)	7.9	-	-
Iron (Fe)	0.2	0.2	1.2
Calcium (Ca)	5.6	-	-
Magnesium (Mg)	0.9	-	-
Sodium (Na)	3.9	-	-
Potassium (K)	1.4	144.0	164.0
Bicarbonate (HCO_3)	25.0	-	-
Carbonate (CO_3)	-	6.0	6.0
Sulfate (SO_4)	4.4	-	-
Chloride (CI)	2.8	5.6	5.6
Fluoride (F)	0.1	-	-
Nitrate (NO_3)	0.8	-	-
Dissolved Solids (calculated)	40.0	-	-
Hardness as $CaCO_3$			
Ca, Mg	18.0	92.0	150.0
Non-carbonate	0.0	0.0	5.0
Specific conductance	59.0	-	-
pH	7.3	8.3	8.5

(1) Chattahoochee River at Columbia, Alabama

(2) J. E. McNair Estate - Tallahatta and Hatchetigbee formations undifferentiated (major shallow aquifer)

(3) J. E. McNair Estate - Nanfalia (?) formation (major deep aquifer)

ALABAMA POWER COMPANY
JOSEPH M. FARLEY, NUCLEAR PLANT
ENVIRONMENTAL REPORT

GROUND WATER CONDITIONS

FIGURE 2-10

Six shallow observation wells, designated P-1(a), were installed in the Undifferentiated Terrace and Residuum in an attempt to detect possible isolated perched water lenses above the shallow aquifer. Water has been present in only one of these, the P-1(a) piezometer in Group 680.

Water is present in two (Groups 640 and 643) of the three P-1(b) designated observation wells located in the floodplain alluvium. At Group 643 the levels have fluctuated from elevation 106.5 to 109.5 feet MSL. In Group 643, the P-1 piezometer was initially dry but water levels subsequently rose within the well and have ranged from elevation 107.5 to 109.5 feet MSL, from February 10, 1969, to June 30, 1969. The P-1 piezometer in Group 640 has been dry to date. Its top elevation is 108 feet MSL.

The piezometer data, individual boring logs and observation well data were utilized in contouring the phreatic surface and the piezometric surface of the shallow aquifer. Water level data obtained February 25-28, 1969, (considered maximum seasonal levels) were used in constructing the contours.

During the field operations, permeability data were obtained. The U. S. Bureau of Reclamation's Method E-18 was followed while performing pumping-in tests in selected piezometers. A permeability of 10,000 feet per year was indicated for the Tallahatta sand in a test conducted in the piezometers in Group 683, located at elevation -40 feet MSL. The upper Lisbon formation has a permeability of about 500 feet per year. This value was obtained in Group 630 at elevation +81 feet MSL.

There are two major groundwater aquifers beneath the plant site. It is convenient to describe these as a shallow and a deep aquifer.

The shallow aquifer consists of two water bearing zones which can be divided into an upper and lower aquifer separated by the upper Lisbon which acts as an aquiclude. This aquiclude consists of the upper two-thirds of the Lisbon formation and is composed of claystone, siltstone, silty fine sandstone and limestone.

The upper aquifer is perched upon this impervious material. Its phreatic surface is within the soils at the higher elevations and within the alluvium of the lower terrace and floodplain adjacent to the Chattahoochee River. The highest elevation measured on this surface is about 136 feet MSL. This groundwater surface slopes eastward across the site toward the Chattahoochee and northward toward Rock Creek. The gradient of this surface beneath the uplands ranges from 1:50 to 1:100 and decreases beneath the floodplain to about 1:300. This groundwater ultimately discharges into the Chattahoochee River, with a portion of it first discharging into Rock Creek and thence by surface flow to the river.

Beneath the upper aquifer are water bearing sediments of the lower Lisbon and Tallahatta formations. Piezometric levels were found to be essentially the same at all locations and generally ranged from elevation 125 to 135 feet MSL. The 130-foot contour line on this piezometric surface is quite straight, and is located in a north-south direction. It has a gradient dipping toward the east at a slope approximately 7 feet per mile. The Hatchetigbee formation, which underlies the Tallahatta, is also considered to be part of this lower aquifer. Recharge for these formations originates in their outcrop belt in northern Houston County. The regional slope of the piezometric surface is reported to be toward the south, corresponding to the regional dip of these strata.

Contours of the phreatic surface and piezometric surface of the shallow aquifers are shown on Figure 2-10. These were based on piezometer data obtained at the site and represent the upper local groundwater conditions.

The deep aquifer which is the major source of industrial and municipal water supply in Houston and Henry counties consists of the Tuxcahoma sand and sands and limestone of the Nanafalia and Clayton formations. The relatively impermeable upper portion of the Tuscahome forms an aquiclude separating the major deep aquifer from the overlying shallow aquifer.

The piezometric surface of the deep aquifer is somewhat below that of the overlying shallow aquifer, at about elevation 70 feet MSL, and dips to the south about 30 feet per mile. The upper boundary of this deep water bearing zone, the Hatchetigbee-Tuscahoma sand contract, occurs at approximate elevation -125 feet MSL. The base of this deep aquifer dips toward the south at about 35 feet per mile and is at an approximate elevation of -600 feet MSL at the plant site. These formations crop out to the north and underlie all of Houston County.

The Tuscahoma sand varies in thickness from about 170 to 260 feet. Its upper part consists of silty and sandy, dark gray, laminated carbonaceous clays overlying light gray calcareous silty sandstone. The water bearing portions of this unit generally consist of 10 to 40 feet of a basal, very coarse-grained, fossiliferous sand that locally contains gravel.

Underlying the Tuscahoma sand is about 140 feet of lower Eocene sands and limestone of the Nanafalia formation. The sands are greenish-gray, medium to coarse-grained; and the limestones are light gray fossiliferous and sandy. Calcareous sandy clays separate the basal water bearing coarse-grained gravelly sands.

The lower member of this deep aquifer is the Paleocene Clayton formation. It is about 125 to 150 feet thick and contains sandy and fossiliferous limestone with minor amounts of interbedded coarse-grained sand and micaceous sandy clay.

No reversal of the groundwater movement at the site should occur as a result of the construction and operation of the plant. Because the groundwater gradient within the shallow aquifer at the site is eastward toward the river, accidental spillage of a contaminant will present no groundwater problem.

Likewise, contamination of the shallow artesian aquifer is considered remote because of the aquiclude formed by the upper Lisbon and artesian pressure associated with this aquifer. Any adverse effects on this aquifer are eliminated as a result of these factors.

In addition to the reasons outlined for the major shallow aquifer, seepage of contaminated waste into the major deep aquifer is unlikely due to the additional aquiclude formed by the clays of the upper Tuscahoma sand at approximate elevation -135 feet MSL and the piezometric surface of the major shallow aquifer at about elevation 70 feet MSL.

The possibility of adversely affecting the groundwater resources or existing wells in the area as a result of the operation of a nuclear plant is remote. The groundwater hydrologic characteristics of the site are quite favorable for the plant.

2.4.4.2 Surface Water

The dominant surface hydrological feature of the site region is the Chattahoochee River and some small tributary streams. The drainage basin formed by the Chattahoochee-Flint-Apalachicola Rivers is shown on

Figure 2-11. This Figure also shows the site location, river mileages and the location of locks and dams. The river system is navigable up to Bainbridge, Georgia, on the Flint and to Columbus, Georgia, on the Chattahoochee.

Flow characteristics of the Chattahoochee River at Columbia for the period 1929-1960 are summarized by Figure 2-12, taken from Geological Survey of Alabama Circular 32, Flow Characteristics of Alabama Streams.[6]

At the present time, the river flow past the site in influenced by a number of factors: (1) the intermittent operation of Walter F. George Dam for the production of electric power and for navigation control; (2) the operation of Columbia Lock and Dam (located about 3 river miles upstream) for navigation control; and (3) the operation of Jim Woodruff Dam (located about 44 river miles downstream) for the production of electric power and navigation. However, a channel of nine-foot depth is required for navigation and this corresponds to a minimum river elevation at the plant site of 76 feet (MSL).

There are 33 years of record available from a gaging station at Columbia, Alabama (located about 6 river miles upstream) prior to the start of operation of the Walter F. George Dam in 1963 and the Columbia Lock and Dam in 1964. These records show a minimum average daily flow of 1210 cfs occurring in 1964. During the period from 1938 to 1944 and from 1960 to the present time a gaging station has been operated at Alaga, Alabama (located about 8 river miles downstream). These records indicate a minimum average daily flow of 1230 cfs occurring in 1962. However, during the month that this recorded flow occurred, the initial filling of Walter F. George Dam caused the storing of an equivalent daily average flow of 892 cfs, thus reducing recorded downstream flows.

2-3435. CHATTAHOOCHEE RIVER AT COLUMBIA, ALA.
DURATION OF DAILY DISCHARGE

CLASS	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	
YEAR																					NUMBER OF DAYS IN CLASS															CFS-DAYS
1929								3	11	32	54	38.	25	44	24	34	24	10	14	7	12	5		3	2	3	2	2	5	3	4	3	1			6739280.0
1930					2	10	17	7	10	7	24	28	16	67	59	39	33	8	10	9	8	6	2			1		2								4323770.0
1931				2	16	28	24	33	22	8	20	26	20	86	40	19	10	3	3		1				2	2										2886040.0
1932		5	19	13	18	16	11	10	10	7	39	28	30	45	44	19	17	11	15	4	3	1	1													3118010.0
1933					1	5	8	13	12	19	58	34	25	39	16	31	36	17	18	5	9	6	3	3	5	2										4483020.0
1934					10	33	37	35	16	16	50	38	24	64	19	5	2	5	3	2	1	1		1	2	1										2587110.0
1935					6	13	37	22	19	48	56	32	33	57	9	11	2	6	6	2	3	1	1	1												2622900.0
1936			6	4	30	10	18	30	28	22	27	9	23	21	19	18	22	8	20	3	4	5	6	1	12	7	5	7	1							5350910.0
1937						2	4	12	19	18	44	20	19	51	34	36	31	12	20	11	8	9	7	2	6											4752050.0
1938						1	7	21	26	24	65	71	28	52	19	8	15	3	6	4	2	4	1	1	2		2	3								3472220.0
1939					9	34	16	12	26	19	23	26	22	61	33	18	25	8	12	5	5	2	2	1	2	2	2									3708370.0
1940						3	58	31	34	30	29	20	11	42	36	21	14	5	12	11	2	4	2	1												3236750.0
1941				3	34	51	32	19	26	18	34	31	22	66	19	7	2	1																		2080370.0
1942			3	27	20	16	7	10	12	13	44	35	33	36	30	23	12	13	11	7		2	4	3		1	2	1								3517190.0
1943							7	14	29	19	23	36	16	55	51	20	30	17	17	7	5	3	1	1	2	3	2	4	3							4946650.0
1944						1	15	24	21	16	31	44	37	42	30	21	13	17	16	6	2	7	4	2	5	3	1	8								4892400.0
1945							4	31	35	20	44	51	42	51	37	12	9	7	6	4	4	1	4	2	1											3249780.0
1946							2	5	21	16	29	11	20	50	36	26	50	20	23	19	8	10	4	5	5	4	1									5569200.0
1947							4	18	33	34	56	24	17	31	43	20	32	14	12	6	4	4	6	2	5											4049010.0
1948							23	7	5	12	29	22	23	43	41	41	21	20	21	7	20	9	7	4	8		2	1								5496520.0
1969										6	13	14	19	43	47	35	57	32	35	19	13	7	7	5	2	3	2	3	3							6699290.0
1950						3	10	15	7	12	31	72	38	80	45	22	13	7	7	3																3163440.0
1951					15	32	35	30	26	27	40	46	39	32	16	8	12	4		3																2273740.0
1952					16	26	22	27	20	18	28	29	27	28	26	23	21	20	9	3	6	5	3	2	3	3	1									3809810.0
1953					4	50	15	14	16	9	21	32	15	40	30	28	35	17	12	10	4	4	1	2	2	2		2								4065230.0
1954		5	16	7	20	14	27	30	26	19	29	17	11	46	17	22	23	8	14	6	3	2	1	1	1											3060370.0
1955		24	19	15	30	20	33	34	24	14	28	32	21	23	22	9	5	3	4	1	2	2														2082270.0
1956			3	41	61	47	40	17	20	14	17	11	15	15	18	15	14	8	2	1	4			2	1											2191050.0
1957				1	20	41	45	21	15	22	34	21	23	35	26	19	17	5	4	5		3	1	1	3	1	2									3045620.0
1958							6	18	26	10	39	43	36	54	28	35	36	7	11	3	3	4	2	1	1	1	1									3837470.0
1959						2	10	30	15	23	68	38	30	43	24	19	18	9	19	7	4	3	2		1											3498820.0
1960						6	6	5	10	16	43	45	38	54	27	15	27	28	19	13	5		1	2	3		2	1								4347440.0

Summary for water years, 1929-60

CLASS	CFS	TOTAL	ACCUM	PERCT	CLASS	CFS	TOTAL	ACCUM	PERCT	CLASS	CFS	TOTAL	ACCUM	PERCT	CLASS	CFS	TOTAL	ACCUM	PERCT
	.0		11688	100.0	09	4500.0	588	8901	76.2	18	20000	381	1150	9.8	27	80000	34	57	.5
1	1200.0	34	11688	100.0	10	5000.0	1170	8313	71.1	19	25000	193	769	6.6	28	100000	12	23	.2
2	1400.0	6.	11654	99.7	11	6000.0	1024	7143	61.1	20	30000	145	576	4.9	29	120000	3	11	.1
3	1700.0	113	11588	99.1	12	7000.0	798	6119	52.4	21	35000	110	431	3.7	30	140000	4	8	.1
4	2000.0	312	11475	98.2	13	8000.0	1496	5321	45.5	22	40000	73	321	2.7	31	170000	3	4	.0
5	2500.0	464	11163	95.5	14	10000.0	965	3825	32.7	23	45000	49	248	2.1	32	200000	1	1	.0
6	3000.0	580	10699	91.5	15	12000.0	679	2860	24.5	24	50000	76	199	1.7	33				.0
7	3500.0	598	10119	86.6	16	14000.0	678	2181	18.7	25	60000	39	123	1.1	34				.0
8	4000.0	620	9521	81.5	17	17000.0	353	1503	12.9	26	70000	27	84	.7	35				

DATA TAKEN FROM

FLOW CHARACTERISTICS OF ALABAMA STREAM
Geological Survey of Alabama
Circular 32

ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT

FLOW CHARACTERISTICS OF THE CHATTAHOOCHEE RIVER AT COLUMBIA, ALABAMA

SHEET 1 OF 2 FIGURE 2-12

2-3435. CHATTAHOOCHEE RIVER AT COLUMBIA, ALA.

LOWEST MEAN DISCHARGE, IN CFS, FOR THE FOLLOWING NUMBER OF CONSECUTIVE DAYS IN YEAR BEGINNING APRIL 1

YEAR	1	3	7	14	30	60	90	120	150	183	274
1929	3550.0	3750.0	4420.0	4930.0	5710.0	6970.0	7830.0	8550.0	10700.0	11500.0	12700.0
1930	2300.0	2480.0	2760.0	2980.0	3530.0	4450.0	4660.0	5210.0	5240.0	5820.0	7870.0
1931	1310.0	1330.0	1360.0	1410.0	1550.0	1860.0	2100.0	2730.0	3070.0	3070.0	5490.0
1932	2570.0	2690.0	3080.0	3310.0	3860.0	4740.0	5430.0	5920.0	6140.0	6430.0	8590.0
1933	2140.0	2240.0	2450.0	2540.0	2800.0	2990.0	3140.0	3440.0	37[illegible].0	4050.0	4680.0
1934	2460.0	2550.0	2960.0	3060.0	3650.0	4220.0	4750.0	5090.0	5530.0	5680.0	6530.0
1935	1510.0	1540.0	1660.0	1840.0	2050.0	2580.0	3710.0	4080.0	4290.0	4520.0	5600.0
1936	2200.0	2770.0	3260.0	3410.0	3730.0	4860.0	6000.0	5960.0	6370.0	6650.0	9140.0
1937	2940.0	3150.0	3620.0	3850.0	4270.0	5730.0	6320.0	6270.0	6480.0	6450.0	6640.0
1938	2390.0	2450.0	2480.0	2560.0	2660.0	3040.0	3360.0	3580.0	3910.0	4590.0	5900.0
1939	3110.0	3230.0	3360.0	3390.0	3420.0	3460.0	3830.0	4200.0	5560.0	6280.0	7430.0
1940	2300.0	2330.0	2380.0	2420.0	2520.0	2800.0	3440.0	4180.0	4710.0	5480.0	6900.0
1941	1630.0	1680.0	1770.0	1800.0	1880.0	2140.0	2460.0	2770.0	3380.0	3820.0	5000.0
1942	3690.0	3860.0	4190.0	4280.0	4660.0	4960.0	5320.0	6040.0	6120.0	6660.0	7510.0
1943	2930.0	3110.0	3170.0	3250.0	3500.0	3780.0	4250.0	4350.0	5110.0	5800.0	7190.0
1944	3290.0	3520.0	3790.0	3800.0	3890.0	4220.0	5000.0	5380.0	5620.0	5950.0	6840.0
1945	3200.0	3660.0	3980.0	4180.0	5040.0	5590.0	5720.0	6010.0	6170.0	6200.0	9140.0
1946	3650.0	3770.0	4130.0	4230.0	4620.0	5000.0	4960.0	5160.0	5620.0	6750.0	9310.0
1947	3110.0	3170.0	3240.0	3350.0	3420.0	3670.0	4460.0	5110.0	6180.0	6910.0	9310.0
1948	4300.0	4570.0	4960.0	5070.0	5870.0	6650.0	8000.0	9930.0	12100.0	11300.0	16000.0
1949	4950.0	5350.0	5580.0	6000.0	6120.0	6700.0	6730.0	7270.0	7660.0	8450.0	10700.0
1950	2600.0	2700.0	2860.0	2910.0	3110.0	3860.0	4190.0	4980.0	5310.0	5470.0	6060.0
1951	2180.0	2180.0	2210.0	2310.0	2520.0	3010.0	3090.0	3380.0	3690.0	4020.0	5890.0
1952	2440.0	2470.0	2520.0	2540.0	2580.0	2810.0	3240.0	3490.0	3490.0	3800.0	5800.0
1953	2920.0	2920.0	2930.0	3130.0	3710.0	4230.0	5100.0	5070.0	6220.0	6410.0	9700.0
1954	1210.0	1280.0	1290.0	1310.0	1360.0	1420.0	1630.0	1850.0	2180.0	2470.0	3580.0
1955	1640.0	1640.0	1660.0	1730.0	1880.0	1970.0	2710.0	2580.0	2610.0	2870.0	3860.0
1956	1640.0	1680.0	1770.0	1840.0	2030.0	2330.0	2930.0	3080.0	3770.0	3980.0	5460.0
1957	1900.0	2030.0	2250.0	2410.0	2800.0	2990.0	3600.0	3940.0	471[illegible].0	4640.0	6750.0
1958	3220.0	3360.0	3540.0	3590.0	4010.0	4230.0	4780.0	5130.0	[illegible]	5980.0	6540.0
1959	2540.0	2620.0	2780.0	3180.0	4990.0	5200.0	5750.0	6240.0	[illegible]490.0	6690.0	8280.0

HIGHEST MEAN DISCHARGE, IN CFS, FOR THE FOLLOWING NUMBER OF CONSECUTIVE DAYS IN THE YEAR ENDING SEPTEMBER 30

YEAR	1	3	7	15	30	60	90	120	150	183	274
1929	202000.0	196000.0	168000.0	126000.0	105000.0	63600.0	49300.0	40700.0	34700.0	30300.0	22800.0
1930	96200.0	84200.0	53600.0	31200.0	19900.0	18300.0	17000.0	16300.0	16400.0	16400.0	14000.0
1931	68400.0	63100.0	44200.0	27300.0	18800.0	16200.0	12900.0	12000.0	11800.0	11600.0	9250.0
1932	41400.0	37100.0	25500.0	21200.0	18800.0	17000.0	15800.0	14800.0	13400.0	12300.0	10600.0
1933	63200.0	59800.0	51100.0	36500.0	29700.0	24200.0	23100.0	22700.0	20900.0	18600.0	14600.0
1934	62600.0	58700.0	45600.0	28600.0	19100.0	14000.0	12100.0	11800.0	10900.0	10100.0	8390.0
1935	46700.0	41400.0	29700.0	24600.0	17100.0	14100.0	12100.0	10700.0	9770.0	8900.0	7780.0
1936	101000.0	97800.0	82300.0	61900.0	45100.0	39400.0	34000.0	33300.0	28400.0	24100.0	18400.0
1937	56100.0	52000.0	43900.0	29500.0	26500.0	23700.0	21700.0	22000.0	21100.0	19000.0	15100.0
1938	90000.0	88500.0	72800.0	50400.0	33300.0	22900.0	17300.0	14500.0	14200.0	12700.0	10800.0
1939	76600.0	73500.0	59100.0	40300.0	29300.0	24000.0	19900.0	17400.0	15700.0	14300.0	12400.0
1940	49700.0	45500.0	33700.0	27100.0	19100.0	16700.0	15100.0	13800.0	12200.0	12300.0	10600.0
1941	17900.0	15400.0	12100.0	11400.0	10700.0	9050.0	8490.0	8520.0	7950.0	7360.0	6530.0
1942	80600.0	76100.0	57100.0	35500.0	28000.0	22700.0	18000.0	17600.0	15300.0	14200.0	11900.0
1943	118000.0	112000.0	91800.0	62100.0	41200.0	28800.0	28800.0	25800.0	23200.0	20700.0	16500.0
1944	96000.0	90200.0	71200.0	64700.0	44800.0	39300.0	32600.0	26900.0	23700.0	21000.0	16300.0
1945	58400.0	51900.0	38600.0	27600.0	20600.0	15800.0	16400.0	14600.0	13300.0	12100.0	10200.0
1946	71900.0	68500.0	55300.0	44000.0	36100.0	28900.0	27300.0	25800.0	24300.0	22600.0	18500.0
1947	58700.0	55300.0	46000.0	33000.0	25700.0	22700.0	20900.0	19700.0	18100.0	16700.0	13200.0
1948	80000.0	74000.0	60400.0	40500.0	33100.0	30600.0	25700.0	22800.0	21000.0	19500.0	17800.0
1949	110000.0	107000.0	94700.0	68000.0	45500.0	34600.0	31200.0	28600.0	26500.0	25600.0	21500.0
1950	27500.0	25700.0	21900.0	20000.0	16700.0	14500.0	12800.0	11800.0	11200.0	10900.0	9480.0
1951	28400.0	26600.0	20300.0	15700.0	14900.0	12200.0	10500.0	9620.0	9160.0	8460.0	7210.0
1952	70200.0	66400.0	52600.0	37800.0	36000.0	25900.0	22000.0	20100.0	18100.0	16500.0	12700.0
1953	90500.0	81100.0	66600.0	44100.0	30900.0	22100.0	21900.0	20200.0	18700.0	16600.0	13500.0
1954	55500.0	48700.0	36900.0	31700.0	25700.0	20200.0	17100.0	16000.0	14600.0	13100.0	10300.0
1955	38700.0	35400.0	25400.0	18300.0	17500.0	9630.0	10200.0	9500.0	8890.0	7980.0	6990.0
1956	50500.0	47200.0	33900.0	22200.0	17700.0	14000.0	13100.0	11200.0	9680.0	8690.0	7090.0
1957	73000.0	69600.0	53100.0	34200.0	25400.0	19400.0	15900.0	14600.0	14400.0	12900.0	9960.0
1958	73800.0	65600.0	45500.0	32800.0	23900.0	21100.0	18800.0	16400.0	15300.0	14500.0	12100.0
1959	50700.0	44200.0	33700.0	24900.0	21300.0	19500.0	17100.0	15000.0	15100.0	13700.0	11200.0
1960	83500.0	77700.0	63200.0	44900.0	31000.0	26000.0	24200.0	21700.0	19300.0	17100.0	13800.0

Note:--Flow regulated by Lake Sidney Lanier beginning January 1956 and Bartletts Ferry Reservoir beginning in 1926.

DATE TAKEN FROM

FLOW CHARACTERISTICS OF ALABAMA STREAMS
Geological Survey of Alabama
Circular 32

ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT

FLOW CHARACTERISTICS OF THE CHATTAHOOCHEE RIVER AT COLUMBIA, ALABAMA

SHEET 2 OF 2 FIGURE 2-12

An examination of the records since 1964 when Walter F. George Lock and Dam and Columbia Lock and Dam were completed, shows the minimum average daily flow was 1760 cfs and occurred when discharge was 4010 cfs the day before and 5290 cfs the day after. Also during the month this occurred, Walter F. George Reservoir stored the equivalent of 1539 cfs. This indicates that low flow is presently being controlled by operation of upstream dams.

The availability of water in the river does not depend on flow past the plant site, however, because of the impoundment formed by Jim Woodruff Dam. According to the Corps of Engineers, Lake Seminole varies in elevation between 76 and 78 feet MSL. The Corps of Engineers maintains a nine foot deep navigation channel in the Chattahoochee River which corresponds to a river elevation of 76 feet MSL at the plant site.

The area of the drainage basin affecting the Chattahoochee River at the site is about 8,246 square miles. The maximum historical flow based on 60 years of record was estimated to be 207,000 cfs during the flood of 1929. This flow corresponds to an estimated maximum stage at the site of about 124 feet MSL. This event might be expected to be equaled or exceeded on the average of once in 130 years.

To establish the design flood for the Joseph M. Farley Nuclear Plant, a more improbable situation was considered, namely, the positioning of probable maximum precipitation upstream of the plant site so that the probable maximum discharge and elevation would result at the site. It should be pointed out, however, that this probable maximum precipitation resulted from transposition of the maximized storm of March, 1929 which had its primary center at Elba, Alabama. It is possible but highly improbable that this storm, modified to produce the maximum flood at the plant site, might actually occur during the life of the Joseph M. Farley Nuclear Plant.

The flood elevation at the site resulting from estimates made as described above is 144.2 feet (MSL). This corresponds to the maximum probable peak discharge at the site of 642,000 cfs which is more than triple the maximum estimated flood discharge of record.

The river intake structure will be flood protected to the level of the probable 1000 year flood (127 feet MSL). All other structures and equipment necessary for maintaining long-term safe conditions will be located on or above the plant level of 154.5 feet (MSL).

The design storm for the storage pond was assumed to be a six-hour storm with a probable maximum precipitation of 29.9 inches based on U. S. Weather Bureau Hydrometeorological distribution found in the U. S. Corps of Engineers Bulletin 52-8. A simple triangular unit hydrograph was used to develop the inflow hydrograph.

The inflow was routed using the arithmetic tabular method and assuming that the pond was full (elevation 186 MSL) at the beginning of the routing. Maximum routed outflow is 1850 cfs.

The above analysis neglects the normal removal of service water from the storage pond.

A wave height analysis was made based on procedures described in "Freeboard Allowances for Waves in Inland Reservoirs", Saville, McClendon, and Cochran, Journal of Waterways and Harbors Division, ASCE, May, 1962. The most critical wind direction for wave formation was found to be from the northwest.

The required duration of wind velocity for wave formation was found to be approximately seven minutes.

A wind velocity of 50 miles per hour over land would produce a significant wave height of 1.4 feet. (The significant wave height is that height which is exceeded by only 13 percent of the waves.) On the riprapped face of the dam, the wave runup would be approximately 1.7 feet including 0.1 feet for wind setup. The maximum wave would produce a runup of approximately 2.3 feet. Such a wave would be expected to occur once every 12 minutes.

Rock Creek flows along the northern edge of the Farley Plant site. The drainage area is roughly rectangular with an area of 7.32 square miles. The highest point on the divide is approximately elevation 300 and the ground gradually slopes to the outfall at elevation 110.5. The time of concentration for this basin is estimated to be 1.6 hours.

The procedures developed by the U. S. Department of Agriculture, Soil Conservation Service, for design of emergency spillways for small watersheds in high risk areas was utilized to determine the six-hour storm hydrograph. The probable maximum storm hydrograph had a peak runoff of 54,700 cfs for a six hour probable maximum rainfall of 31 inches as obtained from Hydrometeorological Report No. 33.[5] The storm runoff was routed through the impoundment created by the railway embankment conservatively assuming no infiltration or ponding losses.

The construction in the Rock Creek area involves a railroad crossing Rock Creek on a fill with the track at 153 feet MSL. A 23-foot diameter culvert with the inlet invert at 110.5 MSL is to be provided in the railroad fill for the normally expected flows of Rock Creek.

Since studies showed that the 23-foot diameter pipe could not carry the probable maximum flood water without overtopping of the railway fill, a protective dike is planned along the north and west edges of the plant construction yard with a top at 165.0 feet MSL. With this dike, the maximum impoundment level will be 160.5 feet MSL for the maximum probable storm. The dike will direct the discharge away from the plant area.

When the storm flow overtops the railroad fill, it is expected that the railroad ballast, track and ties, and some portion of the earth fill will be washed away. However, this was not considered in routing the inflow to determine the maximum ponding elevation.

1. Linsley, R. K., Kohler, M. A., and Paulhus, J. L., Hydrology for Engineers, McGraw-Hill Book Company, Inc., 1958. pp. 52-168

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3. Herrick, S. M., and Vorhis, R. C., Subsurface Geology Of The Georgia Coastal Plain, Information Circular 25, Department of Mines, Mining and Geology, State Division of Conservation, Atlanta, Georgia, 1963.

4. Jones, W. B., Water Resources and Hydrology of Southeastern Alabama, United States Geological Survey and Geological Survey of Alabama, Special Report 20, Tuscaloosa, Alabama, 1949.

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2.4.5 Chemical And Physical Characteristics Of Water, Aquatic Life, And Bottom Muds In The Chattahoochee River

From 1965 through June 1970, the Auburn University Agricultural Experiment Station, under the leadership of Dr. John Lawrence, conducted a thorough investigation of the dynamics of physical and chemical characteristics of water, suspended matter, hydrosol, plants and fish in Lakes Seminole, Eufaula, and Bartlett's Ferry, on the Chattahoochee River. This work was conducted with the aid of funds provided in part by the Office of Water Resources Research, U. S. Department of the Interior. The Joseph M. Farley Nuclear Plant is on the upper reaches of Lake Seminole, while Lakes Eufaula and Bartlett's Ferry are located sequentially upstream from Lake Seminole. The objectives of the research were stated in the final report for OWRR Project B-101-Ala as:

1. Locate the stratification or density currents in various regions of the impoundment.
2. Determine the distribution of oxygenated waters (i.e. those water regions suitable for occupancy by fish) in various regions of the reservoir throughout each year.
3. Obtain information on the concentrations of plant nutrients, including minor elements and toxic cations in waters and bottom muds of tributary streams, various regions of the reservoir, and its tailwaters during various seasons of the year.
4. Determine concentrations of suspended organic, and inorganic materials present at various water depths in various parts of the reservoir and its tailwaters during various seasons of the year.

5. Determine the distribution, chemical composition, and production of plankton in waters at various depths and regions of the reservoir during various seasons of the year.
6. Determine rate of development, distribution, and chemical composition of rooted aquatic plants at each region sampled in the reservoirs.
7. Determine the condition of various species of fish in various portions of the reservoir at different seasons of the year.
8. Correlate data obtained in achieving the above objectives by computer data analysis, and develop prediction techniques for use in future monitoring of waterplant, and fish life in these reservoirs.

The three reservoirs were divided into several water areas for study. The data on physical and chemical characteristics of these three impoundments were collected at stations scattered over a distance of 200 river miles. To facilitate arrangement and interpretation of these data they are separated for each impoundment and the major water areas within each impoundment were designated as follows:

Bartlett's Ferry Reservoir

Chattahoochee River (inlet).

Osanippa Creek arm (inlet).

Halawakee Creek arm (inlet).

One-quarter mile above Bartlett's Ferry Dam (outlet).

Lake Eufaula

Upper region; Columbus, Ga. to river mile 120.

Middle region; river mile 120 to river mile 97.5.

Lower region; river mile 97.5 to Walter F. George Dam.

Lake Seminole

Chattahoochee River; between Columbia Dam and Jim Woodruff Dam

Flint River; between Bainbridge, Ga. and Jim Woodruff Dam

Spring Creek arm.

The following tables are reproduced directly from the final report submitted on project B-101-Ala. They show average temperature, dissolved oxygen, resistivity, pH and total alkalinity.

The averaged temperature and dissolved oxygen content of waters at various stations and depths in Lake Eufaula for the period May through September, 1965 to 1969.

Location	Year		Depth 0'	20'	40'	80'
Upper region	1965	C	29.6	28.9	28.8	
		O_2 ppm	6.6	5.2	5.2	
	'66	C	25.5	23.0	25.7	
		O_2 ppm	6.8	6.3	5.0	
	'67	C	24.7	23.8	26.1	
		O_2 ppm	6.9	6.6	6.7	
	'68	C	27.9	27.9	26.2	
		O_2 ppm	10.8	7.2	5.9	
	'69	C	29.0	28.2	28.0	
		O_2 ppm	6.6	4.9	2.9	
Middle region	'65	C	26.0	25.0	24.6	
		O_2 ppm	6.2	3.8	2.7	
	'66	C	28.7	26.7	26.1	
		O_2 ppm	6.7	4.3	2.4	
	'67	C	27.1	25.2	24.9	
		O_2 ppm	7.3	4.7	3.5	
	'68	C	28.5	26.3	25.0	
		O_2 ppm	8.8	5.0	3.3	
	'69	C	28.4	25.7	25.1	
		O_2 ppm	9.3	5.2	3.8	
Lower region	'65	C	30.5	28.4	27.3	26.2
		O_2 ppm	7.6	3.4	1.6	1.9
	'66	C	29.0	27.2	26.6	26.6
		O_2 ppm	6.8	4.7	3.3	1.2
	'67	C	27.3	25.2	24.4	24.5
		O_2 ppm	8.4	4.6	2.2	1.1
	'68	C	29.1	25.7	24.4	22.2
		O_2 ppm	8.2	4.3	2.4	1.0
	'69	C	32.3	27.7	26.2	24.3
		O_2 ppm	8.7	2.1	1.1	0.0

The averaged temperature and dissolved oxygen content of waters at various stations and depths in Lake Seminole for the period May through September, 1968-1969.

Location	Year		Depth 0'	Depth 20'
Flint river	'68	°C	27.5	26.0
		O_2 ppm	7.3	5.3
	'69	°C	26.4	26.0
		O_2 ppm	6.3	5.7
Spring creek	'68	°C	27.1	
		O_2 ppm	7.8	
	'69	°C	25.0	
		O_2 ppm	7.5	
Chattahoochee river Above Great Northern Plant	'68	°C	24.6	24.7
		O_2 ppm	6.8	6.1
	'69	°C	26.0	
		O_2 ppm	5.7	
Neal's landing	'68	°C	28.1	27.7
		O_2 ppm	5.7	5.5
	'69	°C	27.0	27.0
		O_2 ppm	5.5	5.0
Jim Woodruff Dam	'68	°C	29.0	26.8
		O_2 ppm	7.7	4.1
	'69	°C	26.5	27.0
		O_2 ppm	7.35	5.0

Averaged resistivity in ohms/cm^3 of water at various stations and depths in Bartlett's Ferry Reservoir, Lakes Eufaula and Seminole for periods May through September 1965-1969.

Reservoir and Region	Year	Mean Ohms/cm^3	95% CI*	Range
Bartlett's Ferry				
Input	'68	18,626	1,700	6,500-27,000
Output	'68	18,037	995	15,300-24,000
Input	'69	17,715	3,300	8,200-29,500
Output	'69	16,525	2,200	12,200-21,500
Lake Eufaula				
Upper	'65-'67	16,667		
	'68	15,242	984	7,500-26,000
	'69	16,684	1,174	12,000-28,000
Middle	'65-'67	16,933	-	- -
	'68	15,230	1,052	7,500-51,500
	'69	16,966	1,038	13,000-24,000
Lower	'65-'67	13,200	-	- -
	'68	16,393	732	8,000-29,000
	'69	17,400	848	10,400-22,500
Lake Seminole				
Chattahoochee r.	'67	12,775	800	11,500-14,500
	'68	13,105	1,150	2,000-17,600
	'69	14,206	2,115	6,500-22,000
Flint r.	'67	14,925	500	14,500-15,400
	'68	10,801	815	7,000-17,700
	'69	9,784	990	6,800-21,000
Spring cr.	'67	7,465	680	5,300-11,000
	'68	8,038	870	4,900-11,000
	'69	7,954	930	5,500-10,000

*Conficence interval = Mean ± 95% C. I.

Averaged pH values for selected areas within the 3 impoundments and their associated 95 percent confidence intervals during 1965 through 1969.

Reservoir and Region	Year	Mean pH	95% CI*	Range
Bartlett's Ferry				
Input	'68	7.64	.53	6.1-10.0
Output	'68	7.26	.74	5.9-10.2
Input	'69	7.20	.40	6.7- 9.2
Output	'69	7.59	.78	6.7- 9.8
Lake Eufaula				
Upper	'65-'67	7.0		
	'68	7.58	.18	6.6- 9.5
	'69	6.88	.24	6.1- 8.5
Middle	'65-'67	7.0	-	-
	'68	7.53	.14	6.9- 9.4
	'69	6.77	.19	6.0- 8.5
Lower	'65-'67	7.1	-	-
	'68	7.48	.18	6.7- 9.2
	'69	6.78	.18	6.0- 8.7
Lake Seminole				
Chattahoochee r.	'67	7.31	.20	7.0- 7.7
	'68	7.43	.10	7.1- 7.9
	'69	7.73	.30	6.6- 8.5
Flint r.	'67	7.23	.17	7.0- 7.4
	'68	7.84	.20	7.1- 9.3
	'69	7.81	.21	6.6- 9.0
Spring cr.	'67	7.63	.30	6.4- 8.8
	'68	8.23	.21	7.5- 8.9
	'69	8.00	.33	6.9- 8.7

*Confidence interval = Mean ± 95% C. I.

The averaged total alkalinity, as ppm $CaCO_3$, for all depths by reservoirs, stations within reservoirs, and by years, and the associated 95 percent confidence intervals for 1965 through 1969.

Reservoir and Region	Year	T. alkalinity ppm $CaCO_3$	95% CI*	Range ppm
Bartlett's Ferry				
Input	'68	25.25	6.20	16.25-81.25
Output	'68	20.25	1.94	16.25-28.75
Input	'69	31.35	9.20	11.25-60.00
Output	'68	33.75	16.00	21.25-88.75
Lake Eufaula				
Upper region	'65-'67	19.90	-	-
	'68	25.45	2.70	15.0 -57.50
	'69	22.40	3.16	13.75-46.25
Middle region	'65-'67	19.70	-	-
	'68	25.72	2.20	18.70-60.00
	'69	22.88	3.16	13.70-70.00
Lower region	'65-'67	21.20	-	-
	'68	24.42	2.44	16.25-85.00
	'69	23.83	2.96	13.70-70.00
Lake Seminole				
Chattahoochee	'67	26.72	2.00	21.25-28.75
river	'68	32.10	6.20	20.00-100.00
	'69	32.29	6.30	25.00-43.75
Flint river	'67	21.56	.65	21.25-22.50
	'68	48.14	6.20	25.00-100.00
	'69	54.14	5.00	25.00-83.75
Spring creek	'67	69.68	6.65	42.50-93.75
	'68	60.45	8.80	40.00-91.25
	'69	78.36	11.00	45.00-100.00

*Confidence interval = Mean ± 95% C.I.

The following tables from the same report show the element content of lake water, hydrosol, fish, and aquatic plants. Elements listed are:

Nitrogen	(N)	- Table 20
Phosphorous	(P)	- Table 21
Potassium	(K)	- Table 22
Carbon	(C)	- Table 23
Calcium	(Ca)	- Table 24
Strontium	(Sr)	- Table 25
Magnesium	(Mg)	- Table 26
Sodium	(Na)	- Table 27
Iron	(Fe)	- Table 28
Manganese	(Mn)	- Table 29
Zinc	(Zn)	- Table 30
Copper	(Cu)	- Table 31
Lead	(Pb)	- Table 32
Nickel	(Ni)	- Table 33
Cadmium	(Cd)	- Table 34
Chromium	(Cr)	- Table 35
Cobalt	(Co)	- Table 36

The tables are reproduced directly from the original report and therefore carry the table numbers originally given in the report.

This data serves as baseline data and establishes conditions in the river prior to construction and operation of the Joseph M. Farley Plant. It will serve as a basis for comparison with conditions which will be found after the plant is in operation.

Table 20

Distribution of elemental NITROGEN in major components of 3 largestream impoundments

BARTLETT'S FERRY RESERVOIR

	1968	1969
Ratio of N - soluble to suspended matter in water		
Input-Chattahoochee river	1:--	1:0.7
Output-Bartlett's Ferry Dam	1:--	1:1.24
Average total N concentration in water, ppm	0.192	1.044
Total N, lbs per mi^2 drainage area, April-October		
Input-Chattahoochee river	229.0	827.0
Output-Bartlett's Ferry Dam	282.0	925.0
Hydrosol - Total N concentration in sample, ppm	2,770.0	2,480.0
Total lbs N per acre in 0.01 inch	7.83	6.03
Fish - Total standing crop, lbs per acre	190.0	190.0
Average concentration N, per cent	9.61	9.61
Total lbs N per acre		4.82

Aquatic plants

Species	Year	Acres	Wet weight, lbs per acre	N content, percent	Pounds N per acre
Waterwillow		0.5	30,000	2.67	160.2

LAKE EUFAULA

	1968	1969
Ratio of N - soluble to suspended matter in water		
Input-Upper region	1:--	1:0.66
Middle region	1:--	1:0.64
Lower region	1:--	1:0.66
Average total N concentration in water, ppm		
Upper region	0.172	0.652
Middle region	0.198	0.553
Lower region	0.190	0.356
Total N, lbs per mi^2 drainage area, April-October		
Input-Upper region	177.0	771.0
Middle region	152.0	565.0
Lower region	158.0	522.0
Output-Walter F. George Dam	168.0	429.0
Hydrosol - Total N concentration in sample, ppm		
Upper region	1,970.0	2,340.0
Middle region	2,910.0	2,930.0
Lower region	2,220.0	3,390.0
Pounds total N per acre in 0.01 inch		
Upper region	5.77	6.67
Middle region	8.60	8.60
Lower region	6.50	10.00
Fish - Total standing crop, lbs per acre	190.0	190.0
Average concentration N, per cent	9.61	9.61
Total lbs N per acre		4.82

Aquatic plants

Species	Year	Acres	Wet weight lbs per acre	N content, per cent	Pounds N per acre
Alligatorweed	'68	1	150,000	2.96	355.2
-do-	'69	5	150,000	2.47	296.4

Table 20 Continued

LAKE SEMINOLE (Nitrogen continued)

	1968	1969
Ratio of N - soluble to suspended matter in water	Not available	
Average total N concentration in water, ppm		
Chattahoochee river arm	0.216	0.341
Flint river arm	0.188	0.522
Spring creek arm	0.170	0.340
Total N, lbs per mi^2 drainage area, April-October		
Input-Chattahoochee river arm	226.0	309.0
Flint river arm	157.0	347.0
Spring creek arm	117.0	145.0
Output-Chattahoochee river arm	267.0	379.0
Flint river arm	183.0	295.0
Hydrosol - Total N concentration in sample, ppm		
Chattahoochee river arm		2,750.0
Flint river arm	2,370.0	2,585.0
Spring creek arm	2,960.0	2,070.0
Pounds total N per acre in 0.01 inch		
Chattahoochee river arm	8.6	8.3
Flint river arm	7.0	5.8
Spring creek arm	8.7	0.7
Fish - Total standing crop, lbs per acre	210.0	210.0
Average concentration N, ppm	96,000.0	96,100.0
Total lbs N per acre	5.25	5.25

Aquatic plants

Species	Year	Acres	Wet weight lbs per acre	N content, per cent	Pounds N per acre
Alligatorweed	'68	250	155,000	3.36	416.6
-do-	'69	100	155,000	2.37	293.9
Waterhyacinth	'68	100	143,000	2.51	287.1
-do-	'69	200	143,000	2.12	242.5
Eurasian milfoil	'68	2,000	- - -	1.67	167.0
-do-	'69	2,000	- - -	1.71	171.0
Giant cutgrass	'68	400	31,000	1.53	123.3
-do-	'69	450	31,000	1.02	82.2
Others	'68	500	30,000	1.69	101.4
-do-	69	500	30,000	1.70	102.0

The averaged summertime "standing crop" of N in each aquatic environment component (including the 0.01 inch layer of hydrosol) for the 3 impoundments are given below.

Component	Year	Bartlett's Ferry Reservoir (lbs)	Lake Eufaula (lbs)	Lake Seminole (lbs)
Water + suspended matter	'68	76,050	469,896	175,545
-do-	'69	413,887	1,175,206	373,791
Hydrosol	'68	45,805	315,175	282,850
-do-	'69	35,275	404,763	200,570
Fish	'68	28,197	216,900	183,750
-do-	'69	28,197	216,900	183,750
Aquatic plants	'68	80	355	566,880
-do-	'69	80	1,482	522,430
Total N	'68	150,132	1,002,326	1,209,025
-do-	'69	477,439	1,798,351	1,280,541
Lbs N per acre	'68	25.66	22.27	34.54
-do-	'69	81.61	39.96	36.59
Lbs N per acre-foot	'68	1.03	1.11	3.67
-do-	'69	3.26	2.00	3.89

Table 21

Distribution of elemental PHOSPHORUS in major components of 3 largestream impoundments

BARTLETT'S FERRY RESERVOIR

	1968	1969
Ratio of P - soluble to suspended matter in water		
Input - Chattahoochee River	1:3.8	1:1
Output - Bartlett's Ferry Dam	1:2.7	1:1
Average total P concentration in water - ppm	0.249	0.234
Total P, lbs per mi^2 drainage area, April-October		
Input - Chattahoochee River	242.0	560.0
Output - Bartlett's Ferry Dam	192.0	164.0
Hydrosol - Total P concentration in sample, ppm	2,507.0	4,466.0
Total lbs P per acre in 0.01 inch	7.3	11.2
Fish - Total standing crop - lbs per acre	190.0	190.0
Average concentration P, per cent	3.01	3.01
Total lbs P per acre		1.51

Aquatic Plants

Species	Year	Acres	Wet weight lbs per acre	P content, per cent	Pounds P per acre
Waterwillow		0.5	30,000	0.30	18.0

LAKE EUFAULA

	1968	1969
Ratio of P - soluble to suspended matter in water		
Input - Upper region	1:9	1:1.7
Middle region	1:15	1:2.2
Lower region	1:5	1:4.7
Output - Walter F. George Dam		
Average total P concentration in water		
Upper region	0.747	0.287
Middle region	0.599	0.263
Lower region	0.208	0.149
Total P, lbs per mi^2 drainage area, April-October		
Input - Upper region	859.0	374.0
Middle region	265.0	470.0
Lower region	55.0	224.0
Output - Walter F. George Dam	68.0	95.0
Hydrosol - Total P concentration in sample, ppm		
Upper region	2,409.0	2,891.0
Middle region	1,903.0	3,873.0
Lower region	862.0	3,230.0
Pounds total P per acre in 0.01 inch		
Upper region	7.1	8.1
Middle region	5.6	11.3
Lower region	2.5	9.5
Fish - Total standing crop - lbs per acre	190.0	190.0
Average concentration P, per cent	3.01	3.01
Total lbs P per acre	1.51	1.51

Aquatic plants

Species	Year	Acres	Wet weight lbs per acre	P content, per cent	Pounds P per acre
Alligatorweed	'68	1	150,000	0.33	39.3
-do-	'69	5	150,000	0.33	39.3

Table 21 Continued

LAKE SEMINOLE (Phosphorus continued)

	1968	1969
Ratio of P - soluble to suspended matter in water		
Chattahoochee River arm	1:4.1	1:1.4
Flint River arm	1:2.5	1:0.8
Spring Creek arm	1:2.2	1:0.5
Average total P concentration in water		
Chattahoochee River arm	0.209	0.103
Flint River arm	0.146	0.193
Spring Creek arm	0.068	0.096
Total P - lbs per mi^2 drainage area, April-October		
Input - Chattahoochee River arm	129.0	89.0
Flint River arm	81.0	389.0
Spring Creek arm	69.0	104.0
Output - Chattahoochee River arm	152.0	112.0
Flint River arm	132.0	69.0
Hydrosol - Total P concentration in sample, ppm		
Chattahoochee River arm		920.0
Flint River arm	358.0	2,087.0
Spring Creek arm	433.0	720.0
Pounds total P per acre in 0.01 inch		
Chattahoochee River arm	-	2.7
Flint River arm	1.1	6.1
Spring Creek arm	1.3	0.7
Fish - Total standing crop - lbs per acre	210.0	210.0
Average concentration P, per cent	3.01	3.01
Total lbs P, per acre	1.64	1.64

Aquatic Plants

Species	Year	Acres	Wet weight lbs per acre	P content, per cent	Pounds P per acre
Alligatorweed	'68	250	155,000	0.24	21.7
-do-	'69	100	155,000	0.41	50.[illegible]
Waterhyacinth	'68	100	143,000	0.37	42.3
-do-	'69	260	143,000	0.82	93.8
Eurasian milfoil	'68	2,000		0.23	11.3
-do-	'69	2,000		0.13	10.3
Giant cutgrass	'68	400	31,000	0.10	8.1
-do-	'69	450	31,000	0.17	13.7
Others	'68	500	30,000	0.20	12.0
-do-	'69	500	30,000	0.22	13.2

The averaged summertime standing crop of P in each aquatic environmental component (including the 0.01 inch layer of hydrosol) for the 3 impoundments are given below.

Component	Year	Bartlett's Ferry Reservoir (lbs)	Lake Eufaula (lbs)	Lake Seminole (lbs)
Water + suspended matter	'68	99,450	1,032,817	138,885
-do-	'69	92,137	552,632	120,931
Hydrosol	'68	42,705	186,097	54,770
-do-	'69	65,520	440,489	130,300
Fish	'68	8,833	67,950	57,400
-do-	'69	8,833	67,950	57,400
Aquatic plants	'68	9	39	41,545
-do-	'69	9	196	55,345
Total P	'68	150,997	1,286,905	292,600
-do-	'69	166,499	1,061,267	363,976
Lbs P per acre	'68	25.8	28.6	8.4
-do-	'69	28.5	23.6	10.4
Lbs P per acre foot	'68	1.03	1.43	.89
-do-	'69	1.14	1.18	1.10

Table 22

Distribution of elemental POTASSIUM in major components of 3 largestream impoundments

BARTLETT'S FERRY RESERVOIR

	1968	1969
Ratio of K - soluble to suspended matter in water		
Input - Chattahoochee River	1:0.09	1:0.04
Output - Bartlett's Ferry Dam	1:0.07	1:0.04
Average total K concentrations in water, ppm	1.51	1.83
Total K - lbs per mi^2 drainage area, April-October		
Input - Chattahoochee River	2,152.0	1,644.0
Output - Bartlett's Ferry Dam	1,360.0	1,691.0
Hydrosol - Total K concentration in sample, ppm	2,507.0	4,470.0
Total lbs K per acre in 0.01 inch	12.4	24.4
Fish - Total standing crop - lbs per acre	190.0	190.0
Average concentration K, per cent	0.91	0.91
Total lbs K per acre	0.45	0.45

Aquatic plants

Species	Year	Acres	Wet weight per acre, lbs	K content, per cent	Pounds K per acre
Waterwillow		0.5	30,000	2.37	142

LAKE EUFAULA

Ratio of K - soluble to suspended matter in water		
Input - Upper region	1:0.04	1:0.03
Middle region	1:0.05	1:0.03
Lower region	1:0.04	1:0.03
Output - Walter F. George Dam		
Average total K concentration in water		
Upper region	1.65	2.98
Middle region	1.64	2.92
Lower region	1.64	2.35
Total K - lbs per mi^2 drainage area, April-October		
Input - Upper region	1,637.0	2,216.0
Middle region	1,540.0	4,268.0
Lower region	1,550.0	3,152.0
Output - Walter F. George Dam	1,401.0	2,912.0
Hydrosol - Total K concentration in sample, ppm		
Upper region	2,409.0	2,891.0
Middle region	1,903.0	3,873.0
Lower region	862.0	3,230.0
Pounds total K per acre in 0.01 inch		
Upper region	4.9	72.5
Middle region	5.7	6.6
Lower region	2.8	13.6
Fish - Total standing crop, lbs per acre	190.0	190.0
Average concentration K, per cent	0.91	0.91
Total lbs K per acre	0.45	0.45

Aquatic plants

Species	Year	Acres	Wet weight lbs per acre	K content, per cent	Pounds K per acre
Alligatorweed	'68	1	150,000	3.98	477.6
-do-	'69	5	750,000	4.87	584.4

Table 22 Continued

LAKE SEMINOLE (Potassium continued)

	1968	1969
Ratio of K - soluble to suspended matter in water		
Input - Chattahoochee River arm	1:0.06	1:0.03
Flint River arm	1:0.06	1:0.05
Spring Creek arm	1:0.06	1:0.03
Average total K concentration in water		
Chattahoochee River arm	1.60	1.24
Flint River arm	1.12	1.15
Spring Creek arm	0.58	1.54
Total K - lbs per mi^2 drainage area, April - October		
Input - Chattahoochee River arm	1,784.0	2,103.0
Flint River arm	875.0	1,505.0
Spring Creek arm	67.0	965.0
Output - Chattahoochee River arm	1,738.0	946.0
Flint River arm	1,557.0	559.0
Hydrosol - Total K concentration in sample, ppm		
Chattahoochee River arm		7,800.0
Flint River arm	2,562.0	4,823.0
Spring Creek arm	1,042.0	6,000.0
Pounds total K per acre in 0.01 inch		
Chattahoochee River arm	1.3	23.0
Flint River arm	7.6	4.6 *
Spring Creek arm	3.1	2.5
Fish - Total standing crop - lbs per acre	210.0	210.0
Average concentration K - per cent	0.91	0.91
Total lbs K per acre	0.50	0.50

Aquatic plants

Species	Year	Acres	Wet weight lbs per acre	K content, per cent	Pounds K per acre
Alligatorweed	'68	250	155,000	39,943	495.0
-do-	'69	100	155,000	46,900	581.0
Waterhyacinth	'68	100	143,000	39,000	446.0
-do-	'69	260	143,000	47,950	548.0
Eurasian milfoil	'68	2,000		4,062	406.0
-do-	'69	2,000		6,000	600.0
Giant cutgrass	'68	400	31,000	19,332	155.0
-do-	'69	450	31,000	17,000	137.0
Others	'68	500	30,000	21,500	129.0
-do-	'69	500	30,000	21,961	132.0

The averaged summertime standing crop of K in each aquatic environmental component (including the 0.01 inch layer hydrosol) for the 3 impoundments are given below.

Component	Year	Bartlett's Ferry Reservoir (lbs)	Lake Eufaula (lbs)	Lake Seminole (lbs)
Water + suspended matter	'68	599,625	4,077,480	1,060,320
-do-	'69	731,250	6,665,920	1,137,400
Hydrosol	'68	72,540	180,033	151,000
-do-	'69	142,740	890,654	395,950
Fish	'68	2,632	20,250	17,500
-do-	'69	2,632	20,250	17,500
Aquatic plants	'68	71	478	294,850
-do-	'69	71	2,920	332,230
Total K	'68	674,868	4,288,241	1,523,670
-do-	'69	876,693	7,559,744	1,903,080
Lbs K per acre	'68	115.4	95.3	43.5
-do-	'69	149.8	168.0	54.3
Lbs K per acre - foot	'68	4.61	4.76	4.62
-do-	'69	5.99	8.40	5.77

Table 23

Distribution of elemental CARBON in major components of 3 largestream impoundments

BARTLETT'S FERRY RESERVOIR

	1968	1969
Ratio of C - soluble to suspended matter in water		
Input - Chattahoochee River	1:0.15	1:0.48
Output - Bartlett's Ferry Dam	1:0.06	1:0.39
Average total C concentration in water, ppm	9.51	8.85
Hydrosol - Total C concentration in sample, ppm	37,400.0	30,600.0
Total lbs C per acre in 0.01 inch	131.0	77.5
Fish - Total standing crop - lbs per acre	190.0	190.0
Average concentration C, per cent	47.8	47.8
Total lbs C per acre	24.0	24.0

Aquatic plants

Species	Year	Acres	Wet weight lbs per acre	C content per cent	Pounds C per acre
Waterwillow		0.5	30,000	41.38	1,241.0

LAKE EUFAULA

	1968	1969
Ratio of C - soluble to suspended matter in water		
Input - Upper region	1:0.28	1:0.10
Middle region	1:0.31	1:0.16
Lower region	1:0.22	1:0.0
Average total C concentration in water, ppm		
Upper region	13.28	17.31
Middle region	13.04	13.00
Lower region	12.11	9.91
Hydrosol - Total C concentration in sample, ppm		
Upper region	37,500.0	23,900.0
Middle region	36,900.0	24,200.0
Lower region	26,400.0	32,100.0
Pounds total C per acre in upper 0.01 inch		
Upper region	110.2	67.0
Middle region	109.4	71.2
Lower region	77.7	94.4
Fish - Total standing crop, lbs per acre	190.0	190.0
Average concentration C, per cent	47.8	47.8
Total lbs C per acre	24.0	24.0

Aquatic plants

Species	Year	Acres	Wet weight lbs per acre	C content per cent	Pounds C per acre
Alligatorweed	'68	1	150,000	36.3	4,356.0
-do-	'69	5	150,000	35.2	4,224.0

Table 23 Continued

LAKE SEMINOLE (Carbon continued)

	1968	1969
Average total C concentration in water, ppm		
Chattahoochee River arm	16.938	12.392
Flint River arm	13.089	14.034
Spring Creek arm	16.825	12.638
Hydrosol - Total C concentration in sample, ppm		
Chattahoochee River arm	27,800.0	
Flint River arm	25,500.0	45,400.0
Spring Creek arm	48,300.0	63,100.0
Pounds total C per acre in 0.01 inch		
Chattahoochee River arm	39.0	82.0
Flint River arm	134.0	60.5
Spring Creek arm	185.0	15.5
Fish - Total standing crop - lbs per acre	210.0	210.0
Average concentration C, per cent	47.8	47.8
Total lbs C per acre	26.1	26.1

Aquatic plants

Species	Year	Acres	Wet weight lbs per acre	C content per cent	Pounds C per acre
Alligatorweed	'68	250	155,000	39.20	4,861.0
-do-	'69	100	155,000	36.70	4,550.0
Waterhyacinth	'68	100	143,000	41.70	4,770.0
-do-	'69	260	143,000	35.60	4,072.0
Eurasian milfoil	'68	2,000		31.92	640.0
-do-	'69	2,000		35.90	705.0
Giant cutgrass	'68	400	31,000	43.87	3,538.0
-do-	'69	450	31,000	41.00	3,304.0
Others	'68	500	30,000	39.10	2,346.0
-do-	'69	500	30,000	39.10	2,346.0

The averaged summertime standing crop of C in each aquatic environmental component (including the 0.01 inch layer hydrosol) for the 3 impoundments are given below.

Component	Year	Bartlett's Ferry Reservoir (lbs)	Lake Eufaula (lbs)	Lake Seminole (lbs)
Water + suspended matter	'68	3,758,625	31,614,740	13,857,480
-do-	'69	3,510,000	30,570,680	11,841,650
Hydrosol	'68	766,350	4,690,177	2,857,000
-do-	'69	453,375	2,154,744	2,200,500
Fish	'68	140,400	1,080,000	913,500
-do-	'69	140,400	1,080,000	913,500
Aquatic plants	'68	620	4,356	5,560,450
-do-	'69	620	21,120	5,583,520
Total	'68	4,665,995	37,389,273	23,188,430
-do-	'69	4,104,395	33,726,544	20,539,170
Lbs C per acre	'68	797.6	830.8	662.5
-do-	'69	701.6	749.4	586.8
Lbs C per acre-foot	'68	31.9	41.5	70.4
-do-	'69	28.0	37.4	62.4

Table 24

Distribution of elemental CALCIUM in major components of a largestream impoundments

BARTLETT'S FERRY RESERVOIR

	1968	1969
Ratio of Ca - soluble to suspended matter in water		
Input - Chattahoochee River	1:0.04	1:0.04
Output - Bartlett's Ferry Dam	1:0.04	1:0.05
Average total Ca concentration in water, ppm	2.62	2.55
Total Ca - lbs per mi^2 drainage area, April-October		
Input - Chattahoochee River	2,528.0	2,512.0
Output - Bartlett's Ferry Dam	2,346.0	2,488.0
Hydrosol - Total Ca concentration in sample, ppm	2,508.0	4,466.0
Total lbs Ca per acre in 0.01 inch	4.34	4.85
Fish - Total standing crop - lbs per acre	190.0	190.0
Average concentration Ca, per cent	37.2	37.2
Total lbs Ca per acre	18.7	18.7

Aquatic plants

Species	Year	Acres	Wet weight lbs per acre	Ca content, per cent	Pounds Ca per acre
Waterwillow		0.5	30,000	15.4	92.4

LAKE EUFAULA

	1968	1969
Ratio of Ca - soluble to suspended matter in water		
Input - Upper region	1:0.02	1:0.03
Middle region	1:0.02	1:0.04
Lower region	1:0.03	1:0.04
Average total Ca concentration in water, ppm		
Upper region	5.07	4.22
Middle region	5.38	3.52
Lower region	4.34	3.92
Total Ca - lbs per mi^2 drainage area, April - October		
Input - Upper region	2,605.0	4,076.0
Middle region	2,919.0	3,227.0
Lower region	3,358.0	3,783.0
Output - Walter F. George Dam	3,698.0	2,432.0
Hydrosol - Total Ca concentration in sample, ppm		
Upper region	2,749.0	2,923.0
Middle region	1,820.0	1,693.0
Lower region	7,344.0	1,680.0
Pounds total Ca per acre in 0.01 inch		
Upper region	8.1	8.2
Middle region	5.4	5.1
Lower region	21.7	5.0
Fish - Total standing crop - lbs per acre	190.0	190.0
Average concentration Ca, per cent	37.1	37.1
Total lbs Ca per acre	18.6	18.6

Aquatic plants

Species	Year	Acres	Wet weight lbs per acre	Ca content per cent	Pounds Ca per acre
Allignatorweed	'68	1	150,000	.71	88.0
-do-	'69	5	150,000	.68	84.3

Table 24 Continued

<u>LAKE SEMINOLE</u> (Calcium continued)

	1968	1969
Ratio of Ca - soluble to suspended matter in water		
Input - Chattahoochee River arm	1:0.02	1:0.02
Flint River arm	1:0.01	1:0.01
Spring Creek arm	1:0.01	1:0.01
Average total Ca concentration in water, ppm		
Chattahoochee River arm	6.27	7.51
Flint River arm	12.60	14.77
Spring Creek arm	20.17	20.56
Total Ca - lbs per mi^2 drainage area, April-October		
Input - Chattahoochee River arm	6,427.0	7,826.0
Flint River arm	10,742.0	15,590.0
Spring Creek arm	16,295.0	20,525.0
Output - Chattahoochee River arm	10,360.0	7,163.0
Flint River arm	11,719.0	6,780.0
Hydrosol - Total Ca concentration in sample, ppm		
Chattahoochee River arm		2,478.0
Flint River arm	2,625.0	1,520.0
Spring Creek arm	8,480.0	1,200.0
Pounds total Ca per acre in 0.01 inch		
Chattahoochee River arm	5.3	4.5
Flint River arm	8.36	9.45
Spring Creek arm	25.0	0.39
Fish - Total standing crop - lbs per acre	210.0	210.0
Average concentration Ca - per cent	37.1	37.1
Total lbs Ca per acre	20.25	20.25

Aquatic plants

Species	Year	Acres	Wet weight lbs per acre	Ca content per cent	Pounds Ca per acre
Alligatorweed	'68	250	155,000	2.02	250.5
-do-	'69	100	155,000	1.56	193.4
Waterhyacinth	'68	100	143,000	1.56	155.6
-do-	'69	260	143,000	1.03	117.8
Eurasian milfoil	'68	2,000		2.59	25.9
-do-	'69	2,000		9.25	92.5
Giant cutgrass	'68	400	31,000	.42	33.7
-do-	'69	450	31,000	.20	16.1
Others	'68	500	30,000	2.02	121.2
-do-	'69	500	30,000	2.00	120.0

The averaged summertime standing crop of Ca in each aquatic environment component (including the 0.01 inch layer hydrosol) for the 3 impoundments are given below.

Component	Year	Bartlett's Ferry Reservoir (lbs)	Lake Eufaula (lbs)	Lake Seminole (lbs)
Water + suspended matter	'68	1,038,375	11,966,470	13,237,550
-do-	'69	1,010,587	9,645,280	11,954,860
Hydrosol	'68	25,389	468,520	380,850
-do-	'69	28,372	246,067	200,050
Fish	'68	109,395	837,000	708,750
-do-	'69	109,395	837,000	708,750
Aquatic plants	'68	46	88	204,065
-do-	'69	46	421	302,213
Total	'68	1,[illegible]73,205	13,452,078	14,567,215
-do-	'69	1,1[illegible],400	10,728,768	13,165,873
Lbs per acre	'68	[illegible],005	2,989	4,162
-do-	'69	1,[illegible]63	2,384	3,762
Lbs per acre-foot	'68	80.2	149.4	442.7
-do-	'69	78.5	119.2	400.2

Table 25

Distribution of elemental STRONTIUM in major components of 3 largestream impoundments

BARTLETT'S FERRY RESERVOIR

	1968	1969
Average total Sr concentration in suspended matter, ppm	.0008	.0015
Total Sr - lbs per mi^2 drainage area, April-October		
Input - Chattahoochee River	.50	1.12
Output - Bartlett's Ferry Dam	.63	1.36
Hydrosol - Total Sr concentration in sample, ppm	16.2	29.0
Total lbs Sr per acre in 0.01 inch	.05	.083
Fish - Total standing crop - lbs per acre	190.0	190.0
Average concentration Sr, ppm	16.6	16.6
Total lbs Sr per acre	.0008	.0008

Aquatic plants

Species	Year	Acres	Wet weight lbs per acre	Sr content ppm	Pounds Sr per acre
Waterwillow	'68	0.5	30,000	6.2	.037
-do-	'69	0.5	30,000	6.2	.037

LAKE EUFAULA

	1968	1969
Average total Sr concentration in suspended matter, ppm		
Upper region	.0008	.0018
Middle region	.0008	.0012
Lower region	.0009	.0011
Total Sr - lbs per mi^2 drainage area, April-October		
Input - Upper region	.86	1.81
Middle region	.70	1.29
Lower region	.60	.97
Output - Walter F. George Dam	.71	
Hydrosol - Total Sr concentration in sample, ppm		
Upper region	18.8	18.1
Middle region	16.5	25.3
Lower region	18.2	28.5
Pounds total Sr per acre in 0.01 inch		
Upper region	.05	.05
Middle region	.04	.07
Lower region	.05	.08
Fish - Total standing crop - lbs per acre	190.0	190.0
Average concentration Sr, ppm	16.6	16.6
Total lbs Sr per acre	.0008	.0008

Aquatic plants

Species	Year	Acres	Wet weight lbs per acre	Sr content ppm	Pounds Sr per acre
Alligatorweed	'68	1	150,000	6.6	.079
-do-	'69	5	150,000	26.0	.312

Table 25 Continued

LAKE SEMINOLE (Strontium continued)

	1968	1969
Average total Sr concentration in suspended matter, ppm		
Chattahoochee River arm	.0008	.0014
Flint River arm	.0010	.0012
Spring Creek arm	.0008	.0014
Total Sr - lbs per mi^2 drainage area, April-October		
Input - Chattahoochee River arm	1.20	1.89
Flint River arm	1.50	.98
Spring Creek arm	.08	.92
Output - Chattahoochee River arm	.37	
Flint River arm	.61	
Hydrosol - Total Sr concentration in sample, ppm		
Chattahoochee River arm		30.0
Flint River arm	13.3	24.1
Spring Creek arm	19.1	22.0
Pounds total Sr per acre in 0.01 inch		
Chattahoochee River arm	.02	.09
Flint River arm	.04	.07
Spring Creek arm	.05	.01
Fish - Total standing crop - lbs per acre	210.0	210.0
Average concentration Sr, ppm	16.6	16.6
Total lbs Sr per acre	.0009	.0009

Aquatic plants

Species	Year	Acres	Wet weight lbs per acre	Sr content ppm	Pounds Sr per acre
Alligatorweed	'68	250	155,000	15.0	.186
-do-	'69	100	155,000	22.1	.273
Waterhyacinth	'68	100	143,000	9.3	.106
-do-	'69	260	143,000	16.8	.192
Eurasian milfoil	'68	2,000		15.0	.150
-do-	'69	2,000		24.0	.240
Giant cutgrass	'68	400	31,000	1.5	.012
-do-	'69	450	31,000	2.0	.016
Others	'68	500	30,000	16.6	.100
-do-	'69	500	30,000	16.6	.100

The averaged summertime standing crop of Sr in each aquatic environment component (including the 0.01 inch layer hydrosol) for the 3 impoundments are given below.

Component	Year	Bartlett's Ferry Reservoir (lbs)	Lake Eufaula (lbs)	Lake Seminole (lbs)
Water + suspended matter	'68	292.50	2,134.28	802.29
-do-	'69	585.00	2,181.04	1,186.28
Hydrosol	'68	292.50	2,092.25	1,225.00
-do-	'69	485.55	3,232.70	2,305.00
Fish	'68	4.68	36.00	31.50
-do-	'69	4.68	36.00	31.50
Aquatic plants	'68	.018	.079	411.90
-do-	'69	.018	1.560	614.42
Total	'68	589.698	5,262.609	2,470.69
-do-	'69	1,075.248	6,451.300	4,137.20
Lbs Sr per acre	'68	.1008	1.1695	.7059
-do-	'69	.1838	1.4336	1.1821
Lbs Sr per acre - foot	'68	.0040	.0585	.0751
-do-	'69	.0074	.0717	.1257

Table 26

Distribution of elemental MAGNESIUM in major components of a largestream impoundments

<u>BARTLETT'S FERRY RESERVOIR</u>

	1968	1969
Ratio of Mg - soluble to suspended matter in water		
Input - Chattahoochee River	1:0.04	1:0.05
Output - Bartlett's Ferry Dam	1:0.04	1:0.05
Average total Mg concentration in water, ppm	1.202	1.240
Total Mg - lbs per mi^2 drainage area, April-October		
Input - Chattahoochee River	1,237.0	1,157.0
Output - Bartlett's Ferry Dam	1,038.0	1,113.0
Hydrosol - Total Mg concentration in sample, ppm	3,503.0	3,840.0
Total lbs Mg per acre in 0.01 inch	9.71	11.62
Fish - Total standing crop - lbs per acre	190.0	190.0
Average concentration Mg, per cent	0.22	0.22
Total lbs Mg per acre	0.11	0.11

Aquatic plants

Species	Year	Acres	Wet weight lbs per acre	Mg content per cent	Pounds Mg per acre
Waterwillow		0.5	30,000	.73	43.8

<u>LAKE EUFAULA</u>

	1968	1969
Ratio of Mg - soluble to suspended matter in water		
Input - Upper region	1:0.04	1:0.04
Middle region	1:0.04	1:0.04
Lower region	1:0.02	1:0.04
Average total Mg concentration in water, ppm		
Upper region	1.255	1.326
Middle region	1.322	1.208
Lower region	1.383	1.180
Total Mg - lbs per mi^2 drainage area, April-October		
Input - Upper region	1,198.0	1,337.0
Middle region	1,146.0	1,423.0
Lower region	1,224.0	1,249.0
Output - Walter F. George Dam	1,191.0	1,214.0
Hydrosol - Total Mg concentration in sample, ppm		
Upper region	3,438.0	3,151.0
Middle region	2,397.0	3,067.0
Lower region	1,768.0	3,400.0
Pounds total Mg per acre in 0.01 inch		
Upper region	10.1	8.9
Middle region	7.1	9.0
Lower region	5.2	10.0
Fish - Total standing crop - lbs per acre	190.0	190.0
Average concentration Mg, per cent	0.22	0.22
Total lbs Mg per acre	0.11	0.11

Aquatic plants

Species	Year	Acres	Wet weight lbs per acre	Mg content per cent	Pounds Mg per acre
Alligatorweed	'68	1	150,000	.37	45.8
-do-	'69	5	150,000	.37	45.8

Table 26 Continued

LAKE SEMINOLE (Magnesium continued)

	1968	1969
Ratio of Mg - soluble to suspended matter in water		
Input - Chattahoochee River arm	1:0.05	1:0.06
Flint River arm	1:0.27	1:0.04
Spring Creek arm	1:0.15	1:0.05
Average total Mg concentration in water, ppm		
Chattahoochee River arm	1.275	.844
Flint River arm	1.147	.955
Spring Creek arm	.761	.975
Total Mg - lbs per mi^2 drainage area, April-October		
Input - Chattahoochee River arm	1,558.0	1,108.0
Flint River arm	903.0	804.0
Spring Creek arm	53.0	635.0
Output - Chattahoochee River arm	1,554.0	971.0
Flint River arm	945.0	685.0
Hydrosol - Total Mg concentration in sample, ppm		
Chattahoochee River arm		1,720.0
Flint River arm	1,304.0	2,301.0
Spring Creek arm	626.0	312.0
Pounds total Mg per acre in 0.01 inch		
Chattahoochee River arm	3.4	4.4
Flint River arm	3.84	4.85
Spring Creek arm	1.85	1.00
Fish - Total standing crop - lbs per acre	210.0	210.0
Average concentration Mg - per cent	0.22	0.22
Total lbs Mg per acre	0.12	0.12

Aquatic plants

Species	Year	Acres	Wet weight lbs per acre	Mg content per cent	Pounds Mg per acre
Alligatorweed	'68	250	155,000	.64	78.4
-do-	'69	100	155,000	.21	26.0
Waterhyacinth	'68	100	143,000	.61	69.8
-do-	'69	260	143,000	.31	35.5
Eurasian milfoil	'68	2,000		.12	12.0
-do-	'69	2,000		.04	4.0
Giant cutgrass	'68	400	31,000	.10	8.1
-do-	'69	450	31,000	.07	5.6
Others	'68	500	30,000	.27	16.2
-do-	'69	500	30,000	.27	16.2

The averaged summertime standing crop of Mg in each aquatic environment component (including the 0.01 inch layer hydrosol) for the 3 impoundments are given below.

Component	Year	Bartlett's Ferry Reservoir (lbs)	Lake Eufaula (lbs)	Lake Seminole (lbs
Water + suspended matter	'68	476,775	3,350,610	1,002,040
-do-	'69	491,400	3,060,260	829,550
Hydrosol	'68	56,803	291,750	114,500
-do-	'69	67,977	425,258	136,500
Fish	'68	643	3,850	5,400
-do-	'69	643	3,850	5,400
Aquatic plants	'68	25,272	46	619,200
-do-	'69	25,272	275	304,500
Total	'68	559,493	3,779,764	1,741,140
-do-	'69	585,292	3,489,643	1,275,950
Lbs Mg per acre	'68	956	840	497
-do-	'69	1,000	775	365
Lbs Mg per acre - foot	'68	47.8	42.0	52.8
-do-	'69	50.0	38.7	38.8

Table 27

Distribution of elemental SODIUM in major components of 3 largestream impoundments

BARTLETT'S FERRY RESERVOIR

	1968	1969
Ratio of Na - soluble to suspended matter in water		
Input - Chattahoochee River	1:0.01	1:0.01
Output - Bartlett's Ferry Dam	1:0.01	1:0.02
Average total Na concentration in water, ppm	5.67	4.52
Total Na - lbs per mi^2 drainage area, April-October		
Input - Chattahoochee River	8,906.0	1,615.0
Output - Bartlett's Ferry Dam	4,413.0	2,192.0
Hydrosol - Total Na concentration in sample, ppm	1,383.0	1,646.0
Total lbs Na per acre in 0.01 inch	4.9	6.94
Fish - Total standing crop - lbs per acre	190.0	190.0
Average concentration Na, per cent	0.36	0.36
Total lbs Na per acre	0.18	0.18

Aquatic plants

Species	Year	Acres	Wet weight lbs per acre	Na content per cent	Pounds Na per acre
Waterwillow		0.5	30,000	.29	17.4

LAKE EUFAULA

	1968	1969
Ratio of Na - soluble to suspended matter in water		
Input - Upper region	1:0.01	1:0.02
Middle region	1:0.01	1:0.02
Lower region	1:0.02	1:0.03
Average total Na concentration in water, ppm		
Upper region	6.100	5.299
Middle region	5.764	5.756
Lower region	5.044	3.849
Total Na - lbs per mi^2 drainage area, April-October		
Input - Upper region	4,314.0	2,027.0
Middle region	5,628.0	2,604.0
Lower region	5,216.0	2,184.0
Output - Walter F. George Dam	4,217.0	1,951.0
Hydrosol - Total Na concentration in sample, ppm		
Upper region	4,399.0	3,400.0
Middle region	1,393.0	1,607.0
Lower region	3,008.0	1,340.0
Pounds total Na per acre in 0.01 inch		
Upper region	6.7	9.5
Middle region	4.1	4.7
Lower region	8.8	4.0
Fish - Total standing crop - lbs per acre	190.0	190.0
Average concentration Na, per cent	0.36	0.36
Total lbs Na per acre	0.18	0.18

Aquatic plants

Species	Year	Acres	Wet weight lbs per acre	Na content per cent	Pounds Na per acre
Alligatorweed	'68	1	150,000	.09	10.8
-do-	'69	5	150,000	.12	14.4

Table 27 Continued

LAKE SEMINOLE (Sodium continued)

	1968	1969
Ratio of Na - soluble to suspended matter in water		
Input - Chattahoochee River arm	1:0.01	1:0.01
Flint River arm	1:0.02	1:0.03
Spring Creek arm	1:0.03	1:0.05
Average total Na concentration in water, ppm		
Chattahoochee River arm	5.63	5.72
Flint River arm	4.33	3.38
Spring Creek arm	2.57	1.60
Total Na - lbs per mi^2 drainage area, April-October		
Input - Chattahoochee River arm	6,072.0	2,438.0
Flint River arm	3,761.0	1,119.0
Spring Creek arm	1,665.0	1,740.0
Output - Chattahoochee River arm	6,450.0	2,060.0
Flint River arm	3,515.0	1,003.0
Hydrosol - Total Na concentration in sample, ppm		
Chattahoochee River arm		760.0
Flint River arm	2,200.0	1,880.0
Spring Creek arm	1,153.0	3,040.0
Pounds total Na per acre in 0.01 inch		
Chattahoochee River arm	6.2	2.25
Flint River arm	6.5	5.51
Spring Creek arm	3.4	0.98
Fish - Total standing crop - lbs per acre	210.0	210.0
Average concentration Na - per cent	.36	.36
Total lbs Na per acre	[illegible]	[illegible]

Aquatic plants

Species	Year	Acres	Wet weight lbs per acre	Na content per cent	Pounds Na per acre
Alligatorweed	'68	250	155,000	.53	65.7
-do-	'69	100	155,000	.39	48.3
Waterhyacinth	'68	100	144,000	.44	50.7
-do-	'69	260	144,000	.24	27.6
Eurasian milfoil	'68	2,000		.51	51.0
-do-	'69	2,000		.32	32.0
Giant cutgrass	'68	400	31,000	.15	12.1
-do-	'69	450	31,000	.05	4.0
Others	'68	500	30,000	.39	23.4
-do-	'69	500	30,000	.39	23.4

The averaged summertime standing crop of Na in each aquatic environment component (including the 0.01 inch layer hydrosol) for the 3 impoundments are given below.

Component	Year	Bartlett's Ferry Reservoir (lbs)	Lake Eufaula (lbs)	Lake Seminole (lbs)
Water + suspended matter	'68	2,223,000	13,650,880	4,010,040
-do-	'69	1,784,250	11,756,160	3,510,430
Hydrosol	'68	28,665	312,716	203,450
-do-	'69	40,599	225,183	117,620
Fish	'68	1,053	8,100	7,000
-do-	'69	1,053	8,100	7,000
Aquatic plants	'68	8.7	10.8	140,035
-do-	'69	8.7	72.0	89,506
Total	'68	2,252,726	13,971,707	4,360,525
-do-	'69	1,825,910	11,989,515	3,724,556
Lbs Na per acre	'68	385.1	310.5	124.6
-do-	'69	312.1	266.4	106.4
Lbs Na per acre -foot	'68	15.4	15.5	13.2
-do-	'69	12.5	13.3	11.3

Table 28

Distribution of elemental IRON in major components of 3 largestream impoundments

BARTLETT'S FERRY RESERVOIR

	1968	1969
Ratio of Fe - soluble to suspended matter in water		
Input - Chattahoochee River	1:2.6	1:2.9
Output - Bartlett's Ferry Dam	1:3.5	1:2.6
Average total Fe concentration in water, ppm	0.870	0.956
Total Fe - lbs per mi^2 drainage area, April-October		
Input - Chattahoochee River	921.0	933.0
Output - Bartlett's Ferry Dam	837.0	847.0
Hydrosol - Total Fe concentration in sample, ppm	29,028.0	44,447.0
Total lbs Fe per acre in 0.01 inch	91.3	138.8
Fish - Total standing crop - lbs per acre	190.0	190.0
Average concentration Fe, per cent	.098	.49
Total lbs Fe per acre	.49	.49

Aquatic plants

Species	Year	Acres	Wet weight lbs per acre	Fe content per cent	Pounds Fe per acre
Waterwillow		0.5	30,000	.07	4.2

LAKE EUFAULA

	1968	1969
Ratio of Fe - soluble to suspended matter in water		
Input - Upper region	1:5.7	1:1.70
Middle region	1:4.27	1:2.00
Lower region	1:2.80	1:1.95
Average total Fe concentration in water, ppm		
Upper region	.665	.848
Middle region	.596	.804
Lower region	.574	.735
Total Fe - lbs per mi^2 drainage area, April-Octobe		
Input - Upper region	726.0	854.0
Middle region	572.0	850.0
Lower region	416.0	943.0
Output - Walter F. George Dam	449.0	489.0
Hydrosol - Total Fe concentration in sample, ppm		
Upper region	23,506.0	36,505.0
Middle region	31,610.0	40,300.0
Lower region	26,200.0	42,450.0
Pounds total Fe per acre in 0.01 inch		
Upper region	69.0	103.0
Middle region	93.5	110.0
Lower region	77.7	125.0
Fish - Total standing crop - lbs per acre	190.0	190.0
Average concentration Fe, per cent	.098	.098
Total lbs Fe per acre	.49	.49

Aquatic plants

Species	Year	Acres	Wet weight lbs per acre	Fe content per cent	Pounds Fe per acre
Alligatorweed	'68	1	150,000	.16	19.2
-do-	'69	5	150,000	.16	19.2

Table 28 Continued

Lake Seminole (Iron continued)

	1968	1969
Ratio of Fe - soluble to suspended matter in water		
Input - Chattahoochee River arm	1:1.80	1:1.53
Flint River arm	1:0.94	1:1.80
Spring Creek arm	1:1.47	1:3.04
Average total Fe concentration in water, ppm		
Chattahoochee River arm	.739	.785
Flint River arm	.771	.727
Spring Creek arm	.230	.311
Total Fe - lbs per mi^2 drainage area, April-October		
Input - Chattahoochee River arm	677.0	801.0
Flint River arm	312.0	22.7
Spring Creek arm	161.0	16.4
Output - Chattahoochee River arm	774.0	1,117.0
Flint River arm	453.0	92.5
Hydrosol - Total Fe concentration in sample, ppm		
Chattahoochee River arm		31,200.0
Flint River arm	14,460.0	33,733.0
Spring Creek arm	14,030.0	20,000.0
Pounds total Fe per acre in 0.01 inch		
Chattahoochee River arm	15.8	92.0
Flint River arm	42.7	100.0
Spring Creek arm	41.5	6.4
Fish - Total standing crop - lbs per acre	210.0	210.0
Average concentration Fe - per cent	.098	.098
Total lbs Fe per acre	.54	.54

Aquatic plants

Species	Year	Acres	Wet weight lbs per acre	Fe content per cent	Pounds Fe per acre
Alligatorweed	'68	250	155,000	.20	24.8
-do-	'69	100	155,000	.37	45.9
Waterhyacinth	'68	100	143,000	.26	30.0
-do-	'69	260	143,000	.37	42.6
Eurasian milfoil	'68	2,000		.29	29.0
-do-	'69	2,000		.24	24.0
Giant cutgrass	'68	400	31,000	.20	16.1
-do-	'69	450	31,000	.08	6.4
Others	'68	500	30,000	.28	16.8
-do-	'69	500	30,000	.28	16.8

The averaged summertime standing crop of Fe in each aquatic environment component (including the 0.01 inch layer hydrosol) for the 3 impoundments are given below.

Component	Year	Bartlett's Ferry Reservoir (lbs)	Lake Eufaula (lbs)	Lake Seminole (lbs)
Water + suspended matter	'68	345,150	1,502,544	1,219,608
-do-	'69	378,787	1,949,411	1,312,422
Hydrosol	'68	534,105	3,636,284	1,143,700
-do-	'69	811,980	5,352,663	2,740,000
Fish	'68	286.7	22,050	18,900
-do-	'69	286.7	22,050	18,900
Aquatic plants	'68	2.1	19.2	82,040
-do-	'69	2.1	96.0	74,946
Total	'68	879,543	5,160,897	2,464,248
-do-	'69	1,191,055	7,324,220	4,146,268
Lbs Fe per acre	'68	150.3	114.7	70.4
-do-	'69	203.6	162.8	118.5
Lbs Fe per acre-foot	'68	6.0	5.73	7.49
-do-	'69	8.14	8.14	12.61

Table 29

Distribution of elemental MANGANESE in major components of 3 largestream impoundments

BARTLETT'S FERRY RESERVOIR

	1968	1969
Ratio of Mn - soluble to suspended matter in water		
Input - Chattahoochee River	1:1.05	1:0.87
Output - Bartlett's Ferry Dam	1:0.41	1:1.32
Average total Mn concentration in water, ppm	.176	.113
Total Mn - lbs per mi^2 drainage area, April-October		
Input - Chattahoochee River	134.0	141.0
Output - Bartlett's Ferry Dam	202.0	70.0
Hydrosol - Total Mn concentration in sample, ppm	966.0	1,410.0
Total lbs Mn per acre in 0.01 inch	2.78	2.9
Fish - Total standing crop - lbs per acre	190.0	190.0
Average concentration Mn, per cent	0.016	0.016
Total lbs Mn per acre	.008	

Aquatic plants

Species	Year	Acres	Wet weight lbs per acre	Mn content per cent	Pounds Mn per acre
Waterwillow		0.5	30,000	.052	3.12

LAKE EUFAULA

	1968	1969
Ratio of Mn - soluble to suspended matter in water		
Input - Upper region	1:3.5	1:2.8
Middle region	1:0.58	1:4.7
Lower region	1:0.65	1:1.73
Average total Mn concentration in water, ppm		
Upper region	.094	.113
Middle region	.161	.119
Lower region	.178	.164
Total Mn - lbs per mi^2 drainage area, April-October		
Input - Upper region	94.0	138.0
Middle region	58.0	182.0
Lower region	142.0	121.0
Output - Walter F. George Dam	119.0	174.0
Hydrosol - Total Mn concentration in sample, ppm		
Upper region	1,406.0	1,799.0
Middle region	1,793.0	2,047.0
Lower region	1,020.0	1,893.0
Pounds total Mn per acre in 0.01 inch		
Upper region	4.1	5.1
Middle region	5.3	6.0
Lower region	3.0	5.6
Fish - Total standing crop - lbs per acre	190.0	190.0
Average concentration Mn, per cent	0.016	0.016
Total lbs Mn per acre	.008	

Aquatic plants

Species	Year	Acres	Wet weight lbs per acre	Mn content per cent	Pounds Mn per acre
Alligatorweed	'68	1	150,000	.053	6.36
-do-	'69	5	150,000	.092	11.04

Table 29 Continued

LAKE SEMINOLE (Manganese continued)

	1968	1969
Ratio of Mn - soluble to suspended matter in water		
Input - Chattahoochee River arm	1:3.4	1:1.78
Flint River arm	1:1.4	1:3.3
Spring Creek arm	1:0.65	1:3.0
Average total Mn concentration in water, ppm		
Chattahoochee River arm	.106	.089
Flint River arm	.103	.086
Spring Creek arm	.097	.056
Total Mn - lbs per mi^2 drainage area, April-October		
Input - Chattahoochee River arm	134.0	105.0
Flint River arm	38.0	60.0
Spring Creek arm	75.0	34.0
Output - Chattahoochee River arm	120.0	103.0
Flint River arm	80.0	40.0
Hydrosol - Total Mn concentration in sample, ppm		
Chattahoochee River arm		1,690.0
Flint River arm	813.0	2,149.0
Spring Creek arm	1,576.0	760.0
Pounds total Mn per acre in 0.01 inch		
Chattahoochee River arm	1.95	5.0
Flint River arm	2.41	3.46
Spring Creek arm	4.67	0.24
Fish - Total standing crop - lbs per acre	210.0	210.0
Average concentration Mn - per cent	0.016	0.016
Total lbs Mn per acre	0.008	0.008

Aquatic plants

Species	Year	Acres	Wet weight lbs per acre	Mn content per cent	Pounds Mn per acre
Alligatorweed	'68	250	155,000	.15	18.6
-do-	'69	100	155,000	.09	11.2
Waterhyacinth	'68	100	143,000	.11	12.6
-do-	'69	260	143,000	.20	22.9
Eurasian milfoil	'68	2,000		.19	19.0
-do-	'69	2,000		.08	8.0
Giant cutgrass	'68	400	31,000	.049	3.9
-do-	'69	450	31,000	.086	6.9
Others	'68	500	30,000	.18	10.8
-do-	'69	500	30,000	.19	11.4

The averaged summertime standing crop of Mn in each aquatic environment component (including the 0.01 inch layer hydrosol) for the 3 impoundments are given below.

Component	Year	Bartlett's Ferry Reservoir (lbs)	Lake Eufaula (lbs)	Lake Seminole (lbs)
Water + suspended matter	'68	69,761.25	395,897.0	92,989.5
-do-	'69	44,752.50	354,014.4	73,056.8
Hydrosol	'68	16,263.0	173,833.6	96,295.0
-do-	'69	16,965.0	252,481.8	118,970.0
Fish	'68	46.8	360.0	280.0
-do-	'69	46.8	360.0	280.0
Aquatic plants	'68	1.56	6.36	50,870.0
-do-	'69	1.56	55.20	31,879.0
Total	'68	86,072.61	570,096.96	240,434.5
-do-	'69	61,765.86	606,911.40	224,185.8
Lbs Mn per acre	'68	14.713	12.669	6.869
-do-	'69	10.558	13.487	6.405
Lbs Mn per acre - foot	'68	.588	.633	.731
-do-	'69	.422	.674	.681

Table 30

Distribution of elemental ZINC in major components of 3 largestream impoundments

BARTLETT'S FERRY RESERVOIR

	1968	1969
Ratio of Zn - soluble to suspended matter in water		
Input - Chattahoochee River	1:0.37	1:0.38
Output - Bartlett's Ferry Dam	1:0.37	1:0.15
Average total Zn concentration in water, ppm	0.1913	0.1071
Total Zn - lbs per mi^2 drainage area, April-October		
Input - Chattahoochee River	134.0	81.0
Output - Bartlett's Ferry Dam	149.0	112.0
Hydrosol - Total Zn concentration in sample, ppm	460.0	113.0
Total lbs Zn per acre in 0.01 inch	1.45	1.33
Fish - Total standing crop - lbs per acre	190.0	190.0
Average concentration Zn, per cent	0.02	0.02
Total lbs Zn per acre	0.01	0.01

Aquatic plants

Species	Year	Acres	Wet weight lbs per acre	Zn content per cent	Pounds Zn per acre
Waterwillow		0.5	30,000	.016	0.96

LAKE EUFAULA

	1968	1969
Ratio of Zn - soluble to suspended matter in water		
Input - Upper region	1:0.27	1:0.5
Middle region	1:0.26	1:0.63
Lower region	1:0.23	1:0.74
Average total Zn concentration in water, ppm		
Upper region	.2089	.0765
Middle region	.2176	.0752
Lower region	.2356	.0600
Total Zn - lbs per mi^2 drainage area, April-October		
Input - Upper region	200.0	245.0
Middle region	113.0	506.0
Lower region	145.0	347.0
Output - Walter F. George Dam	58.0	343.0
Hydrosol - Total Zn concentration in sample, ppm		
Upper region	651.0	445.0
Middle region	301.0	221.0
Lower region	627.0	36.0
Pounds total Zn per acre in 0.01 inch		
Upper region	1.92	1.25
Middle region	.89	.65
Lower region	1.85	.10
Fish - Total standing crop - lbs per acre	190.0	190.0
Average concentration Zn, per cent	0.02	0.02
Total lbs Zn per acre	0.01	0.01

Aquatic plants

Species	Year	Acres	Wet weight lbs per acre	Zn content per cent	Pounds Zn per acre
Alligatorweed	'68	1	150,000	.017	2.04
-do-	'69	5	150,000	.017	2.04

Table 30 Continued

LAKE SEMINOLE (Zinc continued)

	1968	1969
Ratio of Zn - soluble to suspended matter in water		
Input - Chattahoochee River arm	1:0.33	1:0.42
Flint River arm	1:0.21	1:0.46
Spring Creek arm	1:0.31	1:1.75
Average total Zn concentration in water, ppm		
Chattahoochee River arm	.2318	.0608
Flint River arm	.3382	.0827
Spring Creek arm	.1731	.0228
Total Zn - lbs per mi^2 drainage area, April-October		
Input - Chattahoochee River arm	383.0	36.0
Flint River arm	373.0	102.0
Spring Creek arm	112.0	15.0
Output - Chattahoochee River arm	184.0	106.0
Flint River arm	180.0	69.0
Hydrosol - Total Zn concentration in sample, ppm		
Chattahoochee River arm		28.0
Flint River arm	506.0	99.0
Spring Creek arm	685.0	286.0
Pounds total Zn per acre in 0.01 inch		
Chattahoochee River arm	1.76	.08
Flint River arm	1.50	.29
Spring Creek arm	2.02	.09
Fish - Total standing crop - lbs per acre	210.0	210.0
Average concentration Zn - per cent	0.02	0.02
Total lbs Zn per acre	.01	.01

Aquatic plants

Species	Year	Acres	Wet weight lbs per acre	Zn content per cent	Pounds Zn per acre
Alligatorweed	'68	250	155,000	.016	1.98
-do-	'69	100	155,000	.020	2.48
Waterhyacinth	'68	100	143,000	.013	1.48
-do-	'69	260	143,000	.030	3.43
Eurasian milfoil	'68	2,000		.013	1.3
-do-	'69	2,000		.017	1.7
Giant cutgrass	'68	400	31,000	.013	1.04
-do-	'69	450	31,000	.004	.32
Others	'68	500	30,000	.019	1.14
-do-	'69	500	30,000	.019	1.14

The averaged summertime standing crop of Zn in each aquatic environment component (including the 0.01 inch layer hydrosol) for the 3 impoundments are given below.

Component	Year	Bartlett's Ferry Reservoir (lbs)	Lake Eufaula (lbs)	Lake Seminole (lbs)
Water + suspended matter	'68	85,081.5	565,406.4	237,608.5
-do-	'69	47,632.5	169,960.3	55,849.7
Hydrosol	'68	8,482.5	69,542.5	60,660.0
-do-	'69	7,780.5	19,893.0	5,960.0
Fish	'68	58.5	450.0	350.0
-do-	'69	58.5	450.0	350.0
Aquatic plants	'68	0.48	2.04	4,229.0
-do-	'69	0.48	10.2	5,253.8
Total	'68	93,623.0	635,400.9	302,847.5
-do-	'69	55,472.0	190,313.5	67,404.5
Lbs Zn per acre	'68	16.004	14.120	8.652
-do-	'69	9.482	4.229	1.926
Lbs Zn per acre - foot	'68	.640	.706	.920
-do-	'69	.379	.211	.205

Table 31

Distribution of elemental COPPER in major components of 3 largestream impoundments

BARTLETT'S FERRY RESERVOIR

	1968	1969
Ratio of Cu - soluble to suspended matter in water		
Input - Chattahoochee River	1:1.19	1:1.46
Output - Bartlett's Ferry Dam	1:0.61	1:0.94
Average total Cu concentration in water, ppm	.0388	0.1235
Total Cu - lbs per mi^2 drainage area, April-October		
Input - Chattahoochee River	34.5	101.0
Output - Bartlett's Ferry Dam	34.7	126.0
Hydrosol - Total Cu concentration in sample, ppm	97.0	128.0
Total lbs Cu per acre in 0.01 inch	0.177	0.453
Fish - Total standing crop - lbs per acre	190.0	190.0
Average concentration Cu, per cent	0.013	0.013
Total lbs Cu per acre	0.006	0.006

Aquatic plants

Species	Year	Acres	Wet weight lbs per acre	Cu content per cent	Pounds Cu per acre
Waterwillow		0.05	30,000	.01	0.6

LAKE EUFAULA

	1968	1969
Ratio of Cu - soluble to suspended matter in water		
Input - Upper region	1:1.63	1:1.71
Middle region	1:1.52	1:1.07
Lower region	1:1.96	1:0.23
Average total Cu concentration in water, ppm		
Upper region	.0365	.0768
Middle region	.0312	.0612
Lower region	.0317	.0874
Total Cu - lbs per mi^2 drainage area, April-October		
Input - Upper region	39.4	120.0
Middle region	41.9	768.0
Lower region	29.7	216.0
Output - Walter F. George Dam	28.7	318.0
Hydrosol - Total Cu concentration in sample, ppm		
Upper region	57.9	158.0
Middle region	44.3	229.3
Lower region	80.4	86.3
Pounds total Cu per acre in 0.01 inch		
Upper region	.17	.44
Middle region	.13	.68
Lower region	.23	.24
Fish - Total standing crop - lbs per acre	190.0	190.0
Average concentration Cu, per cent	0.013	0.013
Total lbs Cu per acre	0.006	0.006

Aquatic plants

Species	Year	Acres	Wet weight lbs per acre	Cu content per cent	Pounds Cu per acre
Alligatorweed	'68	1	150,000	.086	10.32
-do-	'69	5	150,000	.086	10.32

Table 31 Continued

LAKE SEMINOLE (Copper continued)

	1968	1969
Ratio of Cu - soluble to suspended matter in water		
Input - Chattahoochee River arm	1:0.7	1:1.04
Flint River arm	1:0.93	1:2.8
Spring Creek arm	1:1.05	1:0.5
Average total Cu concentration in water, ppm		
Chattahoochee River arm	.0323	.0621
Flint River arm	.0314	.0872
Spring Creek arm	.0314	.0482
Total Cu - lbs per mi^2 drainage area, April-October		
Input - Chattahoochee River arm	38.7	32.0
Flint River arm	24.4	33.0
Spring Creek arm	21.1	44.0
Output - Chattahoochee River arm	31.3	61.0
Flint River arm	39.2	73.0
Hydrosol - Total Cu concentration in sample, ppm		
Chattahoochee River arm		80.0
Flint River arm	122.0	152.0
Spring Creek arm	55.0	100.0
Pounds total Cu per acre in 0.01 inch		
Chattahoochee River arm	.24	.24
Flint River arm	.36	.31
Spring Creek arm	.16	.03
Fish - Total standing crop - lbs per acre	210.0	210.0
Average concentration Cu - per cent	0.013	0.013
Total lbs Cu per acre	.007	.007

Aquatic plants

Species	Year	Acres	Wet weight lbs per acre	Cu content per cent	Pounds Cu per acre
Alligatorweed	'68	250	155,000	.013	1.61
-do-	'69	100	155,000	.278	34.47
Waterhyacinth	'68	100	143,000	.01	1.14
-do-	'69	260	143,000	.20	22.88
Eurasian milfoil	'68	2,000		.022	2.2
-do-	'69	2,000		[illegible]	0.2
Giant cutgrass	'68	400	31,000	.0	.8
-do-	'69	[illegible]	31,000	.002	.16
Others	'68	500	[illegible]	.013	.78
-do-	'69	500	[illegible]	.013	.78

The averaged summertime standing crop of Cu in each aquatic environment component (including the 0.01 inch layer hydrosol) for the 3 impoundments are given below.

Component	Year	Bartletts Ferry Reservoir (lbs)	Lake Eufaula (lbs)	Lake Seminole (lbs)
Water + suspended matter	'68	15,356	81,577	28,745
-do-	'69	48,994	194,738	62,722
Hydrosol	'68	1,035	8,462	9,660
-do-	'69	2,650	18,269	7,960
Fish	'68	35.1	270	245
-do-	'69	35.1	270	245
Aquatic plants	'68	0.3	10.3	5,627
-do-	'69	0.3	51.5	10,258
Total	'68	16,426.4	90,319.3	44,277
-do-	'69	51,679.4	213,328.5	81,185
Lbs Cu per acre	'68	2.808	2.007	1.265
-do-	'69	8.834	4.740	2.319
Lbs Cu per acre - foot	'68	0.112	0.100	0.134
-do-	'69	0.353	0.237	0.247

Table 32

Distribution of elemental LEAD in major components of 3 largestream impoundments

BARTLETT'S FERRY RESERVOIR

	1968	1969
Average Pv concentration in suspended matter, ppm	.0103	.0111
Total Pb - lbs per mi^2 drainage area, April-October		
Input - Chattahoochee River	6.75	7.95
Output - Bartlett's Ferry Dam	8.92	11.08
Hydrosol - Total Pb concentration in sample, ppm	123.0	153.0
Total lbs Pb per acre in 0.01 inch	0.29	0.41
Fish - Total standing crop - lbs per acre	190.0	190.0
Average concentration Pb, ppm	13.5	13.5
Total lbs Pb per acre	0.0007	0.0007

Aquatic plants

Species	Year	Acres	Wet weight lbs per acre	Pb content ppm	Pounds Pb per acre
Waterwillow		0.5	30,000	28.0	.168

LAKE EUFAULA

	1968	1969
Average total Pb concentration in suspended matter, ppm		
Upper region	0.0100	0.0119
Middle region	0.0101	0.0106
Lower region	0.0098	0.0139
Total Pb - lbs per mi^2 drainage area, April-October		
Input - Upper region	16.40	14.27
Middle region	8.13	8.33
Lower region	9.00	12.87
Hydrosol - Total Pb concentration in sample, ppm		
Upper region	113.0	247.0
Middle region	91.0	229.0
Lower region	79.0	106.0
Pounds total Pb per acre in 0.01 inch		
Upper region	0.33	0.70
Middle region	0.27	0.67
Lower region	0.23	0.31
Fish - Total standing crop - lbs per acre	190.0	190.0
Average concentration Pb, ppm	13.5	13.5
Total lbs Pb per acre	0.0007	0.0007

Aquatic plants

Species	Year	Acres	Wet weight lbs per acre	Pb content ppm	Pounds Pb per acre
Alligatorweed	'68	1	150,000	117.0	1.45
-do-	'69	5	150,000	117.0	1.45

Table 32 Continued

LAKE SEMINOLE (Lead continued)

	1968	1969
Average total Pb concentration in suspended matter, ppm		
Chattahoochee River arm	.0084	.0091
Flint River arm	.0125	.0104
Spring Creek arm	.0142	.0107
Total Pb - lbs per mi^2 drainage area, April-October		
Input - Chattahoochee River arm	12.00	
Flint River arm	19.47	
Spring Creek arm	10.58	5.41
Output - Chattahoochee River arm	8.72	10.23
Flint River arm	3.48	8.90
Hydrosol - Total Pb concentration in sample, ppm		
Chattahoochee River arm		50.0
Flint River arm	135.0	135.0
Spring Creek arm	88.0	120.0
Pounds total Pb per acre in 0.01 inch		
Chattahoochee River arm	.30	.15
Flint River arm	.40	.47
Spring Creek arm	.26	.87
Fish - Total standing crop - lbs per acre	210.0	210.0
Average concentration Pb, ppm	13.5	13.5
Total lbs Pb per acre	.0007	.0007

Aquatic plants

Species	Year	Acres	Wet weight lbs per acre	Pb content ppm	Pounds Pb per acre
Alligatorweed	'68	250	155,000	34.0	.42
-do-	'69	100	155,000	54.0	.67
Waterhyacinth	'68	100	143,000	14.7	.168
-do-	'69	260	143,000	61.0	.698
Eurasian milfoil	'68	2,000		35.0	.35
-do-	'69	2,000		80.0	.80
Giant cutgrass	'68	400	31,000	12.0	.096
-do-	'69	450	31,000	12.0	.096
Others	'68	500	30,000	27.3	.164
-do-	'69	500	30,000	27.3	.164

The averaged summertime standing crop of Pb in each aquatic environment component (including the 0.01 inch layer hydrosol) for the 3 impoundments are given below.

Component	Year	Bartlett's Ferry Reservoir (lbs)	Lake Eufaula (lbs)	Lake Seminole (lbs)
Water + suspended matter	'68	4,080.37	25,020.9	10,201.82
-do-	'68	4,387.50	31,195.1	9,009.90
Hydrosol	'68	1,696.50	11,505.13	11,800.0
-do-	'69	2,398.50	21,530.65	15,365.0
Fish	'68	4.10	31.5	24.5
-do-	'69	4.10	31.5	24.5
Aquatic plants	'68	.084	1.45	942.20
-do-	'69	.084	7.25	1,973.68
Total	'68	5,781.054	36,558.98	22,968.52
-do-	'69	6,790.184	52,764.50	26,373.08
Lbs Pb per acre	'68	.988	.812	.656
-do-	'69	1.161	1.173	.753
Lbs Pb per acre - foot	'68	.0395	.0406	.0698
-do-	'69	.0464	.0586	.0801

Table 33

Distribution of elemental NICKEL in major components of 3 largestream impoundments

BARTLETT'S FERRY RESERVOIR

	1968	1969
Average total Ni concentration in water, ppm	.0048	.0089
Total Ni - lbs per mi^2 drainage area, April-October		
Input - Chattahoochee River	4.00	2.75
Output - Bartlett's Ferry Dam	3.99	1.00
Hydrosol - Total Ni concentration in sample, ppm	52.5	105.0
Total lbs Ni per acre in 0.01 inch	.16	.72
Fish - Total standing crop - lbs per acre	130.0	190.0
Average concentration Ni, ppm	17.3	17.3
Total lbs Ni per acre	.00086	.00086

Aquatic plants

Species	Year	Acres	Wet weight lbs per acre	Ni content ppm	Pounds Ni per acre
Waterwillow		0.5	30,000	36.0	.216

LAKE EUFAULA

	1968	1969
Average total Ni concentration in water, ppm		
Upper region	.0064	.0072
Middle region	.0124	.0091
Lower region	.0108	.0094
Total Ni - lbs per mi^2 drainage area, April-October		
Input - Upper region	7.20	7.65
Middle region	5.78	10.36
Lower region	6.15	8.34
Output - Walter F. George Dam	1.47	
Hydrosol - Total concentration in sample, ppm		
Upper region	76.3	280.0
Middle region	66.0	331.0
Lower region	90.0	1,020.0
Pounds total Ni per acre in 0.01 inch		
Upper region	.22	.79
Middle region	.19	.97
Lower region	.27	3.00
Fish - Total standing crop - lbs per acre	190.0	190.0
Average concentration Ni, ppm	17.3	17.3
Total lbs Ni per acre	.00086	.00086

Aquatic plants

Species	Year	Acres	Wet weight lbs per acre	Ni content ppm	Pounds Ni per acre
Alligatorweed	'68	1	150,000	10.5	.126
-do-	'69	5	150,000	67.4	.809

Table 33 Continued

LAKE SEMINOLE (Nickel continued)

	1968	1969
Average total Ni concentration in water, ppm		
Chattahoochee River arm	.0060	.0091
Flint River arm	.0069	.0093
Spring Creek arm	.0120	.0093
Total Ni - lbs per mi^2 drainage area, April-October		
Input - Chattahoochee River arm	.72	8.95
Flint River arm	.70	6.32
Spring Creek arm	5.86	3.09
Output - Chattahoochee River arm	.70	
Flint River arm	5.16	
Hydrosol - Total Ni concentration in sample, ppm		
Chattahoochee River arm		440.0
Flint River arm	449.0	885.0
Spring Creek arm	142.0	400.0
Pounds total Ni per acre in 0.01 inch		
Chattahoochee River arm	1.02	1.30
Flint River arm	1.33	2.61
Spring Creek arm	.42	.13
Fish - Total standing crop - lbs per acre	210.0	210.0
Average concentration Ni, ppm	17.3	17.3
Total lbs Ni per acre	.00094	.00094

Aquatic plants

Species	Year	Acres	Wet weight lbs per acre	Ni conten' ppm	Pounds Ni per acre
Alligatorweed	'68	250	155,000	23.4	.290
-do-	'69	100	155,000	26.4	.327
Waterhyacinth	'68	100	143,000	17.3	.198
-do-	'69	260	143,000	43.0	.492
Eurasian milfoil	'68	2,000		14.5	.145
-do-	'69	2,000		12.0	.120
Giant cutgrass	'68	400	31,000	17.0	.136
-do-	'69	450	31,000	12.0	.096
Others	'68	500	30,000	24.9	.149
-do-	'69	500	30,000	24.9	.149

The averaged summertime standing crop of Ni in each aquatic environment component (including the 0.01 inch layer hydrosol) for the 3 impoundments are given below.

Component	Year	Bartlett's Ferry Reservoir (lbs)	Lake Eufaula (lbs)	Lake Seminole (lbs)
Water + suspended matter	'68	1,901.25	26,007.9	6,739.8
-do-	'69	3,510.00	21,886.5	8,215.6
Hydrosol	'68	93.60	1,059.8	3,620.5
-do-	'69	421.20	9,061.9	5,637.0
Fish	'68	5.03	38.7	32.9
-do-	'69	5.03	38.7	32.9
Aquatic plants	'68	.108	.126	511.2
-do-	'69	.108	4.045	518.3
Total	'68	1,999.988	27,106.526	10,904.4
-do-	'69	3,936.388	30,991.145	14,403.8
Lbs Ni per acre	'68	.3418	.6024	.3110
-do-	'69	.6728	.6887	.4115
Lbs Ni per acre - foot	'68	.01367	.03012	.0331
-do-	'69	.02691	.03443	.0438

Table 34

Distribution of elemental CADMIUM in major components of 3 largestream impoundments

BARTLETT'S FERRY RESERVOIR

	1968	1969
Average total Cd concentration in water, ppm	.0031	.0021
Total Cd - lbs per mi^2 drainage area, April-October		
Input - Chattahoochee River	1.672	2.0
Output - Bartlett's Ferry Dam	3.052	2.0
Hydrosol - Total Cd concentration in sample, ppm	59.3	8.4
Total lbs Cd per acre in 0.01 inch	.177	.177
Fish - Total standing crop - lbs per acre	190.0	190.0
Average concentration Cd, ppm	2.3	2.3
Total lbs Cd per acre	.00011	.00011

Aquatic plants

Species	Year	Acres	Wet weight lbs per acre	Cd content ppm	Pounds Cd per acre
Waterwillow		0.5	30,000	4.0	.024

LAKE EUFAULA

	1968	1969
Average total Cd concentration in suspended matter, ppm		
Upper region	.0022	.0022
Middle region	.0020	.0014
Lower region	.0023	.0013
Total Cd - lbs per mi^2 drainage area, April-October		
Input - Upper region	1.84	2.51
Middle region	1.74	1.74
Lower region	1.58	1.29
Output - Walter F. George Dam	1.39	
Hydrosol - Total Cd concentration in sample, ppm		
Upper region	59.5	31.6
Middle region	72.7	14.9
Lower region	63.2	13.9
Pounds total Cd per acre in 0.01 inch		
Upper region	.17	.09
Middle region	.21	.04
Lower region	.18	.04
Fish - Total standing crop - lbs per acre	190.0	190.0
Average concentration Cd, ppm	2.3	2.3
Total lbs Cd per acre	.00011	.00011

Aquatic plants

Species	Year	Acres	Wet weight lbs per acre	Cd content ppm	Pounds Cd per acre
Alligatorweed	'68	1	150,000	2.0	.024
-do-	'69	5	150,000	22.9	.275

Table 34 Continued

LAKE SEMINOLE (Cadmium continued)

	1968	1969
Average total Cd concentration in water, ppm		
Chattahoochee River arm	.0025	.0014
Flint River arm	.0018	.0013
Spring Creek arm	.0073	.0013
Total Cd - lbs per mi^2 drainage area, April-October		
Input - Chattahoochee River arm	1.98	1.80
Flint River arm	1.44	1.15
Spring Creek arm	1.51	1.52
Output - Chattahoochee River arm	1.38	
Flint River arm	.61	
Hydrosol - Total Cd concentration in sample, ppm		
Chattahoochee River arm		10.4
Flint River arm	31.4	20.7
Spring Creek arm	37.0	8.8
Pounds total Cd per acre in 0.01 inch, ppm		
Chattahoochee River arm	.15	.03
Flint River arm	.09	.20
Spring Creek arm	.10	.01
Fish - Total standing crop - lbs per acre	210.0	210.0
Average concentration Cd - ppm	2.3	2.3
Total lbs Cd per acre	.00011	.00011

Aquatic plants

Species	Year	Acre	Wet weight lbs per acre	Cd content ppm	Pounds Cd per acre
Alligatorweed	'68	250	155,000	11.0	.136
-do-	'69	100	155,000	15.2	.188
Waterhyacinth	'68	100	143,000	4.0	.046
-do-	'69	260	143,000	19.2	.219
Eurasian milfoil	'68	2,000		5.0	.050
-do-	'69	2,000		10.0	.100
Giant cutgrass	'68	400	31,000	8.0	.064
-do-	'69	450	31,000	8.0	.064
Others	'68	500	30,000	11.8	.071
-do-	'69	500	30,000	11.8	.071

The averaged summertime standing crop of Cd in each aquatic environment component (including the 0.01 inch layer hydrosol) for the 3 impoundments are given below.

Component	Year	Bartlett's Ferry Reservoir (lbs)	Lake Eufaula (lbs)	Lake Seminole (lbs)
Water + suspended matter	'68	1,170.000	5,469.590	2,571.37
-do-	'69	833.625	3,727.590	1,206.02
Hydrosol	'68	1,035.450	8,398.120	4,071.00
-do-	'69	1,035.450	2,119.640	3,380.00
Fish	'68	.644	4.95	3.85
-do-	'69	.644	4.95	3.85
Aquatic plants	'68	.012	.024	399.70
-do-	'69	.012	1.375	340.04
Total	'68	2,206.106	13,872.634	7,045.92
-do-	'69	1,871.731	5,853.555	4,929.91
Lbs Cd per acre	'68	.3771	.3083	.2013
-do-	'69	.3199	.1301	.1408
Lbs Cd per acre - foot	'68	.0151	.0154	.0214
-do-	'69	.0128	.0065	.0150

Table 35

Distribution of elemental CHROMIUM in major components of 3 largestream impoundments

BARTLETT'S FERRY RESERVOIR

	1968	1969
Average total Cr concentration in suspended matter, ppm	.0148	.0077
Total Cr - lbs per mi^2 drainage area, April-October		
Input - Chattahoochee River	12.00	4.43
Output - Bartlett's Ferry Dam	13.10	10.09
Hydrosol - Total Cr concentration in sample, ppm	113.0	99.0
Total lbs Cr per acre in 0.01 inch	0.31	0.24
Fish - Total standing crop - lbs per acre	190.0	190.0
Average concentration Cr, ppm	28.2	28.2
Total lbs Cr per acre	.014	.014

Aquatic plants

Species	Year	Acres	Wet weight lbs per acre	Cr content ppm	Pounds Cr per acre
Waterwillow		0.5	30,000	13.2	.106

LAKE EUFAULA

	1968	1969
Average total Cr concentration in water, ppm		
Upper region	.0159	.053
Middle region	.0125	.0085
Lower region	.0125	.0084
Total Cr - lbs per mi^2 drainage area, April-October		
Input - Upper region	14.8	6.23
Middle region	12.3	10.21
Lower region	10.7	7.45
Output - Walter F. George Dam	10.3	
Hydrosol - Total Cr concentration in sample, ppm		
Upper region	149.8	135.0
Middle region	156.0	145.0
Lower region	65.5	87.3
Pounds total Cr per acre in 0.01 inch		
Upper region	.44	.37
Middle region	.46	.43
Lower region	.19	.26
Fish - Total standing crop - lbs per acre	190.0	190.0
Average concentration Cr, ppm	28.2	28.2
Total lbs Cr per acre	.014	.014

Aquatic plants

Species	Year	Acres	Wet weight lbs per acre	Cr content ppm	Pounds Cr per acre
Alligatorweed	'68	1	150,000	43.0	.516
-do-	'69	5	150,000	32.0	.384

Table 35 Continued

<u>LAKE SEMINOLE</u> (Chromium continued)

	1968	1969
Average total Cr concentration in water, ppm		
Chattahoochee River arm	.0105	.0079
Flint River arm	.0134	.0068
Spring Creek arm	.0162	.0072
Total Cr - lbs per mi^2 drainage area, April-October		
Input - Chattahoochee River arm	12.5	6.4[illegible]
Flint River arm	10.9	5.42
Spring Creek arm	11.7	3.17
Output - Chattahoochee River arm	14.7	
Flint River arm	11.2	
Hydrosol - Total Cr concentration in sample, ppm		
Chattahoochee River arm		66.0
Flint River arm	43.0	68.0
Spring Creek arm	80.0	60.0
Pounds total Cr per acre in 0.01 inch		
Chattahoochee River arm	.09	.19
Flint River arm	.13	.20
Spring Creek arm	.23	.02
Fish - Total standing crop - lbs per acre	210.0	210.0
Average concentration Cr, ppm	28.2	28.2
Total lbs Cr per acre	.015	.015

Aquatic plants

Species	Year	Acres	Wet weight lbs per acre	Cr content ppm	Pounds Cr per acre
Alligatorweed	'68	250	155,000	24.2	.30
-do-	'69	100	155,000	22.2	.275
Waterhyacinth	'68	100	143,000	16.0	.183
-do-	'69	260	143,000	22.7	.259
Eurasian milfoil	'68	2,000		20.2	.202
-do-	'69	2,000		10.0	.100
Giant cutgrass	'68	400	31,000	67.0	.539
-do-	'69	450	31,000	24.0	.193
Others	'68	500	30,000	63.5	.381
-do-	'69	500	30,000	63.5	.381

The averaged summertime standing crop of Cr in each aquatic environment component (including the 0.01 inch layer hydrosol) for the 3 impoundments are given below.

Component	Year	Bartlett's Ferry Reservoir (lbs)	Lake Eufaula (lbs)	Lake Seminole (lbs)
Water + suspended matter	'68	5,850.00	33,005.40	11,562.00
-do-	'69	3,071.25	19,816.50	6,526.30
Hydrosol	'68	1,813.50	13,966.59	4,816.00
-do-	'69	1,404.00	14,748.72	5,595.00
Fish	'68	81.90	630.00	525.00
-do-	'69	81.90	630.00	525.00
Aquatic Plants	'68	.053	.516	903.400
-do-	'69	.053	1.92	752.190
Total	'68	7,745.453	47,602.506	17,806.400
-do-	'69	4,557.203	35,197.140	13,218.490
Lbs Cr per acre	'68	1.324	1.058	.509
-do-	'69	.779	.782	.378
Lbs Cr per acre - foot	'68	.053	.053	.054
-do-	'69	.031	.039	.040

Table 36

Distribution of elemental COBALT in major components of 3 largestream impoundments

BARTLETT'S FERRY RESERVOIR

	1968	1969
Average total Co concentration in water, ppm	.0027	.0032
Total Co - lbs per mi^2 drainage area, April-October		
Input - Chattahoochee River	3.00	2.50
Output - Bartlett's Ferry Dam	2.11	3.52
Hydrosol - Total Co concentration in sample, ppm	77.0	142.0
Total lbs Co per acre in 0.01 inch	.26	.22
Fish - Total standing crop - lbs per acre	190.0	190.0
Average concentration Co, ppm	5.5	5.5
Total lbs Co per acre	.0027	.0027

Aquatic plants

Species	Year	Acres	Wet weight lbs per acre	Co content ppm	Pounds Co per acre
Waterwillow		0.5	30,000	6.9	.0414

LAKE EUFAULA

	1968	1969
Average total Co concentration in water, ppm		
Upper region	.0024	.0059
Middle region	.0023	.0059
Lower region	.0021	.0063
Total Co - lbs per mi^2 drainage area, April-October		
Input - Upper region	1.80	6.09
Middle region	2.17	6.15
Lower region	2.40	8.86
Output - Walter F. George Dam	1.21	
Hydrosol - Total Co concentration in sample, ppm		
Upper region	91.2	217.0
Middle region	99.3	139.0
Lower region	96.0	182.0
Pounds total Co per acre in 0.01 inch		
Upper region	:27	.61
Middle region	.29	.41
Lower region	.28	.54
Fish - Total standing crop - lbs per acre	190.0	190.0
Average concentration Co, ppm	5.5	5.5
Total lbs Co, per acre	.0027	.0027

Aquatic plants

Species	Year	Acres	Wet weight lbs per acre	Co content ppm	Pounds Co per acre
Alligatorweed	'68	1	150,000	5.9	.071
-do-	'69	5	150,000	67.4	.809

Table 36 Continued

LAKE SEMINOLE (Cobalt continued)

	1968	1969
Average total Co concentration in water, ppm		
Chattahoochee River arm	.0025	.0023
Flint River arm	.0029	.0051
Spring Creek arm	.0029	.0036
Total Co - lbs per mi² drainage area, April-October		
Input - Chattahoochee River arm	2.52	3.22
Flint River arm	4.66	3.83
Spring Creek arm	2.35	2.31
Output - Chattahoochee River arm	2.09	
Flint River arm	3.48	
Hydrosol - Total Co concentration in sample, ppm		
Chattahoochee River arm		76.0
Flint River arm	66.0	142.0
Spring Creek arm	36.0	168.0
Pounds total Co per acre in 0.01 inch		
Chattahoochee River arm	.09	.22
Flint River arm	.19	.42
Spring Creek arm	.13	.05
Fish - Total standing crop - lbs per acre	210.0	210.0
Average concentration Co, ppm	5.5	5.5
Total lbs Co per acre	.003	.003

Aquatic plants

Species	Year	Acres	Wet weight lbs per acre	Co Content ppm	Pounds Co per acre
Alligatorweed	'68	250	155,000	1.0	.012
-do-	'69	100	155,000	38.0	.471
Waterhyacinth	'68	100	143,000	1.2	.013
-do-	'69	260	143,000	28.0	.320
Eurasian milfoil	'68	2,000		1.0	.01
-do-	'69	2,000		60.0	.60
Giant cutgrass	'68	400	31,000	5.0	.040
-do-	'69	450	31,000	16.0	.128
Others	'68	500	30,000	13.2	.079
-do-	'69	500	30,000	13.2	.079

The averaged summertime standing crop of Co in each aquatic environment component (including the 0.01 inch layer hydrosol) for the 3 impoundments are given below.

Component	Year	Bartlett's Ferry Reservoir (lbs)	Lake Eufaula (lbs)	Lake Seminole (lbs)
Water + suspended matter	'68	1,023.75	5,500.09	2,463.27
-do-	'69	1,257.75	15,304.90	3,351.57
Hydrosol	'68	1,521.0	12,582.62	4,945.00
-do-	'69	1,287.0	22,751.36	9,413.00
Fish	'68	15.79	121.5	105.0
-do-	'69	15.79	121.5	105.0
Aquatic plants	'68	.0207	.071	79.8
-do-	'69	.0207	4.045	1,227.4
Total	'68	2,560.56	18,204.28	7,593.07
-do-	'69	5,121.12	38,180.99	14,096.97
Lbs Co per acre	'68	4.377	.404	.217
-do-	'69	8.754	.848	.403
Lbs co per acre - foot	'68	.175	.020	.023
-do-	'69	.350	.042	.043

2.4.6 Climatology And Meteorology

The following narrative description is quoted from a 1955 U. S. Department of Commerce, Weather Bureau publication entitled "Climatological Summary, Dothan, Alabama 1902-1954". Since Dothan is approximately sixteen miles west of the site the description applies well to the Farley site.

> "Situated approximately 75 miles from the Gulf of Mexico, Dothan has a climate which borders on the sub-tropical.
>
> During the period, June-September, inclusive, temperatures and atmospheric moisture are very even and generally change little from day to day because the area is covered nearly all the time by warm moist air from the Gulf. From May through August, nearly all precipitation is from local, mostly day-time, thundershowers and there are apt to be considerable differences in day-to-day amounts of rainfall in different portions of the Dothan area.
>
> During September, summer conditions of temperature and atmospheric moisture persist as air continues to drift in from the Gulf but local thundershowers become less frequent due to the shortening of the days and the decrease in heat from the sun. Local heat thundershowers give way to thundershowers which herald the slight drops in temperature which begin to occur, and to occasional general rains which accompany storms on the Gulf.
>
> Rains during October, the driest month of the year, are nearly

always showers or thundershowers which occur ahead of temperature drops which become more frequent and more pronounced as winter approaches. The same is largely true of November.

All types and intensities of rain may occur at any time from December through March, excepting the heat thundershowers of summer.

During the coldest months of December, January, and February, there are frequent shifts between mild air which has been moistened and warmed by the Gulf, and dry and cold continental air. Hard freezes are, however, not frequent, and normally there is some growth of wild pasture grasses and weeds throughout the winter. The lower temperatures which occur here are more keenly felt than similar temperatures in the north and west, due to the physiological effects of the mild weather which usually prevails before the moving in of each little "cold snap", and to higher humidities.

Most rain during April and May is in the form of thundershowers or showers which occur ahead of incoming cool waves which become weaker and less frequent as summer approaches. Droughts sometimes occur in late spring, late summer, and early autumn.

Snow rarely falls and usually melts as it falls.

Wind movement is usually light. Strong winds seldom last long at a time, and dangerous winds are very rare."

Figures 2-13 and 2-14 give average precipitation, wind speed, wind direction, and psychrometric data for Dothan along with comparative data for temperature and precipitation. Figure 2-15 graphically gives hourly average dry bulb, wet bulb, and dew point temperatures for spring, summer, fall, winter and annual averages. Figure 2-16 gives average hourly relative humidities for the same spring, summer, fall, winter and annual averaging periods.

A complete meteorological station has been installed at the Farley site. Instrumentation installed at the site is listed in Table 2-2. Data is collected from each of the sensors on continuous analog strip chart recorders. In addition, a punched paper tape system provides tape records of the sensor values at 3 minute intervals. Data from this station will be used to determine diffusion conditions in connection with design and operation of the nuclear plant.

2.4.7 Ecology

The land area at the Joseph M. Farley Nuclear Plant site consists of typical coastal plain soils with associated vegetation. Trees consist of a variety of pines along with oak and hickory and normal river-bottom hardwood such as ash, magnolia and cypress.

The river adjacent to the plant site consists of a normal river channel which has been modified in recent years by the construction of impoundments both upstream and downstream. At the site itself, the river elevation is affected somewhat by the operation of Jim Woodruff, Walter F. George and Columbia Locks and Dams for power generation and navigation. This causes daily fluctuations in flow and elevations. There is a normal population of warm water fish in the river.

DOTHAN, ALABAMA

AVERAGES AND COMPARATIVE DATA

LATITUDE 31°14' N., LONGITUDE 85°26' W. ELEVATION 321 FEET

MONTH	PRECIPITATION (INCHES)													WIND	
	NORMAL	RECORD MEAN	GREATEST 24-HOUR AMOUNTS	YEAR	GREATEST 48-HOUR AMOUNTS	YEAR	GREATEST 72-HOUR AMOUNTS	YEAR	GREATEST MONTHLY	YEAR	LEAST MONTHLY	YEAR	AVERAGE SNOWFALL	PREVAILING DIRECTION	AVER. HOURLY VELOCITY (MPH)
JANUARY	4.49	4.24	6.42	1936	6.42	1936	7.30	1925	16.88	1936	0.34	1927	T	SE	8.8
FEBRUARY	5.24	4.68	4.26	1937	4.92	1940	5.77	1929	10.36	1939	0.93	1951	T	SW	9.7
MARCH	5.15	6.15	9.00	1929	11.68	1929	12.34	1929	16.40	1929	0.89	1945	T	NW	10.0
APRIL	4.16	4.18	4.75	1946	4.99	1946	4.99	1946	12.60	1928	0.60	1902	0	SE	8.2
MAY	3.18	3.10	4.10	1903	4.39	1903	4.59	1903	8.73	1947	0.58	1927	0	SW	6.6
JUNE	4.63	4.47	4.76	1940	4.76	1940	4.83	1940	8.52	1942	1.10	1945	0	SW	6.6
JULY	5.92	6.07	6.73	1948	7.44	1948	7.45	1948	12.73	1948	2.22	1903	0	SW	6.3
AUGUST	5.43	5.38	5.80	1939	6.23	1939	6.96	1939	20.85	1939	2.20	1925	0	NE	5.8
SEPTEMBER	5.16	5.08	8.00	1929	9.20	1926	10.45	1926	13.86	1929	0.63	1940	0	NE	7.3
OCTOBER	2.77	1.88	7.37	1932	7.37	1932	7.37	1932	12.41	1932	T	1939	T	NE	6.9
NOVEMBER	3.05	3.44	4.50	1912	4.50	1912	4.50	1912	10.29	1930	0.05	1931	T	NE	7.7
DECEMBER	4.85	4.74	3.90	1945	5.50	1927	5.50	1927	13.61	1953	0.53	1946	T	NW	9.3
YEAR	54.03	53.41	9.00	MAR. 1929	11.68	MAR. 1929	12.34	MAR. 1929	20.85	AUG. 1939	T	OCT. 1939	T	SW	7.8

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DOTHAN, ALABAMA
AVERAGES AND COMPARATIVE DATA
PRECIPITATION AND WIND

FIGURE 2-13

DOTHAN, ALABAMA

AVERAGES AND COMPARATIVE DATA

LATITUDE 31° 14' N., LONGITUDE 85° 26' W. — ELEVATION 321 FEET

MONTH	TEMPERATURE (°F.) AVERAGE DAILY MAXIMUM	AVERAGE DAILY MINIMUM	AVERAGE	AVERAGE DAILY RANGE	ABSOLUTE HIGHEST	YEAR	ABSOLUTE LOWEST	YEAR	HEATING DEGREE DAYS	AVERAGE NUMBER HOURS 45° OR BELOW	AVERAGE HOURLY DRY-BULB	AVERAGE HOURLY WET-BULB	AVERAGE HOURLY DEW-POINT	AVERAGE HOURLY RELATIVE HUMIDITY(%)
JANUARY	63.4	41.4	52.4	22.0	83	1949	12	1940	400	228	52	48	45	77
FEBRUARY	65.3	43.0	54.2	22.3	84	1944	12	1951	322	181	54	49	45	73
MARCH	71.1	48.1	59.6	23.0	88	1954#	21	1943	212	99	59	56	49	71
APRIL	78.9	54.9	66.9	24.0	95	1942	31	1940	57	15	67	60	55	69
MAY	86.8	62.4	74.6	24.4	99	1953	44	1954	5	0	74	66	62	68
JUNE	92.2	69.8	81.0	22.4	104	1952	52	1954	0	0	80	73	70	73
JULY	91.7	71.1	81.4	20.6	103	1952	62	1953#	0	0	80	74	72	80
AUGUST	92.2	70.6	81.4	21.6	103	1954#	60	1952#	0	0	80	74	72	72
SEPTEMBER	87.6	66.2	76.9	21.4	100	1951#	47	1949#	2	0	75	70	67	78
OCTOBER	80.9	55.9	68.4	25.0	98	1954	30	1952	43	11	67	61	57	72
NOVEMBER	69.4	44.8	57.1	24.6	88	1950#	17	1950	253	145	57	52	48	73
DECEMBER	62.5	40.8	51.7	21.7	82	1951	18	1945	414	271	51	48	45	81
YEAR	78.5	55.8	67.2	22.7	104	JUNE 1952	12	JAN. 1940 FEB. 1951	1708	950	66	61	57	75

ALSO ON EARLIER DATES

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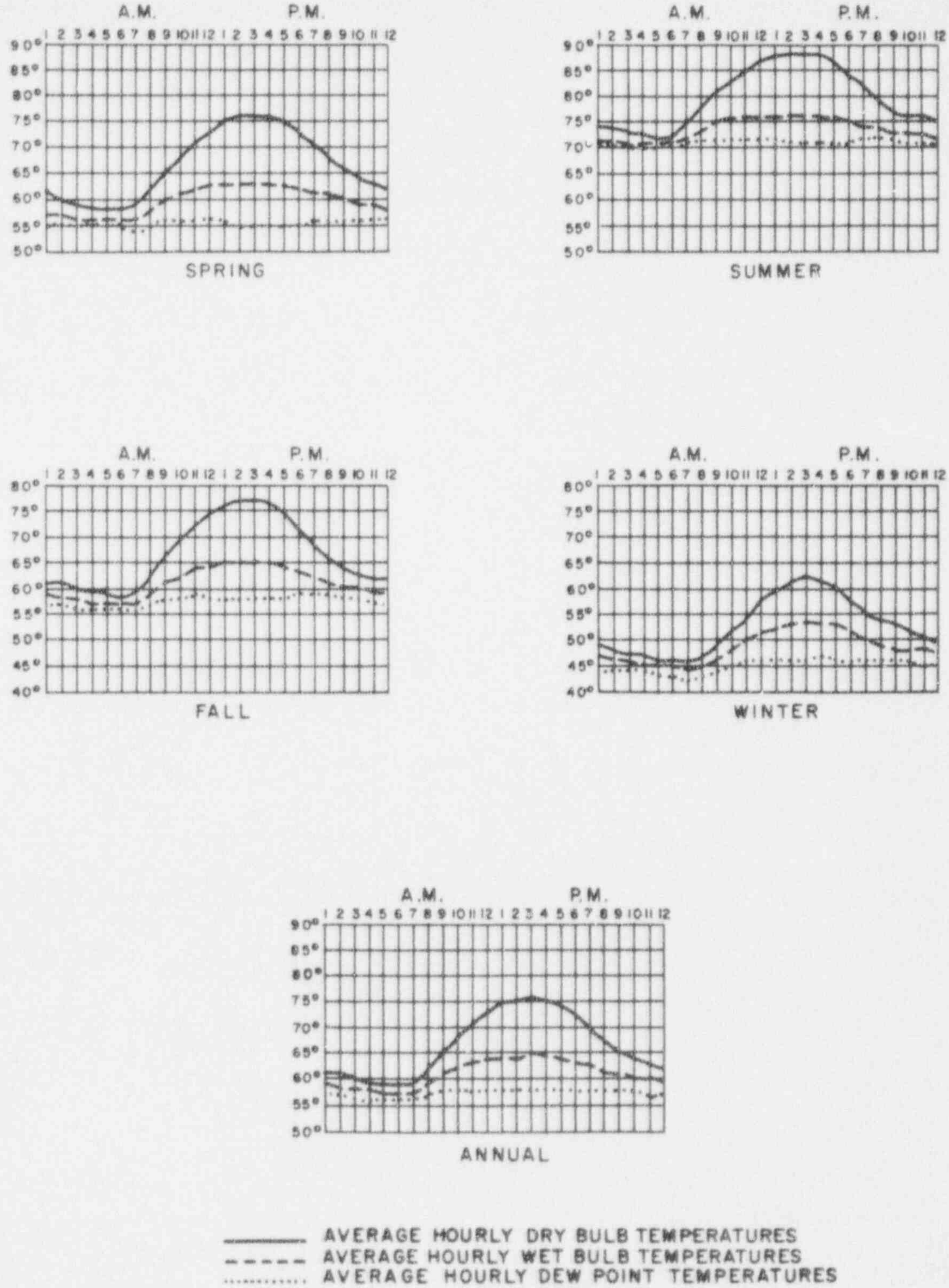
DOTHAN, ALABAMA
AVERAGES AND COMPARATIVE DATA
PSYCHROMETRIC DATA
FIGURE 2-14



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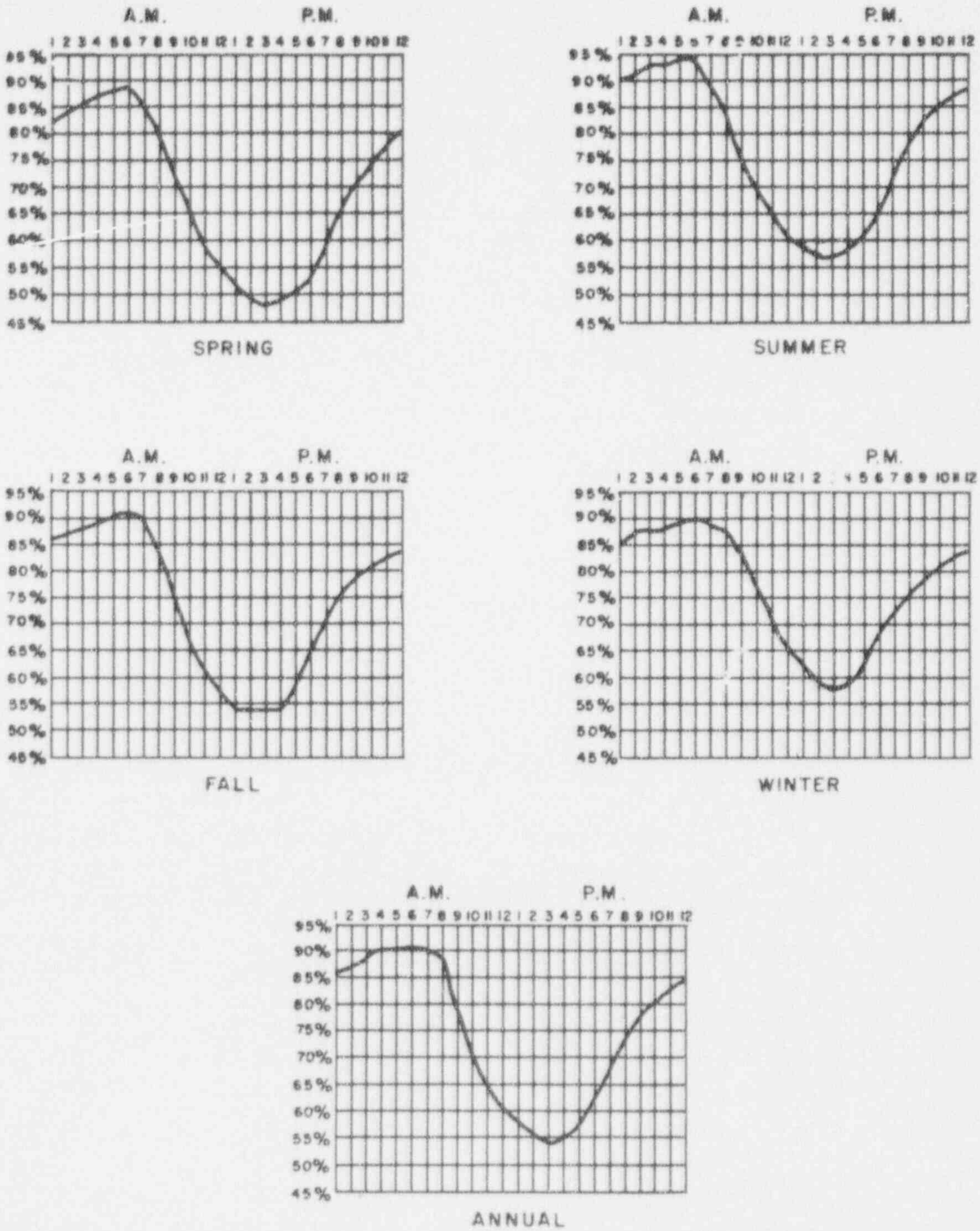
ENVIRONMENTAL REPORT

AVERAGE HOURLY DRY BULB, WET BULB AND DEW POINT TEMPERATURES
DOTHAN, ALABAMA
1940-1952

FIGURE 2-15



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ENVIRONMENTAL REPORT

AVERAGE HOURLY RELATIVE HUMIDITY
DOTHAN, ALABAMA
1940-1952

FIGURE 2-16

Table 2-2

Weather Instrumentation At The Joseph M. Farley Plant Site

Approximate Height Above Tower Base	Sensed Parameter	Recorded Parameter	Instrument Characteristics
200'	Temperature for comparison with 35' level	-	Thermistor in aspirated solar radiation shield. Accuracy ± 0.15°C.
150'	Wind speed and direction	Wind speed and direction	Climet Model 4-011-1(speed) 0.6 mph threshold; and model 4-012-10(direction). Distance constant is 5 feet, vane has 1 mph threshold and a damping ratio of 0.4.
100'	Temperature for comparison with 35' level	-	Thermistor in aspirated solar radiation shield. Accuracy ± 0.15°C.
50'	Wind speed and direction	Wind speed and direction	Climet (same as above).
50'	Vertical and horizontal wind direction	Vertical and horizontal wind direction	Climet Model 012-11 Bivane. Distance constant is 3.3 ft., vane has .75 mph threshold and a damping ratio of .6.
35'	Ambient temperature	Ambient temperature	Thermistor in aspirated solar radiation shield.
35'	Reference temperature for comparison with 200' level	$T_{200'} - T_{35'}$	Thermistor in aspirated solar radiation shield.
35'	Reference temperature for comparison with 100' level	$T_{100'} - T_{35'}$	Thermistor in aspirated solar radiation shield.
35'	Dew point temperature	Dew point temperature	Climet Model 015-12 Dewcell probe in aspirated solar radiation shield.

Table 2-2 (Continued)

Weather Instrumentation At The Joseph M. Farley Plant Site

Approximate Height Above Tower Base	Sensed Parameter	Recorded Parameter	Instrument Characteristics
Located on 8' pole approx. 100' south of tower	Solar radiation	Solar radiation	Climet Model 0503-1 Pyrometer. Sensitivity 7.5 mv/cal/cm^2/min.
Located on 12" concrete pad approx. 80' north of tower	Rainfall	Rainfall	Climet Model 0501-1 Range 0-10"

The bird population in the area consists of substantial numbers of heron, ducks, swallows, dove, quail and turkey.

It is interesting to note that the region where the plant is being constructed has been known historically as the wiregrass section of Alabama. Changes in agricultural and other land uses in the past have led to the virtual extinction of the type of grass for which the area was named.

2.4.8 Land Use

2.4.8.1 Industrial

There are four manufacturing concerns located on the east side of the river about 3.5 and 4 miles south of the plant. These are: The Ross-Wright Chemical Company, Gulf Fiber Mill, Great Northern Plywood Plant and the Great Southern Paper Mill. A small garment factory and a feed mill are located in Columbia, Alabama about five miles to the north.

2.4.8.2 Transportation

The nearest airport with scheduled passenger service is Napier Field near Dothan, Alabama, about 22 miles to the west-north-west. There are small municipal fields not used for scheduled commercial service at Headland, Alabama, about 16 miles to the northwest and Blakely, Georgia, 15 miles to the northeast. There is a small private landing strip at the Great Southern Paper Mill about 3.5 miles south of the plant on the east side of the Chattahoochee River.

State Highway 95, a hard surface secondary road, forms the west boundary of the site property and is used principally for local transportation. There is commercial truck traffic on U. S. Highway 84, about six miles south of the plant location and on State Highway 52 about five miles to the north. The Central of Georgia Railroad passes about five miles north of the plant and the Seaboard Coast Line Railroad passes about six miles to the south. The highways and railroads referred to above are shown on Figures 2-1 and 2-2. The applicant has constructed a railroad to serve the Joseph M. Farley Plant. This railroad connects with the Central of Georgia track at Columbia, Alabama, and will serve for transporting materials and equipment during construction and possibly nuclear fuel during operation. The construction of this railroad will make the land lying west of the Chattahoochee River and from the north boundary of the plant site to Columbia more attractive for industrial development which residents of the area are actively promoting.

There is commercial barge traffic on the Chattahoochee River 4400 feet east of the plant location. The channel is maintained nine feet deep and 100 feet wide by the Corps of Engineers. In 1968, approximately 12 loads per month of commercial freight were moved along the river past the site consisting principally of sand, gravel, associated agricultural products and petroleum products.

2.4.8.3 Farming

About 45 percent of the land area in the site region is wooded and is used for the production of pulp wood and timber. The remaining land area is used for various agricultural purposes. Cotton, corn and peanuts are the principal products with watermelons, small grain and hay as secondary crops. Beef cattle, hogs and chickens are also raised in the area. There is milk produced in the general area, which is used for both local consumption and shipment to processors. However, there are no commercial dairy farms within a 10 mile radius of the site.

2.4.8.4 Forestry

Before Houston County was settled, it was entirely wooded. About 38 percent of the county is still wooded (1968), and most of the woodland is owned and managed by farmers. About half of the timber is softwood, mostly pine, and half is hardwood. The major forest types are long leaf, slash, loblolley and short leaf pine, and oak, gum and cypress. Small areas of oak and hickory are scattered throughout the county.

In 1953 33.5 percent of the county was in forest. This increased to 38 percent in 1968 due to a large extent to the soil bank program, when land owners took land out of agricultural production and planted pine trees.

In the site area, about one half of the land is in forest. On the upland soils, the principal commercial species are loblolley, slash, short leaf and long leaf pines. On the somewhat poorly drained bottom land, the principal commercial species are pine, gum, oak, yellow poplar and cottonwood.

2.4.8.5 Recreation

The topography of Houston County is predominately gently rolling. In some areas it is fairly level and in the plant site area it is dominated by the Chattahoochee River Valley. This provides a very pleasant, but not unique, view for tourists.

The soil of the county and the abundance of woodland provide food and cover for many kinds of wildlife. Quail, doves, rabbits, squirrels and many non-game birds and animals are common.

Major species of fish in the various waters in, and near, the county consist of bream, bass, catfish, shellcrackers and crappie. Although there is some fishing in farm ponds and lakes and in the Chattahoochee

River, particularly around Columbia Lock and Dam, the close proximity and excellent fishing in Lake Seminole and Lake Eufaula attracts many of the local fishermen.

2.4.8.6 Wildlife Preserves

At present, the only government owned wildlife preserve in Houston County is 600 acres owned by the state in the southeastern corner of the county about seven miles south of Gordon, Alabama. This site consists of a forested area containing many varieties of flowering trees and a 17 acre fresh water lake. Fishing, picnicking and hiking are allowed. The Alabama Department of Conservation is in charge of this facility.

Present plans for the Joseph M. Farley Nuclear Plant site include designating a substantial portion of the site a wildlife preserve. Such a preserve would not only protect existing wildlife, but would also improve the opportunity for propogation of wildlife which would be expected to migrate to surrounding areas.

Discussions regarding implementation of this plan are underway and consideration is being given to conducting this program in cooperation with the Alabama Department of Conservation. The applicant will also provide limited recreational areas which will be compatible with the wildlife preserve and open to the public along with the visitors' information center.

2.4.8.7 Population Distribution

There will be no people living on the site. The nearest existing occupied house is about 4500 feet west of the plant buildings.

The site is located in a sparsely populated region, with approximately 2300 permanent residents within a 5 mile radius. It is estimated that about one half of this number is located in and around the town of

Columbia, the center of which is about 5 miles north of the plant. These population estimates are based on a count of occupied dwellings within a 5 mile radius. The city and community populations shown on Figure 2-2 are based on the 1960 census.

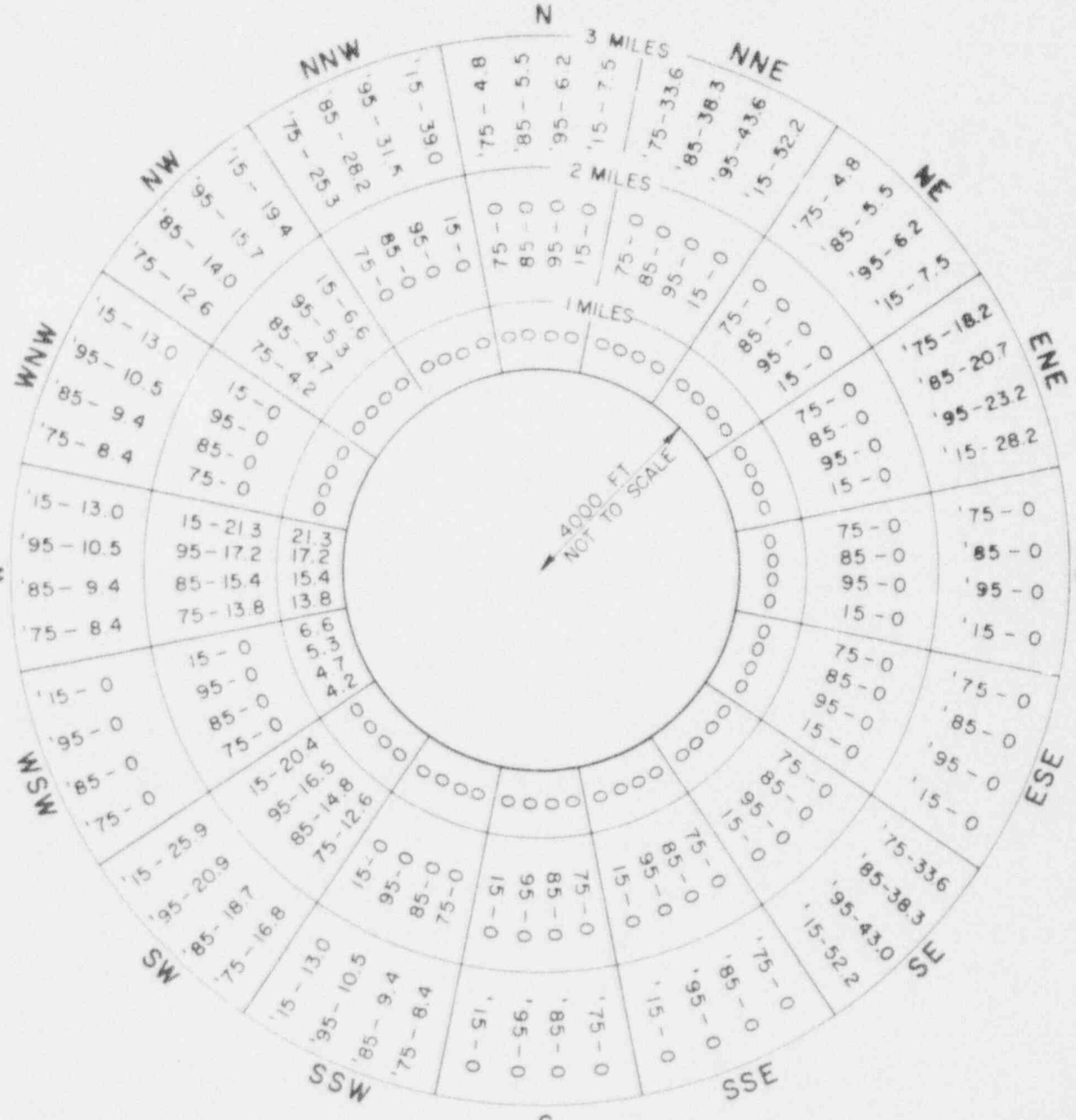
The largest town within a 10 mile radius is Ashford, 8.3 miles southwest of the plant, with a 1970 population of 1,980. The population center as defined in 10CFR100 is Dothan, located 16.5 miles west of the plant, with a 1970 population of 36,733. Population centers over 20,000 within 100 miles of the site are shown on Figure 2-1. The shaded areas shown on Figure 2-1 indicate the location of the major cities and the more heavily populated counties in Alabama, Florida and Georgia for a distance of about 150 miles from the site.

Estimates of the projected population distribution in the site region are shown for the years 1975, 1985, 1995, and 2015 by 16 direction sectors and 1 mile increments up to 5 miles and by 10 mile increments up to 50 miles as shown on Figure 2-17, Sheets 1 through 4. These estimates are based on information obtained from Reference 1.

2.4.8.8 Waterways

The principal streams in Houston County are the Chattahoochee, Choctawhatchee, and Little Choctawhatchee Rivers, and Omusee, Cowarts and Big Creeks. The Chattahoochee River which borders Houston County on the east is the largest and only navigable waterway. The name "Chattahoochee" is derived from the Cherokee Indians and in free translation means "river of the painted rock". The river was used for hundreds of years by the Indians and then early settlers as a major communication route.

POPULATION DISTRIBUTION *
0-3 MILES
(1975, 1985, 1995 AND 2015)



* NUMBER OF INHABITANTS PER SEGMENT

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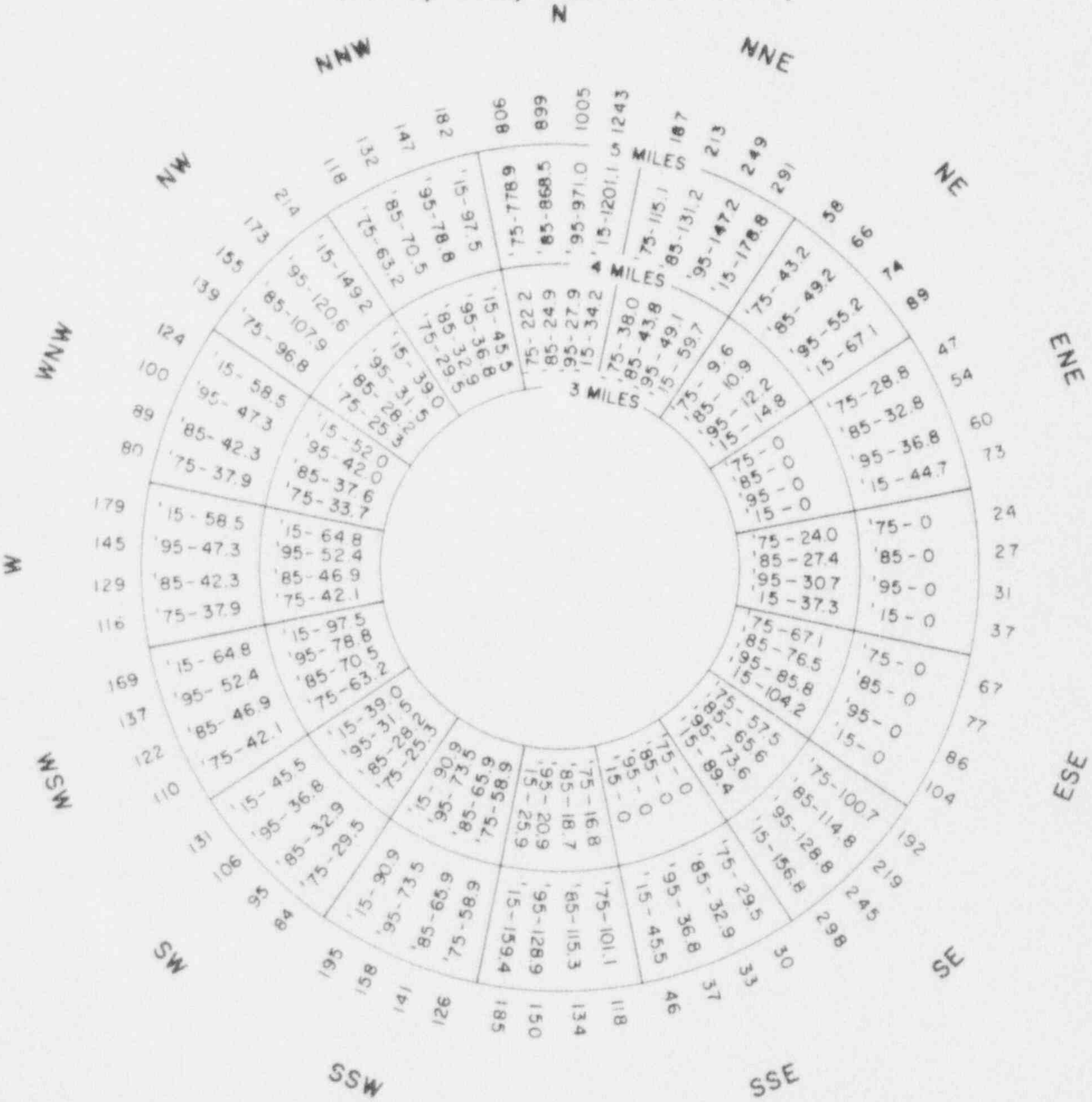
POPULATION DISTRIBUTION
0-3 MILES

SHEET 1 OF 4 FIGURE 2-17

POPULATION DISTRIBUTION *
3-5 MILES
(1975, 1985, 1995 AND 2015)



* NUMBER OF INHABITANTS PER SEGMENT

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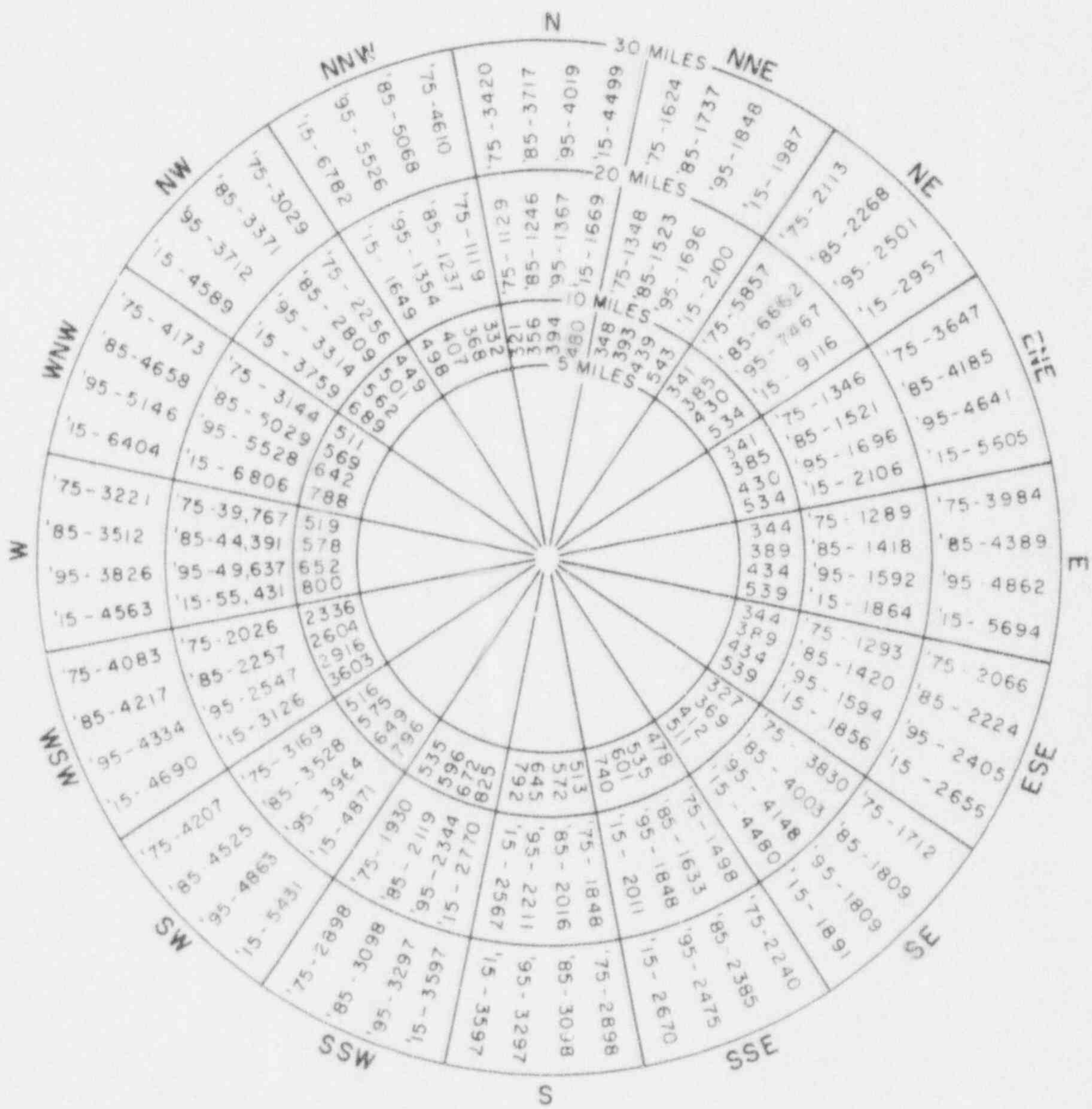
POPULATION DISTRIBUTION
3 - 5 MILES

SHEET 2 OF 4 FIGURE 2-17

POPULATION DISTRIBUTION *
5-30 MILES
(1975, 1985, 1995 AND 2015)



* NUMBER OF INHABITANTS PER SEGMENT

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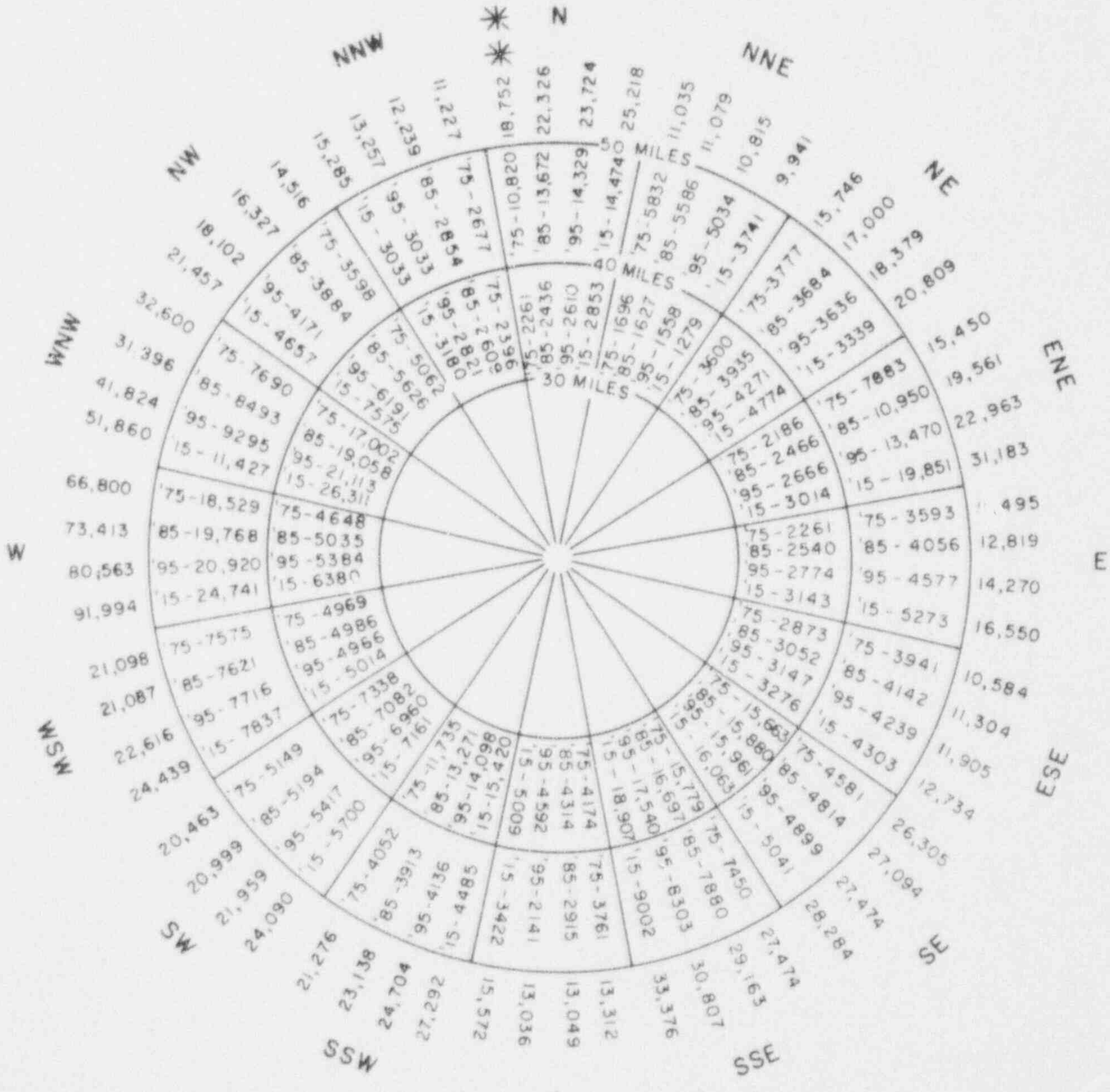
POPULATION DISTRIBUTION
5-30 MILES

SHEET 3 OF 4 FIGURE 2-17

POPULATION DISTRIBUTION *
30-50 MILES
(1975, 1985, 1995 AND 2015)



* NUMBER OF INHABITANTS PER SEGMENT

** TOTALS 0-50 MILES

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ENVIRONMENTAL REPORT

POPULATION DISTRIBUTION
30 - 50 MILES

SHEET 4 OF 4 FIGURE 2-17

The Chattahoochee and Flint Rivers join to form the Apalachicola River 44 river miles downstream from the site. Jim Woodruff Dam is located at this confluence and forms Lake Seminole which covers about 37,500 acres.

This initial phase of the comprehensive plan for development of the Chattahoochee, Flint, Apalachicola River basin, the Jim Woodruff Lock and Dam, was completed in 1957. The State of Alabama facility, the Columbia Inland Dock, near Columbia, Alabama received its first commercial barge shipment on January 30, 1958. Since that time the Chattahoochee River system has become increasingly important for commercial and recreational navigation. In the vicinity of the site the river is used to some extent for recreation and sports fishing with catches consisting mainly of cat-fish, bream and bass. However, the majority of such activities take place in Columbia Reservoir, three river miles upstream and further downstream in Lake Seminole. There is some commercial fishing in Lake Seminole. In the coastal waters near the mouth of the Apalachicola River (144 river miles downstream from the site) there is commercial fishing for shrimp, oysters, crabs, mullet, red snapper and grouper.

There are no known municipal water supplies taken from the river below the plant site. River water has been used intermittently for irri-gation by three downstream farms. The Great Southern Paper Mill uses river water for industrial purposes but no other industrial use is known.

Alabama Power Company personnel have made thorough field investi-gations to establish the water use of lower Chattahoochee-Apalachicola River Basin. Their findings have been confirmed by the U. S. Army Corps of Engineers.

2.4.8.9 Government Reservations and Installations

The Chattahoochee River, which is the eastern boundary of the site, has been developed by the U. S. Corps of Engineers by construction of facilities including the Jim Woodruff Lock and Dam (Lake Seminole) downstream and Columbia Lock and Dam upstream of the site.

The only federal recreational facility in Houston County is owned by the U. S. Corps of Engineers, and is located one mile south of Columbia. This is the Omussee Park located at the confluence of Omussee Creek and the Chattahoochee River. This area is used for picnicking and fishing, and U. S. Army Corps of Engineers representatives state there are long range plans for development of additional recreational facilities.

The Chattahoochee State Park, a tract of approximately 600 acres, is located in the southeast corner of the county about 14 miles south of the site. This park is a forested area containing a 17 acre lake and is open to the public for fishing, picnicking and hiking.

2.4.8.10 Scenic Or Unusual Aspects

There are no known unusual or unique aspects of the environment at the site or in the surrounding area.

1. Lyle, C. V., Chief Economist, Southeast Region - Federal Water Pollution Control Administration, U. S. Department of the Interior; Georgia County Population Projections As Developed By The Georgia Social Sciences Advisory Committee, February 1968

   Communications between the Applicant and the Federal Water Pollution Control Administration, U. S. Department of the Interior, Southeast Region; Total Population for all Counties, Alabama and Florida, 1968.

2. Houston County Resource Development Committee and Technical Action Panel, Overall Economic Development Program - Houston County, Alabama, 1968. Published by Cooperative Extension Service, Auburn, Alabama.

3. Waterway News of Alabama, February, 1958, Alabama State Docks Department, State of Alabama.

4. Rivers of Alabama, The Strode Publishers, 1968 (portion by Joel P. Smith)

5. Letter from Allen M. Mathews, County Extension Chairman, USDA

6. U. S. Department of Health, Education, and Welfare Public Health Service; Municipal Water Facilities, Region IV 1963 Inventory.

2.4.9 Plant and Animal Species Of Economic Or Sports Value

The following plants and animals of economic or sports value are found in the Joseph M. Farley Nuclear Plant site area.

On the upland soils the principal commercial timber species are loblolley, slash, short leaf and long leaf pines. On the somewhat poorly drained bottom land are found commercial species of pine, gum, oak, yellow poplar, and cottonwood. The principal crops in the area are peanuts, corn and hay. The principal domestic animals are swine and beef cattle. Quail, dove, rabbits and squirrel are common and deer, turkey, opossum and racoon are present in lesser numbers. Fish species of economic and sports value are bream, crappie, bass, carp, bullhead and catfish.

Plans for the site include designating a substantial portion of the site a wildlife preserve. This will include a 65 acre lake which will be available to wildlife in the area. Such a preserve would not only protect existing wildlife, but would also improve the opportunity for their propagation and migration to surrounding areas.

The applicant employs competent foresters who will oversee the planting and growing of timber species compatible with area soil conditions and the management of the area as a wildlife preserve.

Element analysis and radiological studies are underway to establish background information on fish, wildlife, crops, pork, beef, milk and topsoils in the area. It is anticipated that the plant's operation will have minimal or no adverse effect on plant and animal life in the area. Table No. 2-3 lists the fish available in the area.

TABLE 2-3

Common Name	Scientific Name
Sports Fish	
Redbreast Sunfish	Lepomis auritus (Linneaus)
Orange-spotted Sunfish	L. humilis (Girard)
Bluegill	L. macrochirus (Rafinesque)
Longear Sunfish	L. megalotis (Rafinesque)
Redear Sunfish	L. microlophus (Gunther)
Black Crappie	Pomoxis nigromaculatus (LeSueur)
Largemouth Bass	Micropterus salmoides (Lacepede)
Warmouth	Chaenobryttus gulosus (Cuvier)
Stripped Bass	Morone Saxatilis (Walbaum)
Fish of Commercial Value	
Carp	Cyprinus carpio (Linneaus)
Black Bullhead	Ictalurus melas (Rafinesque)
Yellow Bullhead	I. natalis (LeSueur)
Brown Bullhead	I. benulosus (LeSueur)
White Catfish	I. catus (Linneaus)
Channel Catfish	I. punctatus (Rafinesque)

2.4.10 Previous, Present and Anticipated Future Aspects of the Area

Prior to and at the beginning of recorded history, the Chattahoochee River served as a major communication route for the regional Indians and early settlers. This is evidenced by mounds, town sites and artifacts in the region. Due to its access to the river, the site was probably used for hunting by the Indians. With the encroachment of settlers and the development of cotton farming the river was used for transportation of that product to Apalachicola, Florida, which flourished in the early and middle 1800's as a seaport town. The site probably was used to grow cotton and other crops by early settlers. In the last few years, peanuts and corn have been the major crops raised in the area.

It is planned that a large portion of the site will be used for a wildlife preserve, limited recreational areas and a visitor's center. In this manner the site in the future will probably support more wildlife than has been possible in many years. It will also be of considerably more recreational and educational value to the public, and will also continue to be a productive area.

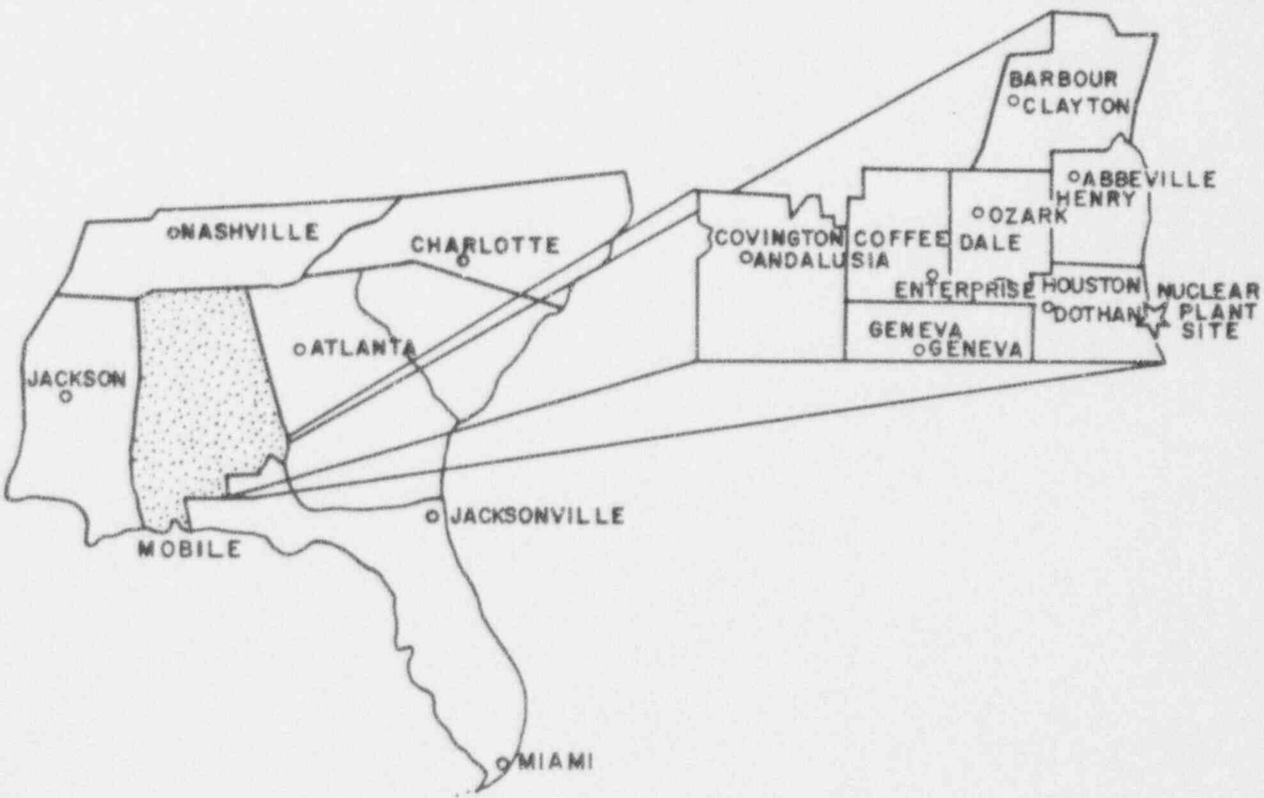
3.0 Environmental Impact of the Joseph M. Farley Plant

With the exception of radiological impact which is covered in Part 4, this Part 3 assesses the probable impact of the Farley Project on the total environment of the general area. This impact considers the compatibility of the plant facilities with area resources, alternatives to proposed facilities and the net benefits of facilities selected.

3.1 Compatibility of Joseph M. Farley Plant with Planned Regional Economic Development

The site of the Joseph M. Farley Nuclear Plant is located in Houston County, a member county of the Southeast Alabama Regional Planning and Development Commission. The Commission is responsible for regional planning and development activities in the seven southeastern Alabama counties of Barbour, Coffee, Covington, Dale, Geneva, Henry and Houston. The seven counties also make up the Southeast Alabama Economic Development District, Figures 3-1 and 3-2, which was designated by the Economic Development Administration in April 1970, as authorized under the Public Works and Economic Development Act of 1965. The objective of the EDA Program is to provide for multi-county organizations whereby several counties can cooperate in and coordinate the planning and implementation of a regional program to stimulate development and growth in economically lagging areas. The District is also a designated State Planning and Development Commission and carries on regional planning activities, including land use planning, as well as local community planning assistance to municipalities throughout the district. This organization is also the designated regional "A-95" Review authority and in this role is responsible for the review and the coordination of all State and Federal programs and

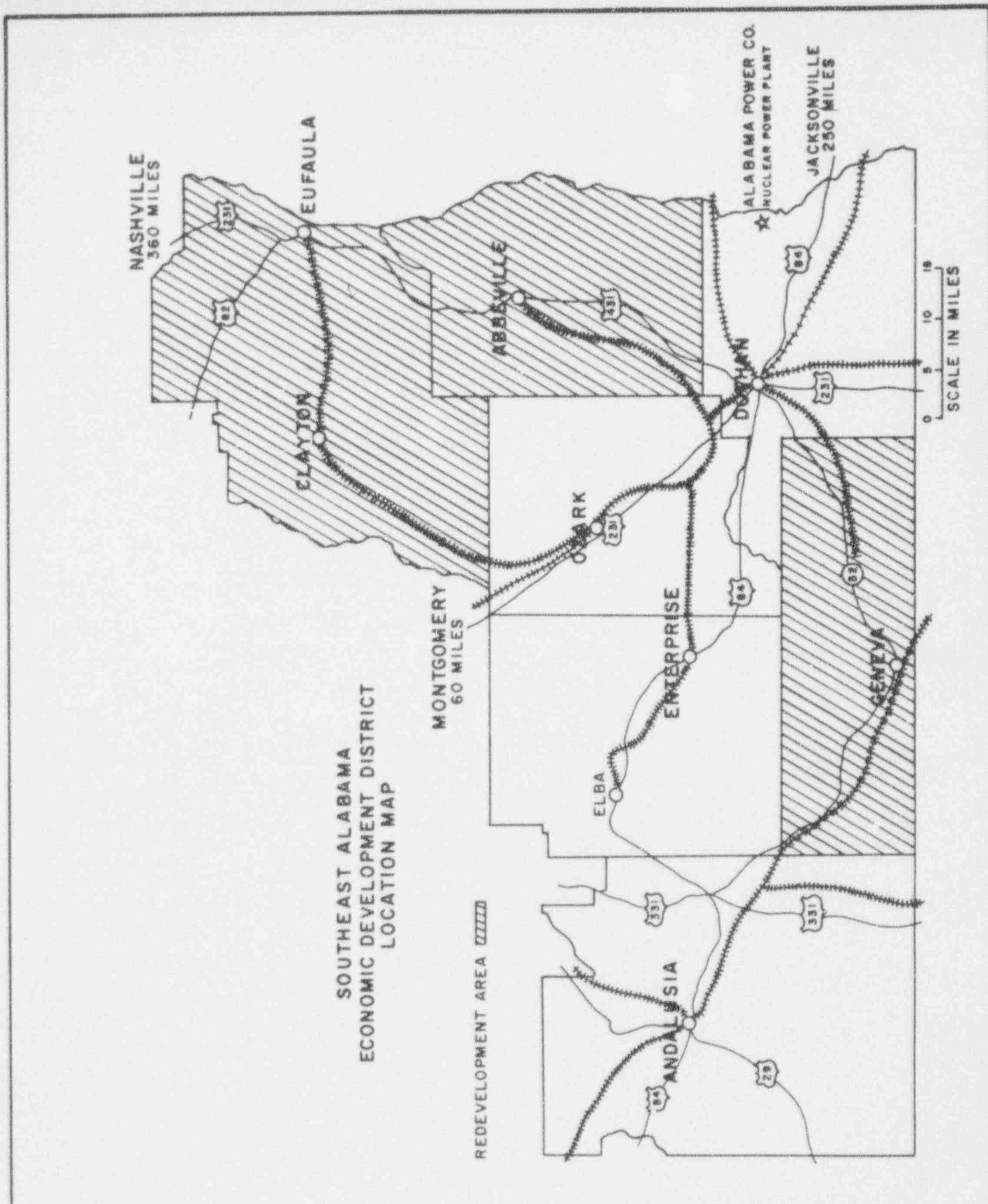
SOUTHEAST ALABAMA
ECONOMIC DEVELOPMENT DISTRICT



ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT

SOUTHEAST ALABAMA
ECONOMIC DEVELOPMENT DISTRICT
LOCATION MAP

FIGURE 3-1



ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT

SOUTHEAST ALABAMA
ECONOMIC DEVELOPMENT DISTRICT
LOCATION MAP

FIGURE 3-2

projects throughout its seven county area of jurisdiction.

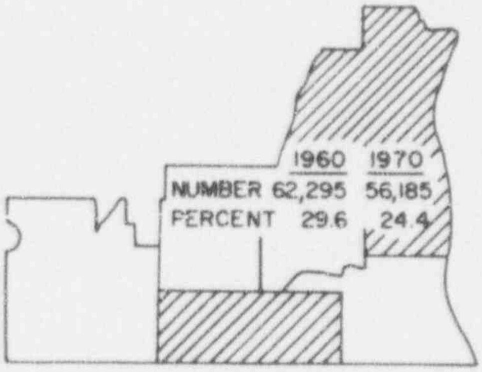
There are two other regional Planning and Development Commissions, which are also Economic Development Districts, some of whose member counties will be affected either directly or indirectly by the construction and operation of the Joseph M. Farley Nuclear Plant. These are the Lower Chattahoochee Valley Regional Planning and Development Commission with offices in Columbus, Georgia, and consisting of the Georgia counties of Chattahoochee, Clay, Early, Muscogee, Quitman, Randolph and Stewart; and the Southwest Georgia Area Planning and Development Commission with offices in Camilla, Georgia, and which consists of the Georgia counties of Baker, Calhoun, Colquite, Decatur, Dougherty, Grady, Lee, Miller, Mitchell, Seminole, Terrell, Thomas and Worth. Alabama Power Company has consulted with the staff of the Southeast Alabama Regional Planning and Development Commission on a regular basis and this has resulted in the mutual exchange of ideas and information on the proposed project and its relationship to the Overall Economic Development Program of the Commission and its environmental and economic impact on the area. The staff of the Southeast Alabama Commission has a direct working relationship with the staffs of the Southwest Georgia and the Lower Chattahoochee Valley Commissions, and has coordinated the dissemination of information on the proposed project between the company and the three affected Commissions.

The construction and operation of the Joseph M. Farley Nuclear Plant will have significant and prolonged regional economic impact. The Overall Economic Development Program (Stage I) of the Southeast Alabama Regional Planning and Development Commission, which was developed during the latter stages of planning of the nuclear plant project, makes a statement to this effect, in general terms. The Commission has stated that the proposed project will have a beneficial economic effect, especially on the "Re-development Area" counties close to the site of the plant as shown on Figure 3-3. These Re-development Area counties are counties which have been designated by the Economic Development Administration, Department of Commerce, as eligible for public works grants and loans and other benefits under the Economic Development Act of 1965, because of experience of high out-migration, low median family incomes, high unemployment, or a combination of these factors. (Refer to Figure 3-4.) The Re-development Areas closest to the site are Henry County, Alabama, and Clay, Early, Miller and Seminole Counties, Georgia.

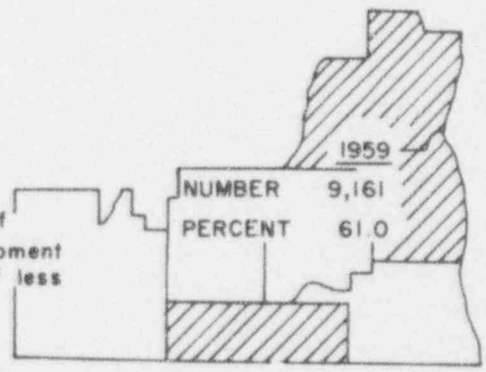
The Regional Planning and Development Commissions are enthusiastic in their support of the project because they believe that employment opportunities, especially in the poorer member counties, in the long construction phase, and later in the operational phase of the project, will help to significantly raise the living conditions and income levels of residents of these counties, and will have a significant income generating effect through the region.

The short-term economic impact in this region will be considerable. During the construction phase of the project (1971-1977) the total payroll of the prime contractor and sub-contractors will approach $70 million for the period. Using the customary multiplier of 2.5, this payroll alone will have a regional economic impact of approximately $175 million. Besides direct employment in the Region as a result of the project, there will be considerable impact on employment and income in such service industries as restaurants, motels, trailer courts, as well as in wholesale and retail trade.

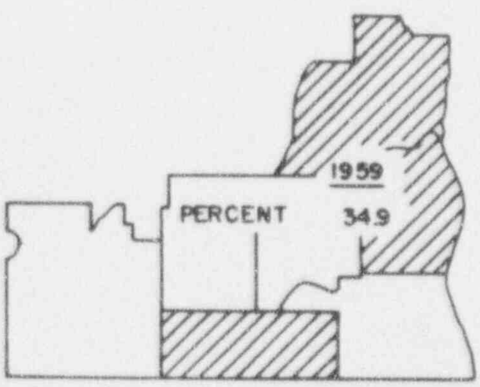
SOUTHEAST ALABAMA
ECONOMIC DEVELOPMENT DISTRICT



Number and percent of persons living in Re-development Areas.



Number and percent of families in Re-development Areas with income of less than $3,000 a year.



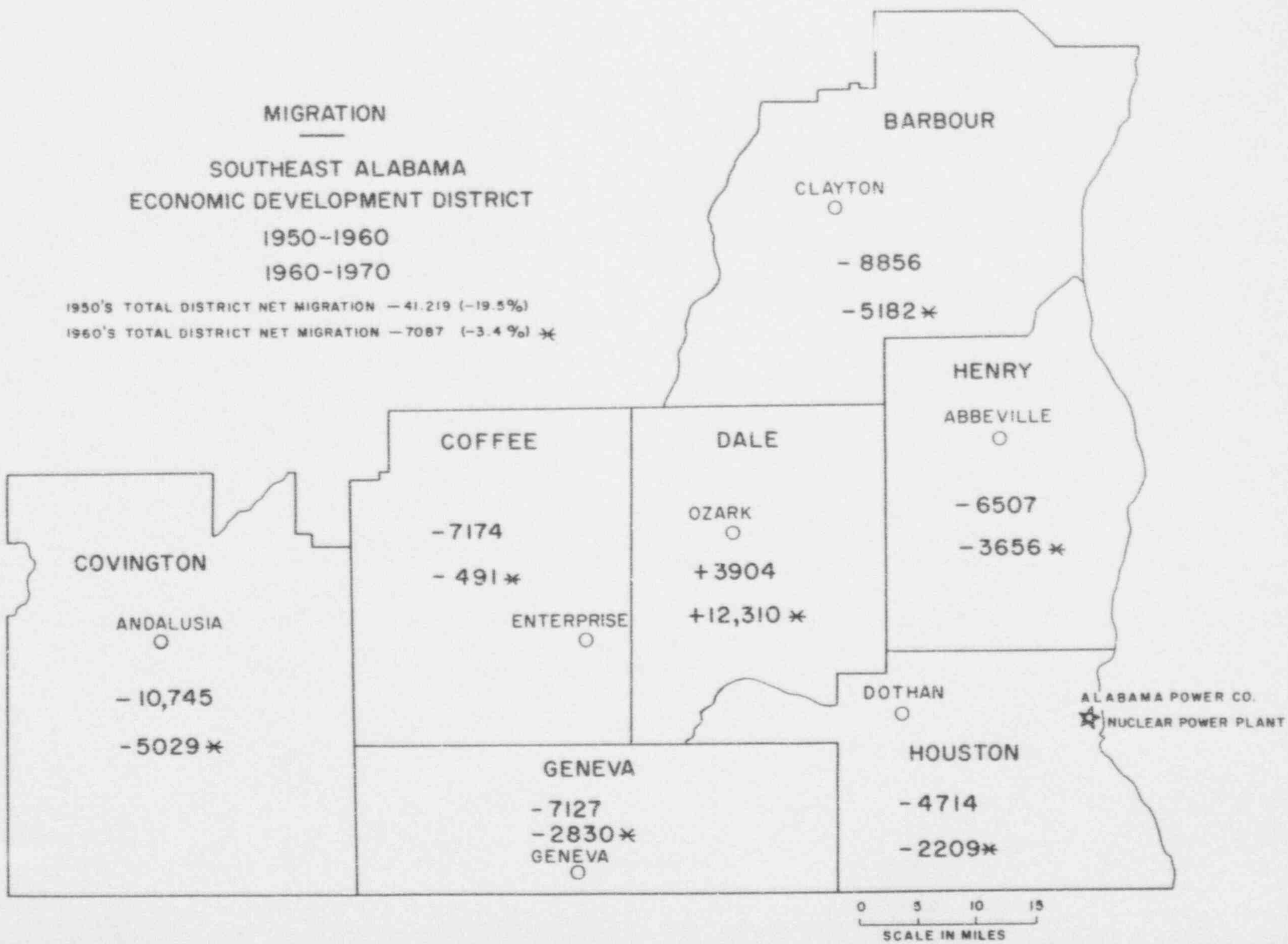
Families in Re-development Areas with income of less than $3,000 per year, as a percent of the total number of families in the District with an annual income of less than $3,000.

▨ REDEVELOPMENT AREA

ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT

SOUTHEAST ALABAMA
ECONOMIC DEVELOPMENT DISTRICT
REDEVELOPMENT AREA

FIGURE 3-3



ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT

SOUTHEAST ALABAMA
MIGRATION MAP

FIGURE 3-4

In addition to the economic impact of the large construction payroll, there is also the impact within the region of the purchase of large amounts of materials and supplies from local businesses. Records indicate that almost $2 million has gone into the local economy in recent months for purchases from over 100 local suppliers.

The long-term impact of the project on the area is perhaps the most important. The $500 million investment that the completed project will represent is an indication of the confidence of the company in the potential of the entire area and will be the largest single investment made in the State of Alabama by an investor-owned utility. When the plant is in operation, the permanent work force of 125 highly skilled professional and technical employees (with an annual payroll of $1.4 million) will be an asset to the communities in which they reside. Also, when the plant is completed, Houston County will realize an increase in ad valorem tax revenue from approximately $1.2 million to $3.2 million - without any significant additional burden for increased services as a result of the construction of the plant. This will increase the ability of the county to finance increased public services such as those to public education, health, welfare, etc., and make it possible for it to qualify for Federal grants-in-aid by providing a source of local matching funds. A large section of the county is a designated Economic Development Center (Growth Center) within the Southeast Alabama Economic Development District and as such qualifies for grants of 50% of total cost (from the Economic Development Administration) of projects designed to stimulate economic development in the Growth Center, thus contributing to the improvement of economic and social conditions in the surrounding Re-development Area counties.

SOUTHEAST ALABAMA REGIONAL PLANNING & DEVELOPMENT COMMISSION

P.O. BOX 1406 DOTHAN, ALABAMA 36301 TELEPHONE 794-4093

July 2, 1971

BARBOUR
COFFEE
COVINGTON
DALE
GENEVA
HENRY
HOUSTON

Mr. Joseph M. Farley, President
Alabama Power Company
Birmingham, Alabama

Dear Mr. Farley:

This organization is fully aware of your Company's plans with regard to the proposed Nuclear Power Plant to be located east of Dothan near the Chattahoochee River, in this District.

We believe that this project will significantly increase the economic potential of Southeast Alabama and will be an important factor in raising the living standards and income levels of the residents of our area. We believe that it will also contribute to the attractiveness of the Chattahoochee River as a site for both industrial and recreational development.

We therefore strongly endorse the project from an economic development standpoint. We have been receiving, on a regular basis, information with respect to your plans for the construction of the plant both from your company and the Atomic Energy Commission in Washington.

If we can be of further assistance in providing you with information on the social and economic characteristics of this area, please feel free to call upon us.

Sincerely,

William T. Cathell
Executive Director

WTC/dg

Southwest Georgia

Planning & Development Commission

POST OFFICE BOX 346 - CAMILLA, GEORGIA 31730 - PHONE 912-336-5616-5617

September 13, 1971

Mr. W. T. Cathell, Executive Director
207 Plaza - 2
Dothan, Alabama 36301

Dear Bill:

The matter of the impact of the Joseph M. Farley Nuclear Plant of the Alabama Power Company near Columbia, Alabama on the economy of Southwest Georgia is not open to question.

As you know, we have been having, within our staff and the Commission, a discussion as to the potential for future energy shortages in our area. The new Alabama Power facility would, through its tie into the Southeastern grid system, provide a backup for the demands presently being made upon Georgia Power Company.

But our more real concern is the need for economic expansion. We have a very active program aimed at improving the economic condition of our area. We have completed a study of the potential for additional manufacturing opportunities in plastics. The potential is there. We have distributed over 500 copies of this study to manufacturers. Their interest is growing each day.

We also have found and substantiated the need for additional manufacturing in the packaging industry. We have other research projects that will aid us in promoting the areas. Everything we have identified is a heavy user of electricity. Moreover, the efforts of this office, along with other organizations such as yours, to accelerate the development of the Tri-Rivers system will make further demands on our energy sources or, if these sources cannot meet the demands, will make our efforts sterile. Our area with 9 EDA designated Redevelopment Area Counties cannot face the future except in despair under those latter conditions.

So, Bill, I'm saying that we need the Alabama Power Company facility. Let's hope that nothing is said or done that will delay its completion.

Sincerely,

Carroll

Carroll C. Underwood
Executive Director

CCU:nl

DATE RECEIVED 9-15-71
SUSPENSE
ACTION 2
FILE
INFO 2
1. SECRETARY [illegible]
2. DIRECTOR
3. ECON.
4. IND. SPEC.
5. PROJ. COORD.
6. PLANNERS
7. DRAFTSMAN
8. BOOKKEEPER

Lower Chattahoochee Valley

Area Planning & Development Commission

OFFICE OF
EXECUTIVE DIRECTOR

P.O. BOX 1908
COLUMBUS, GEORGIA 31902

September 13, 1971

Mr. William Cathell, Executive Director
Southeast Alabama Economic Development District
PO. Box 1406
Dothan, Alabama 36301

Re: Joseph M. Farley
Nuclear Power Plant

Dear Mr. Cathell:

I am taking this opportunity to write confirming our opinion of the proposed Joseph M. Farley Nuclear Power Plant, a project of the Alabama Power Company.

As you know, we represent a district that is bounded by the Chattahoochee River adjacent to the site of this facility on the Georgia - Alabama State Boundary.

Over these months we have had an opportunity to evaluate the potential economic effect and impact of this project on our district. I am pleased to report that our evaluations to date indicate a strong positive impact on the economic future of this region should this facility be constructed.

We would be happy to further discuss this project and its future potential to our region, at your convenience.

Very sincerely,

Rick Allen

Richard K. Allen
Executive Director

RKA/cjs

SOUTHEAST ALABAMA REGIONAL PLANNING & DEVELOPMENT COMMISSION

P.O. BOX 1406 DOTHAN, ALABAMA 36301 TELEPHONE 794-4093

September 14, 1971

BARBOUR

Mr. Joseph M. Farley, President
Alabama Power Company
Birmingham, Alabama

Dear Mr. Farley:

COFFEE

With regard to the effect of the proposed Joseph M. Farley Nuclear Plant on land use in Houston County, this Commission believes that the project is compatible with existing and proposed future land use, and does not conflict with the Regional Concept Plan being prepared by the staff of the Commission.

COVINGTON

The small acreage of land which will be withdrawn from agricultural use will have no significant impact on existing land use patterns. We understand that your company intends to reserve a substantial portion of the land acquired to be used as a wild life management area and we therefore feel that the ecological balance of the area will be largely maintained.

DALE

Sincerely,

J. Gary Ament
Chief Planner

GENEVA

JGA/dg

HENRY

HOUSTON

But perhaps the broadest long run economic impact on the entire region will be to increase its potential for future residential and industrial growth. Adequate sources of electric energy for industrial and residential purposes will become increasingly important if the region is to realize its potential for economic development. Realizing this, all three Regional Planning Commissions strongly endorse the project and have given their help and support in providing information and statistics on the area, when requested. Likewise, the Commissions have made it clear that the negative effect on the economic development potential of the entire region of the Lower Chattahoochee Basin of any prolonged delay in the completion of the project would be extremely severe.

3.2 Land Use Compatibility

The area surrounding the site is rural and sparsely populated. Table 3-1 shows the population density of the counties adjacent to the plant site and compares these densities to those of Georgia and Alabama. If the city of Dothan is excluded, the population density of rural Houston County is 38 persons per square mile.

Land use is oriented toward agriculture and forestry, more land being in forest and woodland than in row crops and pasture. The general trend in the past decade has been a shift from row crops to pasture and timberland. The main row crops are peanuts, corn and cotton, and hogs and beef cattle are the most important livestock raised in the area. Pulpwood and timber are the main forest products.

The largest city in the area is Dothan, 16.5 miles to the west of the site, with a 1970 population of 36,733. The largest town within 10 miles of the site is Ashford, 8.3 miles to the southwest, with a 1970

TABLE 3-1

POPULATION DENSITY OF COUNTIES ADJACENT TO PLANT SITE, COMPARED TO ALABAMA & GEORGIA

County	Area (Sq. Miles)	1970 Population	Population Density (Persons per Sq. Mile)
Houston (Ala.)	575	56,574	98
Henry (Ala.)	554	13,254	24
Early (Ga.)	524	12,682	24
Clay (Ga.)	200	3,636	18
Seminole (Ga.)	246	7,059	28
TOTAL	2,099	93,205	44
ALABAMA	50,708	3,444,165	68
GEORGIA	58,073	4,589,575	79

Source: U. S. Census of Population - 1970 population of 1,980.

The Southeast Alabama Planning and Development Commission has been consulted by Alabama Power Company and has given its assurance that the acquisition of the site for and construction of the power plant will not conflict with the regional land use plan being prepared by the Commission.

The Commission has prepared an existing land use map for Houston County. A copy of the plant area portion, Figure 3-5, is a part of this report. Table 3-2 shows the land use inventory in 1958 and projected land use in 1975, both for Houston County and for Henry County, which lies directly north of Houston County.

As can be seen from this table, Houston County has over 150,000 acres in cropland and about 200,000 acres in pasture, woodland and forest. The withdrawal of 1,850 acres from this total will have an almost negligible impact on existing and future land use patterns in Houston County. Also, the company intends to preserve a substantial portion of the 1,850 acres in its natural state as a wildlife preserve, thus assuring a minimal effect on the ecology of the area. Farming and forestry activities in the surrounding area will continue relatively undisturbed.

The long run effect of land use for industrial purposes, especially along the Chattahoochee River north and south of the plant, will most likely change somewhat, but this change will not conflict with existing and proposed plans. At present, over 500 acres on the west bank of the river approximately four miles south of the site are reserved for industrial development. This land is owned by the Dothan-Houston County Chamber of Commerce. The Southeast Alabama Regional Planning and Development Commission in its Overall Economic Development Program has stated that

LAND USE LEGEND
Agricultural
Woodland & Timberland
Residential
Commercial & Industrial
Public & Semi-Public
0
1
2
SCALE IN MILES
G E O R G I A
EARLY COUNTY
CHATTAHOOCHEE RIVER
EARLY COUNTY
G E

FIGURE 3-5

TABLE 3-2

LAND USE IN HOUSTON & HENRY COUNTIES, ALABAMA

EXISTING, 1958; PROJECTED, 1975

(Thousands of Acres)

	Cropland		Pasture-Range		Forest-Woodland		Other Land		Total	
County	1958	1975	1958	1975	1958	1975	1958	1975	1958	1975
Houston	188.7	147.1	54.7	80.9	105.1	115.7	5.3	5.9	353.8	349.6
Henry	128.2	120.5	18.7	17.7	185.7	191.4	21.3	18.8	353.9	348.4

Source: Alabama Soil and Water Conservation Needs Inventory
(State Soil Conservation Committee, 1961)

this tract should be developed for industrial purposes as its optimum use. The Commission sees no conflict with future plans, therefore, as a result of the construction of the nuclear power plant. The Commission has also indicated its feeling that this could be especially important in the next several years as an employment alternative to the helicopter pilot training center of Fort Rucker and related defense oriented industries which have recently released and no doubt will continue to release, workers as a result of cut-backs due to the declining role of the U. S. in Southeast Asia.

It is anticipated that land use for the construction of transportation facilities, especially highways, will change somewhat, but not to a great extent. Increased traffic on U. S. 84 East from Dothan and on State Highway 52 from Dothan to Columbia, and also on State Highway 95 South from Columbia to the site will result from workers commuting to the site during the 6-year construction period.

The State Highway Department has plans for four-laning of U. S. 84 East from Dothan to the Chattahoochee River and the construction of a new 39 ft. clearance bridge over the river. Funds have been appropriated and contracts will be let within three years.

There are also plans to widen State Highway 52 from Dothan to Columbia. Both of these highways are heavily traveled and plans for their improvement were not contingent upon the construction of the power plant, although this will make the improvements even more necessary. State Highway 52 carries local tourists and commuters between Dothan and Columbia and Blakeley, Georgia. U.S. Highway 84 East carries commercial and tourist traffic to connect with Interstate Highway 75 going north to

Atlanta and south to Florida. Highway 84 is also used heavily by local commercial traffic such as logging trucks.

Alabama Power has constructed a railroad spur to move construction materials and equipment to the site during construction and may transport nuclear fuel and other materials after the plant is placed in operation. The railroad is connected with the Central of Georgia Railroad at Columbia, some five miles to the north. This opens up the possibility that if later, this spur were extended south to connect with the Seaboard Coast Line track, the Chattahoochee River would have greater potential for industrial development, so that in the long run, existing land use along the western bank of the Chattahoochee River could change, although this would not necessarily conflict with future land use plans, as has already been pointed out.

A 269 acre recreation area just south of Columbia on Omussee Creek and the Chattahoochee River, which has been partially developed by the U. S. Army Corps of Engineers, will be leased by the Corps to the State of Alabama for further development into a park with amenities for camping, fishing and boating, will attract local tourists to the general area of the plant site. The proposed visitor center on the site will, no doubt, encourage these tourists to stay longer in the general area to take advantage of the opportunity to combine a camping and/or fishing outing with a visit to the information center at the plant. This is the major impact on recreational activities that is foreseen as a result of the location of the plant in the area.

The plant location is not in any designated public owned wildlife sanctuary or preserve, so no adverse effect is expected on the wildlife of the area. Indeed, it is the intention of Alabama Power to set aside lands around the plant as a wildlife preserve to encourage the propagation of birds and animals indigenous to the area. Plant facilities, for the most part, are to be situated in areas which already had been cleared for farming, thereby making it possible to leave untouched and in its natural state much of the surrounding land. Certain other presently cleared areas on the site will be allowed to return to a state compatible with good wildlife preserve management.

To summarize, the location of the plant on its proposed site will have no important effect on the presently existing conditions of wildlife in the area. Furthermore, no detrimental change in land use for outdoor recreational activity will result from the construction of the plant on the proposed site.

Future land use for residential and commercial purposes in the area will depend upon the rate of growth and development. The location of the power plant will increase the potential for growth of the entire region, as has been pointed out. The Southeast Alabama Regional Planning and Development Commission's regional plan and its plans developed for municipalities include projections of needs for various land categories, including commercial and residential. No conflict of land uses as proposed in these plans is foreseen as a result of the location of the plant on its proposed site.

3.2.1 Environmental Impact of Transmission Routes

The electrical power generated at the Joseph M. Farley Plant will be delivered to the interconnected transmission system of Alabama Power Company and The Southern Company ·· 230 Kv and 500 Kv transmission lines. The size, voltage levels, and routings of these lines were determined primarily on the basis of reliability of electrical service.

Initial studies for these transmission facilities began in 1968. Load flow and transient stability studies simulated peak hour conditions in the period 1975-1977 with the initial operation of the two Farley units in 1975 and 1977. Three basic plans involving different combinations of lines and different voltage levels were studied. Alternatives of different line conductor sizes were also considered.

The plan selected is:

(a) Two 230 Kv lines to Alabama Power Company substation at Pinckard.

(b) One 230 Kv line to Georgia Power Company.

(c) One 500 Kv line to Georgia Power Company (Initial operation at 230 KV).

(d) One 500 Kv line to Alabama Power Company substation in Montgomery, Alabama.

Georgia Power Company will be responsible for the transmission connections from the Farley substations to the Georgia system which is adjacent to the Farley Plant on the east side of the Chattahoochee River.

The first 230 Kv line to Pinckard will be energized by mid-1973 to supply plant testing power. The other 230 Kv lines will be completed between 1973 and 1975. The 500 Kv lines will be required for service with Unit #2 by 1977.

Underground transmission lines to deliver the amount of power to be produced at the Farley Plant are not considered technically feasible or economically justifiable. Transmission of such blocks of power at 230 Kv underground is estimated to cost in the order of 10 to 40 times more than conventional overhead construction.[1]

Projection work was begun on the Farley transmission line routes early in 1970. Aerial maps and other geographical data were obtained. Figure 3-6 indicates the general routes that were considered. Detailed field investigations were conducted and final routes selected. The three routes which were selected are discussed below:

(a) Farley-Webb 230,000 Volt Line

This line is approximately 10.5 miles long and runs in a westerly direction from the Farley Plant Substation to the Webb Transmission Substation. The right-of-way will be 125 feet wide. The present land use along the right-of-way route is primarily agricultural. There are no towns along this route; therefore, the route runs in an almost straight line with only slight deviations for churches, homes and road crossings. There are no places in this area listed in "The National Register of Historic Places, 1969", published by the National Park Service, U. S. Department of the Interior. There is no public use land along this route, except for roads and highways, and the route is located in an area which is not subject to floods from the Chattahoochee River. The area traversed by the route is served by a network of roads which will provide a means for easy access for construction and maintenance of the transmission line. It is anticipated that land in this area will continue to serve agricultural

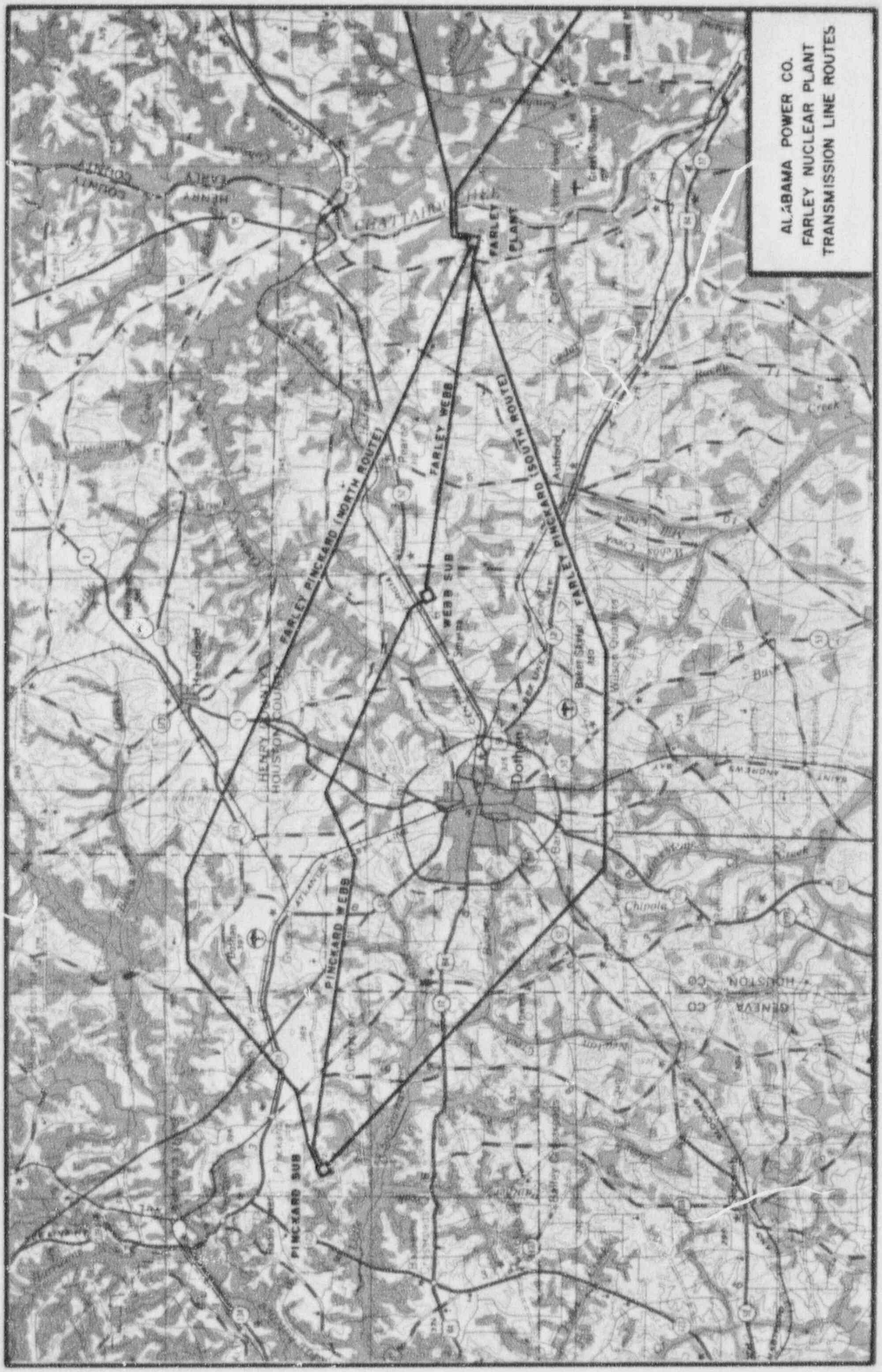

ALABAMA POWER CO.
FARLEY NUCLEAR PLANT
TRANSMISSION LINE ROUTES
FARLEY PLANT
FARLEY WEBB
FARLEY PINCKARD (NORTH ROUTE)
FARLEY PINCKARD (SOUTH ROUTE)
WEBB SUB
PINCKARD WEBB
PINCKARD SUB
Dothan
Statute Miles

FIGURE 3-6

needs and the area will remain essentially rural. This line will therefore have little or no impact on land use. A straight line route is desirable because it requires the least amount of land and is the least costly to build. The major adverse environmental impact resulting from construction of this line will be from its effect on agricultural use of the land, and this will be minimal. It will not appreciably affect production of trees, shrubs, grass or other plants, and will have no effect on birds, animals, fish or other fauna. Cultural factors, such as land use and recreation will not be affected to any extent by the selection of this route.

Route selection was also evaluated on the basis of the Federal Power Commission's Guidelines for the Protection of Natural, Historic, Scenic and Recreational Values in the Design and Location of Rights-of-Way and Transmission Facilities. The route selected complies with applicable items of this document.

(b) Webb-Pinckard 230,000 Volt Line

This line is approximately 18.5 miles long and runs in an easterly direction approximately 10 miles from the Pinckard Transmission Substation to a point north of Dothan, then northeasterly approximately 2 miles, and then southeasterly to the Webb Transmission Substation. The right-of-way is 125 feet wide. The land along this route is now used primarily for agriculture. The route is almost straight with slight deviations to miss a trailer park at Highway 231 and a subdivision north of Dothan. There are no places in this area listed in "The National Register of Historic Places, 1969". There is no public use land along the route, except for roads and highways, and the route is located in an area which is not subject to floods from the Choctawhatchee River. The area traversed by the route has a network of roads providing easy access for construction and maintenance of transmission lines. It is anticipated that land in this area will remain essentially rural except for the land between Highway 231 and Highway 431. Construction of this line should have little impact on the environment of this area. A straight line route is desirable because it requires the least amount of land and is the least costly to build. The major adverse environmental impact resulting from construction of this line will be from its effect on agricultural use of the land, and this will be minimal. It will not appreciably affect production of shrubs, trees, grass or other plants, and will have no effect on birds, animals, fish or other fauna. Cultural factors, such as land use and recreation will not be affected to any extent by the route choice.

Route selection was also evaluated on the basis of the Federal Power Commission's Guidelines for the Protection of Natural, Historic, Scenic and Recreational Values in the Design and Location of Rights-of-Way and Transmission Facilities. The route selected complies with applicable items of this document.

(c) Farley-Pinckard 230,000 Volt Line

Two routes were considered for this line. A north route which was considered was approximately 30 miles long and ran in a west-north-west direction from the Farley Plant Substation to a point northeast of the Dothan Airport, then west approximately 2 miles, and then southwest to the Pinckard Transmission Substation. A south route which was chosen was judged preferable because there are fewer towns along the route and also because it does not go near the Dothan Airport. This line was routed around the City of Dothan. There are no places in this area listed in "The Register of Historic Places, 1969". There is no public use land along this route, except for roads and highways, and the route is located in an area which is not subject to floods from the Chattahoochee River.

The area has a network of roads which provide a means for easy access for construction and maintenance of the transmission line. Currently there are no major transmission lines in the area south of Dothan. Additional power requirements for this area could be served from this line.

The environmental impact of this line will be limited to the effects of the line on agricultural development in the area, and this will be minimal. The route selected is expected to remain out of heavily populated areas of Dothan for many years. Construction of this line will not appreciably affect production of trees, grass or other plants, and will have no effect on birds, animals, fish or other fauna. Cultural factors such as land use and recreation will not be affected by the selection of this route.

Route selection was also evaluated on the basis of the Federal Power Commission's Guidelines for the Protection of Natural, Historic, Scenic and Recreational Values in the Design and Location of Rights-of-Way and Transmission Facilities. The route selected complies with applicable items of this document.

The projection of the route for the Farley-Montgomery 500,000 volt line has not been completed.

This line is estimated to be approximately 105 miles long. It will be constructed on a 150 foot wide right-of-way and will traverse a sparsely populated, relatively flat area similar to that between Farley and Pinckard. By using guidelines similar to those applied to the 230,000 volt line already described, Alabama Power Company will minimize the environmental impact of this line to the area which it traverses.

The economic effects of these transmission rights-of-way can be evaluated on the basis of estimated loss of income to the landowner.

In Figure 3-7, the three transmission line routes selected are divided into use and revenue evaluation by county. Land use classifications are wood product areas, farm crop or cultivated areas and pasture areas. Acreages devoted to such uses were determined from maps made from aerial photographs. The revenue derived per acre from these land uses is based on data supplied by the Annual Report of the Houston County Agent. In Table 3-3 the total farm income for Houston County is shown on a crop-acre-income basis.

Gross figures supplied in the data have been modified to represent a net income figure by the application of a 30 percent factor as an averaged multiplier to reduce gross to net. This factor was recommended by the Houston County Agent.

Annual average income from cultivated areas was estimated to be $40 per acre, while that from wood product areas was estimated to be $5.40 per acre, based on 20-year cutting intervals. To determine the reduction of annual income from the property caused by the construction of the

TOTAL ANNUAL LOSS OF REVENUE PER ACRE

	LENGTH IN MILES	ACRES IN R/W	ACRES R/W IN WOODS	ACRES R/W IN FARM	ANNUAL TAX PAID TO COUNTY FOR LINES	ANNUAL TAX PER ACRE	ESTIMATED TOTAL ANNUAL REV. FROM PRESENT USE		DEVALUATION FACTORS DUE TO LINE			ANNUAL LOSS OF REVENUE DUE TO TRANS. LINE			TOTAL ANNUAL LOSS OF REVENUE PER ACRE
							TIMBER	FARM	TIMBER	FARM	PAST.	TIMBER	FARM	PAST.	
I FARLEY-WEBB															
10.5 MILES					*		**	**							
1. HOUSTON CO.	10.5	159	51.5	107.5	$1,060	$6.67	$278	$4,300	1	.1	0	$278	$430	0	$4.45
2. DALE CO.	0	0	0	0	–	–	0	0	1	.1	0	0	0	0	0
II WEBB-PINCKARD															
18.5 MILES															
1. HOUSTON CO.	12	181	49.5	131.5	1,210	6.67	267	5,260	1	.1	0	267	526	0	4.38
2. DALE CO.	6.5	98	27	71	630	6.41	146	2,840	1	.1	0	146	284	0	4.39
III FARLEY-PRICHARD SOUTH															
31 MILES															
1. HOUSTON CO.	27	408	126	282	2,721	6.67	680	11,280	1	.1	0	680	1,128	0	4.43
2. DALE CO.	4	60.5	19	41.5	386	6.41	103	1,660	1	.1	0	103	166	0	4.45

* BASED ON CURRENT METHOD OF TAX PAYMENT AND ESTIMATED VALUE OF $80,000 PER MILE FOR CONSTRUCTION AND RIGHT OF WAY

** TIMBER ANNUAL VALUE EQUAL $5.40/ACRE AND FARM VALUE AT $40/ACRE. SEE ITEMS I AND II OF REPORT. HOUSTON AND DALE COUNTY FIGURES ASSUMED EQUAL.

NOTE 1: FOR PURPOSES OF ANNUAL LAND INCOME, ALL OPEN LAND ASSUMED AS CROP LAND WITH DEVALUATION FACTOR OF .1

ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT

TOTAL ANNUAL LOSS OF REVENUE PER ACRE

FIGURE 3-7

TABLE 3-3

1970 - HOUSTON COUNTY FARM INCOME
TOTAL RURAL ACREAGE - 350,000

1. FARM CROPS, FRUITS AND NUTS

130,000 Acres Available - 106,725 Acres Harvested

Crop	Acres Harvested	Gross Income	Gross Income Per Acre
Cotton	7,300	1,586,462	217
Peanuts	31,215	8,615,340	276
Soy Beans	1,500	66,000	44
Corn	40,000	1,600,000	40
Sorghum	6,000	270,000	45
Grains	9,200	196,000	21
Pecans	500	128,000	256
Vegetables	9,000	1,500,000	167
Watermelons Canteloupes	2,000	240,000	120
Fruits	10	10,000	1,000
TOTALS	106,725	14,211,802	133

Estimated net income at 30% of gross income = $40/acre harvested

TABLE 3-3 (Continued)

2. TIMBER LANDS

Total Acreage	- 130,000
1970 Harvest	- 6,000 Acres
1970 Income	- \$650,000
1970 Income/Acre Harvested	- \$108 Stumpage

Based on cutting each 20 years, annual value of wood products/acre = 108/20 = \$5.40

3. LIVESTOCK AND PASTURE (55,000 Acres)

Cattle and Calves	\$ 2,000,000
Hogs and Pigs	\$ 2,344,000
Dairying	\$ 365,000
Broilers	\$ 100,000
Eggs	\$ 905,000
Total	\$ 6,714,000

Gross income equals 6,714,000/55,000 = \$122 per acre.

Net income @ 30% of gross equals \$37 per acre.

4. Remaining acreage not in use or rented to Federal Government = 58,275

23,275 Acres Idle Crop Land
15,000 Acres Govt. Programs
20,000 Acres Non-Productive Land

Government payments plus hunting rights = 221,060 and assuming this is averaged over above land = \$3.79 per acre.

transmission line, a devaluation factor was applied which represents the estimated reduction in productivity. Wood products will be eliminated on the transmission line right-of-way and, therefore, a devaluation factor of one was used. Cultivated land is not affected to any great extent since less than one percent of the land will be removed from productivity. However, a devaluation factor of one-tenth was assumed for this type of property use, based on considerations of inconvenience to the owner. Pasture land is only slightly affected by transmission lines and therefore a devaluation factor of zero was applied to pasture areas. Figure 3-7 shows these reduction factors and the total annual loss of revenue in dollars per acre for land used for right-of-way. This is compared in Figure 3-7 with the estimated annual tax payment which is expected to be made to Houston County for the transmission lines. It is recognized that only a small portion of the tax payment will benefit the landowner. Therefore, the initial price paid for the right-of-way is treated as a direct purchase from the landowner.

The economic effect on the area of construction of these transmission lines will be small and will be compensated for by tax payments to the County as well as by purchase of the rights-of-way.

3.2.2 Environmental Impacts of Transportation Systems

The Joseph M. Farley Plant site was originally selected for either nuclear fueled or fossil fueled units. Consequently, it was considered essential for the site to have easy access to transportation facilities suitable for carrying heavy loads. Highway 95, which is the west boundary of the site, can provide access to the site from the surrounding area. This will be used by construction employees and for the transportation of much of the equipment and supplies needed. It will also be used for access by permanent employees and for the transportation of most of the plant operating supplies. This use will cause little additional environmental impact. The on-site access roads will have some environmental impact but this should be more than offset by the use of a large portion of the site area as a wildlife preserve.

The Chattahoochee River will be used for barge transportation of the reactors and other heavy plant equipment items. It is desirable to transport this equipment by barge, not only for economic reasons, but also because overland transportation of these items would require rebuilding or strengthening of numerous highway or railroad bridges. This work and the shipment of the equipment overland would be disruptive to the normal flow of transportation and would create more environmental impact than barge transportation.

The construction and use of a 5 mile long railroad connecting the Joseph M. Farley Plant to the Central of Georgia Railroad at Columbia, Alabama, is not essential to the plant's construction or operation, but it is desirable for two major reasons. These are:

(a) Construction of the plant can be accomplished at less cost by building and using the railroad for the transportation of heavy construction equipment and bulk materials. This will also remove a considerable amount of truck traffic from State Highway 95.

(b) It was considered desirable to have the alternative to ship the radioactive spent fuel from the plant in special railroad cars as well as by specially designed trucks.

The construction and use of this railroad does have an environmental impact but this is more than offset by removing some of the heavy truck traffic from public highways.

3.2.3 Environmental Impact of Railroad Routes

Three basic alternative railroad routes were investigated. The route selected runs from the Joseph M. Farley Plant about 5 miles northward to a point within the railroad yard limit of the Central of Georgia Railroad immediately west of Columbia, Alabama. This route had the following advantages:

(a) It was estimated to be the least costly route on which to build a railroad.

(b) The bridge over Omussee Creek did not require clearance for commercial navigation.

(c) The foundation material for bridge piers was very competent and required a minimum amount of preparation.

(d) Although this route crosses three secondary roads, they are not heavily traveled.

(e) This route had less potential for causing environmental impact due to its relatively short length and its not materially altering the hydrological characteristics of the Chattahoochee Valley.

Another route considered was from the Joseph M. Farley Plant to a point on the Seaboard Coast Line Railroad southwest of Gordon, Alabama. This route was approximately 7 miles long. It required building a bridge over Cedar Creek and crossing State Highway 95. This route was rejected because:

(a) It was longer than the route selected and was, therefore, more costly and required more right-of-way acreage.

(b) The bridge over Cedar Creek would have required rather large and long abutments.

(c) The foundation material for bridge piers was not as satisfactory as that underlying Omussee Creek.

(d) A grade crossing over Highway 95 would have been required.

The third route considered was from the Joseph M. Farley Plant eastward across the Chattahoochee River to a point on the Chattahoochee Valley Industrial Railroad. This route was rejected because:

(a) The high cost of constructing a bridge over the Chattahoochee River. The bridge would have had to be built high enough to provide vertical clearance for barge traffic on the Chattahoochee River or it would have had to have a movable section.

(b) Long abutments would have been required. These would have had the potential of affecting the hydraulic characteristics of the river during periods of high flow.

3.2.4 Environmental Impact of Water Storage Pond

An emergency cooling water storage pond, with an area of approximately 65 acres is being constructed as part of the Joseph M. Farley Plant. The primary purpose of the storage pond is to retain a minimum supply of cooling water to cool down and maintain the plant in cold shutdown condition for a minimum of 30 days assuming recirculation of service water from the plant to the pond, evaporative cooling, no makeup, a conservative seepage rate and atmospheric conditions, and heat load from either the shutdown of two units or shutdown of one unit and loss of coolant accident in the other. Although these events are highly improbable, circumstances can be postulated which would result in loss of water in the river should a dam located downstream fail and a dam located upstream be used to stop flow in the river.

The only possible alternative to the construction of a cooling pond is the use of a well water system, but this was considered impractical because of the extreme difficulty of developing a dependable well-water system which would meet the stringent requirements of the Atomic Energy Commission.

Alternative locations for the cooling water pond were considered. The most promising were (1) the impoundment of Rock Creek, and (2) the excavation of a deep basin on the river bank in the flood plain. The impoundment of Rock Creek was abandoned because it would have flooded Highway 95 and produced other undesirable effects by the flooding of a larger area both on and off the site. The excavation of the basin was not selected because of undesirable effects in the event of a flood and the difficulties resulting from permeability and instability of the alluvial materials in the flood plain.

The pond which will be constructed will have no adverse environmental impact other than precluding use of the land for other purposes. A portion of the pond area was previously used as a farm pond. The water in the pond will serve as a desirable source of water for wildlife and waterfowl. Thus the net benefits of this pond are positive and greatly outweigh any environmental costs associated with its construction.

3.3 Water Use Compatibility

3.3.1 Hydrologic Aspects of Surface Water Use

Approximately 78,000 gpm of water will be withdrawn from the Chattahoochee River to serve the plant. It will furnish makeup water for the two-unit operation of the condenser cooling water systems. It is

estimated that approximately 28,000 gpm of water will be lost from the 1
cooling water systems due to evaporation and drift and approximately 37,000 gpm will be returned to the river as blowdown from the cooling water systems during full load operation of both units. The water lost to evaporation and drift constitutes the only significant impact of the facility on the surface water resources of the area.

The 28,000 gpm evaporation and drift from the cooling towers at 1
the Joseph M. Farley Plant will result in a small loss in generation at the downstream Jim Woodruff Hydroelectric Plant. No other water resource user along the river is adversely affected by this loss in water volume. Flow duration data extrapolated to the Jim Woodruff Dam site indicate a flow greater than turbine discharge occurs about 46.4 percent of the time.
Table 3-4 indicates that the loss of 28,000 gpm causes a maximum annual 1
generation loss of 592,000 KWH at Jim Woodruff Dam, all of which occurs during the time when river flows are less than the Jim Woodruff turbine discharge capacity.

3.3.2 Hydrologic Aspects of Groundwater Use

No reversal of the groundwater movement at the site is expected to occur as a result of the construction and operation of the plant. The movement of groundwater within the shallow aquifer at the site is eastward toward the Chattahoochee River. No reversal of this movement is expected to occur as a result of construction and operation of the plant; therefore, construction and operation of the plant are expected to have no adverse effect on the groundwater.

Likewise, any adverse effect on the major shallow aquifer is considered remote because of the aquiclude formed by the upper Lisbon and the artesian pressure associated with the aquifer. Any adverse effects on

TABLE 3-4

ENERGY LOST AT JIM WOODRUFF DUE TO

FARLEY COOLING WATER EVAPORATION

Evaporation Loss at Farley (14,000 gpm/unit)	31 cfs/unit
Drainage Area at Jim Woodruff[1]	17,150 sq. mil.
Installed Capacity at Jim Woodruff[1]	30,000 KW
Annual Energy from Jim Woodruff[1]	220,000,000 KWH
Gross Head[1]	33 ft.
Net Head[2]	30 ft.
Efficiency[2]	0.8
Turbine Discharge[2]	14,750 cfs
Flow Duration of Turbine Discharge[3]	46.4%

1

Annual Energy Lost Due to Farley Evaporation:

$$\frac{30,000}{14,750} \times 24 \times 62.2 \times .536 \times 365 = 592,000 \text{ KWH}$$

(1) Corps of Engineers Information Pamphlet

(2) Estimated

(3) Based on Gauge at Alaga, Alabama prorated to Woodruff site.

this aquifer are virtually eliminated as a result of these factors.

In addition to the reasons outlined for the major shallow aquifer, affecting the major deep aquifer is precluded due to the additional aquiclude formed by the upper Tuscahoma sand and the piezometric level of the major deep aquifer at about elevation 70 feet msl.

The possibility of adversely affecting the groundwater resources or existing wells in the area as a result of the operation of a nuclear plant is remote. The groundwater hydrologic characteristics of the site are quite favorable for the proposed location of a nuclear plant.

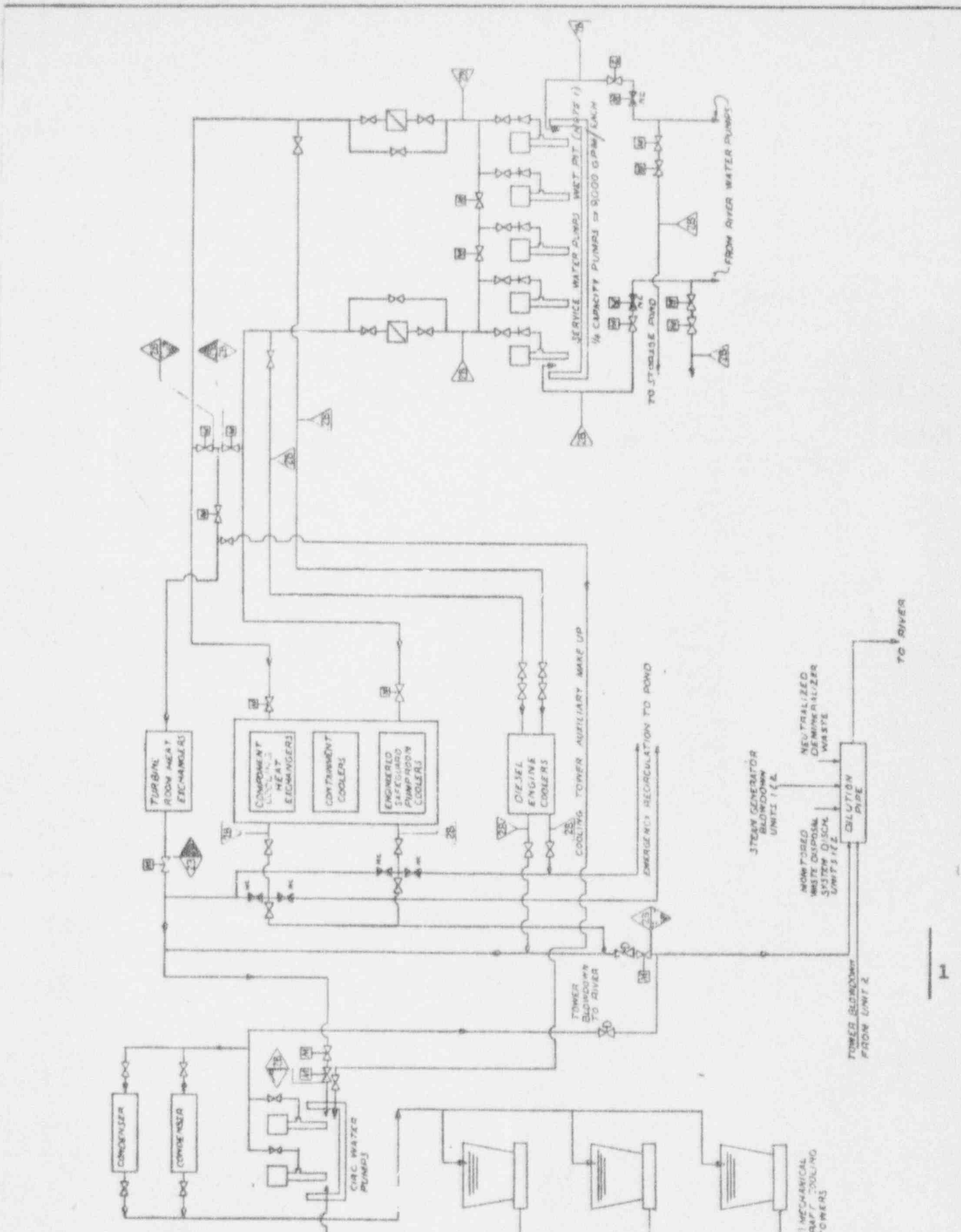
3.3.3 Heat Dissipation

3.3.3.1 Cooling Water System

The Condenser Circulating Water System constitutes a closed system loop integrated with mechanical draft cooling towers which reject heat to the atmosphere. Makeup water is supplied from the service water system outlet and the maximum flow is designed to provide allowances for evaporation, drift and blowdown. Figure 3-8 is a schematic representation of the plant service water system.

Each of the two units of the Joseph M. Farley Plant will be served by three mechanical draft cooling towers. The individual towers will each contain 12 cells and measure approximately 505 feet long by 62 feet wide by 59 feet high. The volume of the condenser flow through each of the plant's two units will be approximately 635,000 gallons per minute (1415 cfs). The water losses to evaporation and drift are estimated to be 14,000 gallons per minute (31 cfs) per unit, for a total of 28,000 gallons per minute (62 cfs). 1

To prevent excessive buildup of solids in the system, there will be a blowdown from the towers of each unit of approximately 18,500 gallons 1



Amend. 1 - 2/28/72

ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT

PLANT SERVICE WATER
SYSTEM FOR EACH UNIT

FIGURE 3-8

per minute (41.5 cfs), for a total of 37,000 gallons per minute (83.0 cfs). 1
To replace these losses and supply a relatively small quantity of plant service water will require maximum withdrawal rate of makeup from the Chattahoochee River of approximately 78,000 gpm (174 cfs) for the two units.

The cooling towers are designed on the basis of a wet bulb temperature of 78°F., with an approach of 11°F. The range of the towers (difference between inlet and outlet temperature) is 20°F. When the design wet bulb temperature prevails, the temperature of the blowdown water is expected to be approximately 89°F., but because the wet bulb temperature will be less than 78°F. almost all the time, the blowdown will normally be at a lower temperature.

Water withdrawn from the Chattahoochee River through the intake is delivered to a storage pond from which it is withdrawn for plant use. The storage pond serves also as an emergency cooling pond. It has an area of 65 acres and a volume of 1,639 acre-feet.

Since the Joseph M. Farley Plant will be equipped with cooling towers, we anticipate no problem in meeting existing water quality standards for temperature or those proposed by EPA. (See Section 3.3.6)

The net benefits of the cooling system selected by Alabama Power Company greatly outweigh any adverse effects which are associated with its construction and use. These adverse effects are identified as a relatively small consumptive use of water and an unquantified but probably small fogging potential.

3.3.3.2 Alternate Cooling Water Systems

Evaporative cooling towers have been chosen as the best method available for protecting the waters of the Chattahoochee River from adverse thermal effects which might otherwise result from plant operation. There are four basic ways which were considered for handling the condenser cooling water. In addition to the evaporative cooling tower method selected, a once-through cooling system could have been employed, whereby water from the Chattahoochee River would have passed through the condensers and returned to the river at a higher temperature. A third method would have been the use of either a closed or open cycle cooling pond, with the warm water from the condensers passing into the pond, being cooled by evaporation, convection and radiation, and then either being reused for condenser cooling or discharged at a lower temperature to the river. A fourth possibility would have been the use of "dry" cooling towers which would have utilized air to cool the condenser cooling water in heat exchangers.

Studies showed conclusively that the once-through method would have periodically caused water temperature in the Chattahoochee River to become higher than is allowed by applicable water quality standards. A closed cooling pond system would have involved dedication of over 3,000 acres for the cooling pond for Unit No. 1 alone. This method was rejected because of problems resulting from terrain, road relocation and land availability and usage, and other considerations which made such a cooling pond impractical. An "open-type" cooling pond was considered, but it was determined that more than 2,000 acres would have been necessary to provide adequate cooling water for Unit No. 1 alone. This method also was considered impractical for essentially the same reasons as the closed-type cooling pond. The other alternative, use of dry-type cooling towers, has not been found feasible for generating plants of the size of the Farley Nuclear Plant and was, therefore, rejected. On the basis of these considerations, the evaporative cooling tower method of providing condenser cooling water was selected.

The mechanical-draft evaporative cooling towers were selected in preference to the natural draft type because of economic considerations resulting from their suitability for use under meteorological conditions in the area. The use of these towers will protect water quality of the Chattahoochee River, require minimum land use, and have minimal impact on the environment.

3.3.4 Impact with Respect to Meteorological Phenomena, Drift, Noise and Blowdown

The meteorological effect of the mechanical induced draft cooling towers will have minimal environmental impact on the area. The effluent to the atmosphere will consist of ambient air with moisture added. The principal contribution to the environment will be a visible plume of moist air, the magnitude of which will vary according to ambient air conditions.

The visible vapor plume is expected to be usually less than 2,000 feet long, based on observations at similar installations. Effects of drift from the tower will be confined to the region near the towers within the plant property. The manufacturer guarantees that drift from the towers will be less than 0.2 percent of the flow rate. The blowdown of 18,500 | 1
gallons per minute will be under strict surveillance and will meet present guidelines relating to water quality.

The background noise level is expected to be less than 45 dba. Only within 10 feet of the fan motor gear box assembly at the top of the tower is the sound expected to approach a significant intensity of approximately 90 dba. No plant personnel will be in this area for extended periods of time.

3.3.5 Impact of the Effluent on Temperature of the Receiving Station

The Joseph M. Farley Nuclear Plant cooling towers are designed to operate with an 11°F. approach to wet bulb temperature. The blowdown is taken from the cool side of the tower at a flow rate which is approximately 5% of the 10 year, 7 day low flow of the Chattahoochee River. Therefore, the blowdown should have very little effect on the temperature of the receiving stream.

3.3.6 Applicable Thermal Standards, Environmental Approvals and Consultations

The boundary between Alabama and Georgia lies along the west bank of the Chattahoochee River at the Joseph M. Farley Plant site. Although the plant itself and its associated equipment is located in Alabama, the river lies entirely within the State of Georgia. In 1967, Georgia adopted water quality standards for the Chattahoochee River which specified that no discharges would be allowed if they raised the temperature of the receiving stream more than 10°F., after mixing, up to a maximum allowable temperature of 93.2°F. These standards were approved by the Secretary of the Department of the Interior.

Alabama adopted similar water quality standards allowing a maximum temperature rise of 10°F., after mixing, up to a maximum temperature of 93°F., but these standards were never approved by the Secretary of the Interior or by others who have since been assigned responsibility for federal approval of state water quality standards.

On April 5-7, 1971, the U. S. Environmental Protection Agency (EPA) 1
conducted a public hearing in Montgomery, Alabama, to consider the setting of federal standards for water quality in Alabama, as they related to temperature and other parameters, since these Alabama standards had not been previously approved. EPA proposed standards which would limit the temperature of the receiving streams in the southern part of Alabama to a maximum temperature rise of 5°F., after mixing, and a maximum allowable

temperature of 90°F. It is understood that EPA has requested Georgia to substitute similar water quality standards for its federally approved standards, but at this time negotiations are continuing between Georgia and Alabama and EPA.

3.3.7 Status of 21(b) Certification

Certification of reasonable assurance that the plant will comply with state water quality criteria was obtained in accordance with Section 21(b) of the Federal Water Pollution Control Act and AEC regulations. The Joseph M. Farley Nuclear Plant is being constructed on the west bank of the Chattahoochee River. The boundary between Alabama and Georgia is at the high-water mark on the west bank and, therefore, the entire river lies within the state of Georgia. The plant itself and its associated structures lie within the state of Alabama. After meetings with both the Georgia Water Quality Board and the Alabama Water Improvement Commission, a certification of reasonable assurance was obtained from the Alabama Commission with a letter from the Georgia Board indicating its approval. A copy of the certification is reproduced on the following pages.

3.4 Chemical Discharges

3.4.1 Cooling Water System Chemistry

The cooling water system of each of the units of the Joseph M. Farley Plant is designed on the following basis:

Design Flow	635,000 gpm
Design Tower Evaporation @ 2.0% Max.	12,700 gpm
Design Tower Drift Loss @ 0.2% Max.	1,270 gpm
Temperature to Tower (Max. Design)	109°F.
Temperature from Tower (Max. Design)	89°F.

State Water Quality Control Board

47 Trinity Avenue, S. W.
ATLANTA, GEORGIA 30334

April 14, 1971

RECEIVED
APR 15 1971
BUREAU OF
ENVIRONMENTAL HEALTH

Mr. J. L. Crockett, Jr.
Director, Technical Staff
Alabama Water Improvement Commission
State Office Building
Room 324
Montgomery, Alabama 36104

RE: Alabama Power Company
Joseph M. Farley Nuclear Plant
Chattahoochee River

Dear Mr. Crockett:

We have received a reply to our letter of February 26, 1971, in which we asked for clarification of a number of items. A copy of that letter was provided to you.

On March 25, 1971, Mr. Alan R. Barton, Senior Vice President, Alabama Power Company, replied to our letter. The letter together with the attached material provided sufficient information to enable us to certify the project. Therefore, you may consider this letter as the Georgia Water Quality Control Board's certification that we have reasonable assurance from the Alabama Power Company that the proposed Joseph M. Farley Nuclear Plant will not violate applicable water quality standards of the Chattahoochee River.

Please forward copies of this letter to the Alabama Power Company advising them of this certification. If you or the Power Company have any questions, please advise.

Sincerely,

R. S. Howard, Jr.
Executive Secretary

RSH:mdg

STATE OF ALABAMA

WATER IMPROVEMENT COMMISSION

ROOMS 324-326
STATE OFFICE BUILDING
MONTGOMERY 4, ALABAMA

IRA L. MYERS, M. D.
CHAIRMAN

April 19, 1971

ARTHUR N. BECK
TECHNICAL SECRETARY

Mr. Allen R. Barton
Senior Vice-President
Alabama Power Company
P. O. Box 2641
Birmingham, Alabama 35202

Dear Mr. Barton:

We have reviewed Alabama Power Company's revised application for certification of the Joseph M. Farley Nuclear Plant on the Chattahoochee River in Houston County, Alabama. This revised application was submitted to the Georgia Water Quality Board on March 25, 1971, together with your letter to Mr. R. S. Howard, Jr., Executive Secretary, Georgia Water Quality Board, clarifying certain items questioned by Mr. Howard in his letter of February 26, 1971, to you.

Alabama Power Company's revised application for certification and information contained in your letter of March 25, 1971, to Mr. Howard provide us with reasonable assurance that activities associated with construction and operation of the Joseph M. Farley Nuclear Plant will not violate applicable water quality standards. This letter may, therefore, be considered as certification of this project by the Alabama Water Improvement Commission in accordance with provisions of Section 21(b) of the Federal Water Pollution Control Act, as amended.

A copy of Mr. Howard's letter of April 14, 1971, to us expressing certification of the above project on behalf of the Georgia Water Quality Board is attached.

Yours very truly,

Arthur N. Beck
Technical Secretary
Water Improvement Commission

ANB/cbw

Enclosure

cc: Mr. R. S. Howard

Total heat exchanger cooling water flow of 32,500 gpm maximum will be routed
into the circulating pump suction as tower makeup.

Of the 32,500 gpm of makeup water, approximately 14,700 gpm will be bypassed
for diluting the tower blowdown, 12,700 gpm will be lost as tower evaporation,
and 1,300 gpm will be lost as tower drift. The balance, amounting to approximately 1
3,800 gpm, will be removed as tower blowdown, diluted with the bypass water, and
routed through the discharge line to the river. Controlled quantities of monitored
radwaste will be mixed in this flow for discharge to the river. Controlled quantities
of neutralized demineralizer wastes will also be mixed in this flow for discharge to
the river.

The maximum concentration of solids of the water in the tower-condenser
cycle will be 3.5, on the basis of the following calculation:

$$\frac{\text{makeup}}{\text{Blowdown + Drift}} = \frac{17,800}{5,100} = 3.5$$

Dissolved solids in the river have been found to vary from a low of 45 ppm 1
to a high of 117 ppm based on Georgia Water Quality Control Board Water Analysis as
collected by U.S.G.S. An average dissolved solids concentration of 63 ppm covering
the years 1968-1969 can be inferred from this data. Therefore, the tower blowdown
with a concentration factor of 3.5 would have a range of dissolved solids concentration
of 158 ppm to 410 ppm with an average of approximately 220 ppm prior to dilution with 1
bypass water. This process, of course, adds no dissolved solids, and the increase of
concentration in the discharge is of no consequence to the environment.

The concentration of suspended solids in the tower blowdown will be significantly
reduced by pumping the river water into the storage pond where some of the solids can
settle before the water is repumped into the cooling system. Suspended solids in the
river water are reported to vary from 10 ppm to 100 ppm with an average concentration

of about 25 ppm. The settlement of suspended solids will reduce the concentration of suspended solids downstream in the river to some slight extent.

The pH of the tower blowdown will be about 7.8. The concentration of solids in the drift will be the same as that in the blowdown and will have little environmental effect because the dissolved salts are not corrosive or otherwise harmful and will not be dispersed off the site.

It is not expected that any chemicals will be needed for controlling silt in the mechanical draft towers.

Chlorine, fed in gaseous form, will be used intermittently in the tower system to control algae and slime. The intervals when it is used may vary from once per day to once per week. The chlorine will be injected only in the amount needed to control biological growths. The free residual chlorine in the system will be controlled by a chlorine residual monitor, with a maximum allowable concentration of 1 ppm. The expected concentration of residual chlorine in the tower blowdown system will vary from 0.25 ppm to 0.5 ppm. Dilution with the bypass water (14,700 gpm) 1 and further dilution in the river will reduce the concentration to essentially zero.

Alternatives in selecting a suitable chemical for keeping the cooling tower-condensing system free of water-borne and air-borne microorganisms consist first of making a choice between oxidizing and nonoxidizing materials.

Oxidizing materials are chlorine, which was selected, and calcium and sodium hypochlorites. Chlorine is received in the liquid form of the pure element and is then applied as a gas dissolved in water. The hypochlorites are supplied either as dry powders or in dilute liquid form. Chlorine is a broad spectrum biocide and is effective, relatively easy to handle with precautions, and readily dissipates into forms of harmless, non-toxic chlorides. Elemental chlorine costs only approximately 10 percent as much as the hypochlorites which offer no particular advantage in this application.

Non-oxidizing materials which may be used as biocides are mostly patented products. They may be effective in providing treatment in tower-condensing water systems but are generally more expensive than chlorine and usually produce toxic end products which are not acceptable in the blowdown to the river. Typical of the non-oxidizing materials are acrolein, chlorinated phenolic compounds, chromates, copper salts, phenolic amines, and thiocynates. Such materials are not practical for a large cooling tower system such as that at the Joseph M. Farley Plant because of both cost and toxicity.

It was therefore apparent after consideration of the above alternates that chlorine was the best choice for control of biological growths in the plant's tower-condenser cooling system. The system is designed on the basis of using no more chlorine than is absolutely necessary, and when it is used, there will be strict control over the rate of feed of chlorine and the concentrations of chlorine reached in the water system.

The use of mechanical methods of controlling biological growth will not eliminate the need for chemical controls in parts of the system and will not affect the concentration of the chemicals in the blowdown.

3.4.2 Makeup Water Demineralizer for Two Units

The demineralizer wastes will contain neutralized sulfuric acid and sodium hydroxide in the form of sodium sulfate.

The regeneration of the cation-anion beds will produce the following waste products mixed in 18,000 to 19,000 gallons of water.

1374 lbs. Sodium Sulfate	(Na_2SO_4)	
39 lbs. Calcium (Ca)	)	
18 lbs. Magnesium (Mg)	)	Cations
48 lbs. Sodium (Na)	)	
8 lbs. Sulphate (SO_4)	)	
21 lbs. Chlorid (Cl)	)	Anions
63 lbs. Silica (SiO_2)	)	
10 lbs. Carbon Dioxide (CO_2)	)	
1581 lbs. Total Dissolved Solids		

Diluted in 19,000 gallons of water, each of the above produce the following concentrations:

Sodium Sulfate..	(Sodium	392.5 lb.	= 2479 ppm
	(Sulfate	981.5 lb.	= 6199 ppm
	(Calcium	39 lb.	= 245 ppm
Cations........	(Magnesium	18 lb.	= 113 ppm
	(Sodium	48 lb.	= 303 ppm
	(Sulfate	8 lb.	= 52 ppm
Anions.........	(Chloride	21 lb.	= 132 ppm
	(Silica	63 lb.	= 398 ppm
	(Carbon Dioxide	10 lb.	= 63 ppm
Total Dissolved Solids			=9984 ppm in 19,000 gallons of water

When the 19,000 gallon batch of diluted regenerant waste is discharged at a controlled rate of 127 gpm into the diluted tower blowdown (which may contain as much as 120 ppm of dissolved solids), the average dissolved solids concentration in the water going to the river will be an estimated 160 ppm over the discharge period of approximately 2½ hours. For the two units at the plant, the minimum number of discharges will be one batch per day and the maximum number will be two batches per day. Batches will never be discharged simultaneously, but always separated by a time interval of several hours. Two sand filters, through which the makeup water for demineralizer system passes initially, will occasionally be backwashed, and this water will be routed to the discharge line and the river. The maximum quantity of water used for backwashing will be about 5,000 gallons, twice a day. Each backwash will last about 10 minutes. The filter backwash water will be very clean, filtered well water. The dissolved solids concentration in the filter backwash water will be about 120 ppm, and the pH will be 7.6.

3.4.3 Projected Effect of Chemical Discharges on Biota

Usually aquatic biota live in natural waters that contain endless varieties of dissolved materials. There will be no deleterious effect on aquatic biota from the very low concentrations of materials from the cooling tower system. The same substances which will be in tower blowdown occur naturally in the river.

These discharges will be in compliance with all established water quality criteria.

No environmental costs associated with these discharges can be identified.

3.5 Sanitary Wastes

3.5.1 Control During Construction

During construction of the Joseph M. Farley Nuclear Plant, control of sanitary waste will be accomplished by three different systems. These are:

1. A Sewage Treatment System
2. Septic Tanks
3. Portable Chemical Toilets

The sewage disposal system is a Pollution Control Inc. "Activator" Sewage Treatment System. This device is used for the human waste systems and is designed to serve 600 people per day. Its operation is based on the aerobic aeration principle which works by maintaining sufficient oxygen mixing and detention time to allow microorganisms or sludge floc to decompose the organic wastes into harmless carbon dioxide, water and ash. The effluent from this system is then discharged to a chlorine contact tank to kill any pathogenic bacteria which might remain in the effluent. The system is maintained in accordance with manufacturer's schedule of maintanance.

The septic tank system consists of two - 1500 gallon septic tanks with a crushed limestone filter bed. This system is designed to serve 100 people and will be connected to sanitary facilities in the pipe fabrication shop area.

The third system consists of the use of portable chemical toilets. These units serve construction personnel at locations where it is impractical to tie facilities into the main system or to install a septic tank. The portable units are leased from agencies which service them as needed.

These three systems are handling all sanitary wastes during the construction of the plant and preventing detrimental releases in the area.

3.5.2 Control During Operation

After completion of the plant, sanitary sewage will be treated in a permanent plant system which will provide primary and secondary treatment. The system will employ the extended aeration process and provide a minimum of 95 percent removal of BOD_5 before release. The wastes will receive final chlorination to accomplish bacterial disinfection.

The permanent system has been designed for a capacity of 10,000 gallons per day and has been reviewed and approved by the Alabama Water

Improvement Commission as a satisfactory method of treating sanitary sewage.

3.6 Biological Impact

3.6.1 Local Species Important to Sport and Commercial Use

Fish species of sports and commercial use are shown in the following tables. None of these species are classified as unique.

1. Species of Sport Importance

Common Name	Scientific Name
Redbreast Sunfish	*Lepomis auritus* (Linneaus)
Orange-Spotted Sunfish	*L. humilis* (Girard)
Bluegill	*L. macrochirus* (Rafinesque)
Longear Sunfish	*L. megalotis* (Rafinesque)
Redear Sunfish	*L. microlophus* (Gunther)
Black Crappie	*Pomoxis nogromaculatus* (LeSueur)
Largemouth Bass	*Micropterus salmoides* (Lacepede)
Warmouth	*Chaenobryttus gulosus* (Cuvier)
Stripped Bass	*Morone saxatilis* (Walbaum)

2. Species of Commercial Importance

Common Name	Scientific Name
Carp	*Cyprinus carpio* (Linneaus)
Black Bullhead	*Ictalurus melas* (Rafinesque)
Yellow Bullhead	*I. natalis* (LeSueur)
Brown Bullhead	*I. nebulosus* (LeSueur)
White Catfish	*I. catus* (Linneaus)
Channel Catfish	*I. punctatus* (Rafinesque)

Wildlife of sport use found on the site consists of squirrel, rabbit, deer, turkey, quail and dove. When a wildlife preserve has been established on the site, no hunting will be permitted.

3.6.2 Importance of Locale to Existence of Species

Due to the lack of uniqueness of the site, the project will have no impact on the existence of any known species.

With the designation of a substantial portion of the site as a wildlife preserve, there should be an improvement in the opportunity for propagation of wildlife in the area.

The protective measures incorporated in the design of the plant will protect wildlife in the area from adverse effects of plant construction and operation.

3.6.3 Effect on Planktonic Forms

Planktonic forms in the water that pass through the condenser and cooling towers will probably be destroyed by heat or chlorination, but only approximately 5 percent of the minimum recorded river flow will be affected by this process. The Chattahoochee River flows directly into Lake Seminole which receives additional water from several sources. Since planktonic forms flourish in Lake Seminole, the effect of the plant will be minimal.

3.6.4 Potential Hazards of Cooling Water Intake and Discharge to Important Fish Species

The quantity of water to be withdrawn from the Chattahoochee River will be relatively small as compared with that which would be required for a plant of equal size using a once-through condenser cooling system. There will be 10 pumps located at the intake, 8 normally in use and 2 available on a standby basis. Each pump is designed to deliver 9,750 gpm at rated head, based on normal river and pond elevation. See Figure 2-4 for details of the intake system.

The intake structure is designed so that under normal full operation with 8 pumps, the velocity of flow across the screen will not exceed approximately 1.0 feet per second when the river is at its normal minimum pool level of 77 feet above msl and 0.3 feet per second in the canal. Velocities at the screen and in the 200 foot long entrance canal will diminish as elevation increases, due to the increase in area across the flow section. The intake screen will utilize a 3/8" mesh.

Due to hydroelectric operations at the Corps of Engineers' Walter George Dam upstream from Columbia Lock and Dam, the flow velicity past the plant site varies considerably. Based on average monthly flows, the estimated average velocity in the river at the plant site will range between 1.8 f.p.s. in August and 7.5 f.p.s. in April. Fish and biota in the river are subjected almost daily to velocities far in excess of the flow into the intake. Due to the location of the discharge at a considerable distance downstream from the intake, no recirculation of cooling water will occur. Therefore, there is no reason to expect fish to be attracted to the intake, and in the event a fish does enter the intake canal, the relatively low velocity will not prevent escape.

The discharge structure, Figure 2-5, will be submerged and the velocity of discharge will be approximately 0.3 f.p.s. The physical presence of the structure should have no adverse effect on fish and wildlife and should not interfere with other uses of the Chattahoochee River.

3.6.5 Summary of Effects of Withdrawal and Return of Water

Potential effects of the Farley Plant on withdrawals from, and returns to the Chattahoochee River are limited because of the essentially closed cycle nature of the circulating water system. The Site Water Management Study prepared by Southern Services, Inc. for the Farly Plant indicates a condenser cooling water flow per unit of 32,500 gpm, tower blowdown (return to river) of 18,500 gpm and an evaporation and drift loss of 14,000 gpm. Solids contained in the cooling water will be concentrated by a factor of approximately 3.5. (See Section 3.4.1 for a detailed discussion of chemical releases). A State of Alabama Geological Survey Publication, Information Series 27, contains tests of Chattahoochee River water at Columbia on May 1, 1960 and August 29, 1960, and at Alaga on August 28, 1960. 1

Water returned to the river as blowdown from the cooling towers will be taken from the cold side of the towers. The temperature of the blowdown will approximate that of the receiving river and therefore the Joseph M. Farley Plant, equipped with evaporative cooling towers, presents no problem in meeting existing water quality standards for temperature or those proposed by EPA. (See Section 3.3.6)

The package-plant secondary treatment system for sanitary sewage at Farley Nuclear Plant is a 10,000 GPD extended aeration process which will provide a minimum of 95 percent BOD_5 removal. This will result in a maximum of 12 mg/1 BOD_5 being discharged from the package system. The system has been reviewed and approved by the Alabama Water Improvement Commission. Chlorination for bacterial disinfection will follow secondary treatment.

3.6.6 Expected Biological Impact

The construction and operation of the Joseph M. Farley Nuclear Plant is not expected to have any significant biological impact on the area.

As a further protection of the environment, both pre-operational and post-operational biological studies will be made which will detect any incipient biological changes early enough to allow corrective action before any harm is done to the environment.

3.7 Non-Radiological Monitoring Programs

Section 2.4 of this report provides an indication of the massive amount of background information available on the Chattahoochee River. Dr. John Lawrence, Fisheries Department, Auburn University, and others have studied various aspects of the river for many years. Alabama Power Company's environmental monitoring program is designed to add to this available data and is being conducted in associated with Dr. Lawrence.

Most of the samples that are collected for the radiological monitoring program are analyzed for many elements that are not related to possible radioactive releases, but are of general interest for water quality and biological studies.

Hydrological monitoring of the Chattahoochee River is a regular activity of the U. S. Corps of Engineers in connection with the operation of their locks and dams. The U. S. Geological Survey also maintains several gauging stations on the river.

The U. S. Geological Survey has been requested by Alabama Power Company to develop a plan for measuring river elevations and stream flow at the Joseph M. Farley Plant site. Alabama Power Company will contract with U.S.G.S. to install and operate a gauging station after suitable plan is developed.

3.8 Measures Taken to Assure Adequacy of Ecological Studies

The applicant employs general nuclear, meteorological and health physics consultants and actively seeks the advice of local knowledgeable persons and involved agencies to assure the completeness of the ecological studies.

Westinghouse, Inc., Bechtel, Inc., Pickard, Lowe & Associates, Dr. G. Hoyt Whipple, Dr. J. Halitsky, Stewart Laboratories, Inc., Dr. John Lawrence of Auburn University Fisheries Department, Dr. G. Winston Menzell of Florida State University Department of Oceanography, Mr. J. Dan Ward, District Supervisor of the Alabama Department of Conservation, Mr. Angus Golson, Assistant Reservoir Manager, Lake Seminole, and Mr. Allen Matthews, Houston County and others have been involved in the ecological studies.

Studies of the lower Chattahoochee River by Dr. John Lawrence and others, including the U. S. Army Corps of Engineers and the U. S. Geological Survey, over a period of several years have established background information which, as far as we know, is unparalleled for any river in the southeastern United States. The ecological studies undertaken by the applicant with the advice and assistance of Dr. Lawrence are adding to this mass of knowledge.

It should be noted that the character of the lower Chattahoochee River has been changed during the last two or three decades from a free flowing river to a series of impoundments created by Locks and Dams. It now serves as an important navigable waterway and the lakes provide excellent recreational benefits.

3.9 Other Approvals Required and Consultations with Other Agencies

The Alabama Public Service Commission has, following public hearings, issued Certificates of Convenience and Necessity for both units and associated transmission facilities of the Joseph M. Farley Nuclear Plant. Jurisdiction of the Alabama Public Service Commission includes general authorization of the facilities in the proposed plant and related substation and high voltage substation and transmission facilities.

The company will submit an application to the Corps of Engineers, U. S. Army, for permits for river-associated facilities at the Joseph M. Farley Nuclear Plant. Reviews of these facilities by appropriate agencies are required prior to issuance of such permits.

The following state, local and regional planning authorities have been contacted in connection with the construction of the Joseph M. Farley Nuclear Plant:

Bureau of State Planning and
Community Affairs
Room 611
270 Washington Street, S.W.
Atlanta, Georgia 30303

Altamaha Area Planning and
Development Commission (APDC)
P. O. Box 328
Baxley, Georgia 31513

Lower Chattahoochee Valley APDC
P. O. Box 1908
Columbus, Georgia 31901

Department of Administration
Attention: Mr. Don Albright
Capitol Building
Tallahassee, Florida

Southeast Alabama Regional Planning
and Development Commission
P. O. Box 1406
Dothan, Alabama 36301

Southwest Georgia Planning and
Development Commission
P. O. Box 346
Camilla, Georgia 31730

Information discussions have taken place at various times not only with these agencies but also with other interested federal, state and local government agencies including:

- U. S. Army Corps of Engineers
- U. S. Coast Guard
- U. S. Environmental Protection Agency
- U. S. Geological Survey
- County Agents of Houston and Surrounding Counties
- Alabama Water Improvement Commission
- Alabama Department of Conservation
- Alabama Geological Survey
- Alabama State Department of Health
- Georgia Water Quality Board
- Georgia Department of Conservation
- Florida Water & Air Pollution Control Agency
- Florida Division of Health
- Florida Fish and Game Commission
- Florida Department of Health and Rehabilitative Services
- Florida Air and Water Pollution Control Commission
- Florida Department of Natural Resources
- Florida State Planning and Development Clearing House

1. Underground Power Transmission - A Report to the Federal Power Commission by the Commission's Advisory Committee on Underground Transmission, April 1966.

4.0 Radiological Monitoring Program and Radiological Impact

This part describes the Radiological Monitoring Program undertaken for the Farley Plant and the radiological impact of the plant. Included are discussions of dosage, accident analysis, waste processing systems and the transportation of fuel.

4.1 Radiological Monitoring Program

The actual measurements of background radiation in the environment have begun. The studies now being made will indicate the optimum number of sampling points, the locations for these points, the types of samples to be collected and the frequencies of collection. These studies are not complete and all the information necessary to determine the optimum values for these monitoring parameters is not yet at hand. As a consequence, the following description is in somewhat general terms.

One of the principal purposes of the pre-operational phase of the radiological monitoring program is to determine whether there are any anomalous conditions in the environment before the plant goes into operation. If such conditions are present and unrecognized, they may interefere with the ability of the post-operational program to detect releases from the plant. However, if such anomalies do exist and are recognized before the plant starts operating, the monitoring program can be modified to be free from interference of this kind.

The ecological and chemical studies now being made are intended, (1) to delineate the more important pathways along which radioactive materials discharged from the plant might reach human beings, (2) to indicate organisms suitable for monitoring these pathways, and (3) to provide assurance that the several monitoring stations are matched, biologically and chemically. The importance of the last point rests on the use of indicator and background stations in the radiological monitoring program.

Indicator stations are those places where samples are taken and measurements are made that are expected to have the highest environmental levels of plant-produced radioactivity. Background stations are collecting and measuring points where levels of plant-produced radioactivity will be insignificant (e.g. points far away or upstream from the plant). When the plant begins operations, data from these two sets of stations will be compared and this comparison will provide a reliable and sensitive means for verifying the behavior of plant-produced radioactivity in the environment. However, such comparisons require that the background and indicator stations be carefully matched with respect to as many characteristics (including biology and chemistry) as possible, excepting only concentrations of plant-produced material.

To this end, the river is being studied from above the plant site to the estuary where it enters the Gulf of Mexico. Samples of water, sediment and microscopic organisms are being collected, identified and analyzed to determine the concentrations of the stable chemical elements corresponding to the principal radioactive isotopes anticipated in the liquid radioactive discharges to the river. The information gained from these studies will lead to the selection of one or two background sampling stations up-river from the plant, two or more indicator sampling stations down-river from the plant, an indicator sampling station in the Apalachicola Bay, and a background sampling station in the Ochlockonee Bay. Provisional locations for these sampling stations will be selected by the end of 1972.

The river studies will also lead to the provisional selection of materials to be sampled and analyzed in the radiological program. These materials seem likely to include water, sediment, mollusks, fish and aquatic plants. Since wild fowl and wild animals hunted and eaten by man partake of river water, they are being studied by stable element analysis to determine whether any important pathways to man exist here. The use of river water to irrigate food crops appears to be practiced to a very limited extent but could be expanded in the future. Consequently, a number of food crops are being analyzed for stable element concentrations to assess the importance of this pathway from the river to man.

Application of the indicator/background concept to the monitoring of materials discharged into the air leads to two rings of stations around the plant; the indicator ring with a radius corresponding to the distance where the ground concentration, averaged over a year, is expected to be maximum, and the background ring with a radius large enough so that the ground concentration of plant-produced material is an insignificant fraction of that at the indicator ring. The meteorological data from which the optimum locations of these two sets of atmospheric stations will be calculated are now being obtained at the site.

Further, in this same connection, data on the grazing of milk cows and meat-producing animals, and on the growing of agricultural food materials in the area are being gathered. This information will be used in conjunction with the meteorological data, already referred to, to select locations for indicator and background milk samples and for such other agricultural products as are necessary for a rigorous monitoring program.

Although the programs outlined above are underway, they have as yet produced no data on the present radiological status of the environment of the Farley site. No reason has been found for believing that this region is in any way untypical of the southeast.

No large nuclear establishments exist in the area; the nearest is the Savannah River Plant, several hundred miles to the northeast. As far as is now known, there are no appreciable radioactive discharges into the Chattahoochee River or its tributaries. Nor has any reason been found to believe that fallout from nuclear detonations has been different in the vicinity of the site than that throughout the southeast.

4.2 Radioactive Discharge Systems

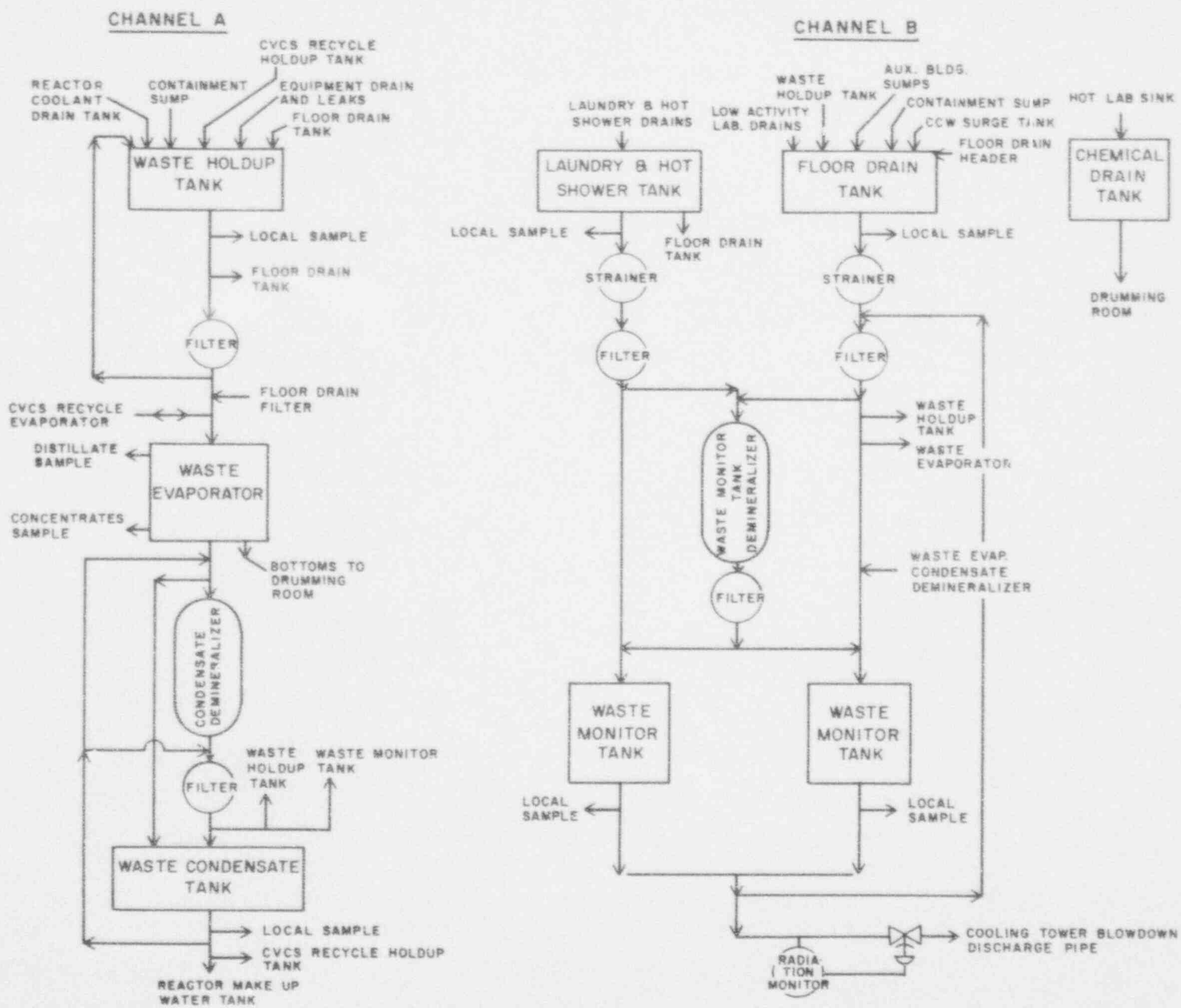
4.2.1 Design of Waste Processing Systems

Alabama Power Company will install the new Environmental Assurance System, designed by Westinghouse, in both of the Farley units. This system will provide means to limit the radioactive releases from the plant to the environment to levels as low as practicable. Part of this system is the use of silver-indium-cadmium control rods to reduce the production of tritium in the reactor. A summary description of the systems for liquid, gaseous and solids waste processing as well as the expected radioactive release rates with isotopic breakdown is given below.

4.2.1.1 Liquid Waste Processing System

The liquid waste processing system is designed to segregate the liquid wastes into two separate subsystems. A schematic flow diagram of the liquid waste processing system is shown in Figure 4-1. These subsystems, referred to as Channel A and Channel B, utilize different process methods most suitable to the category of liquid waste to be treated. Categories of the liquid wastes are determined by their points of origin, by their radioactivity content, and the practicality, as well as suitability, for recycling their processed products. This design feature enables the applicant to reduce the radioactive discharges, including tritium, from the plant to the environment to levels as low as practicable.

Channel A collects and processes reactor grade water wastes through filters, evaporator, and demineralizer and returns the product liquid to the appropriate tank to be reused in the primary system. Bottoms of the waste evaporator are either drummed or, if radioactivity and chemical content permits, can be returned to boron recycle system for reuse.



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SCHEMATIC FLOW DIAGRAM OF LIQUID WASTE PROCESSING SYSTEM

FIGURE 4-1

Channel B collects and processes non-reactor grade water wastes which will be discharged to the environment. The largest source of liquid waste collected in this subsystem will originate from laundry and hot shower drains. This very low activity waste will be filtered, monitored and discharged to the environment. The remaining wastes collected in Channel B consist of various leaks and drains which are either processed through filter, or filter and demineralizer, before being monitored and discharged to the environment. Provisions are made to process liquid waste from Channel B in the waste evaporator should this become necessary. Processed liquid from the evaporator would then be returned to Channel B for ultimate discharge to the environment. The bottoms from the evaporator would be drummed for off-site disposal. Channel B also collects the chemical waste produced in the laboratory in the chemical waste tank. This waste consists of samples taken from various parts of the plant which are likely to be tritiated or contain high activity, as well as chemicals used for laboratory analysis. However, due to the very low volume of these wastes they are drummed directly for off-site shipment.

Under normal operating conditions, when fuel cladding defects in combination with steam generator tube leaks in the plant are minor such that limits specified in Table 4-1, on an annual average basis, are not exceeded, steam generator blowdown will be discharged to the environment without treatment. Steam generator blowdown will also be discharged to the environment without treatment if the combination of leaking steam generator tubes and very little fuel cladding failure exists. This solids content would depend upon the boron concentration in the primary to secondary steam systems.

For a combination of fuel cladding defects and steam generator tube

TABLE 4-1

ESTIMATED ANNUAL LIQUID ISOTOPIC RELEASES

FOR NORMAL OPERATION (EACH UNIT) *

Isotope	Release millicuries/yr	Fraction MPC Annual Avg.	Isotope	Release millicuries/yr	Fraction MPC Annual Avg.
Cr 51	1.821	2.5×10^{-8}	Mo 99	2.82×10^{2}	2.0×10^{-4}
Mn 54	0.288	8.0×10^{-8}	I 131	5.01×10^{2}	4.6×10^{-2}
Mn 56	0.058	1.6×10^{-8}	I 132	1.611	5.5×10^{-6}
Fe 55	0.262	8.9×10^{-9}	I 133	6.45×10^{1}	1.7×10^{-3}
Fe 59	0.320	1.7×10^{-7}	I 134	0.388	5.4×10^{-6}
Co 58	1.76×10^{1}	5.4×10^{-6}	I 135	1.12×10^{1}	7.7×10^{-5}
Co 60	2.731	2.5×10^{-6}	Te 132	1.57×10^{1}	2.2×10^{-5}
Rb 88	0.870	8.0×10^{-6}	Cs 134	1.65×10^{2}	5.1×10^{-4}
Rb 89	0.021	2.0×10^{-7}	Cs 136	2.89×10^{1}	1.3×10^{-5}
Sr 89	1.290	1.2×10^{-5}	Cs 137	7.10×10^{2}	9.8×10^{-4}
Sr 90	0.053	4.9×10^{-6}	Cs 138	0.387	1.1×10^{-7}
Sr 91	0.0.14	7.8×10^{-9}	Ba 140	0.799	1.1×10^{-6}
Y 90	0.0087	1.2×10^{-8}	La 140	0.045	6.2×10^{-8}
Y 91	0.862	7.9×10^{-7}	Ce 141	1.47×10^{1}	4.6×10^{-6}
Y 92	0.0022	1.0×10^{-9}	Ce 144	6.478	1.8×10^{-5}
Zr 95	4.630	2.1×10^{-6}			
Nb 95	9.978	2.7×10^{-6}			

	curies/yr	$\sum_i \frac{\text{Concentration}}{\text{MPC}_i}$
Totals	1.84	0.0497
Tritium (total expected in reactor coolant all assumed to be released)	509	0.037

*Based on operation with cladding defects in fuel rods generating 1 percent of the rated core thermal power, and a dilution flow rate of 18,500 gpm. 1

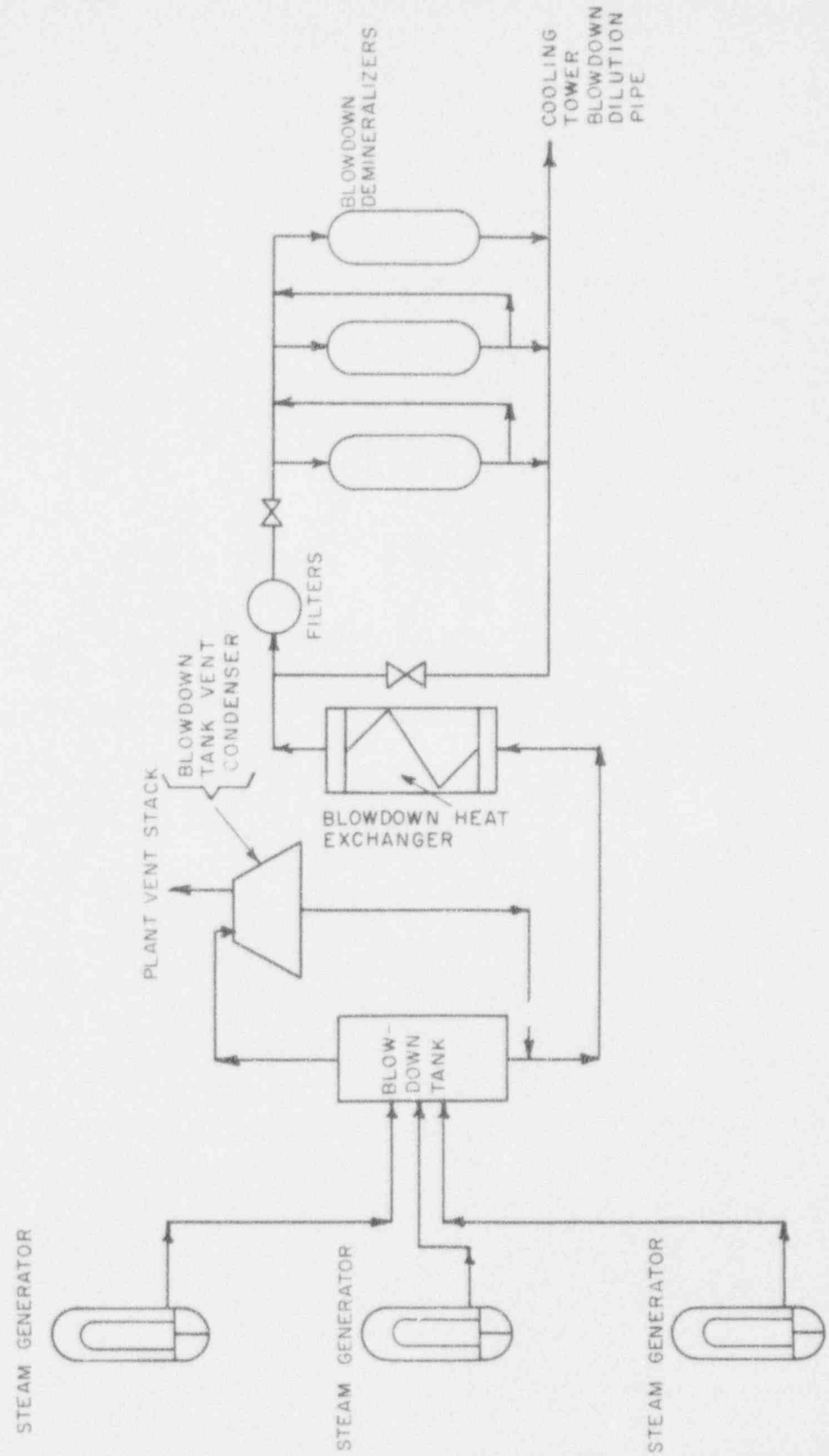
leaks, analysis shows that the most limiting activity release from the secondary side is the I-131 concentration in the blowdown liquid. Therefore, a steam generator blowdown treatment system will be provided with the objective of reducing the iodine discharge to the environment to levels as low as practicable. A schematic flow diagram of the system is shown in Figure 4-2.

This system consists of a blowdown tank, a condenser to condense the steam produced in the blowdown tank, heat exchangers, anion resin beds, and radiation monitors. All blowdown liquid will be processed through the demineralizer to remove most of the iodine.

Two anion exchangers (56 $ft.^3$ each) will be used in series. A thrid one (16 $ft.^3$) in series will serve as a backup. Radiation monitors are provided to detect and isolate the blowdown in the event the radiation exceeds predetermined levels. Treated blowdown liquid will be diluted by mixing with cooling tower blowdown before entry into the river. Interlocks are provided to terminate the discharge if the cooling tower blowdown rate falls below a pre-set value.

The treatment system design is based on short-term treatment for 1 percent fuel cladding defects with a simultaneous steam generator tube leakage of up to 1 gpm and a blowdown flow rate of 50 gpm for three steam generators.

Steam generator tube leakage in combination with failed fuel cladding is considered to be equipment faults in the category of moderate frequency of occurance. A combination of other equipment faults which can occur with a moderate frequency, with fuel cladding defects are: malfunction in liquid waste treatment system; excessive leakage in the reactor coolant system equipment; and excessive leakage in the auxiliary system equipment.



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SCHEMATIC FLOW DIAGRAM OF
STEAM GENERATOR BLOWDOWN
TREATMENT SYSTEM

FIGURE 4-2

Plant annual average liquid isotopic releases resulting from operation with equipment faults of moderate frequency, in combination with failed fuel cladding are given in Table 4-2. The radioactive releases under this condition will be within 10 CFR 20 limits on a short-term basis when summing the fraction of MPC for each of the principal radionuclides being discharged. However, as shown in Table 4-2, annual average total plant radioactive discharges (including both design discharges as well as equipment fault discharges) will be limited to 10 percent of MPC on an isotopic basis, excluding tritium. The 10 percent of MPC liquid discharge would become less than 1 percent of MPC had once through cooling of turbine condenser been used as was the case in some nuclear plants of similar rating. Therefore, it is Alabama Power Company's judgment that releases to the environment, resulting from equipment faults, from Farley Plant are as low as practicable.

4.2.1.2 Gaseous Waste Processing System

Another major component of the plant systems which serves to protect the environment is the gaseous waste processing system. A schematic flow diagram of the system is shown in Figure 4-3. The system will be a closed loop, comprised of two waste compressors, two catalytic hydrogen recombiners, six gas decay tanks for service during normal operation, and two gas decay tanks for service at shutdown and startup. The system will be designed to remove most of the fission product gases from the reactor coolant system. This is accomplished by continuous purge of hydrogen gas into the volume control tank of the Chemical and Volume Control System (CVCS) and transport of stripped fission product gases from the reactor coolant to the gaseous waste processing system. The hydrogen gas mixed with radioactive gases will mix with the nitrogen carrier gas, continuously circulating around the loop, and will be removed by the recombiners. The resulting gas stream will be transferred

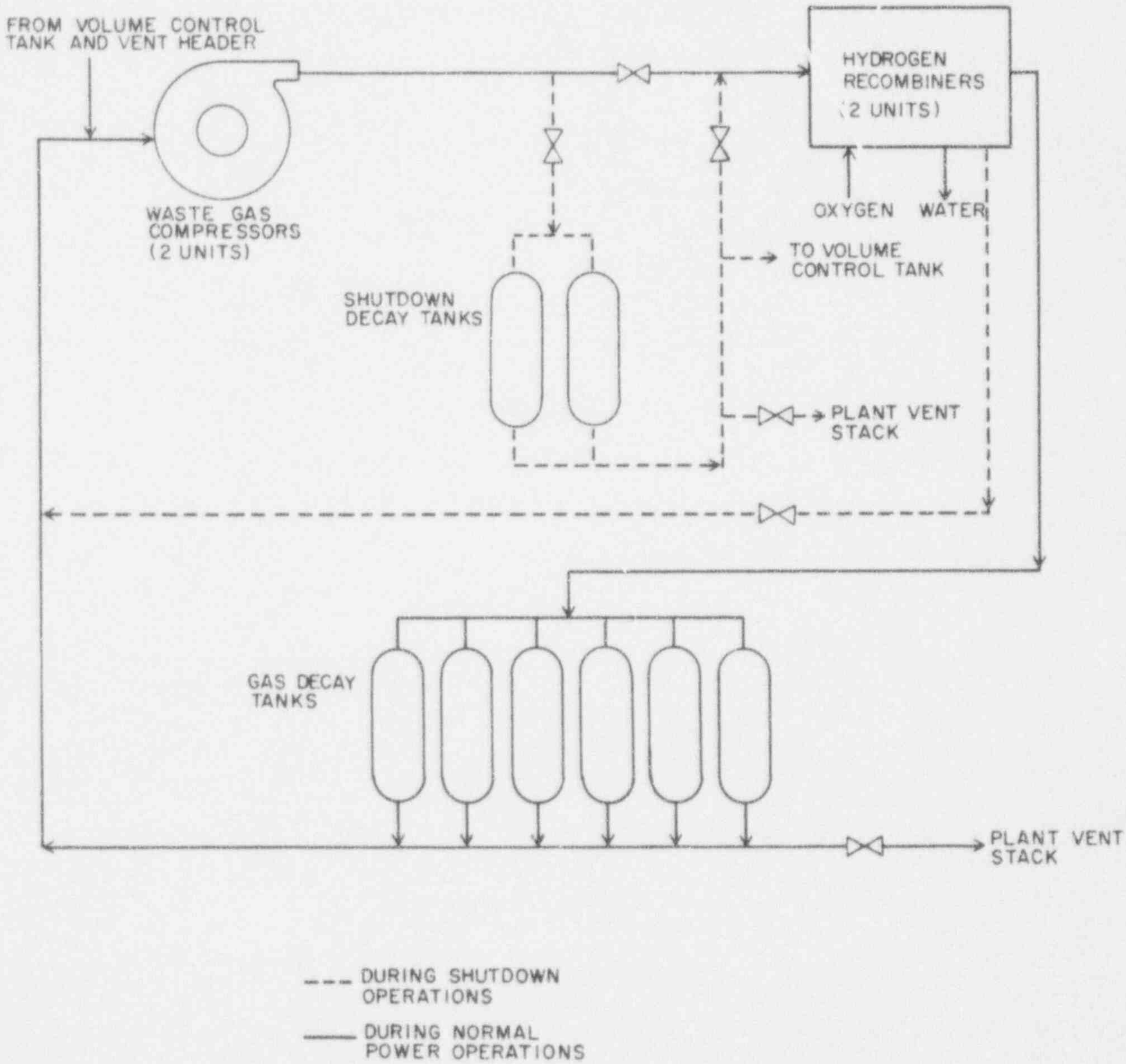
TABLE 4-2

PLANT ANNUAL AVERAGE LIQUID ISOTOPIC RELEASES FOR 10 PERCENT MPC

FOR IDENTIFIED RADIONUCLIDE MIXTURES (TYPICAL MIXTURE PER UNIT) *

Isotope	Release millucuries/yr	Fraction MPC Annual Average	Isotope	Release millicuries/yr	Fraction MPC Annual Average
Cr-51	3.64×10^{0}	5.0×10^{-8}	Mo-99	5.64×10^{2}	4.0×10^{-4}
Mn-54	5.67×10^{-1}	1.6×10^{-7}	I-131	1.00×10^{3}	9.2×10^{-2}
Mn-56	1.16×10^{-1}	3.2×10^{-8}	I-132	3.22×10^{0}	1.1×10^{-5}
Fe-55	5.2×10^{-1}	1.8×10^{-8}	I-133	1.29×10^{2}	3.4×10^{-3}
Fe-59	6.40×10^{-1}	3.4×10^{-7}	I-134	7.76×10^{-1}	1.1×10^{-5}
Co-58	3.52×10^{1}	1.1×10^{-5}	I-135	2.24×10^{1}	1.5×10^{-4}
Co-60	5.46×10^{0}	5.0×10^{-6}	Te-132	3.14×10^{1}	4.4×10^{-5}
Rb-88	1.74×10^{0}	1.6×10^{-5}	Cs-134	3.30×10^{2}	1.0×10^{-3}
Rb-89	4.20×10^{-2}	4.0×10^{-7}	Cs-136	5.78×10^{1}	2.6×10^{-5}
Sr-89	2.58×10^{0}	2.4×10^{-7}	Cs-137	1.42×10^{3}	1.9×10^{-3}
Sr-90	1.06×10^{-1}	9.8×10^{-6}	Cs-138	7.74×10^{-1}	2.2×10^{-7}
Sr-91	2.80×10^{-2}	1.6×10^{-8}	Ba-140	1.60×10^{0}	2.2×10^{-6}
Y-90	1.71×10^{-2}	2.4×10^{-8}	La-140	9.0×10^{-2}	1.3×10^{-7}
Y-91	1.72×10^{0}	1.6×10^{-6}	Ce-141	2.94×10^{1}	9.2×10^{-6}
Y-92	4.4×10^{-3}	2.0×10^{-9}	Ce-144	1.30×10^{1}	3.6×10^{-5}
Zr-95	9.26×10^{0}	4.2×10^{-6}			
Nb-95	2.0×10^{1}	5.4×10^{-6}			
				Curies/yr	$\sum_{1} \frac{\text{Concentration}}{MPC_i}$
Totals				3.7	0.10

* Based on operation with cladding defects in fuel rods generating 1 percent of the rated core thermal power



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SCHEMATIC FLOW DIAGRAM OF GASEOUS WASTE PROCESSING SYSTEM

FIGURE 4-3

to the gas decay tanks where accumulated activity will be contained in six approximately equal parts. By the operation of this system, a considerable reduction in the fission product gas inventory in the reactor coolant system will be achieved. This will substantially reduce the fission product release from unavoidable reactor coolant leakage in the plant.

The gaseous waste processing system also collects the residual radioactive gases discharged to the vent header from various equipment in the plant. This includes the gases stripped by the gas stripper and evaporator in the CVCS system. The system will be provided with gas storage capacity to accumulate all the fission product gases released to the reactor coolant with the very conservative assumption that the plant operates with 1 percent failed fuel over a 40 year period. The two shutdown tanks will be utilized during plant cooldown after the majority of the gases are stripped from the reactor coolant. This system will carry very small amounts of radioactive gas; however, it is incorporated in the design with the intent to reduce the controlled discharge from the plant to levels as low as practicable.

The bulk of the activity collected in gas decay tanks will be from Xe-133 with a half life of 5.3 days. If all gases are stored for 40 years, the amount of Kr-85 inventory present at the end of this time will be only approximately equal to the Xe-133 activity present during any fuel cycle with 1 percent fuel cladding defects. This number will be approximately 91,000 dose equivalent curies of Xe-133. Since the volumetric quantity of these gases is small, the system pressure is not expected to exceed about 15 to 20 psig during the life of the plant.

Anticipated operation will result in no significant gaseous activity release to the environment from this system. However, should it become necessary to discharge waste gas to the atmosphere, the system will include provisions to sample and control the discharge to assure that releases are made within the permissible limits for the plant.

4.2.1.3 Solid Waste Processing System

Solid wastes, from the Farley Plant, will be shipped in 55 gallon drums to off-site burial facilities. Each shipment will be made in accordance with Atomic Energy Commission and Department of Transportation regulations. However, it is Alabama Power Company's feeling that estimates of anticipated frequency and mode of shipment at this time would be premature. Solid waste shipment from any Nuclear Power Plant facility depends on the operation of the plant as well as the availability and schedule of the carriers.

Farley Plant (2 Units) will have a solid waste handling facility for each unit. It is conservatively estimated that approximately 500-55 gallon drums, the majority containing low-level activity, will be shipped from Farley Plant each year. If, in the very unlikely event of operation of the plant with design basis fuel cladding failures (1 percent), it is anticipated that filters shipped from the primary side of the plant will contain high-level activity solid wastes and will amount to approximately 50 shielded 55 gallon drums per year. These 50 drums are included in the 500 drum estimate given above.

Each Unit facility has the capacity to store 80-55 gallon drums. Approximately 12 to 15 low-level-activity and 15 high-level-activity shipments from the site are estimated for each year.

Alabama Power Company feels that the solid waste handling facilities incorporated in Farley Plant design have the flexibility and the capability to handle the solid wastes which will be generated within the plant and will allow flexibility in the schedule for off-site shipments from the plant.

4.3 Radioactive Discharge Quantities

4.3.1 Liquid Wastes

Estimates of normal annual liquid volumes through the waste processing system for each unit are given in Table 4-3. Processed liquid waste will be diluted with cooling tower blowdown before entry into the river. Interlocks are provided to terminate the discharge if either the radiation level in the liquid exceeds a preset value or cooling tower blowdown flow rate falls below a preset value. Estimated annual liquid isotopic releases from normal operation of each unit are listed in Table 4-1. This table also includes the fraction of most probable concentration for each isotope on an annual average basis. As shown in Table 4-1, the estimated annual average radioactivity concentration in the cooling tower blowdown is expected to be approximately 5 percent of the 10 CFR 20 limits for identified mixtures, excluding tritium. Tritium releases are not expected to exceed about 4 percent of 10 CFR 20 limits in the plant effluents during normal operation.

Cooling tower blowdown is approximately 1/30 of the dilution flow available to those nuclear plants using once-through cooling in the turbine condenser. Thus, in evaluating the effectiveness of the waste processing system the 5 percent of 10 CFR 20, given in Table 4-1, should be compared with less than 1 percent, if once through cooling dilution were used as for most previous nuclear plants. It is Alabama Power Company's judgment that releases to the environment from Farley Plant will be as low as practicable.

4.3.2 Gaseous Wastes

The estimated annual average activity release rates during normal plant operation, including contributions from containment purging, unavoidable reactor coolant leakage, and possible leakage from the gaseous waste processing system, is expected to be approximately 5 percent of 10 CFR 20

TABLE 4-3

JOSEPH M. FARLEY NUCLEAR UNITS 1 OR 2

ESTIMATES OF NORMAL ANNUAL LIQUID VOLUMES

THROUGH WASTE PROCESSING SYSTEM FOR EACH UNIT

	Volume (gal/yr)	
	Recycled	Processed and Discharged
Equipment Drains and leakoffs	60,000	-
Lab Equipment Rinses (40 gallons per day)	-	16,000
Systems Leaks (20 gallons per day - Primary System water 40 gallons per day - all other leakage)	-	20,000
Decontaminations	-	15,000
Laundry and Hot Shower	-	120,000
TOTAL	60,000	171,000

limits for identified mixtures, for both units, excluding iodine. The isotopic breakdown of this release is given in Table 4-4. Gaseous release of isotopes of iodine will be measured and releases will be controlled so as not to exceed an annual I-131 gaseous release limit of 1.5 curies (1/700 of MPC of I-131 on an annual average basis).

Gaseous activity releases during the occurence of equipment faults of moderate frequency will be within the 10 CFR 20 limits on a short time basis, when summing the fraction of MPC for each of the principal radionuclides being discharged. However, on an annual average basis the total plant gaseous radioactivity discharges will be limited to 10 percent of MPC as shown in Table 4-5.

It is the Applicant's judgment that the gaseous activity releases from Farley Plant to the environment are as low as practicable.

4.4 Important Pathways of Exposure to Man

At this time, only the possible pathways by which radiation and radioactivity from the Farley Plant may cause human radiation exposure can b[illegible]en. The assessment of the importance of each of these pathways can be made only when the studies, described previously (Sec. 4.1) have been completed. The following list, therefore, constitutes a check list, not an exact list of important pathways.

A. Possible pathways of human exposure from releases of radioactive material to the atmosphere

(1) External exposure from airborne material

(2) External exposure from material deposited on the ground

(3) Inhalation of airborne material

TABLE 4-4

ESTIMATED ANNUAL AVERAGE

GASEOUS RELEASE RATES FROM PLANT VENTILATION

SYSTEMS DURING NORMAL OPERATION (TOTAL FOR BOTH UNITS) *

Isotope	Release Rate Curies/second
Kr-85m	4.85×10^{-5}
Kr-85	4.70×10^{-4}
Kr-87	2.82×10^{-5}
Kr-88	9.5×10^{-5}
Xe-133m	3.26×10^{-5}
Xe-133	2.23×10^{-3}
Xe-135m	6.75×10^{-5}
Xe-135	1.56×10^{-4}
Total	3.12×10^{-3}
Percent MPC (Summation of above isotopes)**	5

* Based on operation with cladding defects in fuel rods generating 1 percent of the rated core thermal power.

** Based on annual average $X/Q = 3.0 \times 10^{-6}$ sec/m^3

TABLE 4-5

PLANT ANNUAL GASEOUS ISOTOPIC RELEASES FOR 10 PERCENT MPC

FOR IDENTIFIED RADIONUCLIDE MIXTURES (TYPICAL MIXTURE TWO UNITS) *

Isotope	Release Rate Curies/Second
Kr-85m	9.70×10^{-5}
Kr-85	9.38×10^{-4}
Kr-87	5.86×10^{-5}
Kr-88	1.83×10^{-4}
Xe-133m	6.50×10^{-5}
Xe-133	4.47×10^{-3}
Xe-135m	1.35×10^{-4}
Xe-135	3.12×10^{-4}
Total	6.26×10^{-3}
Tritium **	20 - 40 curies/year

* Based on operation with cladding defects in fuel rods generating 1 percent of the rated core thermal power.

** Tritium release from the containment with 2.5 uc/cc in the reactor coolant after 12 years of operation.

(4) Ingestion of airborne material which has found its way into food

(a) pasture - cow-milk
(b) field - crop-food
(c) woods - wild game-food
(d) field - forage-domestic animal-food

B. Possible pathways of human exposure from releases of radioactive material to the river

(1) External exposure from material in the river (e.g. boating, swimming, water-skiing)

(2) External exposure from material on the river bank (e.g. fishing, hunting, camping)

(3) Ingestion of river water

(4) Ingestion of organisms which live in the river

(a) fish
(b) turtles
(c) plants

(5) Ingestion of organisms which use river water

(a) ducks
(b) wild game (deer, racoons)
(c) irrigated crops

(6) Ingestion of organisms which live in the estuary

(a) oysters
(b) crabs
(c) shrimp
(d) fish

4.4.1 Estimates of the Increase in Levels of Radioactivity From the Principal Radionuclides

Table 4-6 shows the concentrations of radioactive materials in the Chattahoochee River expected from normal operation of the Farley Plant. For comparison the concentration of certain radioactive materials already present in surface water and sea water are also presented. Possibly it should be noted that about 44 river miles downstream from the

TABLE 4-6

COMPARISON OF CONCENTRATIONS OF RADIOACTIVE MATERIALS EXPECTED IN THE CHATTAHOOCHEE RIVER FROM THE JOSEPH M. FARLEY PLANT WITH THOSE OF RADIOACTIVE MATERIALS ALREADY PRESENT

Source	Concentration - μCi/cc Tritium	Concentration - μCi/cc Other Isotopes
Farley Plant	4.8×10^{-8}	1.75×10^{-10}
Surface water[1.]		
before 1952	3.2×10^{-8}	-
1964	3×10^{-6}	-
Sea water[2.]		
potassium-40	-	3.2×10^{-17}
rubidium-87	-	5.9×10^{-9}

1. Hawkins and Schmalz, IDO-12043, 1965

2. NAS-NRC Publication No. 551, 1957, page 41

plant site the Chattahoochee River joins the Flint River to form the Apalachicola. The resulting increase in flow will further dilute the concentration of radioactive material due to plant operation.

4.5 Potential Annual Radiation Doses

During normal operation of the Farley Plant, radioactive gaseous and liquid wastes will be generated. Only a small fraction of these will be released to the environment under controlled conditions in accordance with applicable regulations and the AEC operating license. Using this small fraction, and taking into consideration the measured climatology of the area, river system characteristics and principal modes of exposure, an estimate of the population exposure out to a 50-mile radius is developed. This estimate, the derivation of which is shown below, indicates that population exposure attributable to routine operation will be very small compared to that from natural background radiation.

Estimates of maximum individual exposure are also made and their derivations are shown below. Such exposures are small compared to limits in applicable regulations and compared to natural background (see Section 4.6).

4.5.1 Estimates of Exposure Due to Gaseous Releases

A. Source of Radioactive Gaseous Effluent

The radiation waste processing systems will be designed to maintain gaseous releases to a level as low as practicable. In this report, it is conservatively assumed that the plant is releasing gases equivalent to 5 percent of the maximum permissible concentrations (MPC) shown in Table 4-7. This table gives quantities of radioactive gases of significance which are expected to be released to the environment, assuming that the plant is operating under design basis conditions.

B. Atmospheric Dispersion Estimates

Isopleths, which are lines on a map showing where equal long-term average ground level concentrations of materials released from the plant are expected, have been prepared using one year of weather data measured at the Dothan Airport.

Using these isopleths which extend out to 50 miles, the average annual ground level concentration for released materials is approximated in each of sixteen 22-1/2° direction sectors at distances of 3/4, 1-1/2, 2-1/2, 3-1/2, 4-1/2, 7-1/2, 15, 25, 35 and 45 miles from the plant which represents the center of the ten annuli used in making the evaluation of population exposure within a 50-mile radius.

C. Population Estimates

Population estimates were taken from Figure 2-17. The figures give population estimates projected for the year 2015 in each of sixteen direction sectors. Each sector is separated into ten rings corresponding to the annuli for which average annual ground concentrations are estimated as discussed above.

4.5.1.1 Computation of Individual Exposure

A. Whole Body Gamma Dose

The whole body gamma dose to an individual in air is calculated using the semi-infinite cloud model:

$$D_\gamma = (X/Q)\ (F_{wb}) \quad \text{(a)}$$

$$F_{wb} = 0.25 \sum_{i=1}^{N} (A)_i\ (\bar{E})_i$$

Where:

D_γ = Gamma dose for year (rad)

X/Q = Annual average atmospheric dispersion (sec/m^3)

N = Number of isotopes considered

A_i = Amount of i^{th} isotope released during the year (Ci)

$\bar{E}_i$ = Average gamma energy per disintegration (Mev/dis) of the isotope

F_{wb} = Whole body gamma dose factor $\left[\frac{rad}{yr.} \times \frac{m^3}{sec}\right]$ (See Table 4-8 for work sheet)

B. Surface Body Beta Dose

The beta dose to the surface of the body is calculated using the infinite cloud model[2] as follows:

$$D_B = (X/Q)(F_{be}) \quad \text{(b)}$$

$$F_{be} = 0.23 \sum_{i=1}^{N} (A)_i (\bar{E}b)_i$$

Where the simbols are the same as for 2.4.1 except:

D_B = Beta dose for the year (rad)

$\bar{E}b_i$ = Average beta energy per disintegration (Mev/dis) of the i^{th} isotope

F_{be} = Beta dose factor $\left[\frac{rad}{yr.} \times \frac{m^3}{sec}\right]$ (See Table 4-9 for work sheet)

C. Whole Body Equivalent Due to Inhalation of Iodine

It is estimated that, as shown in Table 4-7, only a small amount of iodine will be released to the atmosphere. The limiting exposure from iodine will be the dose received by the thyroid. The equivalent whole body dose due to inhalation of iodine is computed by dividing the thyroid doses obtained by a factor of 3. Thus, the equivalent whole body dose to the thyroid is that dose which is judged to have the same relative effect on the individual as a numerically equal dose to the whole body.

The equation used for determining the whole body equivalent dose due to inhalation of iodine is as follows:

$$D_I = (X/Q)(F_I) \qquad \text{(c)}$$

$$F_I = \frac{(BR)(f_c)(A)}{3}$$

Where:

D_I = Whole Body equivalent dose due to inhalation of iodine-131 during the year (rad/yr.)

X/Q = Average annual atmospheric dispersion (sec/m^3)

BR = Average breathing rate (m^3/sec)

f_c = Dose conversion factor for I-131 (rad/Ci)

A = Amount of I-131 released during the year (Ci)

F_I = Inhalation dose factor $\left[\frac{rad}{yr.} \times \frac{m^3}{sec}\right]$ (See Table 4-10 for work sheet)

D. <u>Whole Body Equivalent Dose Due to Ingestion of Iodine</u>

Computation of doses due to ingestion of iodine is made considering possible concentration of iodine in the "cow-milk" pathway. Studies have shown that for a given ground level atmospheric concentration the dose would be about 700 times the inhalation dose for certain population groups. However, the concentration factor would not be this high for the entire population exposed, thus a weighted average factor is computed taking into account differences in thyroid weight, breathing rate and amounts of milk consumed by age groups as follows:

(1) For the 1-10 year old age group the factor of 700 is used. About 20% of the population is estimated to be in this age group.

(2) For ages of 10 years and above a factor of 150 is estimated assuming that on the average about half as much milk is consumed per person; that the thyroid weight is 7.5 times greater and that the breathing rate is 3.3 times higher than for the 1-10 year old group.

(3) The resulting population group weighted average concentration factor is

$$0.2 \times 700 + 0.8 \times 150 = 260.$$

The whole body equivalent dose to the average population group from ingestion of iodine-131 is computed by multiplying the inhalation dose by the concentration factor as follows:

$$D_{IG} = (D_I)(f_{cm}) \quad \text{(d)}$$

Where:

D_I = Whole body equivalent dose due to inhalation of I-131 (rad/yr.)

f_{cm} = Concentration factor in cow-milk pathway.

4.5.1.2 Computation of Total Population Exposure

The annual population dose (man-rads/yr.) due to gaseous effluent was estimated for each annular sector by multiplying the exposure at the center of the sector by the population in the sector for the year 2015. This is done for each of the four types of exposure, i. e., whole body gamma, surfact body beta, inhalation and ingestion. Then the total annual population dose for each type of exposure out to a radius of 50 miles is calculated by summing such doses for all annular sectors using the following relationship:

$$TD_{i,j} = \sum_{i=1}^{s} \sum_{j=1}^{d} D_{i,j} P_{i,j}$$

Where:

i	=	Subscript for direction sector
j	=	Subscript for annulus (population ring)
$TD_{i,j}$	=	Annual total population dose for the particular type of exposure (man-rads/yr.)
s	=	Number of direction sectors (16)
d	=	Number of annuli (10)
$D_{i,j}$	=	Gamma, beta, inhalation or ingestion dose (rad/yr.)
$P_{i,j}$	=	Population estimate for the year 2015 for each direction and annular section.

The results of these calculations are summarized in column (1) of Table 4-13.

4.5.1.3 Computation of Maximum Off-Site Exposure

The maximum off-site exposures to an individual due to routine gaseous effluent releases are computed using the methods described above and the maximum average ground level concentrations at the site boundary.

A value of $X/Q = 3.0 \times 10^{-6}$ sec/m^3 is used which corresponds to the highest estimated average value at any site boundary.

The maximum whole body gamma dose from Table 4-8 and equation (a) is computed as follows:

$$D_{\gamma max} = (X/Q)_{ave}(F_{wb})$$

The maximum surface body beta dose from Table 4-9 and equation (b) is computed as follows:

$$D_{bmax} = (X/Q)_{ave}(F_{be})$$

The maximum inhalation dose from Table 4-10 and equation (c) is as follows:

$$D_{Imax} = (X/Q)_{ave}(F_I)$$

For an individual to receive these doses, he would have to remain, for the whole year, at the point of highest exposure on the site boundary. The realistic maximum exposure would be much lower.

The maximum exposure due to ingestion of milk is estimated assuming that the milk producing cows graze at the site boundary continuously during the year and that the individual drinking milk drinks only the milk from this source. A factor of 700 for concentration in the cow-milk pathway is used. The maximum dose from above and Section 4.5.1.1 is computed as follows:

$$D_{IGmax} = D_{Imax} \times 700.$$

Results of these computations are given in column (3) of Table 4-13.

4.5.1.4 Computation of Average Population Exposure

Estimates of the average annual population exposure are made by dividing the total population exposure due to the given type exposure from Column (1) of Table 4-13 by the total population within the 50-mile radius (450,250 people). Results are given in Column (2) of Table 4-13.

4.5.2 Estimates of Exposure Due to Liquid Release

The liquid portion of the rad-waste system will be designed to maintain liquid releases to a level as low as practicable. Prior to release into the cooling tower blowdown water (which flows to the river), the liquid wastes will normally be processed through filters, and ion exchange beds or evaporators. The annual quantities of radioactive materials which are estimated to be released from both units under the design basis conditions are listed in Column (2) of Table 4-11.

Average concentrations of each isotope downstream of the plant are estimated for the Chattachoochee River including Lake Seminole and for the Apalachacola River below Lake Seminole. The average Chattahoochee River flow is 11,850 cfs. Since the Chattahoochee and Flint rivers both discharge to Lake Seminole and the Apalachacola River begins at the discharge from Lake Seminole, additional dilution is available below the lake. The flow rate below the lake in the Apalachacola River is 21,900 cfs.

Average concentrations in the upper and lower river system are determined by dividing the annual quantity of each isotope by the annual river flow in each of the two locations considered. River concentrations are shown in Columns (3) and (4) of Table 4-11.

4.5.2.1 Estimates of Population Exposed Through Assumed Pathways

Significant pathways whereby radioisotopes released to the river system could reach man have been investigated. There is no known use of the Chattahoochee River, Lake Seminole or the Apalachacola River for human drinking water. There is essentially no use of river or lake water for irrigation of farm land downstream of the plant. The most significant pathway identified was through ingestion of fish in the river system and through ingestion of seafood taken from the lower Apalachacola estuary and bay.

The population group of interest for this study is that within a 50-mile radius of the Farley Plant. There are projected to be about 450,250 people in this area in the year 2015. It is assumed that the amount of fish and seafood estimated to be consumed in this population group is distributed equally.

4.5.2.2 Compilation of Doses to Individuals

Three pathways to man of radionuclides in liquid effluent have been identified in the river system. These include the ingestion of fish, the ingestion of oyster meat (mollusk) and the ingestion of shrimp (crustacea). The average annual amounts of each group taken from the river system and Apalachacola Bay are given in Table 4-12.

Aquatic organisms concentrate certain elements which exist in the water and in the food they eat (generally living near or in the water). Therefore, the fish or seafood consumed may have a higher concentration of certain radioactive isotopes than that present in the water. To account for this, estimates of concentration factors are made for fish and for each type of seafood as shown in Columns (6), (7) and

(8) of Table 4-11. These are based on preliminary studies made on fresh water fish. For mollusks and crustacea which live in marine environments, the factors reported by Freke[3.] were used.

A survey is now underway for the river system to determine the extent to which organisms in the river concentrate elements of interest. When these studies are complete, they will provide information specific to this river system. A concentration factor of zero was used for isotopes with half-lives less than three days since it is judged that they would have decayed to insignificant levels by the time they were ingested by humans.

From Table 4-12, the amount of fish caught in the Chattachoochee River and Lake Seminole is approximately 1,025,000 lbs. It is assumed that the edible portion of this fish is one-third of the total weight and that one-half this amount is consumed by the population group of interest (450,250 people within the 50-mile radius). Each exposed person would, therefore, consume on the average 0.47 gram of fish flesh per day.

For the fish caught downstream of the lake in the Apalachacola River (900,400 lbs.) and in the Apalachacola Bay (264,000 lbs.), it is assumed that one-half this amount is consumed by the population group of interest. This amounts to an average of 0.53 gram of fish flesh per day.

To compute doses through fish ingestion, the following relationships are used:

$$D_f = \sum_{i=1}^{N} \frac{(C)_i \ (F_{cf})_i \ (W) \ (0.5)}{(2200) \ (MPC)_i}$$

Where:

D_f = Dose due to ingestion of fish (rad/yr.)

i = Isotope

N = Number of isotopes

C_i = Concentration in water (µCi/cc)

F_{cf_i} = Concentration factor in fish flesh of i^{th} isotope

W = Weight of fish flesh consumed per day (grams)

0.5 = Dose due to drinking 2200 cc/day of water at MPC concentration

2200 = Average amount of water ingested per day (cc/day)

MPC_i = Maximum permissible concentration of isotope in water

Doses due to ingestion of fish are given in Column (9) and (10) of Table 4-11.

From Table 4-12, the amount of oysters (mollusks) taken from the bay is about 2.0×10^6 lbs. (meat) per year. It is assumed that since most of this meat is exported, only 10 percent is consumed by the 450,250 people within the 50-mile radius. Each person would, therefore, consume on the average about 0.55 gm/day of oyster meat.

Doses due to ingestion of oysters are computed using the equation of Section 4.5.1.1 and are shown in Column (11) of Table 4-11.

From Table 4-12, the amount of shrimp (crustacea) taken from the bay is about 265,000 lbs. It is assumed that about 25 percent of this amount is consumed by the 450,250 people within the 50-mile radius. Each person would, therefore, consume on the average about 0.185 gram of shrimp from the bay per day.

Doses due to ingestion of shrimp are computed using the equation of Section 4.5.2.2 and are shown in Column (12) of Table 4-11.

4.5.2.3 Computation of Total Population Exposure Through Ingestion

The total population dose (man-rad/yr.) to groups exposed by ingestion of fish and seafood is obtained by multiplying the individual doses for ingestion of each type of food given at the bottom of Columns (9), (10), (11) and (12) in Table 4-11 by the population so exposed as follows:

$$PD_f = D_f \times P_f$$

Where:

PD_f = Total population exposure due to eating fish and seafood (man-rad/yr.)

D_f = Average individual dose due to eating fish and seafood (rad/yr.)

P_f = Population that eats fish and seafood from the river system.

Results of these calculations are shown in Column (1) of Table 4-13.

4.5.2.4 Computation of Maximum Individual Exposure

The maximum exposed individual through ingestion of fish is assumed to be a person who eats 200 grams per day of fish caught from the Chattahoochee River or Lake Seminole. This is about eight times the average per capita consumption of fish in the U.S.[4.] It is further assumed that the individual eats an additional 10 grams of oysters and 10 grams of shrimp per day taken from Apalachacola Bay.

The maximum individual exposure due to ingestion of fish flesh is obtained by multiplying the value at the bottom of Column (9) of Table 4-11 by 200/.47 or the ratio of assumed maximum to average consumption (grams) of fish per day.

The maximum individual exposure due to oyster ingestion is computed by multiplying the value at the bottom of Column (11) of Table 4-11 by (10/.55) or the maximum to average oyster consumption.

The maximum individual exposure due to ingestion of shrimp is computed using Column (12) of Table 4-11 in the same manner as for oysters, using the ratio 10/.185 to represent the maximum to average shrimp consumption.

The results of the above computations are given in Column (3) of Table 4-13.

4.5.2.5 Computation of Average Population Exposure

The average annual exposure of the population within a 50-mile radius due to ingestion of fish and seafood is estimated by dividing the total population exposure from Column (1) of Table 4-13 by the total population within this radius (450,250 people). The results are shown in Column (2) of Table 4-13.

4.6 Total Radiological Effects of Operation of the Joseph M. Farley Plant

4.6.1 Comparison of Average Exposure with Natural Background

The natural background radiation exposure for the station area is estimated to be about 0.125 rad/yr.[5] If this exposure is compared to the average per-capita exposure due to plant operation from Column (2) of Table 4-13, as is done in Table 4-14, it is seen that plant operations would increase the exposure due to natural radiation by a small fraction.

4.6.2 Comparison of Total Population Exposure with Natural Background

The total population exposure due to natural background is obtained by multiplying the average individual exposure due to natural background (0.125 rad/yr.) by the total population in the 50-mile radius. The resulting exposure is 56,280 man-rad/yr. The comparison of this exposure with the exposure from operation of the unit is given in Table 4-15 which shows that the plant would increase the total population exposure by only a small fraction.

4.6.3 Comparison of Maximum Individual Exposure with Applicable Regulations

The Federal Regulations concerning limits of exposure of individuals are set forth in 10 CFR 20. The limit for "non-occupational" whole body exposure is presently set at 0.5 rem/yr.(For β and γ radiation of the energies considered in these calculations, one rem is equal to one rad). In Table 4-16, the maximum computed exposure to an individual, due to operation of the plant is compared with this limit. As shown, the plant effluent would result in a maximum exposure much lower than the 0.5 rem/yr. limit.

1. Slade, D. H. (Editor), Meteorology and Atomic Energy, 1968, p 339.

2. Ibid, p 330.

3. Freke, A. M., A Model for the Approximate Calculation of Safe Rates of Discharge of Radioactive Wastes into Marine Environments, Health Physics Pergamon Press, Vol. 13, 1967, pp 743-758.

4. U.S. Public Health Service, Radiological Health Data, Vol. 6, Number 11, November 1965, p 627.

5. National Council on Radiation Protection and Measurements, Basic Radiation Protection Criteria, Report No. 39, 1971.

TABLE 4-7*

Estimate of Gaseous Releases
From J. M. Farley Plant

Nuclide	Curies Released/Yr.
Kr-85m	1,530
Kr-85	14,800
Kr-88	2,890
Xe-133m	1,025
Xe-133	70,500
Xe-135m	2,135
Xe-135	4,925
I-131	0.040

* Includes releases from both units.

TABLE 4-8

Work Sh('or Whole Body Gamma Dose Factor

Gaseous Isotope	A_i (Curies/Yr.)	$\overline{E}_i$ (Mev/dis)	F_{wb} $0.25\ A_i\overline{E}_i$ $\left(\frac{rad}{yr.} \times \frac{m3}{sec}\right)$
K-85m	1,530	0.179	68.4
Kr-85	14,800	0.003	11.1
Kr-88	2,890	2.060	1495.0
Xe-133m	1,025	0.233	59.7
Xe-133	70,500	0.081	1427.5
Xe-135m	2,135	0.530	282.9
Xe-135	4,925	0.264	325.0
I-131	0.040	0.389	0.0155
			$\sum$ =3669.6

TABLE 4-9

Work Sheet for Surface Body Beta Dose Factor

Gaseous Isotope	A_i (Curies/Yr.)	$\overline{Eb}_i$ (Mev/dis)	F_{be} $.23\ A_i\ \overline{Eb}_i$ $\left(\frac{rad}{yr.} \times \frac{m^3}{sec}\right)$
Kr-85m	1,530	0.222	78.1
Kr-85	14,800	0.224	762.5
Kr-88	2,890	0.331	220.0
Xe-133m	1,025	0.0	0.0
Xe-133	70,500	0.115	1864.5
Xe-135m	2,135	0.0	0.0
Xe-135	4,925	0.3	339.5
I-131	0.040	0.191	0.00764
			$\sum$ =3264.6

TABLE 4-10

Work Sheet for Inhalation Dose

Isotope	A (Curies/Yr.)	f_c Dose Conversion (Factor I-131) (rad/Ci)	BR Breathing Rate (m^3/sec)	F_I $\frac{[(A)(BR)(f_c)]}{3}$ $\frac{rad}{yr.} \times \frac{m^3}{sec}$
I-131	0.04	$1.46 \times 10^{+6}$	2.32×10^{-4}	4.51

1

IMAGE EVALUATION TEST TARGET (MT-3)

150mm

6"

1

IMAGE EVALUATION TEST TARGET (MT-3)

1.0 2.8 2.5 3.2 2.2 3.6 2.0 4.0 1.1 1.8 1.25 1.4 1.6

150mm

6"

TABLE 4-11

Quantity of Finfish, Mollusks and Oysters Taken From the River System

(1) Isotope	(2) Quantity*** Released Annually (mCi)	(3) Average Concentration in Chattahoochee River & Lake Seminole (μCi/cc)	(4) Average Concentration in Apalachocola River (μCi/cc)	(5) MPC For Isotope (μCi/cc)	(6) F_{cf} Concentration* Factor For Fish Flesh	(7) F_{cm} Concentration Factor For Mollusk	(8) F_{ce} Concentration Factor For Crustacea	(9) Individual Dose Due to Ingestion of 0.47 gm/day of Fish Flesh From Chattahoochee River & Lake Seminole (rad/yr.)	(10) Individual Dose Due to Ingestion of 0.53 gm/day of Fish Flesh From Apalachocola River & Bay	(11) Individual Dose Due to Ingestion of 0.55 gm/day of Oyster Meat (rad/yr.)	(12) Individual Dose Due to Ingestion of 0.185 gm/day of Shrimp (rad/yr)
CR-51	3.64	3.44 (-13)	1.86 (-13)	2.00 (-3)	200	1,000	1,000	3.67 (-12)	2.24 (-12)	1.16 (-11)	3.91 (-12)
MN-54	5.67 (-1)**	5.30 (-14)	2.90 (-14)	1.00 (-4)	50	50,000	10,000	2.86 (-12)	1.74 (-12)	1.81 (-09)	1.22 (-10)
MN-56	1.16 (-1)	1.09 (-14)	5.90 (-15)	1.00 (-4)	-	-	-	-	-	-	-
FE-55	5.20 (-1)	4.91 (-14)	2.66 (-14)	2.00 (-3)	10	2,000	4,000	2.62 (-14)	1.60 (-14)	3.32 (-12)	2.23 (-12)
FE-59	6.40 (-1)	6.00 (-14)	3.27 (-14)	6.00 (-5)	10	20,000	4,000	1.07 (-12)	6.50 (-13)	1.36 (-09)	9.11 (-11)
CO-58	3.52 (+1)	3.32 (-12)	1.80 (-12)	1.00 (-4)	100	300	10,000	3.55 (-11)	2.17 (-10)	6.70 (-10)	7.50 (-09)
CO-60	5.46	5.01 (-13)	2.78 (-13)	5.00 (-5)	100	300	10,000	1.10 (-10)	6.70 (-11)	2.09 (-10)	2.35 (-09)
RB-88	1.74	1.65 (-13)	8.90 (-14)	3.00 (-6)	-	-	-	-	-	-	-
RB-89	4.20 (-2)	3.97 (-15)	2.15 (-15)	3.00 (-6)	-	-	-	-	-	-	-
SR-89	2.58	2.44 (-13)	1.32 (-13)	3.00 (-6)	5	1	1	4.34 (-11)	2.65 (-11)	5.50 (-12)	1.85 (-12)
SR-90	1.06 (-1)	1.00 (-14)	5.40 (-15)	3.00 (-7)	5	1	1	1.78 (-11)	1.09 (-11)	2.26 (-12)	7.60 (-13)
SR-91	2.80 (-2)	2.64 (-15)	1.43 (-15)	7.00 (-5)	-	-	-	-	-	-	-
Y-90	1.71 (-2)	1.61 (-15)	8.70 (-16)	2.00 (-5)	-	-	-	-	-	-	-
Y-91	1.72	1.64 (-13)	8.80 (-14)	2.00 (-5)	100	10	100	8.70 (-11)	5.30 (-11)	5.50 (-12)	1.85 (-11)
Y-92	4.40 (-3)	4.16 (-16)	2.25 (-16)	6.00 (-5)	-	-	-	-	-	-	-
ZR-95	9.26	8.71 (-13)	4.73 (-13)	6.00 (-5)	500	100	100	7.80 (-10)	4.75 (-10)	9.80 (-11)	3.32 (-11)
NB-95	2.00 (+1)	1.89 (-12)	1.02 (-12)	1.00 (-4)	300	200	200	6.00 (-10)	3.69 (-10)	2.55 (-10)	8.60 (-11)
MO-99	5.64 (+2)	5.03 (-11)	2.88 (-11)	2.00 (-4)	-	-	-	-	-	-	-
I-131	1.00 (+3)	9.40 (-11)	5.10 (-11)	3.00 (-7)	100	100	100	3.36 (-06)	2.05 (-06)	2.13 (-06)	7.10 (-07)
I-132	3.22	3.04 (-13)	1.64 (-13)	8.00 (-6)	-	-	-	-	-	-	-
I-133	1.29 (+2)	1.22 (-11)	6.60 (-12)	1.00 (-6)	-	-	-	-	-	-	-
I-134	7.76 (-1)	7.35 (-14)	3.97 (-14)	2.00 (-5)	-	-	-	-	-	-	-
I-135	2.24 (+1)	2.11 (-12)	1.14 (-12)	4.00 (-6)	-	-	-	-	-	-	-
TE-132	3.14 (+1)	2.97 (-12)	1.60 (-12)	2.00 (-5)	10	100	10	1.58 (-10)	9.60 (-11)	1.00 (-09)	3.37 (-11)
CS-134	3.30 (+2)	3.12 (-11)	1.69 (-11)	9.00 (-6)	500	10	50	1.85 (-07)	1.13 (-07)	2.34 (-09)	3.94 (-09)
CS-136	5.78 (+1)	5.40 (-12)	2.95 (-12)	9.00 (-5)	500	10	50	3.24 (-09)	1.98 (-09)	4.10 (-11)	6.90 (-11)
CS-137	1.42 (+3)	1.34 (-10)	7.20 (-11)	2.00 (-5)	500	10	50	3.58 (-07)	2.18 (-07)	4.54 (-09)	7.60 (-09)
CS-138	7.74 (-1)	7.30 (-14)	3.96 (-14)	3.00 (-6)	-	-	-	-	-	-	-
BA-140	1.60	1.51 (-13)	8.20 (-14)	3.00 (-5)	5	3	3	2.69 (-12)	1.64 (-12)	1.02 (-12)	3.44 (-13)
LA-140	9.00 (-2)	8.50 (-15)	4.60 (-15)	2.00 (-5)	-	-	-	-	-	-	-
CE 141	2.94 (+1)	2.78 (-12)	1.50 (-12)	9.00 (-5)	10	100	100	3.30 (-11)	2.01 (-11)	2.09 (-10)	7.00 (-11)
CE-144	1.30 (+1)	1.23 (-12)	6.60 (-13)	1.00 (-5)	100	100	100	1.31 (-09)	8.00 (-10)	8.30 (-10)	2.79 (-10)
H-3	1.00 (+6)	9.45 (-08)	5.11 (-08)	3.00 (-3)	1	1	1	3.37 (-09)	2.05 (-09)	2.13 (-09)	7.17 (-10)
								$\sum$ = 3.92 (-06)	$\sum$ = 2.39 (-06)	$\sum$ = 2.15 (-06)	$\sum$ = 7.40 (-07)

* Assumed 0 for isotopes with less than three day half-life.

** Numbers in ( ) are powers of 10.

TABLE 4-12

Estimated Annual Quantity of Fish and Shellfish Taken From the River System and Apalachacola Bay

Category	Quantity
Fish	
Chattahoochee River and Lake Seminole (including the Flint River portion of the lake)	1,025,000 lbs.
Apalachacola River (north of the bay)	900,400 lbs.
Apalachacola Bay	264,000 lbs.
Oysters	
Apalachacola Bay	2,000,000 lbs. (meat)
Shrimp	
Apalachacola Bay	265,000 lbs.

TABLE 4-13

Results of Annual Exposure Calculations

Type of Exposure	(1) Annual Total Population Exposure (Man-rad/yr.)	(2) Annual Average Exposure Per Capita (rad/yr.)	(3) Annual Maximum Individual Exposure (rad/yr.)
From Gaseous Effluents:			
Whole Body Gamma	23.8	5.28×10^{-5}	1.10×10^{-2}
Surface Body Beta	21.2	4.70×10^{-5}	1.95×10^{-4}
Inhalation	0.091	2.02×10^{-7}	1.35×10^{-5}
Ingestion of Milk	23.7	5.25×10^{-5}	9.46×10^{-3}
			$\sum = 20.4 \times 10^{-3}$*
From Liquid Effluents:			
Ingestion of Fish From Chattahoochee River & Lake Seminole	1.76	3.92×10^{-6}	1.66×10^{-3}
Ingestion of Fish From Appalachacola River	1.07	2.39×10^{-6}	-
Ingestion of Oyster Meat	0.968	2.15×10^{-6}	3.90×10^{-5}
Ingestion of Shrimp	0.33	7.40×10^{-7}	4.00×10^{-5}
	$\sum = 72.9$	$\sum = 1.61 \times 10^{-4}$	$\sum = 1.74 \times 10^{-3}$**

* From gaseous effluents only.
** From liquid effluents only.

TABLE 4-14

Comparison of Average Exposures to Natural Background Exposure

Average Per Capita Exposure All Sources From Table 4-13 (rad/yr.)	Natural Background Exposure (rad/yr.)	Fraction of Natural Background
0.000161	0.125	0.00129

TABLE 4-15

Comparison of Total Population Exposure to Natural Background

Total Population Exposure From Table 4-13 (Man-rad/yr.)	Total Population Exposure Due to Natural Background (Man-rad/yr.)	Fraction of Natural Background
72.9	56,280	0.00129

TABLE 4-16

Comparison of Maximum Individual Exposure with Applicable Regulations

	Maximum Exposure From Table 4-13 (rad/yr.)	Exposure Limit to General Population (rad/yr.)	Fraction of Limit
Airborne Effluent	0.02	0.5	0.04
Liquid Effluents	0.00174	0.5	0.00348

4.7 The Possible Radiological Effects on Important Species

Previous portions of this report have shown that the operation of the Farley Plant poses no possible threat to the health of the people living in the vicinity. The radiation doses to the public anticipated from the plant are well below the limits recommended by the International Commission on Radiological Protection and the National Council on Radiation Protection. There is no question that the operation of this plant will be safe for humans.

It follows that the operation can have no possible effects on wild species living in the vicinity. This contention is supported by several observations. With a single exception, no effects of any kind have been observed at radiation levels up to, and considerably larger than the public limits recommended by ICRP and NCRP. The single exception is the report of Pilikarpov that drinking water concentration of strontium-90 produced injury to fish eggs. Several attempts have been made to repeat Polikarpov's experiment, but none has shown the effects which he reported. Perhaps the most recent such attempt is that of Trabalka (doctoral thesis, University of Michigan), who found no differences between any of a number of species, including spawning fish, in a pair of matched tanks, one of which was maintained at a concentration of cerium-144 well above the drinking water limit.

During the past 20 years much of the world's surface has experienced levels of radioactivity from fallout which at times were considerable larger than the levels that may be produced by the Farley Plant. In spite of widespread and intensive study, no ecological effects have been recorded.

Finally, it can be stated that the radiological monitoring program will detect the presence of radioactive materials from the Farley Plant in the environment at levels many orders of magnitude lower than those which can possibly produce effects on species in the area. This monitoring program will detect and give notice on unexpected concentrations so that if corrective action is necessary, it can be taken long before any ecological effect is produced.

4.8 Status of Incomplete Studies

An extensive program of element and radiological analysis of plants and animals has been undertaken to supplement accumulated information. This program is under the direction of Dr. G. Hoyt Whipple of the University of Michigan, with the assistance of Dr. John Lawrence of Auburn University and Dr. G. Winston Menzell of Florida State University. Element analyses are made by Stewart Laboratories, Inc. of Knoxville, Tennessee and Fisheries Department of Auburn University.

The radiological monitoring program will continue throughout construction and during operations of the plant.

The following tables of element analysis are taken directly from three reports from the Stewart Laboratories, Inc. The sample code numbers are only for laboratory work use. The sample station numbers indicate the location from which the samples were taken. Sample station No. 1 is upstream of Columbia Lock and Dam. Sample station No.14 is a background station in Ochlockonee Bay, Florida. The other stations are between these two points.

Animal and Plant Tissue Samples -- Estuary
Farley Project (APC 00726)

Values are expressed as ppm in original sample

	JG-1 Crabs	JG-29 Crabs	JG-33 Clams	JG-2 Clams	JG-24 Clams	JG-7 Shrimp	JG-26 Shrimp	JG-9 Spots
Station	A-11	A-14	A-9	A-11	A-14	A-11	A-14	A-11
% Ash of Original Sample	1.88	1.71	0.35	0.72	1.04	1.23	1.38	1.03
% Moisture of Original Sample	81.6	78.9	93.4	92.3	90.9	81.9	80.6	83.9
Antimony	0.09	0.09	0.004	0.006	0.01	0.09	0.09	0.09
Barium	1.9	0.12	0.88	0.25	0.42	0.12	0.35	0.11
Cerium	0.21	0.28	0.27	0.23	0.29	0.22	0.28	0.25
Cesium	0.01	0.008	0.02	0.02	0.03	0.007	0.008	0.01
Chromium	0.07	0.14	0.35	0.29	0.29	0.05	0.08	0.06
Cobalt	0.20	0.18	0.04	0.06	0.26	0.31	0.22	0.07
Copper	38.	34.	3.5	3.6	9.4	12.	21.	0.41
Hafnium	0.006	0.002	0.001	0.005	0.001	0.004	0.005	0.004
Iodine	2.1	1.7	2.2	1.5	1.8	1.4	1.7	1.2
Iron	83.	51.	14.	108.	94.	25.	14.	21.
Lanthanum	0.47	0.12	0.08	0.20	0.32	0.27	0.26	0.24
Manganese	7.5	1.7	2.1	36.	3.7	0.62	0.55	0.52
Mercury	0.13	0.04	0.03	0.06	0.03	0.07	0.03	0.07
Molybdenum	0.19	0.17	0.09	0.14	0.26	0.24	0.28	0.10
Niobium	0.28	0.34	0.03	0.18	0.21	0.37	0.41	0.20
Phosphorus	2312.	1175.	436.	380.	1425.	2425.	2805.	1750.
Rubidium	1.8	2.5	1.4	1.1	1.3	1.3	1.1	1.5
Silver	0.04	0.09	0.007	0.29	1.1	0.01	0.06	0.03
Sodium	1205.	2440.	195.	870.	575.	800.	875.	200.
Strontium	19.	6.8	0.25	1.8	4.2	1.2	5.5	0.41
Sulfur	1270.	1585.	720.	425.	862.	1880.	2010.	2240.
Tantalum	0.001	0.002	0.003	0.001	0.001	0.001	0.002	0.002
Tellurium	3.8	1.5	0.70	0.36	0.72	0.55	1.0	0.58
Tin	0.61	0.68	0.07	0.29	1.0	0.49	0.52	0.23
Tungsten	0.001	0.001	0.007	0.004	0.004	0.001	0.002	0.002
Yttrium	0.08	0.07	0.009	0.04	0.05	0.19	0.22	0.26
Zinc	60.	61.	9.5	14.	13.	11.	15.	4.9
Zirconium	0.09	0.10	0.14	0.18	0.28	0.09	0.07	0.05

(continued)

	Jg-27 Spots	JG-10 Oysters	JG-25 Oysters	JG-13 Trout	JG-30 Trout	JG-42 Oyster Shells	JG-43 Oyster Shells	JG-5 Ruppiaceae
Station	A-14	A-11	A-14	A-11	A-14	A-11	A-14	A-11
% Ash of Original Sample	0.88	2.53	1.16	1.17	1.02	---	---	3.37
% Moisture of Original Sample	86.0	88.9	88.9	84.1	84.6	---	---	93.0
Antimony	0.09	0.05	0.03	0.06	0.10	*	*	0.04
Barium	0.25	1.3	0.29	0.04	0.26	22.	18.	1.2
Cerium	0.28	0.24	0.28	0.28	0.28	0.09	0.09	0.23
Cesium	0.006	0.01	0.05	0.007	0.009	*	*	0.04
Chromium	0.08	0.29	0.10	0.16	0.41	0.42	0.75	0.37
Cobalt	0.09	0.25	0.08	0.13	0.07	3.2	2.7	1.1
Copper	4.4	51.	13.	1.5	10.	10.	8.3	1.5
Hafnium	0.003	0.009	0.007	0.002	0.002	0.01	0.01	0.02
Iodine	1.4	3.6	2.7	0.33	0.37	*	*	3.2
Iron	13.	177.	93.	22.	14.	720.	640.	1010.
Lanthanum	0.21	0.63	0.35	0.35	0.05	0.41	0.35	0.85
Manganese	0.44	9.4	2.9	1.2	2.0	98.	75.	34.
Mercury	0.04	0.04	0.02	0.05	0.05	$<$ 0.02	$<$ 0.02	0.02
Molybdenum	0.09	0.48	0.07	0.06	0.06	0.72	0.48	0.14
Niobium	0.23	0.51	0.12	0.08	0.07	0.32	0.45	1.3
Phosphorus	1795.	838.	598.	1790.	1415.	550.	478.	179.
Rubidium	2.9	1.4	1.4	1.9	3.0	0.5	0.4	2.3
Silver	0.04	0.12	0.02	0.02	0.01	0.01	0.01	0.03
Sodium	255.	3290.	1485.	145.	165.	5[illegible]00.	2465.	440.
Strontium	0.35	6.4	1.2	0.11	0.12	1105.	1025.	3.6
Sulfur	2065.	2950.	2115.	1370.	1930.	1550.	1400.	376.
Tantalum	0.002	0.001	0.001	0.002	0.001	0.001	0.001	0.001
Tellurium	1.1	1.9	1.3	0.55	0.95	*	*	5.0
Tin	0.35	1.0	0.42	0.29	0.21	0.40	0.31	0.13
Tungsten	0.002	0.003	0.003	0.001	0.003	0.0001	0.0001	0.004
Yttrium	0.10	0.13	0.28	0.05	0.04	0.52	0.50	0.24
Zinc	4.8	81.	245.	4.4	3.1	11.	13.	9.6
Zirconium	0.05	0.76	0.06	0.07	0.03	2.0	1.6	10.

* Analysis was not possible because of analytical interferences due to sample type and gross composition.

Fish Samples -- John Lawrence
Farley Project (APC 00726)

Values are expressed as ppm in original sample

	JG-44 White Catfish	JG-45 Gizzard Shad	JG-46 L. Mouth Bass	JG-47 L. Mouth Bass	JG-48 Gizzard Shad
% Ash of Original Sample	1.14	1.68	1.43	1.22	1.59
% Moisture of Original Sample	81.8	80.2	77.5	77.4	82.2
Antimony	0.08	0.07	0.10	0.09	0.09
Barium	0.52	0.67	0.14	0.12	0.65
Cerium	0.08	0.09	0.08	0.07	0.07
Cesium	0.01	0.009	0.005	0.009	0.008
Chromium	0.29	0.08	0.10	0.09	1.6
Cobalt	0.04	0.10	0.14	0.12	0.11
Copper	4.6	6.7	14.3	6.1	3.2
Hafnium	0.003	0.004	0.007	0.002	0.004
Iodine	0.26	0.35	0.23	0.18	0.33
Iron	8.0	11.8	10.0	8.5	14.3
Lanthanum	0.05	0.17	0.07	0.05	0.06
Manganese	0.29	5.0	0.06	0.31	4.8
Mercury	0.10	0.03	0.20	0.35	0.03
Molybdenum	0.15	0.15	0.03	0.05	0.16
Niobium	0.11	0.17	0.10	0.12	0.32
Phosphorus	2435.	3095.	2290.	2440.	2645.
Rubidium	2.6	3.1	3.0	3.5	2.5
Silver	0.10	0.07	0.06	0.02	0.11
Sodium	547.	583.	465.	337.	477.
Strontium	0.48	1.2	0.08	0.01	0.64
Sulfur	1715.	1865.	2430.	2355.	1690.
Tantalum	0.0006	0.0005	0.0008	0.001	0.0008
Tellurium	0.30	1.4	0.25	0.31	1.3
Tin	0.25	0.67	0.57	0.49	0.64
Tungsten	0.003	0.002	0.002	0.001	0.004
Yttrium	0.008	0.07	0.06	0.06	0.02
Zinc	7.1	5.6	8.0	4.9	4.0
Zirconium	0.12	0.08	0.05	0.07	0.04

Sediment Samples
Farley Project (APC 00726)

Values are expressed as ppm in original sample (dry)

	JG-21 Sediment	JG-12 Sediment	JG-32 Sediment
Station	A-9	A-11	A-14
Antimony	3.0	16.	15.
Barium	120.	45.	55.
Cerium	3.1	2.7	2.9
Cesium	0.11	0.14	0.05
Chromium	13.	8.1	7.8
Cobalt	12.	9.6	16.
Copper	42.	18.	26.
Hafnium	0.2	0.1	0.1
Iodine	0.34	0.21	0.53
Iron	4250.	4475.	3140.
Lanthanum	18.	9.7	8.4
Manganese	225.	82.	65.
Mercury	0.003	0.002	0.002
Molybdenum	7.1	4.2	12.
Niobium	25.	15.	21.
Phosphorus	79.	34.	57.
Rubidium	8.	6.	6.
Silver	0.15	1.5	1.0
Sodium	750.	4800.	5300.
Strontium	110.	135.	85.
Sulfur	475.	610.	2380.
Tantalum	0.1	0.2	0.05
Tellurium	0.05	0.03	0.06
Tin	0.26	0.20	0.18
Tungsten	0.01	0.01	0.01
Yttrium	0.24	0.51	0.43
Zinc	12.	5.4	7.1
Zirconium	11.	260.	24.

Water Samples
Farley Project (APC 00726)

Values are expressed as ppm in original sample

	JG-20 Water	JG-11 Water	JG-31 Water
Station	A-9	A-11	A-14
% Residue	0.0156	2.03	0.786
Antimony	0.001	0.02	0.01
Barium	0.01	0.05	0.009
Cerium	0.005	0.0004	0.002
Cesium	0.0001	0.00002	0.00002
Chromium	0.02	0.009	0.03
Cobalt	0.001	0.002	0.004
Copper	0.08	0.14	0.15
Hafnium	0.00001	0.00001	0.00001
Iodine	0.06	0.07	0.06
Iron	0.39	0.20	0.31
Lanthanum	0.0006	0.007	0.005
Manganese	0.02	0.008	0.01
Mercury	0.0003	0.0002	0.0002
Molybdenum	0.002	0.005	0.007
Niobium	0.0001	0.0004	0.0004
Phosphorus	0.02	0.07	0.05
Rubidium	0.003	0.04	0.07
Silver	0.00005	0.009	0.003
Sodium	13.	5300.	2550.
Strontium	0.09	2.1	1.2
Sulfur	4.1	627.	397.
Tantalum	0.0002	0.00001	0.00002
Tellurium	0.0001	0.0001	0.0001
Tin	0.002	0.003	0.006
Tungsten	0.0003	0.0004	0.0003
Yttrium	0.0004	0.0002	0.0002
Zinc	0.006	0.03	0.02
Zirconium	0.005	0.006	0.009

Plant & Animal Tissues - River

Farley Project (APC 01015)

	P594 Juncus	P601 Juncus	P597 Peltandra	P595 Peltandra	P595 Spike-brush	P598 Smart-weed	P599 Umbelli-ferae	P600 Vassey Grass	P580 Milk
Station	2	1	1	2	1	1	1	1	Near Plant Site
% Ash	1.36	1.32	1.07	1.69	8.44	2.12	4.38	1.99	0.59
% Moisture	81.56	74.90	88.72	92.55	85.40	84.58	87.72	83.47	88.01
Antimony	0.26	0.11	0.03	0.06	0.10	0.60	0.12	0.08	0.007
Arsenic	0.02	0.02	0.08	0.05	0.02	0.13	0.03	0.02	0.001
Barium	1.39	3.30	4.28	1.81	21.1	2.15	13.1	1.39	0.06
Cadmium	0.56	2.20	0.08	0.04	0.11	0.11	2.20	0.06	0.0006
Cerium	0.27	0.13	0.15	0.42	3.38	0.42	1.10	0.80	0.001
Cesium	0.06	0.08	0.05	0.08	0.09	0.05	0.07	0.06	0.0004
Cobalt	0.16	0.05	0.11	0.85	1.75	0.53	0.44	0.20	0.003
Copper	1.36	1.32	1.10	1.69	4.22	2.12	3.94	3.99	0.24
Iodine	0.40	0.24	0.59	0.45	0.62	1.03	1.46	0.53	0.08
Manganese	95.2	66.0	278.	42.3	341.	424.	175.	398.	1.18
Mercury	0.02	0.06	0.03	0.01	0.06	0.56	0.06	0.02	0.0008
Molybdenum	0.14	0.35	0.54	0.07	1.69	0.11	0.31	0.08	0.03
Phosphorus	222.	285.	364.	336.	156.	407.	476.	253.	1013.
Strontium	1.30	1.37	2.14	1.75	2.20	0.57	3.07	0.40	0.15
Tellurium	0.009	0.006	0.008	0.006	0.005	0.01	0.006	0.006	0.0001
Tin	0.54	0.33	0.08	0.05	0.13	0.25	0.02	0.03	0.006
Zinc	14.3	18.9	12.7	9.27	12.6	13.3	11.6	13.3	7.2

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Plant & Animal Tissues - River, Continued

Farley Project (APC 01015)

	P516 Largemouth Bass	P521 Largemouth Bass	P534 Largemouth Bass	P544 Largemouth Bass	P518 Crappie	P545 Crappie	P542 White Catfish	P524 Catfish	P533 Mullet
Station	3	2	9	6	3	6	6	2	9
% Ash	1.31	2.01	1.40	1.44	1.71	1.09	1.07	1.18	1.29
% Moisture	78.97	77.83	80.13	79.87	79.25	78.37	81.18	81.60	77.57
Antimony	0.22	0.08	0.20	0.06	0.06	0.10	0.11	0.25	0.15
Arsenic	0.02	0.11	0.01	0.08	0.07	0.03	0.06	0.02	0.06
Barium	0.03	0.08	0.10	0.10	0.07	0.42	0.13	2.27	1.29
Cadmium	0.11	0.55	0.83	0.22	0.13	2.20	0.56	1.10	0.25
Cerium	0.13	0.09	0.14	0.29	0.10	0.06	0.04	0.06	0.21
Cesium	0.08	0.02	0.02	0.07	0.04	0.04	0.04	0.04	0.04
Cobalt	0.11	0.14	0.07	0.13	0.09	0.03	0.07	0.05	0.26
Copper	0.92	0.80	0.56	1.30	0.68	1.09	0.96	2.36	0.52
Iodine	0.42	0.71	0.44	1.07	0.50	0.34	0.20	1.49	1.02
Manganese	0.15	0.08	0.14	0.14	0.07	0.44	0.43	0.83	0.52
Mercury	0.08	0.15	0.09	0.07	0.08	0.06	0.03	0.25	0.07
Molybdenum	0.04	0.04	0.13	0.03	0.06	0.05	0.04	0.05	0.03
Phosphorus	1438.	1293.	1346.	1199.	1415.	949.	1017.	1588.	1318.
Strontium	0.05	0.07	0.08	0.27	0.17	0.39	0.11	0.30	0.90
Tellurium	0.006	0.01	0.008	0.01	0.09	0.008	0.004	0.009	0.01
Tin	0.33	0.37	0.30	0.21	0.08	0.45	0.35	0.58	0.12
Zinc	12.9	10.0	9.00	10.9	9.9	11.5	12.1	11.7	11.5

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Plant & Animal Tissues - River, Continued

Farley Project (APC 01015)

	P543 Bluegill	P519 Bluegill	P522 Bluegill	P532 Bluegill	P535 Bluegill	P517 Gizzard Shad	P520 Gizzard Shad	P536 Gizzard Shad
Station	6	3	2	1	9	3	2	9
% Ash	1.49	1.42	1.19	1.39	1.27	1.65	1.57	1.65
% Moisture	75.96	78.06	80.80	79.23	79.44	80.21	81.96	83.82
Antimony	0.11	0.06	0.10	0.11	0.14	0.42	0.17	0.15
Arsenic	0.06	0.02	0.06	0.06	0.07	0.03	0.08	0.09
Barium	0.15	0.02	0.12	0.13	0.13	0.69	0.39	0.3[illegible]
Cadmium	0.82	0.02	0.44	0.56	0.54	1.40	0.62	0.55
Cerium	0.04	0.10	0.02	0.06	0.08	0.17	0.13	0.17
Cesium	0.03	0.03	0.02	0.009	0.05	0.01	0.005	0.04
Cobalt	0.06	0.10	0.12	0.10	0.09	0.08	0.16	0.83
Copper	0.60	0.57	1.19	0.97	0.52	1.16	1.41	1.65
Iodine	1.15	1.65	0.91	1.83	0.56	0.71	0.48	1.69
Manganese	0.37	0.28	0.36	0.56	0.32	4.95	3.14	3.30
Mercury	0.08	0.01	0.06	0.06	0.07	0.10	0.08	0.14
Molybdenum	0.02	0.07	0.05	0.42	0.01	0.17	0.05	0.14
Phosphorus	1514.	1582.	1493.	1624.	1400.	1921.	1855.	2438.
Strontium	0.15	0.04	0.30	0.52	0.26	0.66	0.63	0.12
Tellurium	0.11	0.006	0.005	0.006	0.01	0.007	0.10	0.03
Tin	0.43	0.03	0.56	0.22	0.54	0.56	0.12	0.45
Zinc	12.2	14.2	12.3	12.3	8.82	9.42	8.83	13.1

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Plant & Animal Tissues - River, Continued

Farley Project (APC 01015)

	P612 Water-melon	P613 Corn	P614 Peanuts	P581 Mushroom Squash	P582 Yellow Squash	P583 Tomatoes	P585 Beans	P586 Peas
Station	Near Plant Site	Near Plant Site	Near Plant Site	Near Plant Site	Near Plant Site	Near Plant Site	Near Plant Site	Near Plant Site
% Ash	0.40	0.92	2.02	0.54	0.49	0.73	0.76	1.09
% Moisture	91.09	44.63	26.75	94.30	94.85	91.25	91.18	73.63
Antimony	0.06	0.11	0.13	0.12	0.09	0.12	0.10	0.08
Arsenic	0.06	0.06	0.01	0.01	0.03	0.08	0.03	0.06
Barium	0.40	0.18	1.41	0.60	0.49	0.73	0.38	0.76
Cadmium	0.39	0.44	0.10	0.11	0.09	0.17	0.50	0.06
Cerium	0.02	0.04	0.07	0.02	0.02	0.07	0.07	0.08
Cesium	0.03	0.007	0.008	0.02	0.03	0.12	0.07	0.05
Cobalt	0.02	0.04	0.06	0.05	0.05	0.07	0.04	0.04
Copper	0.45	2.39	8.08	1.08	0.49	1.46	0.30	2.18
Iodine	0.04	0.007	0.006	0.34	0.21	0.47	0.02	0.11
Manganese	0.40	2.30	18.2	13.5	1.96	3.65	3.04	9.81
Mercury	0.04	0.06	0.01	0.08	0.05	0.03	0.02	0.02
Molybdenum	0.01	0.18	0.08	0.02	0.03	0.02	0.05	0.55
Phosphorus	33.0	928.	1573.	109.	109.	227.	123.	1104.
Strontium	0.16	0.02	0.85	0.54	0.34	0.29	0.30	0.44
Tellurium	0.04	0.01	0.002	0.006	0.006	0.01	0.005	0.005
Tin	0.32	0.15	0.06	0.15	0.18	0.17	0.40	0.05
Zinc	1.27	12.3	17.9	5.73	5.63	7.30	6.71	15.7

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Plant & Animal Tissues - River, Continued

Farley Project (APC 01015)

	P572 Asiatic Clams	P607 Asiatic Clams	P605 Asiatic Clams	P608 Beef	P609 Pork	P610 Deer	P611 Turkey	P592 Spanish Moss	P593 Spanish Moss
Station	9	1	3,4,6	Near Plant Site	Near Plant Site	Near Plant Site	Near Plant Site	2	1
% Ash	1.44	0.96	1.67	1.31	0.94	1.21	1.14	3.48	2.71
% Moisture	75.20	78.16	78.21	77.46	76.18	73.55	76.58	44.94	35.23
Antimony	0.14	0.30	0.36	0.05	0.08	0.11	0.15	0.56	0.10
Arsenic	0.07	0.08	0.09	0.05	0.02	0.06	0.06	0.22	0.04
Barium	0.58	3.84	6.68	0.14	0.09	0.45	0.09	13.1	2.75
Cadmium	0.62	1.10	1.31	0.07	2.25	1.10	1.15	0.56	0.18
Cerium	0.14	0.48	0.57	0.03	0.04	0.08	0.08	1.39	0.68
Cesium	0.11	0.10	0.09	0.12	0.08	0.17	0.07	0.10	0.13
Cobalt	0.31	0.40	0.67	0.06	0.07	0.12	0.05	1.78	1.08
Copper	5.76	6.83	8.35	0.52	2.35	4.84	2.28	17.4	13.6
Iodine	1.30	0.88	0.67	0.01	0.09	0.73	0.04	0.14	0.12
Manganese	5.76	6.72	15.0	0.13	0.24	0.24	0.23	139.	27.1
Mercury	0.03	0.06	0.18	0.03	0.02	0.56	0.06	0.78	0.02
Molybdenum	0.29	0.38	0.33	0.05	0.04	0.03	0.21	0.70	0.54
Phosphorus	1147.	1222.	1257.	1189.	959.	1400.	1179.	451.	330.
Strontium	0.33	0.69	1.17	0.01	0.06	0.48	0.11	13.9	2.71
Tellurium	0.009	0.01	0.008	0.007	0.007	0.008	0.009	0.02	0.008
Tin	0.58	0.08	0.13	0.01	0.25	0.35	0.22	3.13	1.08
Zinc	6.20	31.4	31.2	39.7	19.3	31.9	12.3	61.6	43.7

Plant and Animal Tissues - Estuary

Farley Project (APC 01015)

	P568 Neritina Snails	P557 Neritina Snails	P567 White Shrimp	P548 White Shrimp	P569 Blue Crabs	P552 Blue Crabs	P561 Oyster Shells	JG3 Juncus
Station	11	14	11	14	11	14	11	11
% Ash	29.84	27.38	1.71	1.98	1.89	2.23	-	3.27
% Moisture	61.47	63.03	77.44	75.33	81.25	78.61	-	81.70
Antimony	0.15	0.03	0.03	0.03	0.11	0.08	0.10	0.13
Arsenic	0.12	0.08	0.05	0.06	0.03	0.06	0.05	0.02
Barium	253.	9.83	0.07	0.18	0.95	1.12	22.8	1.31
Cadmium	0.77	0.34	0.006	0.08	0.33	0.33	0.20	0.10
Cerium	1.19	2.56	0.10	0.20	0.17	0.41	1.52	0.16
Cesium	0.04	0.04	0.04	0.05	0.11	0.22	*	0.06
Cobalt	3.04	5.48	0.07	0.08	0.08	0.19	3.01	0.82
Copper	268.	10.9	6.84	5.94	9.45	8.92	12.2	1.57
Iodine	*	*	0.32	0.11	0.40	1.93	1.76	0.18
Manganese	59.7	27.4	1.71	0.59	1.32	0.45	25.0	81.8
Mercury	0.03	0.10	0.08	0.02	0.06	0.02	0.07	0.06
Molybdenum	2.98	0.23	0.12	0.05	0.19	0.22	1.80	0.13
Phosphorus	2361.	4235.	2104.	1909.	1878.	2270.	3932.	164.
Strontium	298.	274.	5.13	1.96	1.84	8.03	1724.	1.28
Tellurium	0.008	0.02	0.006	0.004	0.007	0.008	0.006	0.006
Tin	0.08	0.08	0.12	0.1[illegible]	0.45	0.20	0.53	0.09
Zinc	0.17	0.51	16.40	17.33	42.67	44.80	10.5	9.57

Whole body plus foot pad.

*Analysis was not possible because of analytical interferences due to sample type and gross composition.

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Plant and Animal Tissues - Estuary, Continued

Farley Project (APC 01015)

	JG8 Mullet	JG37 Mullet	P546 Mullet	P579 Mullet	P575 Spots	P549 Spots	P574 Seatrout	P547 Seatrout
Station	11	14	14	11	11	14	11	14
% Ash	4.70	1.32	1.49	1.28	1.26	1.06	1.94	1.23
% Moisture	74.61	74.90	76.38	73.87	79.34	76.84	76.94	78.36
Antimony	0.18	0.10	0.15	0.12	0.10	0.15	0.08	0.08
Arsenic	0.06	0.05	0.06	0.08	0.07	0.02	0.02	0.03
Barium	0.04	0.13	0.15	0.24	0.09	0.38	0.06	0.20
Cadmium	0.15	0.56	0.56	0.45	0.10	0.83	5.60	0.83
Cerium	0.05	0.04	0.03	0.03	0.05	0.02	0.04	0.07
Cesium	0.04	0.04	0.003	0.05	0.01	0.06	0.008	0.05
Cobalt	0.19	0.05	0.07	0.05	0.11	0.03	0.08	0.05
Copper	1.88	1.19	1.49	1.28	5.04	0.74	1.36	1.23
Iodine	0.11	0.02	0.36	0.67	0.08	0.37	0.09	0.09
Manganese	0.05	0.40	0.33	0.26	0.50	0.11	0.04	0.25
Mercury	0.07	0.07	0.02	0.08	0.03	0.03	0.06	0.11
Molybdenum	0.03	0.05	0.06	0.32	0.13	0.04	0.02	0.86
Phosphorus	1388.	1147.	1315.	1225.	1074.	1553.	1410.	1708.
Strontium	0.15	0.26	1.34	0.51	0.38	0.42	0.05	0.49
Tellurium	0.003	0.003	0.009	0.007	0.006	0.01	0.008	0.002
Tin	0.27	0.22	0.22	0.36	0.30	0.10	0.15	0.25
Zinc	11.67	9.40	13.47	7.87	9.93	9.10	10.27	9.40

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Plant and Animal Tissues - Estuary, Continued

Farley Project (APC 01015)

	P570 Oysters	P555 Oysters	P571 Rangia Clams	P556 Rangia Clams
Station	11	14	11	11
% Ash	2.66	3.19	0.93	2.07
% Moisture	80.14	86.87	83.28	81.74
Antimony	0.13	0.08	0.06	0.25
Arsenic	0.06	0.06	0.05	0.08
Barium	1.86	0.64	1.73	0.41
Cadmium	0.56	0.83	0.05	0.22
Cerium	0.52	0.08	0.37	0.20
Cesium	0.20	0.86	0.08	0.18
Cobalt	0.16	0.22	0.24	0.19
Copper	18.7	12.8	2.79	6.21
Iodine	3.05	7.25	0.49	3.19
Manganese	10.6	6.38	18.6	2.07
Mercury	0.02	0.06	0.01	0.06
Molybdenum	0.19	0.32	19.0	0.23
Phosphorus	2014.	1168.	1028.	1032.
Strontium	5.32	7.98	0.93	2.00
Tellurium	0.009	0.008	0.004	0.01
Tin	0.03	0.09	0.03	0.13
Zinc	56.00	117.	19.68	22.79

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Plant and Animal Tissues - Estuary, Continued

Farley Project (APC 01015)

	P563 Ruppia	P565 Spartina	P576 Spanish Moss	P562 Juncus	JG23 Juncus	P553 Juncus	P578 Broadleaf Cattails	P554 Broadleaf Cattails
Station	11	11	14	11	14	14	11	14
% Ash	2.39	1.22	1.95	2.60	2.59	5.10	1.79	1.70
% Moisture	92.55	81.66	56.49	72.72	77.76	77.33	87.16	82.62
Antimony	0.12	0.03	0.14	0.25	0.12	0.33	0.15	0.12
Arsenic	0.06	0.08	0.18	0.06	0.02	0.02	0.03	0.02
Barium	2.56	1.25	4.88	2.65	0.28	2.26	1.25	0.38
Cadmium	0.53	0.11	0.89	0.33	0.11	0.12	0.74	0.06
Cerium	0.25	0.31	0.17	0.52	0.51	0.51	0.13	0.34
Cesium	0.07	0.05	0.004	0.09	0.06	0.08	0.006	0.15
Cobalt	0.48	0.49	0.20	0.13	1.81	0.26	0.07	0.17
Copper	2.42	3.05	3.90	1.04	2.33	0.51	0.72	0.68
Iodine	0.08	0.74	0.02	0.67	0.08	0.53	0.04	0.66
Manganese	23.9	24.4	78.0	13.0	7.77	10.2	71.6	17.0
Mercury	0.05	0.06	0.12	0.07	0.02	0.03	0.10	0.08
Molybdenum	0.10	0.09	0.14	0.10	0.10	0.20	0.02	0.17
Phosphorus	113.	605.	633.	230.	169.	129.	304.	176.
Strontium	1.20	0.85	3.90	1.08	0.26	2.04	3.58	1.19
Tellurium	0.01	0.01	0.009	0.006	0.004	0.006	0.006	0.003
Tin	0.10	0.08	0.09	0.07	0.07	0.07	0.18	0.06
Zinc	10.73	14.90	3.33	12.03	18.13	11.20	11.77	13.47

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Soil and Sediment Samples - River

Farley Project (APC 01015)

	P510 Sediment	P511 Sediment	P506 Sediment	P507 Sediment	P512 Sediment	P508 Sediment	P509 Sediment	P527 Sediment
Station	1	2	2	3	3	4	4	6
Antimony	0.11	0.03	0.30	0.37	0.10	0.32	0.10	0.07
Arsenic	0.03	0.05	0.05	0.07	0.05	0.03	0.05	0.03
Barium	11.2	120.	92.6	45.8	126.	63.2	140.	55.2
Cadmium	0.18	0.10	0.13	0.05	0.14	0.10	0.09	0.23
Cerium	12.1	24.1	10.2	12.0	8.13	4.41	7.82	4.38
Cesium	0.27	0.33	0.30	0.29	0.25	0.31	0.15	0.12
Cobalt	8.25	16.0	7.29	7.37	28.5	20.3	21.7	7.06
Copper	96.4	22.7	12.0	18.1	26.2	72.7	113.	12.8
Iodine	0.41	0.46	0.59	0.58	0.76	0.64	0.56	0.39
Manganese	107.	72.5	82.4	51.3	88.3	87.8	107.	96.1
Mercury	0.005	0.002	0.002	0.03	0.002	0.005	0.002	0.007
Molybdenum	7.32	18.4	4.38	3.06	6.42	4.62	7.28	2.93
Phosphorus	103.	46.2	26.3	42.1	237.	61.0	37.5	87.0
Strontium	14.0	21.4	25.1	10.9	15.4	7.03	22.4	9.84
Tellurium	0.005	0.10	0.08	0.01	0.005	0.02	0.005	0.005
Tin	4.15	18.3	26.2	10.5	11.4	22.4	4.02	3.19
Zinc	24.5	14.3	4.00	3.25	65.0	3.75	15.5	11.8

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Soil and Sediment Samples - River, Continued

Farley Project (APC 01015)

	P529 Sediment	P584 Soil
Station	9	Near Plant Site
Antimony	0.03	0.10
Arsenic	0.02	0.03
Barium	130.	47.1
Cadmium	0.18	0.16
Cerium	18.5	22.3
Cesium	0.24	0.30
Cobalt	22.7	15.6
Copper	25.8	26.5
Iodine	0.59	0.78
Manganese	430.	96.1
Mercury	0.002	0.005
Molybdenum	6.15	3.74
Phosphorus	370.	272.
Strontium	45.0	4.28
Tellurium	0.003	0.02
Tin	2.36	0.52
Zinc	46.3	3.25

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Soil and Sediment Samples - Estuary

Farley Project (APC 01015)

	P560 Sediment	P525 Sediment
Station	11	14
Antimony	0.12	0.21
Arsenic	0.02	0.03
Barium	42.3	47.0
Cadmium	0.15	0.22
Cerium	26.1	2.21
Cesium	0.18	0.20
Cobalt	16.7	4.59
Copper	10.8	17.4
Iodine	0.41	0.61
Manganese	275.	35.5
Mercury	0.002	0.005
Molybdenum	8.95	3.76
Phosphorus	59.0	321.
Strontium	14.4	26.8
Tellurium	0.005	0.005
Tin	28.0	4.91
Zinc	9.50	4.25

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Water Samples - River

Farley Project (APC 01015)

Station	P591 Water 1	P502 Water 2	P501 Water 3	P513 Water 3	P503 Water 4	P526 Water 6	P528 Water 9
% Residue	0.0061	0.0063	0.0071	0.0093	0.0085	0.0097	0.0086
Antimony	0.0005	0.0005	0.0005	0.0004	0.001	0.0005	0.0005
Arsenic	0.0002	0.0003	0.0005	0.0005	0.0005	0.0002	0.0002
Barium	0.03	0.004	0.007	0.02	0.007	0.02	0.007
Cadmium	0.001	0.002	0.003	0.001	0.002	0.001	0.001
Cerium	0.006	0.001	0.01	0.003	0.003	0.003	0.0008
Cesium	0.0001	0.0001	0.00008	0.00008	0.0001	0.00008	0.00009
Cobalt	0.0006	0.0005	0.007	0.002	0.002	0.001	0.0006
Copper	0.003	0.006	0.006	0.009	0.009	0.007	0.003
Iodine	0.02	0.03	0.05	0.06	0.03	0.04	0.04
Manganese	0.15	0.006	0.03	0.37	0.03	0.05	0.02
Mercury	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0002
Molybdenum	0.0004	0.0006	0.0006	0.0009	0.0006	0.0007	0.0005
Phosphorus	0.019	0.017	0.016	0.008	0.009	0.010	0.009
Strontium	0.02	0.006	0.008	0.004	0.008	0.004	0.006
Tellurium	0.00005	0.0001	0.00005	0.0001	0.00005	0.00005	0.00005
Tin	0.002	0.0019	0.003	0.0001	0.0001	0.0001	0.001
Zinc	0.10	0.02	0.45	0.05	0.06	0.02	0.04

Water Samples - Estuary

Farley Project (APC 01015)

	P559 Water	P530 Water
Station	11	14
% Residue	0.163	2.75
Antimony	0.001	0.001
Arsenic	0.0002	0.0005
Barium	0.04	0.18
Cadmium	0.001	0.001
Cerium	0.03	0.06
Cesium	0.00007	0.00005
Cobalt	0.008	0.04
Copper	0.65	0.23
Iodine	0.06	0.07
Manganese	0.02	0.06
Mercury	0.0002	0.0002
Molybdenum	0.007	0.03
Phosphorus	0.032	0.048
Strontium	0.05	1.10
Tellurium	0.0001	0.0001
Tin	0.04	0.0003
Zinc	0.26	0.12

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TERRESTIAL ANIMALS DELIVERED TO STEWART LABORATORIES

BY J. S. WINEFORDNER ON JANUARY 8, 1971

(APC 00817)

	Opossum	Doves	Raccoon	Quail	Squirrel
% Ash of Original Sample	1.26	0.79	1.30	1.32	1.16
% Moisture of Original Sample	73.0	86.2	75.0	73.8	77.9
Barium	0.13	0.16	0.26	0.25	0.12
Cerium	0.005	0.003	0.007	0.004	0.006
Cesium	0.16	0.09	0.22	0.12	0.18
Cobalt	0.07	0.03	0.09	0.05	0.08
Iodine	0.15	0.35	0.27	0.34	0.28
Iron	31.5	7.9	32.5	13.2	11.6
Manganese	0.50	0.40	0.39	0.66	0.46
Mercury	0.07	0.03	0.06	0.03	0.04
Phosphorus	1470.	724.	1146.	1437.	1389.
Strontium	0.04	0.06	0.07	0.05	0.05
Tellurium	0.004	0.006	0.006	0.005	0.005
Zinc	47.4	14.0	51.6	13.6	15.8
Zirconium	0.05	0.02	0.05	0.03	0.05

STEWART LABORATORIES, INC.

BY Anna M. Yoakum, Ph.D.

4.9 Environmental Effects of Postulated Accidents and Occurrences

The following analysis of the Environmental Effects of Postulated Accidents and Occurences was developed as a separate study by Alabama Power Company and Southern Services, Inc., based on information supplied by Westinghouse Electric Corporation.

FARLEY

Outline of Accident Analysis for Environmental Report

I. INTRODUCTION

II. METEOROLOGY AND POPULATION DISTRIBUTION

A. METEOROLOGICAL ASSUMPTIONS AND DATA
B. POPULATION DISTRIBUTION DATA

III. EVALUATION OF CLASS 2 EVENTS

A. DISCUSSION OF CLASS 2 EVENTS
B. DESCRIPTION OF REPRESENTATIVE CLASS 2 EVENT
C. DISCUSSION OF REMOTENESS OF POSSIBILITY OF A VOLUME CONTROL TANK RELEASE
D. ANALYSIS AND EVALUATION OF VOLUME CONTROL TANK RELEASE

1. Assumptions
2. Justification for Assumptions
3. Doses at the Site Boundary and Total Population Dose (man-rem)

IV. EVALUATION OF CLASS 3 EVENTS

A. DISCUSSION OF CLASS 3 EVENTS
B. DESCRIPTION OF REPRESENTATIVE CLASS 3 EVENT
C. DISCUSSION OF REMOTENESS OF POSSIBILITY OF A GAS DECAY TANK RELEASE
D. ANALYSIS AND EVALUATION OF GAS DECAY TANK RELEASE

1. Assumptions
2. Justification for Assumptions
3. Doses at Site Boundary and Total Population Dose (man-rem)

Outline of Accident Analysis for Environmental Report (cont'd)

V. EVALUATION OF CLASS 4 EVENTS

A. DISCUSSION OF CLASS 4 EVENTS
B. ANALYSIS AND EVALUATION OF FUEL DEFECTS

1. Assumptions for Termination of Transients
2. Justification for Assumptions
3. Consequences

VI. EVALUATION OF CLASS 5 EVENTS

A. DISCUSSION OF CLASS 5 EVENTS
B. DESCRIPTION OF CLASS 5 EVENTS - FUEL DEFECTS WITH STEAM GENERATOR TUBE LEAKS
C. DISCUSSION OF REMOTENESS OF POSSIBILITY OF AN OFF-NORMAL OPERATIONAL RELEASE
D. ANALYSIS AND EVALUATION OF OFF-NORMAL OPERATIONAL RELEASE

1. Assumptions
2. Justification for Assumptions
3. Doses at Site Boundary and Total Population Dose (man-rem)

VII. EVALUATION OF CLASS 6 EVENTS

A. DISCUSSION OF CLASS 6 EVENTS
B. DESCRIPTION OF CLASS 6 EVENT - FUEL HANDLING ACCIDENT INSIDE CONTAINMENT
C. DISCUSSION OF REMOTENESS OF POSSIBILITY OF A FUEL HANDLING ACCIDENT INSIDE CONTAINMENT
D. ANALYSIS AND EVALUATION OF FUEL HANDLING ACCIDENT INSIDE CONTAINMENT

1. Assumptions
2. Justification for Assumptions
3. Doses at Site Boundary and Total Population Dose (man-rem)

VIII. EVALUATION OF CLASS 7 EVENTS

A. DISCUSSION OF CLASS 7 EVENTS
B. DESCRIPTION OF CLASS 7 EVENT - FUEL HANDLING ACCIDENT OUTSIDE CONTAINMENT
C. DISCUSSION OF REMOTENESS OF POSSIBILITY OF A FUEL HANDLING ACCIDENT OUTSIDE CONTAINMENT
D. ANALYSIS AND EVALUATION OF REFUELING ACCIDENT OUTSIDE CONTAINMENT

1. Assumptions
2. Justification of Assumptions
3. Doses at Site Boundary and Total Population Dose (man-rem)

Outline of Accident Analysis for Environmental Report (Cont'd)

IX. EVALUATION OF CLASS 8 EVENTS

A. DISCUSSION OF CLASS 8 EVENTS

1. Loss-of-Coolant Accident

a. Description of Class 8 Event - Loss-of-Coolant Accident
b. Discussion of Remoteness of Possibility of Loss-of-Coolant Accident
c. Analysis and Evaluation of Loss-of-Coolant Accident

(1) Assumptions
(2) Justification for Assumptions
(3) Doses at Site Boundary and Total Population Dose (man-rem)

2. Steam Line Break

a. Description of Class 8 Event - Steam Line Break Accident
b. Discussion of Remoteness of Possibility of Steam Line Break Accident
c. Analysis and Evaluation of Steam Line Break

(1) Assumptions
(2) Justification for Assumptions
(3) Doses at Site Boundary and Total Population Dose (man-rem)

3. Steam Generator Tube Rupture

a. Description of Class 8 Event - Steam Generator Tube Rupture Accident
b. Discussion of Remoteness of Possibility of Steam Generator Tube Rupture
c. Analysis and Evaluation of Steam Generator Tube Rupture

(1) Assumptions
(2) Justification for Assumptions
(3) Doses at Site Boundary and Total Population Dose (man-rem)

Outline of Accident Analysis for Environmental Report (Cont'd)

4. Rod Ejection Accident

   a. Description of Class 8 Event - Rod Ejection Accident
   b. Discussion of Remoteness of Possibility of Rod Ejection Accident
   c. Analysis and Evaluation of Rod Ejection Accident

      (1) Assumptions
      (2) Justification for Assumptions
      (3) Doses at Site Boundary and Total Population Dose (man-rem)

5. Waste Gas Decay Tank Rupture Accident

   a. Description of Class 8 Event - Waste Gas Decay Tank Rupture
   b. Discussion of Remoteness of Possibility of Waste Gas Decay Tank Rupture
   c. Analysis and Evaluation of Waste Gas Decay Tank Rupture

      (1) Assumptions
      (2) Justification for Assumptions
      (3) Doses at Site Boundary and Total Population Dose (man-rem)

6. Volume Control Tank Rupture

   a. Description of Class 8 Event - Volume Control Tank Rupture
   b. Discussion of Remoteness of Possibility of Volume Control Tank Rupture
   c. Analysis and Evaluation of Volume Control Tank Rupture

      (1) Assumptions
      (2) Justification for Assumptions
      (3) Dose and Site Boundary and Total Population Dose (man-rem)

X. TABLE OF DOSES FOR EACH CLASS

XI. CONCLUSIONS

I. INTRODUCTION

This appendix evaluates the environmental impact of postulated accidents and occurrences which may occur, however remote, during the operating life of the Joseph Farley Nuclear Power Plant. The evaluation follows the guidelines given in the AEC document "Scope of Applicants' Environmental Reports with Respect to Transportation, Transmission Lines, and Accidents" issued on September 1, 1971. The results of the evaluation reveal that the consequences of the postulated accidents and occurences have no significant adverse environmental effects.

The postulated accidents and occurrences are divided into the nine accident classes identified in the AEC guide of September 1, 1971 as shown in Table A-1. The environmental impact of the postulated incidents is evaluated using assumptions in the analyses as realistic as the state of knowledge permits. Past Operating experience has been considered in selecting the assumptions, and the analyses are based on those conditions that are expected to exist if the postulated accident were to occur. The radiological consequences of an accident are evaluated on the basis that average meteorological conditions, as calculated from the meteorology data of the Dothan Airport, and the population distribution at the mid point of plant life, exist at the time of an accident. This is considered realistic for random events.

In the following pages, a typical accident for each class, identified in the AEC guide, is described and its consequences evaluated. Where only one accident example is considered in a class, the postulated accident was selected from consideration of several possible accidents in that class on

TABLE A-1

CLASSIFICATION OF POSTULATED ACCIDENTS AND OCCURRENCES

NO. OF CLASS	DESCRIPTION	EXAMPLE(S)
1	Trivial Incidents	Small Spills Small leaks inside containment
2	Misc. Small Releases Outside Containment	Spills Leaks and pipe breaks
3	Radwaste System Failure	Equipment failure Serious malfunction or human error
4	Events that release radioactivity	Fuel failures during normal operation. Transients outside expected range of variables
5	Events that release radioactivity into secondary system	Class 4 & Heat Exchanger Leak
6	Refueling accidents inside containment	Drop fuel element Drop heavy object onto fuel Mechanical malfunction or loss of cooling in transfer tube
7	Accidents to spent fuel outside containment	Drop fuel element Drop heavy object onto fuel Drop shielding cask - loss of cooling to cask Transportation incident on site
8	Accident initiation events considered in design-basis evaluation in the Safety Analysis Report	Reactivity transient Rupture of primary piping Flow decrease - Steamline break
9	Hypothetical sequences of failures more severe than Class 8	Successive failures of multiple barriers normally provided and maintained

the basis that it conservatively represents a potential accident situation. Consideration of the nine classes reveals that these classes can be conveniently grouped on the basis of their likelihood of occurrence as follows:

Class 1 through Class 5

This group deals with events which may occur at one time or another during the life of the plant. The compilation of a complete list of events with their corresponding frequency which fall in this group is not practical nor necessary. The environmental impact of each event, as will be shown later, is very small. Throughout plant operating life, a record of the magnitude and consequences of each event is maintained and the cumulative effect of such occurrences is evaluated. This procedure will give timely identification of any possible cumulative effects or trends leading to unacceptable environmental effects. This will also allow corrective actions (such as equipment repair, changes in procedure, more frequent inspection, temporary plant shutdown, etc.) to be taken before a significant adverse impact on the environment can be imposed.

Postulated occurrences for Classes 2 through 5 are considered in the following pages. Class 1 events, because of their trivial consequences, are not considered in this report.

Classes 6 and 7

This group deals with refueling and fuel handling accidents inside and outside the containment. Detailed procedures are provided to handle irradiated fuel properly. However, considering the large number of fuel assemblies handled during the life of the plant, an incident falling in this category could conceivably occur during the plant life. The consequences of such an accident, as shown in the subsequent pages, have no significant adverse impact on the environment.

Class 8

This class includes those accidents that are not expected to occur during the life of this plant. These accidents correspond to the accident initiation events considered in the Preliminary Safety Analysis Report.

Each Class 8 accident is treated separately in the following pages. The treatment consists of a brief description of the accident, a summary of the steps in the design, manufacturing, installation and operation to essentially eliminate the possibility of its occurrence, a list of the most significant assumptions and the results of the dose calculations. The consequences of these accidents are evaluated by using the analytical models described in the PSAR. The basic difference between the PSAR evaluations and those presented in this section is represented by the values of the parameters used as input in the analytical models. The PSAR analyses are based on extremely conservative input parameters while the analyses performed in this report are based on realistic assessments of the performance of core and plant safeguards.

It can be concluded that accidents falling in this class have no significant adverse environmental effects because:

i) Hypothetical PSAR types of accident initiation events are not expected to occur during the life of this plant because of the numerous steps in design manufacture, construction, operation and maintenance to prevent them.

ii) and, the expected environmental consequences, if any one of the accidents occur, are below the limits considered safe for normal operation

(10 CFR 20 limits).

If any of the accidents covered in this category were to occur, assessment of the actual impact on the environment will be performed and a comprehensive plant inspection conducted before return to power.

Class 9

This accident class involves hypothetical sequences of failures more severe than Class 8, i.e., successive failures of multiple barriers normally provided and maintained.

Considering, as an example, the rupture of a Reactor Coolant System pipe, Class 8 covers the case of this initiation event and expected performance of the plant safeguards. Class 9, on the contrary, would consider the initiation of the event, i.e., rupture of a Reactor Coolant System pipe plus hypothetically deteriorated performance of plant safeguards, for example, failure of off-site power supply, and/or failure of a diesel, and/or failure of a high head safety injection pump, and/or failure of a low head safety injection valve, and/or failure of a containment spray pump, and/or failure of a containment spray valve, etc. This chain of failures can, theoretically, be carried as far as an individual's imagination can go. The Preliminary Safety Analysis Report contains studies on the consequences of successive failures. The likelihood of the combination of the initiation event and these successive failures is extremely remote. The consequences, as presented in the PSAR, are within the allowable limits for remote probability accidents (10 CFR 100 limits).

The occurrence of successive failures is so remote that its environmental risk is extremely low. Hence, it is not necessary to discuss these multiple failures in the present report, as indicated in the AEC guide published on September 1, 1971.

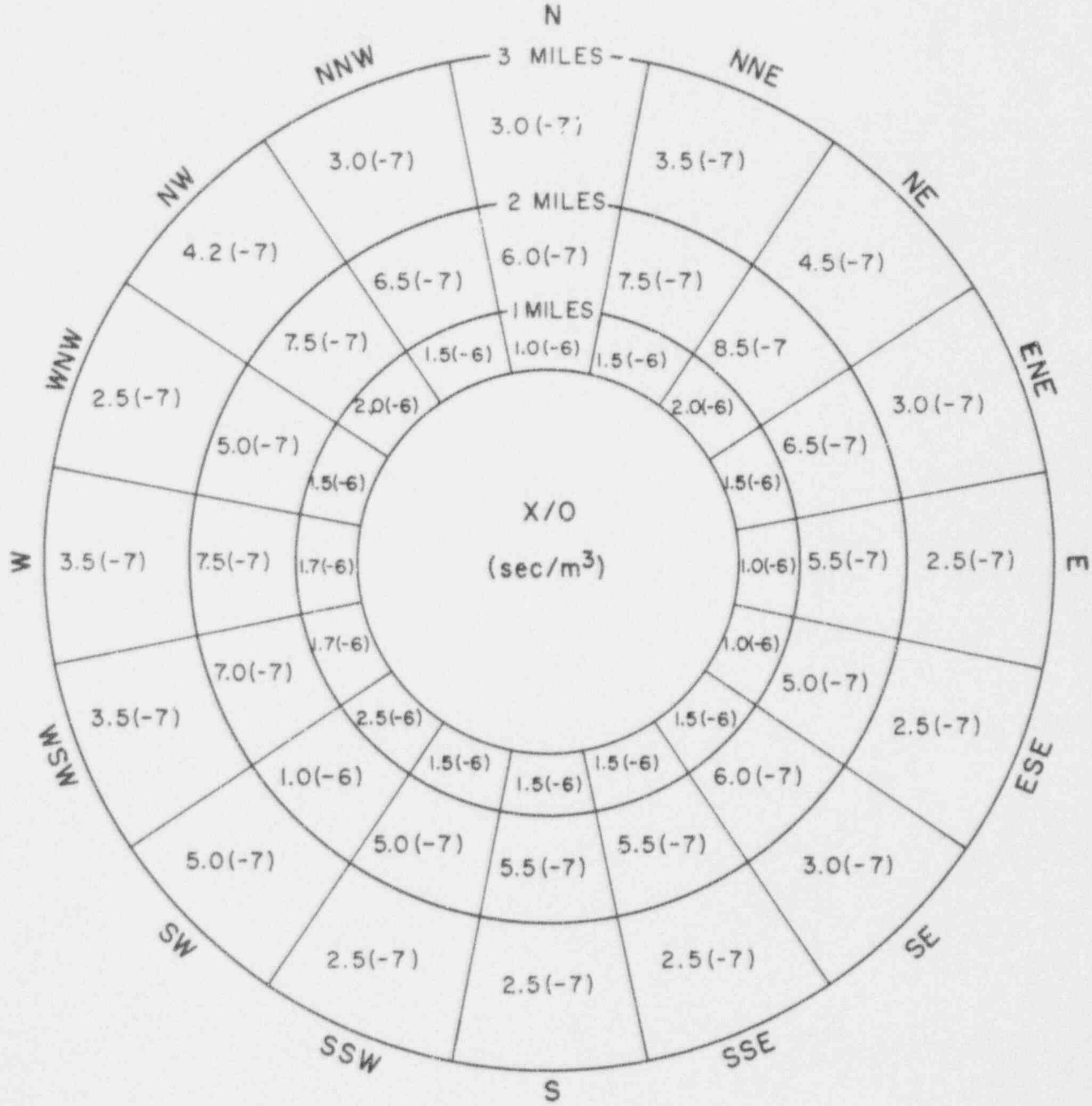
II. METEOROLOGY AND POPULATION DISTRIBUTION

A. METEOROLOGICAL ASSUMPTIONS AND DATA

The meteorological data used in this report was developed based on weather data from Dothan Airport for 1950. The annual average gas dispersion estimates are based on an integrated form of the Pasquill diffusion relationships and assumes a ground level source at a virtual distance X' upwind of the actual source to account for dilution in the vertical direction from the building wake. This model is presented in more detail in the Joseph M. Farley Nuclear Plant Preliminary Safety Analysis Report. A summary of the dispersion estimates used to evaluate the environmental effect of accidents in this Appendix are given in Figures II-1 through II-4.

The dispersion estimates for each sub-sector as shown in Figures II-1 through II-4 were computed based on the midpoint distance of each sub-sector from the containment.

The average annual dispersion estimate used in this report for estimating the site boundary thyroid and whole body doses was obtained by summing the site boundary annual average dispersion estimates for each of the sixteen sectors and dividing by sixteen. The average annual dispersion estimate at the site boundary is given in Figure II-1.



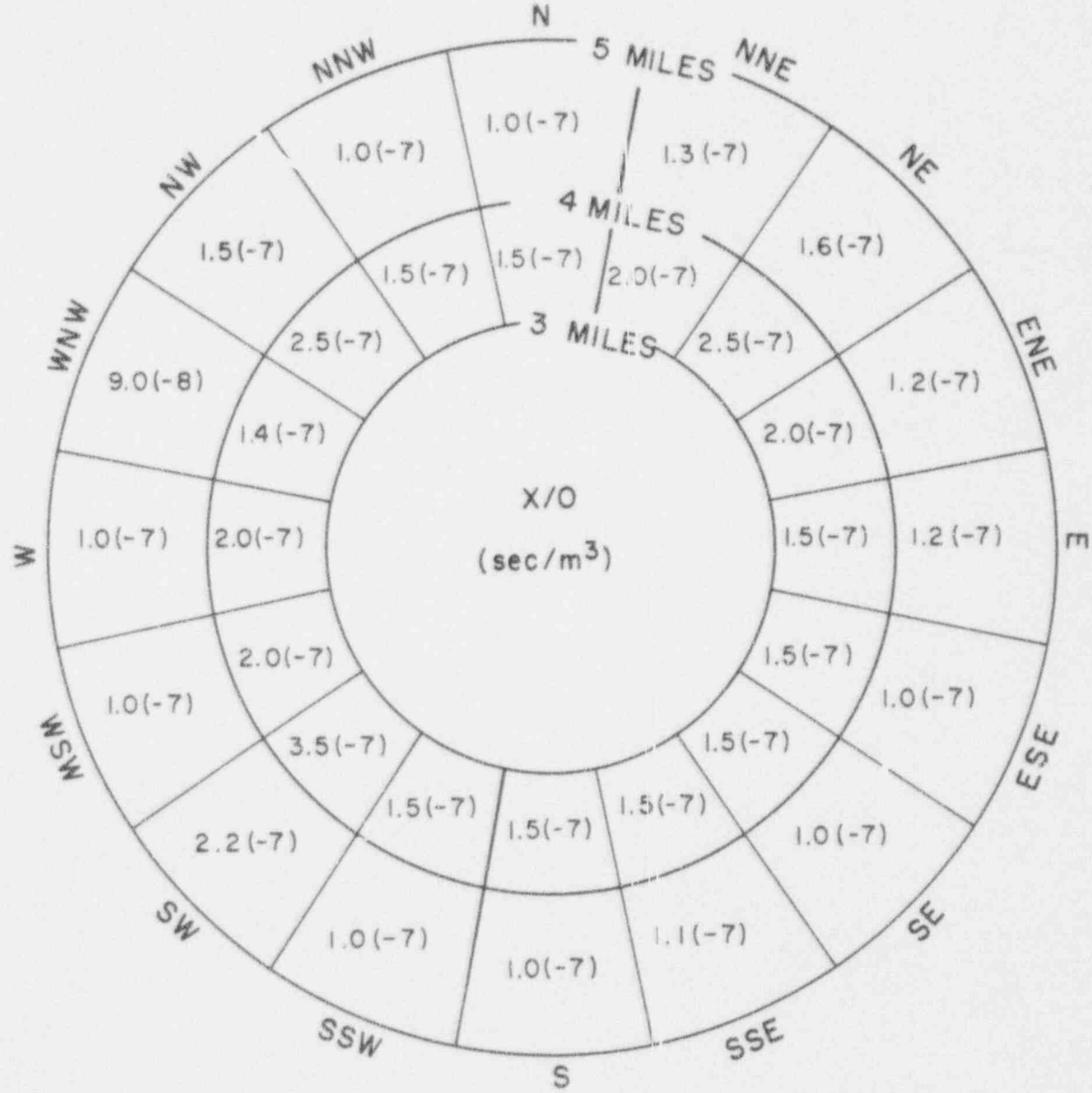
AVERAGE ANNUAL X/O
AT SITE BOUNDARY

1.557×10^{-6} (sec/m^3)

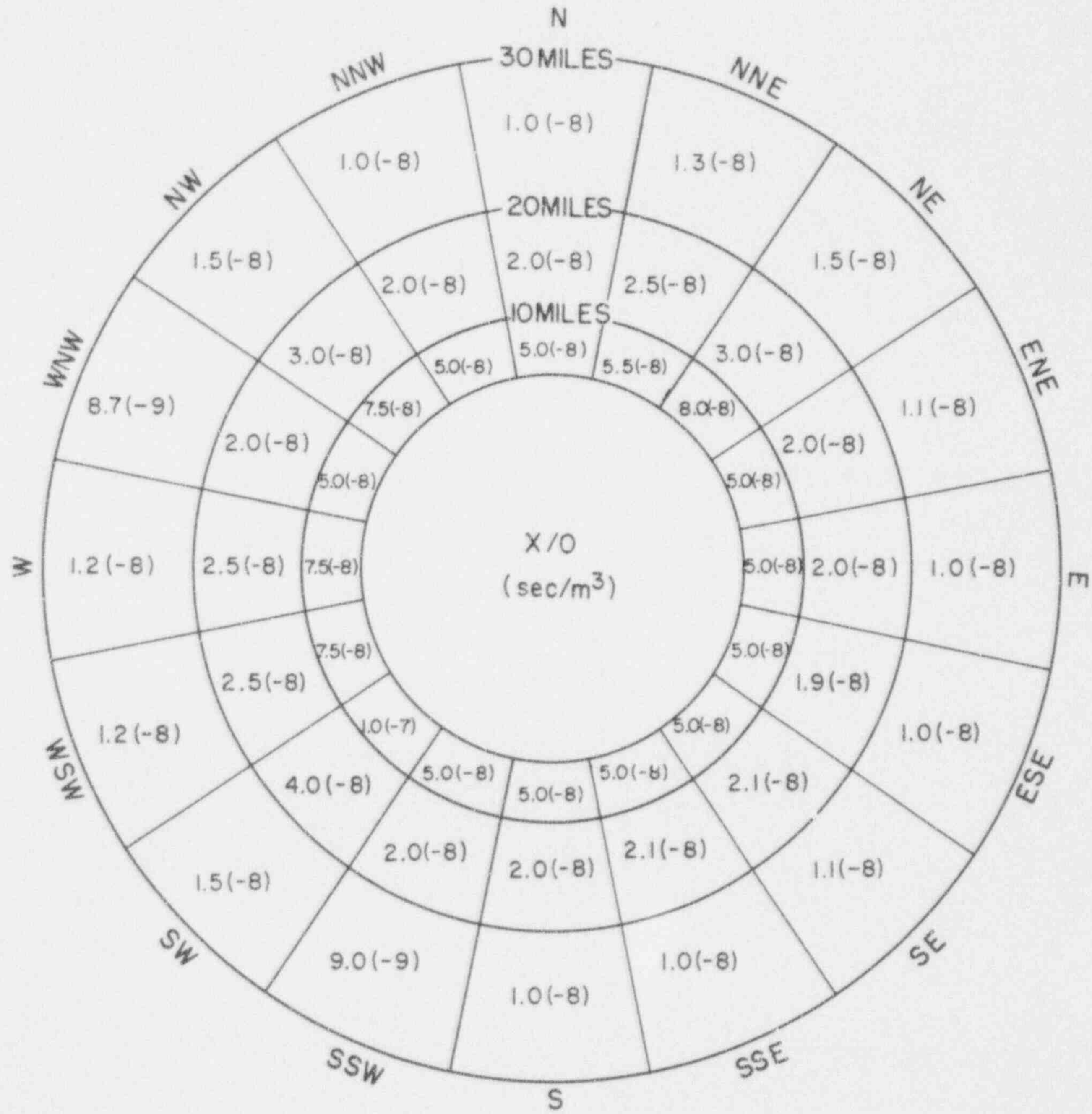
NOTE: 2.5(-7) = 2.5×10^{-7}

ATMOSPHRIC DILUTION FACTORS
0- 3 MILES

FIGURE II-1

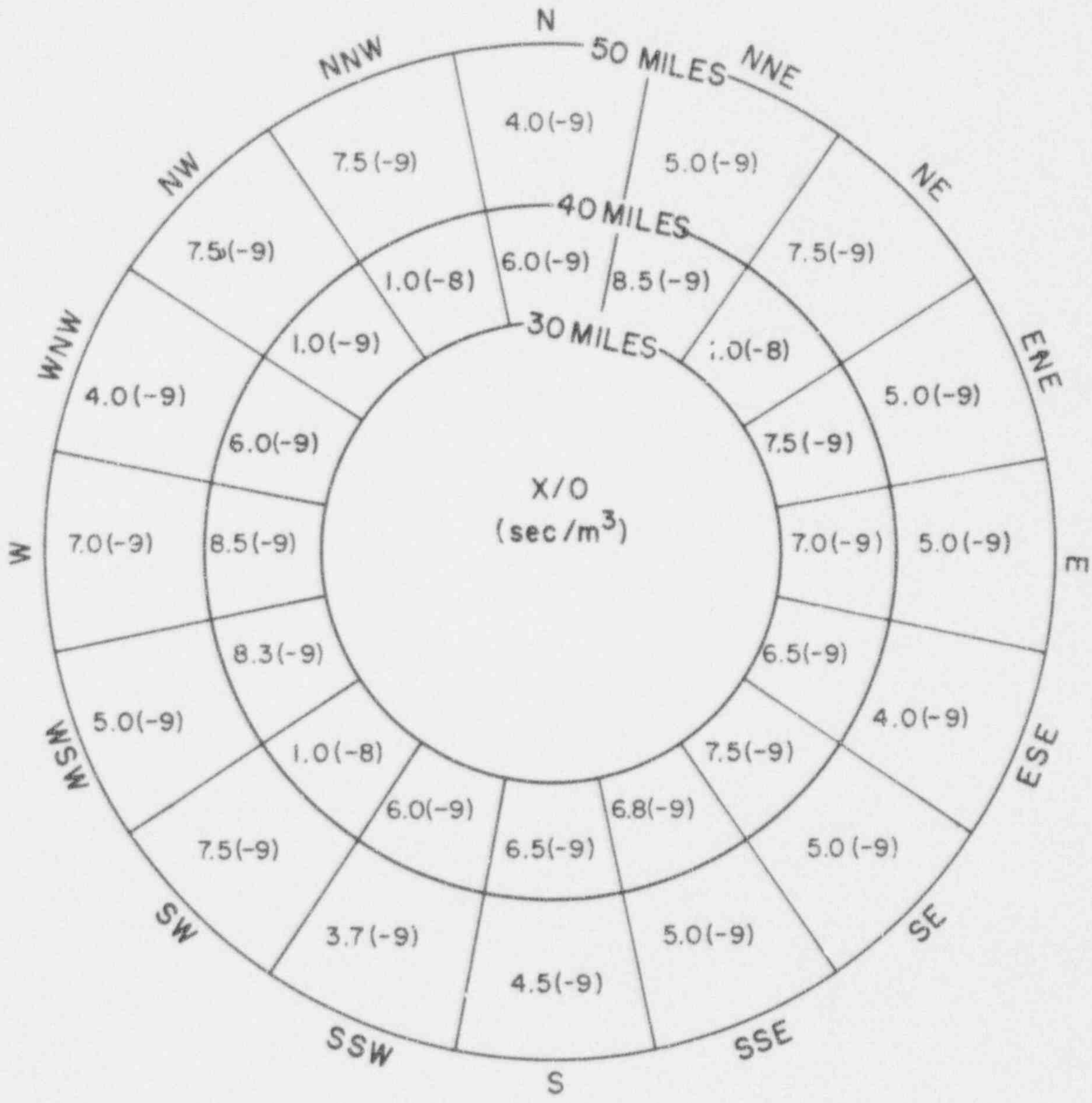


ATMOSPHERIC DILUTION FACTORS
3 - 5 MILES
FIGURE 11-2



ATMOSPHERIC DILUTION FACTORS
5- 30 MILES

FIGURE II-3



ATMOSPHERIC DILUTION FACTORS
30 - 50 MILES

FIGURE 11-4

B. POPULATION DISTRIBUTION DATA

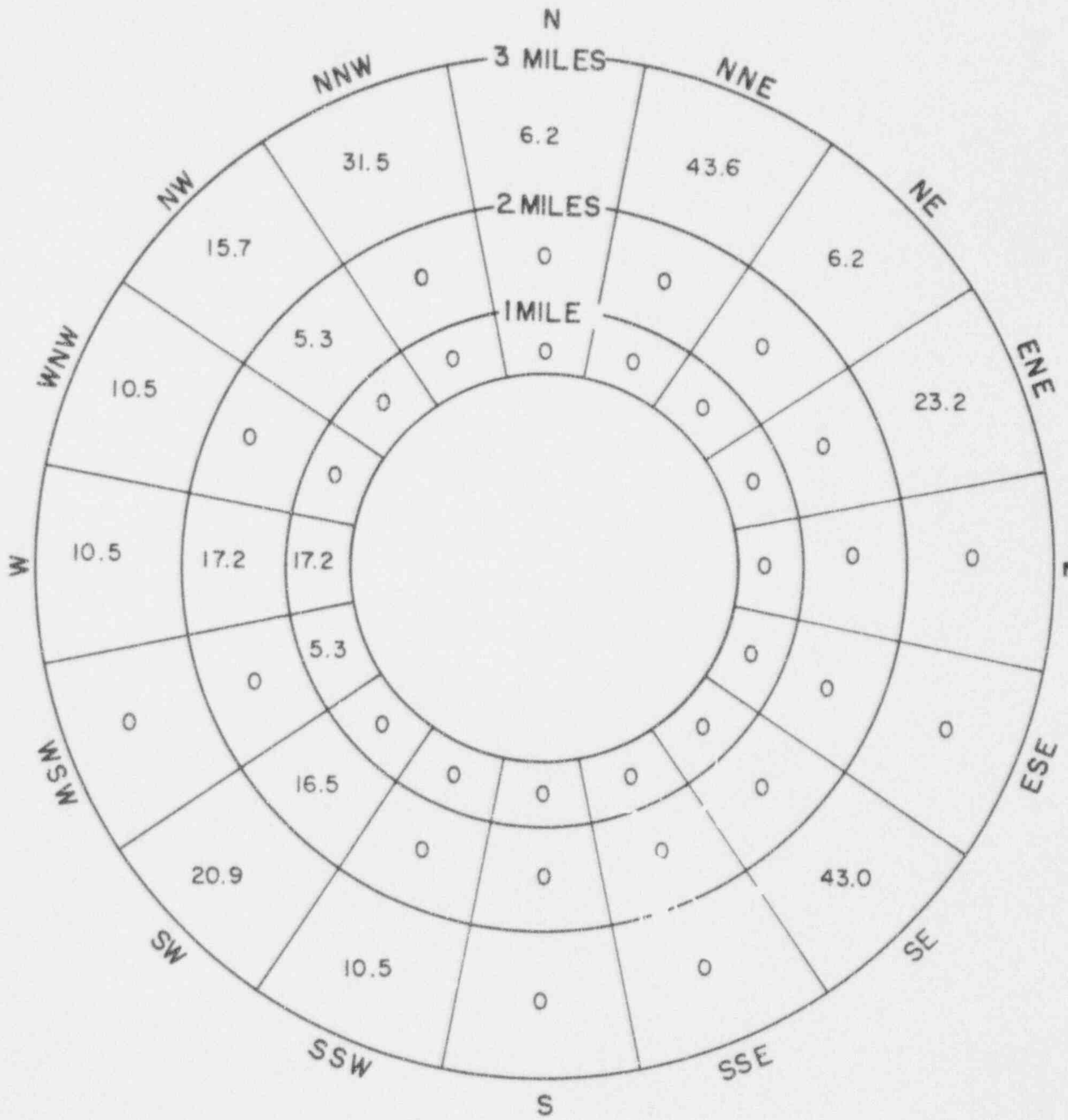
The population distribution used in this analysis was taken from the Joseph M. Farley Nuclear Plant PSAR. Since the expected plant life is 40 years (1975-2015), the average environmental effect on the population can be estimated by using the estimated population distribution for a year close to the mid-point of the plant life. The estimate closest to this point in time is that for the year 1995. Using this population distribution, the average environmental effect of the plant over its expected lifetime is determined in man-rem. The 1995 population distribution used in this report is given in Figures II-5 through II-8.

III. EVALUATION OF CLASS 2 EVENTS

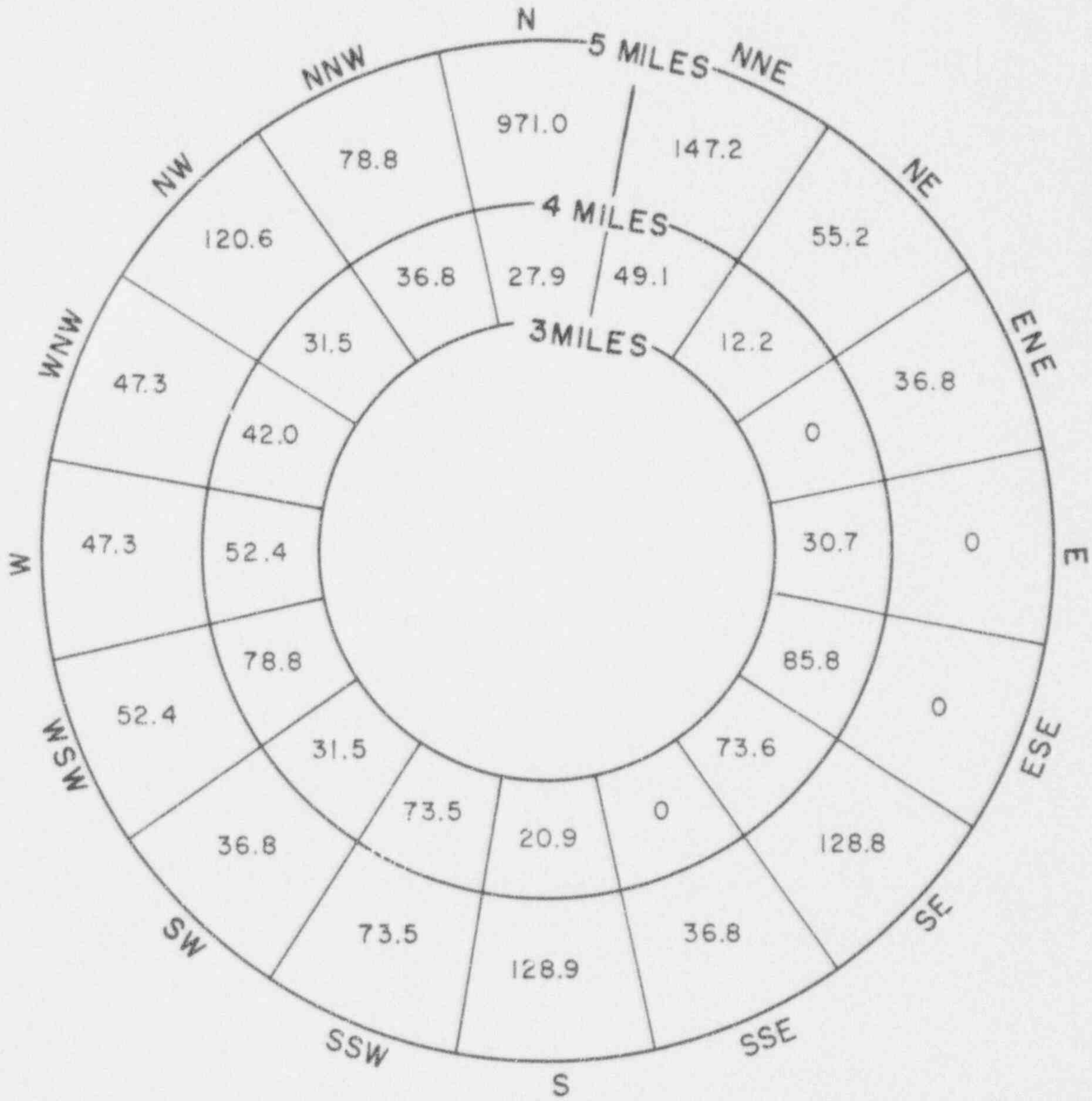
A. DISCUSSION OF CLASS 2 EVENTS

Class 2 events include spills and leaks from equipment outside the containment. Small valve leaks and pipe leaks may be expected during the lifetime of the plant. There is expected to be a low level of continuous leakage from components such as valve packing and stems, pump seals, flanges, etc. Infrequent increases in leakage from specific components might occur; however, these would be detected by operators and/or inplant monitoring and appropriately repaired to minimize any potential off-site effect.

Liquid releases will be collected in the radwaste processing systems and therefore will not contribute to adverse effects on the environment other than the environmental effects associated with radioactive releases discussed in Section 4.2.1.1.

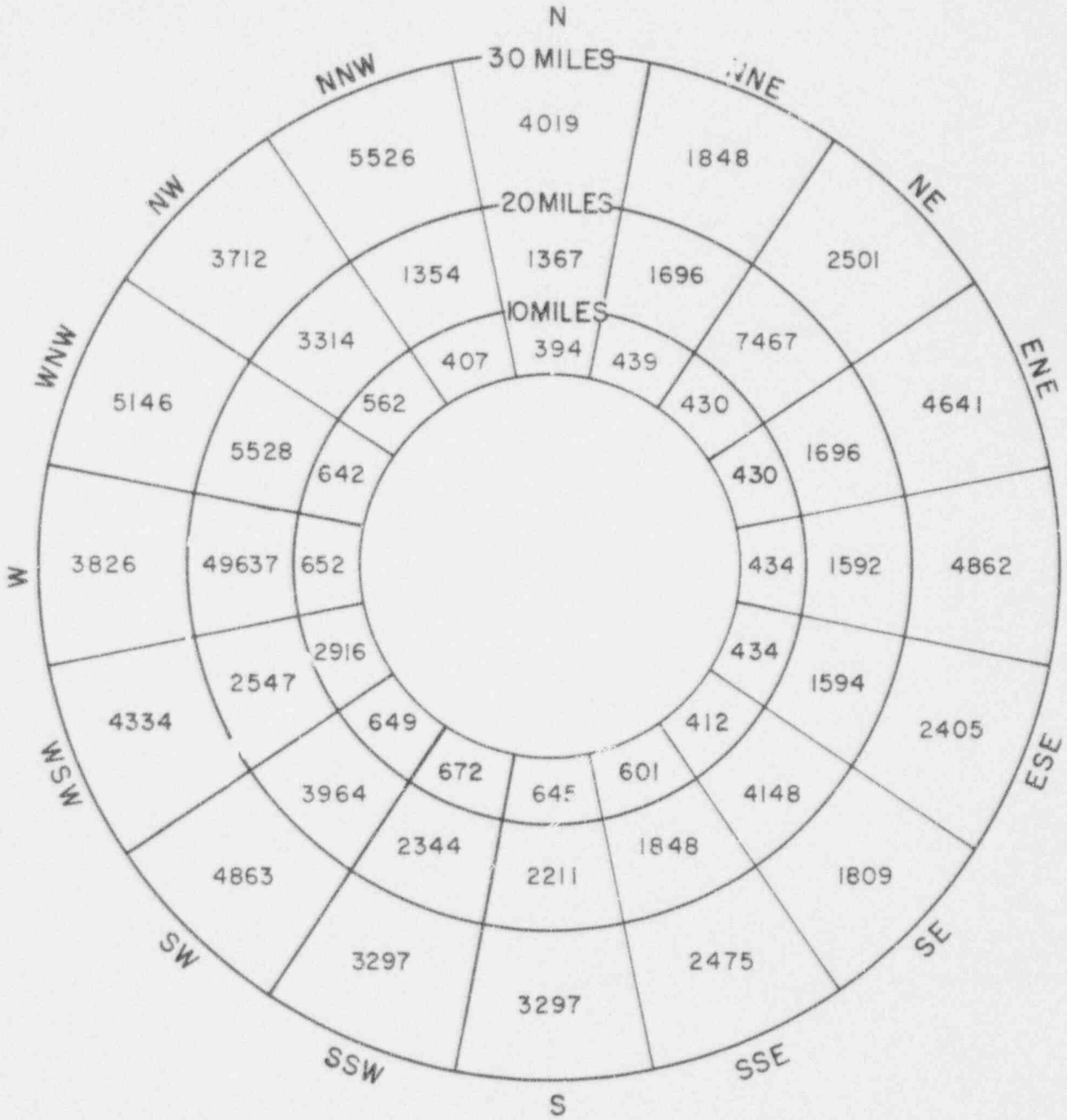


POPULATION DISTRIBUTION
0 – 3 MILES
FIGURE II-5



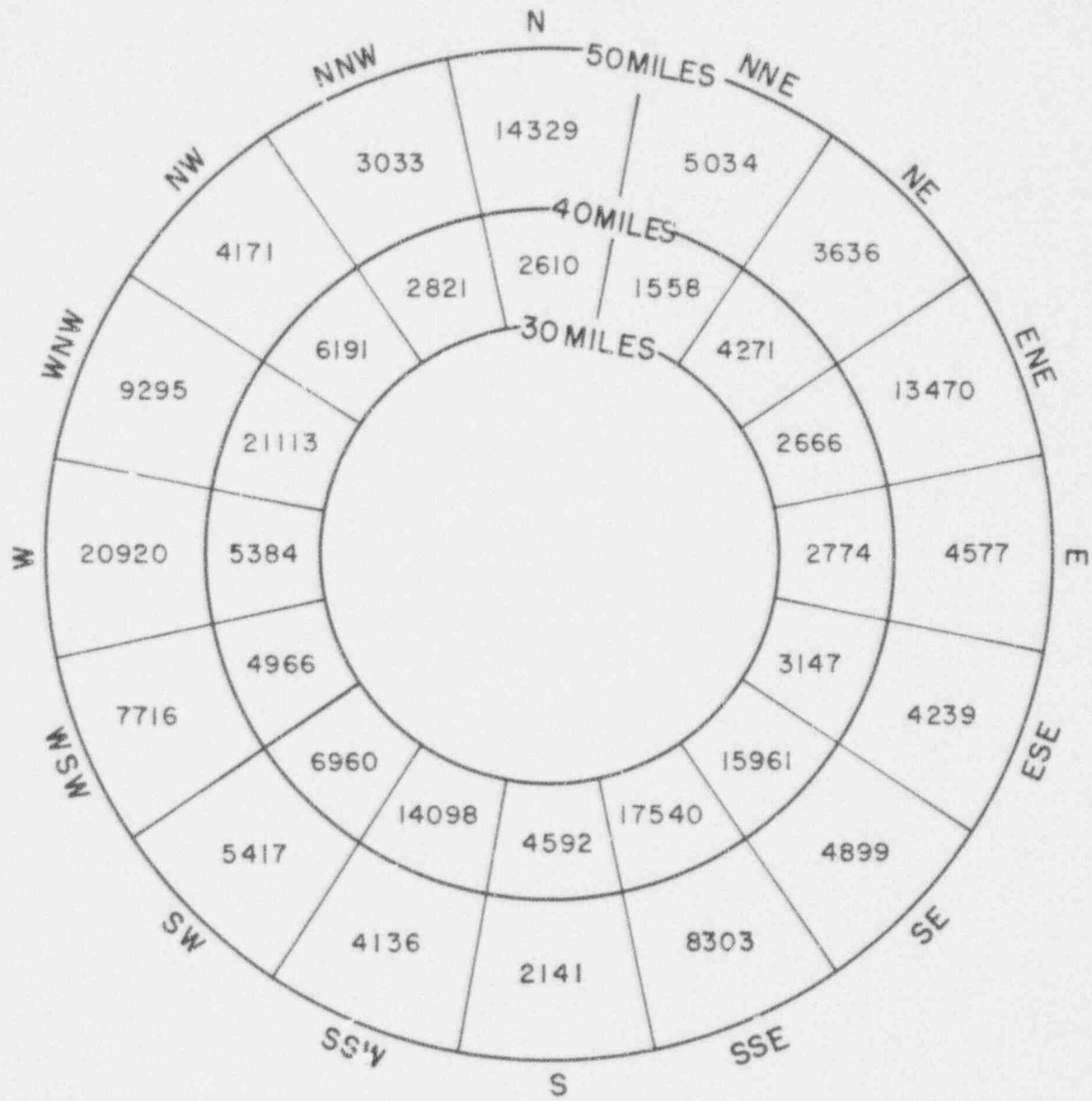
POPULATION DISTRIBUTION
3 - 5 MILES

FIGURE II-6



POPULATION DISTRIBUTION
5 - 30 MILES

FIGURE II-7



POPULATION DISTRIBUTION
30 - 50 MILES

FIGURE II-8

B. DESCRIPTION OF REPRESENTATIVE CLASS 2 EVENT

A significant valve and/or pipe leak in the reactor coolant letdown system may occur during the lifetime of the plant. A conservative example of such an occurrence would be a leak in the volume control tank sampling line which would allow a fraction of the contents of the volume control tank to be released. Were such a leak to occur, the plant vent monitor would detect the activity and with appropriate operator action the release could be limited to 10% of the noble gas contained in the tank. The event used to evaluate the environmental effect is defined as the release to the outside atmosphere of 10% of the noble gas activity in the volume control tank.

C. DISCUSSION OF REMOTENESS OF POSSIBILITY OF VOLUME CONTROL TANK RELEASE

The volume control tank is designed to Quality Class 2a with a normal internal operating pressure of approximately 15 psig.

The volume control tank design provides for level alarms, pressure relief and valve control to assure that a safe condition is maintained during system operation.

Since the volume control tank is not subjected to high pressure or stress and is Quality Class 2a, the possibility of a release from the tank is considered very remote.

The letdown line and the reactor coolant pumps seal water return line penetrate the containment. The letdown line contains air-operated valves inside the containment and one air-operated valve outside the containment which is automatically closed by the containment isolation signal. The reactor coolant pumps seal water return line contains two motor-operated isolation valves, one inside and one outside of the containment. These valves are automatically closed by the containment isolation signal.

Quality control in the design, manufacture, and installation introduces a high degree of reliability and confidence to further assure that no failure in this system will occur. In summary, the release of 10% of the noble gas inventory is considered to conservatively represent the accident or occurrences following in this class.

D. ANALYSIS AND EVALUATION OF VOLUME CONTROL TANK RELEASE

1. Assumptions

The following assumptions are used in the evaluation of the environmental effects of the release of the volume control tank activity.

(a) The activity in the tank is based on 0.2% equivalent fuel defects and a continuous purge rate from the tank to the Radwaste System of 0.7 SCFM.

(b) Within two hours after initiation of a noble gas activity release from the volume control tank, 10% of the tank noble gas inventory is released. Immediately after the noble gas activity escapes from the volume control tank, it is released from the auxiliary building at ground level to the outside atmosphere. Holdup in the auxiliary building is expected, thus reducing even further the environmental effect of this occurrence, however, no credit for this holdup is taken in the analysis.

(c) Natural decay is neglected after the activity is released to the outside environment.

2. Justification for Assumptions

The 0.2% equivalent fuel defect level is based on Westinghouse Pressurized Water Reactor operating experience with Zircaloy clad fuel to date.

Nonvolatile fission product concentrations are greatly reduced as the reactor coolant is passed through the purification demineralizers. An iodine removal factor of at least 10 is expected in the mixed bed demineralizers.

In addition, the iodine will primarily remain in the liquid phase in the volume control tank due to the high partition factor between the liquid and vapor phases in the tank.

The released noble gas will be detected by the plant vent monitor and cause an alarm in the control room. Once the operators have been alerted, the leak can be detected and isolated to hold the activity release to 10% of the total noble gas inventory of the volume control tank.

3. Doses at the Site Boundary and Total Population Dose (Man-Rem)

The parameters used to calculate the noble gas activity in the volume control tank are given in Table III-1. Based on these parameters, 10% of the total noble gas activity in the tank, which is assumed to be released instantaneously to the environment, is 46.6 curies of equivalent Xe-133.

The whole body dose at the site boundary, as calculated by the method shown in Section X, is 3.14×10^{-3} mrem from the released noble gas activity, while the total population dose is 1.13×10^{-2} man-rem.

TABLE III-1

PARAMETERS FOR COMPUTING VOLUME CONTROL TANK
SPECIFIC ACTIVITY OF EQUIVALENT Xe-133

1.	Core thermal power, MWt	2766
2.	Fraction of fuel containing clad defect	0.002
3.	Reactor coolant liquid volume, cu ft	9146.5
4.	Reactor coolant average temperature, ^{o}F	~580
5.	Purification flow rate (maximum), gpm	120
6.	Volume control tank volumes	
	a. Vapor, cu ft	180
	b. Liquid, cu ft	120
7.	Fission product escape rate coefficients:	
	a. Noble gas isotopes, sec^{-1}	6.5×10^{-8}
8.	Volume control tank purge rate, SCFM	0.7
9.	Reactor Coolant System Equilibrium Activities	

Isotope	µCi/cc
Kr-85	0.008
Kr-85m	0.3
Kr-87	0.2
Kr-88	0.6
Xe-133	4.6
Xe-133m	0.1
Xe-135	0.8

IV. EVALUATION OF CLASS 3 EVENTS

A. DISCUSSION OF CLASS 3 EVENTS

Class 3 events cover equipment malfunction and human error which may result in the release of activity from the Radwaste Processing System. The malfunction of a valve or the inadvertent opening of a valve by an operator may cause such a release. This type of event is expected to occur infrequently during the operation of the plant.

Activity release from the liquid radwaste treatment system is a highly unlikely event due to the following reasons: Primary grade radioactive liquids enter into the radwaste system and are collected in a separate channel from which there is no direct path of discharge to the environment. The channel which collects the non-primary grade liquid wastes and whose contents are discharged to the environment after treatment, will not have significant activity to adversely affect the environment even if discharged without treatment. However, interlocks are provided to alarm and automatically terminate the discharges from the liquid radwaste system under these conditions. Therefore the inadvertent releases from the liquid radwaste system is not considered in this evaluation.

B. DESCRIPTION OF REPRESENTATIVE CLASS 3 EVENT

The major collection point for activity outside the containment is the gaseous waste section of the Radwaste Processing System. A conservative example of a Class 3 event would be a malfunction or error which would allow initiation of activity release from a waste gas decay tank. This activity would leak into the auxiliary building atmosphere and pass through the plant vent to the outside atmosphere. The plant vent monitor would detect this radiation and transmit an alarm signal to the control room. The event used to evaluate the environmental effect is defined as the release of 10% of the noble gas activity in the waste gas decay tank to the outside atmosphere.

C. DISCUSSION OF REMOTENESS OF POSSIBILITY OF A GAS DECAY TANK RELEASE

The six gas decay tanks of each reactor contain the gases vented from the reactor coolant drain tank, recycle evaporator, and volume control tank.

The gaseous waste processing system is designed such that during normal operation a hydrogen recombiner will remove hydrogen from nitrogen-fission gas mixtures by oxidation to water vapor which is removed by condensation. This limits the amount of gas which is transferred to the gas decay tanks.

At beginning of life the gas decay tanks will operate under an initial pressure of 3 to 5 psig compared to a design pressure of 150 psig. The maximum anticipated pressure in any gas decay tank is not expected to exceed 50 psig.

The gas decay tanks are designed to Quality Class 3 requirements and are designed to ASME Section VIII requirements.

Because of the conservative design, quality assurance, the close monitoring and sampling throughout the system, and since the gas decay tanks are not subjected to any high pressures or stresses, and they are of Quality Class 3 design, the possibility of an accidental release from any of the tanks is very remote.

For these reasons the release of 10% of the noble gases stored in the gas decay tank is considered to conservatively represent the accident and the occurrences falling in this class.

D. ANALYSIS AND EVALUATION OF GAS DECAY TANK RELEASE

1. Assumptions

The following assumptions are used in the evaluation of the environmental effect of the release of activity from the waste gas decay tank.

(a) 0.2 percent fuel defects.

(b) Within 2 hours after initiation of noble gas activity release from the gas decay tank, 10% of the noble gas is released.

(c) The noble gas inventory in the waste gas decay tank is based on activity stored in one gas decay tank using daily cycling between the 6 gas decay tanks, and volume control tank purge rate of 0.7 scfm.

(d) Immediately after the noble gas activity escapes from the waste gas decay tank it is released at ground level from the auxiliary building to the outside atmosphere.

(e) Natural decay is neglected after the activity is released to the outside environment.

2. Justification for Assumptions

The 0.2% equivalent fuel defect level is based on Westinghouse Pressurized Water Reactor experience with Zircaloy clad fuel to date.

The plant vent monitor will detect the noble gas activity being released to the outside atmosphere and cause closure of the waste gas control valve and annunciate in the control room. This alerts the operators and the leak can be detected and isolated to hold the activity release to 10% of the total noble gas activity in the waste gas decay tank.

3. Doses at Site Boundary and Total Population Dose (Man-Rem)

The noble gas activity released to the environment is given in Table IV-1. From this activity release the whole body dose at the site boundary is 3.84×10^{-2} mrem and the total population dose is 1.38×10^{-1} man-rem.

TABLE IV-1

NOBLE GAS ACTIVITY RELEASE

Isotope	Activity (Curies)
Xe-133	206.2
Xe-133m	2.0
Xe-135	15.0
Kr-85m	2.32
Kr-85	210.7
Kr-87	0.4
Kr-88	2.72

V. EVALUATION OF CLASS 4 EVENTS

A. DISCUSSION OF CLASS 4 EVENTS

This is described as those events that release radioactivity into the primary system. Examples given include assumptions of fuel failures during normal operation and transients outside expected range of variables.

The nuclear steam supply system is designed so that it may operate with an equivalent 1% fuel defect. The level of defective fuel, averaged over the life of the plant, will be much less than the value as shown, based on the operating experience of similar plants to date. The occurrence of a fuel defect in itself will not result in any environmental impact because of the multiple barriers provided in the Pressurized Water Reactor. Nevertheless this occurrence may result in activity levels which could affect the consequences in other accident classes which are evaluated in appropriate sections of this report. Operational transients for the plant such as turbine trip, load changes, rod withdrawals and other conceivable transient within accident conditions covered in other classes are not expected to increase the defect level. The Preliminary Safety Analysis Report demonstrates this as described below.

B. ANALYSIS AND EVALUATION OF FUEL DEFECTS

1. Assumptions for Termination of Transients

A plant operational transient could result in an uncontrolled addition of reactivity. Assuming the source and intermediate range nuclear instrumentation indications are ignored, a transient will be terminated by the following automatic protection features:

a. Source Range Flux Level Trip

Actuated when either of two independent sources range channels indicates a flux level above a preselected, manually adjustable value. This trip function may be manually bypassed when either intermediate range flux channel indicates a flux level above the source range cutoff power level. It is automatically reinstated when both intermediate range channels indicate a flux level below the source range cutoff power level.

b. Intermediate Range Rod Stop

Actuated when either of two independent intermediate range channels indicates a flux level above a preselected, manually adjustable value. This rod stop may be manually bypassed when two out of the four power range channels indicate a power level above approximately ten percent power. It is automatically reinstated when three of the four power range channels are below this value.

c. Intermediate Range Flux Level Trip

Actuated when either of two independent intermediate range channels indicates a flux level above a preselected, manually adjustable value. This trip function may be manually bypassed, when two of the four power range channels are reading above approximately ten percent power and is automatically reinstated when three of the four channels indicate a power level below this value.

d. Power Range Flux Level Trip (Low Setting)

Actuated when two out of the four power range channels indicate a power level above approximately 25 percent. This trip function may be manually bypassed wher two of the four power range channels indicate a power level above approximately ten percent power and is automatically reinstated when three of the four channels indicate a power level below this value.

e. Power Range Flux Level Trip (High Setting)

Actuated when two out of the four power range channels indicate a power level above a preset set point. This trip function is always active.

The nuclear response to a continuous reactivity insertion is characterized by a very fast power rise terminated by the reactivity feedback effect of the negative fuel temperature coefficient. This self-limitation of the initial power rise results from a fast negative fuel temperature feedback (Doppler effect) and is of prime importance during a start-up accident since it limits the power to a tolerable level prior to external control action. After the initial power rise, the nuclear power is momentarily reduced and then if the accident is not terminated by a reactor trip, the nuclear power increases again, but at a much slower rate.

2. Justification for Assumptions

Analysis of this transient will be performed by digital computation incorporating the neutron kinetics, with six delayed neutron groups, and the core thermal and hydraulic equations. In addition to the nuclear flux response, the fuel, clad and water temperature, and also the heat flux response, will be computed.

In order to give conservative results for a start-up accident, the following additional assumptions are made concerning the initial reactor conditions:

a. Since the magnitude of the nuclear power peak reached during the initial part of the transient, for any given rate of reactivity insertion, is strongly dependent on the fuel temperature reactivity coefficient, the least negative value will be used for the start-up accident analysis.

b. The contribution of the moderator reactivity coefficient is negligible during the initial part of the transient because the heat transfer between the fuel and the moderator is much slower than the nuclear flux response. However, after the initial nuclear flux peak, the succeeding rate of power increase is affected by the moderator reactivity coefficient. Accordingly, a conservative value of zero is used, since this yields the maximum rate of power increase.

c. The reactor is assumed to be at hot zero power. This assumption is more conservative than that of a lower initial system temperature. The higher initial system temperature yields a larger fuel to water thermal conductivity, a larger fuel thermal capacity, and a less negative (smaller absolute magnitude) Doppler coefficient. The less negative Doppler coefficient reduces the Doppler feedback effect thereby increasing the nuclear flux peak. The high nuclear flux peak combined with a high fuel thermal capacity and large thermal conductivity yields a larger peak heat flux. Initial multiplication (k_o) is assumed to be 1.0 since this results in the maximum nuclear power peak.

d. The most adverse combination of instrument and set point errors, as well as delays for trip signal actuation and rod release, are taken into account. Also the rate of negative reactivity insertion corresponding to the trip action is based on the assumption that the highest worth rod is stuck in its fully withdrawn position.

3. Consequences

Transient results based on previous designs demonstrate the considerable margin to safety limits for this accident. This margin is a consequence of the small rise in core heat flux to only a fraction of nominal, i.e., of the order of 50 percent, and of the considerable degree of subcooling in the core during the transient. This detailed information includes transient response of core heat flux, neutron flux, fuel temperatures and margin to DNB. The sensitivity to variations in input parameters as well initial conditions will be considered in a detailed analysis in the Final Safety Analysis Review (FSAR).

The maximum possible number of rod cluster control assemblies (RCCA) which can be moved and their maximum withdrawal speed will be established by detailed plant design. This information and the maximum incremental RCCA reactivity worth will be used to verify that the protection afforded by source, intermediate and power range trip settings is adequate to terminate the transient safely. Protection in this case is considered adequate if it can be shown that the departure from nucleate boiling ratio (DNBR) is equal to or greater than 1.3, thus ensuring that no fuel damage or fission product release occurs.

Taking into account the conservative assumptions, it is concluded that in the unlikely event of a transient outside of expected range of variables, the core and reactor coolant system will not be adversely affected.

VI. EVALUATION OF CLASS 5 EVENTS

A. DISCUSSION OF CLASS 5 EVENTS

The Class 5 events are defined as those accident events that transfer the radioactivity in the reactor coolant into the secondary system through steam generator tube leakage, with a fraction of the transferred radioactivity in turn being released into the environment through the air ejector. Radioactivity releases into the environment resulting from the events in this class require a concurrent occurrence of two independent events of fuel defects and steam generator tube leakage. If the fuel defects and steam generator tube leakage do occur simultaneously, these concurrent faults would be evaluated continuously in terms of plant secondary system activity technical specification limit and corrective steps will be taken before any limit is approached.

B. DESCRIPTION OF CLASS 5 EVENTS - FUEL DEFECTS WITH STEAM GENERATOR TUBE LEAKAGE

In the event of fuel defects with a concurrent steam generator tube leakage, the secondary system would become contaminated with fission products and radioactive corrosion products. The degree of fission product transport into the secondary side is a function of the amount of defective fuel in the core and the primary-to-secondary leak rate. These parameters also determine the radioactivity releases from the secondary system if the plant were to continue to operate under these off-normal conditions. Since the air ejector effluent is monitored with a radiation monitor, it would alarm upon the steam generator tube leakage and the resultant radioactivity releases. The liquid blowdown from the steam generators is terminated upon receipt of a high radiation signal. In addition, the steam generator liquid sample monitor provides backup information to indicate primary-to-secondary leakage. The operator will evaluate the secondary system activity in terms of plant technical specifications. If the primary-to-secondary leak rate and the resultant releases are within specification limits, the operator may continue to operate the plant until a convenient time is available to shut down and repair the leaking steam generator.

C. DISCUSSION OF REMOTENESS OF POSSIBILITY OF AN OFF-NORMAL OPERATION RELEASE

An off-normal operation release requires fuel defects and a simultaneous steam generator tube leakage. Since the occurrence of these two events are not related to each other, the possibility of an excessive off-normal release resulting from these two independent events is relatively low.

In addition, the radiation level of the air ejector discharge and steam generator liquid are monitored and any excessive gaseous or liquid releases would be detected by the monitor system and terminated by the operator. To conservatively represent events in Class 5, it has been assumed, for the purposes of analysis, that full power operation with 1 gpm primary to secondary leakage and 0.2% equivalent fuel defect is continued for 2 days.

D. ANALYSIS AND EVALUATION OF OFF-NORMAL OPERATIONAL RELEASE

1. Assumptions

An analysis has been performed of possible releases of radioactivity from the secondary system in the event of fuel defects with steam generator tube leakage. The analysis is based on the following assumptions:

(a) 0.2% defective fuel.

(b) The primary-to-secondary leak rage is 1 gpm.

(c) No steam generator blowdown tank release to the environment during excessive off-normal operation and the air ejector discharge is the only release.

(d) The period of off-normal operation is 2 days at full power.

(e) The atmospheric dispersion factor at site boundary used in the dose calculation is the annual average. (1.557×10^{-6} sec/m^3).

(f) Secondary steam decontamination factors:

Steam generator water to steam:

$$DF = 10 \frac{\mu c/gm \text{ SG water}}{\mu c/gm \text{ steam}} \quad \text{(all halogens)}$$

$$DF = 1 \frac{\mu c/gm \text{ SG water}}{\mu c/gm \text{ steam}} \quad \text{(all noble gases)}$$

Steam to air ejector:

$$DF = 10^4 \frac{\mu c/gm \text{ steam}}{\mu c/cc \text{ air}} \quad \text{(all halogens)}$$

$$DF = 1 \frac{\mu c/gm \text{ steam}}{\mu c/cc \text{ air}} \quad \text{(all noble gases)}$$

(g) No noble gas accumulated in the steam generator water since these are continuously released from the condenser air ejector.

(h) Air flow rate through air ejector is 40 scfm.

2. Justification for Assumptions

The first assumption is based on plant operating experience to date. The second assumption is a conservative one well within the leak-rate which can be detected and result in remedial action. The third assumption is based on the fact that the steam generator blowdown is terminated within a few minutes of institution of the off-normal operation. The two-day off-normal operation therefore will not result in blowdown release. The two day off-normal operation at full power given in the fourth assumption is the expected off-normal operational time. The operator can shut the plant down sooner if the releases are excessive The fifth assumption is based on the site meteorological data. The sixth assumption is based on the reference:

Styrikovich M. A., Martynova O. I., Katkovska K. Ya., Dwbrovskii I. Ya., Smrinova I. N. "Transfer of Iodine from Aqueous Solutions to Saturated Vapor," Translated from Atomnaya Energiya, Vol. 17, No. 1, P. 45-49, July, 1964.

The air ejector flow rate of 40 scfm is a system parameter.

3. Doses at Site Boundary and Total Population Dose (man-rem)

With the above assumptions the thyroid dose and the whole body dose at the site boundary resulting from the air ejector release are 5.16×10^{-4} mrem and 2.12×10^{-2} mrem, respectively. The total population whole body dose is 7.59×10^{-2} man-rem.

VII. EVALUATION OF CLASS 6 EVENTS

A. DISCUSSION OF CLASS 6 EVENTS

Accidents which fall into accident Class 6 are: fuel element mishandling and mechanical malfunctions or loss of cooling in the transfer tube.

The only event in this accident class which could possible result in a release of radioactive gases from a fuel assembly is the mishandling of a fuel element. The fuel handling procedures are such that no objects can be unintentionally moved over any fuel elements being transferred or moved over the core. A loss of cooling in the transfer tube will not cause the cladding of a fuel assembly to be damaged. The residual heat generated by the assembly will be removed by natural convection.

B. DESCRIPTION OF CLASS 6 EVENT - FUEL HANDLING ACCIDENT INSIDE CONTAINMENT

The accident is defined as the mishandling of a spent fuel assembly. The accident is assumed to result in the equivalent of one row of fuel rods in the assembly being damaged. The subsequent release of radioactivity from the damaged fuel element will bubble through the water covering the assembly, where most of the radioactive iodine will be entrained, and be released to the containment atmosphere. For the first five (5) minutes following the accident, activity is drawn through the containment purge line to the environment. After five (5) minutes the purge line is isolate and the only means of escape of any radioactive gases airborne in the containment is by means of containment leakage which is negligible since there is no positive pressure in the containment during this accident.

C. DISCUSSION OF REMOTENESS OF POSSIBILITY OF A FUEL HANDLING ACCIDENT INSIDE CONTAINMENT

The possibility of a fuel handling incident is remote due to the administrative controls and physical limitations imposed on fuel handling operations. All refueling operations are conducted in accordance with prescribed procedures under the direct surveillance of personnel technically trained in nuclear safety. Also, before any refueling operations begin, verification of complete rod cluster control assembly insertion is obtained by tripping each rod individually to obtain indication of rod drop and disengagement from the control rod drive mechanisms. Boron concentration in the coolant is raised to the refueling concentration and verified by sampling. Refueling boron concentration is sufficient to maintain the clean, cold, fully loaded core subcritical with all rod cluster assemblies withdrawn. The refueling cavity is filled with water meeting the same boric acid specifications.

After the vessel head is removed, the rod cluster control drive shafts are removed from their respective assemblies. A spring scale is used to verify that the drive shaft is free of the control cluster as the lifting force is applied.

The fuel handling manipulators and hoists are designed so that fuel cannot be raised above a position which provides adequate shield water depth for the safety of all operating personnel.

Adequate cooling of fuel during underwater handling is provided by convective heat transfer to the surrounding water. The fuel assembly is immersed continuously while in the refueling cavity. Even if a spent fuel assembly becomes stuck in the transfer tube, natural convection will maintain adequate cooling.

Two Nuclear Instrumentation System source range channels are continuously in operation and provide warning of any approach to criticality during refueling operations. This instrumentation provides a continuous audible signal in the containment, and would annunciate a local horn and a horn and light in the plant control room in the unlikely event that the count rate increased above a preset low level.

Refueling boron concentration is sufficient to maintain the clean, cold, fully loaded core subcritical by at least 10 per cent $\Delta \rho$ with all rod cluster control assemblies inserted. At this boron concentration the core would also be more than 2 per cent $\Delta \rho$ subcritical with all control rods withdrawn. The refueling cavity is filled with water meeting the same boric acid specifications

Special precautions are taken in all fuel handling operations to reduce the possibility of damage to fuel assemblies during transport to and from the spent fuel pool and during installation in the reactor. All handling operations on irradiated fuel are conducted under water. The handling tools used in the fuel handling operations are conservatively designed and the associated devices are of a fail-safe design. In addition the motions of the cranes which move the fuel assemblies are limited to a low maximum speed.

The design of the fuel assembly is such that the fuel rods are restrained by grid clips which provide a restraining force on each fuel rod. If the fuel rods are in contact with the bottom plate of the fuel assembly, the maximum force which may be transmitted to the fuel rods is limited due to the restraining force of the grid clips. The force transmitted to the fuel rods during fuel handling is not sufficient to breech the fuel rod cladding. If the fuel rods are not in contact with the bottom plate of the assembly, the rods would have to slide against the friction force. This would absorb the shock and thus limit the force on the individual fuel rods.

After the reactor is shut down, the fuel rods contract during the subsequent cooldown and would not be in contact with the bottom plate of the assembly.

Considerable deformation would have to occur before the rod would make contact with the top plate and apply any appreciable load on the fuel rod. Based on the above, it is felt that it is unlikely that any damage would occur to the individual fuel rods during handling. If one assembly is lowered on top of another, no damage to the fuel rods would occur that would breech the integrity of the cladding.

Refueling operation experience that has been obtained with Westinghouse reactors has verified that no fuel cladding integrity failures occur during any fuel handling operations involving over 50 reactor years of W PWR operating experience in which more than 2200 fuel assemblies have been loaded or unloaded.

D. ANALYSIS AND EVALUATION OF FUEL HANDLING ACCIDENT INSIDE CONTAINMENT

1. Assumptions

The following assumptions are postulated for a calculation of the fuel handling accident:

a) The accident occurs at 100 hrs. following the reactor shutdown; i.e., the time at which spent fuel would be first moved.

b) The accident results in the rupture of the cladding of the equivalent of one row of fuel rods (15 rods).

c) The damaged assembly is the one that had operated at the highest power level in the core region to be discharged.

d) The power in this assembly, and corresponding fuel temperatures, establish the total fission product inventory and the fraction of this inventory which is present in the fuel pellet-cladding gap at the time of reactor shutdown. ($\sim$1.5% of core halogen and $\sim$1.2% of core noble gases)

e) The fuel pellet-cladding gap inventory of fission products in these rods will be released to the refueling cavity water at the time of the accident.

f) The refueling cavity water retains a large fraction of the gap activity of halogens by virtue of their solubility and hydrolysis. Noble gases are not retained by the water as they are not subject to hydrolysis reactions. A decontamination factor of 760 for the halogens is used in this analysis.

g) A small fraction of fission products which are not retained by the water are dispersed into the containment.

h) The purge line on the containment is isolated automatically upon high radiation signal within five (5) minutes after the accident. Ventilation from the refueling canal area will be 11,000 scfm. The total purge from the containment is 25,000 scfm, which is the basis for this calculation.

i) After isolation of the containment, the radioactive gases in the containment are leaked from the containment to the environment at a small leak rate. The amount of activity leaked from the containment is assumed negligible compared to that escaping from the purge line during the first five minutes.

2. Justification for Assumptions

a) It is approximately 100 hours after shutdown that the first fuel assembly is removed from the core. The time delay between shutdown and removal of the first assembly is due to the time required to depressurize the reactor coolant system, remove the vessel head and perform other refueling procedures.

b) Analyses have shown that dropping of a spent fuel assembly onto the bottom of the pool is not expected to result in damage of the cladding of any fuel rods in the dropped assembly. The dropping of a spent fuel element onto a sharp object may result in the breech of the cladding of some fuel elements in the dropped assembly. The rupture of the equivalent of one row of fuel elements has been shown to be a conservative assumption.

c) The highest powered assembly in the discharged region would have the largest quantity of radioactivity in the fuel pellet-cladding gap of all the assemblies to be discharged.

d) The quantity of radioactivity in the fuel pellet-cladding gap is dependent on the power level and temperature distribution of the assembly.

e) Since all fuel handling operations are conducted under water, the release of any radioactive gases from a damaged assembly would be in the form of bubbles to the water covering the assembly.

f) An experimental test program was conducted by Westinghouse to evaluate the extent of iodine removal as the halogen gas bubbles rise to the surface of the pool from a damaged irradiated fuel assembly.

g) The radioactive gases remaining in the bubbles when they reach the surface of the cavity, are released to the atmosphere atop the cavity.

h) Any increase in radioactivity concentrations in the containment will be detected by the radiation monitors. Upon high radiation signal the purge line from the containment will be isolated automatically.

It is conservatively estimated that the purge line will be isolated within 5 minutes following a refueling accident which releases radioactivity into the containment.

i) Since the pressure in the containment will be atmospheric at the time of the postulated accident and no pressure rise is expected due to the accident, the leak rate from the containment is expected to be near zero. The design leak rate of the containment at Farley is 0.1% per day at peak accident pressure.

3. Doses at Site Boundary and Total Population Dose (man-rem)

The doses at the site boundary from a fuel handling accident inside the containment are 4.06×10^{-2} mrem thyroid and 7.61×10^{-3} mrem whole body. The total population dose from this accident is 2.7×10^{-2} man-rem whole body.

VIII. EVALUATION OF CLASS 7 EVENTS

A. DISCUSSION OF CLASS 7 EVENTS

Accidents which fall into accident Class 7 are: Mishandling of fuel element, dropping of heavy object onto fuel, dropping of shielding cask or loss of cooling to cask and transportation incident on site.

The only event in this accident class which could possibly result in a release of radioactive gases from a fuel assembly is the mishandling of a fuel element. The fuel handling procedures and design of the fuel handling equipment is such that no equipment or object can be moved over any fuel element being transferred or stored in the spent fuel pool. The shielding and shipping casks are designed to be dropped with no subsequent damage to the fuel assembly. Loss of cooling to the transfer cask also will not result in any damage which will result in activity release to the environment. The spent fuel is not moved off site until 90-120 days after refueling. Thus most of the major contributing isotopes to the thyroid and whole body dose will be decayed to a negligible level.

B. DESCRIPTION OF CLASS 7 EVENT - FUEL HANDLING ACCIDENT OUTSIDE CONTAINMENT

The accident is defined as the mishandling of a spent fuel assembly. The accident is assumed to result in the equivalent of one row of fuel rods in the assembly being damaged. The subsequent release of radioactive gases from the damaged fuel element will bubble through the water covering the assembly, where most of the iodine will be entrained, and be released to the spent fuel building. The activity is then exhausted to the environment via the plant vent.

C. DISCUSSION OF REMOTENESS OF POSSIBILITY OF A FUEL HANDLING ACCIDENT OUTSIDE CONTAINMENT

A fuel handling incident outside the containment is considered to be equally as remote as that inside the containment. The administrative controls and physical limitations imposed on fuel handling operation are essentially the same as those described for the Class 6 events. As described earlier, the fuel handling manipulators and hoists are designed so that the fuel assembly is continuously immersed while in the spent fuel pit. In addition, the design of storage racks and manipulation facilities in the spent fuel pit is such that:

Fuel at rest is positioned by positive restraints in a safe, subcritical, geometrical array, with no credit for boric acid in the water.

Fuel can be manipulated only one assembly at a time.

Violation of procedures by placing one fuel assembly in with any group of assemblies in racks will not result in criticality.

In summary, those factors which are discussed under Section VII.C regarding remoteness of possibility of fuel handling accidents within the containment also apply here.

D. ANALYSIS AND EVALUATION OF FUEL HANDLING ACCIDENT OUTSIDE CONTAINMENT

The identical assumptions a) through g) of Section VII.D.1 are also postulated for calculation of the fuel handling accident outside the containment. In addition, it is assumed that the fuel handling area ventilation system purge line will be automatically isolated upon high radiation signal (within 5 minutes). The flow rate through the purge line is 18,000 scfm.

After isolation of the fuel handling area ventilation system purge line, the penetration room filtration system will be actuated. Activity released into the fuel handling area will be drawn through charcoal and HEPA filters before being discharged to the atmosphere. The efficiency of penetration room filtration system is 99%.

2. Justification for Assumptions

The justification for the assumptions are the same as given in Section VII.D.2. Additionally, the justification for the final assumption follows. The fuel handling area ventilation system draws air from outside through filters (pre-filters), passes the air over the fuel pool, and discharges it to the atmosphere after passing through pre and HEPA filters. A slight negative pressure will be maintained in this area during refueling operations. After a postulated fuel handling accident, a signal from the redundant radiation monitors in the exhaust line will automatically secure the ventilation fans and isolate the fuel handling area ventilation system. Two motor operated valves will then be remotely opened to connect the fuel handling area with the penetration room filtration system through the ducts. The fan and filter subsystems of the penetration room filtration system will maintain a slight negative pressure in the fuel handling area. The air from the fuel handling area will pass through particulate, absolute and charcoal filters prior to being released to the environment.

3. Doses at Site Boundary and Total Population Dose (man-rem)

The doses at the site boundary from a fuel handling accident inside the containment are 2.03×10^{-1} mrem thyroid and 5.57×10^{-2} mrem whole body. The totel population dose from this accident is 2.0×10^{-1} man-rem whole body.

IX. EVALUATION OF CLASS 8 EVENTS

A. DISCUSSION OF CLASS 8 EVENTS

Accidents considered in this class are loss of coolant, steam line break, steam generator tube rupture, rod ejection, and ruptures of the waste gas decay tank and the volume control tank. These extremely unlikely accidents are used, with highly conservative assumptions, as the design basis events to establish the performance requirements of engineered safety features. For purposes of this environmental report, the accidents are evaluated on a realistic basis that the engineered safeguards will be available and will either prevent the accident or mitigate the consequences.

1. Loss of Coolant (LOCA)

a. Description of Class 8 Event - Loss of Coolant

A LOCA is defined as the loss of primary system coolant due to a rupture of a Reactor Coolant System (RCS) pipe or any line connected to that system. Leaks or ruptures of a small cross section would cause expulsion of the coolant at a rate which could be accommodated by the charging pumps. The pumps would maintain an operational water level in the pressurizer permitting the operator to execute orderly shutdown. A small quantity of the coolant containing fission products normally present in the coolant would be released to the containment.

Should a break occur which is beyond the capacity of the charging pumps, depressurization of the RCS causes fluid to flow from the pressurizer to the break resulting in a pressure decrease in the pressurizer. Reactor trip occurs when the pressurizer low pressure set point is reached. The Emergency Core Cooling System (ECCS) is actuated when the pressurizer low pressure and low level set points are reached. Reactor trip and ECCS actuation are also provided by a high containment pressure signal. These countermeasures limit the consequences of the accident in two ways:

1. Reactor trip and borated water injection supplement void formation in causing rapid reduction of the core thermal power to a residual level corresponding to the delayed fission product decay.
2. Injection of borated water ensures sufficient flooding of the core to limit the peak fuel cladding temperature to well below the melting temperature of Zircaloy-4 in addition to limiting the average core metal-water reaction to substantially less than 1%.

Before the reactor trip occurs, the plant is in an equilibrium condition, i.e., the heat generated in the core is being removed via the secondary system. Subsequently, heat from decay, hot internals, and the vessel are transferred to the RCS fluid and then to the secondary system. The ECC signal stops normal feedwater flow to the steam generators and initiates the Engineered Safety Features. If off-site power is available, steam may or may not be dumped to the condenser depending on the size of the break. The secondary flow aids in the reduction of reactor coolant system pressure. If the reactor coolant system pressure falls below the setpoint, the passive accumulators inject borated water due to the pressure differential between the accumulators and the reactor coolant loops.

Despite the fact that ECCS actuation prevents fuel clad melting as a result of the rapid depressurization of the reactor coolant system, cladding failures may occur in the hottest regions of the core. Some of the volatile fission products contained in the pellet-cladding gap may be released to the containment. These fission products, plus those present in that portion of the primary coolant discharged to the containment, are partially removed from the containment atmosphere by the spray system and plate-out effect on the containment structures. Some of the remaining fission products in the containment atmosphere will be slowly released to the external environment through minute leaks in the containment during the time when containment pressure is above atmospheric pressure. These minute leaks could be expected to be choked by water and water vapor although credit for this was not taken in evaluating the releases.

b. Discussion of Remoteness of Possibility of Loss of Coolant

The rupture of a reactor coolant pipe, or a pipe connected to it, is not expected to occur because of very careful selection of design, construction, operation and quality control requirements. A very strict and detailed "Quality Assurance Program" is enforced to make sure that the specific requirements are met during the various stages of design, construction, erection, and fabrication.

The reactor coolant system is designed to withstand the "maximum hypothetical earthquake" at the site and to assure capability of shutdown and maintain the nuclear facility in a safe condition. Pressure-containing components of the reactor coolant system are designed, fabricated, inspected and tested in conformance with the applicable codes, i.e., ASME Boiler and Pressure Vessel Code, Section III, Nuclear Vessels and USAS B31.7. The design loads for normal operational fatigue and faulted conditions are selected by conservatively predicting the type and number of cycles that the plant is expected to experience. Also, essential equipment has been placed in a structure which is capable of withstanding natural phenomena, such as tornado, flooding condition or earthquakes.

The materials and components of the reactor coolant system are subjected to thorough non-destructive inspection prior to operation and a pre-operational hydro test is performed at 1.25 times the design pressure.

The plant is also operated under very closely controlled conditions to ensure that the operating parameters are kept within the limits assumed in the design. The concentration of oxygen

($\leq$0.10 ppm) is kept to low levels so that the integrity of the reactor coolant system is assured under all operaing conditions. The reactor pressure vessel is paid particular attention because of the shift in Nil Ductility Transition Temperature (NDTT) with irradiation. Therefore, technical specification limits are imposed on the maximum heatup and cooldown rates to make sure that the vessel wall temperature is above the NDTT to prevent brittle fracture whenever the stresses become significant. Materials of construction are selected for the expected environment and service conditions in accordance with the appropriate code requirements.

It is expected that for pipes of the size, thickness and material used in the RCS, significant leakage will occur before catastrophic failure. The plant is provided with various means of detecting leakage from the reactor coolant system. The sensitivity of these leak detection systems gives reasonable assurance that a small crack will be detected and repaired before it reaches the size that will cause failure.

Furthermore, provisions are made for periodically inspecting the areas of relatively high stress in order to discover potential problems before significant flaws develop. The inspection processes vary from component to component and include such inspection techniques as visual inspection, ultrasonic, radiographic or magnetic particle examinations. This in-service inspection program provides additional assurance of the continuing integrity of the reactor coolant system.

Fault conditions which could cause pressure surges are analyzed and protection demonstrated by actuation of the following:

(a) Reactor protection system.

(b) Pressurizer relief and safety valves.

(c) Steam side safety and relief valves.

These ensure that the system pressures and temperatures attained under expected modes of plant operation or anticipated system interactions will be within the design limits giving further assurance that a rupture of the reactor coolant system is very remote.

c. Analysis and Evaluation of Loss-of-Coolant Accident

1. Assumptions

The analysis for this accident is based on:

(a) Only activity in the fuel pellet-clad gap ($\sim$1.5% of core halogen and $\sim$ 1.2% of core noble gases) would be released.

(b) Fuel clad perforation ranges from zero for small breaks to a maximum of 70%. The fuel rods represented in this 70%, however, generate $\sim$ 90% of the core power, so that $\sim$ 90% of the total gap inventory would be released.

(c) Of the gap fission product activity, 25 percent of the halogens and 100% of the noble gases are available for leakage from the containment.

(d) The spray efficiency is 78.6 hr^{-1} for elemental iodine.

(e) The containment leak rate is 0.05% day for the first 24 hours and 0.025%/day for the next 30 days.

(f) Fifty percent of containment leak rate is into the penetration room where the filter efficiency is 99%.

2. Justification for Assumptions

Fission product diffusion through the fuel pellet is a temperature dependent process. Since the reactor has been made subcritical, fissioning becomes negligible and the pellet temperature begins to drop from the operating value almost immediately. The gap activity represents1-1/2 years of operation. The additional fission product diffusion to the gap after the accident is negligible.

Extensive analyses of the core behavior during a LOCA, based on theoretical and experimental evidence, have been performed. These analyses are reported in the PSAR, supplemented by "Response to AEC letter 7/20/71 ECCS Performance Evaluation, Appendix 14B to the PSAR", dated 9/1/71. These analyses show that fuel rods which operate at or above 10 kw/ft might reach clad temperatures in excess of 1300°F. Reaching such a temperature is assumed to lead to clad perforation and all rods which exceed 10 kw/ft at any point along their length are assumed to release gaseous fission products. Assuming a prior core power shape which is the worst expected in normal operation approximately 70% of the rods exceed 10 kw/ft locally, based on an average rod power of 7.0 kw/ft.

This is consistent with the total peaking factor of 2.1 or an axial factor of 1.5 and a radial factor of 1.4.

As per the model used in TID 14844, 25% of the released iodine is considered available in the containment atmosphere after plate-out on reactor internals and containment structures and entrainment in the coolant and condensed steam.

Available data presented indicate that little organic iodine is released from the fuel.

The calculation of the spray effectiveness for iodine removal is based on the drop diffusion model developed by L. F. Parsly.(1) The spray drop size data used in this model are based on drop size measurements performed by Westinghouse, which have been previously reported in the PSAR. The effects of liquid phase resistance, steam condensation, and drop coalescence are accounted for in the model. The input parameters for the spray evaluation are based on realistic estimates of the expected performance of the spray system.

The design leak rate is 0.1%/day. Historically, the leak rate as measured in the Containment Leak Rate Test has been less than the design value. In addition, with all the Engineered Safeguards operating, the pressure transient will be more rapidly quenched than was considered in the PSAR.

Leakage from the containment will take place primarily through the penetrations. Therefore, 50% of the leakage going into the penetration rooms is a conservative assumption. Penetration room filtration system, equipped with charcoal and HEPA filters, will establish a negative pressure throughout the penetration room boundary, will recirculate the air through the filters and discharge only a small portion of the flow to the environment. Therefore, 99% filter efficiency for retaining the iodine and particulates, leaking from the containment into the penetration room, is a conservative assumption.

3. <u>Doses at Site Boundary and Total Population Dose</u>

With the above assumptions the thyroid dose and the whole body dose at the site boundary are 2.16×10^{1} mrem and 7.9×10^{-1} mrem, respectively. The total population whole body dose is 2.85 man-rem.

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(1)L. F. Parsly, "Design Considerations of Reactor Containment Spray Systems, Part VII", ORNL-TM-2412, Part VII, Oak Ridge National Laboratory.

2. Steam Line Break

a. Description of Class 8 Event - Steam Line Break

A rupture of a steam line is assumed to include any accident which results in an uncontrolled steam release from a steam generator. The release can occur due to a break in the steam line or due to valve malfunction. The steam release results in an initial increase in steam flow which decreases during the accident as the steam pressure decreases.

The following systems limit the potential consequences of a steam line break:

(1) Emergency core cooling actuation on

Coincident pressurizer low pressure and low level signals.

High differential pressure between steam lines.

High containment pressure signals.

High steam flow in any two steam lines in coincidence with either low reactor coolant system average temperature or low pressure in the other steam line.

(2) The overpower reactor trips (neutron flux and ΔT) and the reactor trip occurring upon actuation of the ECCS.

(3) Redundant isolation of the main feedwater lines. Sustained high feedwater flow would cause additional cooldown, thus, in addition to the normal control action which will close the main feedwater valves, any ECCS signal will rapidly close all feedwater control valves, trip the main feedwater pumps, and close the

feedwater pump discharge valves.

(4) Trip of the fast acting steam line stop valves (designed to close within 5 seconds with no flow) on

High steam flow in any two steam lines in coincidence with either low reactor coolant system average temperature or low pressure in the other steam line.

High containment pressure signals.

Each steam line has a fast closing stop valve and a check valve. These six valves prevent blowdown of more than one steam generator for any break location even if one valve fails to close. For example, for a break upstream of the stop valve in one line, closure of either the check valve in that line or the stop valve in the other lines will prevent blowdown of the other steam generators. Flow restrictors are located in the steam generator nozzle and serve to limit the rate of release of steam through a break.

If there are no steam generator tube leaks (Class 5), there would be no fission product release to the atmosphere from this accident. With tube leaks, a portion of the equilibrium fission product activity in the secondary system will be released. In addition, some primary coolant with its entrained fission products will be transferred to the secondary system as the reactor is cooled down. The steam is dumped to the condenser, and the noble gases transferred from the primary system would be released through the air ejector.

b. Discussion of Remoteness of Possibility of a Steam Line Break Accident

A steam line break is considered highly unlikely. The piping is a ductile material completely inspected prior to installation. After installation, the entire system undergoes hot functional testing prior to fuel loading. This pre-operational hydrotesting is conducted at 1.25 the design pressure and at a minimum water temperature of 70°F. This test is designed to locate any flaws that may exist in the piping, fittings or valves.

In addition to pre-operational tests to insure the steam system integrity, during operation the water in the secondary side of the steam generators is held within chemistry specifications to control deposits and corrosion inside the steam generators and steam lines. A chemical treatment is used to prevent the formation of free caustic which would cause this corrosion. The phenomena of stress-corrosion cracking and corrosion fatigue are not generally encountered unless a specific combination of conditions (i.e., combination of susceptible alloy, aggressive environment, stress and time) is present. The steam system is designed to avoid any critical combination of these conditions.

With this combination of conservative design, quality control and assurance, pre-operational testing, and control over steam chemistry the potential for a steam line break is minimal.

c. Analysis and Evaluation of Steam Line Break

1) Assumptions

(a) An equilibrium radioactivity in the secondary system of 0.2% equivalent fuel defects with a 20 gpd steam generator leakage.

(b) No additional fuel defects or additional releases from fuel occur due to the accident.

(c) Primary to secondary leakage of 20 gpd occurs for 8 hours after the accident.

(d) The break occurs outside the containment upstream of the steam line stop valves.

(e) The condenser (and thus off-site power) is available for steam dump after the faulted line is isolated.

2) Justification for Assumptions

The fuel defect level and steam generator leak rate are derived from operating experience with W PWR's.

Fuel rods will not have a minimum DNBR (Departure from Nucleate Boiling Ratio) of less than 1.3, and thus there is no clad damage.

Eight hours is required for an orderly cooldown and depressurization of the primary system. Primary-secondary coolant transfer occurs for this time period.

Two faults (steam line break and loss of off-site power) are not expected to occur simultaneously.

3) Doses at Site Boundary and Total Population Dose

With the above assumptions the thyroid dose and the whole body dose at the site boundary are 5.7×10^{-4} mrem and 4.25×10^{-5} mrem, respectively. The total population whole body dose is 1.52×10^{-4} man-rem.

3. Steam Generator Tube Rupture

a. Description of Class 8 Event - Steam Generator Tube Rupture

This accident consists of a complete single tube break in a steam generator. Since the reactor coolant pressure is greater than the steam generator shell side pressure, contaminated primary coolant is transferred into the secondary system. A portion of this radioactivity would be vented to the atmosphere through the condenser air ejector. The sequence of events following a tube rupture is as follows:

The operator will be notified within seconds by the air ejector vent monitor of a radioactivity release.

Pressurizer water level will decrease for one to four minutes before an automatic low pressure reactor trip occurs. Seconds later, low pressurizer level will automatically complete the safety injection actuation signal.

Automatic actions and cooldown procedures are as follows:

Automatic boration by high head safety injection pumps.

Restoration of discernible fluid level in the pressurizer by safety injection pump operation.

Operator-controlled reduction of safety injection flow to permit the RCS pressure to decrease, minimizing the flow through the break to the secondary system.

Operator-controlled steam dumping to the condenser in order to: (1) reduce the reactor coolant temperature; (2) maintain primary coolant subcooling equivalent to a suitable overpressure; (3) to minimize steam discharge from the affected steam generator.

Isolation of the affected steam generator will be achieved by:

Identifying the affected steam generator by observation of rising liquid level and use of the liquid sample activity monitor.

Closing the main steam stop valve connected to the affected steam generator.

Securing the auxiliary feedwater flow to that steam generator.

b. Discussion of Remoteness of Possibility of Steam Generator Tube Rupture

The potential for rupture of a steam generator tube is considered minimal. The steam generator tube is constructed out of a highly ductile material - inconel 600. Further, based on ultimate strength at design temperature, the calculated bursting pressure of a steam generator tube is ~7000 psi, compared to the maximum operating differential pressure the tube wall sees of about 1500 psi. The steam generator is hydrotested at 3107 psig on the primary side and zero psig on the secondary side. This margin applies to the longitudinal failure modes. An additional factor of two applies to ultimate pressure strength in the axial direction tending to resist double-ended failure.

It is expected that rupture would be preceded by crackin which failure would be induced by fretting, corrosion, erosion or fatigue. This type of failure is of such a nature as to produce tell-tale leakage in substantial quantity while ample metal remains to prevent severance of the tube. The activity in the secondary system is continuously monitored via the air ejector discharge and periodic sampling, and continued unit operation is not permitted if the leakage exceeds technical specification limits. As a result, any failure of this nature would be detected before the large safety margin in pressure strength is lost and a rupture develops.

Finally, in over 400,000 tube years for Westinghouse built steam generators, there have been no gross tube ruptures. This experience, combined with stringent quality control requirements in the construction of the generator tubes and constant monitoring of the secondary system renders the likelihood of a steam generator tube rupture highly remote.

c. Analysis and Evaluation of Steam Generator Tube Rupture

1) Assumptions

The analysis of this accident is based on:

(a) Activity in primary coolant based on 0.2% equivalent fuel defects. The accident will cause no additional fuel damage.

(b) 125,000 pounds of primary coolant are carried over to the secondary side.

(c) Initial activity in the secondary system based on a 20 gpd steam generator leak rate.

(d) An iodine decontamination factor of 10 $\frac{\mu c/\text{gm water}}{\mu c/\text{gm steam}}$ in the steam generator.

(e) The faulty steam generator is isolated within 30 minutes.

(f) An iodine decontamination factor of $10^4 \frac{\mu c/gm\ steam}{\mu c/gm\ air}$ in the condenser.

(g) Blowdown from all steam generators is terminated at the start of the accident.

2) Justification for Assumptions

The 0.2% defect level is based on average reactor operating experience with W PWR Zircaloy fuel. No clad damage is anticipated as described in the PSAR.

The steam generator leakage is based on plant operating experience with W PWR Inconel steam generators.

The 125,000 pounds of primary coolant carryover is based on the amount of time it takes for the primary system pressure to come into equilibrium with the secondary side.

The iodine partition factors in the steam generator and condenser are based on the following reference:

Styrikovich M. A., Martynova O. I., Katkovska K. Ya., Dwbrovskii I. Ya., Smrinova I. N. "Transfer of Iodine from Aqueous Solutions to Saturated Vapor", Translated from Atomnaya Energiya, Vol. 17, No. 1, P. 45-49, July, 1964.

The 30 minute steam generator isolation time is based on estimates on the time it would take for the operators to identify the faulted steam generator from the instrumentation provided in the control room, and effect isolation.

3) Doses at Site Boundary and Total Population Dose

With the above assumptions the thyroid dose and the whole body dose at the site boundary are 4.51×10^{-4} mrem and 9.08×10^{-2} mrem, respectively. The total population whole body dose is 3.27×10^{-1} man-rem.

4. Rod Ejection Accident

a. Description of Class 8 Event - Rod Ejection Accident

The highly unlikely event of rupture of a control rod mechanism housing, creating a full system pressure differential acting on the drive shaft, must be postulated for this accident to occur. The resultant reactor core thermal power excursion is limited by the Doppler reactivity effects of the increased fuel temperature and terminated by a reactor trip actuated by a high neutron flux signal.

The operation of a plant which uses chemical shim for reactivity control is such that the severity of an ejection accident is inherently limited. Normally there are only a few control rods in the core at full power. Proper positioning of these rods is monitored by a control room alarm system. There are low and low-low level insertion monitors with visual and audio signals. Operating instructions require boration at low level alarm and emergency boration at the low-low alarm. By utilizing the flexibility in the selection of control rod cluster groupings, radial locations, and axial positions as a function of load, the design minimizes the peak fuel and clad temperature for the worst ejected rod.

No clad melting occurs as a result of this accident. Activity in the primary coolant is released to the containment. There, sprays and plateout partially reduce the airborne fission product concentration. Fission products escaping to the external environment do so through minute leaks in the containment structure.

b. Discussion of Remoteness of Possibility of a Rod Ejection Accident

A failure of a control rod mechanism housing sufficient to allow a control rod to be rapidly ejected from the core is considered very remote. Each control rod drive mechanism housing is completely assembled and shop tested at pressures higher than normal operating pressures. On-site, the mechanism housings are individually hydrotested when installed, at 3750 psi, which is considerably higher than the operating pressures and considerably higher than the power relief valve setting of 2335 psi and the safety valve setting of 2485 psi, and checked during the hydrotest of the completed Reactor Coolant System.

Stress levels for the mechanism are not affected by anticipated system transients at power, or by the thermal movement of the coolant loops. The latch mechanism housing and rod travel housing are each a single length of forged type-304 stainless steel. This material exhibits excellent notch toughness at all temperatures that will be encountered. This significant margin of strength in the inelastic range together with the large energy absorption capability in the plastic range gives additional assurance that gross failure of the housing will not occur.

Finally, periodic inspections of the housings are made during the plant lifetime to insure against defects.

Because of the conservative design, the number of pre-operational tests, the material of construction and the periodic inspection program, the potential of a rod ejection accident is considered minimal.

c. <u>Analysis and Evaluation of Rod Ejection Accident</u>

1) <u>Assumptions</u>

The analysis for this accident is based on:

(a) Activity in primary coolant due to 0.2% equivalent fuel defects.

(b) No additional fuel damage as a result of the accident.

(c) All activity in the coolant prior to the accident is assumed to be released to the containment.

(d) The remaining assumptions are the same as for the LOCA.

2) <u>Justification for Assumptions</u>

The 0.2% equivalent fuel defects level is based on <u>W</u> PWR reactor operating experience with Zircaloy clad fuel to date.

Based on the estimated value of the ejected rod worth and beginning of life (i.e., low feedback values), approximately 2% of the fuel rods fall below a DNBR of 1.3 and no rods fall below a DNBR of 1.1. It is therefore concluded that no rods will suffer clad perforations during the transient.

3) Doses at Site Boundary and Total Population Dose

With the above assumptions the thyroid dose and the whole body dose at the site boundary are 2.31×10^{-3} mrem and 4.24×10^{-4} mrem, respectively. The total population whole body dose is 1.53×10^{-3} man-rem.

5. Waste Gas Decay Tank Rupture

a. Description of Class 8 Event - Waste Gas Decay Tank Rupture

The postulated accident is the gross structural failure of a Waste Gas Decay Tank.

The decay tanks contain the gases vented from the reactor coolant system and the volume control tank and the recycle evaporator. Sufficient volume is provided in these tanks to store the gases evolved during reactor operation. No release from this system is planned.

b. Discussion of the Remoteness of Possibility of a Waste Gas Decay Tank Rupture

Most of the gas received by the waste disposal system during normal operation is cover gas displaced from the chemical and volume control system. The gaseous waste processing system is designed such that during normal operation a hydrogen recombiner will remove hydrogen from nitrogen-fission gas mixtures by oxidation to water vapor which is removed by condensation. This limits the amount of gas which is transferred to the gas decay tanks.

At the beginning of life the gas decay tanks will operate under an initial pressure of 3 to 5 psig, compared to a design pressure of 150 psig. The maximum anticipated pressure in any gas decay tank is not expected to exceed 50 psig.

The gas decay tanks are designed to Quality Class 3 and ASME Section VIII requirements.

Because of the conservative design, extensive QA, the close monitoring and sampling throughout the system, and the fact that the system components are not subject to high pressure or stresses, an accidental release of waste gases is highly unlikely.

c. Analysis and Evaluation of Waste Gas Decay Tank Rupture

1) Assumptions

The analysis for this accident is based on:

(a) Operation with 0.2% equivalent fuel defects.

(b) Noble gas release only.

(c) The inventory of the tanks is based on the hydrogen recombiner flow rate from the volume control tank using daily cycling between the 6 gas decay tanks.

2) Justification for Assumptions

The 0.2% equivalent fuel defect level is based on W PWR operating experience with Zircaloy clad fuel to date.

Halogens remain in solution in the volume control tank.

3) Doses at Site Boundary and Total Population Dose

With the above assumptions the whole body dose at the site boundary is 3.84×10^{-1} mrem. The total population whole body dose is 1.38 man-rem.

6. Volume Control Tank Rupture

a. Description of Class 8 Event - Volume Control Tank Rupture

The accident is the sudden and total structural failure of the volume control tank, releasing the contents to the atmosphere. The volume control tank is in the Reactor Coolant System letdown line and contains primary coolant. Its function is to regulate the primary coolant volume as the fluid expands and contracts with temperature changes.

b. Discussion of Remoteness of Possibility of Volume Control Tank Rupture

The volume control tank is designed to Quality Class 2a with an internal pressure of 75 psig. The normal internal operating pressure is approximately 15 psig. Level alarms, pressure relief valves, and automatic tank isolation and valve control assure that safe conditions are maintained during system operation. Since the volume control tank is not subjected to high pressures or stresses and is designed to Quality Class 2a, structural failure of the tank is considered very remote.

c. Analysis and Evaluation of Volume Control Tank Rupture

1) Assumptions

This accident analysis is based on:

(a) Plant operation with 0.2% equivalent fuel defects.

(b) Continuous purge rate from the tank to the Radwaste System of 0.7 scfm.

(c) Noble gas release only.

2) Justification for Assumptions

The 0.2% equivalent fuel defect level is based on W PWR operating experience with Zircaloy clad fuel to date and design purge rate. The halogen concentration in the liquid is low and the iodine will primarily remain in the volume control tank.

3) Doses at Site Boundary and Total Population Dose

With the above assumptions the whole body dose at the site boundary is 3.14×10^{-2} mrem. The total population whole body dose is 1.13×10^{-1} man-rem.

X. TABLE OF DOSES FOR EACH CLASS

For each of the accident classes considered in this report an average site boundary thyroid and whole body dose were computed. The average whole body dose includes the beta skin dose contribution. In addition, the total dose to the total population within a 50 mile radius of the site was analyzed for each accident class using the meteorological and population data presented in Section II. These doses are presented in Table X-1.

The models used to compute the thyroid, whole body and population doses are presented below:

1) Thyroid Dose

The average thyroid dose at the site boundary was computed using the equation:

$$\text{Thyroid Dose} = \left(X/Q\right)_{S.B.} \times \overline{B} \times \sum_i A_i \times DCF_i$$

where: A_i = Activity release to the environment of isotope i

DCF = Dose conversion factor of isotope i

$\overline{B}$ = Average breathing rate of the average man

$\left(X/Q\right)_{S.B.}$ = Average annual X/Q at the site boundary as given in Section II.

TABLE X-1

SUMMARY OF DOSES AND ENVIRONMENT EFFECT

Class	Representative Event	Site Boundary Dose (mrem) Whole Body	Site Boundary Dose (mrem) Thyroid	Environmental Effect (Man-Rem)
2	Volume Control Tank Release	3.14×10^{-3}	-	1.13×10^{-2}
3	Gas Decay Tank Release	3.84×10^{-2}	-	1.38×10^{-1}
4	Fuel Defects	N.A.	N.A.	N.A.
5	Off-Normal Operation	2.12×10^{-2}	5.16×10^{-4}	7.59×10^{-2}
6	Refueling Accident Inside Containment	7.61×10^{-3}	4.06×10^{-2}	2.70×10^{-2}
7	Refueling Accident Outside Containment	5.57×10^{-2}	2.03×10^{-1}	2.00×10^{-1}
8	SAR Accidents			
	a. LOCA	7.90×10^{-1}	2.16×10^{1}	2.85
	b. Steam Line Break	4.25×10^{-5}	5.7×10^{-4}	1.52×10^{-4}
	c. Tube Rupture	9.08×10^{-2}	4.51×10^{-4}	3.27×10^{-1}
	d. Rod Ejection	4.24×10^{-4}	2.31×10^{-3}	1.53×10^{-3}
	e. Gas Decay Tank Rupture	3.84×10^{-1}	-	1.38
	f. Volume Control Tank Rupture	3.14×10^{-2}	-	1.13×10^{-1}

2) Whole Body Dose

The average whole body dose, including the beta contribution, at the site boundary was computed using the equation for a semi finite spherical cloud as given by:

$$\text{Whole Body Dose} = 0.246 \times (X/Q)_{S.B.} \times \sum_i A_i \times (\bar{E}_{Y_i} + \bar{E}_{B_i})$$

where: A_i = Activity released to the environment of isotope i

$\bar{E}_{Y_i}$ = Gamma energy of isotope i

$\bar{E}_{B_i}$ = Beta energy of isotope i

$(X/Q)_{S.B.}$ = Average annual X/Q at the site boundary as given in Section II

3) Population Dose

The total population dose was computed using the equation.

$$\text{Population Dose} = 0.246 \left[\sum_i A_i \times (\bar{E}_{Y_i} + \bar{E}_{B_i})\right]\left[\sum_r \sum_\phi \frac{X}{Q}_{r,\phi} P_{r,\phi}\right]$$

where: A_i, $\bar{E}_{Y_i}$ and $\bar{E}_{B_i}$ are the same as given for the whole body dose model, and

$X/Q_{r,\phi}$ = the X/R for a given sector (ϕ) and distance (r) as given in Section II

$P_{r,\phi}$ = the population estimatε for a given sector (ϕ) and distance (r) as given in Section II.

These radiation releases are monitored by the environmental monitoring system which provides an assessment of inadvertent exposures.

XI. CONCLUSIONS

Based on the evaluations of the various postulated accidents and occurrences in Sections III through IX and the resultant radiological results as tabulated in Section X, it is concluded that the environmental impact from these accidents and occurrences are insignificant and inconsequential. In fact, the maximum man-rem realistically established as a result of any accident is well within the increment of exposure to the general public corresponding to variations in natural background.

4.10 Transportation of Fuel

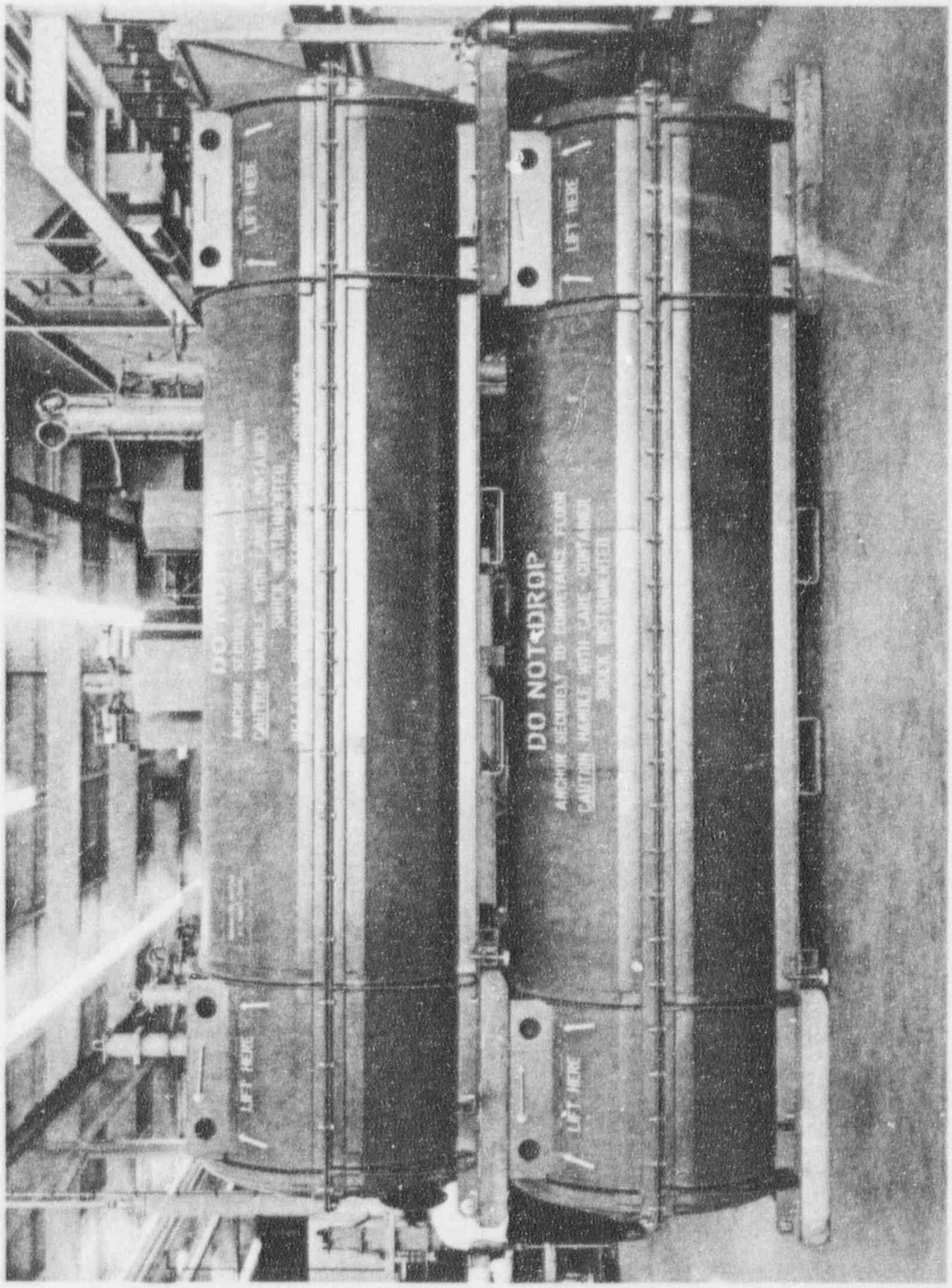
The transportation of new fuel assemblies to the Farley Plant from a fabrication facility and the transportation of spent fuel assemblies from the Farley Plant to a reprocessing facility will be in accordance with Atomic Energy Commission and Department of Transportation regulations as well as any other applicable regulations in effect at the time.

4.10.1 Transportation of New Fuel

The initial fuel loading for each of the two units will consist of 157 fuel assemblies. About 56 new assemblies are expected to be loaded every year into each of the units after they begin commercial operation. These fuel assemblies will have been fabricated at a fuel fabrication plant and shipped to the plant site shortly before they are required. It is anticipated that these shipments will be made by truck in containers similar to those shown in Figure 4-4. Each of these containers can accommodate two fuel assemblies and six or seven containers would constitute a truckload. Thus, for each unit about twelve to fourteen shipments will be required for the initial loading with only about four or five shipments every year thereafter.

4.10.2 Transportation of Spent Fuel

Approximately 56 spent fuel assemblies are expected to be discharged from each unit annually and will remain at the plant for at least three months while the short half-life isotopes decay. The fuel will then be transported to a reprocessing plant for the necessary reprocessing services. It is anticipated that these shipments will be made by rail in containers generally similar to the one shown in Figure 4-5. This container is shown arranged for shipping on a railroad flat car in Figure 4-6.



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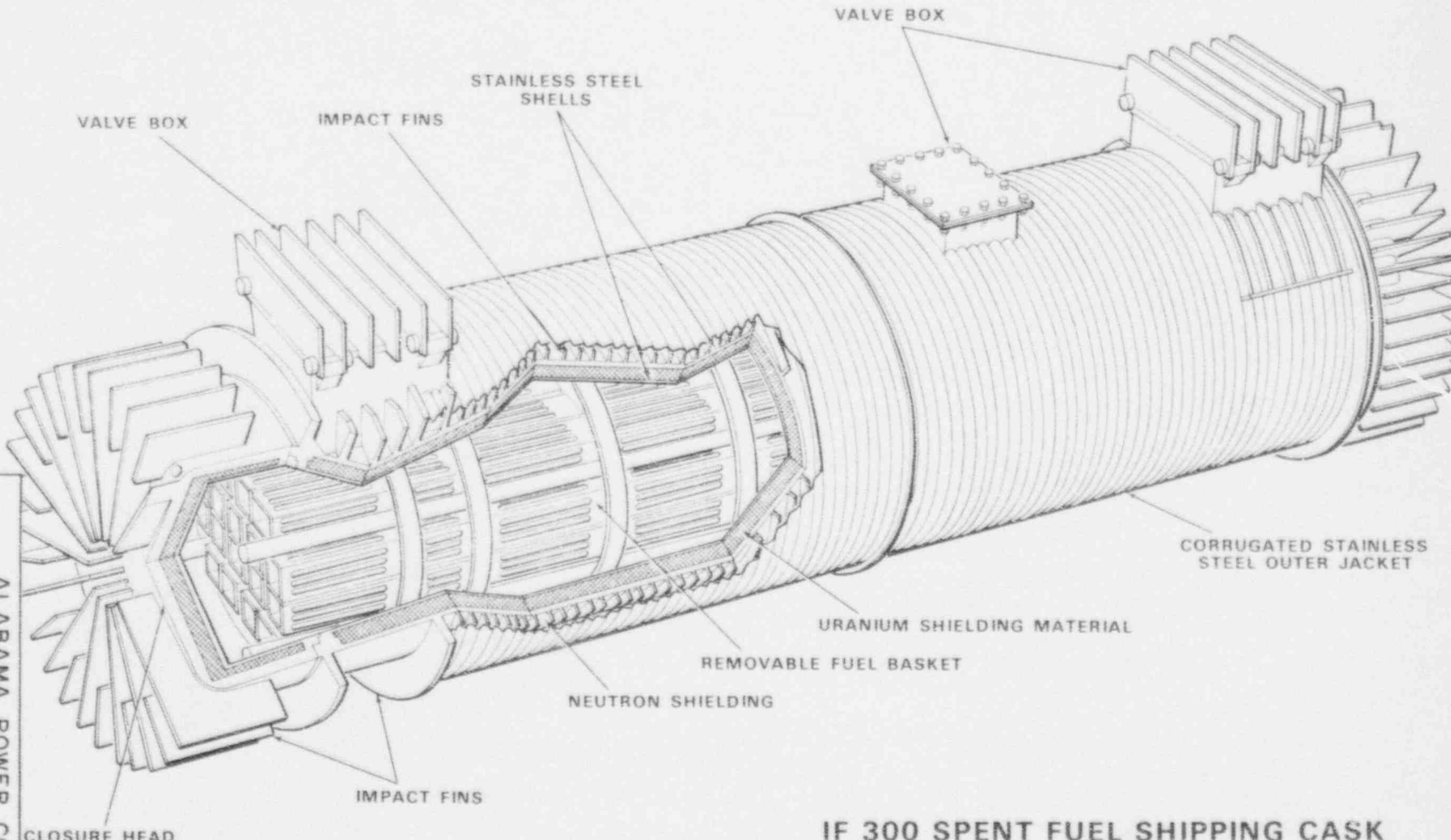
NEW FUEL
SHIPPING CONTAINERS

FIGURE 4-4



IF 300 SPENT FUEL SHIPPING CASK

GENERAL ELECTRIC

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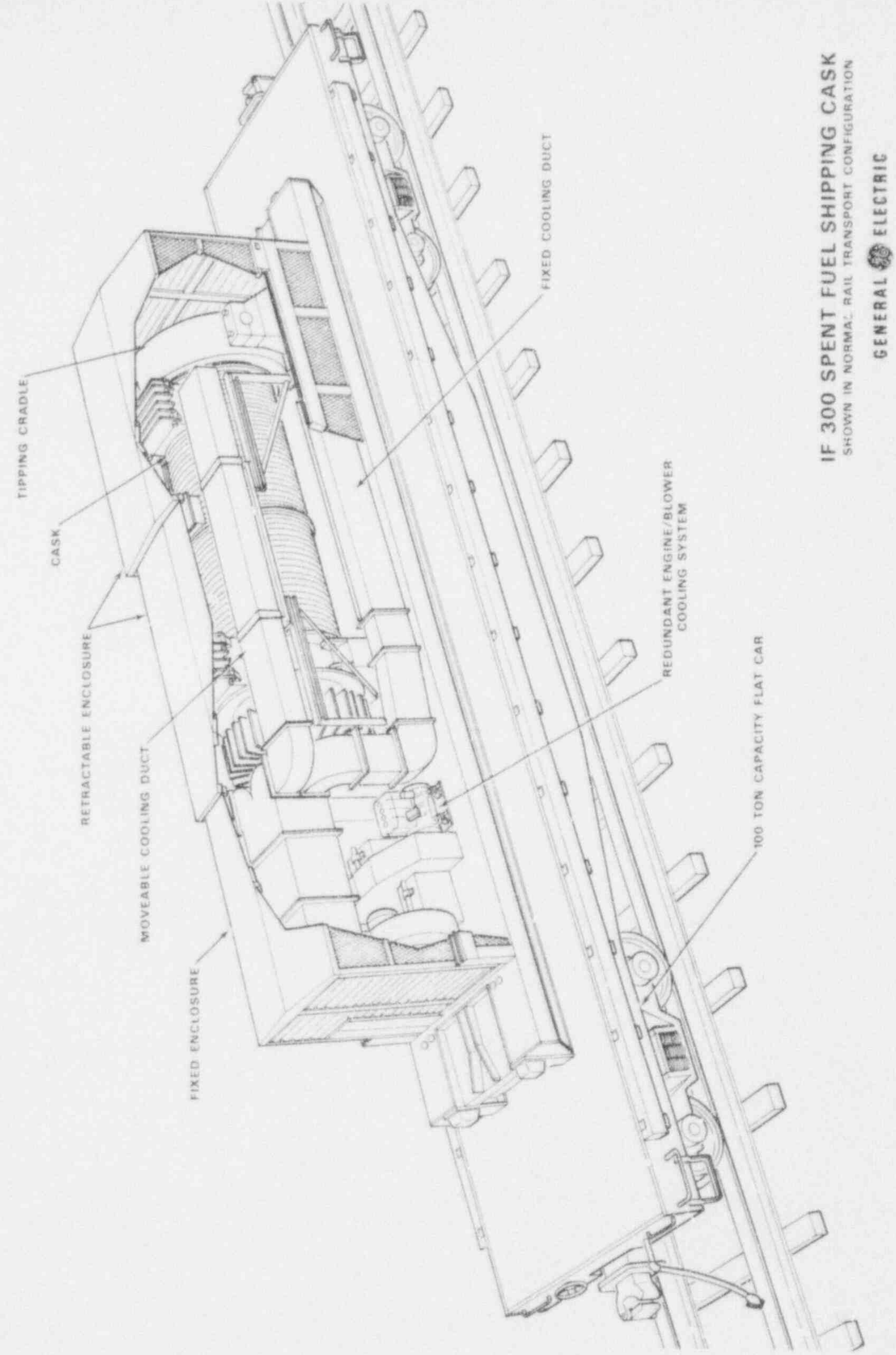
SPENT FUEL
SHIPPING CASK

FIGURE 4-5



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SPENT FUEL SHIPPING CASK
RAIL TRANSPORT CONFIGURATION

FIGURE 4-6

The flat car will carry no other cargo and there will be no intermediate handling of the container system between the Farley Plant and the reprocessing plant. The container will be able to accommodate from about six to about sixteen fuel assemblies, depending upon its size. Thus, for each unit the shipment of from four to ten containers will be required each year.

The exact details of the container designs, shipping procedures, routings, etc., will depend upon the requirements of the suppliers providing the fabrication and reprocessing services. These items will always comply with applicable regulations.

The USAEC and U.S. Department of Transportation (DOT) regulations specify both normal and accident conditions for which a package designer must evaluate any radioactive material packaging. These conditions are intended to assure that the package has requisite integrity to meet all conditions which may be encountered during transport. The normal shipping conditions require that the package be able to withstand temperatures ranging from -40°F to 130°F and to withstand the normal vibrations, shocks and wetting that would be incident to normal transport. In addition, the packages are required to withstand specified accident conditions with the release of no radioactivity except for slightly contaminated coolant and 1,000 curies of radioactive noble gases. The accident conditions for which the package must be designed include, in sequence, a 30-foot free fall onto an essentially unyielding surface, followed by a 40-inch drop onto a 6-inch diameter pin, followed by 30 minutes in a 1475°F fire, followed by 8 hours immersion in 3 feet of water. A cask, identical to those which will actually be used will be tested to determine that these required specifications will be met. The maximum permissible radiation levels and releases under these accident conditions are shown in Table 4-17.

These levels represent limits established by the regulations. In most cases, the containers will exhibit radiation levels and releases less than those permitted by the regulations. This is because the fuels and materials which will be handled will not be at the maximum activity levels for which the containers have been designed.

Under normal shipping conditions, no release of any radioactive materials will occur and under the very severe accident conditions postulated, the only releases expected are slightly contaminated coolant and noble gases. An accident may also result in a minor increase in radiation levels associated with the reduction of shielding.

Prior to shipment, the fuel will be retained at the plant for a minimum of 100 days with the result that essentially all noble gases with the exception of Krypton-85 will be gone and the iodine-131 will have decayed to a very low level. Further, the decay heat will have been reduced to about 0.1 percent of the heat which has been generated by the fuel during reactor irradiation. This, coupled with the high melting point of the fuel pellets assures that during a shipping cask accident, there is very little potential for any radioactivity other than the noble gases being released into the cask cavity. Mechanical properties of the irradiated reactor fuel will act in a substantial way to mitigate the consequences of an accident by tightly binding the fission products within the basic fuel assembly.

There are several features which are typical of all shipping casks, such as heavy stainless steel shells on the inside and outside, separated

TABLE 4-17

CONTAINER DESIGN REQUIREMENTS

	NORMAL CONDITIONS	ACCIDENT CONDITIONS
EXTERNAL RADIATION LEVELS		
Surface	200 MR/hr	
3 ft. from surface		1000 MR/hr
6 ft. from surface	10 MR/hr	
PERMITTED RELEASES		
Noble Gases	None	1000 Ci
Contaminated Coolant	None	.01 Ci alpha, 0.5 Ci mixed fission products 10 Ci Iodine
Other	None	None
CONTAMINATION LEVELS		
Beta and Gamma	2200 dpm/100 cm^2	
Alpha	220 dpm/100 cm^2	

by dense shielding material, such as depleted uranium. Additionally, the cask has an extended surface area for dissipation of decay heat, and will be equipped with an energy absorbing impact structure such as fins, to absorb the energy in case of a fall, and to limit the forces imposed on the cask and contents. The cask also will contain a basket which will be provided to support the fuel during transport. Additionally, for high exposure fuel, provisions will be made for a hydrogenous material, such as water, to provide for absorption of the fast neutrons generated through spontaneous fission and alpha-n reactions of the transuranium isotopes.

The principal normal environmental effect from these shipments will be the direct radiation dose from the shipments as they move from the reactor to the reprocessing plant. For the purpose of this calculation, it has been assumed that the shipments will be made at the maximum permitted level of 10 mrem per hour at a distance of six feet from the nearest accessible surface. Based on this assumption, and assuming that the nearest person will be 100 feet from the centerline of the tracks, it is estimated that the dose rate would be 0.2 mrem per hour. This would be reduced to 0.01 mrem per hour at a distance of 300 feet and beyond this distance the radiation exposure received would be negligible.

A principal environmental effect from an accident would be whole body radiation due to the increased radiation levels caused by the release of noble gases. Exposure to personnel could result from direct radiation. Because of the dose attenuation effects with distance, it can be concluded that the direct radiation dose effects to the general population will be negligible. Calculations indicate that because the decay heat has been allowed to decrease substantially prior to shipment, there would be no release of the fission gases unless there is a source of external heat, such as from a fire. However, even if this accident is evaluated in accordance with 10CFR71 criteria, which considers that 1000 Ci of gaseous activity is released to the environment, the population exposure should be negligible. A similar conclusion may be reached regarding thyroid dose from iodine.

4.10.3 Conclusions

It is currently expected that new fuel will be shipped by truck to the Joseph M. Farley Plant and that spent fuel will be shipped from the plant by rail. All shipments will be made in accordance with Atomic Energy Commission (AEC) and Department of Transportation (DOT) regulations as well as any other applicable regulations in effect at the time.

As the result of having the alternates of barge, railroad and highway transportation from the plant, Alabama Power Company is in a position to select the mode of shipment for fuel that will have the least risk of accident and minimal environmental impact when shipments are made. Since nuclear fuel shipping technology is still developing, Alabama Power Company considers it important to have these alternates for fuel shipment.

Errata to Part 4

Page 4-36, line 5 - Add "into the auxiliary building" after "released".

Page 4-39, line 13 - Delete "automatically".

Page 4-63, line 6 - Delete "absolute" and replace with "HEPA".

Page 4-78, line 22 - Delete "axial" and replace with "circumferential".

Page 4-85, line 14 - Delete "accidental".

Page 4-83, line 14 - Add "due to a tank rupture" after "gases".

Table IX, following page 4-88 - Add footnote, "N.A. - Not applicable - no environmental effects.

5.0 Environmental Effects Which Cannot Be Avoided

The following sections identify and discuss unavoidable adverse environmental effects which may occur as a result of the construction and operation of the Joseph M. Farley Nuclear Plant. These adverse effects are identified as being of only minor importance to the environment of the area.

5.1 Environmental Effects Caused by Construction

The construction activities at the Joseph M. Farley Plant site will cause limited adverse environmental effects which cannot be avoided but in most cases can be minimized by attention to desirable construction practices. The following sections describe, generally, the scheduled construction activities, their impact on the environment and efforts undertaken to eliminate or minimize the impact.

5.1.1 General Plans and Schedule

The plant site area investigation began in 1967 with geologic field mapping, aerial reconnaissance, air photo interpretation and a review of pertinent geological and hydrological literature. This was followed with geologic borings, undisturbed sampling and core drilling, geophysical surveys, piezometric observations, contour mapping and surveying. Additional or more detailed investigations were made as needed.

The general site grading began on September 28, 1970. On April 12, 1971, Alabama Power Company received a waiver which permitted continuation of construction. Since that time, 483 acres have been cleared, graded or excavated. Through September 30, 1971, 4,044,700 c.y. of earth and 49,700 c.y. of rock have been excavated, and approximately 17,400 c.y. of concrete have been poured.

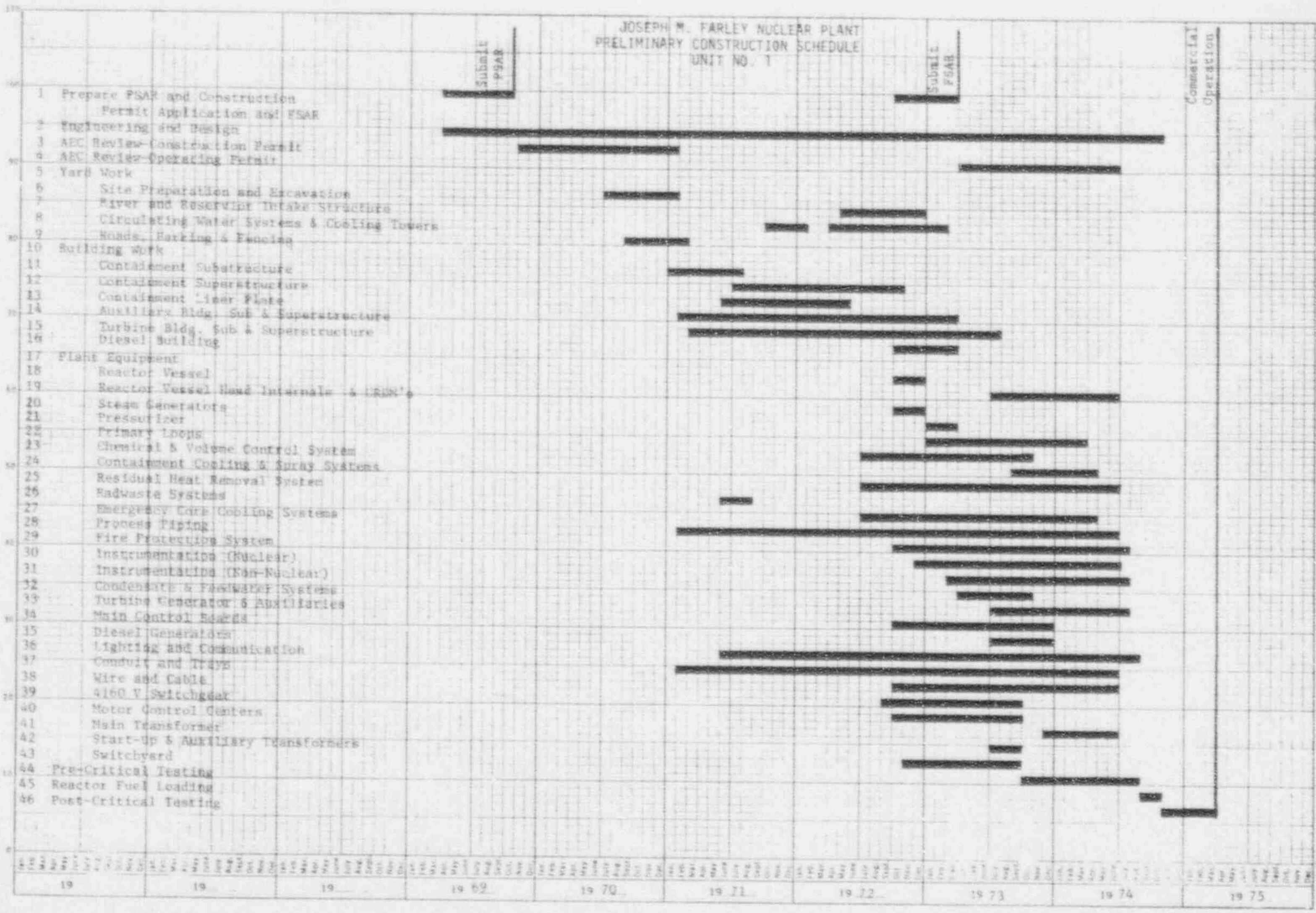
Construction of five miles of railroad, with a bridge crossing Omussee Creek and a 23 foot diameter culvert for Rock Creek, have been completed. All right-of-way slopes have been seeded and mulched. This railroad connects the jobsite to the Central of Georgia Railroad at Columbia, Alabama. Construction of railroad yard tracks on the plant site is in progress.

A 12 KV primary loop electric transmission line for construction power has been completed. A well-water system to supply water during construction has been installed with a total pumping capacity of 450 gpm from three wells. Fire protection pump house and storage tanks have been erected. The sewage disposal facilities to accommodate construction personnel requirements have been completed and are operational. Construction office, warehouse and shop facilities have been completed and are in use. A microwave-meteorological tower has been erected and is in service with meteorological recording instruments installed and functioning. Paving of permanent and temporary entrance roads was begun on June 8, 1971.

A general schedule for construction of the Joseph M. Farley Nuclear Plant is shown in Figure 5-1.

5.1.2 Measures Taken to Minimize Impact

A series of catch basins and storm sewers are being installed on the site as roads and other facilities are being built. The slopes along entrance roads have been grassed, and grassing is continuing in other areas where possible and practicable. This procedure of land stabilization will be continued throughout construction and into the final landscaping of the plant area.



ALABAMA POWER COMPANY
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PRELIMINARY CONSTRUCTION SCHEDULE

FIGURE 5-1

Unpaved temporary roads are being watered as needed and most heavily traveled temporary roads are being paved.

During construction, the control of sanitary wastes will be accomplished by three different means. These are: a sewage treatment system, septic tanks and portable chemical toilets (see Section 3.5.2).

The sewage treatment system is an "activator" system manufactured by Pollution Control, Inc. It is designed to accommodate 600 people per day. This system utilizes oxygen mixing and detention time followed by chlorination of the effluent.

Sanitary facilities connected to two 1500 gallon septic tanks with field lines are located near the fabrication shop area. This system is designed to accommodate 100 people per day. Portable chemical toilets are supplied and maintained by a licensed commercial agency. The number and location of these depend upon their need.

As permanent facilities are completed, or as soon as practicable, the surrounding areas have been or will be provided with erosion control and grassing.

Alabama Power Company intends to landscape the access roads and plant area. The remainder of the site will be permitted to remain or return to a near-natural condition in accordance with good wildlife management practices. This program is under consideration and may include planting cover and perennial feed crops in some presently cleared areas and planting of selected species of trees.

5.1.3 Impact on Water Supplies

No construction activity is known to have an impact on water supplies in the area. Drainage of the construction area is maintained and erosion control is practiced as thoroughly as practicable. Bridging of Omussee Creek and diversion of Rock Creek through a 23' diameter culvert was accomplished without the damming of either creek and with a minimum of excavation erosion into the creeks.

The areas of influence of the water supply wells are entirely within the site and the aquifers that supply the wells have tremendous capabilities for supplying water far in excess of the amount used.[1.]

Construction of the facilities in or near the Chattahoochee River should have little or no effect on the flow or water quality.

5.1.4 Impact of Work on the Chattahoochee River

Only three facilities will be on the bank of, in, or be physically associated with the Chattahoochee River. These are the intake and discharge structures and the barge unloading facility. The discharge pipe and diffusion box will be under water on the west side of the river. See Figure 2-5.

The intake structure will be on the west bank and connected to the river by a 200 foot long channel. See Figure 2-4.

It is not anticipated that any earth fill will be placed in the river. Any material removed from the river or river bank will be placed on the west bank of the river and left in such a manner as not to be obtrusive.

The work on these three facilities should have little or no effect on navigation, fish, wildlife, water quality, water supply, or recreational use of the river. Neither the work nor the facilities should result in noticeable restrictions in river flow and could not be responsible for any potential flood damages.

1. Scott, J. C., J. F. McCain, and J. R. Avrett, Water Availability in Houston County, Alabama, Geological Survey of Alabama, 1967.

5.2 Environmental Effects Which Cannot Be Avoided During Operations

The operation of any large facility will inevitably result in certain changes in the environment, some of which may be to some extent adverse to the natural ecosystem in the area. Although every effort has been made in the planning of the Joseph M. Farley Nuclear Plant to eliminate or minimize any adverse environmental effects, some of the changes produced may prove harmful to some aspects of the environment. Possible adverse effects will be discussed under the following headings:

A. Air and water pollution

B. Land use

C. Meteorology

5.2.1 Effects on Air and Water Quality

The use of closed-cycle mechanical draft cooling towers will virtually eliminate any thermal effects on the Chattahoochee River. As discussed in Section 3.3.3.1 of this report, the use of these towers is based on a design wet-bulb temperature of 78°F and an approach of 11°F, which indicates that the temperature of the blowdown will not generally exceed 89°F and will usually be considerably less than this temperature. Figure 2-15, based on records at nearby Dothan, Alabama, shows average hourly dry bulb, wet bulb, and dew point temperatures which were recorded during the 12-year period, 1940-1952.

Cooling towers accomplish their purpose mainly through the mechanism of evaporation. Evaporation and drift from the cooling towers must be replaced by water withdrawn from the river, and must be regarded as a consumptive water loss. This loss, from two units, is estimated to be approximately 27,940 gpm (62 cfs). The amount of consumptive loss is not considered to be of great importance at the site because it represents only about 5 percent of the lowest daily flow recorded on the river in its present regime and only 0.5 percent of the average annual flow. It does represent, however, an unavoidable adverse environmental effect.

The blowdown from the cooling towers serves to prevent excessive build-up of solids in the closed-cycle system. The blowdown design is based on the concept of a concentration factor of 1.64, which will result in an average dissolved solids concentration in the blowdown of 103 ppm. Though not considered important in this case, the build-up of the concentration of dissolved solids is an unavoidable adverse environmental effect.

Makeup water for the plant's reactor and turbine-generator systems will be purified by passage through regenerative demineralizer resins. Sodium hydroxide and sulfuric acid will be used to regenerate these resin beds. These small quantities of regeneration solution will be neutralized and diluted and then released to the river under controlled conditions. Though not considered harmful, the addition of these chemicals must be considered, to some small degree, an unavoidable adverse environmental effect.

The regime of Chattahoochee River has been modified in the interest of navigation by construction of locks and dams both upstream and downstream. Columbia Lock and Dam, located approximately 3 miles upstream, was completed in 1963, and Jim Woodruff Lock and Dam, located approximately 43 miles downstream, was completed in 1957. In addition, a navigation channel in the river is maintained by the Corps of Engineers through the use of dredging. The construction and operation of the Joseph M. Farley Nuclear Plant will not affect this use of the river. The river structures which are being built in connection with the plant include an intake, discharge and barge unloading facility which are discussed elsewhere in the report. Since the river has undergone earlier improvements, the construction of the relatively small plant facilities will produce no important adverse environmental effect.

One of the principal advantages of the use of Nuclear plants to produce electric energy is the virtual elimination of air pollution problems which may arise when alternate fuels are employed. The normal operation of the Joseph M. Farley Plant will produce no smoke. There will be five diesel engines installed to drive generators to furnish emergency power for certain equipment in the plant. These diesel units will be operated and tested on a regular but short-term basis to assure their dependability in the event they are needed. Also, a small oil fueled boiler will be installed and used on a short-term, intermittent basis for plant start-up. Although the exhaust from both the diesels and the boiler will be vented to the atmosphere, the resulting emissions will have a negligible, though unavoidable adverse effect on air quality in the area.

5.2.2 Effects on Land Use

The plant will employ approximately 95 people on a permanent basis after it is completed and in operation. The employment of these people will bring economic benefits to the area, with very little important increase in traffic congestion in the relatively sparsely inhabited portion of Houston County in which the plant is being built. Although some land is being removed from agricultural use and there will be losses of timber and vegetation resulting from clearing for the plant, its associated transmission lines, roads and railroad, these unavoidable losses are not considered of major importance in the region. In Houston County alone, there are over 150,000 acres in cropland and about 200,000 acres in pasture, woodland and forest, and adjacent counties have large acreages devoted to these uses.

5.2.3 Effects on Local Meteorology

In evaluating the adverse environmental effects of the Joseph M. Farley Nuclear Plant, consideration must be directed to possible local fogging which may result from the operation of the plant's cooling towers. The plant is located in an area of moderate fogging potential, due to prevailing humidity and temperature conditions. (See Section 2.4.6)

There is insufficient experience in the southeast United States with cooling towers of the size and type to be employed at the Farley Plant site to draw dependable conclusions about the fogging which may result under certain meteorological conditions. There are, however, no important highways in the immediate vicinity of the plant site, and the relatively warm winter temperatures which prevail in the area will ensure minimal problems with icing. For these reasons, there is no serious concern warranted about the potential fogging problem. To the extent that it does occur, however, fogging must be regarded as an adverse environmental effect which cannot be avoided, and it is considered to be much less detrimental to the environment than would be the thermal effects in the river, were the cooling towers not installed. This judgment cannot be quantified but is based on the best information available and on applicable water quality standards in the Chattahoochee River.

6.0 Alternatives

Many alternatives have been considered in connection with the location, design and construction of the Joseph M. Farley Nuclear Plant and its associated facilities. These alternatives have been discussed throughout the Supplemental Environmental Report where the particular aspects of the plant were described and evaluated.

The following pages contain a summary and evaluation of the identifiable alternatives which were available in plant location, design and construction in which environmental considerations were involved.

A. Alternatives to Providing Electric Power

Alabama Power is under the jurisdiction of the Alabama Public Service Commission and has a legal obligation to provide adequate and reliable electric power in its service area. Also, there is, in Section 202 of the Federal Power Act, a statement by the Congress of the United States that assurance of adequate supplies of electric power is a national goal.

Therefore, the alternative to providing adequate power, which would be not providing it, is neither feasible nor legal. Alabama Power Company is initiating means for fulfilling the demand for electric power expected in future years, and construction of the Joseph M. Farley Plant is of utmost importance to the Company in its plans for meeting its obligations.

The rate structure which Alabama Power Company uses as the basis for charges to its customers for electric power must be approved by the Alabama Public Service Commission.

The Commission, in fulfilling its obligations to the citizens of Alabama, requires that these rates be as low as possible consistent with providing dependable electric service and also an adequate rate of return to the company to justify its investment in an electric system. It is, therefore, incumbent upon the company to make every effort in providing electric power to choose economic alternatives consistent with all facets of the public interest, including reliability and protection of the natural environment.

B. Alternatives to Location of the Plant

The alternative to locating the Joseph M. Farley Plant in Southeast Alabama was the location of a large generating plant in another part of the state. The alternative of bringing power into the area by transmission lines from distant locations would have resulted in higher losses of power along the transmission lines and a lesser degree of reliability.

Since generating plants in any area require approximately the same amount of land, it follows that location of generating plants throughout a service area in proximity to electrical load centers results in minimum need for transmission lines, maximum reliability and has the least potential for adverse environmental impact. Alabama Power Company, by locating the Joseph M. Farley Plant in southeast Alabama, had achieved these objectives, and no important adverse environmental effects have been identified which would indicate that generating capacity should be located elsewhere in Alabama.

C. Alternatives to Selection of Site

The chief considerations which entered into the selection of potential plant sites were, (1) location on a navigable river to provide water for a cooling system and to provide barge transportation for heavy equipment and fossil fuel if necessary, (2) a large site area available for exclusion purposes or for storage of fossil fuel and flyash disposal, (3) location in an area of low population density, (4) satisfactory foundation conditions, and (5) compliance with AEC requirements for geological and hydrological factors. A careful search was made in southeast Alabama to find a site that would fulfill all of the above requirements for either a fossil fueled or a nuclear fueled plant.

Numerous sites were considered and rejected for various reasons during the course of the area investigation. The site selected is outstanding and meets the AEC requirements in every respect. No other site investigated had characteristics as favorable for filling the needs of a nuclear fueled plant.

D. Alternatives to Type of Generating Plant

Load studies which the company had undertaken to forecast future needs indicated the need for additional generating capacity to meet both base load and peak requirements. Combustion turbines, because of relatively low capital cost, but high fuel cost, and hydroelectric plants, because of the characteristics of stream flows in Alabama, are best suited for peaking purposes. Additional peaking capacity will be provided by hydroelectric generating plants to be located elsewhere in Alabama, subject to approval of the Federal Power Commission. Steam electric plants are best suited for base load operation.

In order to meet the need for additional base load generating capacity, the alternative was narrowed to a choice between a fossil fueled and nuclear fueled generating plant in southeast Alabama. Gas and oil were eliminated because of relatively higher costs, and in the case of gas, its unavailability.

The selection of a nuclear plant was made on the basis of a comparison of the long range costs of constructing and operating coal fueled and nuclear fueled plants. On the basis of the best estimates available at the time this decision was made, a nuclear plant was found to have clear, long range economic advantages.

This decision was made in 1968 prior to the enactment of the National Environmental Policy Act, but in retrospect, it appears that the decision to construct a nuclear plant in southeast Alabama provides important environmental advantages. These advantages are demonstrated by the elimination of emission of substantial quantities of pollutants to the atmosphere which would occur from a coal fueled plant, and other environmental considerations relating to land use, aesthetics, transportation and noise.

Since the decision to construct a nuclear plant in southeast Alabama was made, the cost of nuclear construction has risen sharply due in part to changes in regulations and the addition to equipment related to safety and environmental protection. There has been a sharp increase, however, in the price of coal, which offsets the rise in the cost of constructing a nuclear plant, and the decision to construct the nuclear plant still has a solid economic justification.

E. Alternatives to Various Plant Facilities

There were several alternatives to the transmission line facilities which will be constructed in connection with the Joseph M. Farley Nuclear Plant. One theoretical alternative to the construction of the transmission line system was the use of underground transmission. The use of underground transmission to deliver the amount of power to be produced at the Farley Plant is not considered technically feasible at this time or economically justifiable. Transmission of large blocks of power at 230,000 volts underground is estimated to cost in the range of 10 to 40 times more than use of the conventional overhead-type construction.

The average cost per mile for the overhead 230,000 volt transmission lines associated with this project will be approximately $75,000 per mile. Since the two 230,000 volt lines required at the Pinckard Substation will be a total of 60 miles long, the premium for underground construction, if it were technically possible, would be at least 40.5 million dollars. A decision was, therefore, made to construct overhead transmission lines because no benefit could be determined which would justify the large cost associated with underground transmission.

The transmission line routes selected between the Farley Plant and Pinckard Substation are based on studies which were begun early in 1970, using aerial maps and other geographical data. The routes selected were judged superior to alternate routes considered because, (1) they traverse agricultural land and will not greatly affect land use, (2) they traverse relatively sparsely inhabited areas and are not generally close to urban areas, (3) they are essentially straight line routes and therefore, involve use of a minimal amount of land. One of the alternate routes was rejected in part because of its proximity to the Dothan airport (Napier Field).

The route for the 500,000 volt transmission line which will connect the Farley Plant to Montgomery has not yet been determined, but route selection will be based on criteria which were used in selecting the 230,000 volt lines. A route entailing the least environmental impact consistant with reasonable economic considerations will be selected.

F. Alternative Transportation Methods

The Joseph M. Farley Plant site was originally evaluated for either nuclear fueled or fossil fueled units. Consequently, it was considered essential for this site to have easy access to transportation facilities capable of handling heavy shipments and large quantities of fossil fuel, if necessary.

The site selected provides the alternative of using the Chattahoochee River for barge transportation of the reactors and other heavy plant equipment items. Use of barges to transport this equipment has been selected, not only for economic reasons, but also because overland transportation of these items would require extensive rebuilding or strengthening of numerous highway or railroad bridges. This work and shipment of the equipment over land would be disruptive to the normal flow of transportation and would create more environmental impact than will barge transportation.

Access to railroad transportation will provide a desirable alternative for shipping construction materials to the plant site and for shipping spent fuel after the plant is in operation. The construction and use of the five-mile-long railroad which connects the plant to the Central of Georgia Railroad at Columbia, Alabama is not essential to either the plant's construction or operation but is desirable for two major reasons. Construction of the plant can be accomplished with less cost by building and using the railroad for transportation of heavy construction equipment and bulk materials which will remove a considerable amount of heavy truck traffic from Highway 95. Also, it provides the desirable alternative of enabling shipment of radioactive spent fuel from the plant to be made in special railroad cars rather than by truck.

There were three alternative railroad route considered before the route northward to the Central of Georgia Railroad was selected. One alternate route would have connected the plant with the Seaboard Coast Line Railroad southwest of Gordon, Alabama. This route was not chosen because it was longer than the route to the Central of Georgia Railroad and involved more difficult and costly stream crossings.

The second alternative involved connecting the plant site with the Chattahoochee Valley Industrial Railroad which runs along the east side of the Chattahoochee River in Georgia. This route would have involved construction of a bridge over the Chattahoochee River which would have been expensive because of the necessity of providing vertical clearance for barge traffic. Other further disadvantages involved the necessity of building long bridge abutments and their potential for affecting hydraulic characteristics of the river during periods of high flow.

It was apparent that the route selected, which connects the plant site to the Central of Georgia Railroad at Columbia, Alabama, offered clear advantages over the other alternatives since it was shorter, involved less expensive bridges and was judged to have the least environmental impact on the area.

G. Water Storage Ponds

There was only one feasible alternative to the construction of a cooling pond to supply a sufficient quantity of cooling water to accommodate plant operational and emergency requirements. This alternative involved using well-water. It was rejected because of the difficulty or impossibility of developing a dependable well-water system which would meet the stringent requirements of the Atomic Energy Commission.

Alternative locations for the cooling water pond were considered. The most promising were either the impoundment of

Rock Creek or the excavation of a deep basin on the river bank in the flood plain. The impoundment of Rock Creek was rejected because it would have flooded Highway 95 and produced other undesirable effects by the flooding of a larger area both on and off the site. The excavation of a basin into the flood plain was not selected because of undesirable effects in the event of a flood and the difficulties resulting from permeability and instability of the alluvial materials in the flood plain. The location selected was the most desirable because it presented the least environmental impact on the area and presented the fewest apparent problems related to construction and land use. A portion of the area selected was previously used as a farm pond and will continue to be a desirable source of water for wildlife in the area.

H. Heat Dissipation

Evaporative cooling towers have been chosen as the best method available for protecting the waters of the Chattahoochee River from adverse thermal effects which might otherwise result from plant operation. There were four basic alternatives considered for handling the condenser cooling water. In addition to the evaporative cooling tower method selected, a once-through cooling system could have been employed, whereby water from the Chattahoochee River would have passed through the condensers and returned to the river at a higher temperature. A third method would have been the use of either a closed or open cycle cooling pond, with the warm water from the condensers passing into the pond, being cooled by evaporation, convection and radiation, and then either being reused for condenser cooling or discharged at a lower temperature to the river. A fourth possibility would have been the use of "dry" cooling towers which would have utilized air to cool the condenser cooling water in heat exchangers.

Studies showed conclusively that the once-through method would have periodically caused water temperature in the Chattahoochee River to become higher than is allowed by applicable water quality standards. A closed-cycle cooling pond system would have involved dedication of over 3,000 acres for the cooling pond for Unit No. 1 alone. This method was rejected because of problems resulting from terrain, road relocation and land availability and usage, and other considerations which made construction of such a cooling pond impractical. An "open-type" cooling pond was considered, but it was determined that more than 2,000 acres would have been necessary to provide adequate cooling water for Unit No. 1 alone. This method also was considered impractical for essentially the same reasons as the closed-type cooling pond. The other alternative, use of dry-type cooling towers, has not been found technically feasible for generating plants of the size of the Farley Nuclear Plant and was, therefore, rejected.

On the basis of these considerations, the evaporative cooling tower method of providing condenser cooling water was selected as the best alternative. The mechanical-draft evaporative cooling towers were selected in preference to the natural draft type because of economic considerations resulting from their suitability for use under meteorological conditions in the area. The use of these towers will protect water quality of the Chattahoochee River, require minimum land use, and have minimal impact on the environment.

As an alternative to the cooling tower system selected, it would be possible to add a cooling tower to the blowdown to obtain further cooling of the water being discharged to the Chattahoochee River. The addition of such a tower was not considered necessary, however, because with the design approach of 11°F. and the wet bulb temperatures which have been recorded in the Dothan area, the temperature of the discharge is expected to approach closely the water temperatures which have been recorded in the Chattahoochee River. Because the volume of water being discharge is small in relation to the flow in the river (less than 5% of minimum average daily flow), any small difference in temperature which may occur from time to time between the blowdown and the river will have very little effect on river temperature.

I. Alternative Chemical Discharges

The alternatives available relating to chemical discharges from the Joseph M. Farley Plant involve the selection of a method for keeping the cooling tower-condenser system free of water-borne and air-borne microorganisms. The use of chlorine has been selected as the most desirable alternative.

Use of alternate oxidizing chemicals, such as hypochlorites, was rejected because they provided no advantages to justify their higher cost.

Other alternatives involved use of non-oxidizing chemicals such as chromates, copper salts and other similar chemical compounds. Use of these materials was not considered an acceptable alternative because of their toxicity which renders them unsuitable for use in a large cooling tower system, such as that of the Joseph M. Farley Plant.

The use of mechanical methods of controlling biological growths will not eliminate the need for chemical control in parts of the system and will not affect concentration of the chemicals in the blowdown.

J. Alternatives to Fish Screen Design

Two alternative designs were considered for the intake of the Joseph M. Farley Plant. The first design would have resulted in flow velocities across the screen of up to 1.5 fps, but it was rejected and a second alternate design was selected which will result in maximum velocities of approximately 1.0 fps across the screen and 0.3 fps in the canal. The design selected will result in an additional cost for the intake of about $100,000, but the benefits which it affords in added protection to fish species is considered to justify the extra cost.

K. Conclusions

We submit that careful consideration of the basis from which decisions are made in planning for, designing and constructing the Joseph M. Farley Nuclear Plant will assure that every feasible action is being taken to minimize the effects of the plant on the environment. Many of the decisions made, such as those to use cooling towers, an improved radwaste system and related safety features, and to provide a large exclusion area, will materially reduce the environmental effects of the plant's operation. These decisions, in many cases, were made because of a stated policy to minimize the environmental impact of the plant rather than as a result of cost-benefit analysis.

7.0 Relationship Between Short-Term Environmental Usage and Long-Term Productivity of the Environment

The construction and operation of the Joseph M. Farley Nuclear Plant will bring about certain changes in the environment of the area in which it is located. These changes have been described and evaluated in detail throughout this Supplement to the Environmental Report, and in general, the conclusions have indicated that the environmental effects of the plant will not be deleterious to the area.

The construction of the plant will change the use of some land from agriculture and forestry, and dedicate it to industrial use and a managed wildlife preserve. The amount of land involved is relatively small, and the change will produce some positive environmental benefits to wildlife on a large portion of the site.

The use of information derived from the biological, chemical and radiological background studies identified earlier in this report, and those to be conducted during the operation of the plant should benefit the long-term productivity of the area.

The impact on the natural environment produced by the Farley Plant will be much less than that caused in the past by the conversion of land from wilderness to agricultural use. In any event, the change in land use anticipated will be short-term and is not expected to adversely affect the long-term productivity of the area. In the short-term, the production of a large quantity of electric power during the life of the plant will be a more productive utilization of this land.

There is nothing about the construction and operation of this plant to preclude the area's return to use for agriculture or forestry in future years, if needed, nor will the plant affect the existing short-term or long-term productivity of the aquatic environment of the Chattahoochee River to any important extent. Likewise, sub-surface conditions, including the groundwater resources, will not be affected.

The railroad which has been constructed and runs northward from the Farley Plant site to the Central of Georgia Railroad at Columbia, Alabama, is a principal off-site facility which may affect short-term productivity in the area. The railroad makes the development of industrial facilities along its route more feasible, if such developments prove to be acceptable and not detrimental to the environment. In the short-term, the railroad will be likely to increase the productivity of the area, but in the long-term, it is not expected to preclude any needed changes in land use.

Another principal off-site facility associated with the Joseph M. Farley Plant is the transmission system which will be constructed to deliver electric power to load centers where needed. The transmission rights-of-way which are used by this system will cause very little change in the short-term productivity of the lands which they occupy and no change at all in the long-term productivity of the land or other elements of the environment.

In summary, since the Farley Plant and its associated off-site facilities can be almost entirely removed at the end of plant life, or sooner, if justified, the short-term use of the environment for the production of electric power does not in any way restrict or preclude long-term uses or productivity of the environment for other purposes.

8.0 Irreversible and Irretrievable Commitments of Resources

The useful life of nuclear power units of the Joseph M. Farley Plant type is expected to be approximately 40 years, or until improved energy systems warrant replacement for economic or other reasons. Since it is conceivable that the facility could be almost entirely dismantled, there are no absolutely irreversible and irretrievable commitments of land resources in the long-term. Agricultural usage of the area surrounding the site, and within the site if needed, can continue unimpaired. Wildlife can continue to exist in the area without interference and under improved conditions due to the water storage pond and the added protection afforded by the wildlife preserve.

Except for part of the materials of construction and the Uranium-235 fissioned in the uranium dioxide fuel, there are no irreversible and irretrievable commitments of raw material resources. The depletion of Uranium-235 is, of course, partially offset by the production of fissile plutonium and other nuclides of potential value.

Other important resources necessary for the operation of the Farley Plant include river water for cooling system make-up, groundwater for potable usage and fire protection, and the atmosphere to effect evaporative cooling. None of these resources will be irreversibly or irretrievably changed in the long-term. At the end of plant operating life, these resources can return to their present state barring other changes not associated with the Farley Plant.

This report has described in detail the relationship of the Farley Plant and its facilities to the environment and has identified the commitment of all resources. It is the opinion of Alabama Power Company that the benefits to be derived from resource commitments at the Joseph M. Farley Plant clearly justify their use.

APPENDIX A-ENVIRONMENTAL BENEFIT-COST ANALYSIS

Introduction

This analysis has been prepared in accordance with the PROPOSED AEC GUIDE TO THE PREPARATION OF BENEFIT-COST ANALYSES TO BE INCLUDED IN APPLICANTS' ENVIRONMENTAL REPORTS (FOR DEFINED CLASSES OF COMPLETED AND PARTIALLY COMPLETED NUCLEAR FACILITIES) of January 7, 1972.

The benefits and cost associated with the Joseph M. Farley Nuclear Plant have been evaluated for three of the alternative plant designs specified in the AEC Guidelines; Alternatives 1, 2 and 4. Alternative 3, that design which would have minimum impact on land/air, has not been evaluated for the reasons stated in Attachment I of this analysis. Alternatives 1 and 4, the plant design as is and that design for which licensing is requested, are the same design. Alternative 2, that design which would have minimum impact on water, is evaluated on the basis of utilizing dry type cooling towers. The use of natural draft wet cooling towers was not evaluated as explained in Attachment J.

The only alternative subsystem considered in this analysis is the alternative cooling system utilizing dry type cooling towers. The radwaste subsystem releases comply with proposed Appendix I limits (Attachment K - Section 8). Releases from the chemical effluent subsystem are evaluated for the plant as is. There is virtually no environmental impact associated with these discharges. Accordingly, no alternative has been considered for this subsystem.

Alternatives 1 and 4 are the same plant design. The environmental benefits to be gained from the installation of dry type cooling towers are small in relation to the increased cost (capital and operating) associated with the dry-type system. Though sufficient design information is not available for a complete analysis, the dry type cooling towers would eliminate environmental impacts on water and air. However, the immensity of the tower(s) would have a definite impact on the land.

Lost generation and capacity associated with the dry type towers would necessitate increased operation of fossil-fuel plants thus creating additional emission of air pollutants.

In view of the minimal environmental impact associated with the present design of the Joseph M. Farley Nuclear Plant and the questionable environmental benefits to be obtained from dry type cooling towers, alternative designs 1 and 4 are considered to be the same.

FORM AEC-
(1/7/72)

BENEFIT DESCRIPTION OF ALTERNATIVE PLANT DESIGNS

(All monetized benefits expressed in terms of present value)

1. NAME OF FACILITY:

Joseph M. Farley Nuclear Plant
Units No. 1 and No. 2

2. DATE OF REPORT

Note: The letters in parentheses on this tabulation refer to attachments dealing with the evaluation of benefits.

BENEFITS[1,2,3]			ALTERNATIVES 1: Plant As Is	2: Minimum Water Impact	3: Minimum Land/Air Impact	4: Plant License Request
Electric Power Produced and Sold:	Industrial	Annual Energy (Millions of Kwh)	4539.15 (A)	4309.64 (A)		4539.15 (A)
	Commercial	" " "	1824.90 (A)	1732.63 (A)		1824.90 (A)
	Residential	" " "	3407.25 (A)	3234.97 (A)		3407.25 (A)
	Other Uses	" " "	1778.70 (A)	1688.76 (A)		1778.70 (A)
Reliability Index			(B)	(B)		(B)
Process Steam Sold			NONE	NONE		NONE
Environmental Enhancement:	Recreation	Present Worth $	404,486.00 (C)	404,486.00 (C)		404,486.00 (C)
	Navigation		NONE	NONE		NONE
	Air Quality: SO_2	lb/yr	$91.0(10^6)$ (D)	$86.4(10^6)$ (D)		$91.0(10^6)$ (D)
	NO_x	lb/yr	$53.0(10^6)$ (D)	$50.3(10^6)$ (D)		$53.0(10^6)$ (D)
	Particulates	lb/yr	$15.2(10^6)$ (D)	$14.4(10^6)$ (D)		$15.2(10^6)$ (D)
	Others		NONE	NONE		NONE
Education			(C)	SAME		SAME
Research			NONE	NONE		NONE
Regional Gross Product			(E)	(E)		(E)
Local Taxes	Present Worth During Life of Plant		25,015,600 (F)	25,054,500 (F)		25,015,60 (F)
Employment			125 people	SAME		SAME
Other Benefits			(G)	(G)		(G)

[1] Where a item is not relevant to a particular alternative, insert n.a. for not applicable.
[2] See Section III.A. of the guideline for suggested units of measure of benefits. Applicants should specify the units they use on the form.
[3] Where benefits are the same for each alternative, put same in columns 2, 3 and 4.

ATTACHMENT A - BENEFITS OF POWER

It is impractical to determine the future monetary benefits of power to be generated by the Joseph M. Farley Nuclear Plant Units #1 and #2, based on the present value of what users will pay for this power. This power will flow through the interconnected transmission network and distribution systems of the company to its industrial, commercial, residential, municipal, rural electric cooperatives, and other customers. This system is, of course, supplied by power from all of the company's generating plants - old and new - and the selling price of power to customers is dependent on the composite capital investment, fuel and operating costs of all of the generating plants, transmission and distribution systems and other operating and maintenance costs. Alabama Power Company's electric power rates are subject to regulation by the Alabama Public Service Commission and the Federal Power Commission. The future power rates of the company will depend on so many variable and unpredictable factors that it is impractical at this time to predict, with any reasonable assurance, what the selling price of power will be during the life of the Joseph M. Farley Nuclear Plant.

In the draft Guide to the Preparation of Benefit-Cost Analyses for Nuclear Power Plants, dated January 7, 1972, an alternative to supplying the estimated monetary benefits of the power to be generated is suggested. This is to report the expected annual production in kilowatt-hours. This information was developed as follows:

FOR ALTERNATES NO. 1 and NO. 4

ESTIMATED ANNUAL ENERGY GENERATION FROM THE FARLEY NUCLEAR PLANT

FROM EACH OF TWO UNITS IN MILLIONS OF KILOWATT-HOURS

		Plant Factor
1st Year of Operation:	Approx. 5225 M Kwh	73.9%
2nd Year of Operation:	Approx. 5950 M Kwh	80.4%
3rd Year of Operation:	Approx. 6200 M Kwh	83.9%

NOTE: These production figures are based on the plant being available for base load operation at all times except during an estimated 5 weeks per year refueling and maintenance period and during the following estimated forced outage periods.

$$\% \text{ Forced Outage Hours} = \frac{\text{Forced Outage Hours}}{\text{Service Hours} + \text{Forced Outage Hours}} \times 100$$

1st Year	18.2%
2nd Year	11.0%
Mature Rate	7.3%

After the second year, it is expected to operate each of these units at or near 6200 MKwh per year until such time in the future that the plant is no longer base loaded to its full capability. It has also been estimated that the annual production from this plant over its estimated 30 year useful life will be at a levelized plant factor of 78.1%. This amounts to an annual production from each unit of 5775 million kilowatt hours or a total levelized annual production for the two units of 11,550 million kilowatt hours.

The following tabulation shows the estimated levelized annual generation in millions of kilowatt hours by classes of customers served.

Class of Customers	% of Total (1)	Levelized Annual Generation (M Kwh)
Industrial	39.3	4,539.15
Commercial	15.8	1,824.90
Residential	29.5	3,407.25
Other Uses (2)	15.4	1,778.70
Total	100.0	11,550.00

(1) Based on expected percentages in 1976.

(2) Includes sales to municipal systems, REA Co-op Systems, street lighting systems, company uses, and system losses.

For reasons mentioned previously, it is impractical to estimate the future selling price of power over the life of this plant. Due to the rising costs of providing facilities to generate, transmit and distribute electric power, and increases in fuel and cost of operating a power system, the future selling price of power will undoubtedly be considerably higher than today's price.

The very <u>minimum</u> monetary benefit to be expected from the power generated by the Farley Plant during its life could be based on the present average selling price of power by Alabama Power Company. During the past 12 months this average price amounted to approximately 1.3 cents per kilowatt hour.

The present worth of future power, based on today's selling price would amount to the levelized annual production in KWH times 1.3 cents per KWH times the present worth factor for a uniform annual series at the appropriate rate of interest (10.4%) for 30 years (9.118). This amounts to a present worth value of $1,369,100,000.

FOR ALTERNATE NO. 2
(Dry Cooling Towers)

The following data used to determine the loss in energy production using a dry cooling tower as compared to a wet cooling tower, as in Alternates No. 1 and No. 4, was obtained from the draft of a report, "Cost Comparison of Dry Type and Conventional Cooling Systems for Representative Nuclear Generating Plants", by John P. Rossie, Edward A. Cecil and Rodger O. Young of R. W. Beck and Associates, Denver, Colorado. This report was prepared for the Division of Reactor Development and Technology, U. S. Atomic Energy Commission, Contract No. AT(04-3)-848, dated December 1971.

The data in this report for a plant located in the Southeastern United States using conventional forced draft wet cooling towers consisted of design and cost information for the Farley Nuclear Plant, and was supplied to R. W. Beck and Associates by Alabama Power Company.

The loss of energy with dry cooling towers as compared to wet towers is estimated as follows, based on a levelized plant factor of 78.1% during the estimated 30 year life of the plant:

Loss due to lower thermal efficiency of plant using a dry system	179 Million KWH
Extra energy required to operate a dry cooling tower system	113 " "
Total loss of energy with dry system	292 Million KWH

Levelized annual production for 1 unit:

Wet system	5775 Million KWH
Loss with dry system	-292 " "
Available with dry system	5483 Million KWH

For two units the levelized annual energy would amount to 10,966 million KWH. The following tabulation shows the estimated levelized annual generation in millions of kilowatt hours by classes of customers served.

Class of Customers	% of Total (1)	Levelized Annual Generation (M Kwh)
Industrial	39.3	4,309.64
Commercial	15.8	1,732.63
Residential	29.5	3,234.97
Other Uses (2)	15.4	1,688.76
Total	100.0	10,966.00

(1) Based on expected percentages in 1976.

(2) Includes sales to municipal systems, REA Co-op Systems, street lighting systems, company uses, and system losses.

The present worth of future power generated with a dry cooling system based on today's selling price (1.3 cents per KWH) would amount to $1,299,800,000.

Loss of Capacity

A dry type cooling system would also reduce the generating capability of the plant as compared to a wet cooling system during hot weather. This loss of capacity would amount to 96,100 KW during approximately 10 hours per year, with lesser reductions for longer periods of time. Since Alabama Power Company's system peak load occurs in the summer months, this loss of capacity is very significant.

If a dry cooling system were to be installed, the loss of generating capacity due to its use could be replaced either by the purchase of additional capacity from neighboring utility systems, if available, or by the installation of a like amount of additional generating capacity by Alabama Power Company.

If replaced by the least expensive form of peaking capacity (from the standpoint of capital cost), such as combustion turbines, the additional capital investment would amount to approximately $10,000,000.

ATTACHMENT B - RELIABILITY INDEX OF THE PLANT

Experience in actual operation is the true measure of the reliability of a generating plant. However, in planning the amount of generation needed to supply the expected load during a future year, various methods of simulating the operation of a power system are used. One such method involves calculating the probability that the expected total system load will exceed the available generation during a particular future year. This is done by comparing the availability of system generation during the year with the expected varying pattern of system load during that year. To make such a study, the expected forced outage rates of all generating units as well as the expected down-time for maintenance and refueling must be estimated.

In making system studies of this kind, the following forced outage rates were estimated for the Joseph M. Farley Nuclear Plant Units #1 and #2. This is an index of the expected reliability of the plant.

1st Year of Operation	18.2%
2nd Year of Operation	11.0%
Mature Outage Rate	7.3%

Definition of Forced Outage Rate:

$$\% \text{ Forced Outage Hours} = \frac{\text{Forced Outage Hours}}{\text{Service Hours} + \text{Forced Outage Hours}} \times 100$$

ATTACHMENT C - ENHANCEMENT FROM RECREATION AND EDUCATION BENEFITS

Based on experience at visitors' centers at other Nuclear plants, and on the experience of the temporary information center in downtown Dothan for the Joseph M. Farley plant, it is predicted that approximately 32,000 visitors per year will visit the permanent center to be located at the plant site. Assuming a value of \$1.40 (1) per recreation day, the annual value of these visits is computed to be \$44,800. The present worth of this benefit would be \$408,486.00 on a present worth basis over the 30 year life of the plant.

The visits to the temporary Nuclear Information Center for the Farley Plant have been especially popular for school and college groups, and it is reasonable to credit substantial, though unquantified, educational value to the Visitors' Center program.

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(1) Quoted from "A Study by the N. C. Forest Service Board; Based on Supplement No. 1 to Senate Document No. 97"

ATTACHMENT D - ENVIRONMENTAL ENHANCEMENT FROM REDUCTIONS IN AIR POLLUTION IF GENERATING CAPABILITY IS PROVIDED THROUGH FOSSIL FUEL

EVAPORATIVE COOLING TOWERS - ALTERNATIVES 1 and 4

A coal-fueled plant of 1,000 MW capacity will consume $2.3(10^6)$ tons of coal per year at 100% load factor. The two unit capacity at Farley will be 1,688 MW. The equivalent coal poundage per year will be $7.63(10^9)$ lb/yr.

Assuming 12,500 BTU/lb coal and utilizing the new source standards with an assumed actual load factor of 0.795, the yearly weight of emissions would be:

$9.55(10^{13}) \times 1.2 \text{ lb } SO_2/10^6 \text{ BTU} \times .795 = 91.0(10^6) \text{ lb } SO_2/\text{Yr}$

$9.55(10^{13}) \times 0.2 \text{ lb Part}/10^6 \text{ BTU} \times .795 = 15.2(10^6) \text{ lb Part/Yr}$

$9.55(10^{13}) \times 0.7 \text{ lb } NO_x/10^6 \text{ BTU} \times .795 = 53.0(10^6) \text{ lb } NO_x/\text{Yr}$

DRY TYPE COOLING TOWERS - ALTERNATIVE 2

The reduction of generation through the use of dry type cooling towers would also decrease the environmental enhancement from reduction in Air Pollution.
MKWH generation with evaporative cooling towers - 11,550
MKWH generation with dry cooling towers - 10,966

The annual loss of 584 MKWH would have to be generated from another source within Alabama Power Company or purchased from others. The least capital investment to replace the 96.1 MW capacity loss is a combustion turbine (See Attachment A). However, to utilize such a facility for producing the lost energy is not economically feasible. A coal-fired unit would be utilized to provide the energy lost due to the dry type cooling towers. This would produce the following quantities of emissions:

$584/11550 = 0.05$

$0.05 \times 91.0(10^6) \text{ lb } SO_2/\text{Yr} = 4.6(10^6) \text{ lb } SO_2/\text{Yr}$

$0.05 \times 15.2(10^6) \text{ lb Part/Yr} = 0.8(10^6) \text{ lb Part/Yr}$

$0.05 \times 53.0(10^6) \text{ lb } NO_x/\text{Yr} = 2.7(10^6) \text{ lb } NO_x/\text{Yr}$

If dry type cooling towers are utilized, the environmental enhancement benefits would be reduced by the above quantities.

ATTACHMENT E - REGIONAL GROSS PRODUCT

The economic impact of the Joseph M. Farley Nuclear Plant will be two-fold. During the construction period, the direct payroll and material purchases will have a regional impact of approximately $200 million. In addition to this, there will be considerable impact on employment and income in service industries as well as wholesale and retail trade. The long-term impact will include the annual payroll of $1.4 million, increased ad valorem tax enabling Houston County to obtain more federal grants-in-aid, and increased potential for future residential and industrial growth.

Preferred stock amounts to approximately 11% of capital structure of Alabama Power Company.

Estimated annual levelized franchise tax:

$501,316,000 x .11 x .7462 x .003 = $123,447

Present worth of estimated franchise tax over 30 year plant life:

9.118 x $123,447 = $1,125,600

Present worth of local taxes (ad valorem and franchise) over life of plant:

Ad Valorem	$23,890,000
Franchise	1,125,600
	$25,015,600

Local Taxes for Alternate No. 2

Estimated present worth of county and state ad valorem taxes and state franchise tax over an estimated 30 year life of the plant:

Total estimated capital cost of Units #1 and #2 - $518,634,000

Estimated cost of Units #1 and #2, excluding pollution control equipment which is not subject to ad valorem tax - $468,000,000

Equivalent annual depreciated plant:

$$= \frac{\text{Capital Recovery Factor - Straight Line Depreciation Rate}}{\text{Required Rate of Return}}$$

Capital Recovery Factor = Sinking Fund Depreciation Factor plus Rate of Return

For 30 year life type R_5 Retirement Dispersion

Sinking Fund Depreciation Factor	= 0.69%
Straight Line Depreciation Rate	= 3.33%
Required Rate of Return	= 10.4 %

$$\text{Equivalent Annual Depreciation Plant} = \frac{10.4\% + 0.69\% - 3.33\%}{10.4\%} = .7462$$

1. Estimated Ad Valorem Taxes:

Combined tax rate for State of Alabama and Houston County:

$2.50 per year per $100 of assessed value (or .025).

Assessment Ratio: 30%

Estimated annual levelized ad valorem taxes:

$468,000,000 x .7462 x .025 x .30 = $2,620,000

ATTACHMENT F - LOCAL TAXES

Local Taxes for Alternates No. 1 and No. 4

Estimated present worth of county and state ad valorem taxes and state franchise tax over an estimated 30 year life of the plant:

Total estimated capital cost of Units #1 and #2 - $501,316,000

Estimated cost of Units #1 and #2, excluding pollution control equipment which is not subject to ad valorem tax - 468,000,000

Equivalent annual depreciated plant:

$$= \frac{\text{Capital Recovery Factor - Straight Line Depreciation Rate}}{\text{Required Rate of Return}}$$

Capital Recovery Factor = Sinking Fund Depreciation Factor plus Rate of Return

For 30 year life type R_5 Retirement Dispersion

Sinking Fund Depreciation Factor	=	0.69%
Straight Line Depreciation Rate	=	3.33%
Required Rate of Return	=	10.4 %

$$\text{Equivalent Annual Depreciation Plant} = \frac{10.4\% + 0.69\% - 3.33\%}{10.4\%} = .7462$$

1. Estimated Ad Valorem Taxes:

Combined tax rate for State of Alabama and Houston County:

$2.50 per year per $100 as assessed value (or .025).

Assessment Ratio: 30%

Estimated annual levelized ad valorem taxes:

$468,000,000 x .7462 x .025 x .30 = $2,620,000

Present worth of estimated ad valorem taxes over 30 year plant life:

P.W. Factor for a uniform annual series at 10.4% return or investment: 9.118

9.118 x $2,620,000 = $23,890,000 - The present worth of ad valorem taxes

2. Estimated State Franchise Tax: Payable annually, based on shares of preferred stock outstanding.

Present Rate: $3.00 per $1,000 book value of preferred stock (or .003).

Present worth of estimated ad valorem taxes over 30 year plant life:

P.W. Factor for a uniform annual series at 10.4% return on investment: 9.118

9.118 x $2,620,000 = $23,890,000 - The present worth of ad valorem taxes

2. Estimated State Franchise Tax: Payable annually, based on shares of preferred stock outstanding.

Present Rate: $3.00 per $1,000 book value of preferred stock (or .003).

Preferred stock amounts to approximately 11% of capital structure of Alabama Power Company.

Estimated annual levelized franchise tax:

$518,634,000 x .11 x .7462 x .003 = $127,712

Present worth of estimated franchise tax over 30 year plant life:

9.118 x $127,712 = $1,164,500

Present worth of local taxes (ad valorem and franchise) over life of plant:

Ad Valorem	$23,890,000
Franchise	1,164,500
Total	$25,054,500

ATTACHMENT G - OTHER BENEFITS OF POWER

Power generated at the Joseph M. Farley Nuclear Plant will be used to supply a portion of the electric power that is essential to the operation of many facilities related to the health and welfare of citizens within its service area. As of December 31, 1970, Alabama Power Company was supplying power directly to 180 hospitals, 336 food processing plants, 66 cold storage warehouses, 214 water filter plants and pumping stations, and 76 sewage disposal plants. In addition to the above facilities served directly, Alabama Power Company also supplies part or all of the power distributed by 14 municipal electric systems and 13 rural electric cooperative systems who, in turn, supply many similar health related establishments.

One of the very beneficial uses of power to be generated by the Farley Nuclear Plant will be the power needed to operate new air pollution control devicies in the industrial plants of Alabama. It is too early to measure the full impact of the new air pollution control regulations in terms of electric power requirements; however, the need for this additional power will be very considerable.

FORM AEC- (1/7/72)

COST DESCRIPTION OF ALTERNATIVE PLANT DESIGNS

(All monetized benefits expressed in terms of present value)

1. NAME OF FACILITY

Joseph M. Farley Nuclear Plant
Units No. 1 and No. 2

2. DATE OF REPORT

Note: The letters in parentheses on this tabulation refer to attached documentation.

		ALTERNATIVES 1 Plant As Is	2 Minimum Water Impact	3 Minimum Land/Air Impact	4 Plant License Request
SUBSYSTEMS					
	Alternative Cooling Systems (I)	A[4]	B	(I)	A
	Alternative Rad Waste Systems (II)	A			A
	Alternative Chemical Effluent Systems (III)	A			A
	Alternative ______ System (IV)	A			
	Alternative ______ System (V)	A			
GENERATING COSTS	Capital cost of the plant plus present worth of fuel and operating costs during life of plant in $	868,812,000 (H)	886,130,000 (H)		868,812,000 (H)
ENVIRONMENTAL COSTS[1+2+3]					
Primary Impact	Population or Resource Affected				
1. Heat Discharged to Water Body	1.1 Cooling Capacity	8.9(10^6) BTU/HR	NA		8.9(10^6) BTU/HR
	1.2 Aquatic Biota	No Effect	NA		No Effect
	1.3 Migratory Fish	NA	NA		NA
2. Effects on Water Body of Intake Structure and Condenser Cooling Systems	2.1 Primary Producers and Consumers	8.0(10^6) lb/Yr	NA		8.0(10^6) lb/Yr
	2.2 Fisheries	4,500 lb/Yr	NA		4500 lb/Yr
3. Chemical Discharge to Water Body	3.1 People	No Effect	No Effect		No Effect
	3.2 Aquatic Biota	No Effect	No Effect		No Effect
	3.3 Water Quality–Chemical	No Effect	No Effect		No Effect
4. Consumption of Water	4.1 People	NA	NA		NA
	4.2 Property	See Sup. Form I	NA		See Sup. Form I
5. Chemical Discharge to Ambient Air	5.1 Air Quality-Chemical	NA	NA		NA
	5.2 Air Quality–Odor	No Effect	NA		No Effect

[1] Where a row is not relevant to a particular alternative insert n.a. for not applicable.
[2] See Table 3 for units of measure and methods of computation, units should be specified by the applicant on the form.
[3] Where items are the same for each alternative, put same in columns 2, 3 and 4.
[4] A refers to alternative in the Supplementary Forms.

6. Salts Discharged from Cooling Towers	6.1 People	No Effect	NA		No Effect
	6.2 Plants	No Effect	NA		No Effect
	6.3 Property Resources	NA	NA		NA
7. Chemical Contamination of Ground Water (excluding Salt)	7.1 People	NA	NA		NA
	7.2 Plants	NA	NA		NA
8. Radionuclides Discharged to Water Body	8.1 People–External Contact	(8)	(8)		(8)
	8.2 People–Ingestion rads	$1.8(10^{-3})$ 5 man rads/Yr	Same		Same
	8.3 Primary Consumers	(8)	(8)		(8)
	8.4 Fish	(8)	(8)		(8)
9. Radionuclides Discharged to Ambient Air	9.1 People–External Contact rads	$11(10^{-3})$ (8)	Same		Same
	9.2 People–Ingestion rads	$10(10^{-3})$ (8)	Same		Same
	9.3 Plants and Animals	(8)	(8)		(8)
10. Radionuclide Contamination of Ground Water	10.1 People	No Effect	No Effect		No Effect
	10.2 Plants and Animals	No Effect	No Effect		No Effect
11. Fogging and Icing	11.1 Ground Transportation	Negligible	NA		Negligible
	11.2 Air Transportation	NA	NA		NA
	11.3 Water Transportation	Negligible	NA		Negligible
	11.4 Plants	NA	NA		NA
12. Raising/Lowering of Ground Water Levels	12.1 People	No Effect	No Effect		No Effect
	12.2 Plants	No Effect	No Effect		No Effect
13. Ambient Noise	13.1 People	No Effect	No Effect		No Effect
14. Aesthetics	14.1 Appearance	NA	NA		NA
15. Permanent Residuals of Construction Activity	15.1 Accessibility of Historical Sites	NA	NA		NA
	15.2 Accessibility of Archeological Sites	NA	NA		NA
	15.3 Setting of Historical Sites	NA	NA		NA
	15.4 Land Use	NA	NA		NA
	15.5 Property	15.5	15.5		15.5
	15.6 Flood Control	NA	NA		NA
	15.7 Erosion Control	No Effect	No Effect		No Effect

COMMENTS

AEC FORM-
(1/7/73)

SUPPLEMENTARY FORM – 1

COST DESCRIPTION – ALTERNATIVE COOLING SYSTEMS

(Include Associated Coolant Water Treatment Systems)

1. NAME OF FACILITY
Joseph M. Farley Nuclear Plant

Units No. 1 and No. 2

2. DATE OF REPORT

NOTE: Numbers in parenthesis on this tabulation refer to attached documentation

		ALTERNATIVES A	B	C	D	E	F
INCREMENTAL GENERATING COST			(H)	(I)	(J)		
ENVIRONMENTAL COSTS[1,2]							
Primary Impact	Population or Resource Affected						
1. Heat Discharged to Water Body	1.1 Cooling Capacity BTU/HR	8.9(10^6) (1.1)	NA				
	1.2 Aquatic Biota	No Effect (1.2)	NA				
	1.3 Migratory Fish	NA	NA				
2. Effects on Water Body of Intake Structure and Condenser Cooling System	2.1 Primary Producers & Consumers lb/yr	8.0(10^6) (2.1)	NA				
	2.2 Fisheries lb/yr	4500 (2.2)	NA				
3. Chemical Discharge to Water Body	3.1 People	No Effect (3)	NA				
	3.2 Aquatic Biota	No Effect (3)	NA				
	3.3 Water Quality–Chemical	No Effect (3)	NA				
4. Consumption of Water	4.1 People	NA	NA				
	4.2 Property	(4.2)	NA				
5. Chemical Discharge to Ambient Air	5.1 Air Quality–Chemical	NA	NA				
	5.2 Air Quality–Odor	No Effect (5.2)	NA				
6. Salts Discharged from Cooling Towers	6.1 People	No Effect (6)	NA				
	6.2 Plants	No Effect (6)	NA				
	6.3 Property Resources	NA	NA				
7. Chemical Contamination of Ground Water (excluding Salt)	7.1 People	NA	NA				
	7.2 Plants	NA	NA				
8. Radionuclides Discharged to Water Body	8.1 People–External Contact	NA	NA				

[1] Where a row is not relevant to a particular alternative, insert n.a. for not applicable.
[2] See Table 3 for units of measure and methods of computation.

	8.2 People–Ingestion	NA	NA				
	8.3 Primary Consumers	NA	NA				
	8.4 Fish	NA	NA				
9. Radionuclides Discharged to Ambient Air	9.1 People–External Contact	NA	NA				
	9.2 People–Ingestion	NA	NA				
	9.3 Plants and Animals	NA	NA				
10. Radionuclide Contamination of Ground Water	10.1 People	NA	NA				
	10.2 Plants and Animals	NA	NA				
11. Fogging and Icing	11.1 Ground Transportation	Negligible (11)	NA				
	11.2 Air Transportation	NA	NA				
	11.3 Water Transportation	Negligible (11)	NA				
	11.4 Plants	NA	NA				
12. Raising/Lowering of Ground Water Levels	12.1 People	NA	NA				
	12.2 Plants	NA	NA				
13. Ambient Noise	13.1 People	No Effect (13)	No Effect				
14. Aesthetics	14.1 Appearance						
15. Permanent Residuals of Construction Activity	15.1 Accessibility of Historical Sites	NA	NA				
	15.2 Accessibility of Archeological Sites	NA	NA				
	15.3 Setting of Historical Sites	NA	NA				
	15.4 Land Use						
	15.5 Property						
	15.6 Flood Control	NA	NA				
	15.7 Erosion Control	NA	NA				

COMMENTS

Alternative B - Dry Cooling Towers

Alternative C - Once-through Cooling

Alternative D - Natural Draft Towers

Form AEC-
(1/7/72)

SUPPLEMENTARY FORM – II

COST DESCRIPTION
ALTERNATIVE RADWASTE SYSTEMS

1. NAME OF FACILITY

JOSEPH M. FARLEY NUCLEA" PLANT

Units No. 1 and No. 2

2. DATE OF REPORT

NOTE: Numbers in parenthesis on this tabulation refer to attached documentation

		ALTERNATIVES A	B	C	D	E	F
INCREMENTAL GENERATING COST							
ENVIRONMENTAL COSTS[1,2]							
Primary Impact	Population or Resource Affected						
1. Heat Discharged to Water Body	1.1 Cooling Capacity	NA					
	1.2 Aquatic Biota	NA					
	1.3 Migratory Fish	NA					
2. Effects on Water Body of Intake Structure and Condenser Cooling System	2.1 Primary Producers & Consumers	NA					
	2.2 Fisheries	NA					
3. Chemical Discharge to Water Body	3.1 People	NA					
	3.2 Aquatic Biota	NA					
	3.3 Water Quality–Chemical	NA					
4. Consumption of Water	4.1 People	NA					
	4.2 Property	NA					
5. Chemical Discharge to Ambient Air	5.1 Air Quality–Chemical	NA					
	5.2 Air Quality–Odor	NA					
6. Salts Discharged from Cooling Towers	6.1 People	NA					
	6.2 Plants	NA					
	6.3 Property Resources	NA					
7. Chemical Contamination of Ground Water (excluding Salt)	7.1 People	NA					
	7.2 Plants	NA					
8. Radionuclides Discharged to Water Body	8.1 People–External Contact	(8)					

[1] Where a row is not relevant to a particular alternative, insert n.a. for not applicable.
[2] See Table 3 for units of measure and methods of computation.

	8.2 People–Ingestion rads	1.8(10^{-3}) 5 man rad/yr (8)					
	8.3 Primary Consumers	(8)					
	8.4 Fish	(8)					
9. Radionuclides Discharged to Ambient Air	9.1 People–External Contact rads	11(10^{-3}) (8)					
	9.2 People–Ingestion rads	10(10^{-3}) (8)					
	9.3 Plants and Animals	(8)					
10. Radionuclide Contamination of Ground Water	10.1 People	No Effect (8)					
	10.2 Plants and Animals	No Effect (8)					
11. Fogging and Icing	11.1 Ground Transportation	NA					
	11.2 Air Transportation	NA					
	11.3 Water Transportation	NA					
	11.4 Plants	NA					
12. Raising/Lowering of Ground Water Levels	12.1 People	NA					
	12.2 Plants	NA					
13. Ambient Noise	13.1 People	NA					
14. Aesthetics	14.1 Appearance	NA					
15. Permanent Residuals of Construction Activity	15.1 Accessibility of Historical Sites	NA					
	15.2 Accessibility of Archeological Sites	NA					
	15.3 Setting of Historical Sites	NA					
	15.4 Land Use	NA					
	15.5 Property	NA					
	15.6 Flood Control	NA					
	15.7 Erosion Control	NA					

COMMENTS

Form AEC-
(1/1/72)

SUPPLEMENTARY FORM – III

COST DESCRIPTION
ALTERNATIVE CHEMICAL EFFLUENT SYSTEMS

(Do not include Coolant Water Treatment Systems Described in Supplementary Form – I)

1. NAME OF FACILITY

JOSEPH M. FARLEY NUCLEAR PLANT

Units No. 1 and No. 2

2. DATE OF REPORT

NOTE: Numbers in parenthesis on this tabulation refer to attached documentation

		ALTERNATIVES A	B	C	D	E	F
INCREMENTAL GENERATING COST							
ENVIRONMENTAL COSTS[1]							
Primary Impact	Population or Resource Affected						
1. Heat Discharged to Water Body	1.1 Cooling Capacity	NA					
	1.2 Aquatic Biota	NA					
	1.3 Migratory Fish	NA					
2. Effects on Water Body of Intake Structure and Condenser Cooling System	2.1 Primary Producers & Consumers	NA					
	2.2 Fisheries	NA					
3. Chemical Discharge to Water Body	3.1 People	No Effect (3)					
	3.2 Aquatic Biota	No Effect (3)					
	3.3 Water Quality–Chemical	No Effect (3)					
4. Consumption of Water	4.1 People	NA					
	4.2 Property	NA					
5. Chemical Discharge to Ambient Air	5.1 Air Quality–Chemical	NA					
	5.2 Air Quality–Odor	NA					
6. Salts Discharged from Cooling Towers	6.1 People	NA					
	6.2 Plants	NA					
	6.3 Property Resources	NA					
7. Chemical Contamination of Ground Water (excluding Salt)	7.1 People	NA					
	7.2 Plants	NA					
8. Radionuclides Discharged to Water Body	8.1 People–External Contact	NA					

[1] Where a row is not relevant to a particular alternative, insert n.a. for not applicable.
[2] See Table 3 for units of measure and methods of computation.

	8.2 People–Ingestion	NA					
	8.3 Primary Consumers	NA					
	8.4 Fish	NA					
9. Radionuclides Discharged to Ambient Air	9.1 People–External Contact	NA					
	9.2 People–Ingestion	NA					
	9.3 Plants and Animals	NA					
10. Radionuclide Contamination of Ground Water	10.1 People	NA					
	10.2 Plants and Animals	NA					
11. Fogging and Icing	11.1 Ground Transportation	NA					
	11.2 Air Transportation	NA					
	11.3 Water Transportation	NA					
	11.4 Plants	NA					
12. Raising/Lowering of Ground Water Levels	12.1 People	No Effect (12)					
	12.2 Plants	No Effect (12)					
13. Ambient Noise	13.1 People	NA					
14. Aesthetics	14.1 Appearance	NA					
15. Permanent Residuals of Construction Activity	15.1 Accessibility of Historical Sites	NA					
	15.2 Accessibility of Archeological Sites	NA					
	15.3 Setting of Historical Sites	NA					
	15.4 Land Use	NA					
	15.5 Property	NA					
	15.6 Flood Control	NA					
	15.7 Erosion Control	NA					

COMMENTS

ATTACHMENT H - GENERATING COSTS

The following estimated generating costs were based on the formula in Table 2 Monetized Bases for Plant Costs of the Atomic Energy Commission's draft Guide to the preparation of Benefit-Cost Analyses for Nuclear Power Plants, dated 1-7-72, as reproduced below:

Table 2 – MONETIZED BASES FOR PLANT COSTS

ITEM	SYMBOL	UNITS	METHOD OF COMPUTATION
Total Capital outlay at time when plant is put into operation	C_0	\$	To include total value of capital invested in a presently constructed plant. Applicant may use present worth of all capital costs annualized over life of the plant using the utility's annual carrying charges.
Additional Capital Required By An Alternative i = 1, 2..	C_i	\$	To include all additional costs to the power utility of modifying present installation to alternative installation. The sum should be expressed on a present value basis for disbursements over a number of years, as for C_0 above.
Deficient Power Purchased or Supplied in Year t	P_t	\$	Power purchased or supplied internally in year t to make up deficiency of power in dollars, including environmental costs.
The expected life of this plant	T_l	years	This should conform to period of amortization of the plant investment.
Annual Operating Cost	O_t	\$	This is the total operation and maintenance cost of plant operation in year t.
Annual Fuel Cost of Plant	F_t	\$	This is the total fuel cost in year t.
Discount factor	υ		$\upsilon = (1 + i)^{-1}$ where i is the cost of capital used in Table 1 over the life of this plant.
Total Generating Cost	TC_g	\$	$TC_g = C_0 + C_i + \sum_{t=1}^{T_l} \upsilon^t (O_t + F_t) + \sum_{t=1}^{T_l} \upsilon^t P_t$

Estimated Generating Costs for Alternatives No. 1 and No. 4

C_o = $501,316,000

$C_i = 0$

$P_t = 0$

$T_1 = 30$

$\sum_{t=1}^{T_1} v^t(O_t+F_t)$ = the present worth of operating costs and fuel costs over the life of the plant.

The estimated levelized fuel and operating cost for Units No. 1 and No. 2 is 3.49 mills per KWH, based on a levelized plant factor of 78.1% over an estimated 30 year service life including expected escalation. The expected system peak hour capability of the plant after the initial year of operation is 844 MW for each unit or 1688 MW for the 2 units. The present worth factor for a uniform annual series for 30 years at 10.4% (the annual cost of capital) is 9.118.

The levelized annual fuel and operating cost is equal to the levelized cost of fuel and operation per KWH times the levelized plant factor times 8760 hours per year times the capability of the plant in kilowatts, as follows:

$.00349 x .781 x 8760 x 1,688,000 = $40,304,450

The present worth of the levelized annual cost for 30 years is:

9.118 x $40,304,450 = $367,496,000

The estimated total generating cost for Alternates No. 1 and No. 4 is the capital cost of the plant plus the present worth of the levelized annual fuel and operating costs during the life of the plant, as follows:

TC_g = $501,316,000 + $367,496,000 = $868,812,000

Estimated Generating Costs for Alternative No. 2

C_o = $501,316,000

C_i = $ 17,318,000

$P_t = 0$

$T_1 = 30$

$\sum_{t=1}^{T_1} v^t(O_t+F_t)$ = the present worth of operating costs and fuel costs over the life of the plant.

The estimated total generating cost for Alternate No. 2 is the capital cost of the plant, including the additional cost of dry cooling tower, plus the present worth of the levelized annual fuel and operating costs during the life of the plant, as follows.

$$TC_g = \$501,316,000 + \$17,318,000 + \$367,496,000 = \$886,130,000$$

With Alternative No. 2, the benefits in terms of kilowatt hours generated are less, as shown in Attachment A.

ATTACHMENT I - STATEMENT CONCERNING ALTERNATIVE 3 - MINIMUM IMPACT ON LAND/AIR

For purposes of this analysis, once-through cooling has not been considered because of the legal requirements for maintaining water quality standards in the Chattahoochee River. This navigable, interstate stream forms the boundary between Alabama and Georgia with the state line running along the west bank. Water quality standards of Georgia are applicable and at present time they limit the temperature rise to 10°F up to a maximum temperature of 93.2°F. The condensers for the two units of the Joseph M. Farley Nuclear Plant will require 2,830 cfs of cooling water, which exceeds the total flow of the Chattahoochee River during certain periods of the year and particularly during critical summer months. The temperature rise through the condensers is expected to be approximately 20°F and it is obvious that an attempt to operate the plant with once-through cooling would violate water quality standards. It is understood also that Georgia expects to change its water quality standards so that a maximum temperature rise of 5°F up to a maximum temperature of 90°F will be the maximum allowable limits. This would place the plant in even greater violation if once-through cooling were employed.

ATTACHMENT J - STATEMENT CONCERNING NATURAL DRAFT WET TOWERS

Mechanical draft evaporative cooling towers were selected in preference to the natural draft type because of economic considerations resulting from their suitability for use under meteorological conditions which prevail in the area. In this analysis, no attempt has been made to compare the cost-benefits of mechanical draft and natural draft towers because the benefits afforded in the form of protection of water quality in the Chattahoochee River are essentially identical. Natural draft towers perhaps offer a slightly lower fogging potential than do the mechanical draft towers, but this is largely offset by their greater visual intrusion and possible hazards to aviation. As discussed elsewhere, the area of the Farley plant has a relatively low fogging potential and it could not be established that use of natural draft towers would provide substantial benefits even in this regard.

ATTACHMENT K - ENVIRONMENTAL COST DOCUMENTATION

1.1 - Heat Discharged to Natural Water Body-Effect on Cooling Capacity of Water Body

The average hourly wet bulb temperature in the Dothan area varies from 71° to 76°F during the summer months. The cooling towers at the Joseph M. Farley Nuclear Plant are designed on the basis of a wet bulb temperature of 78°F with an approach of 11°F. The design temperature of the blowdown will be 89°F at maximum operating conditions(1). The projected maximum blowdown temperature under extreme conditions is 91°F, with a wet bulb of 81°F. The blowdown discharge rate is 7,600 GPM for two units. This is diluted with bypass water before being discharged into the river. Assuming a river water temperature of 86°F with the lowest regulated seven day low flow rate of 2,090 CFS (2), the following temperature increase will result.

The blowdown temperature = 89°F
Bypass water = 29,400 GPM @ 86°F

Temperature of discharge to river

$$T_d = [(66 \text{ CFS} * 86^\circ F) + (17 \text{ CFS} * 89^\circ F)] / 83 \text{ CFS} = 86.6^\circ F$$

The temperature increase in the river will be

$$T = [(2{,}090-174) * 86 + (83 * 86.6)] / 1{,}999 = 86.02^\circ F$$

$$86.02 - 86.0 = 0.02 \ \Delta T$$
$$0.02 \times 1{,}999 = 39.98 \text{ CFS degrees} = 8.98(10^6) \text{ BTU/HR}$$

The current proposed EPA standards limit rise in streams in this area to 5°F after mixing with a maximum allowable of 90°F (3).

Discharges from the Joseph M. Farley Nuclear Plant will not create conditions exceeding either the maximum temperature rise or the maximum temperature of applicable Federal Standards.

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(1) Alabama Power Co., The Joseph M. Farley Nuclear Plant Environmental Report, p. 3-24.

(2) Geological Survey of Alabama, 7 Day Low Flows and Flow Duration of Alabama Streams, Bulletin 87, Part A, 1967, p.33.

(3) Alabama Power Co., pp. 3-27, 28

1.2 - Heat Discharged to Natural Water Body - Effect on Aquatic Biota

Under the conditions of Section 1.1 the ΔT of the water body would be 0.02°F or 0.01°C with the temperature of the receiving body elevated to 30.01°C. Studies(1) generally indicate temperatures in excess of 33°C or incremental changes of approximately 5°C at various temperature ranges are required to kill plankton. These conditions also required exposure time in excess of 1 hour.

Based on the available parameters, no harmful effect to aquatic biota in the Chattahoochee River would occur due to heat discharged from the Joseph M. Farley Nuclear Plant.

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(1) U. S. Atomic Energy Commission, Thermal Effects and U. S. Nuclear Power Stations, 1971, pp. 30-32.

2.1 - Effects on Water Body of Intake Structure and Condenser Cooling Systems - Effect on Primary Producers and Consumers

Available data (1) indicates an assumed organism count in the vicinity of the Joseph M. Farley Nuclear Plant of approximately 3,000 organisms/liter. The weight of organisms withdrawn from the river will be approximately 8,000,000 lb/year.

The following methodology was used to obtain this quantity:
3000 organisms/liter x 28.32 liter/ft^3 = 85,000 organisms/ft^3
Withdrawal at maximum operation (2) = 174 ft^3/sec
Weight per organism (3) = 10^{-5} grams = 2.205 10^{-8} lb.
Plant load factor (4) = 0.781

lb/Yr = Organisms/ft^3 x ft^3/sec x Sec/Yr x lb/organisms x load factor
= 8.035 (10^6)

It should be recognized that the nutrients associated with these organisms will be returned to the river system.

It is impossible to separate the organisms withdrawn into species due to the tremendous variability of organism type and the variability of type count in both time and space.

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(1) Deyer, W. and Benson, N. G., OBS. on the Influence of Johnsville Steam Plant on Fish and Plankton Populations (1956) Proc. 10th An. Conf. S.E. Assoc. Game and Fish Commrs. pp. 85-91.

(2) Alabama Power Co., Joseph M. Farley Nuclear Plant Environmental Report, p. 3-24

(3) A.E.C. Benefit/Cost Guidelines of December (Draft), p. 8.

(4) Alabama Power Company., Benefit/Cost Analysis of the Joseph M. Farley Nuclear Plant.

2.2 - Effects of Water Body of Intake Structure and Condenser Cooling System - Effect on Fisheries

Available data (1) indicate a larvae count of approximately 1 per cubic meter. Due to the low velocities in the vicinity of the intake structure (2), it is assumed that only larvae will be entrained. With a natural mortality rate of 90% for larvae and a 4 month growing season, the entrainment will be approximately 4,100 lb/yr. The species breakdown (3) is as follows:

Species	% By Weight	lb/yr Entrained
Bass	3	135
Bream(Sunfish)	17	765
Catfish	5	225
Carp-Suckers	19	855
Forage	56	2,520
	100	4,500

The following methodology was used to obtain these quantities:

1 larval/M^3 x $2.84(10^{-2})$ M^3/ft^3 = $2.84(10^{-2})$ larvae/ft^3
Withdrawal at maximum operation (4) = 174 ft^3/Sec
Weight per larval (5) = 0.001 lb.
Larval growing season = 123 days
Load factor - 0.781

lb/yr = Larvae/ft^3 x Ft^3/Sec x Sec/Day x Days/Yr x lb/Larvae x Load Factor x Mortality adjustment = 4.1×10^3

(1) C. B. Marcy, Jr. (1971) "Survival Of Young Fish in the Discharge Canal of a Nuclear Power Plant." J. Fish Res. Bd Canada 28:1057-1060.

(2) Alabama Power Co., Joseph M. Farley Nuclear Plant Environmental Report, pp.3-36, 37.

(3) Georgia State Game & Fish Commission Annual Progress Report, Southern Reg. Fish Inves. Proj. F-19-R-2/Jul 1, 1966 to Jun 30, 1967 Pittman-Robertson Division. 31 p.

(4) Alabama Power Co., p. 3-24

(5) Length-Weight Relationships of Ala. Fishes (1965) Agri. Experimental Sta., Auburn University, Zool.-Ent. Dept. Series Fisheries No. 3. 27 p.

3 - Chemical Discharge to Water Body - Effects on People, Aquatic Biota, and Water Quality

DISCHARGES FROM COOLING SYSTEM

The cooling tower blowdown from the Joseph M. Farley Nuclear Plant will have 0.25 to 0.5 ppm chlorine, approximately 220 ppm dissolved solids, and a pH of 7.8(1). The cooling process will not add any solids to the water body. The increase in solids concentration in the blowdown is due to evaporative losses. The tower blowdown is diluted by adding bypassed river water to the blowdown before discharging into the river. The blowdown (3,800 GPM per unit) when diluted with the bypass water (14,700 GPM per unit) will contain approximately 90 ppm dissolved solids, and .005 to .01 ppm free residual chlorine.

The concentration of chlorine in the blowdown is well below the level in chlorinated drinking water. A residual chlorine concentration of 0.5 ppm can cause eye irritation but studies have shown that within the pH range 7.0 to 8.0 the pH affects eye irritation more than the residual chlorine (3). With these factors there would be no effect of the chemical discharge on people. This is especially apparent in light of the discharge volume (37,060 GPM or 82.5 CFS) being only 4.7% of the minimum daily flow of record (1760 CFS).

Chlorine concentrations of 0.03 to 1.0 ppm can be fatal to fish and other biota with exposure times ranging from 47 minutes to 16 days (4). However, the fish killed within 47 minutes were trout with a concentration of 0.8 ppm. Considering the 4.7% discharge flow rate to total river flow, the concentration after mixing would be essentially zero. Therefore, no effect on fish and aquatic biota would result from the Joseph M. Farley cooling tower discharge.

The water quality of the Chattahoochee River would not be affected by the discharges from the cooling system. No solids are added to the river. The pH of the discharge is 7.8 versus river water at 7.3. The chlorine concentration is essnetially zero.

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(1) Alabama Power Co., Joseph M. Farley Nuclear Plant Environmental Report, p. 3-29, 32.

(2) United States Department of the Interior Geological Survey, Water Resources Data for Alabama - Part 2. Water Quality Records. 1968-1969.

(3) Resources Agency of California, State Water Quality Control Board, Water Quality Criteria, 1963, pp. 161-163.

(4) Ibid., pp. 161-163.

DISCHARGES FROM MAKE-UP WATER DEMINERALIZER

The regeneration of the cation-anion beds will produce 9,984 ppm of dissolved solids in 19,000 gallons of water. This will be discharged at the rate of 127 GPM into the tower blowdown. This operation will be performed twice a day at a maximum for two unit operation. The filters through which the demineralizer water passes initially will be backwashed a maximum of twice a day. This operation will require approximately ten minutes using 5,000 gallons of water containing approximately 120 ppm dissolved solids with a pH of 7.6 (1).

The 19,000 gallons of water utilized in the regeneration process will be discharged into the diluted tower blowdown at the rate of 127 GPM. When the demineralizer waste are added to this the dissolved solids going to the river will be 160 ppm. This would occur only when the regeneration waste were being discharged.

The demineralizer contribution to solids added to the river would be approximately 1.6 ppm during periods of minimum flow after mixing. The backwashing operation would contribute 0.08 ppm solids under the same condition. The above quantities were calculated as follows:

Regeneration Process:

lbs solids/discharge (2) = 1,580 x 2 per day = 3,160

Minimum daily flow of record (3) = 1,760 CFS

Dilution water during discharge period
$1{,}760\ ft^3/sec \times 449\ GPM/CFS \times 300\ min/discharge = 2.37(10^8)\ gal/discharge$

$lb/gal = 3{,}160/2.37(10^8) = 1.34(10^{-5})$
$1.34(10^{-5})\ lb/gal = 1.61\ ppm$
Backwash Process:

$lb/discharge = 1.115\ ft^3/sec \times 2.832(10^1)\ liter/ft^3 \times 1.2(10^{-1})\ gram/liter \times 1.2(10^3)\ sec/discharge \times 2.205\ (10^{-3})\ lb/gram = 10.1$

Dilution water during discharge period

$gal/discharge = 1.763(10^3)\ ft^3/sec \times 4.49(10^2)\ GPM/CFS \times 20\ min/discharge = 15.8(10^6)\ gal/discharge$

$lb/gal = 10.1/15.8(10^6) = 0.635(10^{-6})$
$0.635(10^{-6})\ lb/gal = 0.076\ ppm$

(1) Alabama Power Co., Joseph M. Farley Nuclear Plant Environmental Report, pp. 3-32, 33.

(2) Ibid, pp. 3-32, 33.

(3) Ibid, p. 2-21.

4.1 - Consumption of Water - Effect on Property

There are no downstream uses of water for agricultural use (1). The only effect on property would be for the production of electricity at Jim Woodruff Dam as previously stated in the Joseph M. Farley Nuclear Plant Environmental Report (2).

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(1) Alabama Power Co., Joseph M. Farley Nuclear Plant Environmental Report, p. 3-22.

(2) Ibid., p. 3-22.

5.2 - Chemical Discharge to Ambient Air - Effect on Air Quality - Odor

The chlorine concentration of the cooling tower blowdown will be 0.25 to 0.5 ppm with expected concentrations in the river at low flow of essentially zero. Studies have shown that chlorine concentrations of 2.0 ppm in pure water will not cause objectionable odors. If organic substances such as phenols are present, small concentrations can cause odors. However, a dosage of 0.1 ppm of chlorine did not produce odor with phenol present at 0.05 ppm (1). Accordingly, no odor should be produced from the discharge of chlorine from the cooling system of the Joseph M. Farley Nuclear Plant.

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(1) Resources Agency of California, State Water Quality Control Board, Water Quality Criteria, 1963, pp. 161-163.

6. Salts Discharged from Cooling Towers - Effects on People, Plants and Property Resources.

The concentration of solids (dissolved and suspended) in the drift from the cooling towers at the Joseph M. Farley Nuclear Plant will be 220 ppm. The drift is 1,300 GPM or 2.83 CFS. Assuming the drift will not exceed the property boundaries and an average rainfall of 54 inches per year, the concentration of solids affecting the environment after dilution by rainwater will be 42.2 ppm. This concentration is well below acceptable levels for potable water as well as agricultural use (1). (See attached tables from Reference (1)). The concentration of dissolved solids in the river averages 63 ppm.

The above concertration was calculated as follows:

Concentration of solids in blowdown (2) = 220 ppm
Drift rate (3) = 1,300 GPM = 2.9 CFS
Rainfall (Normal) (4) = 54 inches/year

lbs solids/yr = ft^3/sec x liter/ft^3 x grams/liter x sec/yr x lb/gram x load factor = $9.55(10^5)$

Rainfall Dilution = in/yr x gal/acre/in x acres = $27.1(10)^8$ gal/yr.

Solid concentration = lb/yr ÷ gal/yr = $0.352(10^{-3})$ lb/gal = 42.2 ppm

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(1) Water Information Center, The Water Encyclopedia, 1970, pp. 305-313.

(2) Alabama Power Co., Joseph M. Farley Nuclear Plant Environmental Report, p. 3-29, 30.

(3) Ibid, p. 3-29.

(4) Ibid, p. 2-31, 32.

(5) Ibid, p. 2-1.

SECTION A. WATER QUALITY

TABLE 6-1. DISSOLVED SOLIDS IN POTABLE WATER

(Source: Davis and DeWiest, Hydrogeology, John Wiley & Sons, Copyright 1966)

(A classification based upon relative abundance of dissolved solids)

Major Constituents (1.0 to 1000 ppm)

Sodium	Bicarbonate
Calcium	Sulfate
Magnesium	Chloride
Silica	

Secondary Constituents (0.01 to 10.0 ppm)

Iron	Carbonate
Strontium	Nitrate
Potassium	Fluoride
Boron	

Minor Constituents (0.0001 to 0.1 ppm)

Antimony*	Lead
Aluminum	Lithium
Arsenic	Manganese
Barium	Molybdenum
Bromide	Nickel
Cadmium*	Phosphate
Chromium*	Rubidium*
Cobalt	Selenium
Copper	Titanium*
Germanium*	Uranium
Iodide	Vanadium
	Zinc

Trace Constituents (generally less than 0.001 ppm)

Beryllium	Ruthenium*
Bismuth	Scandium*
Cerium*	Silver
Cesium	Thallium*
Gallium	Thorium*
Gold	Tin
Indium	Tungsten*
Lanthanum	Ytterbium
Niobium*	Yttrium*
Platinum	Zirconium*
Radium	

*Elements marked with an asterisk occupy an uncertain position in the list.

TABLE 6-2. CLASSIFICATIONS OF WATER

(Sources: Davis and DeWiest, Hydrogeology, John Wiley & Sons, Copyright 1966, and U.S. Geological Survey)

A. Based on Concentration of Total Dissolved Solids

Name	Concentration of Total Dissolved Solids, parts per million
Fresh	0-1000
Brackish	1000-10,000
Salty	10,000-100,000
Brine	More than 100,000

B. Based on Hardness

Name	Hardness as $CaCO_3$, parts per million
Soft	0-60
Moderately hard	61-120
Hard	121-180
Very hard	More than 180

TABLE 6-7. OPTIMUM AND MAXIMUM VALUES OF WATER QUALITY CHARACTERISTICS IN RELATION TO TYPE OF BENEFICIAL USE (continued)

Characteristics	Shellfish Culture	Irrigation			Industrial				Aesthetic Enjoyment
		Truck Garden Vegetables	Citrus Fruits	Other Crops	Food Processing		Cooling and Other		
					Fresh Water	Salt Water	Fresh Water	Salt Water	
1. *Bacterial—per ml.*									
Coliform (opt.)	1.0	1.0	10	100	0.1	1.0	1.0	10	
Coliform (max.)	5	10	100	100	1.0	3.0	10	100	
2. *Organic—ppm.*									
B.O.D. (opt.)	5				none	1	5	5	20
B.O.D. (max.)	20				5	10	10	20	100
D.O. (opt.)	5				5	5	3.0	3.0	5.0
D.O. (min.)	2				1	1	1.0	1.0	1.0
Oil (opt.)	none	none	none	none	none	none	5	5	none
Oil (max.)	2	5	5	5	2	5	10	10	10
3. *Reaction*									
pH (opt.)	6.8-7.2	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	4.0-10.0	4.0-10.0	
pH (critical)	6.6-8.0	6.0-9.0	6.0-9.0	6.0-9.0	6.0-9.0	6.0-9.0	4.0-10.0	4.0-10.0	
4. *Physical—ppm.*									
Turbid. (opt.)	5				5	5			50
Turbid. (max.)	50				20	50			
Color (opt.)	10				10	10			20
Color (max.)	50				30	50			100
Susp. solids (opt.)	10				10	10	50	50	
Susp. solids (max.)	100				50	100	150	150	
Float. solids (opt.)	none				none	none	none	none	slight
Float. solids (max.)	gross				slight	slight	slight	slight	gross
5. *Chemical—ppm.*									
Total solids (opt.)		500	500	500	500		1,000		
Total solids (max.)		1,500	1,500	2,000	1,500		1,500		
Cl (opt.)		200	100	250	500				
Cl (max.)		750	500	750	1,000				
F (opt.)		0.5-1.0							
F (max.)		5							
Toxic metals (opt.)		0.1			none	none			
Toxic metals (max.)	0.1	2.5			0.1	0.5			
Phenol (opt.)	1*	5*			1*	5*			
Phenol (max.)	10*	20*			10*	20*			
Boron (opt.)			0.5	1.0					
Boron (max.)			1.0	5					
Na ratio† (opt.)		35-50†	35-50†	35-50†			90†		
Na ratio† (max.)		80†	75†	80†			90†		
Hardness (opt.)							100		
Hardness (max.)							500		
6. *Temp.—°F.* (max.)	70								
7. *Odor*‡ (max.)	N	O	O	O	M	M	O	O	O
8. *Taste*‡ (max.)	N				M	M			

*Parts per billion.
†Per cent.
‡Key: D—disagreeable; M—marked; N—noticeable; O—obnoxious.

8. Radionuclides in Water, Air, and Ground Water- Effect on People, Plants and Animals

During the PSAR review period the radioactive waste treatment systems for liquids and gases were upgraded to incorporate the Westinghouse Environmental Assurance System which incorporates the latest available technology for maintaining radioactive releases to the lowest practicable levels.

As described in the Environmental Report (1) the liquid radwaste system uses separated drains and treatment systems which will permit recycling of reactor grade water and treatment of non-reactor grade water prior to discharge so as to reduce effluents to very low levels. Even with cooling tower blowdown flow only one-thirtieth of the flow available for dilution in once-through condenser cooling plants, the estimated annual average concentrations of radioactive isotopes in the discharge to the river is only 5 to 10 percent of Maximum Permissable Concentration (MPC) of 10 CFR 20. This would be equivalent to 1/6 to 1/3 of one percent for the same releases from the types of nuclear plants which are in operation today that use once-through cooling.

After mixing in the river, the concentrations in water are about the same as for once-through cooling so the effects on aquatic life, animals, and humans would be about the same. The estimated annual doses to humans have been presented in the Farley Plant Environmental Report and are summarized in Table 4-13 of that report. These doses are less than 2×10^{-3} rem to the maximum exposed individual and less than 5 man-rem to the total population in a 50-mile radius. Furthermore the total liquid releases are less than 4 curies (excluding tritium) as set forth in Table 4-1 of the Environmental Report. The above doses and curie releases are within proposed Appendix I limits.

Releases of tritium are minimized by use of zirconium fuel clad, silver indium-cadmium control rods, boric acid evaporator, and radwaste system which will recycle as much as practicable of reactor grade water. Estimated concentrations of 4 percent of MPC is equivalent to about 1/8 of one percent for once-through cooling plants. Thus as in case of other isotopes, since concentrations affecting the public would be related to those resulting from mixing in the river, doses to the public would be within proposed Appendix I limits.

To summarize, the Farley liquid radwaste system uses the latest available technology to hold releases to levels as low as practicable and meets Appendix I. Thus in accordance with the January 4, 1972 proposed AEC guide on benefit-cost analyses (2), "no further consideration needs to be given to the reduction of radiological impacts in formulating alternative plant designs for Alternatives 2, 3 and 4."

The gaseous radwaste hold-up system for the Farley Plant was changed during the PSAR review period from a 45-day holdup system to a recirculating type of system with continuous holdup. Furthermore the system will scavenge fission product gases from the primary coolant more effectively than the origianl system so that gaseous releases from buildings due to water leaks will be

(1) Alabama Power Company., Joseph M. Farley Nuclear Plant Environmental Report, Section 4.

(2) Proposed AEC Guide to the Preparation of Benefit-Cost Analyses to be Included in Applicants' Environmental Reports (For Defined Classes of Completed and Partially Completed Nuclear Facilities), January 4, 1972, page 4.

decreased. The Farley gaseous radwaste system incorporates the latest available technology to reduce gaseous radioactive releases to the lowest practicable level and should be substantially below releases from currently operating nuclear plants which have gaseous radwaste systems comparable to those originally planned for the Farley Plant.

Since there will be no planned routine releases from the Farley gaseous radwaste system, such releases are well within Appendix I limits. Thus, in accordance with AEC's guide on benefit-cost analyses alternatives need not be considered for such system.

For other gaseous releases from the remainder of the plant, sources have not been precisely defined from operating nuclear plants over the range of expected operating conditions of various water leakage rates, fuel leakage rates, and steam generator leakage rates. It is presumed that such releases would be within Appendix I limits since AEC had implied that Appendix I quantitative limits are based on releases achieved in operating plants. Nevertheless until better information is available concerning such estimated releases, allowances of 5 and 10% for normal operation and expected operational occurrences respectively have been provided such that representations to the public on releases will be conservatively high. Alabama Power Company is continuing to obtain better definition of these releases and will modify plant design to the extent practicable to assure that the allowances are not exceeded. It is not practicable to discuss such alternatives until more reliable estimates are available regarding these types of releases.

The possibility of adversely effecting the ground water resources or existing wells in the area as a result of the operation of a nuclear plant is remote (3).

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(3) Alabama Power Co., Joseph M. Farley Nuclear Plant Environmental Report, pp. 2-19, 20 and 3-22, 23.

11. Fogging and Icing - Effects on Transportation and Plants

Fogging potential can be expressed in terms of the difference between vapor mass at saturation and vapor mass of ambient air (1). The attached table gives average hourly dry bulb temperature and relative humidity from the Dothan area during the winter months (2). From this data, the vapor mass in g/m^3 for saturation conditions and ambient conditions can be calculated and thus the difference or "delta mass." According to reference (1), fogging potential has an extremely low probability as long as the "delta mass" is not less than 0.5 g/m^3. The lowest "delta mass" based on the average conditions of the attached table is 0.8 g/m^3. Under average conditions, there is an extremely low probability of fogging potential in the vicinity of Joseph M. Farley Nuclear Plant.

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(1) Nat. Thermal Pollution Res. Prog., Pacific N.W. Water Lab. and Great Lakes Regional Off., U. S. Dept. of Interior, Fed. Water Qual. Admin., Feasibility of Alternative Means of Cooling for Thermal Power Plants on Lake Michigan, 1970, pp. VI-9, 11.

(2) Alabama Power Co., Joseph M. Farley Nuclear Plant Environmental Report, pp. 2-31, 32.

AVERAGE CLIMATIC AND FOGGING POTENTIAL
BASED ON DOTHAN DATA

WINTER

Time of Day	Dry Bulb °F	Relative Humidity	Vapor Mass g/m³ Saturation	Vapor Mass g/m³ Ambient	Delta Mass
1 AM	49	85	9.2	7.8	1.4
2	48	87	8.8	7.6	1.2
3	47	87	8.5	7.4	1.1
4	47	87	8.5	7.4	1.1
5	46	89	8.2	7.3	0.9
6	46	90	8.2	7.4	0.8
7	46	89	8.2	7.3	0.9
8	47	87	8.5	7.4	1.1
9	49	83	9.2	7.6	1.6
10	52	77	10.1	7.8	2.3
11	54	70	10.7	7.5	3.2
12	58	66	12.3	8.1	4.1
1 PM	60	62	13.0	8.1	4.9
2	62	58	13.9	8.1	5.8
3	63	57	14.4	8.2	6.2
4	62	58	13.9	8.1	5.8
5	61	63	13.5	8.3	5.2
6	57	68	11.8	8.0	3.8
7	55	72	11.1	8.0	3.1
8	54	76	10.7	8.1	2.6
9	53	78	10.3	8.0	2.3
10	52	81	10.1	8.2	1.9
11	50	83	9.4	7.8	1.6
12	49	84	9.2	7.7	1.5

12. Raising and Lowering of Ground Water Levels - Effects on People and Plants

Well water will be utilized for demineralizer make-up, demineralizer regeneration, backwashing the demineralizer filters, and the potable water supply. The maximum quantity to fill these requirements will be 517,800 gallons a day or 360 GPM under extreme conditions. The quantity for each is as follows:

Demineralizer make-up - 364,800 Gal. per day at maximum operation. Maximum operation is 19 hours per day allowing five hours for regeneration.

Demineralizer Regeneration - 38,000 gal. per day at maximum operation. Maximum operation would require two regeneration cycles per day at 19,000 gal. each.

Demineralizer filter backwash - 10,000 gal. per day at maximum operation. Maximum operation would require two backwashing cycles at 5,000 gal. each.

Potable water supply - 5,000 gal. per day. Based on 50 gallons per person per day and 100 people.

The water to supply this quantity will be drawn from deep wells developed in the low acquifers which underly impervious material and will have no effect on the level of the ground water table. The volume of water available in these lower acquifers is of such magnitude that the 360 GPM would have no effect on the availability of water for other users. Each of the lower acquifers (major shallow and major deep) will easily yield 1 million gal. per day (695 GPM) to an individual well (1).

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(1) Geological Survey of Alabama, Water Availability in Houston County Alabama, Map 59, 1967.

13. Ambient Noise - Effect on People

Noise levels due to cooling tower operations on similar installations have been verified to be essentially background noise less than 45 dBA. Within 10 feet of the gearbox assembly the noise level is approximately 90 dBA. If the 90 dBA is assumed to be a point source, the sound level at the boundary of the plant would be 38 dBA and within 1800 feet of the source it would be 45 dBA. Therefore, noise is not expected to affect the population surrounding the Joseph M. Farley Nuclear Plant.

Methodology:

$$dBA_1 = dBA_2 - 20 \log_{10} \frac{r_1}{r_2}$$

dBA_1 = Sound pressure at point 1 in dBA

dBA_2 = Sound pressure at point 2 in dBA

r_1 = Distance in feet from source to point 1

r_2 = Distance in feet from source to point 2

For an average r_1 to the plant boundary of 4,000 feet

$$dBA_1 = 90 - 20 \log (4,000/10) = 37.96$$

The distance from the source to point with 45 dBA level

$$45 = 90 - 20 \log (x)$$
$$X = 177.9$$

Since the 90 dBA is at 10 feet from the source the distance would be

177.9 x 10 = 1,779 ft.

15.5 Permanent Residuals of Construction Activity - Effect on Property Values

The Southeast Alabama Regional Planning and Development Commission has stated that the optimum use of land in the vicitnity of the Joseph M. Farley Nuclear Plant along the Chattahoochee River is for industrial purposes. At present over 500 acres on the west bank approximately four miles from the Farley Site are reserved for industrial development. The construction of the Farley Plant in this area will enhance the potential for industrial development and thus increase the value of surrounding property.

The Transmission Line routes have been selected so as to avoid towns, residential areas, Historical Sites, and public use lands other than roads and highways. The present land use along the transmission routes is primarily agricultural. It is expected that the primary use of these lands will continue to be agricultural. The Transmission Lines will have minimal impact on these property values. (1)

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(1) Alabama Power Company, The Joseph M. Farley Nuclear Plant Environmental Report, Section 3.2.