WISCONSIN PUBLIC SERVICE CORPORATION

Kewaunee Nuclear Power Plant

ENVIRONMENTAL REPORT

OPERATING LICENSE STAGE

JANUARY 1971

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SUMMARY

General

This report is submitted by Wisconsin Public Service Corporation to supplement its "Environmental Report - Operating License Stage" dated January, 1971. The subject of this report is the Kewaunee Nuclear Power Plant which is an electric power generating complex located adjacent to Lake Michigan in Kewaunee County, Wisconsin.

Wisconsin Public Service Corporation, hereinafter referred to as WPS, is acting on behalf of a pool of three power companies which include WPS, Wisconsin Power and Light Company and Madison Gas and Electric Company, hereinafter referred to collectively as the Wisconsin Power Pool (WPP). The power pool is part of a vast, interconnected grid of transmission and production capability which extends over a large portion of the Midwest known as the Mid-America Interpool Network (MAIN). WPP's combined generating capability is presently low with respect to the reserve capability which is considered appropriate for reliable power generation. WPP has attempted to maintain a minimum reserve of 15 percent of its maximum demand. During the last several years this has not always been possible. Reserves have been as low as 9.0 percent in 1969 and 10.2 percent in 1970. During these periods the Wisconsin Power Pool has had to rely on other MAIN members for assistance on numerous occasions.

The MAIN organization has not yet adopted a minimum reserve policy for itself or for its members. However, a minimum reserve that could be considered feasible for the MAIN organization would be 15 percent. This is verified by the continuing discussion of 20 percent being an adequate reserve by the Federal Power Commission (FPC).

The demand for power for WPP is increasing at the annual rate 8.0 percent in the summer and 6.9 percent in the winter. Without additional power producing facilities, a power deficiency will result by the summer of 1973. The MAIN organization total reserve by this time will be at or below minimum requirements. Hence, WPP cannot rely upon the MAIN organization to provide the necessary assistance during the summer of 1973. Similar situations will exist in other neighboring reliability areas; therefore purchase of capacity from outside the MAIN area cannot be viewed as feasible. The obvious conclusion, then, is to enlarge the WPP capacity to produce power to satisfy ensuing power demand.

Facility Description

The facility will consist of a single pressurized water reactor (PWR) nuclear generating unit that will produce a net output of 540 MWe. It is located on the west shore of Lake Michigan in Kewaunee County 27 miles southeast of the City of Green Bay. A once-through cooling system using Lake Michigan water is planned. The facility is located about five miles north of a two unit nuclear generating station (Point Beach) owned and operated by Wisconsin Electric Power Company and Wisconsin Michigan Power Company.

Construction of the Kewaunee facility is now approximately 70% complete. Fuel loading is scheduled for June, 1972; commercial power production is scheduled to begin December, 1972.

Environmental Impact of the Facility

The Kewaunee facility is located in an agricultural region. Most of the 907.57 acre tract purchased by the Owners was formally under cultivation; almost 800 acres of the total amount of land purchased remains under cultivation. If AEC grants approval, the 800 acres will continue to be leased for farming purposes after the plant begins commercial operation.

Small amounts of chemical and radioactive waste material will enter Lake Michigan as a result of plant operation. Waste concentrations are projected to be far below the maximum limits set by applicable standards. The estimated impact on the aquatic environment, and through the food web on humans, is projected to be extremely small. Airborne radioactive waste emissions also are well within applicable limits and are extremely small compared to the measured background radiation. The meteorologic diffusion characteristics of the site are favorable. The radioactive waste treatment system currently being completed at the plant has been modified continuously, incorporating the latest available elements, and reducing releases even further.

The visual or aesthetic impact of the facility is a function of the physical presence of the plant itself and of the 56 miles of associated transmission lines. Every effort has been and is being made to minimize this impact by appropriate design and landscaping procedures. Erosion control and related measures have been undertaken to minimize the impact of the grading program on the land and the introduction of sediment into the lake.

A principal concern in the design and analysis of this facility relative to the environment is the thermal impact on Lake Michigan. In this regard, the overlapping effects of cooling water discharges from Kewaunee and from the Point Beach complex have been examined. Both plants use a once-through heat dissipation system. The design temperature rise through the cooling system at Kewaunee is 20° F (summer) and 28° F (winter). and the temperature increase at the boundary of an area of Lake Michigan approximately 1,000 acres in size is limited to a water temperature increase of about 3° F. A discharge permit applicable to the critical summer operating condition has been obtained from the State of Wisconsin. Because of present and increasing public concern with thermal changes of this type, considerably more attention has been given to this matter than might otherwise be considered necessary. In fact, the Owners have provided for the addition of cooling towers to the complex should thermal standards be revised. This has been done in recognition of the fact that construction delays or operation interruption would force a critical situation in power generation.

Meteorological, biological, hydrological, and radiological studies begun in the past to provide background data for design will be continued throughout completion of construction and operation of the plant to measure actual effects and to permit comparison with predicted effects. These programs are described in greater detail in Section 2.3.9.

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

The most immediate and easily assessable unavoidable impact on the environment is the fact that approximately 110 acres of farm land have been taken out of production and will continue to remain out of production. The impact on terrestrial wildlife is small since this land has been under cultivation for some time; the earlier impact on this aspect of the environment in conversion of forested land to farm land was obviously far greater. That portion of the Lake Michigan shoreline which will experience the greatest thermal impact has been shown to be organically barren as a result of geologic and hydrographic factors. The thermal impact, though significant over a small area, is therefore not serious considering the actual aquatic environment at the discharge point. The predicted small amounts of chemical and radioactive waste discharges are so small at this point that the investment required to further reduce them is not justified by the actual benefit from these reductions. Attempts have been made to minimize visual impact through careful design procedures. Aesthetic effects will be mitigated somewhat as construction and landscaping are completed, but the overall impact is one related to the sheer size of the facility and is essentially unavoidable.

Alternatives to the Proposed Action

Essentially all possible alternatives to the existing facility have been weighed by the Owners since the need for additional power was identified in the mid 1960's. As is shown in Section 2.5 of this report, some of the alternatives were eliminated early in the decision-making process by consideration of the legal and ethical obligations of the companies to provide power and by economic examination of certain alternatives, such as a variety of site choices, and forms of generation which are of limited feasibility considering the capacity requirement. Other first-rank alternatives, such as alternate cooling methods, later required further serious consideration of detailed economic problems and the corresponding impact on the environment as societal values have shifted toward a greater concern for the environment.

Principally, the alternatives which were considered earlier by WPP were a variety of sites and the construction of fossil fuel plants. Following selection of the Kewaunee site, considerable attention was given to developing data relating to the design of alternate methods of cooling systems for the plant and to the relative environmental effects of the alternatives. The system as designed has been shown to be feasible from an environmental cost standpoint. The radwaste system, as it has finally evolved, constitutes one of the finest available to any nuclear generating station; alternatives consist principally of certain add-on elements which have been made possible through technological advances. A cost-benefit analysis has been applied to the principal present alternatives and demonstrates the validity of the decisions made.

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

The unavoidable effects discussed previously, represent environmental costs which can be considered generally short-term uses of man's environment. Essentially all of these impacts will permit rapid restoration of the site and its environment to a state approximating the pre-existing condition following plant shutdown and disassembly. They, therefore, represent investment rather than cost.

The impact of the proposed action on the long-term productivity of the region, considering the social, cultural and economic welfare of power consumers, outweighs the consequences of the short-term use of the environment. The far-reaching effects of power availability on society as a whole is beyond the scope of an environmental report such as this, but it is readily apparent that there is not only a greater demand for power per capita as our standard of living increases but that population increase will require an acceleration of power production in order to maintain an accustomed standard for all individuals. Considering the relatively small and short-term character of environment "use" considered in this section, the net impact on industry and typical consumer alike is, in the carefully considered judgment of the Owners and their consultants, a positive one.

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

Considerable human effort has gone into this facility which is obviously irretrievable, though some things have been learned that could be used to more efficiently design and build a similar generating facility. Many of the construction materials which have gone into the Kewaunee Plant are not salvageable and represent an irretrievable commitment.

Most significant is the depletion of fuel resources which will occur during continuous operation. None of the alternatives examined, however, except that of not producing power at all, represents a more favorable situation in this regard. It is not possible to demonstrate that the committed fuel resources would have better use elsewhere. Except for a complete rearrangement of social, economic and humanistic values from those that public consensus (through its demand for power) has imposed on the Owners, and on government through its regulating bodies, the successful completion and operation of this plant will involve a smaller irretrievable or irreversible commitment of resources - human or material - than any principal alternative.

1.0

INTRODUCTION

1.1 REPORT DESCRIPTION

This report supplements the "Environmental Report, Operating License Stage, Kewaunee Nuclear Power Plant" submitted by Wisconsin Public Service Corporation in January, 1971. Following the initial submittal, certain questions were raised by the Atomic Energy Commission (AEC) review staff which were answered in the form of page supplements to the original.

Since submittal of the January, 1971 Environmental Report, AEC guidelines and instructions have been revised and updated. This report supplement is intended to take into account those instructions and guidelines issued prior to October 1, 1971. The initially submitted Environmental Report has been reorganized to accommodate the organization and section numbering system outlined in the February, 1971 guideline issued by the AEC. This supplement incorporates further consideration of alternatives to the proposed action, including a review of past alternatives and a cost-benefit analysis of key present alternatives. Consideration of the environmental impact of alternative methods of generating power is documented in this supplement and certain new subjects have been treated such as the environmental effects of fuel transportation and possible accidents within the facility.

All of the information incorporated in the initially submitted Environmental Report is resubmitted herein; except for reorganization and additions, the basic material has not been changed. Additionally, those concepts which previously were developed and which relate to the overall conclusions and the relationship of the plant to its environment are not altered.

In summary, this report is intended to satisfy AEC Regulation 10 CFR 50, Appendix D. This regulation requires submittal of an environmental report discussing those items identified in the National Environmental Policy Act of 1969.

1.2 GENERAL INFORMATION

The Kewaunee Nuclear Generating Station is owned jointly by the Wisconsin Public Service Corporation (WPS), the Wisconsin Power and Light Company (WPL) and Madison Gas and Electric Company (MGE) in accordance with a joint power supply agreement signed by the three companies on February 2, 1967 which established a power pool among the participants. WPS is acting on behalf of the three companies in all matters pertaining to the design and construction of this facility. The pool is known as the Wisconsin Power Pool (WPP) and it was established to maximize efficiency of power production and distribution.

WPP will soon have great need for the power that will be produced by the Kewaunee Nuclear Power Plant. This is based on a review of the Wisconsin Power Pool capacity-demand figures (Ref. 52) which forecasts demands of 1944 MW in the 1972-73 winter and 2147 MW in the 1973 summer. These are based upon the latest actual experience which have shown maximum demands of 1670 MW in the 1970-71 winter and 1850 MW in the 1971 summer. The rate of increase forecasted is conservative when compared to the average annual rate of increase experienced during the last ten years of 8.0 percent in summer demand and 6.9 percent in winter demand.

The Wisconsin Power Pool has attempted to maintain a minimum reserve of 15 percent of its maximum demand. During the last several years this has not always been possible. Reserves have been as low as 9.0 percent in 1969 and 10.2 percent in 1970. During these periods the Wisconsin Power Pool has had to rely on other MAIN members for assistance on numerous occasions. The difficulties in obtaining such assistance have verified the necessity of maintaining a minimum of 15 percent reserve in the Wisconsin Power Pool.

The Wisconsin Power Pool reserve during the winter 1972-73 without Kewaunee is estimated to be 13.8 percent. Since this will be less than the required minimum, assistance from MAIN will be required. The MAIN organization reserve during this period is estimated to be 38.7 percent. It appears, therefore, that the necessary assistance may be available, provided that nuclear plants such as Point Beach #1 (WE) and Dresden #3 (CE) are in operation. However, it must be pointed out that based on a MAIN report (Ref. 53) the 38.7 percent reserve will be reduced to the critical level of 15 percent by 1973.

During the summer, 1973, the Wisconsin Power Pool will have no reserve, and in fact a deficiency of 142 MW (Ref. 52) will result from supplying its own load. The MAIN organization total reserve will be at or below minimum requirements by that time, even with all nuclear plants other than Kewaunee (WPS) and Zion #1 and #2 (CE) operating. Based upon the MAIN Report (Ref. 53), it must then be concluded that the Wisconsin Power Pool cannot rely upon the MAIN organization to provide the necessary assistance during the summer, 1973. The MAIN Report also indicates that similar situations will exist in other neighboring reliability areas; hence, purchase of capacity from outside the MAIN area cannot be viewed as feasible.

The proposed Kewaunee nuclear generating station is located on the west shore of Lake Michigan in Kewaunee County, approximately 27 miles southeast of the City of Green Bay. The station will have a net output of about 540 MWe. It is a single unit PWR that uses Lake Michigan water in a once-through, full return cooling system. The Kewaunee plant is located approximately 4.5 miles north of a two unit nuclear generating station operated by the Wisconsin Michigan Power Company, which is known as the Point Beach Nuclear Plant. The first unit at Point Beach is operating; the second is awaiting an operating license. Each unit is generally similar to Kewaunee and employs once-through cooling with Lake Michigan water.

1.3 STATUS OF CONSTRUCTION

Construction of Kewaunee is approximately 70% complete. Many of the systems or structures which are important from an environmental standpoint are at or very near completion, as shown in Table 1.3-1, Environmentally Important Systems and Construction Status. The photo presented as Figure 1.3-1 provides an overview of construction status as of October 15, 1971.

The only major system which is not essentially complete is the Radwaste System. Most of the cost for the system has been committed and installation should be completed by January, 1972. The system has been designed in response to developing technical knowledge and incorporates many of the latest techniques in radioactive waste control. The size, shielding, and layout of the system allows for additional equipment to be added at any time, even after extended full power operation.

One other environmentally important activity that is closely aligned with construction status is erosion control. A soil stabilization and landscaping program to minimize erosion effects and to blend the site into the surrounding area is progressing as construction progress permits.

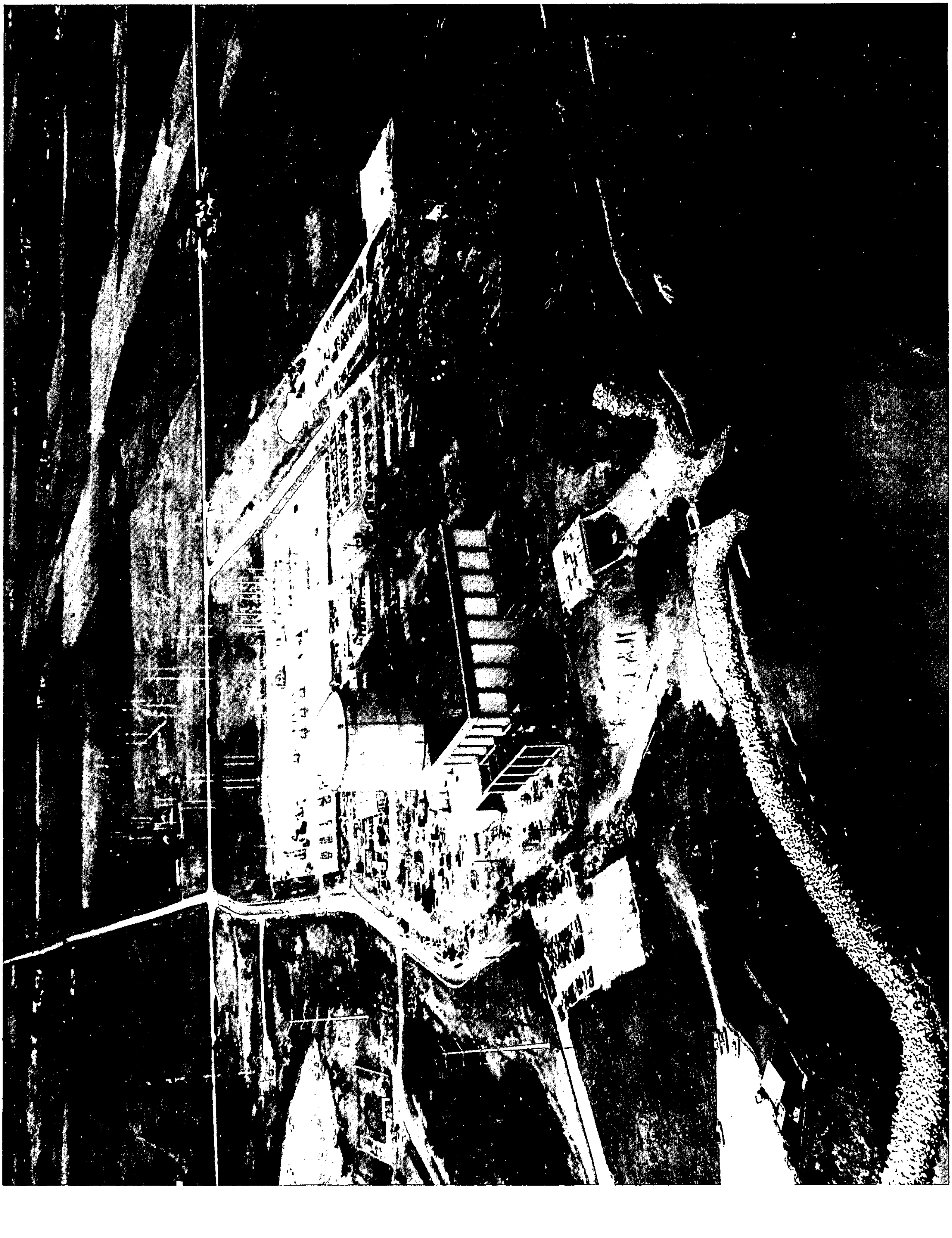
TABLE 1.3-1

ENVIRONMENTALLY-IMPORTANT SYSTEMS

COMMITTED CAPITAL AND CONSTRUCTION STATUS

System or Structure	1 Oct. 71 Est. Percent Construction Completion	Estimated 100% Completion Date	Estimated Total System Cost	Cost to be Committed (Remaining Materials and Constr. Labor)
Circulating Water Intake and Discharge	100	----	$3 525 000	---
Sanitary Sewage	100	----	40 000	---
Transmission Lines	100	----	360 000	---
Substation	100	----	5 400 000	---
Containment Vessel	100	----	2 480 000	---
Heating System (incl. boiler)	75	12/71	350 000	25 000
Plant Structures				
Shield Building	95	1/72	1 300 000	$100 000
Auxiliary Building	95	1/72	Breakdown Not Readily Available	
Turbine-Generator Building	98	1/72	" " " "	
Administration Building	95	12/71	" " " "	
Demineralizers and Makeup Water	90	11/71	450 000	30 000
Rad-waste	20	1/72	800 000	170 000
Reactor Building Internal Concrete	85	2/72	950 000	75 000
Ventilation	*	**	Breakdown Not Readily Available	

*20-80 percent complete, depending on particular ventilation system.
**In range of December 1971 to March 1972.



Kewaunee Site Construction Status
October 15, 1971
Figure 1.3-1

The overall project status is as follows:

Activity	Date
Excavation started	November, 1967
AEC construction permit received	August, 1968
Offshore work completed	October, 1969
Reactor vessel arrived on site	January, 1971
Electrical substation and incoming transmission lines completed	May, 1971
Construction testing started	June, 1971
Reactor coolant cold hydro	February, 1972
Hot functional test start (construction complete)	April, 1972
Fuel loading	June, 1972
Commercial operation	December, 1972

1.4 REPORT OBJECTIVES

The purpose of this report is to present a comprehensive evaluation of environmental considerations associated with the construction and operation of the proposed Kewaunee Nuclear Power Plant. Every effort has been made to address not only the specific regulations and guidelines of the AEC concerning environmental reports, but also to be consistent with the spirit of the National Environmental Policy Act of 1969 which requires that the following principal areas of concern be fully considered:

A. The Environmental Impact of the Proposed Action;

B. Any Adverse Environmental Effects Which Cannot be Avoided Should the Proposal be Implemented;

C. Alternatives to the Proposed Action;

D. Relationship Between Local Short-term Uses of Man's Environment and the Maintenance and Enhancement of Long-Term Productivity, and

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

1.5 INVESTIGATORS

Information was provided by WPS personnel and the following firms and institutions:

1. Pioneer Service and Engineering Company
2. Industrial Bio-Test, Incorporated
3. NUS Corporation
4. University of Wisconsin at Milwaukee
5. Department of Health, State of Wisconsin
6. University of Michigan
7. Environmental Research Group

The information provided by these firms and institutions is cited in pertinent sections of this report and the full title and reference is given in the <u>Literature Cited</u> section. The following principal investigators participated in the preparation of this supplement, and their particular areas of expertise are listed as follows:

John M. Heckard	-	Ground Water Geologist, Project Supervisor (Dames & Moore)
William M. Greenslade	-	Geologist, Technical Coordinator (Dames & Moore)
Donald E. Nelson	-	Civil Engineer, Project Manager (Dames & Moore)
Gerald A. Place	-	Agronomist (Dames & Moore)

W. Ray Seiple	-	Geologist (Dames & Moore)
Robert C. Pendelton	-	Radio-Ecologist (University of Utah)
Eric L. Gieger	-	Radiochemist/Health Physicist (Eberline Instrument Company)
Robert C. Erickson	-	Aquatic Biologist (Dames & Moore)
John W. Hathorn	-	Meteorologist (Dames & Moore)
Hubert B. Visscher	-	Meteorologist and Economist (Dames & Moore)
Gordon Riel	-	Nuclear Physicist (Southern Nuclear Engineering Company)
Fred B. Lobbin	-	Nuclear Physicist (Southern Nuclear Engineering Company)

Resumes of the foregoing individuals are presented in Appendix A.

2.0

ENVIRONMENTAL REPORT - OPERATING LICENSE STAGE

2.1 GENERAL

2.1.1 Location

The location of the Kewaunee Nuclear Power Plant is in east-central Wisconsin within the township of Carlton in Kewaunee County. The site is situated adjacent to the northwest shore of Lake Michigan with a longitude coordinate of 89 degrees 32.1' west and latitude of 44 degrees 20.6' north. Access to the plant is by way of State Highway 42 which approximately bisects the property in a north-south orientation.

The city of Green Bay is approximately 27 miles west-north-west of the site, and contains the largest population of all towns within a 50 mile radius of the plant. Appleton is 43 miles west of the station and Sheybogan 40 miles to the southwest. The largest cities in the area, are Two Rivers and Manitowoc, which are located 13 and 18 miles south of the site in Manitowoc County on the shore of Lake Michigan. Kewaunee and Algoma are the largest towns in Kewaunee County, and they are located about 8 and 18 miles north of the site, respectively. Population data are detailed in Section 2.3.1.1.

The location of the plant is shown geographically on Figure 2.1-1, General Location Map.

(POPULATION CENTERS OF 25,000 OR MORE ⊙)

GENERAL LOCATION MAP
FIGURE 2.1-1

2.1.2 Overview

The plant system will use a pressurized water reactor (PWR) Nuclear Steam Supply System which is furnished by the Westinghouse Electric Corporation. The reactor design is similar to other nuclear stations which have been recently licensed or are currently under review by the Atomic Energy Commission.

The reactor is designed for an initial power output of 1,650 megawatt total (MWt). The designed equivalent net electrical output of the plant is 540 megawatt electrical (MWe).

2.1.3 Components of the Kewaunee Nuclear Power Plant

2.1.3.1 Major Structures

General. The major structures of the Kewaunee Nuclear Power Plant are the following:

(1) Reactor Containment Vessel

(2) Shield Building

(3) Auxiliary Building

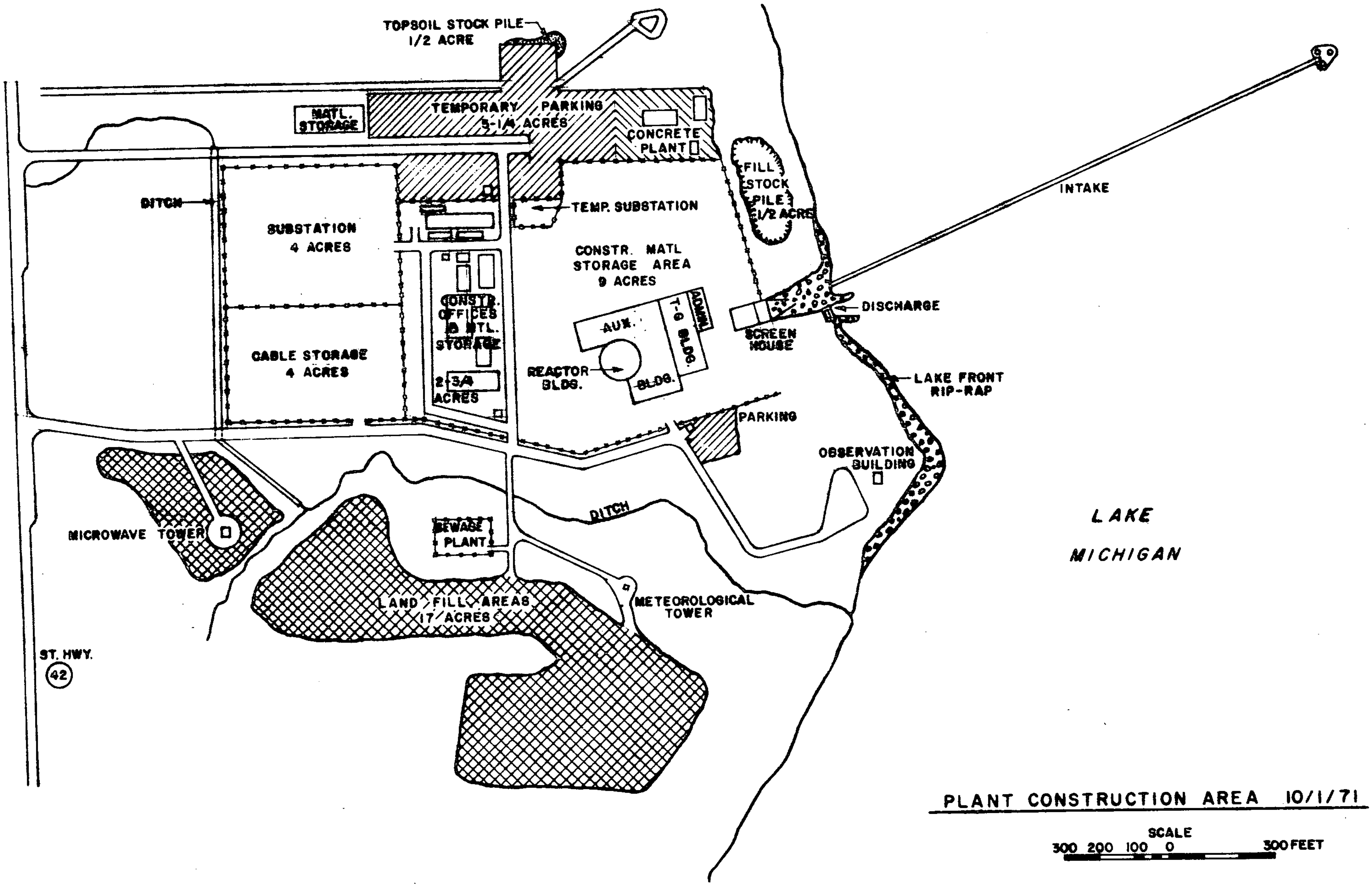
(4) Turbine Generator Building

(5) Administration Building

The layout of these structures is shown on Figure 2.1-2. A brief discussion of each is given in the following paragraphs.

Reactor Containment Vessel. The Reactor Containment Vessel is a cylindrical steel pressure vessel with a hemispherical dome and an ellipsoidal bottom. The vessel's inside diameter is 105 feet and its net free volume is 1,320,000 cubic feet. It houses the reactor pressure vessel, the steam generators, the reactor coolant loops and corresponding pumps, the accumulators of the Safety Injection System, the reactor coolant pressurizer, the pressurizer relief tank, and other branch connections of the Reactor Coolant System.

Shield Building. The Shield Building is a reinforced concrete structure of vertical cylindrical configuration with a shallow dome roof.



PLANT CONSTRUCTION AREA 10/1/71

SCALE
300 200 100 0 300 FEET

FIGURE 2.1-2

It surrounds the Reactor Containment Vessel. A 5 foot annular space is provided between the vertical parts of the Vessel and Shield Building. Clearance at the roof of the Shield Building is 7 feet. The building extends about 187 feet above grade level. It provides radiation shielding during normal operation and in the period following an extremely unlikely loss-of-coolant accident. In addition, the Shield Building acts as a secondary containment structure for the control of Reactor Containment Vessel leakage.

Auxiliary Building. The Auxiliary Building is located adjacent to the Shield Building and is contiguous with the Turbine Generating Building on its eastern side. The building's elevation above grade is approximately 95 feet.

The Auxiliary Building houses the essential auxiliaries, spent fuel storage facilities and the radioactive waste handling and treatment facilities. Essential auxiliaries include the makeup water demineralizers, heating boiler, condensate and reactor makeup water storage tanks, refueling water storage tank, safety injection pumps, residual heat removal pumps and heat exchangers, and various ventilation systems supply fans and filter assemblies.

The Auxiliary Building also houses the Main Control Room and assorted labs (e.g., Instrument, Cold Chemical, Hot Chemical), the

Decontamination Rooms, and the Counting Room.

Turbine Generator Building. This building is located between the Auxiliary Building on the west and the Administration Building on the east. The elevation of the Turbine Generator Building is the same as the Auxiliary Building and it has approximate length-width dimensions of 227 feet and 130 feet, respectively. Major items of equipment housed in the Turbine Building include the main steam turbine and generator units, the main condensers, condensate and feedwater pumps and associated heaters, main and auxiliary transformers (actually located outside the Turbine Generator Building on its south side), diesel generators and electrical switchgear.

Administration Building. The Administration Building contains various offices and conference rooms, the telephone equipment room, first-aid area and rest rooms and lockers. This building is located adjacent to the Turbine Generator Building with interconnecting access.

2.1.3.2 Major Systems

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

Condenser and Condenser Circulating Water System. Cooling water for the main condenser will be provided by the circulating water system at a rate of approximately 400,000 gpm. The circulating water will be supplied from Lake Michigan via an intake structure located approximately 1570 feet from the shore. After passing through the tube side of the condenser, the circulating water will be released back into the Lake via the discharge structure which is located at the shoreline. The temperature rise across the condenser during normal full power operation will be approximately 20° F during summer. As a result, approximately $4x10^9$ Btu/hr of waste heat will be removed during that operational period.

Traveling screens and trash grilles will be provided to minimize the passage of fish and debris through the condenser. In addition, the trash grilles are provided with recirculated water to remove any ice formations. A hypochlorinating system is provided to intermittently inject sodium hypochlorite into the traveling screen inlet area to prevent the buildup of bacterial slime on the condenser tubes.

The main condenser is the double flow, single-pass type with fabricated steel water boxes at both ends. A steam generator tube leak, with subsequent contamination of the steam, would be detected by the condenser air ejector gas monitor and secondary sampling system and appropriate actions would be taken, depending on the activity level. The condenser hotwell has sufficient storage for three minutes operation at maximum throttle flow with an equal free volume for surge protection. It has two condensate outlets from one shell with a hotwell cross-over between shells.

In addition to the above, a steam-jet air ejector, two 50 percent capacity condensate pumps, and two 50 percent capacity feedwater pumps are provided. One steam-driven and two motor-driven auxiliary feedwater pumps are available to remove Reactor Coolant System heat.

Radioactive Waste Disposal System. The Radioactive Waste Disposal System collects and processes all potentially radioactive reactor plant wastes utilizing facilities which are designed so that discharge of effluents and off-site shipments are in accordance with applicable governmental regulations (Ref. 1).

Radioactive fluids entering the Waste Disposal System are collected in tanks for analysis and subsequent treatment. Liquid wastes are processed as required and then released under controlled conditions. System design and operation are directed toward minimizing releases to unrestricted areas. Discharge streams are appropriately monitored and safety features are incorporated to preclude releases in excess of the AEC regulatory limits.

The bulk of the radioactive liquids discharged from the Reactor Coolant System is processed and retained inside the plant by the Chemical and Volume Control System recycle train. This minimizes liquid input to the Waste Disposal System which processes relatively small quantities of generally low-activity level wastes. The processed water from waste disposal, from which most of the radioactive material has been removed, is discharged through a monitored line to the condenser circulating water discharge. A steam generator blowdown treatment system is also provided.

Radioactive gases are pumped by compressors through a manifold to one of the gas decay tanks where they are held a suitable period of time for decay. Cover gases in the Nitrogen Blanketing System are reused to minimize gaseous wastes. During normal operation, gases are discharged intermittently at a controlled rate from these tanks through the monitored plant vent.

The spent resins from the demineralizers, the filter cartridges and the concentrates from the evaporators are packaged and stored on-site until shipment off-site for disposal.

The system is controlled from a central panel in the Auxiliary Building. Malfunction of the system is alarmed in the Auxiliary Building, and annunciated in the control room. All system equipment is located in or near the Auxiliary Building, except for the reactor coolant drain tank and pumps which are located in the Reactor Containment Vessel.

<u>Other Systems</u>

<u>Domestic and Sanitary Sewage</u>. The Kewaunee Nuclear Power Plant has a 600 gallon per day AER-O-FLO sewage treatment system located on the

plant site to treat all waste from lavatories, non-radioactive floor drains, janitor sinks, and normal sanitary wastes. The system employs three basic methods of treatment; these are screening, aeration, and settling. In addition, WPS has added a chlorination system and a polishing pond to further treat the effluent prior to discharge to the Lake.

The system has been in operation for approximately three years, under the jurisdiction of State licensed WPS or its architect-engineer personnel. During this time, State inspectors have been on site and have approved the use of the system.

<u>Chemical Discharge System</u>. The Kewaunee Nuclear Power Plant contains a water system which treats the Lake water to provide a high purity product for plant processes. This system utilizes chemicals (sulphuric acid and caustic soda) for regeneration of the demineralizers. In addition, chemicals are used for water softening for in-plant sanitary purposes, algae control in the condenser cooling water (sodium hypochlorite), and for water treatment in the secondary cycle (i.e., hydrazine, morpholine and phosphate). 2

All liquid volumes associated with these chemicals are collected in the liquid waste process system for treatment which includes neutralization, filtration, demineralization, and/or evaporation. After treatment, the discharged chemical concentrations are well within Federal drinking water criteria. The liquid volumes associated with these chemicals, other than sodium hypochlorite in the condenser cooling water, is neutralized in a waste neutralizing tank and released via the circulating water discharge canal under a discharge permit from the Wisconsin Department of Natural Resources.

2.1.3.3 Other Station Elements

Support facilities associated with the systematic operation of the plant also include substations and transmission towers. A domestic water supply, paved roads and parking facilities will be provided for plant personnel and an observation platform with parking facilities will be provided for the public. The various component buildings and support facilities are well integrated by layout and design. Landscaping of undeveloped portions of the plant site will complete the overall design concept and will help integrate elements of varying sizes or functions.

2.1.4 Operation of the Kewaunee Nuclear Power Station

A nuclear power plant differs from a conventional fossil-fueled steam-electric generating station in that the ordinary steam boiler of the latter is replaced by a nuclear reactor that generates the heat. In the nuclear reactor, the steam-producing heat is generated from uranium fuel rather than fossil fuel. The nuclear reactor plus the Reactor Coolant System and associated auxiliary fluid systems make up the Nuclear Steam Supply System which is the heart of the nuclear station.

The Kewaunee Station uses a pressurized water reactor whose Reactor Coolant System is arranged as two closed reactor coolant loops connected in parallel to the reactor vessel. Each loop contains a reactor coolant pump and a steam generator. An electrically heated pressurizer is connected to the outlet side, or hot leg, of one of these coolant loops to maintain the required high system pressure. The associated auxiliary fluid systems are provided in order to charge the Reactor Coolant System and to add makeup water, purify reactor coolant water, provide chemicals for corrosion inhibition and reactor control, cool various system components, remove residual heat when the reactor is shut down, cool the spent fuel storage pool, sample reactor coolant water, provide for emergency safety injection, and vent and drain the Reactor Coolant System.

The uranium fuel is contained in what is termed the core of the reactor. This core is made up of discrete assemblies of fueled tubes that contain uranium dioxide pellets enclosed in Zircaloy tubes having welded end plugs. The tubes are supported in the assemblies by a spring clip grid structure. The core fuel is loaded in three regions. New fuel is introduced, during refueling, into the outermost region, moved inward into a checkerboard pattern at successive refuelings and discharged from the innermost region to a spent fuel storage area.

During operation, fissioning of the uranium fuel (slightly enriched in the isotope U-235) in the reactor core will generate heat which, in turn, will be transferred to the reactor coolant. The amount of heat generated (thermal power level) will be controlled by a coordinated combination of a soluble neutron absorber (borated water) and mechanical control rods (stainless steel clad silver-indium-cadmium). The mechanical control rods consist of clusters of stainless steel clad absorber rods and Zircaloy guide tubes located within the fuel assembly. Under full power operating conditions, approximately 1720 MW of heat will be produced. The primary loop water does not boil because of the high pressure (2250 psia nominal) in the system. As it passes through the steam generators (heat exchangers) it will convert secondary loop water into steam. It is this steam that will drive the turbine-generator to produce electricity. After the water from the reactor completes its function in the heat exchangers, it will be returned to the reactor where the process begins again. Steam in the secondary loop will be condensed to water as it leaves the turbine and passes into the condenser where it is cooled by Lake water. The condensate will be collected in the hot well and will be returned as feedwater to the steam generators, and go through its cycle again. The primary and secondary water loops are separately enclosed. There is a physical barrier prohibiting the passage of radioactive nuclides from the reactor coolant into the turbine and the condenser. This barrier between steam condensate and Lake water in the condenser keeps the radionuclides from entering the Lake water.

The electricity generated as above will result in net plant output of about 540 MWe. Generated at approximately 21 kv, this output will be fed to transformers that raise the voltage to 345 kv and 138 kv, and deliver it to the system.

2.2 ENVIRONMENTAL APPROVALS AND CONSULTATION

Information listed in Table 2.2-1 gives the status of permits and other approvals of plant construction and operations required by Federal and State authorities. The letters listed in Table 2.2-1 are in the Wisconsin Public Service files and are available on request. Copies of permits which relate most directly to environmental factors are included in Appendix B.

In addition to the permits and approvals noted in the above Table the following authorities were contacted at various stages of project development from planning through construction.

Town of Carlton - Chairman

Kewaunee County Board Chairman

Kewaunee County Sheriff's Department

City of Kewaunee

United States Coast Guard

Many of the people within these organizations gave testimony in behalf of the Kewaunee project at various public meetings and hearings.

There are no planning authorities with jurisdiction over the Kewaunee Nuclear Power Plant site area. Copies of the Preliminary and Final Safety Analysis Reports, as well as the Environmental Report, have been placed in the public libraries within the area.

TABLE 2.2-1

PERMITS AND APPROVALS FROM STATE AND LOCAL AGENCIES

FEDERAL

Agency	Subject	Application Date	Approval Date
Atomic Energy Commission	Construction Permit	E.W. James letter; 8/18/67	8/6/68
	Operating License	1/12/71	Pending
	Special Nuclear Material License	R.C. Straub letter; 8/23/71	9/7/71 to E.W. James
Corps of Engineers	Intake and Discharge Facilities	N.E. Knutzen letter; 6/17/68	Corps letter dated 12/12/68
	Concurrence with Fish & Wildlife Department Requirements	Fish & Wildlife letter; 7/23/68	G.F. Hrubesky letter; 10/23/68
	Temporary Breakwater	Luektue letter; 4/2/69	Corps of Engineers letter; 5/5/69
	Discharge During Construction	R.W. Weaver letter; 6/16/71	Pending

STATE

Department of Natural Resources	Construct High Capacity Wells	Letters of 11/21/67; R.C. Straub to DNR	12/26/71, DNR letter to R.C. Straub
	Yard Piping and Pumbing	N.E. Knutzen letter; 6/13/69 to DNR	DNR letter 10/21/69 to to N.E. Knutzen
	High Capacity Test Well	R.A. Krueger letter; 6/20/69 to DNR	DNR letter of 6/25/69
	Build & Maintain Harbor & Water Supply Structures	Application to Public Service Commission	12/4/67, Supplementary Order 12/27/67

(Continued)

TABLE 2.2-1 (Continued)

Agency	Subject	Application Date	Approval Date
Department of Natural Resources (Cont.)	Approval of Circulating Water Intake & Discharge System	N.E. Knutzen letter to DNR; 3/19/68	DNR letter; 5/21/68
	Sewer Pipe Installation	N.E. Knutzen letter; 4/10/68	DNR letter; 4/15/68
	Sanitary Sewer System & Sewage Treatment Plant	N.E. Knutzen letter; 4/26/68	DNR letter 5/22/68 and DNR letter 8/29/68
	Intended New Wastes	N.E. Knutzen letter to DNR; 1/24/69	DNR letter; 6/5/69
	Discharge During Construction	E.R. Mathews letter; 8/2/71	Pending
State Highway Commission	Install Access Driveway to Trunk Highway	12/8/67	12/12/67
Department of Industry Labor & Human Relations	Grading & Excavating	R.C. Straub letter; 12/28/67	Letter 3/25/68 to Wisconsin Public Service
	Re-inforced Concrete Foundation Mat Substructure	N.E. Knutzen letter; 6/12/68	Letter to N.E. Knutzen 1/15/69
	Reactor Building Re-inforced Concrete Shield Structure	N.E. Knutzen letter; 11/14/68	Letter of 12/12/68; Wisconsin Public Service
	Superstructure	N.E. Knutzen letter; 12/23/68	Letter to N.E. Knutzen; 1/15/69
	Fuel Oil Storage & Handling Facilities	N.E. Knutzen letter; 4/22/70	Letter to Wisconsin Public Service; 5/8/70
	Steam Heating	N.E. Knutzen letter; 4/22/70	Letter to Wisconsin Public Service; 5/13/70
	Heating Ventilating & Air Conditioning for Administration Building	N.E. Knutzen letter; 8/7/70	Letter to Wisconsin Public Service; 9/15/70

(Continued)

TABLE 2.2-1 (Continued)

Agency	Subject	Application Date	Approval Date
Department of Industry Labor & Human Relations (Cont.)	Ventilation of Turbine Building	N.E. Knutzen letter; 10/2/70	Letter to Wisconsin Public Service; 10/15/70
	L. P. Gas Storage	N.E. Knutzen letter; 2/3/71	Letter to N.E. Knutzen 2/22/71
Public Service Commission	Construct & Operate	3/17/67	10/17/67
	Point Beach to North Appleton Transmission Line	12/3/67	2/8/68
	Substation Transmission Lines - 345/138 Kv	12/17/68 Supplementary Information 1/13/69	2/17/69

2.3 ENVIRONMENTAL IMPACT

2.3.1 Land Use Compatibility

2.3.1.1 General

Land along the Lake Michigan shoreline has significant potential for industrial development. General conditions are favorable for construction and operation of power generating stations. For example, in the southern sector of Lake Michigan near the major cities of Milwaukee and Chicago, both nuclear and fossil fuel plants are under construction with operations scheduled for 1972. There are also plants in operation at this time. However, with the exception of the Point Beach Nuclear Plant, 4.5 miles south of the Kewaunee station on the shore of Lake Michigan, there are no nuclear generating plants within approximately 200 miles of the Kewaunee site.

Topography. Kewaunee County is generally characterized by undulating to gently rolling terrain. The most prominent topographic feature of the area is the Kettle Moraine belt that runs through the central part of the country.

The ground surface of the 908 acre site varies from beach level to a maximum of 100 feet above the level of Lake Michigan. Site topography is gently rolling to flat. The natural vegetation is sparse brush and trees. Three intermittent creeks cross the site and empty into Lake Michigan. The lake-side boundary of the site varies from steep bluffs on the extreme north and south borders to sandy beaches near the center of the site.

History. Late in the 18th century, Kewaunee County was visited by early French explorers who established a trading post on the Kewaunee River. However, extensive settlement didn't occur until the 1850's. During the 19th century, German craftsman migrated to the area and built a tradition in woodworking. Furniture of outstanding quality is still made by a local firm (Ref. 2).

The state Historical Society of Wisconsin lists 52 historic sites within the State (Ref. 3). Six of these sites are located within a 40 mile radius of the plant. Specifically, all six are located in the west-north-west quadrant between 20 and 30 miles from the site. Four of the historical sites are situated in the metropolitan area of the city of Green Bay. The other two sites are located approximately ten miles north and south, respectively, of the Green Bay area. The six historical sites are all buildings which represent the early Wisconsin history. According to the National Register of Historic Places (Ref. 56) there are no historical sites on the Kewaunee Nuclear Plant site.

The State Archeological Society was interviewed to determine if archeological diggings were in progress or if any were planned within the Carlton Township. Also, the Society was questioned to ascertain if there are specific archeological records of sites within the site boundary.

Dr. Joan Freeman of the State Archeological Society conducted a search of records of the sections within Carlton Township and verified that presently there are no documented archeological sites within the site boundaries (Ref. 4). However, there are a number of sites located within Kewaunee County. In Ahnapee, there is a village site on the shore of Lake Michigan in Section 33 and a cemetery in Section 27. In the town of Kewaunee (10 miles north of the site) there are traces of garden beds and cultivated areas within an Indian village in Section 7; a cache of 162 Flint blanks and arrowpoints in Section 14 and two conical mounds in Section 17. In the town of Carlton there was a cemetery in Section 29.

The archeological sites along the Lake Michigan shore cover a time span from about 9000 years ago up to the period of historic Indian occupation. Only a small number of these sites have ever been systematically excavated.

2.3.1.2 Physical Characteristics

<u>Geology</u>. The Kewaunee site is located in the Central Lowland Physiographic Providence. In the northern part of Wisconsin, Precambrian granite, gneiss, schist and volcanic rocks form the uppermost bedrock which extends eastward to within approximately 50 miles of Lake Michigan. In the site area, and elsewhere in the State, the Precambrian rocks are

overlain by Paleozoic sedimentary strata, consisting primarily of dolomite, standstone and shale. Younger formations, formerly present in the region, have been removed by erosion.

Most of Wisconsin and adjacent areas were subjected to a repeated glaciation during the Pleistocene epoch (Ref. 5). The advancing glaciers scoured major stream valleys and enlarged the depressions now occupied by the Great Lakes. The glaciers also deposited a thick mantle of glacial drift over the bedrock surface. Recent sediments deposited by streams and lakes added to the unconsolidated cover in local areas, particularly along the Lake Michigan shore.

The site occupies an area of rolling farm land, which is bordered on the east by flat beaches adjoining Lake Michigan. Maximum relief between the rolling terrain and the flat beaches is on the order of 50 feet. Ground surface elevations within the proposed site ranged from 590 to 700 (International Great Lakes Datum, IGLD). The rolling topography at the site presents part of a glacial end moraine deposited along the Lake Michigan shoreline during the most recent period of glaciation. Data from test borings drilled for the Kewaunee project revealed that the glacial drift overlying the bedrock at the site consists of essentially an upper layer of glacial till underlained by glacial lacustrine deposits. The upper layer of till contains layers and pockets of sandy soil and also traces or pockets of buried forest growth and peat beds. The glacial soils consist essentially of a stiff to hard silty clay which contains variable amounts of sand and gravel and seams of sand and silt. Discontinuous deposits of glacial outwash of sand and gravel were encountered immediately above the bedrock at several locations within the site. The glacial drift at the site ranges in thickness from approximately 60 to 150 feet.

The bedrock immediately underlying the glacial drift consists of moderately fractured Niagara dolomite. This formation is 350 to 600 feet thick and has a regional dip to the east of about 30 feet per mile. Deeper bedrock formations consist predominantly of sandstone and dolomite and subordinate layers of shale. Precambrian basement rock is encountered at a depth of more than 1,000 feet below sea level in this part of Wisconsin.

The Precambrian rocks cropping out in northern Wisconsin form a portion of the structural high known as the Wisconsin Arch. In eastern Wisconsin, the sedimentary strata dip gently eastward away from the Wisconsin Arch to form the Michigan Basin, a broad, downward warp extending eastward from Wisconsin across the southern peninsula of Michigan. The eastward dip is interrupted locally by shallow synclines which turn eastward from several points along the Lake Michigan shoreline between the cities of Kewaunee and Milwaukee.

Several inactive faults have been reported approximately 15 miles from the proposed site in the area near the southern end of Green Bay.

Several other ancient faults have been inferred south of Madison and in the southeastern corner of the State near Milwaukee. There is no evidence of activity along any of the known fault zones in the region during the Pleistocene epoch or during more recent geologic times. Seismicity of the site is described under the seismology heading of this section.

Coastline recession along Lake Michigan is a major environmental characteristic effecting the site. The rate of coastline recession is a function of the water level of the lake, storm conditions, wave action, and the amount of ground water seepage along the face of the bluffs, as well as the susceptibility of these materials to erosion. Observations made over a period of time indicate that the rate of recession, at various points along the Wisconsin shoreline, ranges up to 12 feet per year. The shoreline along most of the site is characterized by steep, unstable bluffs. A short stretch of coastline is moderately flat. Stable slopes near the center of the site are protected from active erosion by a promontory extending into the Lake. The shoreline has been stabilized by the judicious placement of larger rock around observation point and the discharge area.

Soils. Agriculturally, Wisconsin can be divided into nine general soils regions (Ref. 6). The Kewaunee site is located in the reddish clay loam region. These soils have developed from reddish calcareous shale. The clays in this system usually have high shrink-swell properties. The predominate soil types within the site are Kewaunee silt loam and Manawa loam. Generally, these soils are considered to be good to fair for agriculture purposes. The land capability classifications of these two soils range from 2 to 4. Capability classifications range from 1 to 8; 1 is best, 8 is poorest for agriculture purposes.

The Kewaunee loam is generally a light colored, well drained, clayey silt topsoil over a reddish brown silt to clay subsoil with an underlying calcareous clayey till at depths of 20 to 40 inches. These relatively impermeable soils have potentially high water holding capacity. The production use of this type soil is medium to high for woodland, and slight for pasture because of erosion. Specialty crops such as peas do well on the low slopes and the soil has high holding capacity for fertilizer (Ref. 7).

The Manawa loam is a poorly drained, dark silt loam topsoil over a dark brown to reddish brown silt to clay subsoil underlain with clayey till at depths of 20 to 40 inches. The rating for cropland of such soils is moderate, slight for pastures and medium to high for hardwoods; low to medium for pines (Ref. 7).

The engineering characteristics of the near-surface soils have been extensively studied. The glacial drift materials which overlie the rock are predominantly compact soils which are fairly dense and relatively incompressible. Soil shearing strengths are high; the overall supporting capability of the soil is excellent with respect to conventional foundations designed for moderate to substantial contact bearing pressures. The actual supporting capability and gradational characteristics of these soils varies somewhat horizontally and vertically. The soil system, while grossly classified as drift, includes outwash, till and lacustrine sequences, the individual characteristics of which were carefully considered in plant layout and design.

Mineral Resources. Except for the Point Beach Nuclear Power Plant, the land within a five mile radius is devoted exclusively to agriculture. The only known economic mineral resource activity in the region is located a considerable distance north and west of the site in the Precambrian basement complex (Ref. 8). The principal ores mined are copper and iron from the Keweenaw area and Gogebic range. The Precambrian basement complex under the plant site is so deep that economic development of possible ore bodies is not feasible.

Regional geology, test borings and other indicators reveal no mineral resource underlying the site at economic depths and the potential loss of mineral resources due to construction and operation of the Kewaunee Nuclear Power Plant, therefore, is not likely. The near-surface soils are generally too fine-grained to be considered a significant sand and gravel aggregate source.

Seismology. Data obtained from an examination of the seismic history and regional tectonics of the area indicate that within 100 miles of the site only minor earthquake activity has been reported during the past 175 to 200 years (Ref. 5). Historically, there is no basis for expecting ground motion of more than a few percent of gravity. However, additional studies have been made to evaluate the site for dynamic response criteria and to establish the design earthquake. Based on these studies, the power plant has been designed to respond elastically, with no loss of function, to earthquake ground motion as high as six percent of gravity. In addition, the plant has been designed for a safe shut-down of the reactor for ground motions reaching 12 percent of gravity in the shallow and firm overburden soils at the site.

2.3.1.3 Land Use

Existing and Future Land Use Within the Project Area. The effects of the Kewaunee project on land use can be categorized as: 1) the effect of construction and operation upon the plant site itself and, 2) the effects which may be directly or indirectly imposed upon adjacent land uses. Each of these two groups is considered with regard to the permanency or transciency of future uses of the land.

The Owners of the Kewaunee project have acquired 908 acres. The actual plant site occupies approximately 110 acres. Of this, the plant buildings, substation, and transporation facilities cover approximately 15 acres, and about 17 acres southwest of the plant proper were used as 2
landfill for the disposal of construction refuse. Four to five acres are being

reserved for proposed high school conservation classes and approximately 790 acres are under cultivation. Agricultural operations will be discontinued this fall; however, the land will be leased back to local farm operations if approval is granted by the Atomic Energy Commission.

The only significant alterations in land use have occurred within the 110 acres where the plant is being constructed. The alterations have been the result of grading activities, the construction of structures and facilities, placement of sanitary landfill, and the transportation and storage of construction materials and equipment. All disturbed areas not otherwise developed will be graded, landscaped, and seeded to grass as soon as the construction schedule permits.

There were originally twelve residences within the site boundary. All have been purchased and, with the exception of three, will be removed from the site within the next 12 months. One of the remaining buildings, a log cabin, will be used as a classroom for conservation instruction, one will serve as an Emergency Control Center, and the disposition of the third has not been finalized. The Emergency Control Center will be moved from its present location to a position 0.8 miles west of the facility.

Situated north of the plant within the site boundary is a cemetery (1.3 acres) which will remain under the ownership of Carlton Township. There are no dwellings or public buildings on the cemetery site and the grounds will be maintained by the Township. Access to the cemetery will be maintained.

Only a limited amount of data is available concerning wildlife uses of the land. However, the regional character is such that it provides limited refuge for inland fowl and small ground animals. This subject is explored more fully in Section 2.3.6.2.

Existing and Future Land Use in the Vicinity and Region. The total surface area within a 50 mile radius from the plant site includes about 60% water and 40% land. The two main bodies of water are the north western portion of Lake Michigan and the southern sector of Green Bay.

Land used within the vicinity (10 mile radius of the site) and the region (within 50 miles of the site) is devoted primarily to agricultural activities. Within the region, about 90% of the land is devoted to farming (Refs. 2,9,10). Dairy and livestock products account for approximately 85% of the farm production with crops (primarily corn for grain or silage, oats, and hay) and poultry accounting for the remainder. Eleven dairy plants are located in Manitowoc County, four dairy plants in Kewaunee County, and 22 processing and bottling plants in Brown County.

The transmission towers and substation at the Kewaunee plant occupy approximately 10 acres of land that was previously used for agriculture, primarily for growing corn or silage and for grazing dairy cattle. The transmission lines required to tie into the existing regional transmission grid includes about 56 miles of new line. New lines extend from the Point Beach Nuclear Plant to the Kewaunee Nuclear Plant from which they head west and tie in with the WEPCo. substation at North Appleton.

Prior land uses along the transmission right-of-way included farm land, (84%), woodland (7%), wetlands (2%) and scrubland (7%).

Every effort has been made to lessen the environmental and visual impact of the transmission tower structures in accordance with existing company policies. This effort has extended from design procedures to planting and maintenance of the right-of-way. No access roads are used. To help offset the visual impact, the substation has as low a profile as feasible. The transmission lines are high enough to avoid a psychological visual partition, or "fencing-in" effect. Routing of transmission lines across hilltops was avoided and the towers were constructed of wood to harmonize with the environs.

One obvious method of reducing the visual impact would have been to use underground transmission. However, the present state of technology of high voltage transmission, in addition to exceedingly high economic cost, prohibited this method.

The portion of land in forestry in Kewaunee, Manitowoc and Brown Counties averages about 15 percent. It is well below the state average of 44 percent (Refs. 2,9,10). The nearest forest is Point Beach State Park, located between 8 and 11 miles south of the plant along the Lake Michigan shore.

The projection of future uses of land in the vicinity involves a review of published economic statistics pertaining to labor, recreation, industry, transportation and agriculture (Refs. 8,11,12,13,14). The results of the available studies (Ref. 12) indicate that land use within the vicinity of the plant site for the next 5 years will continue to be devoted primarily to agriculture. Income will be drived largely from dairy and livestock products. The small amount of acreage removed from the regional economy by the plant will be more than balanced by the corresponding positive economic effects of the plant operation.

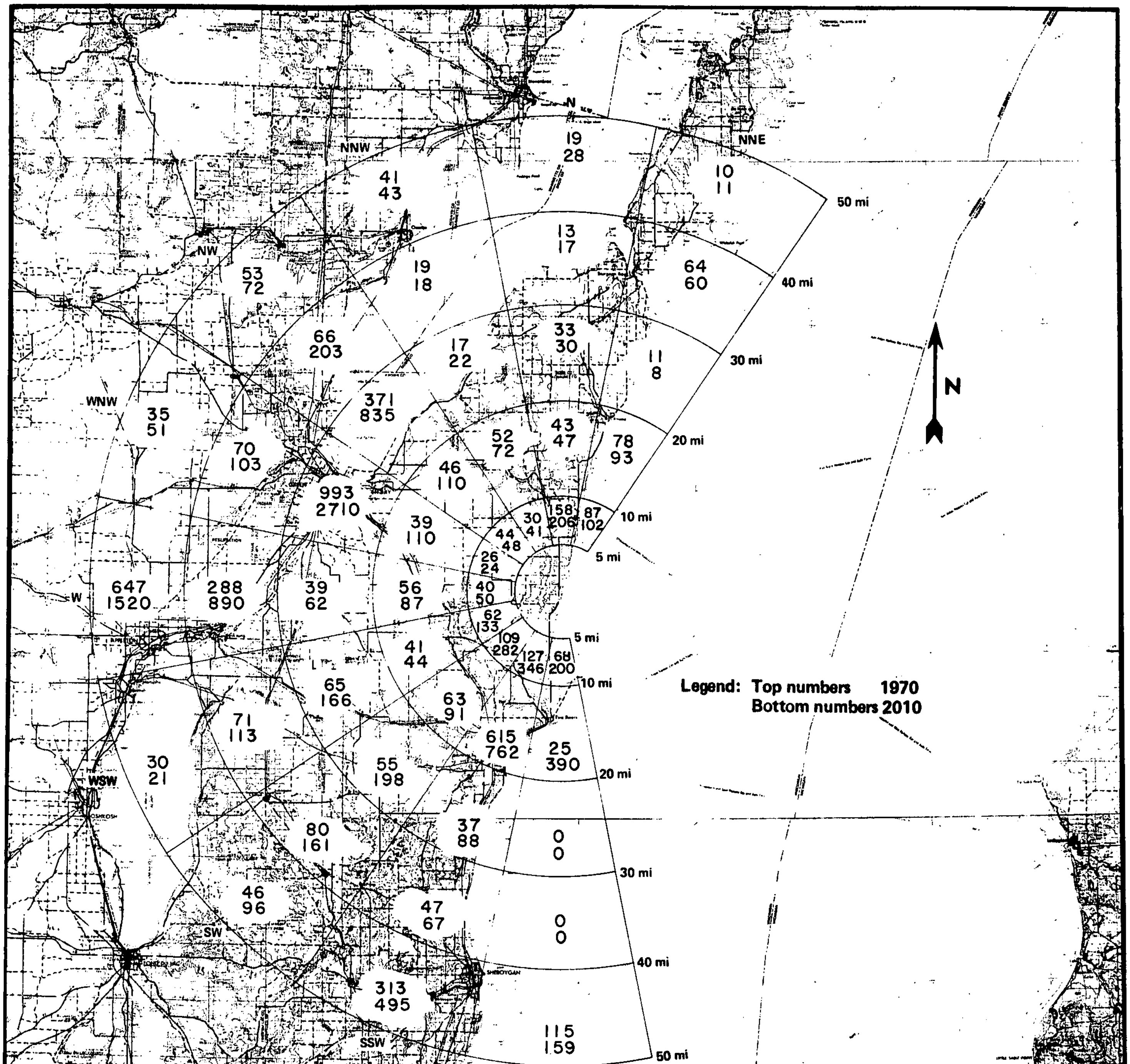
It is concluded that the construction and operation of the Kewaunee Plant will not significantly alter land use in the vicinity and that the overall regional economy will not be negatively affected.

Population Characteristics. The region (50 mile radius) of the site encompasses the entire counties of Calumet, Brown, Kewaunee and Manitowoc. Brown County which is located in the west-northwest segment approximately 20 to 30 miles from the power plant contains the highest population density within the region, 973 persons per square mile (Ref. 10). This is due to the fact the City of Green Bay is located in Brown County. The second highest population density is the west segment between 40 to

50 miles from the plant site which has 647 persons per square mile as a result of the City of Appleton. The third highest population density (615 persons per square mile) is in the 10 to 20 mile segment south-southwest of the site, in which the two cities of Manitowoc and Two Rivers are located. Three other segments with more than 250 people per square mile are located in the 50 mile region. These are: south-southwest, 40 to 50 miles; west, 30 to 40 miles; and west-northwest, 20 to 30 miles. Figure 2.3-1 presents the 1970 population density to a distance from 5 to 50 miles from the Kewaunee Plant along with expected future densities to the year 2010.

Major cities encompassed by the 50 mile area (Figure 4) are Green Bay (30 miles west-northwest) with 87,809, Appleton (43 miles west) with 57,143, Sheboygan (40 miles south-southwest) with 48,484, Manitowoc (18 miles south-southwest) with 33,180 and Two Rivers (13 miles south) with a population of 13,437. The 1970 Census data have been used to calculate the population. Figure 2.3-2 gives the population within the 5 to 50 mile radius of the site.

The total population within fifty miles of the plant was projected to be about 1,200,000 by the year 2010. This represents a growth rate of about 20% per decade from the 1970 population of 572,000. The high rate of growth around the Kewaunee site is due primarily to the counties of Brown (26.5% per decade), Calumet (24% per decade), Winnebago (20.4% per decade) and Outagamie (17.3% per decade). The plant is situated

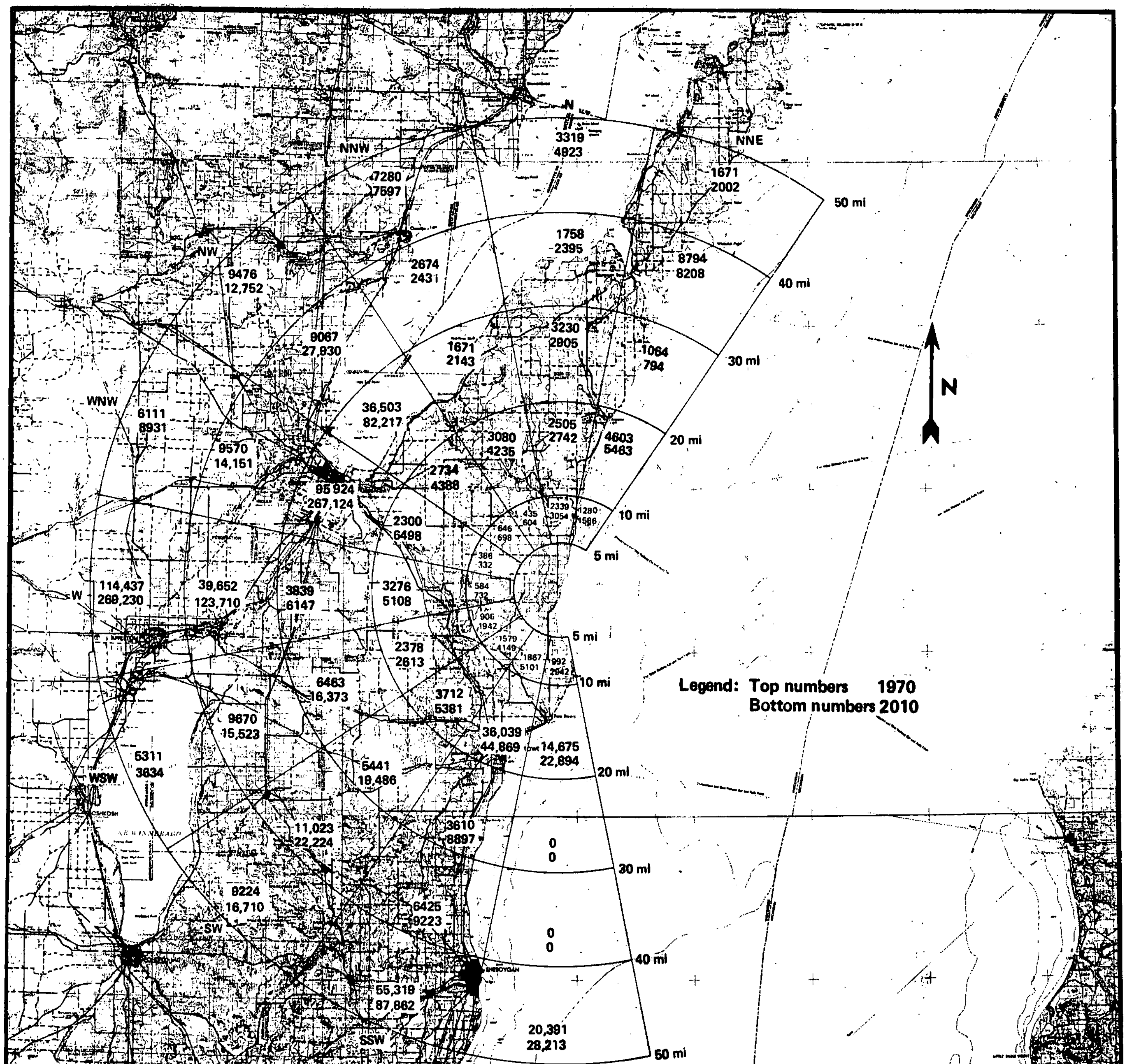


Annulus	5–10 mi	10–20 mi	20–30mi	30–40 mi	40–50mi	5–50 mi
1970 Annulus Total	11,014	76,302	157,745	98,633	230,192	572,501
2010 Annulus Total	21,140	104,191	405,896	225,795	443,200	1,200,222

KEWAUNEE NUCLEAR POWER PLANT

POPULATION DENSITY , 5–50 mi, 1970 and 2010

FIGURE 2.3-1



Annulus	5–10 mi	10–20 mi	20–30 mi	30–40 mi	40–50 mi	5–50 mi
1070 Annulus Total	11,014	75,302	157,745	98,633	230,192	572,501
2010 Annulus Total	21,140	104,101	405,896	225,796	443,200	1,200,222

KEWAUNEE NUCLEAR POWER PLANT

POPULATION DISTRIBUTION, 5–50 mi, 1970 and 2010

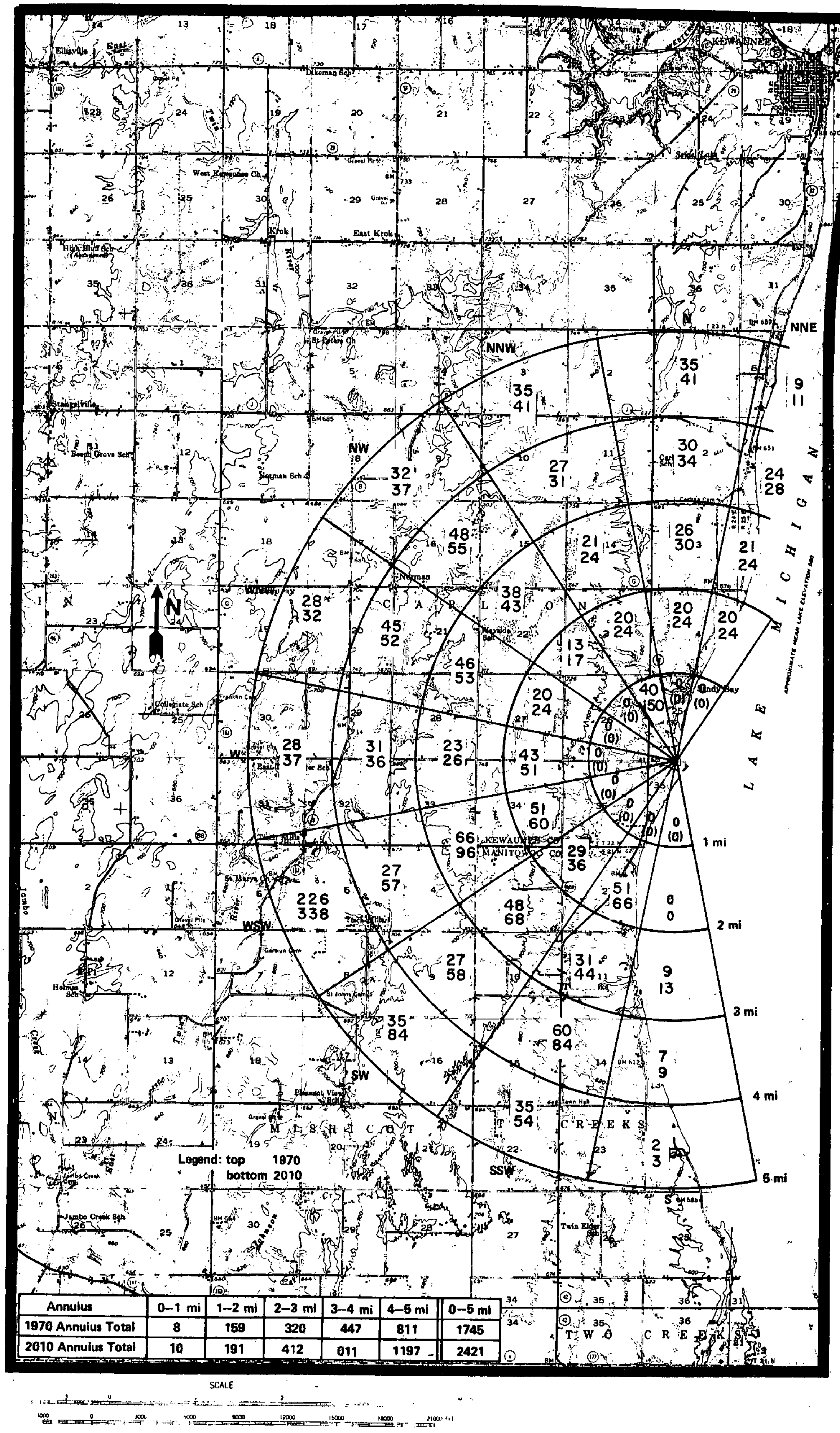
FIGURE 2.3-2

in the general area of the fastest growing portion of Wisconsin; however, within five miles of the site population is not expected to increase appreciably.

Kewaunee County is only slightly urbanized. The two urban centers of Algoma and Kewaunee contain over one-third of the county population. The population density for the segments of these cities in Kewaunee County is 158 persons per square mile between 5 and 10 miles north of the plant. The density of persons per square mile from 0 to 5 mile radius of the station are shown on Figure 2.3-3. The average density for the 5 mile radius is 28 persons per square mile.

The estimated 1970 population data for the 0-5 mile figure was obtained by projecting the 1965 estimate (Ref. 15) house counts to 1970 for the townships of Mishicot and Carlton. For the township of Two Creeks, new data were obtained in the form of a 1971 Land Use Survey of the Town of Two Creeks by the Manitowoc County Planning and Park Commission. This survey map showed the location of all residences in the township. Since the 1970 population was known, an occupancy rate of 4.3 persons per house was obtained for the Town of Two Creeks. Figure 2.3-4 presents the population distribution from 0 to 5 miles from the Kewaunee Plant.

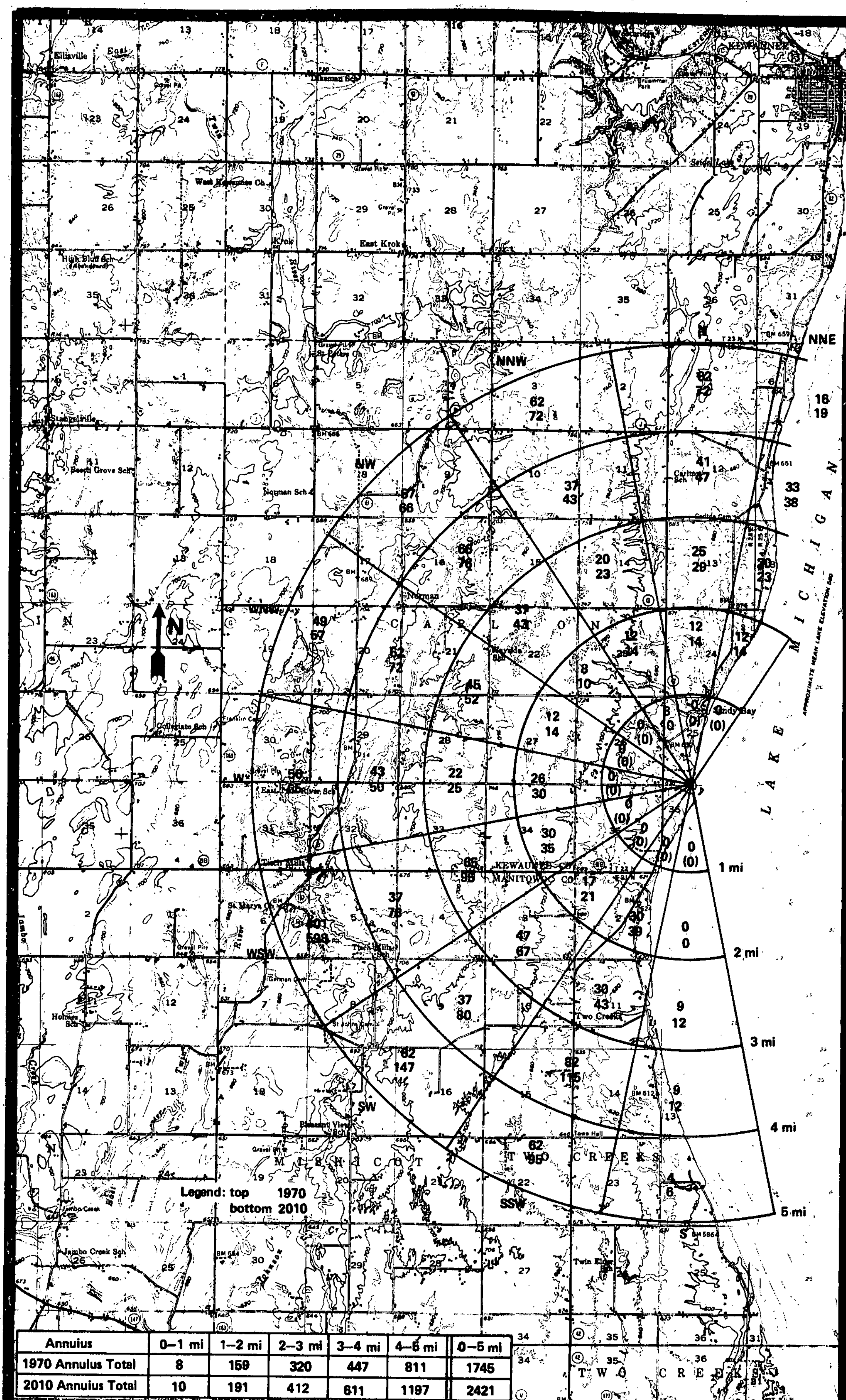
The 0-5 mile projection was based on growth over the last twenty years for both Mishicot and Two Creeks Townships. It is believed



Annulus	0–1 mi	1–2 mi	2–3 mi	3–4 mi	4–5 mi	0–5 mi
1970 Annulus Total	8	159	320	447	811	1745
2010 Annulus Total	10	191	412	611	1197	2421

KEWAUNEE NUCLEAR POWER PLANT
POPULATION DENSITY, 0–5 mi, 1970 and 2010

FIGURE 2.3-3



Annulus	0–1 mi	1–2 mi	2–3 mi	3–4 mi	4–5 mi	0–5 mi
1970 Annulus Total	8	159	320	447	811	1745
2010 Annulus Total	10	191	412	611	1197	2421

SCALE

CONTOUR INTERVAL 20 FEET

KEWAUNEE NUCLEAR POWER PLANT
POPULATION DISTRIBUTION, 0–5 mi, 1970 and 2010

FIGURE 2.3-4

that the high growth rate experienced by these areas in the 1960's was not typical and not likely to continue at that rate for very long. This conclusion is supported by the fact that this area is rural and since 1900 the population has been declining.

The Kewaunee plant site property boundaries (908 acres) lie entirely within a one mile radius of the site. The total accumulative resident population of 8 people is expected within this radius; the closest resident will be 0.8 miles north of the reactor area.

There will be 66 operating personnel at the plant. Most are already permanently established in the area and reside primarily in the cities of Two Rivers and Kewaunee. These have relocated from outside the area and no discernible strain on services has occurred. The few remaining personnel required will be derived largely from local residents. It is concluded that the remaining construction and operation of the Kewaunee Plant will not significantly affect the permanent or future demography of the vicinity.

Fluctuation of the seasonal population is very small within a two mile vicinity of the site. Primarily, the seasonal or temporary residents occupy small cottages along the Lake Michigan shoreline. There are presently 12 part-time residences about 5 miles north-northeast and one cottage approximately 5 miles south of the site. The future use or estimate of future new cottages is difficult to predict with a reasonable degree of certainity, but even a 100% increase by year 2010 would still involve very few people. The duration of stay is not documented, but it appears that weekend use is predominant.

The most transient population within the site vicinity will consist of vacationing motorists. Visit durations within the plant vicinity are variable, ranging from a few hours to overnight stays. The Point Beach State Forest attracts some overnight visitors. There are 120 campsites within the state forest.

There are no activities, such as large college events, or large civic functions to concentrate people in large numbers within the site vicinity.

In summary, the vicinity population (10 mile radius) should not change dramatically in the short-term nor is it expected that the Kewaunee Plant will significantly influence population numbers or distribution.

Agriculture. Agricultural employment remains slightly ahead of manufacturing in employment within the site vicinity (Ref. 2). However, as in other parts of the United States, the number of farms is declining while the average size of farm and value of land is increasing. Crops grown are corn, oats, barley, hay, green peas, potatoes and wheat (Ref. 16). Dairy products still remain by far the largest source of farm income.

Table 2.3-1 shows agricultural and livestock data for Kewaunee and Manitowoc Counties and their relation to the State as a whole.

The dairy industry has long been a valuable asset to the State and to the vicinity. In a radius of two miles from the site, there are 650 milk cows and a few beef cattle. The farms are operated on a full-time basis. The cows are grazed from early June to early October with winter feed being produced locally.

In the past years the economy of the area has been based on agricultural products. This is expected to continue to be the economic base for the foreseeable future. The construction and operation of the Kewaunee Plant will not preclude the future growth of agriculture within the vicinity.

Industry. The main industries of the region (50 mile radius) include the manufacturing of aluminum products, heavy construction machinery, wood products, food and paper (Refs. 2,9,10,11). Industrial activity within a 20 mile radius of the site is confined chiefly to the cities of Manitowoc, Two Rivers, Kewaunee and Algoma.

TABLE 2.3-1

PRODUCTION OF AGRICULTURAL CASH CROPS

AND LIVESTOCK FOR KEWAUNEE AND MANITOWOC COUNTIES

1970 Average State Crop Value Per Acre - $	Crop	Kewaunee County Acres	Kewaunee County Yield Per Acre	Kewaunee County Rank of 72 Counties	Manitowoc County Acres	Manitowoc County Yield Per Acre	Manitowoc County Rank of 72 Counties
110.40	Corn (grain)	3,900	68.0 Bu	53	15,000	61.0 Bu	43
	Corn (silage)	14,300	13.2 Ton	25	23,800	9.8 Ton	15
44.02	Oats	37,500	67.0 Bu	12	54,400	72.0 Bu	4
45.91	Barley	550	48.0 Bu	17	750	48.0 Bu	13
47.28	All Wheat	850	33.9 Bu	17	650	37.5 Bu	20
56.70	Soybeans	100	16.0 Bu	53	300	20.0 Bu	44
	Alfalfa hay	50,700	2.6 Ton	31	84,000	2.8 Ton	7
	Clover and Timothy hay	7,200	2.3 Ton	35	8,600	2.3 Ton	30
609.67	Potatoes	50	160 HWT	49	250	200 HWT	23
127.54	Peas	2,000	1.1 Ton	16	4,500	1.1 Ton	8
90.54	Sweet Corn	200	3.4 Ton	41	1,800	3.2 Ton	18

(Continued)

*Source: 1971 Wisconsin Agricultural Statistics, Wisconsin Statistical Reporting Service, Madison, Wisconsin

TABLE 2.3-1 (Continued)

Livestock	Kewaunee County Number Total Head	Kewaunee County Rank of 72 Counties	Manitowoc County Number Total Head	Manitowoc County Rank of 72 Counties
Cattle and Calves	50,500	38	83,000	22
Milk Cows and Heifers	31,300	25	43,000	13
Calf Crop	31,800	29	44,200	16
Pigs (Saved)	36,450	31	45,500	24
Sheep	Less than one thousand head			
Chickens	63,000	49	120,000	24

Manitowoc, the largest city in the 20 mile zone, is a diversified manufacturing center that produces heavy equipment and aluminum products; shipbuilding is also an important activity. Manitowoc has an active port installation. Over two million short tons per year of rail freight are carried across Lake Michigan by ferries departing from the Manitowoc port (Ref. 9).

Two Rivers is located 13 miles south of the site and is also composed of diversified manufacturing such as appliances and aluminum products.

Kewaunee is the closest city to the site having a population of more than 1,000. A port located at Kewaunee is served year round by the Chesapeake and Ohio and the Ann Arbor railroads. Other firms in the area are involved in the manufacture of wood products, foundry, metal fabrication, welding, and several small cheese factories.

In Algoma the stamping of aluminum utensils is another significant operation and the Hammock Plant ranks as one of the largest such firms in the United States (Ref. 2). The United State Plywood Corporation has undergone continuous growth in Algoma and is the largest manufacturing employer with over 900 employees (Ref. 2).

Industrial expansion in the future within the 20 mile zone of the plant site will be influenced by the advantages offered by the ports of Manitowoc and Kewaunee. The long established industries are likely to grow in production because of the transportation connections with regional and national markets.

In conclusion, the Kewaunee Plant should not interrupt industrial development in the area. In fact, the power produced by the plant should allow continued growth of industry in the vicinity.

Recreation. Outdoor recreation is one of the region's largest industries and represents a potential source of economic growth for the area. The Wisconsin vacationer is offered touring, camping, boating, and fishing opportunities. Most of these vacationers stay at least one night in secluded sites (Ref. 17).

Persons from outside the region comprise 55% of the camping demand in 1960 and are expected to be 65% of the total by 1980 (Ref. 14). The increased demand for camping facilities will occur as the population increases in adjoining states and as the transportation facilities, such as the interstate highway system, are improved.

Sport fishing is popular along the Kewaunee County shore of Lake Michigan and on six small inland lakes in the site vicinity (Ref. 18).

Within a 40 mile radius of the site there are three state parks: Point Beach (8 miles south), Potawatomi (located about 35 miles north), and Lost Dauphin (about 30 miles east) of the plant.

There is a park and zoo in the town of Kewaunee (Ref. 18). In addition, there are public beaches at both Kewaunee and Algoma. Both are located over 8 miles to the north of the plant.

In the County of Kewaunee, there are two public hunting grounds. One is in the southeast corner of the township of West Kewaunee, about 4 miles north of the site and the other is in the southwest corner of Casco Township, 8 miles northwest of the site (Ref. 18). The predominate game species are cotton-tail rabbit, Hungarian partridge and pheasant. Deer and nesting ducks seldom frequent the area because of the lack of suitable habitat.

The nuclear plant will not adversely affect the recreational potential within the area. Fishing and boating in the area of the plant site will not be curtailed or in any way limited. Camping areas will not be affected and hunting will be unaffected with the exception of the acres on which the plant itself is located. Tourism will increase; already over 100,000 visitors have stopped at the Point Beach Plant and we have already observed similar interest at our visitors center.

Aesthetics. The most unique visual characteristic of the Kewaunee Nuclear Power Plant is the tall cylindrical form of the reactor containment structure. This form has the significance of relating to the vernacular architecture of the region through its similarity to the silos prevalent on the surrounding farmsteads. Although the reactor silo is concrete and rises considerably higher than typical farm buildings, views from some distance show the overall massing and silhoutte of the generating plant to be surprisingly analogous to the pre-existing local man-built forms.

Views from Lake Michigan give quite a different, though not unpleasant, view. Here the forceful rectilinear massing typical of modern industrial architecture is apparent. The reactor silo is less pronounced because it is behind the main plant building from this view. However, the vertical linearity established by the silo is reinforced by the structural expression of the main building. The strong vertical lines of the column enclosures are the most dominant element. The well selected colors soften the visual impact of the large rectangular main building. A two story office projection facing the Lake gives a low horizontal contrast to the verticality of the main plant building. This office element has a much smaller scale and readily indicates where the human aspect of the nuclear operation is centered.

The overall installation affects 110 acres of the 908 acre total site, and except for the buildings themselves, there is no significant change in the terrain. Most of the land is left green. Parking and service areas are, of course, paved; and riprap has been added to the shoreline for stabilization. The riprap visually delineates the shoreline better than did the pre-existing shore conditions. The overall aesthetic effect of the building complex on the landscape is one of distinct visual demarcation without significantly disturbing obtrusion.

2.3.2 Water Use Compatibility

2.3.2.1 Surface Water Hydrology

Watershed Description. The regional drainage area is typified by low relief and a dendritic stream pattern controlled by glacial topography. There are no large rivers or streams in the vicinity of the site. The closest major river is the Kewaunee River approximately eight miles north of the Plant site.

In the Kewaunee area, the average annual precipitation is 26.53 inches (Ref.19). It is estimated that about three-fourths of the annual precipitation is evaporated, and the remainder either runs off as surface water or seeps into the ground. Because of the clayey composition of the glacial drift, only small amounts of water will seep into the ground. The majority of the water will flow into Lake Michigan.

A total range of oscillation due to normal tidal action on Lake Michigan does not exceed two inches. However, squalls may raise the surface of the lake by several feet. Deep water wave heights in the general vicinity of the site, due to storms, are responsible for most of the littoral drift on Lake Michigan. The predominant drift appears to be to the north. A short stretch of moderately flat coastline near the center of the site is protected from active erosion by a promontory extending into the lake. The promontory is probably composed of more erosion-resistant glacial material.

Pack ice in the form of frozen spray and ice flows to a height of 20 feet at the shore have been reported by local residents. No measurement of the extent or depth of the pack ice have been made and no official observations or records have been kept by any agency to verify the reports of local residents. Experience at three plants of the Wisconsin Electric Power Company on Lake Michigan, however, has shown that no significant problems have arisen from icing as a result of design features incorporated in these plants. The Kewaunee Plant design will incorporate features (Ref.20) to insure a continuous supply of cooling water.

There is no record that the site area has been inundated by the lake in recent time, since the uppermost sediments at the site are of glacial origin. The most plausible flooding hazard at the site is the probability of a simultaneous melting of a large amount of snow in the spring, combined with sustained heavy rains.

Except for minor diversions of surface water runoff, construction of the Kewaunee Nuclear Power Plant facility will have no effect on surface runoff or evaporation.

Operation of the plant will increase evaporation of Lake Michigan water due to the addition of heat from the plant's condensers. The amount of increase will be negiligible in comparison with the lake volume. Except for a small area immediately adjacent to the discharge structure, no change in natural current patterns are anticipated.

Municipal Utilization. Lake Michigan is used as the source of municipal water supply in the vicinity of the site for the cities of Two Rivers (13 miles south), Manitowoc (25 miles south), Sheboygan (44 miles south), and Green Bay (intake at Rostok, 12 miles north of the site). The nearest surface water bodies that are used for public supply, other than Lake Michigan, are the Fox River (43 miles west) and Lake Winnebago (40 miles west of the site).

Because of dilution with Lake Michigan water and strict control of chemical and radioactive waste quantities, it is expected that chemical and radioactive waste concentrations reaching any municipal water intake (2-1/2 miles south of the plant at Two Creeks) will be far too low to cause any adverse effect. The effects of the effluents are discussed in greater detail in subsequent sections.

2.3.2.2 Ground Water Hydrology

<u>Aquifer System</u>. The major source of ground water at this site is precipitation falling locally and on higher terrain to the west. Described below are the three principal water bearing formations which underlie the site (Ref. 5).

Glacial Outwash Aquifer. Glacial drift in this area consist of clay soils interbedded with irregular outwash (sand and gravel) aquifers. The most persistent aquifer is located at the base of the glacial drift section and directly overlies the Niagara dolomite. This aquifer is not continuous at the site.

Niagara Dolomite Aquifer. The Niagara dolomite is the uppermost bedrock formation along the Lake Michigan coastline in eastern Wisconsin. The upper part of the Niagara is generally cherty. The Niagara dolomite in certain areas within the region is rather sandy and in other areas may be intersected with joints or bedding planes which increase the permeability of the formation. Data from the borings at or near the site indicate that the rock is dense, moderately fractured and does not contain extensive solution cavaties. The Niagara aquifer is recharged by water percolating through the overlying glacial drift and by more direct infiltration of surface runoff in the areas of higher elevation to the west where the infiltration path is shorter.

Deep Sandstone Aquifer. Cambrian sandstones exist between depths of about 1,200 and 1,700 feet below ground surface. They are separated from the Niagara dolomite by about 800 feet of impermeable shale and dolomite strata. Water in the deep sandstone aquifer at this site is generally too saline to be considered potable.

Flow Characteristics and Potential. Observation of water levels in the preliminary borings indicate that the static ground water level inland from the lake is at depths ranging from 10 to 30 feet below the ground surface. The water table at the site slopes in the general direction of Lake Michigan (east), indicating a migration of ground water in that direction.

Water Well Utilization. About half of the domestic water wells located near the site obtain water from the glacial outwash aquifer. Water wells in this aquifer are typically six inches in diameter and generally are rated at approximately 1,000 gallons per hour.

The remaining domestic water wells of the area are drilled into the Niagara aquifer. These wells are generally six inches in diameter and are rated at about 800 gallons per hour. Most wells penetrate 30 to 60 feet into the formation.

Virtually all of rural and village residences and at least five municipalities located within 20 miles of the site draw their water supply from ground water aquifers. The municipalities located within 20 miles of the site which draw their water supply from ground water aquifers are presented in Table 2.3.2, Municipal Ground Water Supplies (Ref. 5).

Because of the clay composition of glacial drift, it is also unlikely that any appreciable amounts of any surface discharge from the nuclear plant would enter the aquifers. Most of the effluent would occur more as surface flow into Lake Michigan. Since the regional movement of ground water is from west to east anyway, it is unlikely that any possible stray discharge into the aquifers at this site would effect municipal well fields. Fluctuations in the level of Lake Michigan are not of sufficient magnitude to affect the direction of ground water movement. Pumpage from either the glacial drift or the Niagara dolomite aquifers at the site would reverse the direction of ground water movement for an estimated distance of only a few hundred yards.

TABLE 2.3-2

MUNICIPAL GROUND WATER SUPPLIES (Ref. 5)

Municipality	1960 Population	Well Depth Feet	Air Miles and Direction from Site
Denmark	1,106	309 to 456	15 miles west
Kewaunee	2,772	187 to 700	8 miles north
Luxemburg	730	431 to 495	16 miles northwest
Mishicot	762	80	9 miles southwest
Whitelaw	420	495	19 miles southwest

2.3.3 Heat Dissipation

2.3.3.1 Circulating Water System

The circulating water intake system is designed to provide a reliable supply of Lake Michigan water regardless of weather or lake conditions to the suction of two circulating water pumps, four service water pumps and two fire pumps. The intake structure is located approximately 1,570 feet from the shore in water depth of 15 feet. The normal summertime intake rate will be 413,000 gallons per minute with a rise in water temperature over the condensers of about 20° F. During the winter it is planned that circulating water flow will be reduced to 287,000 gpm with a corresponding maximum rise in the temperature of the cooling water of about 28° F. Average summertime intake temperatures recorded at the Point Beach Unit 1 intake crib (4.5 miles south) range from 50° to 60° F. On this basis, it is expected that the normal summertime discharge temperature will be approximately 70° to 80° F. During later summer, higher intake temperatures can be expected for short periods. Data for 1969 and 1970 (Refs. 21,22) showed intake temperatures at 66° F or above for 6 to 7 days and temperatures at 70° F or above for 0 to 5 days, respectively. The records also correlate well with the Rostok intake for the City of Green Bay municipal water supply system to the north of the Kewaunee plant site.

Circulating water enters three intake cones (inverted) which are each 22 feet in diameter and triangularly spaced on 40 foot centers. The top of each cone projects one foot above the lake bottom elevation 562. Normal submergence is 14 feet and minimal submergence based on low lake level is 12.4 feet. The submergence and spacing patterns are designed to offer minimal hazards to navigation, and to eliminate surface water vortices as a protection to small boats and swimmers. The velocity at the surface of the intakes at the full plant load is less than one foot per second.

Steel trash grills with 12 inch square openings are provided above the intake openings. The grills are supplied with recirculated warm water to remove any ice formation. In addition, an air bubble screen around the periphery of the intake cones is provided to discourage fish penetrations and inhibit the formation of surface ice above the intake structure. This bubble screen has been very successful at WPS's Pulliam Plant on Green Bay. Traveling screens with a 3/8 inch mesh size are installed in front of the forebay structure. A hypochlorinating system is provided to inject sodium hypochlorite, if necessary, into the traveling screen inlet area to prevent the build up of bacterial slime on the condenser tubes. Based on recent operating experience, however, it has not been necessary to use sodium hypochlorite to control slime at Point Beach. Since Kewaunee will utilize Lake Michigan water and the two plants are similar in design, it is not expected that the use of sodium hypochlorite at the Kewaunee plant will be necessary. The effect of the circulating water system on the aquatic environment is discussed in Section 2.3.6, Biological Impact.

The intake structure designed for the plant incorporates engineering and technological features to guard against trapping of fish at the inflow. Inasmuch as the magnitude of this problem cannot be determined until after the plant is in operation, it is planned that these facilities could be modified insofar as economically feasible to suit the need.

Each intake cone is fabricated from 1/2 inch steel plate with a 22 foot diameter inlet and a six foot diameter radial discharge pipe at the bottom. The six foot diameter steel pipes join at a trifurcation into one 10 foot diameter steel pipe which is buried a minimum of three feet below lake floor and coated inside and out with asphaltum. The 10 foot diameter steel pipe carries the water 1250 feet to a forebay with an overflow weir whose crest is at elevation 582.5 IGLD feet. The forebay water passes through four traveling screens with a mesh size of 3/8 inch. The screens are provided with automatic water backwashing. Trash collected from the screens will be disposed of on site.

The circulating water will be discharged into an outlet basin at the shoreline (Fig. 2.3-5). The discharge from the pipe will be submerged below lake level. Outlet velocity from the circulating water pipe will be approximately six feet per second into the outlet basin. The basin into which it discharges will be 40 feet wide and will vary in depth, having been dredged so it slopes upward to the lake. Average pipeline velocity into the lake is expected to be about two feet per second. In areas where possible

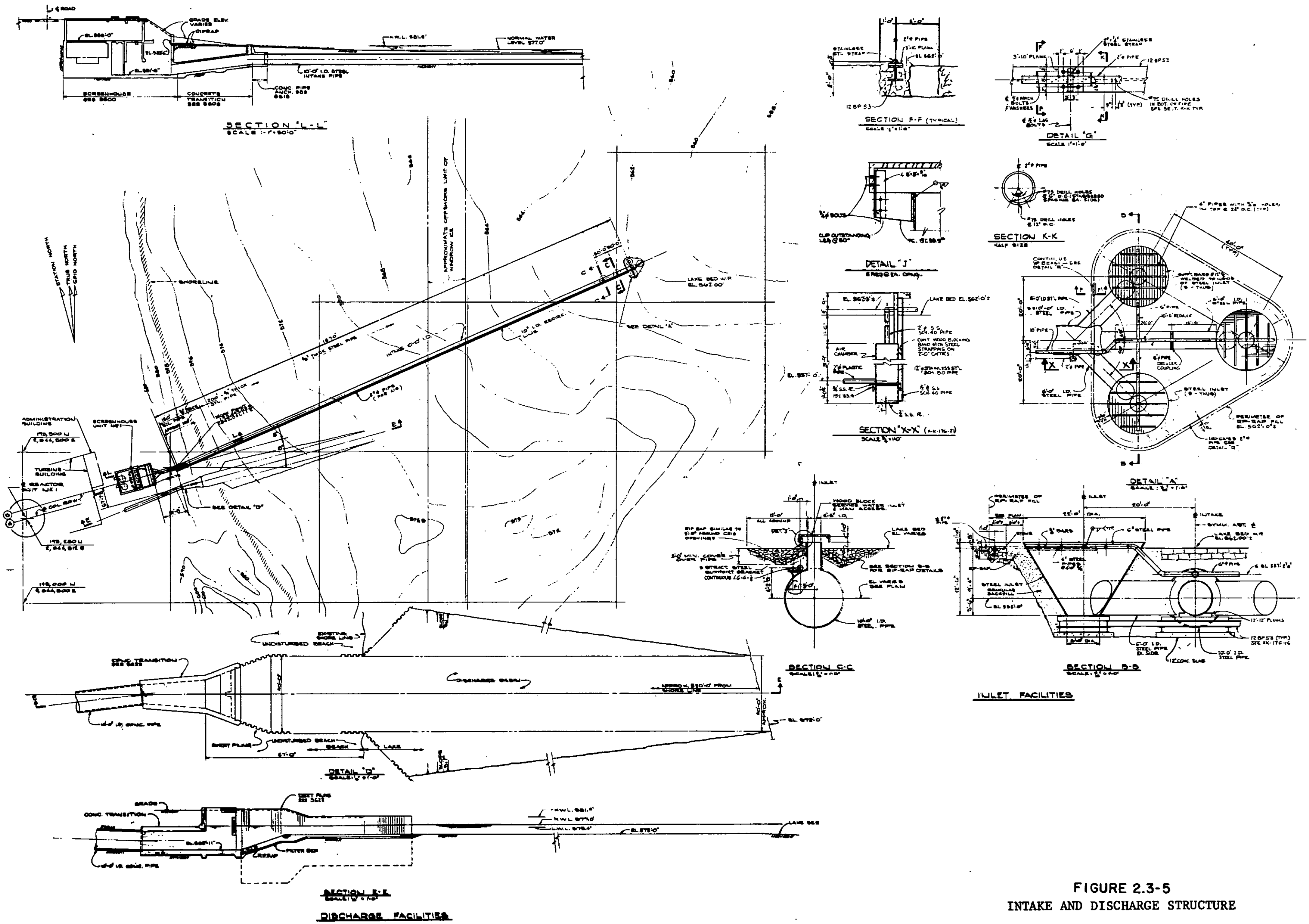


FIGURE 2.3-5
INTAKE AND DISCHARGE STRUCTURE

scour could occur, the sides are protected by sheet piling and the bottom by riprap.

The dredging operations were conducted under permits issued by the U. S. Army Corps of Engineers, the U. S. Coast Guard and The Wisconsin Department of Natural Resources with due regard for the prevention or alleviation of shore erosion, protection of aquatic habitat and protection of coastal navigation to channels and boat basins.

The Kewaunee discharge facility is specifically designed to induce minimum impact to biota in the discharge area. On the basis of information obtained from discussions with the Division of Resource Development, Department of Natural Resources, State of Wisconsin, the original discharge plans for a deep water jet discharge were changed to the present low velocity on shore discharge systems.

Based on the nature of the aquatic ecosystem in the site area, it is not anticipated that the thermal discharges from Kewaunee will have a significant adverse impact on the biota. However, biological studies are being made prior to and following operation of the plant. These studies will monitor any effects on aquatic life. A re-evaluation of the discharge facility can then be made when the necessary information has been obtained. If the re-evaluation indicates the need, the discharge facilities will be modified or expanded insofar as it is economically feasible to improve the aquatic environment in the vicinity of the discharge structure. In connection with this work, the Applicant has retained several consultants in the field of hydrology and aquatic biology to thoroughly investigate the aquatic environment in the Kewaunee area. The biological impact based on data available from these studies are described in Section 2.3.6 of the report.

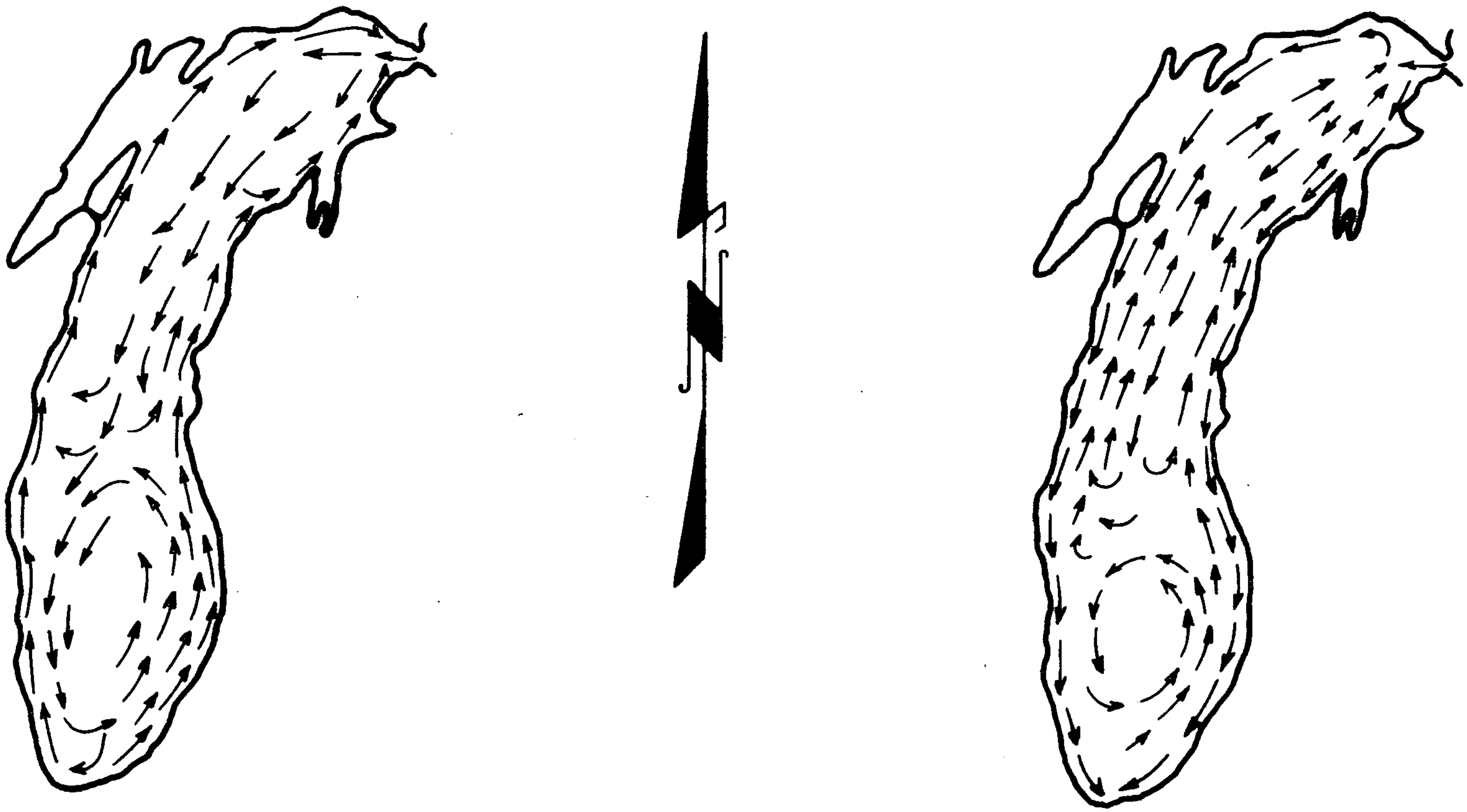
The impact of the plant facility on water quality is discussed in Section 2.3.3.3, Water Quality.

2.3.3.2 Cooling Water Source

Lake Michigan is the sixth largest fresh water lake on earth, having a volume of 1,116 cubic miles and a surface area of 22,400 square miles. The lake has a maximum depth of 923 feet and averages about 276 feet deep. The normal water level is 577 feet above International Great Lakes Datum (IGLD).

Lake currents are variable. Figures 2.3-6 and 2.3-7 show the four principal circulation patterns in Lake Michigan (Ref. 23). In the main body of the northern basin, the currents revolve in a clockwise direction 25 percent of the time and in a counter clockwise direction 25 percent of the time. The other half of the time they flow toward the south in the middle of the basin split near the lower end and return in a northerly direction on each side of the central southerly current. In the southern basin the main currents revolve in a clockwise direction 25 percent of the time and in the opposite direction 75 percent of the time. The principal importance of these data is that favorable mixing characteristics are associated with these patterns.

Of perhaps equal significance are the currents near the shore, as shown on Figure 2.3-8. The shore currents flow in opposite direction to the main currents between 10 percent and 90 percent of the time, depending on the season of the year, the part of the lake involved, whether on the east or west shore and whether they are in the northern or southern basin. The shore currents flow in a southerly direction about 35 percent of the



SUMMER CIRCULATION
S-SW WINDS

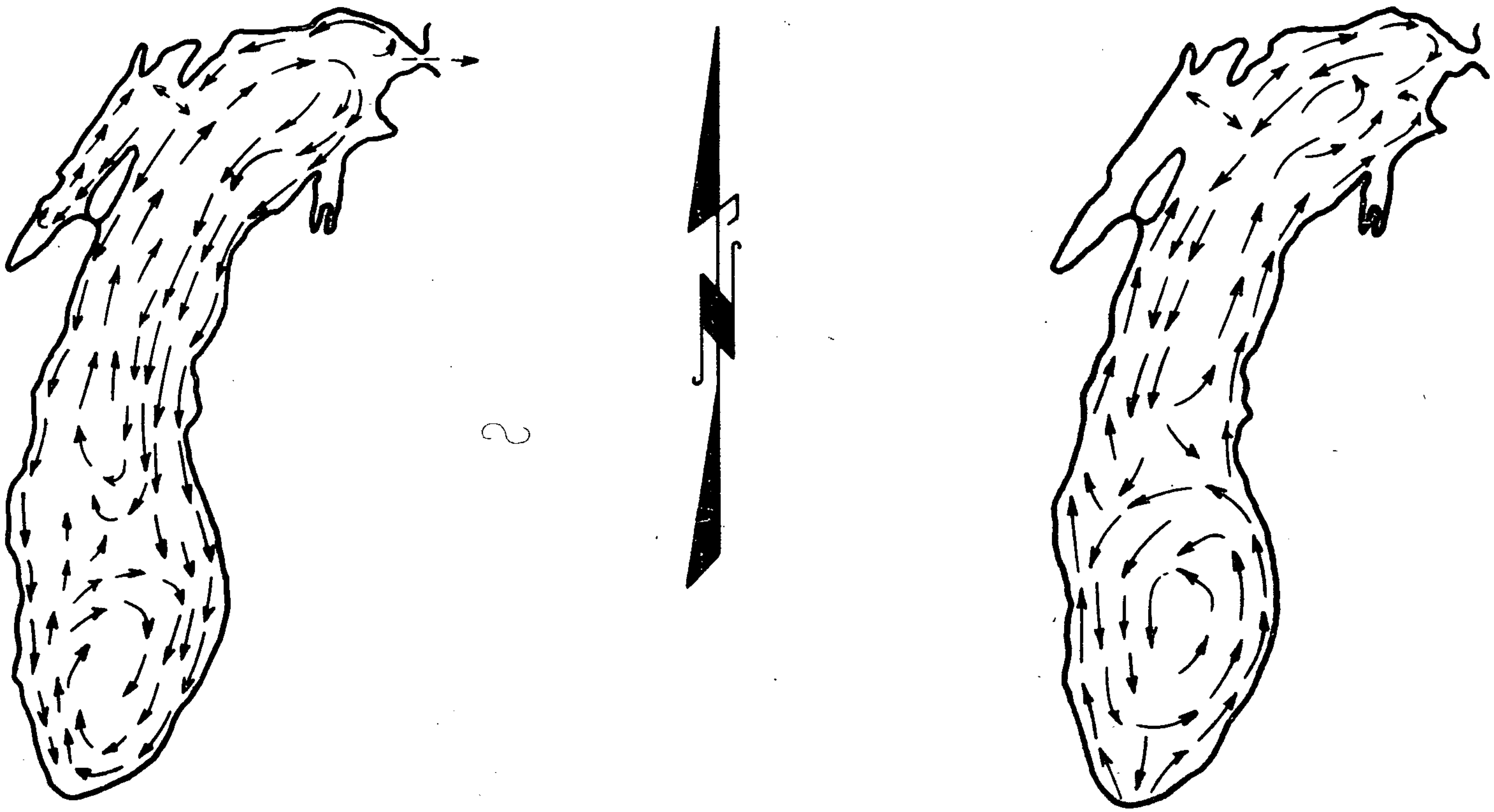
SUMMER CIRCULATION
N-NE WINDS

GENERAL CIRCULATION PATTERNS

PREVALENT CURRENTS AT SURFACE

LAKE MICHIGAN - SUMMER

Figure 2.3-6



WINTER CIRCULATION
N-NW WINDS

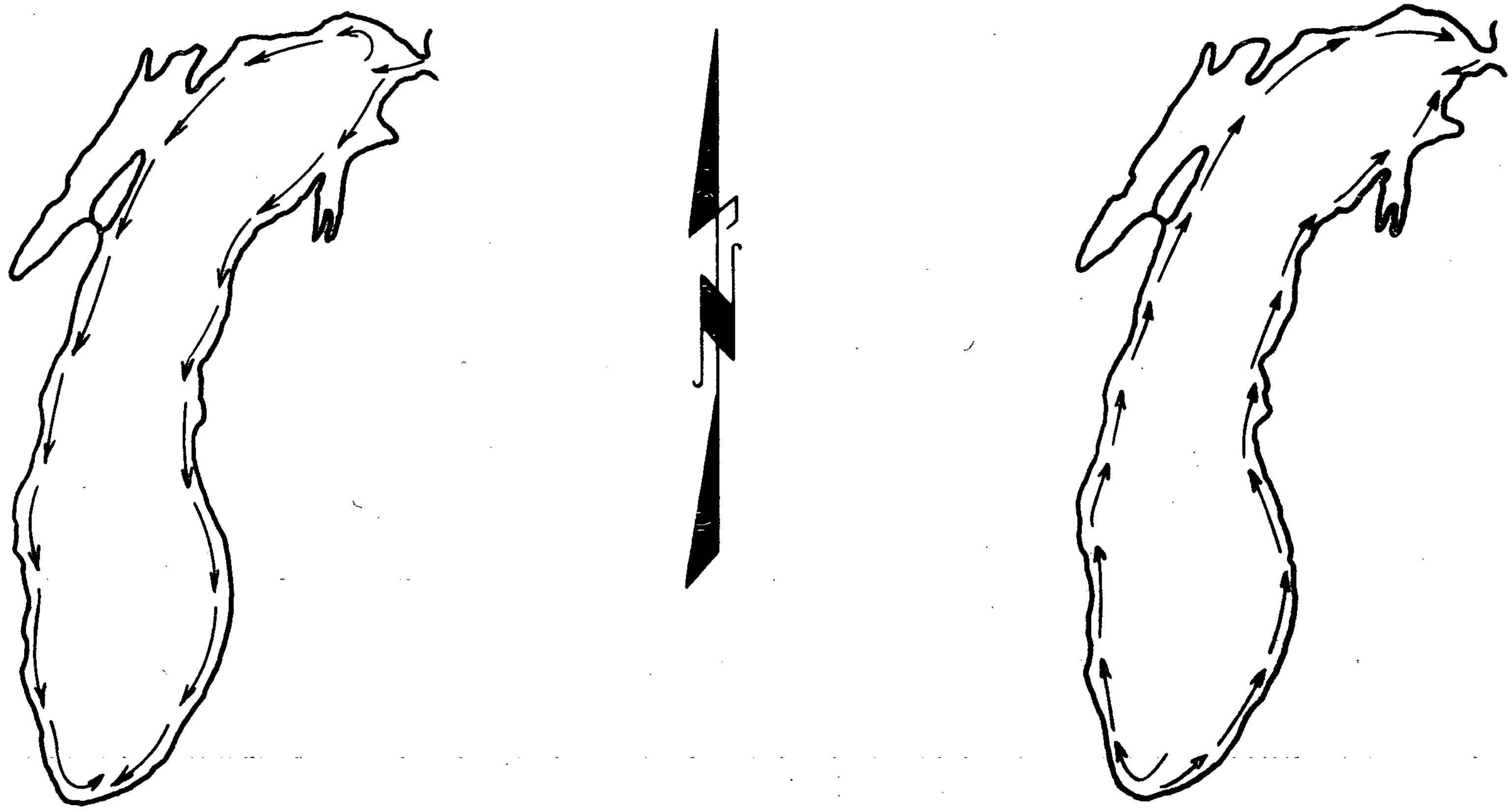
WINTER CIRCULATION
S-SW WINDS

GENERAL CIRCULATION PATTERNS

PREVALENT CURRENTS AT SURFACE

LAKE MICHIGAN - WINTER

Figure 2.3-7



SUMMER CIRCULATION
N-NE WINDS

SUMMER CIRCULATION
S-SW WINDS

INSHORE CURRENTS

LAKE MICHIGAN

Figure 2.3-8

time and 65 percent of the time in a northerly direction in both basins.

The surface current is largely parallel to the shore and nearly 22° to the right of the prevailing wind. The predominant current direction near the western shore during the period of greatest stratification is in a northerly direction. However, temporary reversals of the general trend may take place.

Current velocity was measured at 20 minute intervals for a two month period, two miles off the coast of Sheboygan. The measurements were taken from the surface of the lake down to a depth of 30 feet. The observed persistent patterns for different current velocities are shown in Table 2.3-3 below:

TABLE 2.3-3

PERSISTENCE OF CURRENT IN LAKE MICHIGAN (Ref. 54)

Current Velocity in Feet per Second	Persistence in Percent of the Time
0 to 0.5	68
0.6 to 0.7	10
0.8 to 0.9	12
1.0 or higher	10

A common occurrence in the Kewaunee area is cold water up-wellings. These up-wellings generally occur in late summer and early fall when the lake is stratified.

The thermocline is subject to motion induced mostly by wind. Patterns of oscillation of the thermocline topography are due to shore parallel currents confined to a coastal strip some 14 miles wide and decreasing in amplitude as it moves away from shore into the main body of the lake (Ref. 21). For example, from September 14 through 16, 1969, the temperature dropped from 66° F to 49° F. A comparison of the temperatures from depths of 8 and 16 feet shows little difference. A similar drop in temperature was reported in the Environmental Studies Report Number PBR2 at the Point Beach Nuclear Power Plant when between August 13, 1970 and August 16, 1970 the temperature at the intake crib dropped from 70° F to 49° F. Similarly, little difference was noted between the 8 and 16 feet deep temperatures. This would indicate good mixing of the water due to cold water up-wellings, rapid heat exchange and the turbulence of the area.

Another phenomenon that could occur in the Kewaunee area is the occurrence of thermal bars (Ref. 1). Water along the shore has been found to have a different temperature from that farther offshore. The change in temperature is quite abrupt.

The phenomenon appears to be related to water density and has been found to occur only during the spring and fall, usually in April and December. The near shore waters warm up (or cool down) more rapidly than the deeper off shore areas. A zone of rapid temperature change occurs around the 39.2° F (4° C) isotherm. This zone isotherm (thermal bar) then moves rapidly toward the center of the lake from all sides until it converges at the center and the entire lake surface is above (or below) 39.2° F. This phenomenon usually lasts for only a few weeks. Due to the rapid movement of this "thermal bar", it is not anticipated that this effect will significantly influence the configuration of the Kewaunee Nuclear Power Plant thermal plume. (Personal communication - Dr. Lawrence Beer - 11/1/70).

The Argonne National Laboratories have conducted a field thermal plume study at the Point Beach plant. The results of the study indicate that two general types of plumes are formed. One follows the shoreline and is apparently current-controlled; the other flows out perpendicular to the shore at times when longshore currents are not active. The lengths along the plume axis of a 3° F (above lake temperature) isotherm is about 1-1/2 miles for the longshore plume and 1/2 mile for the offshore plume. Mathematical plume studies for the Kewaunee Nuclear Power Plant indicate a 3° F rise in the offshore direction is 7,000 feet long and that the area confined by the 3° F isotherm is about 1,000 acres.

Preliminary current studies performed for the Point Beach and Kewaunee Nuclear Power Plants indicate that there is not a direct interaction of the waters at Point Beach and Kewaunee (Ref. 22). Additional studies are being performed, however, to define the current patterns more precisely in these areas and to confirm or reject the initial observations.

2.3.3.3 Water Quality

Discharge from the Kewaunee station will meet all applicable water quality standards pertaining to effluents released to the environment. This section of the report discusses existing water quality as it relates to the cooling water system. Chemical and sanitary effluents are discussed in Sections 2.3.4 and 2.3.5, respectively.

A pre-operational sampling program is being concluded to evaluate the chemical lake water quality near the station. Preliminary chemical analyses are presented on Tables 2.3-4 and 2.3-5. Locations of the sampling stations are shown on Figure 2.3-22, Water Quality Sampling Locations. The chemical analyses indicate that the total dissolved solids range from 156 to 214 ppm and that the calcium content is relatively low, ranging from 32 to 40 ppm. The Hydrologic Monitoring Program will continue as described in Section 2.3.9.3 to evaluate the chemical quality of Lake Michigan water in this vicinity.

Because discharges will conform with existing water quality regulations and because of the dilution that they will receive after entering

TABLE 2.3-4

WATER QUALITY DATA

LAKE MICHIGAN NEAR KEWAUNEE NUCLEAR POWER STATION (Ref. 29)

May 25, 1971

Sample No.	Temperature °F	°C	D.O.	% Oxygen Saturation	B.O.D.	pH Units	Specific Conductance at 25° C umhos/cm	Turbidity (J.T.U.)*
K-7-M-A	49.8	9.8	11.8	104	4.5	8.2	270	84
B	49.8	9.8	11.8	104	1.9	8.2	270	79
C	49.8	9.8	11.8	104	5.3	8.2	270	60
K-9-T-A	46.2	7.9	9.4	79	4.6	7.9	270	4
B	46.2	7.9	9.4	79	1.6	7.9	265	3
C	46.2	7.9	9.4	79	1.2	7.9	265	3
K-9-B-A	43.7	6.5	9.8	80	5.0	8.1	265	2
B	43.7	6.5	9.8	80	0.3	8.1	267	1
C	43.7	6.5	9.8	80	2.5	8.1	268	1

*All units are in mg/l except Turbidity (Jackson Turbidity Units).

TABLE 2.3-4 (Cont.)

WATER QUALITY DATA

LAKE MICHIGAN NEAR KEWAUNEE NUCLEAR POWER STATION

May 25, 1971

Sample No.	Ca	Mg	Total Alkalinity as $CaCO_3$	Cl^-	NO_3 as N	Total PO_4	Ortho PO_4
K-7-M-A	39	12.7	122	6.8	0.100	0.220	0.002
B	40	12.4	118	6.5	0.110	0.125	0.002
C	40	12.5	116	6.5	0.110	0.125	0.002
K-9-T-A	32	11.0	111	6.5	0.165	0.034	0.002
B	34	11.0	110	6.5	0.165	0.038	<0.002
C	33	10.9	114	6.8	0.165	0.038	0.010
K-9-B-A	34	10.8	108	6.8	0.160	0.043	<0.002
B	34	10.8	110	6.8	0.162	0.037	<0.002
C	34	10.9	110	6.8	0.160	0.042	<0.002

All units are in mg/l unless expressed otherwise.

TABLE 2.3-5

WATER QUALITY DATA

LAKE MICHIGAN NEAR KEWAUNEE NUCLEAR POWER STATION (Ref. 29)

May 25, 1971

Sample No.	Specific Conductance at 25° C umhos/cm	Ca	Mg	Total Hardness as $CaCO_3$	Na	Cl^-	SO_4	True Color Units
K-7-T	269	36	13.1	135	3.8	7.0	18	13
K-7-M	270	39	12.7	156	4.4	6.8	22	--
K-7-B	269	36	13.9	134	3.8	6.5	20	12
K-8-T	267	34	11.2	135	3.7	6.5	22	3
K-8-M	268	35	11.8	135	3.7	6.5	23	4
K-8-B	267	34	11.8	136	3.8	6.8	22	4
K-9-T	270	32	11.0	138	4.2	6.5	21	--
K-9-M	268	35	11.1	138	3.7	6.5	22	2
K-9-B	265	34	10.8	133	4.2	6.8	21	--

All units are in mg/l unless expressed otherwise.

TABLE 2.3-5 (Cont.)

WATER QUALITY DATA

LAKE MICHIGAN NEAR KEWAUNEE NUCLEAR POWER STATION

May 25, 1971

Sample No.	Temperature °F	Temperature °C	D.O.	% Oxygen Saturation	B.O.D.	pH Units	Total Alkalinity as $CaCO_3$	Carbonate Alkalinity as CO_3^{--}
K-7-T	49.6	9.8	11.8	104	4.5	8.2	120	0
K-7-M	49.8	9.8	11.8	104	4.5	8.2	-	0
K-7-B	49.6	9.8	11.8	104	5.8	8.2	112	0
K-8-T	47.7	8.7	11.0	95	5.7	8.0	110	0
K-8-M	47.5	8.6	10.6	91	3.7	8.0	108	0
K-8-B	47.1	8.4	10.4	87	4.7	7.9	111	0
K-9-T	46.2	7.9	9.4	79	4.6	7.9	-	0
K-9-M	46.0	7.8	9.6	81	3.8	8.0	108	0
K-9-B	43.7	6.5	9.8	80	5.0	8.1	-	-

All units are in mg/l unless expressed otherwise.

TABLE 2.3-5 (Cont.)

WATER QUALITY DATA

LAKE MICHIGAN NEAR KEWAUNEE NUCLEAR POWER STATION

May 25, 1971

Sample No.	NH_4 as N	NO_2 as N	NO_3 as N	Total PO_4	Ortho PO_4	Turbidity J.T.U.	T.D.S.
K-7-T	<0.005	0.0025	-	0.195	-	83	214
K-7-M	-	-	0.100	0.220	0.002	84	-
K-7-B	<0.005	0.0027	-	0.270	-	51	228
K-8-T	<0.005	0.0020	-	0.075	-	7	166
K-8-M	<0.005	0.0022	-	0.060	0	19	156
K-8-B	<0.005	0.0025	-	0.060	-	18	164
K-9-T	-	-	0.165	0.034	0.002	4	-
K-9-M	<0.005	0.0020	-	0.030	-	2	156
K-9-B	-	-	0.160	0.043	<0.002	2	-

All units are in mg/l unless expressed otherwise.

TABLE 2.3-5 (Cont.)

WATER QUALITY DATA

LAKE MICHIGAN NEAR KEWAUNEE NUCLEAR POWER STATION

May 25, 1971

Sample No.	Fe	Cr	Pb	Mn
K-7-T	1.6	0.002	0.001	0.009
K-7-M	-	-	-	-
K-7-B	2.0	0.001	0.002	0.010
K-8-T	0.2	0.001	0.003	0.011
K-8-M	0.5	0.001	0.001	0.003
K-8-B	0.5	0.001	0.002	0.003
K-9-T	-	-	-	-
K-9-M	0.3	0.001	0.003	0.014
K-9-B	-	-	-	-

All units are in mg/l.

the lake, it is not expected that the Kewaunee facility will have a significant adverse effect on the chemical quality of the Lake Michigan water. The impact of chemical discharges on the aquatic environment is discussed in Section 2.3.6, Biological Impact.

The phenomenon of thermal stratification is a well known feature of Lake Michigan (Ref. 1). In summer the surface water warms up more rapidly than the deeper water and continues to be less dense until it becomes separated from the deeper water by a transitional horizontal stratum called the thermocline. The upper warm layer of water is called the epilimnion and lower, cooler water is called the hypolimnion. The warmer water tends to act as a lid on the hypolimnion and prevents total lake mixing. This separation of the two strata in Lake Michigan starts in late May and persists until November or occasionally into December in the southern basin. In the northern basin summer stratification may not begin until late June or early July and likewise may persist into December.

As mentioned in a previous section, cold water up-wellings are common in late summer and early fall after the thermocline has been established. Also, thermoclines are normally not stationary but are subject to oscillation and motion caused by wind action.

Stratification in Lake Michigan occurs naturally. It is possible that an artificial epilimnion can be developed when heated water is discharged at low velocities near the shoreline. However, because of wind, wave and current action, it is anticipated that such an artifically developed epilimnion would be of short duration.

Based on the studies performed by the University of Wisconsin - Milwaukee (Ref. 30) at the Kewaunee Nuclear Power Plant site, the ambient lake water temperature in the vicinity of the Kewaunee intake ranged from 40° F in April to a high of 70° F in the middle of August, 1970. After the high in August the temperature gradually declines until during the winter the lake temperatures are near freezing.

2.3.3.4 Applicable Thermal Discharge Standards and Status of Water Quality Certification

On April 3, 1970, the Water Quality Improvement Act was enacted. It amends the Federal Water Pollution Control Act. Section 21 (b) of the amended Act requires that applicants for a construction permit or operating license for any nuclear power station which will discharge effluents into the navigable waters of the United States provide the Atomic Energy Commission (AEC) with certification from the state or Interstate Pollution Agency or the Secretary of the Interior, as appropriate, that there is reasonable assurance that the plant will not violate applicable water quality standards. Under Reorganization Plan #3 of 1970, the functions and duties of the Secretary of the Interior under this Act have been transferred to the Administrator of the Environmental Protection Agency (EPA).

The Applicant has designed a system to limit discharge temperature in compliance with applicable Wisconsin State criteria governing thermal discharges. In compliance with the Water Quality Improvement Act of 1970, the Applicant has submitted reports, sketches and general arrangements of drawings to the State of Wisconsin. These were reviewed in accordance with Section 144.44 Wisconsin Statutes. The present regulations limit discharge temperatures from 84 to 89°F. depending on the use classification of the surface water. Wisconsin Public Service has been granted a permit to discharge water at a temperature up to 86° F. Formal approval and certification was issued by the Division of Environmental Protection, State of Wisconsin, Department of Natural Resources on June 5, 1969 as presently required by the Water Quality Improvement Act of 1970.

Previous submittals and approvals have been granted for the sanitary waste treatment facility (Approval #68-694, August 29, 1968) and for the circulating water intake and discharge (Approval #68-343, May 21, 1968).

Review and approval by the Division of Environmental Protection Department of Natural Resources, in accordance with Section 144.04 Wisconsin Statutes, was also granted for the following waste systems: service water system, makeup water treatment system, plant potable water softening system, steam generator blowdown, liquid waste disposal system, boric acid recycle system, laundry and shower drains, and turbine building miscellaneous and floor drains (Approval #69-363, June 5, 1969).

The Water Quality Standards in the State of Wisconsin are the only standards that apply to the operation of the Kewaunee Nuclear Power Plant, since the water quality of no other state will be affected. The closest nearby state water which could be affected by plant operation is Michigan, which is 50 miles east of the site across Lake Michigan.

2.3.3.5 Meteorology

General. The atmosphere is one of the primary factors considered in designing the plant because it affords one of the primary transport mechanisms for conveying plant effect to the environment. Climatological summaries of temperature, precipitation, and severe weather together with a climatological summary of diffusion (wind and stability) are presented in this section.

The climate of the site is generally continental in nature. There is a considerable variability of weather conditions over a short period of time during any season. This variability is a result of the location of the site relative to the path of the general storm track in the vicinity of the Great Lakes. Lake Michigan has a considerable effect upon the climate of the site. In comparison with other more inland sites at the same latitude, the site has more moderate temperature extremes, is more moist, and experiences higher average wind speeds.

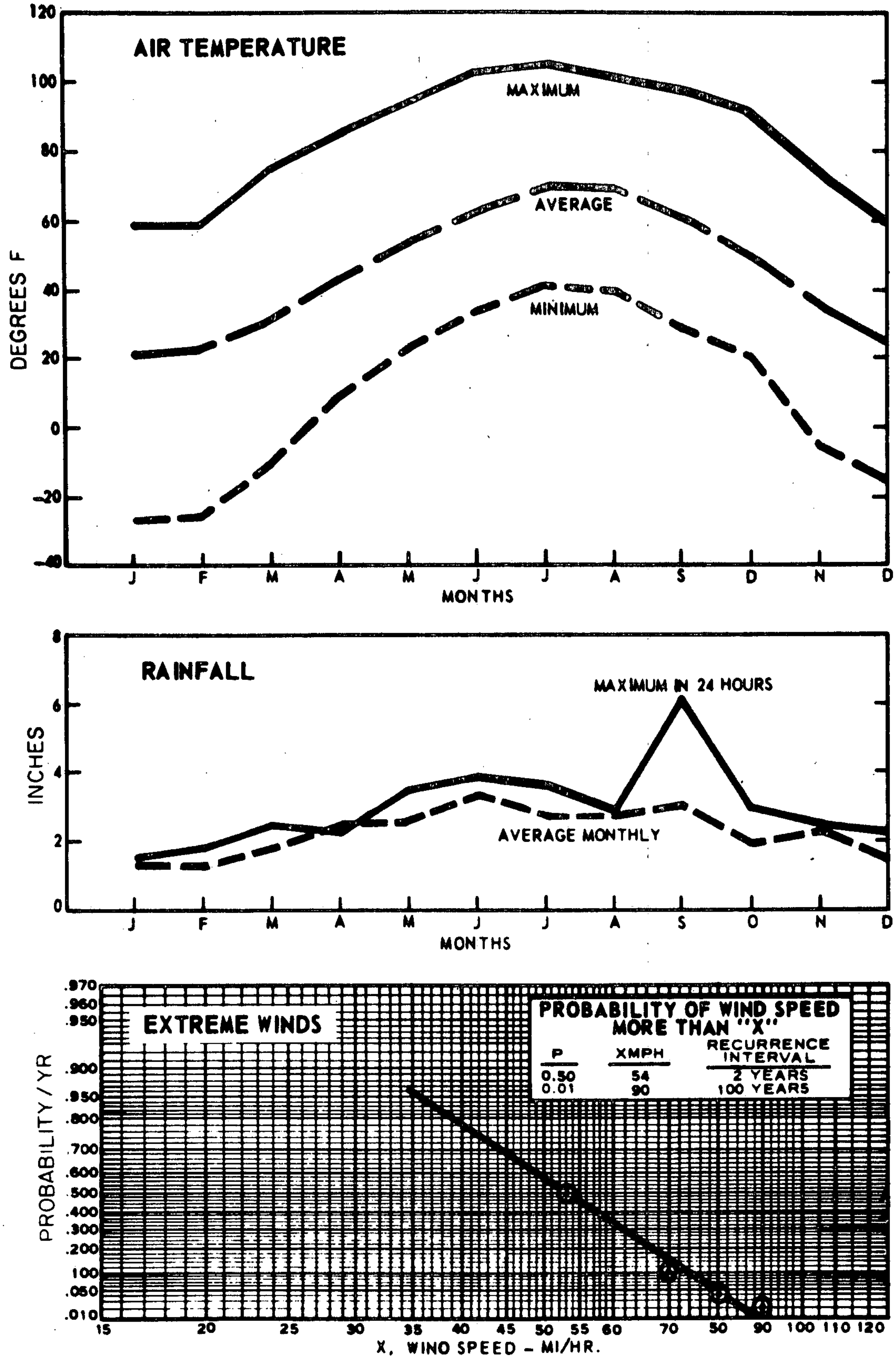
Temperature. The average air temperature is about 45° F, the average varies seasonally from about 21° to 70° F. The extreme temperatures vary from a coldest temperature of about -25° F to a warmest temperature of about 100° F. The relationship of these to the average seasonal variation is presented in Figure 2,3-9.

Precipitation. The monthly variation of rainfall is also presented in Figure 2.3-9. This variation, from about 1.4 inches in February to about 3.5 inches in June, exhibits a fairly uniform distribution of the annual 28 inches throughout the seasons. The maximum 24 hour rainfall was 6 inches in September, 1964. Snowfall averages about 45 inches per year, with a 24 hour maximum of 15 inches in January, 1947.

Severe Weather - Tornadoes. Wisconsin lies to the northeast of the principal tornado belt in the United States. During the ten year period 1960-1969, 161 tornadoes were reported in the State. Only six of these tornadoes occurred in Brown, Door, Kewaunee, or Manitowoc Counties. Tornadoes tend to move from the west with most of the tracks from the southwest toward the northeast. Maximum monthly frequency is in May, with 90 percent reported in May through September.

The probability of a tornado striking a point in Brown, Door, Kewaunee, or Manitowoc Counties is 4.86×10^{-4} tornadoes per year (Ref. 24). The mean recurrence interval is 2,060 years and at a 95 percent confidence interval, the recurrence interval ranges between 1,310 and 4,770 years.

Severe Weather - Ice Storms. Ice storms are infrequent in this region of Wisconsin. Wisconsin Public Service Corporation has transmission lines in this area, one of which is a line from Green Bay to Sturgeon Bay by way of Kewaunee. Six outages due to ice storms have occurred on this



* BASED ON DATA FROM KEWAUNEE AND MANITOWOC 1930 – 1969

CLIMATE OF KEWAUNEE SITE REGION*

FIGURE 2.3-9

line between 1940 and 1956, ranging in duration from 22 minutes to 2.5 hours. Since rebuilding the line with improved conductors in 1956, only one outage has occurred due to ice storms.

Severe Weather - Extreme Wind Speeds. According to the latest compilation by Thom (Ref. 25), extreme wind speeds at the 30 foot height, (as presented in Figure 2.3-9) are not expected to exceed 54 miles per hour once every two years, and 90 miles per hour once every 100 years.

2.3.3.6 Atmospheric Diffusion

General. In order to properly define atmospheric dilution at the site area it is necessary to examine the distribution of wind direction and speed, wind direction persistence, and atmospheric stability.

Wind - Direction and Speed. The importance of the distribution of wind direction cannot be over emphasized. Winds from certain directions may transport releases to uninhabited areas, as with offshore winds at this site, or conversely, to populated areas. Table 2.3-6 presents the distribution of onshore and offshore winds. Onshore winds are winds that blow from the lake toward land and are defined at the Kewaunee site location as those from north-northeast through south. Offshore winds blow from the land toward the lake, from south-southwest through north.

TABLE 2.3-6

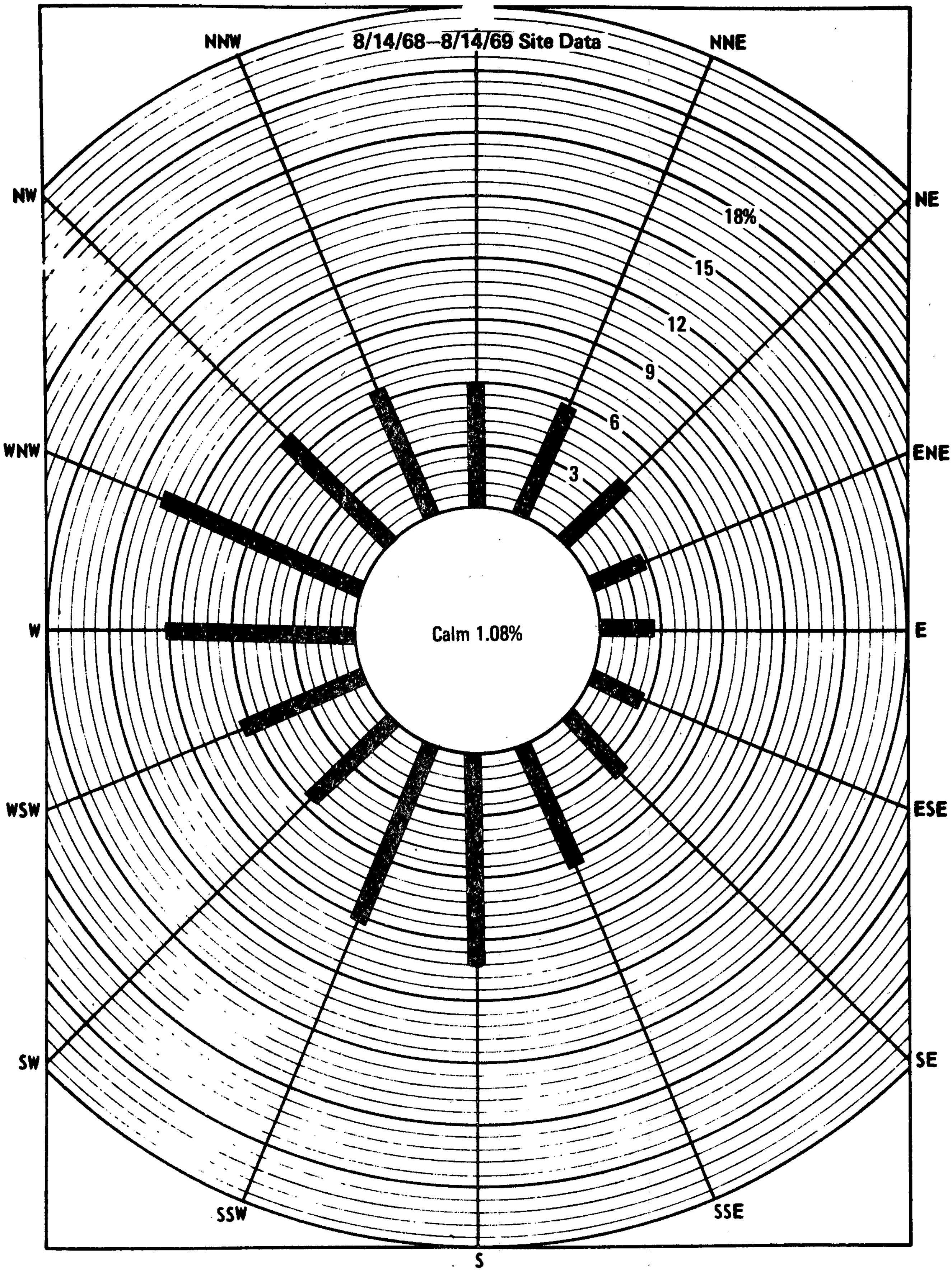
SEASONAL WIND FREQUENCY DISTRIBUTION (PERCENT)

	Onshore	Offshore	Calm
Spring	47.89	51.24	0.86
Summer	42.96	55.51	1.54
Autumn	36.61	62.39	1.01
Winter	28.79	70.20	1.00
Annual	38.29	60.62	1.08

It is significant to note that offshore winds (blowing toward Lake Michigan) occur over 60 percent of the time annually.

The annual distribution of wind direction is presented in Figure 2.3-10. The percentage of occurrence (in percent of the total number of observations in the period) for each of 16 directions is represented by the length of the bars in the wind rose.

Winds occur mainly from the western (180° through 360°) half of the compass (70.88 percent) annually with small peaks at west-northwest and south. The distribution is quite similar to the annual Milwaukee data presented in the FSAR (Ref. 20) and References 25 and 26.



KEWAUNEE WIND ROSE
Annual Summary
FIGURE 2.3-10

Average annual wind rose patterns are shown in Figure 2.3-11 for five weather stations on Lake Michigan within a 100 mile radius of the site. Milwaukee, Green Bay, and Escanaba are first order weather stations of the U. S. Weather Bureau. Data for Kewaunee and Two Rivers were obtained from the U. S. Coast Guard. Wind roses for Green Bay, Escanaba, and Kewaunee reflect the channelling influences due to location and terrain. Lake breezes may veer parallel to the coast due to Coriolis force, as represented by the SW and NE directions at Two Rivers along the coast at the Coast Guard Station.

Ground level concentration of effluent is inversely proportional to the average wind speed. The seasonal and annual wind speed averages for the Kewaunee site are presented in Table 2.3-7.

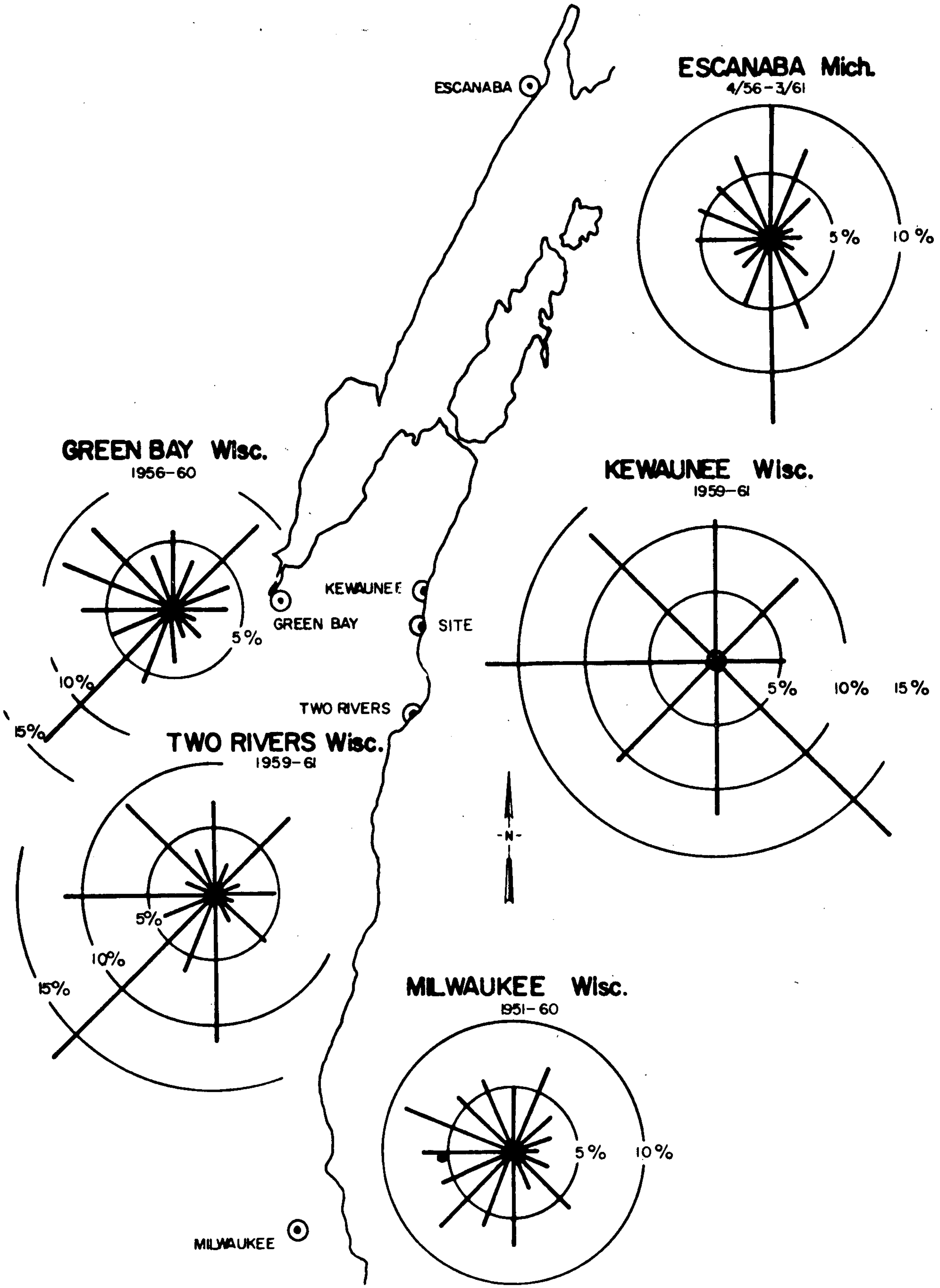
TABLE 2.3-7

AVERAGE WIND SPEED (MPH)

Spring	Summer	Autumn	Winter	Annual
12.5	10.5	13.7	17.2	13.6

The annual occurrence of calms is only 1.08 percent. The maximum occurrence is during the summer (1.28 percent); the minimum is during the spring (0.85 percent). The calm frequency is quite low, land persistent periods of calm do not appear to pose a problem at the site.

ANNUAL WIND ROSES
(DIRECTION FROM WHICH WIND BLOWS)



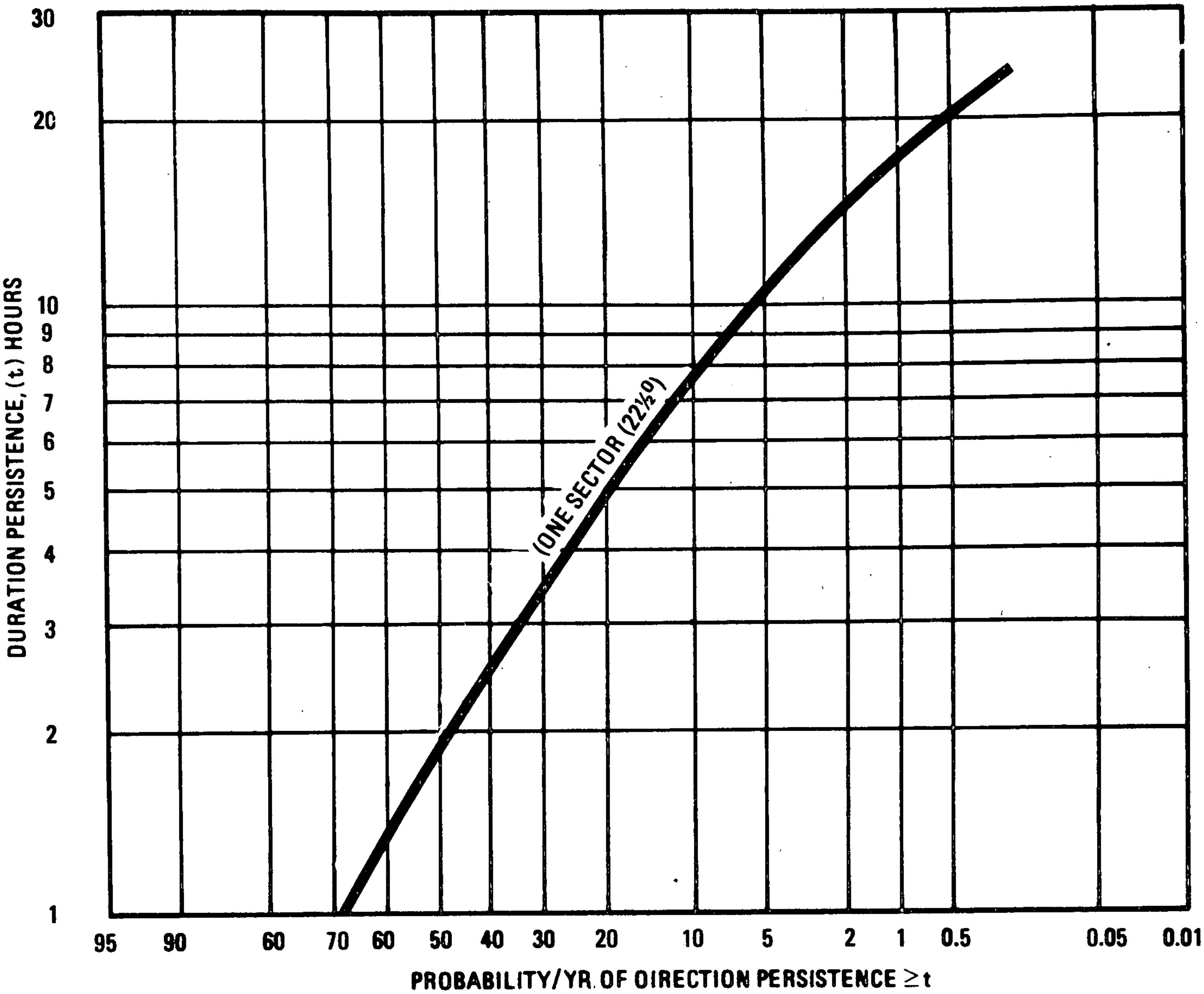
ANNUAL WIND ROSES
FIG. 2.3-11

Wind Direction Persistence. Wind direction persistence is a measure of the tendency of the wind to blow from a specific direction for a continuing period of time. As such, a high probability of persistence will result in a higher probability for a specific dose limit occurring at site boundary.

Figure 2.3-12 presents the probability distribution of specific durations of persistence based upon on-site data. From Figure 2.3-12, there is a five percent probability of occurrence of winds in a 22-1/2 degree sector persisting for more than about 11 hours and only a one percent probability of persisting for more than 18 hours.

Generally, periods of high direction persistence are associated with high wind speeds and as such are not considered as contributing to a high probability of achieving high doses at site boundary.

Atmospheric Stability. As stated earlier, atmospheric stability is important in describing the diffusion capacity of the atmosphere. Reference to atmospheric stability in this report refers to the degree of wind turbulence rather than the vertical thermal structure of the atmosphere. Stable conditions are associated with reduced turbulence and poor atmospheric diffusion capacity. Unstable conditions are associated with increased turbulence and favorable diffusion characteristics.



KEWAUNEE WIND DIRECTION PERSISTENCE

Figure 2.3-12

The atmosphere is stable 83 percent of the time at the site, but this is compensated for by the high average annual wind speed of 13.6 mph. In fact, wind speed tends to increase with stability at this site.

Environmental Impact - Meteorology. To assess the possible impact that the Kewaunee Nuclear Power Plant could have on the atmospheric environment, the physical features and the waste products of the plant were examined. It is estimated that the physical plant structures are not of sufficient size to cause a significant variation in any of the atmospheric elements (such as the wind flow patterns).

The present method of waste heat disposal is a once-through circulating water system. This system returns heated water to Lake Michigan in such a fashion that little forced mixing occurs. This results in a maximum three degree increase in Lake Michigan's surface water temperature at the boundary of an area of about 1,000 acres. This increase in surface water temperature will cause a slight increase in the frequency of occurrences of steam fog over the lake. (Steam fog is that type of fog which forms over water when the air temperature is less than the surface-water temperature). It is estimated, however, that the increase in the frequency of, as well as density of, this type of fog is not large enough to cause a significant environmental impact.

2.3.4 Chemical Discharges

The primary chemical discharged into the lake will be sodium sulphate (Na_2SO_4). This compound results from the regeneration of makeup water demineralizer trains. It is released to the lake through the discharge canal via the waste neutralizing tank where it is neutralized prior to being discharged. Maximum concentrations of sodium sulphate during the release will be less than 0.5 ppm during the summer and 3.3 ppm during the winter. The present sulphate concentration in Lake Michigan water varies from 18 to 23 ppm.

Maximum salt concentrations released from the waste neutralizing tank should not exceed 65 ppm ($CaCO_3$ equivalent) above normal background concentrations in the circulating water with the normal increase being in the 15 to 20 ppm range. The average release of regenerate chemicals will have a pH of 6.5 to 7.5 and contain about 3,000 pounds of dissolved solids (primarily sodium sulphate). The total volume released will average 15,000 to 17,000 gallons every 1-1/2 days. Ambient calcium carbonate ($CaCO_3$) concentrations in Lake Michigan water vary from 108 to 156 ppm.

The in-plant water used for various sanitary purposes is softened using a zeolite salt regenerated water softener. Since the regenerate salt requirements are small, the regenerates will be released directly to the circulating water canal without treatment and will result in a salt concentration increase of approximately 6 ppm in the discharge.

Chemicals for the control of algae may be injected into the circulating water system at various times depending on the water conditions and temperatures. Present plans based on experience at Point Beach indicate injection of sodium hypochlorite (NaO Cl) solution is not presently needed to control slime. Concentrations of free chlorine in the circulating water would thus depend on chlorine demand.

Of the three chemicals (hydrazine N_2H_4, morpholine C_4H_4NO, phosphates PO_4) being used in the secondary cycle, only morpholine and the phosphates will be sent to the circulating water canal via boiler blowdown, since hydrazine breaks up into a gas at high temperatures. Morpholine concentrations will be relatively small and as a result morpholine discharges will be minimal. The residual soluble phosphate should not normally exceed 5 ppm and when diluted in the circulating water flow would increase the background phosphate level by 0.0002 ppm (based on diluting 15 gallons per minute in a total volume of 400,000 gallons per minute). When the steam generator is operating without any significant condenser leakages, the rates of blowdown would be less than 15 gallons per minute and the resulting phosphate concentration would be significantly less. Total ambient phosphates (PO_4) in Lake Michigan water vary from 0.030 to 0.220 ppm.

During the life of the plant it can be expected that there will be infrequent periods of condenser leakage producing waste levels in excess of those reported above. During these periods phosphates will be used to control the hardness ions present. As a result, phosphate concentration as high as 50 to 60 ppm may occur. With dilution, the resulting phosphates in the discharge are expected to be approximately 0.03 ppm, assuming a blowdown rate of 125 gallons per minute.

When the resins from the makeup water system anion, cation and mixed bed units have lost their regenerative capacity, they will be removed to a landfill area since they are not radioactive. Radioactive wastes are discussed in Section 2.3.7.

The system is designed to limit chemical discharge concentrations in compliance with applicable federal and state agency requirements. Based on preliminary data from the pre-operational and operational study of the nearby Point Beach Nuclear Power Plant, there has been no adverse effect from chemical discharges on the aquatic environment.

The Owners plan, however, through an extensive pre-operational and operational monitoring program of the aquatic ecosystem to collect data relative to the Kewaunee Nuclear Power Plant to confirm the conclusion that the aquatic environment will not be significant altered. Should some adverse effect on the aquatic environment not now presently envisioned by determined from studies, the Applicant is agreeable to cooperate with applicable agencies to develop measures which will protect the aquatic environment. The monitoring program plan for the Kewaunee plant is described in Section 2.3.9.

2.3.5 Sanitary Wastes

The Kewaunee Nuclear Power Plant has a 600 gallon per day AER-O-FLO sewage treatment system located on the plant site to treat all waste from lavatories, non-radioactive floor drains, janitor sinks, and normal sanitary wastes. The drains from the laundry and hot shower tanks can be routed to this system after sampling has determined that no radioactivity is present. The system has been in operation for approximately three (3) years, under the jurisdiction of state licensed WPS and its architect-engineer personnel.

The system employs three basic methods of treatment; these are screening, aeration and settling. In addition, WPS has added a chlorination system and a polishing pond to further treat the effluent prior to discharge to the lake.

The screening device employed is a comminutor, which is a mechanical grinder or cutter designed to cut or shred large solids. Smaller particles are more readily digested by the bacteria in the aeration tank.

As the sewage passes from the screening device it enters into the aeration tank. In this tank, the sewage is oxidized and consumed by aerobic organisms, in the presence of air. The bacteria form an activated sludge which is returned to mix with the incoming sewage.

Air is introduced into the tank with compressors using diffusers. The air allows the organisms to oxidize the sewage into carbon dioxide and water and inoffensive organic constituents. The aeration tank is designed to provide a volume equal to three times the maximum eight hour flow. A spray system is provided to break any foam created by the air-mixing action.

From the aeration tank, the mixed liquor passes into a settling tank, or clarifier. The sludge settles to the bottom and the clear, treated liquid flows over a weir into the discharge line. The settling tank has a four hour retention volume, based on average flow. The settled activated sludge is returned to the aeration tank to provide organisms for the incoming raw sewage. The treated sewage will have 85% to 95% of its organic, or pollutional, material removed before it is discharged.

The effluent from the settling tank is passed through a chlorination contact chamber to kill any pathogenic bacteria which might remain in the effluent. The plant effluent is held in the chlorine contact tank for thirty minutes at average design flow. This is twice the contact time recommended by the Department of Natural Resources of the State of Wisconsin. Upon discharge from the chlorine contact tank, the effluent is discharged to a polishing pond which provides additional hold-up time of the treated sewage effluent prior to discharge to the lake. The intake water supply for the sewage treatment system is from a well on site; lake water is not used in this system.

Presently, daily studies show concentration of chlorides of 0.4 to 0.6 mg/liter and a pH of 7.6 for the effluent at the discharge point.

The disposal of solid waste from construction activities and excess excavation soil has been handled by sanitary landfill methods. The material is buried six feet below surface. Over 17 acres of topographically suitable areas southwest of the site have been used. General surface drainage patterns in this area have been improved by grading and stabilized by seeding with grass for erosion control as the landfill has been completed. Almost all of the sanitary landfill requirements have been satisfied. Small amounts of additional waste, largely including general paper trash and debris from intake screens, will be disposed of by contemporary sanitary landfill methods. Such use of this area will not preclude later use of this land for grazing or crop and, with redevelopment, construction in this area is feasible. 2

2.3.6 Biological Impact

2.3.6.1 Aquatic Ecosystems

General

Lake Michigan, in the area of the Kewaunee Plant, is characterized by a shallow, gently sloping bottom. Fifteen hundred feet off shore at the water intake site, water depth is only 15 feet. At a distance of 6000 feet off shore water depth averages about 30 feet. The bottom sediments consist of primarily hard red clay with an overlay of fine to medium sand. The shoreline in the general area experiences heavy erosion and as a consequence there is little to no emergent vegetation along the shore and lake bottom.

Lake current patterns differ in the near-shore areas from the stronger southward or northward (depending upon seasonal variations) currents which occur generally beyond the 30 foot depth contour; these near-shore current patterns are variable and though not well defined are the object of continuing studies.

Seasonal temperatures in the near-shore area range from near freezing in winter to 70° F in late August and September. Although a general warming trend occurs during summer, fluctuations as great as 21° F (47° to 69° F) have been recorded within a period of a few days. These fluctuations are due to cold water up-wellings resulting when warmer surface waters are blown offshore. In general, the inshore areas (to a depth of about 30 feet) experience greater temperature changes during the summer and early fall than do offshore areas. Good mixing in the near-shore areas is indicated by similar temperatures at different depths (Ref. 28).

Species Present in the Area

Benthos. Because of the bottom type and heavy erosion in the near-shore areas there is little attached vegetation and relatively few benthic organisms. In studies (Ref. 29) of benthic organisms at the Kewaunee site, only 7 of 30 bottom grab samples contained organisms and three of these were replicates from a single station. The report states "The majority of all benthic organisms collected were characteristic of cold, oligotrophic conditions." There was a maximum of 18 organisms in any one sample and a total of 71 for all samples. Table 2.3-8 lists the species found.

TABLE 2.3-8

BENTHIC ORGANISMS FROM THE KEWAUNEE SITE (Ref. 29)

Family	Species
Lumbriculidae (oligochaete)	*Stylodrilus heringianus*
Chironomidae	*Sitchtochironomus* sp. *Cricotopus* sp.

TABLE 2.3-8 (Continued)

	Heterotrissocladius sp.
	Paracladopelma sp.
	Polypedilum sp.
	Ablybesmia sp.
	Glyptotendipes sp.
	Psectrocladius sp.
Amnicolidae (gastropod)	Somatogyrus sp.
Haustoriidae (amphipod)	Pontoporela affinis
Tubificidae	Limnodrilus hoffmeisteri

Periphyton. Diatoms were found to be the most abundant form of periphyton that grew on plastic slides placed in the Point Beach area in both 1969 (Ref. 28) and 1970 (Ref. 30). Similar findings were reported at the Kewaunee site from natural substrates (Ref. 29). Of the 59 species and varieties found at Kewaunee, Fragilaria sp. was the most abundant. A full list of species and their relative biomass is given in References 29 and 30.

Phytoplankton. One hundred and four species of phytoplankton including 24 non-diatom species have been identified in the Kewaunee area using the Millipore filter and Lackey scan techniques. These are listed in Reference 29. Species of Fragilaria appear to be the most abundant.

Zooplankton. Various zooplankters are present. The dominant forms are Bosmina, Cyclops, Diaptomus, and Daphnia; of these Bosmina and Diaptomus are generally the most abundant. Plankton hauls have shown a range of 7 to 268 individuals of the <u>Bosmina</u> group during 1969 bi-monthly surveys, the low occurring in December and the high in June (Ref. 28). Data for 1970 were similar, but the largest zooplankton population occurred in August and September. The total number of zooplankton per liter varied from 0 to 1800 during this period with the high occurring in August. A list of organisms found and their relative abundance from April to October is given in References 28 and 30.

<u>Fish</u>. The following species are believed to be present at some time based on collections at the Kewaunee site and observations by state fisheries and game personnel.

TABLE 2.3-9

FISH SPECIES PRESENT AT OR NEAR THE KEWAUNEE SITE

Rainbow trout	Fathead minnow
Brown trout	Shiner
Lake trout	Dace
Coho salmon	Round whitefish
Yellow perch	Lake whitefish
Alewife	Longnose sucker
Sculpin	Bloater chub
Smelt	Carp

Trout and salmon are the most commonly caught sport species and the shoreline area for about 50 miles to the north and south is considered to be good fishing waters for salmonids. (Personal communication, Fisheries biologist, Lee Kernen, Wisconsin Department of Natural Resources).

Effects of Discharge Current

The factors of current and heat will be partially intertwined in the Kewaunee site discharge area and interpretation of effects specific to current will be based on other studies and prior knowledge of species preference or avoidance of current conditions. Data from ecological studies at the Ginna site (Ref. 31), where non-heated discharges occurred for a period, suggest that changes in bottom fauna and fish can occur from current alone. Although strictly local effects of the establishment of a current may be expected in the Kewaunee site, the overall impact is not expected to be great. Within the limited area of bottom and water mass where a current significantly greater than prevailing water currents occurs (up to 1 fps) the attraction of some species of fish and invertebrates can be expected. In a small area where current velocity is high scouring and loss of habitat for organisms that do not favor current will occur. This should not influence a large area. Changes that may occur will be perceived by the present sampling program.

Effects of Temperature Changes

The exposure of the biota of the Kewaunee area to other than natural changes of temperature involve three aspects:

1. Organisms that enter the intake and pass the condensers will experience maximum temperature changes of approximately 20°F in the summer and 28°F in the winter. These organisms will consist primarily of free floating phyto- and zooplankton and may include small fish and fish eggs.

2. Organisms exposed to the warm discharge plume, will experience temperature changes varying in duration and magnitude depending upon where and how long they remain within the plume influence. These organisms include any non-motile forms within the plume influence, phyto- and zooplankton, and motile vertebrates and invertebrates.

3. Motile or non-motile forms that remain within the plume may experience rapid chilling due to a sudden shifting of the plume during changing wind patterns or by plant shutdowns during emergency or normal shutdown operations. Similarly, they may also experience rapid warming from plant start-up and shifting currents.

Area Affected. A model study (Ref. 32) indicates that a surface area of approximately 1,000 acres will be exposed to a 3° F or greater rise, based on a discharge of 412,000 gpm with a 19.5° rise over ambient water temperature. Under conditions of no wind or current dispersal the plume will extend in the direction of discharge no more than 7,000 feet. The 10° F isotherm extends out about 1,000 feet, and the 6° F isotherm about 1,600 feet. Specific measurements will be made during plant operation to evaluate the extent of the plume under varying weather conditions, at various depths and along the bottom. Based on information from nearby Point Beach Nuclear Plant (preliminary thermal plume charts by Argonne National Laboratory, May 1971) which has operated since January, 1971 and has a similar discharge and temperature rise (350,000 gpm, 19.3° F rise) it appears that under various wind directions the plume will not extend more than 1-1/2 miles along the shoreline with an isotherm of 3° F or more. However, since the Kewaunee discharge is essentially at the shore, compared to Point Beach where the discharge is located 150 feet offshore, it is probable the Kewaunee shore area will be warmed a greater portion of the year. Based on present data, then, the 3° F rise line is furthest in the direction perpendicular to the shoreline, about 7,000 feet from the discharge structure, and closer in other directions. The area confined by the 3° F rise isothermal is about 1,000 acres. The shape of the isothermals is oval with its short axis coinciding with the centerline of the discharge.

Benthic Life. As indicated in the Report of the Committee on Nuclear Power Plant Waste Disposal to the Conferees of the Lake Michigan Enforcement Conference (Ref. 33) and confirmed by sampling in the area (Ref. 29), bottom life is relatively scarce in the Kewaunee area. Most organisms have been described as characteristic of cold, oligotrophic waters. Preliminary temperature measurements at Point Beach indicate bottom waters may increase 1-3^{o} F (personal communication, Dr. R. Grunewald, University of Wisconsin - Milwaukee). Since the discharge waters are lighter than lake water they will tend to float. Studies at the Ginna site on Lake Ontario showed that at depths greater than 7 to 9 feet water temperatures were not different from ambient values (Ref. 31).

Beeton (Ref. 34) has reported a shift in the bottom fauna of Lake Erie in the years following the 1918-1928 decade. This was attributed to an average increase in the temperature of lake waters by 2^{o} F plus the addition of chemicals. It is not felt that this will occur in the Kewaunee area because of differences in water quality, and the extent of area warmed. Within the limited warmed zone increased biological activity could occur, and with a possible increased nutrient supply from the mortality of plankton passed through the condenser a small increase and shift in species composition of the benthic community may occur. Considering that the maximum size of the area affected will be under 1000 acres, that the potential change in temperature will be a few degrees, and that only a portion of the area will be affected at any one time, the net effect on abundance and species composition related to the larger Kewaunee area and potential importance to the food web is expected to be negligible.

Phytoplankton and Zooplankton. Potentially, the warming of water may affect a change in algal species composition and abundance resulting in an increase of the less desirable blue-green algae or the green filimentous alga, Cladophora. Cairns (Ref. 35) found that the blue-green algae did best at 95° to 104° F temperatures. During the warmer, summer months nearshore temperatures in the Kewaunee area have ranged from a low of 49 to a high of 70° F based on data from 1969 and 1970. These are extreme values. More typical temperatures are in the order of 60 to 65° F. Summer temperatures, then, would usually be in the 80 to 85° F range at the point of discharge and lower in the surrounding area. These temperatures should not unduly stimulate growth of blue-green algae. Confirmation of this conclusion is indicated from observations at the Point Beach facility. There has been no increase apparent in blue-green algae species or in Cladophora since operation of the plant began. Cairns also found that the more desirable diatoms generally grew best at temperatures of 64.4° to 86° F. The expected temperatures within the plume area are well within the range of the optimum growth of diatoms.

Potential changes in the zooplankton population may also be caused by passage through the condenser system. Several studies have indicated mortality or decreased motility of zooplankters. A report from the Ginna Nuclear Station (Ref. 31) estimates mortality of plankton (primarily zooplankton) at 2-3% of those passing through the pump condenser system and maximum values of 11% mortality under conditions when organisms are exposed to some natural environmental stress (such as storms) before entering the cooling system. Most of the mortality was attributed to mechanical action, but thermal effects cannot be ruled out. Wright (Ref 55) estimated a loss of 10-20% was reasonable from the passage of plankton through the pump and condenser system.

The importance of such losses will depend on the replacement time for these organisms - which is usually rapid - and the size of the population which is being drawn from. Studies of zooplankton abundance and species at the Point Beach Nuclear site, both before and after plant operation began have indicated no effects. A letter from Dr. R. Grunewald, Project Director for the Point Beach Environmental Studies, University of Wisconsin- Milwaukee, states that, "For the phytoplankton and zooplankton phases there have not been any observable changes attributed to the power plant operation based on a comparison with the preoperational data." This statement applies to the first nine months of operation.

It is recognized that due to natural variability in populations and the lack of a full year of post-operational data at Point Beach, a short-term analysis may not detect relatively small effects of the plant operations. Monitoring for changes in baseline populations of phyto- and zooplankton will continue at Kewaunee after operations begin. An advantage to the interpretation of data from the Kewaunee site will be the availability of information from the Point Beach site, which will have been in operation over a year before Kewaunee begins operation.

Fish. Thermal additions may affect fish in several ways: by thermal shock due to relatively sudden increases or decreases in temperature; by influencing species composition in the area through differences in thermal preferences and the possibility of increased or decreased food supply; by influencing spawning times of fish; or by influencing the survival of eggs or young spawned in the area due to direct thermal effects or changes in predation rates; or by influencing migration routes. These effects at the Kewaunee Plant are expected to be minimal or non-existent as described in the following paragraphs.

Information from the nearby Point Beach facility is most pertinent to potential effects of the Kewaunee discharges. No fish kills or other adverse effects have been observed by plant personnel or fish and game representatives of the State Department of Natural Resources.

Independent studies by the University of Wisconsin Center for Oceanographic Study will provide additional information on thermal shock effects from heated water effluents.

Fish moving into the warmed areas are not likely, of their own volition, to move into lethal zones as fish are known to have definite temperature preferences and tend to stay in or move to waters of these temperatures if available. However, it is possible that fish coming from the side of the plume could experience temperature changes up to 20^{o} F in summer and 28^{o} F in winter. Increased predation during these times may take place. Fish that become adjusted to plume temperatures may experience a shock when there is a plant shutdown or an emergency stoppage. During these times temperatures may drop to near ambient conditions within a few hours. Temperature increases due to plant start-up are less sudden.

Wurtz and Renn (Ref. 36) reported that many aquatic organisms are able to acclimate to higher temperatures in relatively short times, a day or less, and that they loose this acclimation slowly. They point out that the effects of sharp rises in temperatures are especially difficult to assess, as sudden change is common in many aquatic environments.

In the area of Point Beach, inshore water temperatures in the summer have naturally varied as much as 20° F within 3 days. It is not known whether fish exposed to this change stay within the area or move to minimize the extent of change. During winter, ambient water temperature is near freezing and there are no natural sudden changes in water temperature. Sudden chilling from the shutdown of the plant may have adverse effects, particularly during the colder months when fish may concentrate in large numbers to the warmer water and could be subjected to a 28° F decrease in temperature within a short period. It is significant to note, however, that operating experience for the first six months at Point Beach showed that with 20 shutdowns, occurring primarily in the winter months, there were no fish killed or other adverse effects observed. Only one shutdown is planned for the first commercial operating year at Kewaunee, although additional shutdowns may occur.

A second aspect of thermal shock is the sudden heating of eggs or young fish that pass through the screening and into the condenser unit. These effects will be integrally related to mechanical and pressure changes experienced going through the pumps.

At the Point Beach site an evaluation (Ref. 38) of the numbers and species of fish that pass through the pump condenser system was made by the Wisconsin Department of Natural Resources. Little damage to fish life was shown. In 14 samples taken at the discharge area during March and May of 1971 the total catch was eight sculpin, two samples with a "few" smelt eggs, and one possible salmonid egg. Total volume filtered was 12-15 million liters. It was concluded that there was little to no direct physical damage to salmonids or whitefish of the area, and it is apparent that few other species were involved during this period. The Kewaunee intake structure is equipped with a screen of bubbles to discourage fish from entering the pump-condenser system. Theoretical calculation made for the Kewaunee site (Ref. 39) estimated a total loss of 20 pounds of potential adult fish per day due to passage of eggs or young into the system. Information gained from the biological monitoring program at Kewaunee will help evaluate the abundance of young fish and eggs in the area that may potentially enter the pump-condenser system.

The species composition in the vicinity of the thermal plume may be altered. Observations at Point Beach and other facilities have shown alewife, trout (brook, rainbow, lake, and brown), salmon, and carp and other fish are attracted to the discharge at various times of the year. At Point Beach this has had a positive effect on sport fishing by providing a zone of concentration of fish. Resultant fish catches, primarily salmonids, have been good. According to state fisheries biologists there is little natural spawning success of salmonids in the general area, and mortality associated with the unavailability of spawning area for sexually mature fish makes it desirable to harvest these fish before they are lost to the fishery.

It is possible that other species, which prefer a habitat warmer than the normal Kewaunee area temperatures, may increase in the immediate area of the plume. Experience at the Point Beach discharge area has shown an increase in desirable sport fishes, primarily trout, however, other species such as carp and alewife has also been attracted. The net impact appears to be beneficial for sport fishing based on the opinion of the state game protector and the popularity of the Point Beach discharge area as a fishing spot. A similar response is expected at the Kewaunee site.

There are no known spawning or nursery grounds for fish in the Kewaunee Plant area, however, investigations of the fish sampling program will specifically look for evidence of spawning. However, because of the high degree of erosion, lack of emergent vegetation, and a bottom of primarily hard clay and shifting sand, few species are likely to utilize this area for spawning. Conversations with state fisheries biologist indicate that only alewife, smelt, and possibly perch (which are not abundant) and some cyprinids may spawn along this type of shoreline. The three small creeks within site property are intermittent and support no spawning for valuable fishes. On the basis of the above no deleterious impact on spawning of important fishes is envisaged.

Migrations of maturing coho salmon are known to occur near the Kewaunee Plant and salmon have been found close in to the Point Beach discharge point. Migrating salmon generally remain close to the coast and pass many streams on their way to their natal stream (or stream of release). There is little likelihood that the creation of a man-made "stream" of warmed water into Lake Michigan will significantly change the migratory patterns of mature fish, although there may be some attraction to local concentrations of alewife in the plume area.

There is the possibility the discharge plume will interfere with near-shore movements of juvenile salmonids. An increased concentration of predator fish in the plume area could result in an increased predation rate on juveniles forced into the plume as they move along the shoreline. Sampling of food habits of fish in the plume area should reveal if this is a major concern.

Mechanical Effects

Phytoplankton and zooplankton. The passage of organisms through the pump condenser system may cause mechanical injury due to turbulence, scraping, or pressure changes. In plant operation these effects cannot generally be distinguished from thermal or chemical effects and are evaluated as part of the sum stress in studies of plankton populations, as described earlier.

Fish. The prime concern in this section is for young fish that may enter the intake system and are unable to swim their way out. Fish may enter the system through one of three intake cones, each approximately 22 feet wide. At this point velocity is approximately 1 fps and most fish could escape the pull with a short burst of speed. The three cones join, and a 10 foot diameter pipe then leads for a distance of 1750 feet to the screenhouse. Fish entering this pipe will be exposed to a velocity of approximately 12 fps.

Once small fish enter the 10 foot pipe it is unlikely they will be able to swim out and they will eventually die and be swept out with trash accumulated on the rotating screens. With this in mind, emphasis has been placed on discouraging fish from entering the intake system by providing a screen of bubbles surrounding the three intake cones. Experience at the Pulliam Plant using the air screen indicates that it is successful in minimizing fish entrapment.

Effects of Chemical Releases

During normal plant operation chemicals are released to discharge waters to control algal and bacterial build-up and for various water processing needs. Sodium hyperchlorite is an algacide which may be released occasionally to keep condenser units free of bacterial and algal build-up.

Operating experience at Point Beach has shown that there is little need for chlorination with the present water quality conditions in this area, and only one chlorination (a test of the system) was run during a 9 month operating period. There is no reason to believe conditions will be any different at Kewaunee and if so chlorination will have essentially no impact on the aquatic environment.

Low concentrations of other chemicals are released, none of which are known to accumulate in a toxic form. Hydrazine breaks down within the system to NH_3, H_2O and NO_2. Concentrations of morpholine are less than 1 ppb and much of this is expected to breakdown. Boron is released at intervals but at very low concentrations averaging 0.01 ppm. The release of phosphates, which might serve to enrich the area, will only increase the background phosphate level by 0.0002 ppm. The effect of all chemical releases is expected to be negligible and no long term build-up is anticipated.

Interaction of Effects of Point Beach and Kewaunee Nuclear Plants

The Kewaunee and Point Beach discharge areas lie within 4-1/2 shoreline miles of one another. Thermal changes and water quantities at the plants are similar, except that discharges would be near double at Point Beach with two units operating.

Current flow studies at Kewaunee and thermal plume studies at Point Beach, although not complete, indicate that there will be no significant interaction of the two facilities (Ref. 29). At a distance of 1-1/4 to 1-1/2 miles from Point Beach, the temperature rise will be $2^{\circ}F$ or less when northward currents move the plume along the shore toward Kewaunee.

Considering thermal interaction under the worst possible conditions, i.e., the plume from each plant going directly towards one another, there would be less than a one degree overlap. This is a highly unlikely condition. Under other conditions the difference will be virtually undetectable. In either case it is highly improbable that any biological effect could be deleterious or even detectable.

The worst conditions for the interaction of chemical and radioactive effluents are an additive effect on concentrations. Without considering any dilution factors which will occur in the intervening distance of the two facilities, there could be an approximate doubling of concentrations of these substances. The concentrations of these substances are already quite low (see sections on Chemical and Radioactive Discharges 2.3.4 and 2.3.7, respectively) even under the worst conditions it is not anticipated that a significant adverse impact would result. In any event, the biological monitoring program at both stations should detect any adverse impact and allow correction measures to be taken.

It is concluded that the biological impact of the interaction of effluents between the two plants will be negligible.

2.3.6.2 Terrestrial Ecosystem

Vegetation. The Kewaunee site encompasses an area of 908 acres. Prior to its use as a power plant site most of the land was in pasture or silage corn production. Wooded areas and edges available for wildlife cover are minimal. The woods are primarily along a wooded creek (about 17 acres) located approximately 3/4 mile north of the plant location and a small woodlot of 13 acres about 1/2 mile south of the plant. The Kewaunee site is an area sparse in types of vegetation that will support both food and cover for a variety of wildlife game species.

Wildlife. The wildlife species listed in Table 2.3-10 are known to occur in the area and a qualitative estimate of their abundance has been made based on conversations with a state biologist.

Table 2.3-10

WILDLIFE SPECIES KNOWN TO OCCUR ON THE PLANT SITE AND THEIR RELATIVE ABUNDANCE*

Species	Abundance
Cotton-tail Rabbit	Present
Squirrel	Present
Deer	Rare
Hungarian Partridge	Common
Ring-necked Pheasant	Present

* Abundance increases in the following order: Rare, Present, Common and Abundant.

In addition to those animals listed, a few red and grey fox, racoon, and migratory woodcock are known to occur in the vicinity, and, according to a state game biologist, migratory waterfowl are hunted off the shores of Lake Michigan in the vicinity of the nuclear site. When the water level of Lake Michigan is low, exposed sand bars in the vicinity of the site attract several hundred geese (snow, blue and Canadian). Also, the agricultural lands adjacent to Lake Michigan attract migratory geese for resting and feeding. Migratory waterfowl utilize aquatic and terrestrial habitat within the vicinity of the Kewaunee Nuclear Plant.

Impacts of the Kewaunee facility on the terrestrial environment include the following: 1) the disturbance of about 40 acres for plant construction and land-fill, and 2) the potential visual effect of the plant and associated power lines on migratory waterfowl.

A net loss of 40 acres of farm land and wildlife habitat was sustained. However, since the habitat is not a rich one for the production of wildlife the loss is not of major significance. The remaining area will be used essentially as it was before, and no basic change in wildlife abundance is expected on this land.

Although some waterfowl may avoid the area (particularly geese) this has not been observed at the nearby Point Beach site and little effect is expected at Kewaunee.

The total impact of plant operation on wildlife of the area appears to be slight. This conclusion is shared by the state game protector and wildlife biologist of the area.

2.3.7 Radioactive Discharges

General. Throughout the design and development of the Kewaunee Nuclear Power Plant, there has been a continuing evaluation and upgrading of the Radioactive Waste Disposal System to incorporate latest improvements in technology, thereby assuring that all effluent releases to the environment are maintained at levels "as low as practicable."

The radwaste system's equipment installed will be capable, by virtue of successive process components and/or recycling features and the appropriate storage facilities, of reducing the contained activity in discharged liquids to, or nearly equal to, background levels, with the possible exception of tritium. However, even the tritium releases will be kept well below the permissible limits. Storage facilities are provided to reduce the gaseous activity levels by decay before their release.

The effects of any radioactive releases on the aquatic and terrestrial ecosystems will be measured in the Radiological Monitoring Program. It is believed that the monitoring program will show no adverse effects because of the extremely low amounts of radioactivity released from the plant. On the basis of the information given in the following subsections, it is concluded that there will be no measurable radiological impact on the environs as a result of the operation of the Kewaunee Nuclear Power Plant.

2.3.7.1 Radioactive Waste Processing System

The Radioactive Waste Processing System, located in the Auxilliary Building, collects and processes all potentially radioactive reactor plant wastes for removal from the plant site within limitations established by applicable governmental regulations. The waste disposal system treats all non-recoverable radioactive liquid wastes, solid wastes and gaseous waste mixtures. The system is designed to process effluent with an activity level based on plant operation with one percent defective fuel. It should be noted that one percent defective fuel is a design number only and affords protection in the event of either transient or long time increases in the amount of failed fuel. The expected percent of defective fuel is 0.2% 2

The waste disposal system is designed to provide controlled treatment and disposal of gaseous and solid wastes and either disposal or reuse of liquid wastes. The principal design criterion concerning disposal is to insure that the general public is protected by maintaining all releases of radioactive materials as low as practicable. Releases of radioactivity will be via the batch process after a period of radioactive decay and after the stored liquid or gas to be released has been sampled. Liquid will be released to the circulating water discharge tunnel which has a minimum flow of 210,000 gpm. Gases will be discharged to the Auxiliary Building vent at a controlled rate through radiation monitors.

Contained in the following discussion are descriptions of the three principal parts of the Radioactive Waste Disposal System for the Kewaunee Plant. These parts are:

a. The Liquid Waste System;

b. The Gaseous Release System; and

c. The Radioactive Waste Solidification System.

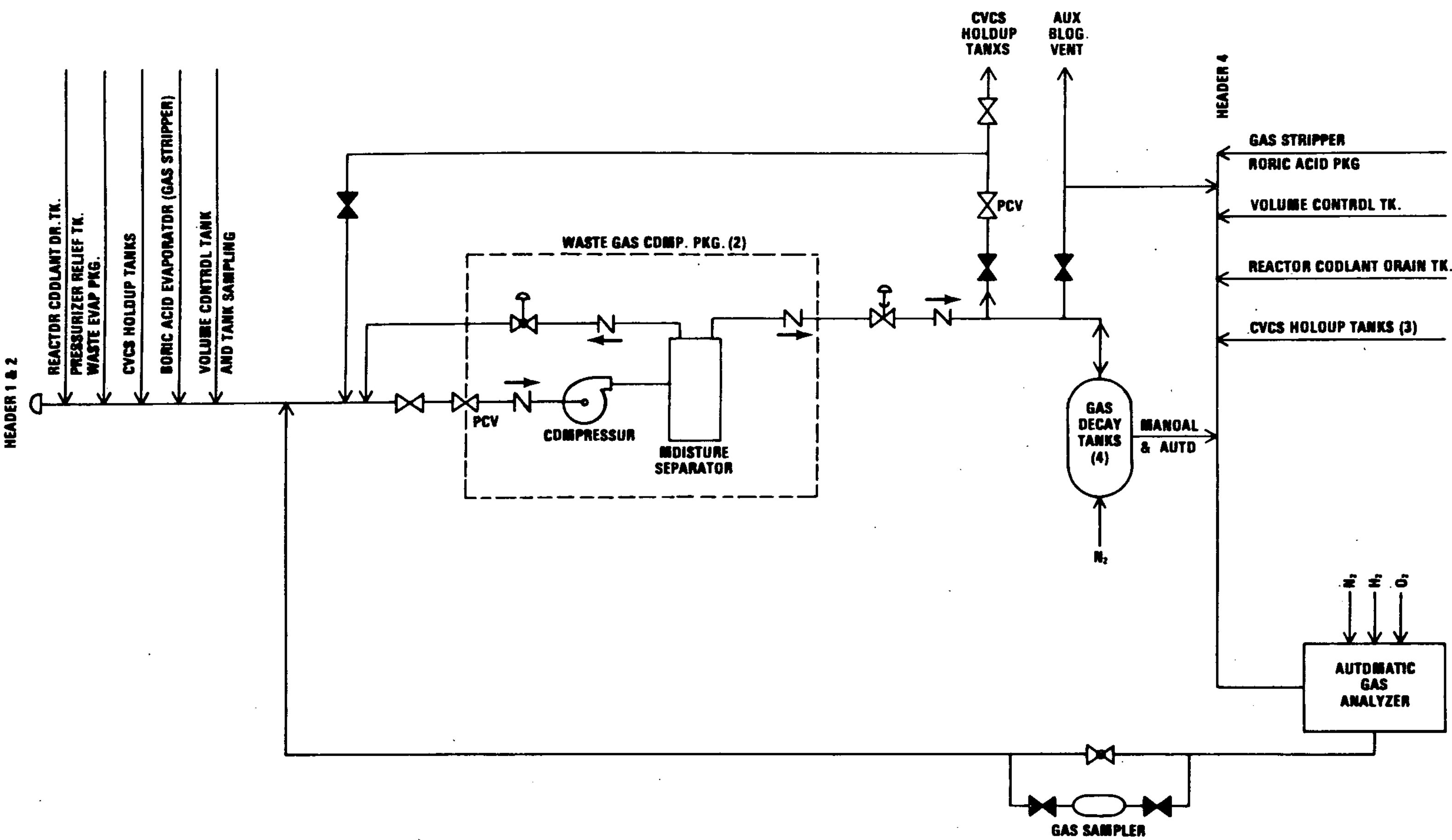
The waste disposal system flow diagrams are shown in Figure 2.3-13, 14 and 15.

The Liquid Waste System. The Kewaunee Nuclear Power Plant Liquid Waste System is shown schematically in Figure 2.3-13.

The waste disposal system collects, processes, stores and disposes of radioactive liquid waste originating anywhere in the plant. These wastes can be categorized as low radioactive wastes and radioactive wastes. Steam generator and heating boiler blowdown will be discussed separately at the end of this section.

Wastes having no or very low radioactivity fall into two categories, namely (1) laundry and hot shower wastes and (2) low radioactivity wastes from the laboratories and building drains.

Laundry and hot shower water are normally discharged to the sewage treatment system and subsequently discharged to the lake. In the event that 2
these waters contain radioactivity levels higher than can be discharged through



GASEOUS WASTE DISPOSAL SYSTEM

FIGURE 2.3-14

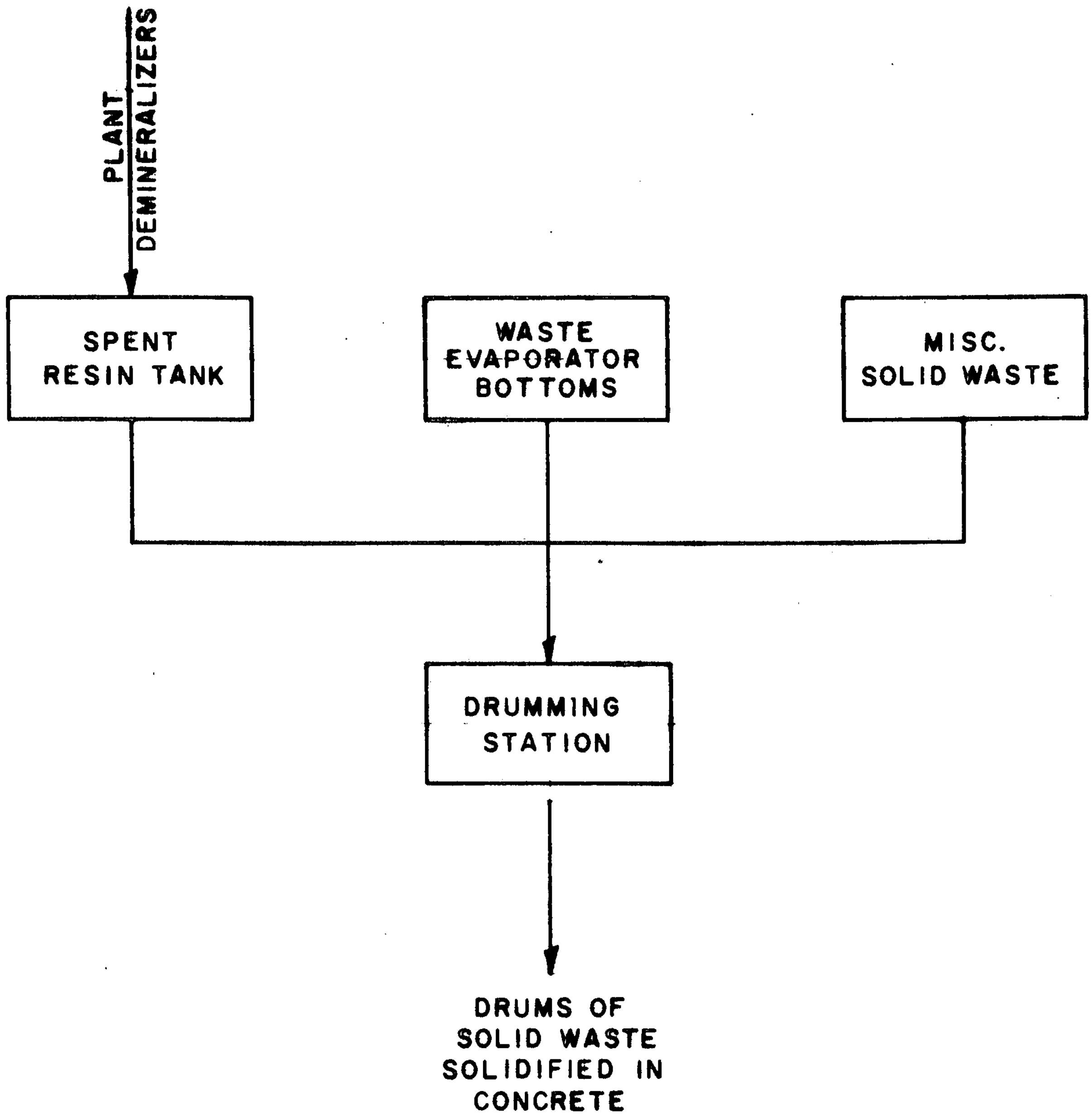


FIGURE 2.3-15
SOLIDS DISPOSAL SYSTEM

this route, they are routed to the waste holdup tank and are processed as are all other low radioactive wastes. 2

Low radioactivity wastes from the laboratories and building drains are all normally routed to the waste holdup tank. These wastes are then passed through a filter and waste evaporator into a waste condensate tank. The tank is sampled and if the effluent radioactivity meets acceptable limits, it is discharged past a radiation monitor directly into the circulating water discharge to the lake. The waste condensate is recycled through the waste holdup tank filter and evaporator until sampling determines that the radioactivity is "as low as practicable".

Wastes having potentially high radioactivity are obtained from valve leak offs, pump secondary seals, reactor coolant loops, and excess letdown heat exchangers. This reactor quality water is collected in a deaerated drain tank which is separate from the low radioactive wastes, and is treated as necessary to permit reactor reuse. Normally, this water is recycled to the reactor, but occasionally release of this water may be necessary. 2

Therefore, the system is designed so the effluent from the Deaerated
Drain Tank can be directed to the Waste Holdup Tank and subsequently through 2
the evaporator, ion-exchange resin, and filters to the environment.

Steam Generator and Heating Boiler blowdown is normally directed to the steam generator blowdown tank. The effluent from this tank is diluted with circulating water and discharged to the lake.

In the event there is a fuel element leak coincident with a
steam generator tube leak, the effluent from the blowdown tank can be 2
processed through ion exchangers and filters and stored in monitor tanks
prior to discharge to the lake. After sampling, the effluent from the
holdup tanks can be directly discharged through the circulating water
system to the lake, or be recycled to the waste holdup tank for processing through that train, as described under low radioactivity wastes.

The Gaseous Release System. The Kewaunee Nuclear Power Plant gaseous release system is shown schematically in Figure 2.3-14.

During plant operations, gaseous wastes will originate from degassing reactor coolant discharge to the Chemical and Volume Control System, displacement of cover gases as liquids accumulate in various tanks, miscellaneous equipment vents and relief valves, sampling operations and automatic gas analysis for hydrogen and oxygen in cover gases.

Most of the gas received by the waste disposal system during normal operation is cover gas displaced from the Chemical and Volume Control System (CVCS) holdup tanks as they fill with liquid. Gases vented to the vent header flow to the waste gas compressor suction header. One of the two compressors is in continuous operation with the second unit instrumented to act as backup for peak load conditions or failure of the first unit. From the compressors, gas flows to one of four gas decay tanks. These tanks have a 45 day holdup capacity before the contents are released, on a batch basis, to the environment or returned to the CVCS holdup tanks. Before a tank is discharged to the environment, it will be sampled and analyzed to determine and record the activity to be released. The tank contents will be released if the sampling has shown that sufficient decay has occurred. During release a trip valve in the discharge line is closed automatically by a high activity level indication in the Auxiliary Building vent.

The Solids Waste Processing System. The Kewaunee Nuclear Power Plant solids waste processing system is shown schematically in Figure 2.3-15.

Radioactive solid wastes consist mainly of dewatered ion exchanger resins, slurry from the evaporated bottoms, filter elements, and contaminated disposable solids such as plastic bags and protective clothing.

Spent resins from the CVCS and other system demineralizers are flushed to a spent resin storage tank located in the Auxiliary Building basement. Periodically, spent resin is transferred to the drumming station where it is solidified with cement in containers. The containers of solidified resin are stored in a shielded area until they are shipped off-site for disposal in a suitable burial site.

Concentrates from the waste evaporator are mixed with cement in drums. These containers are then moved to a storage area. Shielding is provided for the storage area to reduce the dose rate in work areas to an acceptable value.

Miscellaneous contaminated materials, such as paper and glass, are compressed into containers by a hydraulic bailer and stored for shipment to off-site burial. 2

2.3.7.2 Released Radioactivity

This section discusses the anticipated amounts of activity released during the normal operation of the Kewaunee Nuclear Power Plant and compares this released activity with applicable limits and proposed values. Section 2.3.7.3 discusses the doses resulting from these releases.

<u>Comparison with Total Releases and Maximum Permissible Concentrations (MPC's)</u>

A conservative estimate of the quantity of radionuclides expected to be released annually in liquid and gaseous effluents during normal reactor operation has been calculated and is given in Table 2.3-11 and 2.3-12, respectively. The quantities are given both as activity levels (Ci/year), concentrations (μCi/ml) and as fractions of their MPC's as given in Appendix B of 10 CFR 20.

The values given in the Tables assume that plant operation takes place with 0.2 percent failed fuel and that gaseous activity is held up for a 45 day decay period before its release. In practice, the gas may be held longer then 45 days when tank capacity is available. The full delay time is consistent with keeping results as low as practicable. 2

TABLE 2.3-11

ESTIMATED AVERAGE ANNUAL LIQUID RADIONUCLIDE RELEASE*

Radionuclide	Half-Life	Release (Ci)	Average Concentration in Water Discharges (u Ci/ml)	MPC (u Ci/ml)	Fraction of MPC of Water Discharged
H-3**	12.3y	4.04 x (2)	9.7 x (-7)	3 x (-3)	3.2 x (-4)
H-3***		4.0 x (2)	9.6 x (-7)	3 x (-3)	3.2 x (-4)
Mn-54	303d	4.8 x (-5)	1.14 x (-13)	1 x (-4)	1.14 x (-9)
Mn-56	2.6h	2.68 x (-6)	6.4 x (-14)	1 x (-4)	6.4 x (-10)
Co-58	71.3d	9.24 x (-5)	2.2 x (-13)	9 x (-5)	2.4 x (-9)
Co-60	5.3y	1.60 x (-5)	3.8 x (-14)	3 x (-5)	1.28 x (-9)
Fe-59	45.6d	2.06 x (-5)	5.0 x (-14)	5 x (-5)	1.0 x (-9)
Sr-89	52.7d	2.88 x (-5)	6.6 x (-14)	3 x (-6)	2.2 x (-8)
Sr-90	27.7y	5.06 x (-7)	1.2 x (-15)	3 x (-7)	4.0 x (-9)
Y-90	64.0h	5.62 x (-7)	1.36 x (-15)	2 x (-5)	6.8 x (-11)
Sr-91	9.67h	7.98 x (-6)	1.4 x (-14)	5 x (-5)	2.8 x (-10)
Y-91	58.8d	5.44 x (-5)	1.32 x (-13)	3 x (-5)	4.4 x (-9)
Y-92	3.53h	1.22 x (-5)	2.8 x (-14)	6 x (-5)	4.8 x (-10)
Zr-95	65.5d	5.76 x (-6)	1.44 x (-14)	6 x (-5)	2.4 x (-10)
Mb-95	35.0d	5.36 x (-6)	1.28 x (-14)	1 x (-4)	1.28 x (-10)
Mo-99	86.7h	2.22 x (-1)	5.2 x (-10)	4 x (-5)	1.32 x (-5)
I-131	8.05d	1.72 x (-2)	4.2 x (-11)	3 x (-7)	1.38 x (-4)
Te-132	77.7h	1.81 x (-3)	2.2 x (-12)	2 x (-5)	1.44 x (-7)
I-132	2.26h	5.76 x (-4)	1.38 x (-12)	8 x (-6)	1.72 x (-7)
I-133	20.3h	2.22 x (-2)	5.4 x (-11)	1 x (-6)	5.4 x (-5)
I-134	52.0m	6.26 x (-6)	1.98 x (-14)	2 x (-5)	7.4 x (-10)
I-135	6.68h	6.76 x (-3)	1.6 x (-11)	4 x (-6)	4.0 x (-6)
Cs-134	2.05y	8.02 x (-3)	1.98 x (-11)	9 x (-6)	2.2 x (-6)
Cs-136	13.7d	3.72 x (-2)	8.8 x (-11)	6 x (-5)	1.48 x (-6)

2

2
5-8-72

TABLE 2.3-11 (Continued)

Radionuclide	Half-Life	Release (Ci)	Average Concentration in Water Discharges (u Ci/ml)	MPC (u Ci/ml)	Fraction of MPC of Water Discharged	
Cs-137	30.0y	4.92 x (-2)	1.16 x (-10)	2 x (-5)	5.8 x (-6)	
Ba-140	12.8d	2.96 x (-5)	7.2 x (-14)	2 x (-5)	3.6 x (-9)	2
La-140	40.2h	9.9 x (-6)	2.4 x (-14)	2 x (-5)	1.18x (-10)	

Σ = 0.35
(Excluding H-3)

Σ = 2.19 x (-4)
(Excluding H-3)

Numbers in ( ) are powers of ten.

* Based on Circulating Water Flow for Dilution of 210,000 GPM
** Initial Cycle
*** Equilibrium Cycle

TABLE 2.3-12

ESTIMATED AVERAGE ANNUAL GASEOUS RADIONUCLIDE RELEASE

Radio-nuclide	Half-Life	Estimates From Decay Tanks (Ci)	Calculated from Containment Purges (Ci)	Total Releases (Ci)	*Average Maximum Concentration at Site Boundary (u Ci/ml)	MPC (u Ci/ml)	Fraction of MPC at Site Boundary
Kr-85	10.76y	5.74 x (2)	1.36 x (0)	5.75 x (2)	2.73 x (-11)	3 x (-7)	9.12 x (-5)
KR-85m	4.4h		6.9 x (-5)			1 x (-7)	
Kr-87	76m		12.1 x (-6)			2 x (-6)	
Kr-88	2.8h		7.8 x (-5)			2 x (-8)	
Xe-133	5.27d	4.86 x (2)	5.0 x (0)	4.91 x (2)	2.66 x (-11)	3 x (-7)	8.88 x (-5)
Xe-133m	2.26d		11.6 x (-4)			4 x (-7)	
Xe-135	9.14h		4.9 x (-4)			1 x (-7)	
I-131	8.05d		6.65 x (-4)	6.44 x (-3)	3.06 x (-16)	1 x (-10)	3.06 x (-6)
I-132	2.26h		11.7 x (-8)			3 x (-9)	
I-133	20.3h		10.7 x (-5)			4 x (-10)	
I-134	52.0m		2.8 x (-8)			6 x (-9)	
I-135	6.68h		7.7 x (-7)			1 x (-9)	
		Σ = 1.06 x (3)	Σ = 6.4 x (0)	Σ = 1.07 x (3)	Σ = 5.4 x (-11)		Σ = 1.83 x (-4)

Numbers in ( ) are powers of ten.

* Based on the Worst Annual Average X/Q Value of 1.5×10^{-6} SEC/m^3 Expected at the Site Boundary.

2

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The values presented in Table 2.3-11 indicate that the annual release of liquid activity, exclusive of tritium, will be 0.35 Ci and the average concentration will be on the order of four-tenths of one percent of the 10CFR20 limits. The estimated concentrations of the radionuclides in liquid effluent are based on a minimum circulating water flow of 210,000 gpm for dilution purposes, corresponding to the rated capacity of only one circulating water pump.

The annual expected release of tritium in liquid discharges will be approximately 400 curies as is shown in Table 2.3-11. If the total tritium released to the reactor coolant is discharged in the circulating water, the average annual concentration in the discharge water will be about three-hundredths of one percent of the 10CFR20 limits.

Table 2.3-12 contains the estimated maximum gaseous releases per year from two sources, namely, (1) the waste gas decay tanks and (2) routine purging of the containment to allow personnel access. Values given in Table 2.3-12 indicate that the estimated annual release of noble gas activity from the waste gas decay tanks will be about 1070 Ci. The estimated maximum annual release due to containment purges will be approximately 6.4 Ci. This 2
quantity is based on the containment air being recirculated through available charcoal filters, for 32 hours/week and the containment being purged once a year. If radioiodine were detected in the containment prior to purging, it would also be vented through charcoal filters. Use of the charcoal 2

filters available in the purge system will allow a reduction in radioiodine release by at least a factor of 1/200 which corresponds to the design minimum filter removal efficiency of 99.5 percent. Actually, filter efficiencies on the order of 99.9 are considered to be realistic and would provide a further reduction of radioiodine release.

The assumed reduction factor of 1/200 was included in the values for iodine in Table 2.3-12. Not included in the tabulated release values is the expectation that no more than 1/3 of the iodines present in the coolant leakage would ever be released to the containment atmosphere. If included, a further reduction in radioiodine release would be realized.

The average annual concentration at the site boundary of noble gas activity, released from both sources mentioned earlier, will be less than one-tenth of one percent of the 10 CFR 20 limits for such releases.

The release of particulates in the off-gases is expected to be negligible because of the existence of Hepa particle filters in the gaseous exhaust path.

It should be noted that the annual gaseous activity release of 1070 Ci for the Kewaunee Nuclear Power Plant (shown in Table 2.3-12) is artificially high for waste gas releases. This is illustrated by the fact that the annual release estimated, is significantly higher than all but one of the 4 to 10,000 Ci/yr releases reported by operating pressurized water reactor (PWR) plants. The waste gas release experience for four operating PWR's is listed in Table 2.3-13. 2

TABLE 2.3-13

PWR WASTE GAS RELEASE EXPERIENCE

Plant	Annual Average Release Rate (μ Ci/sec)/1000 Mwhr (e)	Extrapolated Expected Kewaunee Release Rate* Ci/yr
Indian Point *1 (265 Mwe)	1.2×10^{-2} (1963-1970)	4.92×10^{2} (Max)
Yankee Rowe (175 Mwe)	1.0×10^{-4} (1964-1970)	4.2×10^{-1} (Min)
San Onofre (430 Mwe)	5.0×10^{-3} (1967-1970)	2.1×10^{1}
Connecticut Yankee (600 Mwe)	3.0×10^{-3} (1967-1970)	1.3×10^{1}

NOTE: Kewaunee design basis annual average gaseous release rate = 1,070 Ci/yr. 2

* Based on a total of 4.1×10^{6} Mwhr (e) per year from a single unit operating at a load factor of 80 percent.

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2.3.7.3 Pathways of Exposure to Man

A number of potential pathways through which local populations may be exposed to the radioactive effluents from nuclear operations are illustrated in Figure 2.3-16. The importance of these individual pathways is determined by the quantity and isotopic composition of radioactivity in liquid and gaseous effluents.

Doses from Gaseous Effluents. Since the noble gases do not react chemically with other substances under normal conditions, there is no physical basis for either transport through food chains or concentrating mechanisms within the human body for these substances.

In terms of inhalation and absorption in the body, both krypton and xenon may be present in physical solution, chiefly in the body water and fat (Ref. 40). Several human exposure experiments revealed that inhalation of millicurie amounts of radioactive inert gases resulted in less than 10 millirem tissue exposures (Refs. 41, 42). In general, it may be estimated that the internal dose from radioactive noble gases dissolved in body tissue following inhalation is less than 1% of the associated external whole body submersion dose.

The submersion dose from the releases of gaseous radioactivity to the atmosphere will be vanishingly small if the operator chooses the off-shore wind direction for release, especially if this can be planned with a

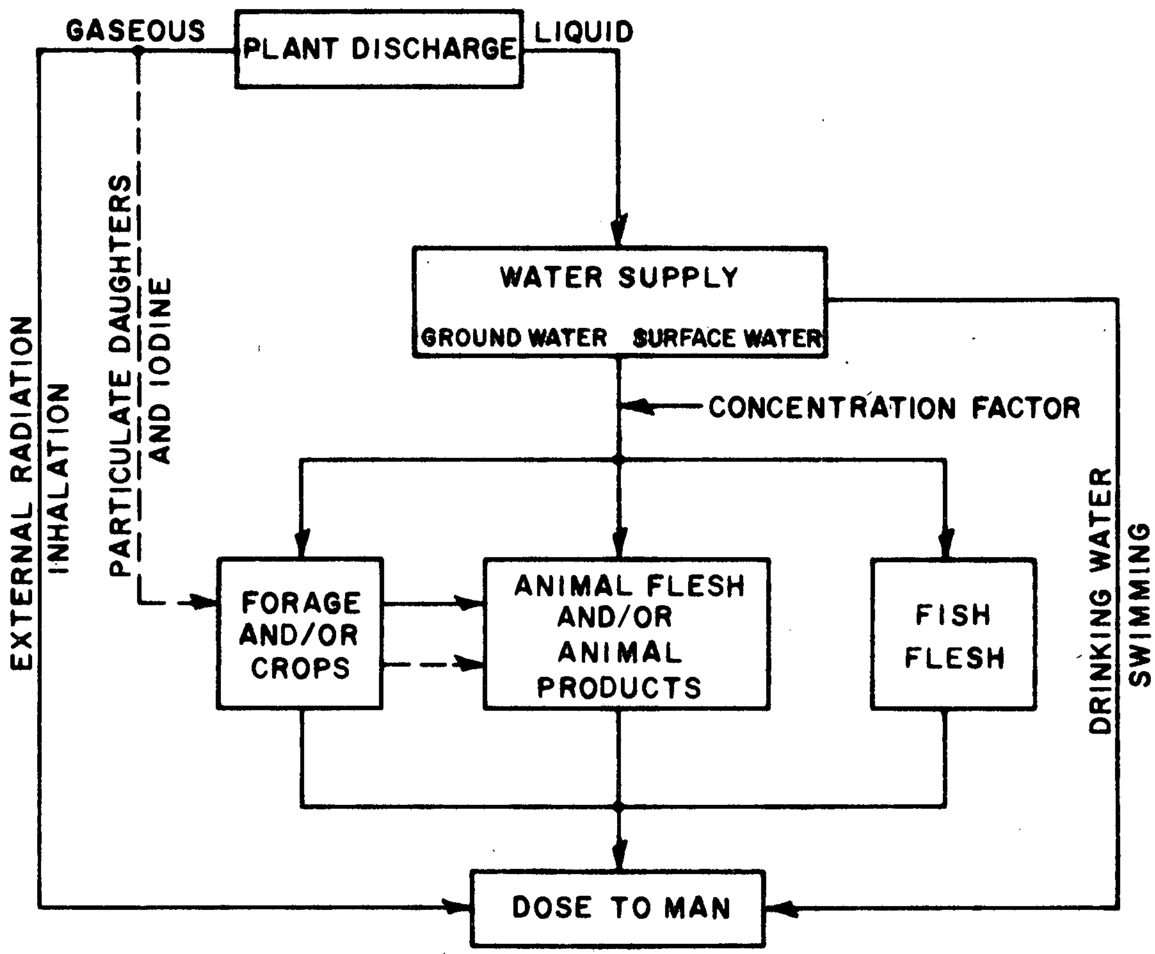


FIGURE 2.3-16
EXPOSURE PATHWAYS

synoptic background indicating a number of hours of travel in that direction. The ability to use such a wind is almost certain, since the offshore winds persist throughout 60 percent of the total year. Localized patterns, even during periods of onshore winds, are such that periods of several hours duration appear as offshore during virtually any 72 hour period. However, dose estimates have been made based on the assumption that no effort is made to control releases so as to limit them to the offshore direction; therefore, the following calculated doses are much higher than expected doses.

Radiation doses from the gaseous effluents as a function of distance and direction were calculated using the ICRP (Ref. 43) "infinite semispherical cloud" model. The exposed individual is assumed to be located at the center of an infinitely large semispherical cloud of uniform radioactivity concentration. The concentration used here is equal to that of the centerline, or maximum, value of the plume at the specified distance.

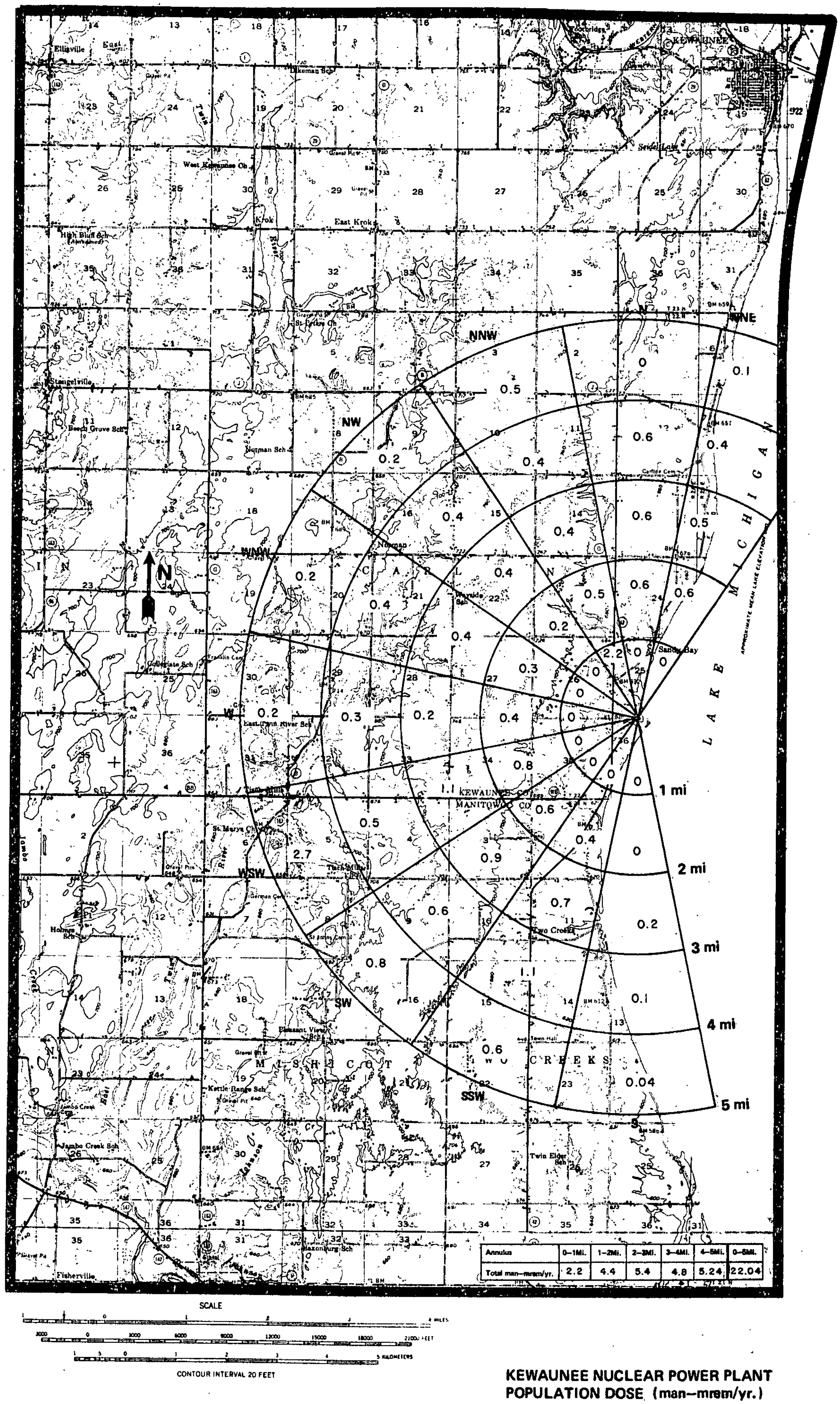
The ICRP method gives valid estimates of the whole body dose for noble gas nuclides which are beta-gamma emitters but may substantially over-estimate the whole body dose from pure beta emitters (Ref. 44) and beta emitters which emit few gammas such as Kr-85.

Since the dose calculations include atmospheric diffusion, meteorological data were required. On-site data covering a one year period (1969) were reduced and summarized using the NUS computer program WINDVANE.

The annual average radiation dose was calculated for each of the population ring sectors shown in Figure 2.3-17 and 2.3-18. The population dose (in man-rem/year) was calculated by multiplying the average dose for a sub-sector by the number of people projected (Ref. 45) for the year 2010 for that sub-sector, and summing over all ring sectors, out to 50 miles from the site. The average per capita dose was calculated by dividing the total population dose by the total year 2010 estimated population within a 50 mile radius.

The resultant average annual whole body doses from exposure to the noble gases are presented in Table 2.3-14 for an individual at the site boundary and for the population within 50 miles of the plant. The doses were also calculated for the high and low range release estimates based on the highest and lowest releases per unit energy generated at operating U. S. PWR stations. Included for comparison are the individual and population doses estimated to result from natural background radiation.

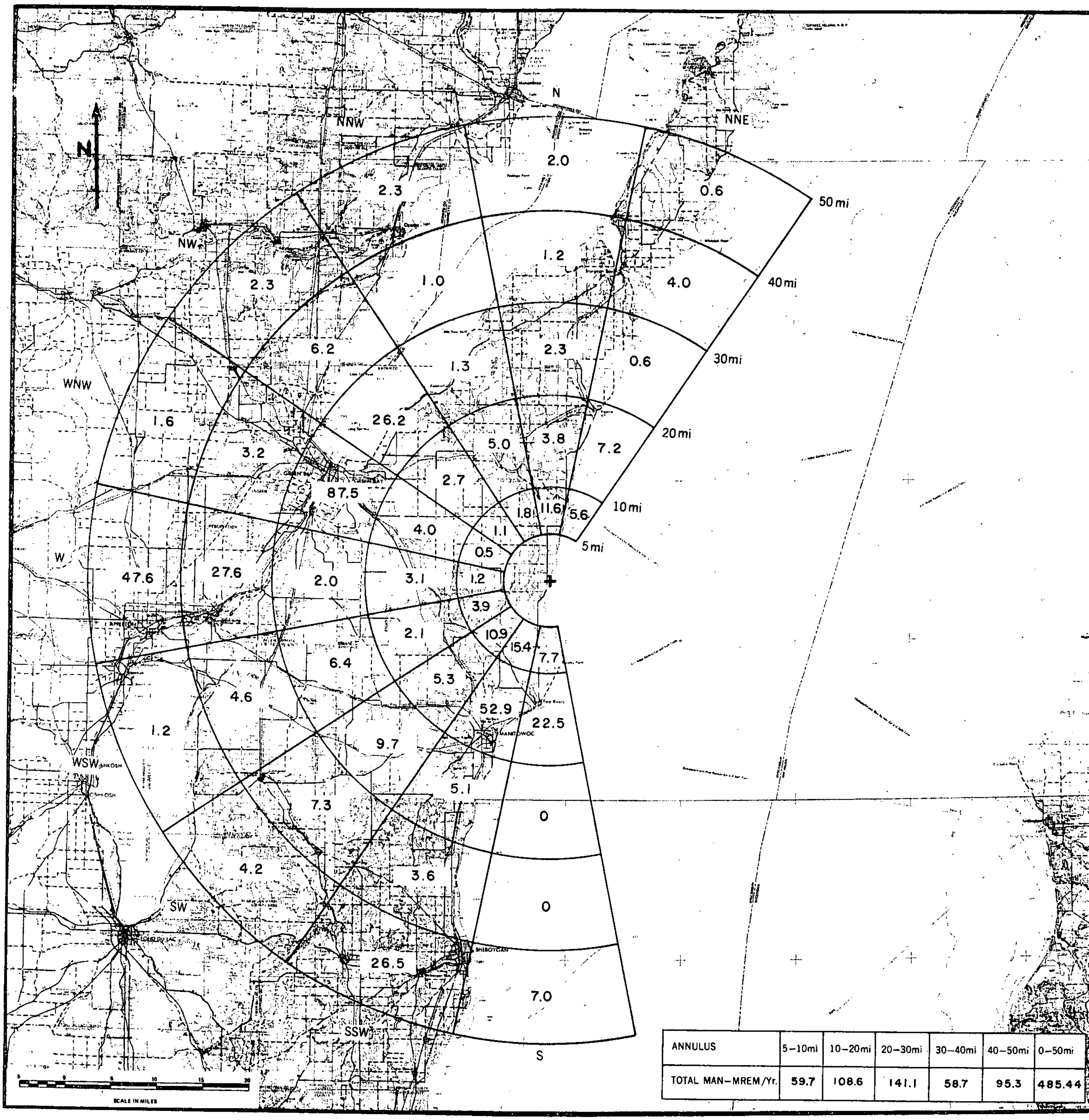
Figures 2.3-17 and 2.3-18 show the annual man-mrem doses for each sub-sector from 0 to 5 miles and from 5 to 50 miles, respectively. The annual average dose isopleths (mrem/yr) out to a distance of about 50 miles are shown in Figure 2.3-19.



Annulus	0–1MI.	1–2MI.	2–3MI.	3–4MI.	4–5MI.	0–5MI.
Total man–mrem/yr.	2.2	4.4	5.4	4.8	5.24	22.04

KEWAUNEE NUCLEAR POWER PLANT
POPULATION DOSE (man–mrem/yr.)
0–5 Miles

FIGURE 2.3-17



ANNULUS	5–10mi	10–20mi	20–30mi	30–40mi	40–50mi	0–50mi
TOTAL MAN–MREM/Yr.	59.7	108.6	141.1	58.7	95.3	485.44

KEWAUNEE NUCLEAR POWER PLANT
POPULATION DOSE (man–mrem/yr)
5–50 miles

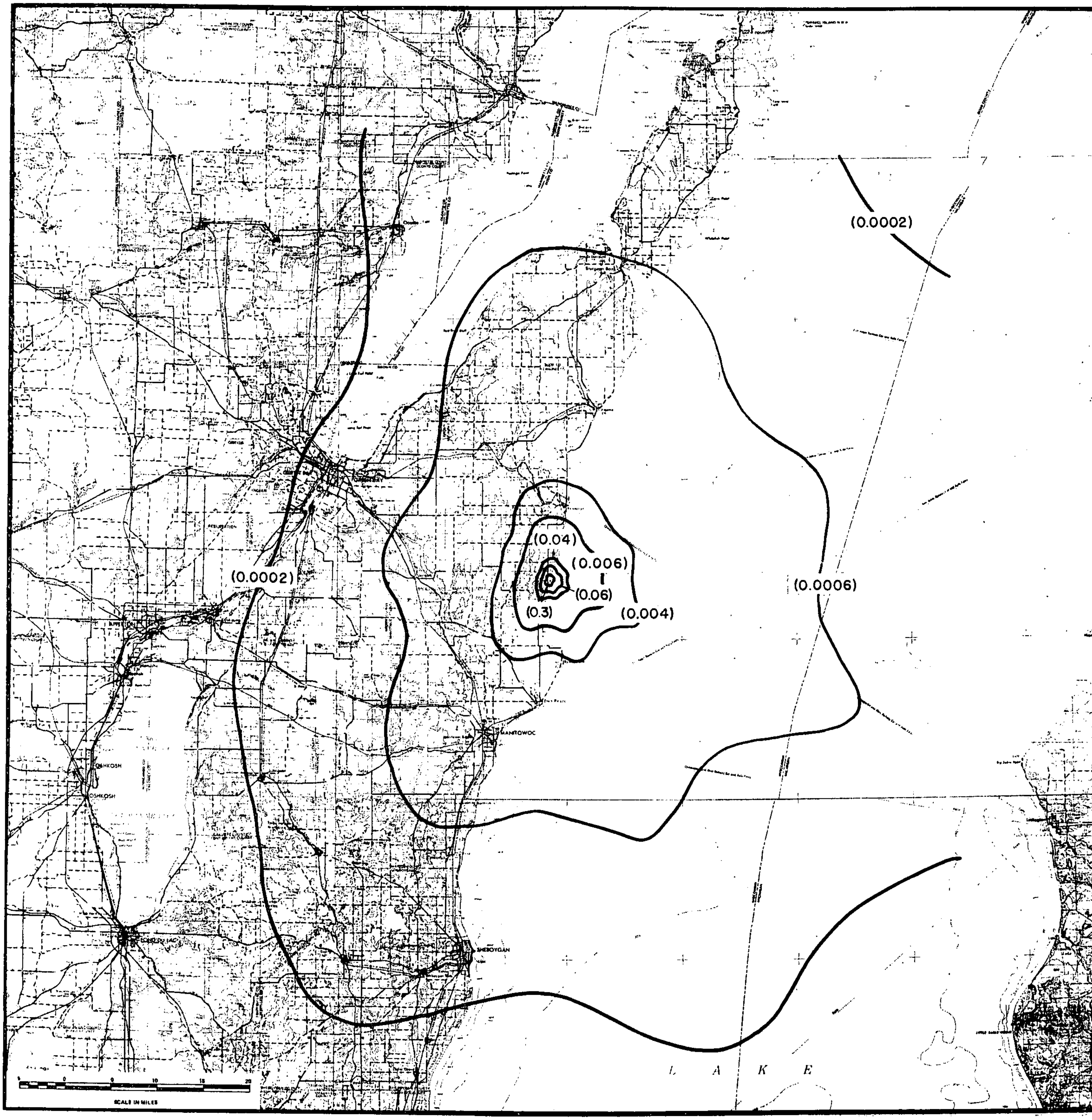
FIGURE 2.3-18

TABLE 2.3-14

RADIATION DOSES FROM GASEOUS RELEASES

Individual Dose	Maximum Calculated Dose	Expected Releases High	Expected Releases Low	
Station Origin				
(a) Dose rate (mrem/year) at SSW site boundary	0.10	0.0084	0.0000072	2
(b) Average annual dose (mrem/year) per person) (within 50-mile radius)	0.0004	0.000034	0.0000000	2
Natural Background				
(c) Radiation dose (mrem/year)	125	125	125	
Population Dose*				
(d) Total station-derived man-rem/year (within 50-mile radius)	0.49	0.042	0.000036	2
(e) Total man-rem/year from natural background radiation (within 50-mile radius)	≈150,000	≈150,000	≈150,000	

*Based on estimated 2010 population of 1.2×10^6 within 50 miles of the Kewaunee Nuclear Power Plant.



KEWAUNEE NUCLEAR POWER PLANT

ANNUAL DOSE ISOPLETHS, MREM

FIGURE 2.3-19

Radioiodine in Milk

The grass, cow, milk, child pathway is relevant if any radioiodine is released to the atmosphere. This is not expected to occur during normal operation. Estimates for maximum release discussed in Section 2.3.7.2 are based on conservative assumptions; however, these release estimates have been used to calculate thyroid dose to a child that drinks one liter of milk/day from a cow that is grazing at the site boundary during the purging period and continues to graze through the period following cessation of venting as the activity on the pasture decays. Under these conditions the maximum thyroid dose to a child is 0.93 mrem/year. (See Section 2.3.7.2 for conservative assumption to estimate release.) This dose is highly unlikely since the cow will not be grazing all twelve months of the year and the pasture is covered with snow a portion of the year. 2

Doses from Aquatic Pathways to Man

Some amount of both external and internal radiation dose to man will result from the ingestion of water and fish and from water contact activities. Various exposure pathways are considered including the individual and population radiation doses from (1) the ingestion of Lake Michigan water, (2) the ingestion of fish which inhabit Lake Michigan, (3) the ingestion of milk from cows which drink water containing liquid effluent and (4) the exposure of swimmers in the lake.

Internal Dose From the Ingestion of Water

Internal dose from ingestion of well water will be negligible since the aquifers all drain toward the lake, away from the inhabited areas. Since there will be virtually no deposition of radioactive materials in the area and because the soils are impervious, that is, having a very high clay content, percolation downward into the water tables is very improbable and the quantities reaching the aquifers will be so small as to be undetectable.

The individual whole body doses derived from the ingestion of lake water are presented in Table 2.3-15. These calculations were made for the concentrations of radionuclides in the discharge canal and potable water intakes on Lake Michigan. Appropriate dose reduction factors due to dilution in Lake Michigan were applied to compute the doses to residents of four cities that use Lake Michigan as a source of drinking water. The potable water intakes on Lake Michigan within 50 miles of the point of release are at Rostok (the intake for Green Bay), about 11.5 miles north; Two Rivers, 16 miles south; Manitowoc, 20 miles south; and Sheboygan, 44 miles south. The dose reduction factors used were 50, 65, 74 and 127 for the above intakes, respectively.

Conservative assumptions such as no radioactive decay and no removal of radioactivity during normal water treatment processes were

TABLE 2.3-15

INDIVIDUAL WHOLE BODY DOSES FROM THE INGESTION OF WATER

Radionuclide	DOSE (rem/year)				
	Discharge Canal	Green Bay Intake	Two Rivers Intake	Manitowoc Intake	Sheboygan Intake
H-3	9.7 (-5)	1.94 (-6)	1.49 (-6)	1.31 (-6)	7.64 (-7)
Sr-89	4.84 x (-10)	9.66 x (-12)	7.40 x (-12)	6.60 x (-12)	3.80 x (-13)
Sr-90	1.92 x (-9)	3.84 x (-11)	2.96 x (-11)	2.60 x (-11)	1.51 x (-16)
Y-90	2.7 x (-15)	5.4 x (-16)	4.14 x (-17)	3.66 x (-11)	2.12 x (-17)
Sr-91	4.08 x (-12)	8.12 x (-14)	6.28 x (-14)	5.52 x (-14)	3.20 x (-14)
Y-91	3.76 x (-13)	7.52 x (-15)	5.78 x (-15)	5.08 x (-15)	2.96 x (-15)
Y-92	5.72 x (-16)	1.19 x (-17)	9.12 x (-18)	8.02 x (-17)	4.68 x (-18)
Zr-95	7.04 x (-14)	1.42 x (-13)	1.09 x (-15)	9.62 x (-16)	5.58 x (-16)
Nb-95	1.85 x (-14)	3.7 x (-16)	2.84 x (-16)	2.5 x (-16)	1.46 x (-17)
Mo-99	3.44 x (-7)	6.88 x (-9)	5.28 x (-9)	4.64 x (-9)	2.70 x (-9)
I-131	1.16 x (-7)	2.32 x (-9)	1.79 x (-10)	1.57 x (-9)	9.12 x (-10)
I-133	3.26 x (-8)	6.5 x (-10)	5.04 x (-10)	4.40 x (-10)	2.64 x (-10)
I-135	4.98 x (-9)	9.96 x (-11)	7.68 x (-11)	6.72 x (-11)	3.92 x (-11)
Cs-134	1.16 x (-6)	2.32 x (-8)	1.77 x (-8)	1.56 x (-8)	9.08 x (-9)
Cs-136	5.36 x (-7)	1.07 x (-8)	8.26 x (-9)	7.26 x (-9)	2.22 x (-9)
Cs-137	4.12 x (-6)	8.2 x (-8)	6.32 x (-8)	5.56 x (-8)	3.24 x (-8)
Te-132	4.52 x (-9)	9.04 x (-11)	6.96 x (-11)	6.12 x (-11)	3.56 x (-11)
I-132	1.92 x (-10)	3.84 x (-12)	2.94 x (-12)	2.58 x (-12)	1.51 x (-12)
Ba-140	7.34 x (-11)	1.47 x (-12)	1.13 x (-13)	9.94 x (-13)	5.76 x (-13)
La-140	6.38 x (-15)	1.28 x (-16)	2.88 x (-16)	8.62 x (-17)	5.0 x (-17)
I-134	6.8 x (-13)	1.36 x (-14)	1.04 x (-14)	9.20 x (-15)	5.36 x (-15)
Mn-54	2.76 x (-12)	5.56 x (-13)	4.26 x (-13)	3.74 x (-13)	2.18 x (-13)

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TABLE 2.3-15 (Continued)

Radionuclide	DOSE (rem/year)				
	Discharge Canal	Green Bay Intake	Two Rivers Intake	Manitowoc Intake	Sheboygan Intake
Mn-56	1.13 x (-12)	2.26 x (-16)	1.74 x (-14)	1.52 x (-14)	8.9 x (-15)
Co-58	2.88 x (-10)	5.74 x (-12)	4.4 x (-12)	3.84 x (-12)	2.26 x (-12)
Co-60	1.39 x (-12)	2.78 x (-13)	2.14 x (-13)	1.87 x (-13)	1.09 x (-14)
Fe-59	1.43 x (-11)	2.86 x (-12)	2.2 x (-12)	1.94 x (-12)	1.13 x (-13)
TOTAL	1.02 x (-4)	2.06 x (-6)	1.59 x (-6)	1.39 x (-6)	8.13 x (-7)

2

Numbers in ( ) are powers of ten.

made for these dose computations. Also assumed was that the total of an individual's water and fluid intake (2200 cc/day according to ICRP) (Ref. 43) was derived from Lake Michigan or the discharge canal.

The maximum dose to an individual from the ingestion of water from the discharge canal was calculated to be 0.129 mrem/year. The doses to individuals taking water from Lake Michigan at distances from the point of discharge are approximately two orders of magnitude lower than for the maximum individual. The population doses from the ingestion of water containing liquid discharges of the plant were calculated based on the 1970 population of the cities within 50 miles of the plant which take their potable water from Lake Michigan. These doses are given in Table 2.3-16. The total population dose from this pathway is estimated to be 0.36 man-rem/year.

Internal Dose from the Ingestion of Fish

The aquatic route to man via fish is shown in Figure 2.3-20. The annual average concentration of radioactive material in liquids released to the lake are estimated in Section 2.3.7.2 Isotopes of cesium are the limiting radionuclides in this base because cesium moves freely in aquatic systems and concentrates in edible portions of the fish. The fish flesh concentration term in this case is the product of the radionuclide concentration in Lake Michigan water and the concentration factor, C_f - the degree to which the radionuclides are either concentrated by or discriminated

TABLE 2.3-16

POPULATION DOSE FROM THE INGESTION OF WATER

CONTAINING LIQUID DISCHARGES

City	Population*	Individual Dose (rem/year)	Population Dose (man-rem/year)
Rostok (Green Bay)	8.74 (4)	2.05 (-6)	1.79 (-1)
Two Rivers	1.36 (4)	1.58 (-6)	2.14 (-2)
Manitowoc	3.34 (4)	1.38 (-6)	4.63 (-2)
Sheboygan	5.18 (4)	8.08 (-7)	4.18 (-2)
		TOTAL	2.89 (-1)

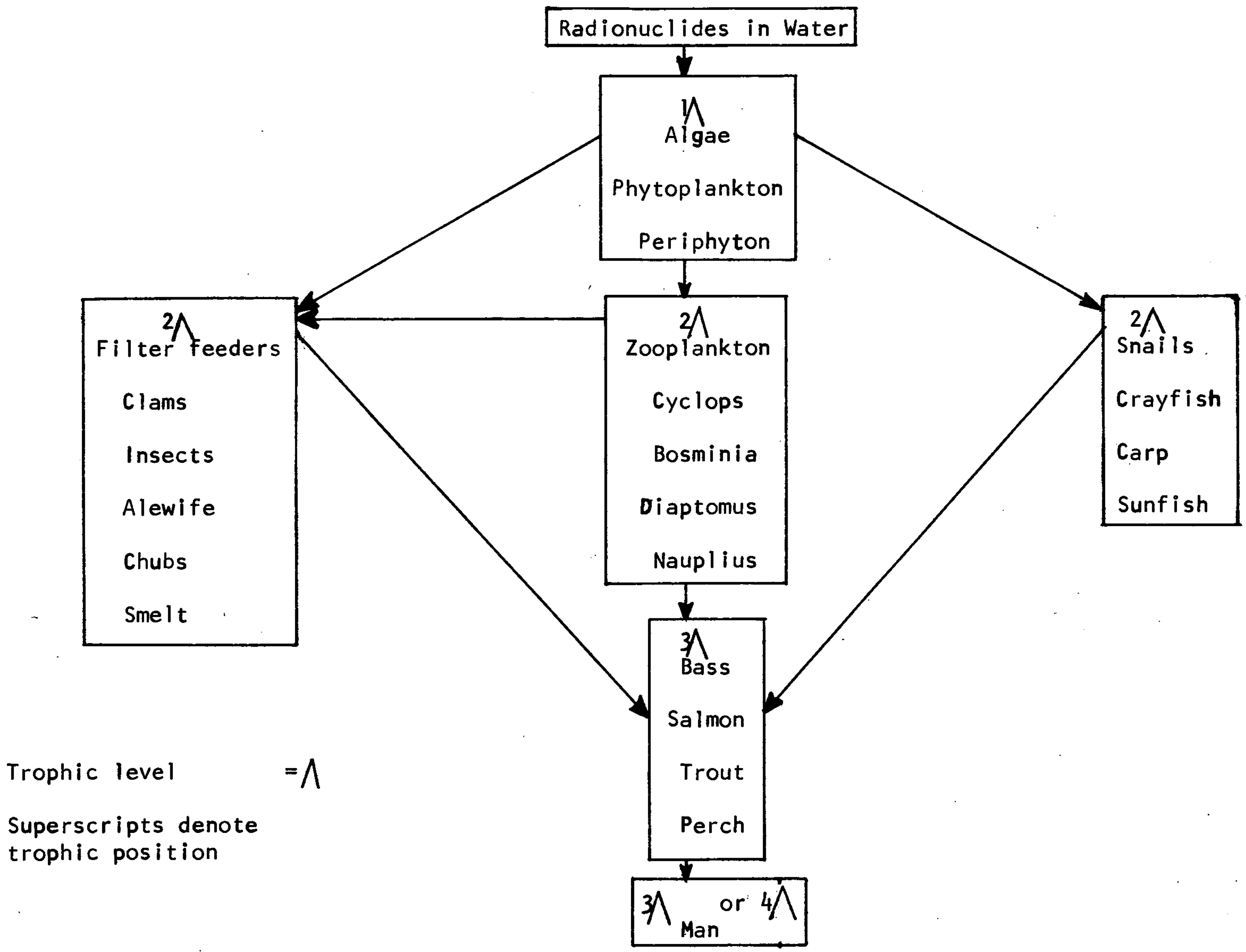
2

Numbers in ( ) are powers of 10

*Bureau of the Census data for 1970

FIGURE 2.3-20

AQUATIC FOOD WEB



against by the organism. For purposes here the C_f is defined as the ratio of the concentration of the radionuclide per gram of fish flesh to the concentration of the radionuclide per cc of water. The values of C_f used in this report are based on stable element concentrations found in nature (Ref. 46) except for the isotope tellurium. The C_f for tellurium is assumed to be 1000. Selenium, which is chemically similar to tellurium has a C_f of 400.

The rate of fish flesh consumption used in the calculation was 50 grams per day. This is about the seafood consumption of commercial fishermen in the United States (Refs. 47, 49).

The doses to the maximum individual and individuals in the population eating fish from Lake Michigan are presented in Table 2.3-17 was assumed that for other than the maximum exposed individual the fish were raised in water containing radionuclides at the Green Bay water intake concentration. For the maximum exposed individual, the fish and all of its food web is assumed to live 100% of the time in water with the same concentration of radionuclides as is estimated for the discharge canal.
The dose to the maximum exposed individual is estimated to be 0.13 mrem 2
per year and the dose to the general population is estimated to be a
maximum of 0.64 man-rem/year. 2

TABLE 2.3-17

INDIVIDUAL WHOLE BODY DOSE

FROM THE INGESTION OF FISH

Radionuclide	Dose (rem/year) Discharge Canal		Green Bay	
H-3	2.04	(-6)	4.06	(-8)
Fe-59	9.76	(-10)	1.95	(-11)
Mn-54	1.57	(-11)	3.14	(-13)
Mn-56	6.4	(-13)	1.23	(-14)
Co-58	3.26	(-9)	6.59	(-11)
Co-60	1.58	(-10)	3.16	(-12)
Sr-89	4.4	(-10)	8.82	(-12)
Sr-90	1.75	(-9)	1.5	(-10)
Sr-91	3.72	(-12)	7.04	(-14)
Y-90	6.16	(-15)	1.23	(-16)
Y-91	8.56	(-13)	1.71	(-14)
Y-92	1.34	(-16)	2.68	(-17)
Zr-95	1.61	(-13)	3.22	(-15)
Nb-95	1.26	(-11)	2.52	(-13)
Mo-99	7.84	(-9)	1.57	(-8)
I-131	2.64	(-9)	4.72	(-11)
I-132	4.36	(-12)	8.76	(-14)
I-133	7.36	(-10)	9.76	(-12)
I-134	1.55	(-14)	3.10	(-16)
I-135	5.10	(-7)	1.02	(-8)
Te-132	1.03	(-8)	2.06	(-9)
Ba-140	1.67	(-12)	3.34	(-13)
La-140	1.45	(-14)	2.90	(-16)
Ca-134	2.62	(-5)	5.24	(-7)
Cs-136	1.22	(-5)	2.44	(-7)
Cs-137	9.32	(-5)	1.86	(-7)

2

Numbers in ( ) are power of 10.

External Dose from Swimming in Liquid Effluent

The only significant source of external exposure from liquid effluents arises from swimming in the liquid effluent. Yet from this direct means of exposure to humans, only a minor radiation dose results.

The method for this dose calculation, assumes that the swimmer is
immersed in an infinite medium and that he receives the same dose as the
water itself. Table 2.3-18 gives the maximum dose to an individual who
swims in water containing the same concentration of radionuclides as the
discharge canal. If it is assumed that an individual spends 200 hours/
year swimming, the resultant whole body dose would be about 0.00086 mrem 2
per year. The population dose from swimming, assuming 2 x 10^6 man hours/
year of swimming in water at the discharge canal concentration, is .0086 2
man-rem per year.

Summary for Aquatic Pathways

Table 2.3-19 presents a summary of the individual and population doses from all aquatic pathways to man.

2.3.7.4 Combined Dose from Point Beach and Kewaunee

Since the Point Beach Nuclear Power Plant is 4.5 miles south of Kewaunee, the combined effect of both plants has been considered. The dose

TABLE 2.3-18

THE DOSE TO SWIMMERS IMMERSED IN

WATER CONTAINING LIQUID EFFLUENT

Radionuclide	Dose (rem/hour) From Swimming In Discharge Canal*	
H-3	2.04 (-8)	
Mo-99	6.04 (-10)	
I-131	1.74 (-10)	
I-133	9.44 (-11)	
Cs-136	1.23 (-10)	2
Cs-137	1.47 (-10)	
	2.15 (-8)	

Numbers in ( ) are powers of 10.

*The total whole body dose (considering that the dose contribution from H-3 was a skin dose only) is 4.3 x 10^{9} rem/hour. 2

TABLE 2.3-19

DOSE SUMMARY FOR LIQUID DISCHARGES

Exposure To	Highest Exposed Individual, mrem/year	Population Dose man-rem/year	
Whole body from			
Ingestion of water	0.103	0.07	
Ingestion of fish	0.13	0.64	
Swimming	0.00086	0.0086	2
TOTAL WHOLE BODY DOSE	0.23	0.72	

to the maximum exposed individual living near the site boundary is not changed by considering both plants. The general population dose is the sum of the man-rem doses calculated for each plant independently.

2.3.7.5 Radiological Effects on Important Species

The total amount of activity released during plant operations is quite low and less than that of the 10 CFR 20 limits (see Radioactive Waste). While it is true that radiation standards for safeguarding aquatic organisms and wildlife are more difficult to establish than those prescribed for man because of the many species involved, the following statement was made by Dr. Raymond Johnson, Assistant Director, Bureau of Sports Fisheries and Wildlife, Department of the Interior (Ref. 37):

> "However, in spite of this problem (numerous species involved), virtually all published data show that concentration of radionuclides required to injure fish and wildlife are much higher than the maximum permissible concentrations prescribed in Title 10, part 20, of the Code of Federal Regulations."

Dr. Johnson went on to say that the cushion provided by the 10 CFR 20 limits appears to be adequate for acute toxicities or effects on aquatic organisms. In addition, Dr. S. I. Auerbach, Director of Ecological Sciences Division, Oak Ridge National Laboratory, recently has reviewed the radiological effects of low-level liquid radioactive waste on aquatic biota. Dr. Auerbach concluded that, with dose rates at or around the maximum permissible concentrations of radionuclides in 10 CFR 20, our best technologies and methods cannot demonstrate that there is any effect on these systems.

On the basis of the above, it is believed that the anticipated releases of radioactivity from the Kewaunee Nuclear Plant will have a minimal radiological effect on the important species in the environs.

2.3.8 Impact of Construction Operations

Construction of the Kewaunee Plant started November, 1967, with site grading and clearing. Plant construction is proceeding and is expected to be completed in April, 1972. Commercial operation is scheduled for December, 1972.

Soil erosion control procedures to minimize the risk of temporary or eventual erosion problems have been employed. Surface drainage systems, including channels, check dams and related features have been extensively and effectively employed. The State Department of Natural Resources and the Soil Conservation Service have actively participated in and approved this program.

Immediately to the southwest of the plant, approximately 17 acres have been used as a sanitary landfill for solid waste disposal of construction debris. This area will increase by no more than 10 percent since production of soild wastes from the construction activities is diminishing rapidly and will essentially cease within the next 12 months. Debris is being buried approximately six feet below the surface. The landfill area has also received excavation material from the plant building area and dredging material from the Lake. This material has been placed in a manner to improve land contour and drainage. As each section of the area is complete, it is graded to blend in with the natural landscape and then planted to grasses for soil erosion control and aesthetic improvement. 2

With the exception of moving farm buildings, the owned area outside the 110 acres which is effected by construction operations is not being signifcantly altered. In order to maintain this area, inhibit erosion, and preserve the original land character, vegetation is to remain undisturbed except by normal farming operation. No other changes are to be made to terrain or plant life without the expressed permission of the owners. No open fires are permitted on land or beach areas adjacent to site. Plant security personnel are instructed to monitor all non-conforming site use.

Dust control measures include water sprinkling and periodic oil treatment during construction on the various roads and parking lots. Problems with dust have been infrequent throughout the construction phase. The roadway and parking facilities are to be paved before operation commences.

Based on biological samples and observations to date, no significant adverse effects have been indicated from the results of construction or past effluent discharge from the sanitary system and no adverse effect is anticipated from continuing construction operations. Although all proposed effluent discharges have been approved by state and local agencies, and even though there are no indications of deleterious effects on the aquatic life from past or continued operations; the on-going biological monitoring program will enable detection of any presently unforeseenable effects.

No noise abatement procedures have been adopted. Even though construction activities have created noise it has not been noticeable beyond a one mile radius of the plant. The closest resident lives at least 0.8 miles from the construction site. There has probably been some unavoidable disruption of the native wildlife through noise and other general activity in and around the construction area. However, because of the nature of the prior land use, this is not a serious effect and is only temporary.

A fire protection system is maintained to control any fire within the construction site. Traffic congestion is not a problem; Highway 42 has been able to handle traffic generated by plant construction.

The impact of a large construction force on the local commercial and social patterns is dependent on numerous factors, most of which have not been studied in detail. Except for key specialists, most of the work force has originated regionally; 544 of the 612 persons now employed are classified as local residents of the lakeshore-Fox River Valley area. The construction has had a positive effect on the local economy, but the work force has not been significant enough to cause real concern over unemployment at the conclusion of construction. It is believed that most of this force can be readily absorbed by the traditional employers of the region within a reasonable period following plant completion. Any undesirable effect in this regard is mitigated by the wide scattering of the work force, including commuters from the large cities of Green Bay and Manitowoc.

2.3.9 Monitoring Programs

2.3.9.1 Radiological Monitoring Program

The radiological monitoring program is designed to accomplish two objectives. The first is to measure the existing level of background radioactivity resulting from natural occurrence and global fallout in the Kewaunee Nuclear Power Plant environs before radioactive materials are delivered to the site. This preoperational phase began in September 1969. Approximately two and one-half years of background data will be available before plant startup.

The second objective of the environmental monitoring program is to determine the effect of the operation of the Kewaunee Nuclear Power Plant on the environment. This operational phase will begin with initial criticality, startup and subsequent operation of the facility, and will be a modification of the preoperational program to place greater emphasis on isotopic analysis and pathways to man.

Significant quantities of radioactive materials should not be released to the environment during the operation of the nuclear unit and the monitoring program is designed to demonstrate this. Additionally, the Applicant is working with the Wisconsin Department of Health and Social Services, Division of Health, Section of Radiation Protection, which is concerned with the phases of the monitoring program outlined above.

The radiological monitoring program described below is the preoperational program as it was established in September 1969. Some modification of this program is planned with less emphasis being placed on gross alpha and gross beta in solid samples and more emphasis on isotopic analysis. The evaluation of pathways to man (2.3.7.3) will provide the basis for making these changes. Other changes may be made based on operational experience.

Monitored variables include measurement of ambient gamma radiation and the collection and radiometric analysis at appropriate frequencies of airborne particulates, well water, surface water, bottom sediments, slime, bottom organisms, fish, milk, vegetation, soil, and miscellaneous food stuffs. Analyses of these samples involves the measurement of gross alpha activity, and gross beta activity and the conducting of a gamma scan. These are done for screening purposes. Detailed isotopic analyses are conducted on some samples either because gross alpha or beta activity exceeds background levels or because isotopes of certain elements are known to be selectively incorporated or concentrated in certain biological media, such as strontium, cesium and iodine in milk.

The sampling frequency depends on the sample being collected as is shown in Table 2.3-20 (refer to Table 2.3-21 for definitions of the codes used in Table 2.3-20). For example, airborne particulates are collected

TABLE 2.3-20

SAMPLING FREQUENCY

Location	Weekly	Monthly	Frequency Quarterly	Semi-Annually	Annually
K-1					
1a		SW		SL	
1b		SW		SL	
1c				BS, BO	
1d		SW		SL	FI
1e		SW		SL	
1f	AI	FB, PD, RC	TLD		TLD
1g		WW			
1h		WW			
K-2	AI	FB, PD, RC	TLD		TLD
K-3		FB, PD, RC, MI	TLD	VE	TLD, SO
K-4		FB, PD, RC, MI	TLD	VE	TLD, SO
K-5		FB, PD, RC, MI	TLD		TLD
K-6		FB, PD, RC, MI	TLD		TLD
K-7	AI	FB, PD, RC	TLD		TLD
K-8	AI	FB, PD, RC	TLD		TLD
K-9		SW		BS, BO, SL	
K-10			WW		
K-11			WW		
K-12			WW		
K-13			WW		
K-14		SW		BS, BO, SL	
K-15	AI	PD, RC	TLD		
K-16	AI	PD, RC	TLD		

TABLE 2.3-21

SAMPLING CODES

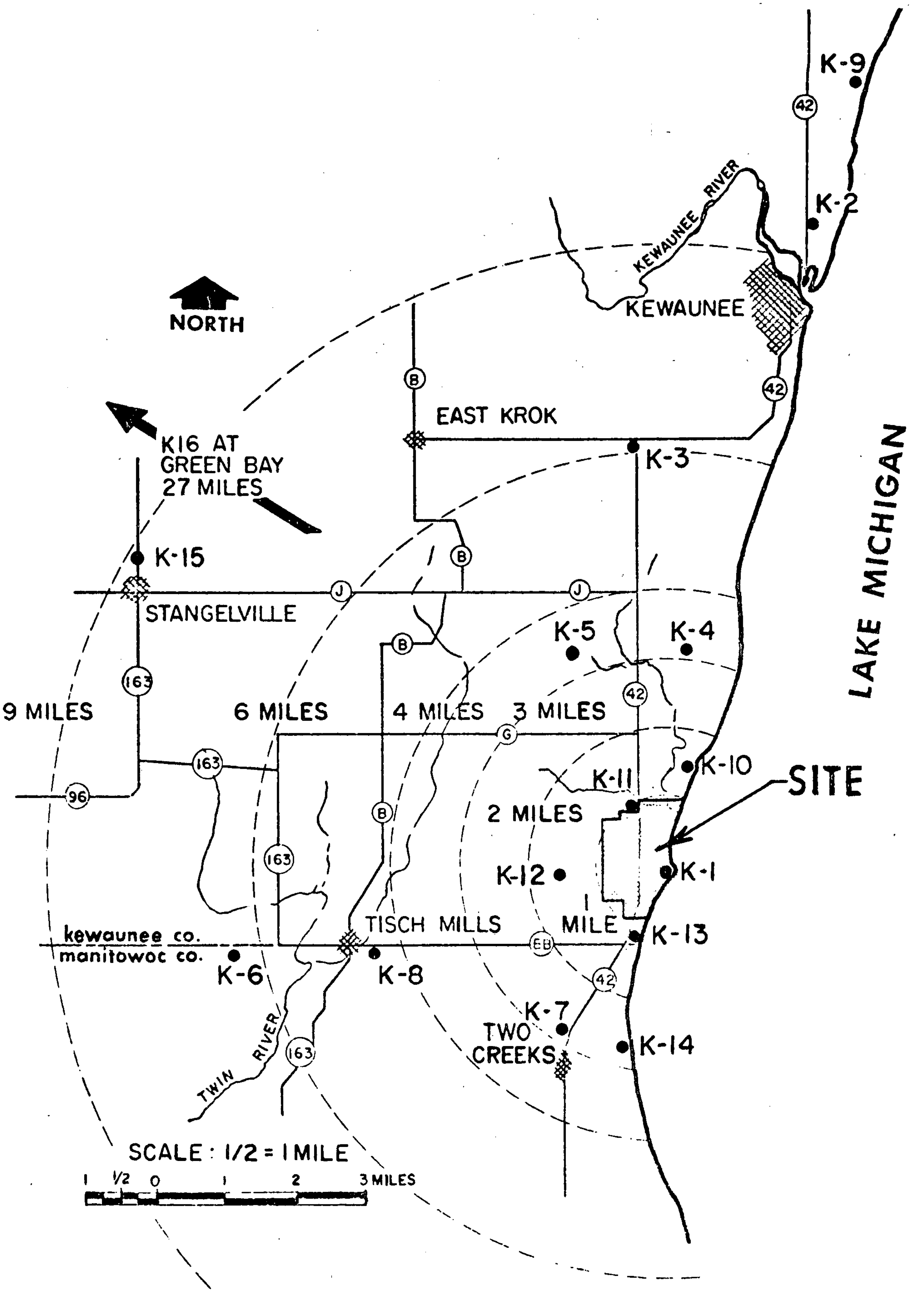
Code	Meaning
A	Annual
AI	Air
BO	Bottom Organism
BS	Bottom Sediment
DS	Dissolved Solids
FB	Film Badge
FI	Fish
MI	Milk
PD	Pocket Dosimeter
Q	Quarterly
RC	Ten-milliroentgen stray radiation chamber
SA	Semi-annual
SL	Slime
SO	Soil
SS	Suspended Solids
SW	Surface Water
TLD	Thermoluminescent Dosimeter
TS	Total Solids
VE	Vegetation
W	Weekly
WW	Well Water

and analyzed weekly. Surface water and milk are collected monthly while well water is collected and analyzed monthly and quarterly. Soil, slime, bottom sediments, bottom organisms, and vegetation are collected and analyzed semi-annually.

The sampling locations around the Kewaunee site are shown in Figure 2.3-21. These coded locations correspond to the code numbers given in Table 2.3-21. Detailed descriptions of each sampling location are given in Table 2.3-22. Descriptions of the samples taken, including the methodology used in sample analysis, are presented below.

Airborne Particulates (A1)

Samples are collected on 47 mm diameter membrane filters of 0.8 micropore size. Air is sampled at a rate of one cubic foot per minute. After approximately one week, in order to allow the short-lived radioactive compounds to decay, the material on the filter is counted in a low background, high efficiency, ultra-thin window, proportional counter. Weekly, from 2 air samplers, charcoal filters are analyzed for iodine determinations.



KEWAUNEE NUCLEAR POWER PLANT
SAMPLING LOCATIONS
FIGURE 2.3 - 21

TABLE 2.3-22

SAMPLING LOCATIONS

Code	Location
K-1	Onsite
1a	North creek
1b	Middle creek
1c	North of condenser discharge
1d	Condenser discharge
1e	South creek
1f	Meteorological tower
1g	South well
1h	North well
K-2	WPS Operations Building in Kewaunee
K-3	Lyle and John Siegmund farm Route 1, Kewaunee
K-4	Dan Stangel farm Route 1, Kewaunee
K-5	Ed Paplham farm Route 1, Kewaunee
K-6	Berres Brothers farm Route 1, Kewaunee
K-7	Earl Bruemmer farm Route 3, Two Rivers
K-8	Francis Valenta farm Tisch Mills
K-9	Rostok Water Intake for Green Bay, Wisconsin, two miles north of Kewaunee
K-10	Turner farm Kewaunee site
K-11	Ihlenfelt farm Kewaunee site
K-12	Deleman farm one mile west of site
K-13	Tavern, Prucha's one mile south of site
K-14	Two Creeks Park two and one-half (2.5) miles south of site

(Continued)

TABLE 2.3-22 (Continued)

Code	Location
K-15	WPS Natural Gas Gate Station one and one-half (1.5) miles north of Stangelville
K-16	WPS Green Bay Division Office Building

Well Water (WW)

Two-gallon well water samples are taken. The concentration of potassium-40 is calculated from total potassium which is determined by flame photometry; the tritium content is determined by liquid scintillation techniques. A gross activity measurement is also performed.

Surface Water (SW)

Samples are from three intermittant creeks on-site and from Lake Michigan. Samples from Lake Michigan are at the point of condenser discharge, at the Rostak Water Intake (11-1/2 miles north of the site), and at Two Creeks Park (2-1/2 miles south of site). Samples are analyzed for activity in the total residue, the dissolved solids, and the suspended solids. Tritium analyses are by liquid scintillation techniques.

Milk (MI)

Samples are from 2 herds that graze within five miles of the reactor site (K-4, K-5) and from 2 herds that graze between five and ten miles from the reactor site (K-3, K-6). The samples are analyzed for Sr-89, Sr-90, I-131, Cs-137, Ba-140, total potassium and calcium.

Ambient Gamma (RC)

Ten milliroentgen stray radiation chambers, pocket dosimeters are placed at stations K-14, K-2, K-3, K-4, K-5, K-6, K-7, and K-8. Performance of these devices were evaluated in the field.

Monthly film badges and quarterly thermoluminescent dosimeters are placed in the same locations; these are not evaluated in the field.

Bottom Sediments (BS)

Samples are taken from Lake Michigan and are analyzed for gross alpha, gross beta, Sr-89 and Sr-90, and are spectroscopically examined for gamma radiation. Since it is known that the specific activity of the sediments increased with decreasing particle size, the sampling procedure assures collection of very fine particles.

Bottom Organisms (BO)

Samples at same location and time as those used for collection of bottom sediments.

Slime Samples (SL)

These samples are scanned for gamma radiation and are analyzed for gross alpha, and gross beta radiation; and certain selected samples are further analyzed for Sr-89 and Sr-90.

Soil (SO)

At each location the top two inches of soil are taken and then the next two inches of soil below the top two inches are taken. All soil samples are scanned for gamma activity and are analyzed for gross alpha, and gross beta activity; certain selected samples are further analyzed for Cs-137, Sr-89 and Sr-90.

Vegetation (VE)

All samples are scanned for gamma activity, and then analyzed for gross alpha and gross beta activity. Samples are then analyzed for Cs-137, Sr-89, Sr-90 and Zr-95.

Fish (FI)

The samples are cleaned and the flesh separated from the bones. The bones and flesh are then scanned for gamma activity and determinations are made for gross alpha and beta activity. The flesh is further analyzed for Cs-137, and the bones are analyzed for Sr-89 and Sr-90.

Precipitation

A monthly cumulative sample of precipitation is taken at Kewaunee on-site. This sample is analyzed for tritium concentration.

2.3.9.2 Meteorological Monitoring Program

Meteorology in the region of the site has been evaluated to provide a basis for determination of annual average waste gas release limits, estimates of exposure from potential accidents and design criteria for storm protection. Site data are continually being recorded; data compilation began in August, 1968. A description of meteorological data in presented in Section 2.3.3.5.

The on-site meteorology facility at the Kewaunee Nuclear Plant consists of Belfort Type "M" wind transmitters (starting threshold of approximately 2 mph) mounted on top of a 180 foot tower which places the sensors at the same elevation as the top of the containment structure. The meteorological tower is located 630 feet due south of the centerline of containment and 675 feet due west from the shoreline. The lake elevation, 578 feet, establishes the shoreline. The transmitted data is recorded on a Rustrak chart recorder and also independently reduced to 15 minute averages of wind speed, direction, and directional variance (defined by applying the statistical definition of variance to wind direction) on a NUS Wind Variance Computer. The recorder and the computer are housed in a shelter for protection against the elements. Modification of the present system is underway to provide a temperature sensor and a ΔT sensor on the existing tower. 2

2.3.9.3 Hydrological Monitoring Program

A Hydrologic Monitoring Program has been initiated which will evaluate the physical and chemical properties of Lake Michigan water.

The purpose of the monitoring program is to:

1. Evaluate the baseline physical and chemical characteristics of Lake Michigan water before and after plant operation commences.
2. Compare the quality of the water in the Lake with applicable standards to assure compliance with regulations.
3. Provide data for evaluating the impact of the project on the aquatic biota.

The Hydrological Monitoring Program is being performed by Industrial Biotest Laboratories, Inc. Initially, two sampling plans were utilized in collecting Lake Michigan water samples for analyses. One plan utilized triplicate samples in the analyses of a limited number of parameters of primary importance to water quality of Lake Michigan with collections to be made three times a year. The other plan called for collections five times each year with single samples and a greater number of analyses.

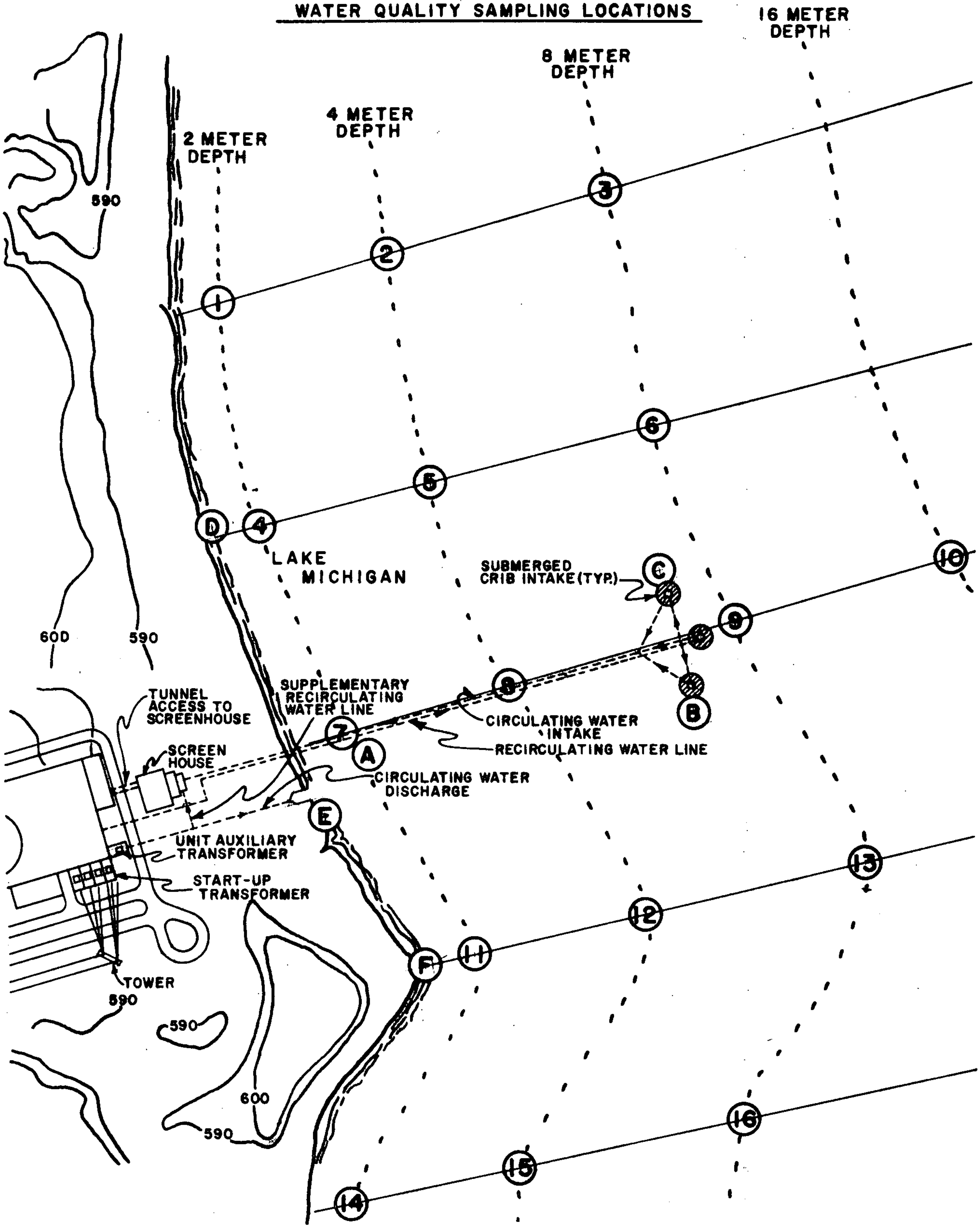
After evaluating both sampling programs it was decided that the triplicate sample plan three times a year gave more reliable results.

Triplicate water samples collected from one location and analyzed as three separate samples will give data on the degree of homogeneity of the body of water sampled. The analyses of triplicate water samples will permit detection of possible contamination or unusual variations in the replicate samples and is necessary to maintain a high confidence level in statistical evaluation of analytical results. A high level of confidence in the water chemistry results assures the validity of monthly and seasonal variations for the body of water studied.

In addition to the reliability provided by triplicate sampling, the three times per year sampling plan eliminated parameters with questionable usefulness in evaluating water quality and redundant parameters. This was based on experience with other Lake Michigan studies. For instance, tests for Fe, Cr, Pb, Mn and turbidity which are parameters characteristic of industrial wastes were omitted along with tests for NO_2-N and NH_4-N which are parameters usually found at very low concentrations limiting their usefulness for interpretating water quality. Instead, samples were analyzed for a total and ortho-phosphate and Mg which are more useful in determining the water quality in the Kewaunee area. It is on this basis that the triplicate sample plan three times a year was selected.

Analyses to be performed on samples are outlined in Table 2.3-23 Hydrologic Monitoring Program. Sampling locations are shown on Figure 2.3-22, Water Quality Sampling Locations.

FIGURE 2.3-22
WATER QUALITY SAMPLING LOCATIONS



LIMNOLOGICAL LEGEND

Conductivity: 1,14 Mid-depth; 3,16 Top, Mid, Bottom Depth
Temperature Each Meter and Secchi Disc 1-16
D.O.,pH,T.Alk., Mid-Depth (2M) : 1,4,7,11,14
D.O.,pH,T.Alk., Top and Bottom Depth : 2,5,8,12,15
D.O.,pH,T.Alk., Top, Mid, and Bottom Depths : 3,6,9,13,16,10
Water Quality, Bacteriology, Plankton (triplicate)
A=Mid-Depth
B=Top and Bottom of the Water Column
Benthos (triplicate samples) A,B,C
Zooplankton (six replicate vertical tows) B, C
Periphyton (triplicate samples): D,E,F

TABLE 2.3-23

HYDROLOGIC MONITORING PROGRAM

Frequency of Sampling	Vector or Index	Analyses	Location
3 times per year	Lake Michigan water	Temperature Dissolved Oxygen (D.O.) Percent Oxygen Saturation Biochemical Oxygen Demand (BOD) pH Units Specific Conductance at 25°C. Calcium (Ca) Magnesium (Mg) Total Alkalinity ($CaCO_3$) Chloride (Cl) Nitrate (NO_3) Total Phosphorus (PO_4) Orthophosphates (PO_4) Turbidity (JTU)	Same as for plankton samples

The sampling program will continue after the plant is operational. It is possible, after the plant is in operation and a number of samples have been collected and analyzed, that a change in the sampling system may be indicated. The Applicant is agreeable to modify the sampling system to assure that the environmental impact of the plant's operation on the aquatic system will be fully evaluated.

2.3.9.4 Biological Monitoring Program

The purposes of the aquatic studies are to provide a basis for detecting and evaluating the effects of plant operation on aquatic life. Baseline biological studies by the Department of Botany, University of Wisconsin - Milwaukee began in the summer of 1969 (Ref. 28) to document the species and abundance of periphyton and zooplankton. In 1971 a more extensive sampling program was begun to evaluate water quality criteria and give additional information on phytoplankton, periphyton, zooplankton, benthos, and fish. These studies will continue during the operating phase.

Organisms are identified to species whenever possible. Triplicate samples are taken at each location for plankton, benthos, and water analysis. Triplicate samples of bottom organisms, plankton and water for chemistry analyses are collected in May, August, and November. Sampling for fish is done seven times a year. Four of these are in spring, one in summer and two in fall.

Benthic organisms are collected in three areas: near the intake, near the discharge, and at a distance about halfway between.

Quantitative and qualitative studies of periphyton attached forms are made from samples at three locations along the littoral area: 1) at the outfall, 2) along a point just south of the outfall, and 3) in a control area.

Phytoplankton are sampled from two locations. A sample at mid-depth is taken near the outfall and samples near the top and near the bottom are taken at the intake.

Two zooplankton sample locations near the intake and near the outfall, are utilized. Samples from six oblique tows are collected at these locations using the Miller Plankton Sampler.

Fish seining is done in selected habitats in the vicinity of the Kewaunee site. Overnight gill nets are set for a 20 hour interval and at least 10 minnow seine hauls are made at each sampling period. The studies are designed to assess the age, species composition, and abundance of fish, as well as their distribution and food habits. Particular emphasis is placed on spawning that might occur in the area.

Bacteriology. Three samples are collected for determination of total coliform, fecal coliform, and fecal streptococci from the same sites as those for phytoplankton samples.

Water Chemistry. Three samples are collected for water chemistry from the same locations as for phytoplankton samples. The chemical parameters measured are shown in Table 2.3-23. In addition at each benthic sample location, determinations for dissolved oxygen and pH are made on water near the bottom, and pH and organic content (volatile solids) are determined in the bottom sediments.

The samples collected are analyzed and evaluated to determine the variations in physical, chemical, bacteriological, and biological values during each sampling period both seasonally and from location to location. Data on phytoplankton and zooplankton are collected at 2 to 4 week intervals from June through October by the University of Wisconsin. Sampling techniques different from those of the Industrial Laboratories' are used and samples are designed to measure vertical dispersion of zooplankton.

In addition to the foregoing, the Applicant is aware of and will take account of other on-going studies which pertain to the Kewaunee site or more generally to thermal effects from power plants on the Great Lakes. These include studies made for the nearby Point Beach Nuclear facility and studies by independent research groups from Argonne National Laboratories, the Center for the Great Lakes Oceanographic Study, the University of Wisconsin - Madison, and the University of Michigan.

2.3.9.5 Land Management Program

The adverse effects of plant construction and future operation upon the land have been and should remain minimal. Of the 110 acres reserved for plant activity, only 15 acres have been actually used for construction. The remaining portion of the total 908 acre site will be used productively for conservation purposes and agriculture, the latter dependent upon AEC approval.

Erosion control of the shoreline near the plant is a land management function and actually represents a positive impact on the environment. It is estimated that beach-building or maintenance processes down-current from the site will not be significantly effected by stabilization of the shoreline now occupied by riprap.

Future land management programs, if planned by the Department of Natural Resources and dealing with wildlife of the vicinity, will have the full cooperation of the Kewaunee operators. To date, no such plans have been made by the Department.

The near-future recreational plans of the state do not include major improvements of the vicinity lands, or new facilities within the area. There is no known recreational use of the 908 acre site with the possible exception of occasional unauthorized hunting.

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

2.4.1 General

Secondary effects which have only an indirect bearing on the local environment are not discussed in this section. These would include such things as the environmental effects of nuclear fuel mining conducted at remote locations. There is also a unique set of environmental effects resulting from the reprocessing of nuclear fuel; this will be accomplished at a remote location and the feasibility of this process will be investigated and will be licensed by separate procedures. Also, in the secondary category there are environmental costs resulting from industrial operations which depend on the power to be generated at Kewaunee. For instance, it is conceivable that one might draw an invalid equation between the production of power at Kewaunee and the resulting pollution at a pulp mill which uses this power. This question is not addressed.

2.4.2 Aesthetic Effects

The land upon which the Kewaunee Plant has been built formally consisted of cultivated farm land, before that, forest land. Objectively, what was once a pastoral scene is now occupied by an imposing complex of buildings and transmission facilities which will have a direct visual impact on local residents (however few of them there are) and one which may be very serious to some of these people and not to others. To assess impact, a system of aesthetic values must be agreed upon. It would be extremely difficult and unproductive to try to objectify this aspect of environmental effect; aesthetic values and tastes are matters upon which philosophers have disagreed throughout man's history.

Aside from the foregoing, however, there are certain aesthetic aspects of any development such as a power plant or industrial complex, and key design concepts, about which there may be some consensus. In this regard, every effort has been made to design the structures and appurtenances in accordance with contemporary tastes, and to adopt exterior design and color treatment which will offend the fewest and appeal to the greatest number of people. The design effort extends to every element of the proposed construction, even including the power poles used. Although there are some who would disagree, landscaping will minimize visual impact; appropriate landscaping and maintenance of this and natural vegetation is underway or planned. The principle alternative to the procedures adopted would have been to bury all of the facilities, eliminating all but a temporary impact. This, however, would be not only economically unfeasible but would introduce other environmental consequences, such as those associated with 2 disposal of the large amounts of excavated material that would be generated.

Shoreline treatment represents an additional visual impact on the environment. Riprap protection has been proveded along the shoreline which has been necessitated by the high rate of natural erosion. The shoreline has been receding at a rate between approximately 2 to 12 feet per year. Riprapping with limestone rock has been chosen not only because it is a practical engineering solution but also because of the harmonizing effect of this method of treatment.

2.4.3 Land Use Effects

Of the approximately 908 acres purchased by the power company, twelve farmsteads have been displaced although farming continues on about 800 of those acres. Assuming approval is granted by the appropriate regulating agencies, farming will be continued on these 800 acres throughout the operation of the plant. Therefore the total land use impact is 110 acres applicable to the plant itself and approximately 56 miles of transmission lines along a corridor approximately 300 feet in width. Essentially all of the land used, including the transmission corridor, was in pasture, cultivation or other compatible land uses.

These effects are unavoidable; even buried facilities would require land use for access and maintenance. Accompanying this, the land occupied by the facilities and perhaps a small perimeter of additional land is no longer available for use by terrestrial wildlife. This impact is not considered serious as documented in Section 2.3.6.2. The prior change from forest to agriculture probably had a much greater impact of this type. In summary, relatively small displacement of wildlife will occur, certainly less than for certain other types of industry and for most other types of utility or transportation corridors.

The impact of the plant on regional land use is inconsequential. The primary factor in this regard is the effect of housing and providing services to operating personnel. It is shown in Section 2.3.1.3 that these requirements will not disrupt the local economy or service base. Most personnel required for full operation have already been integrated into local communities without problems or discernible land use effect.

2.4.4 Effects of Chemical and Radioactive Effluents

Chemical and radioactive waste discharges to both air and water are unavoidable impacts on the environment as a result of operation of the Kewaunee Plant. The specific impacts of these wastes as they relate to biota and to human beings through direct contact with the wastes as well as through the food web are discussed in detail in prior sections. These effects are judged by the owners and their consultants to be insignificant. Consideration of alternatives shows that the only way to avoid essentially similar or analogous effects is to avoid the production of power in this or any other region of the country, except that certain effluents could be further reduced to a slight extent by expending unjustifiably large sums of money.

The standards set by Federal and State agencies for concentration of pollutants in air and water or in effluents have been well satisfied. It has been the philosophy of the Owners, however, to not confine their concern to the limits themselves, but to do everything practicable to minimize these concentrations to as far below the maximum levels set by the regulatory agencies as practicable. It has been demonstrated elsewhere in this report that the concentrations of pollutants resulting from normal plant operation does not directly or indirectly impose a significant hazard to human health; in the case of radioactive wastes, the dose concentrations are an extremely small percentage of normal background radiation at this location. The direct effect on the aquatic biota are minimized by the particular ecological situation at this location, but would be small in any event. Although relatively close by, the Point Beach Nuclear Power Plant effects will not overlap those of Kewaunee to any significant degree. Site boundary radioactive waste concentrations are already small for both plants and the increase in dose level at one site boundary as a result of emissions from the other is immeasurably small. Circulation patterns in the Lake are such that waste discharges do not mix except in a very complex fashion involving a large portion of the Lake through which dilution processes are highly effective and favorable.

2.4.5 Thermal Effects

In terms of present day or immediately projected technology, one major unavoidable consequence of production of electric power by means of nuclear generating stations is waste heat. In the case of Kewaunee, it is planned to use Lake Michigan as a heat sink, producing an impact on the Lake which is unavoidable, but so small as to be difficult to measure. Alternatives to this method of cooling are discussed in detail in the Section 2.5.

During full power operation the temperature rise through the circulating water system will be about 20°F during the summer and about 28°F in winter. The temperature of the water discharged into the Lake will decrease rapidly by mixing and spreading beyond the discharge point. Because of Lake bottom conditions, the biological environment in the vicinity of the discharge point of the Lake is relatively barren and not representative of the Lake as a whole. It is estimated that the temperature at the boundary of an area of 1,000 acres will be only about 3°F above the ambient level; isotherms within the plume will vary according to wind and current conditions. The Owners and their Consultants conclude that the Kewaunee thermal discharges will have a relatively insignificant impact on the aquatic environment. The hydrologic characteristic of this portion of Lake Michigan appears to be such that the near-shore circulation pattern in the vicinity of Kewaunee does not significantly interact with the circulation pattern in the vicinity of the Point Beach facility to the south. The thermal effects, therefore, are not additive.

2.5 ALTERNATIVES TO THE PROPOSED ACTION

2.5.1 Introduction and Summary

The purpose of this section is to examine and compare alternatives to the proposed action. The proposed action is the operation of the Kewaunee Nuclear Power Generating Station as it is now designed and constructed. Alternatives vary from the fundamental choice between producing power and not producing power, to relatively minor systems modifications to the existing facility. Consideration of alternatives includes only those which have significant, direct impact on the environment. Decisions which may be based primarily on economic factors are not treated in detail.

In the planning of a project such as the Kewaunee Nuclear Plant, the simplest form of decision-making involves consideration of a linear series of mutually exclusive alternatives. For example, once the need for power is identified and the decision is made to produce power, it has not usually been necessary in the past to review that decision as plans develop. In terms of present public concern for the environment and changing social priorities, however, it may be necessary to review and justify such decisions even after construction has begun. Such review can be made in terms of those alternatives which may be newly available and those which have always been available but which were not previously considered. This procedure becomes complicated in cases where public priorities change faster than facilities can be planned and built. A key question in this regard, and one which is addressed in this section, is: "have public priorities regarding power production really changed at all?" Concern for environmental protection certainly has grown in the last decade, and with it the responsibility of power companies to protect the environment has grown. But it does not follow that there is a correspondingly reduced responsibility on the part of power producers to provide power.

The complex relationship between environmental concern and power needs is not only affected by evolving priorities, but also by the fact that environmental analysis is, of itself, an uncertain process; the state of art is not well advanced, at least in certain aspects of environmental effects. In comparing the environmental costs of alternative forms of power generation, there are factors such as aesthetics for which there are no objective standards and very seldom consensus -- even among "experts". How, then, does one weigh the aesthetic impact of one type of structure against that of another type? And, how does one measure an aesthetic impact on a scale which is also intended for use with other wide-ranging impacts such as radiological effects?

An attempt has been made to answer these questions in the discussions which follow. The attempt has not been entirely satisfactory and the nature of the subject is such that no really valid consensus will ever be reached. The effort is, however, an instructive process and much can be learned from it.

In consideration of alternatives, two groups have evolved: past alternatives and present alternatives. It has been found useful to examine the history of the Kewaunee project and to review the reasons for the decisions leading to the present advanced state of development. Considering past alternatives, it is apparent that many decisions were made primarily on an economic basis with only a general overall concern for environment beyond a meeting of standards and taking advantage of developing technology. It is found, however, that past decisions have been environmentally sound. This results in a narrowing down to a relatively small group of present alternatives which were either not fully considered in the past or which remain feasible in the light of the present advanced state of construction. Of principal concern in this regard is the return of cooling water to Lake Michigan. An overview of other more economically unattractive alternatives is also presented for instructive but qualitative comparison of environmental effects. In this regard, cost-benefit relationships are established among the quantifiable and unquantifiable factors which are pertinent.

Cost and benefit are defined in Section 2.5.4 before proceeding with the analysis of present alternatives.

To summarize the remainder of this section, it is found that the environmental costs of the proposed action are not significantly different from those of principal alternatives (such as other forms of power generation at this or other sites in the vicinity) and that termination of the Kewaunee project is not a viable alternative. Further, it is found that the proposed method of cooling is presently feasible in terms of environmental cost, but that if operational data or the total future input of waste heat to Lake Michigan eventually does prove to be environmentally too costly, future alternatives are available which will not be foreclosed by starting-up Kewaunee in the manner now planned. No clearly beneficial alternatives to the present very effective radwaste systems are available, but the nature of the system is such that additions are possible where developing technology may prove additions to be desirable, or where future changes in the cooling system may force a change in the method of handling radioactive wastes.

2.5.2 The Demand for Power

Production of power by all power companies in Wisconsin is under the jurisdiction of the Public Service Commission of Wisconsin, an agency established by the Wisconsin Legislature, which controls facility expansions of all utilities in Wisconsin. Utilities are allowed to expand their facilities when it can be shown that additional power demand will occur from Wisconsin residential, commercial, and industrial markets. To meet demand, it becomes necessary to base plans for plant expansion programs on forecasted demands because of the extensive time required in planning and constructing facilities.

Demand forecasts can best be obtained by projecting from previous demands, modified where appropriate as a result of other pertinent information and trends. Experience by the Owners indicates an average annual demand growth of about 8 percent in summer and 6.9 percent in winter. Even though formation of WPP has maximized efficiency for power production, the three companies will be unable to meet power demands if additional facilities are not constructed. The combined demand estimates, as shown in Table 2.5-1, forecasts demands of 1944 MWe in the 1972-73 winter and 2147 MWe in the 1973 summer. If the Kewaunee Plant is not operating, the reserve power will be 6.5 percent during the winter of 1972-73 and by the summer of 1973 a power deficit of 142 MWe will occur.

TABLE 2.5-1

WISCONSIN POWER POOL

CAPACITY-DEMAND ESTIMATES WITHOUT KEWAUNEE NUCLEAR POWER PLANT

1972-1973

	Megawatts	
Capability	Winter 1972-1973	Summer 1973
WPS	799	778
WPL	932	907
MGE	259	245
Total	1990	1930
Demand		
WPS	762	803
WPL	900	970
MGE	282	374
Total	1944	2147
Less MGE Purchase	-75	-75
Total Adjusted Demand	1869	2072
Margin	121	(-)142
% Reserve	6.5%	---
Pool Purchase	120	---
Margin with Purchase	241	---
% Reserve with Purchase	13.8%	---

The Wisconsin Power Pool has found through experience that a minimum power reserve of 15 percent must be maintained to allow for scheduled required maintenance and non-scheduled (breakdown) outages of generating facilities. Below this level, availability of power becomes increasingly less reliable. As existing facilities age, this becomes even more critical and the required reserve margin correspondingly increases. During the last several years it has not been possible to maintain a continuous 15 percent reserve. For example, in 1969 and 1970 the reserves were 9.0 and 10.2 percent, respectively, for peak demand periods. During these periods, the Pool had to rely on the companies of Mid-America Interpool Network (MAIN) for supplemental power on numerous occasions. For inter-pool reliability purposes, the Wisconsin Pool, as a member of the Wisconsin-Upper Michigan Systems, coordinates its principal external capacity transactions through MAIN.

The MAIN organization has not yet adopted a minimum reserve policy; however, a MAIN report, "Analysis of Demand and Capacity Considering Possible Curtailments of Output from Nuclear Power Plants 1971-1978," dated October, 1971, has been prepared to analyze generating capacity reserves and transmission limitations. The MAIN Capability-Demand Estimates with Nuclear Generating Plant Decay, 1972-1973, is shown in Table 2.5-2. The Table shows the MAIN organization reserve during the winter of 1972-73 is estimated to be 38.7 percent. However, by the summer of 1973 the total reserve will be approximately 15 percent, even with all other nuclear units

TABLE 2.5-2

MID-AMERICA INTERPOOL NETWORK (MAIN)

CAPACITY-DEMAND ESTIMATES WITH NUCLEAR GENERATING PLANT DELAY

1972-1973

	Megawatts	
Capability	Winter 1972-1973	Summer 1973
(a) Owned Capability	31 355	32 871
(b) Non-Firm Purchases	1 604	1 788
Adjusted Capability	32 959	34 659
Demand		
(a) Native	22 530	30 526
(b) Firm Sales (Purchases)	1 486	(304)
(c) Interruptible	(239)	(238)
Adjusted Demand	23 777	29 984
Margin	9 182	4 675
% Reserve	38.7%	15.6%
Assumed Nuclear Plant Delay*		
(a) Kewaunee (WPS-WPL-MGE)	527	527
(b) Quad Cities #2 (CE)	809	---
(c) Zion #1 (CE)	1 039	1 089
(d) Zion #2 (CE)	---	1 039
	2 375	2 655

*Assumes one year delay in commercial operation.

Reference - MAIN Report, "Analysis of Demand and Capacity Considering Possible Curtailments of Output from Nuclear Power Plants, 1971-1975", dated October 1, 1971.

operating other than the Kewaunee Plant and Commonwealth Edison's Zion #1 and #2 nuclear Plants. From these projections it can be seen that the Wisconsin Pool cannot rely upon the MAIN organization to provide the necessary power for purchase during the summer of 1973. The MAIN Report also indicates that similar situations will exist in other neighboring reliability areas; hence, purchase of power from outside the MAIN area cannot be viewed as feasible.

The alternative to providing power is to not meet the rising demand for power. This would mean that a power shortage would develop which would lead to extreme measures such as voltage reduction or selected load curtailment. When voltage is reduced some customers will experience inefficient operation of their appliances, equipment, etc. Selected load curtailments would require that certain industrial and business customers be dropped to bring the total system demand down to where it can be handled by the available generating capacity. The immediate effect of reducing electrical power may be merely an inconvenience to some, but it could mean severe loss of revenue from lost production to others. With nearly half of owner's production going to industrial customers, a significant reduction could result in widespread unemployment. If production were to continue to decrease, the availability of consumer products would decrease, and a rise in the cost of goods to the consumer would result. Eventually, all individuals suffer.

The question really involves how society can simultaneously maintain a high-energy civilization and a healthy, stable environment. Do we preserve or conserve our environment? The answers are not immediately forthcoming; priorities shift rapidly within certain sectors of our society; priorities vary widely among sectors. In the past, efforts have been made to satisfy power demands with cursory regard for environmental impact. General public consensus has shifted over a relatively short period to much greater environmental concern. The demand for power however, continues to increase at a rate which bears no apparent relationship to environmental concern.

To accommodate conflicting priorities, decision-making in the production of power must seek an optimum balance among the competing criteria. Adverse impact by power generating facilities is being greatly reduced through the programs of environmental awareness and implementation of technological developments. As new technology develops and is implemented, environmental impact will be reduced, but never completely eliminated.

It is beyond the scope of this environmental report to examine methods of changing social attitudes toward power or to develop theories relating to the ultimate and far-reaching effects of not producing power. That is a subject of national concern. The remainder of this section addresses the subject of how to meet demand in the most acceptable, least environmentally costly way.

2.5.3 Past Alternatives

General. This section is submitted as a review of the environmental consequence of the decision made in the past and summarized in Table 2.5-3. It is intended to demonstrate that certain of the alternatives selected represent environmentally sound decisions that apply as well today as in the past. Further consideration of alternatives in Section 2.5.4, Present Alternatives, can then be confined to those which remain relevant or for which the past decision is specifically controversial.

To Produce Power or Not to Produce Power. In 1966, the Kewaunee Owners were legally obligated to provide sufficient power to meet continually rising demand and that obligation has not changed. Although environmental concerns since 1966 have become very much stronger, there has been no corresponding decrease in power demand; public consensus has not demonstrated a willingness to do with a reduced or less constant power supply. Considering these factors, the Owners conclude that they are morally as well as legally obligated to provide reliable electrical power. Section 2.5.2 demonstrates the degree of need; the conclusion regarding the obligation to provide power extends to the timing of the Kewaunee Plant as well. There is no viable alternative open to the Owners but to provide power in accordance with the present schedule. Only the public, acting though its agencies and its demand for power, have the option to force further consideration of this alternative.

TABLE 2.5-3

PERTINENT PROJECT CHRONOLOGY

Date	Subject	Analysis	Decision
1966	Capacity Requirement	Typical demand forecasts.	Major unit required by about 1971.
1966	Site Selection	Detailed feasibility studies of 11 available sites.	Selection narrowed to group of 3.
1966	Generation Method	Comparison of alternate forms of power generation, primarily fossil steam and nuclear plants.	Build nuclear facility.
1966	Site Re-evaluation	Prime site not available; comparable site sought.	Purchase Kewaunee site.
1967	Joint Ownership	Combined demand forecasts relative to nuclear plant capability.	Agreement between WPS, WPL, MGE.
1967-71	Cooling Alternatives	Detailed comparison of economic and environmental aspects of cooling methods.	Full return system, recognizing option to change.
1967-71	Waste Disposal	Continuous detailed consideration of numerous waste systems alternatives.	Present systems.

To Generate or to Purchase Power. No guarantee has been obtainable by the Owners that reliable power in sufficient quantity would be available for purchase to meet the rising demand in the Owner's service areas. In addition, it was recognized then, as it is now, that power produced at a remote location and transmitted long distances increases power cost to the consumer. The environmental impact of the transmission facilities alone becomes a significant factor. Additionally, it is recognized that the environmental costs of producing power in one section of the country are not grossly different from those associated with power production elsewhere. There are no known data which would lead to the conclusion that centralized power production for the country as a whole or within any region is less environmentally costly. Intuitively, the reverse would appear to be true: environmental costs are simply transferred and possibly increased by remote power generation. It is therefore concluded that power purchase is not an alternative to power generation except as an emergency measure or for short-term balancing of the needs and capabilities of interconnected individual systems.

Site Selection. Eleven sites for a generating plant were considered in the early stages of planning by WPS. These included both lake shore and inland locations. At that time a choice of type of generation had not been made. Each site was considered on the basis of availability, proximity to a cooling water source, load center, transportation facilities, and economic considerations. Certain basic environmental concerns, such as the effects of heat dissipation were also considered. The choice was eventually narrowed to three sites. Still, a decision had not been made as to method of generation and each of the three sites was considered with respect to both coal and nuclear plants. Two of the sites were on Lake Michigan and the third on the Fox River. Earlier studies had not revealed any significant advantages of the eight sites eliminated with respect to environmental factors. All lake sites considered had roughly the same environmental conditions; of the inland sites, the one reaching final consideration appeared to offer as many environmental advantages as the alternates and was the most favorable inland site with respect to economic factors.

Studies conducted simultaneously with site comparisons indicated preference for a nuclear plant over a fossil fuel plant for the capacity eventually required. Site choice was further narrowed to one of the three considered most favorable for a nuclear plant. This property was not acquired, however, since Wisconsin Electric Power Company had already optioned the property by then (the Point Beach site). A re-study of all sites was undertaken, and the present Kewaunee site was selected. It had been previously eliminated because of coal transportation problems, but was considered to be as environmentally favorable for a nuclear plant as any other sites studied. Environmentally, no significant differences between Kewaunee, Point Beach and other lake shore properties have been found to exist. The Kewaunee property was successfully acquired without major public opposition or the need for condemnation.

At about that time, an agreement was reached between WPS and WP&L and MGE to develop joint ownership of the plant and to size the plant to meet the combined needs of the three companies.

It is concluded that no other lake shore sites are more favorable than the Kewaunee site from an environmental standpoint. There is no evidence to suggest that any inland site would offer advantages over Kewaunee with respect to closed cooling systems; Kewaunee has proved to have exceptionally favorable meteorological and location characteristics with respect to radioactive releases and methods of cooling. The predominance of offshore winds is a distinct advantage in minimizing adverse environmental effects.

From the foregoing, it has been concluded that there is no real need for further consideration of alternate sites for a nuclear plant even if the Kewaunee Plant were not already nearing completion. Intense study would be required to prove that any site in the service area offers significant potential advantage over Kewaunee, if such a site exists. It is concluded, therefore, that there is no viable present site alternative to Kewaunee as designed. Were a fossil plant considered as an alternative, however, a different site might indeed by chosen.

Method of Generation. A nuclear plant and a fossil fuel (coal) steam plant were given priority consideration. If a nuclear plant for some reason were to prove environmentally too costly, a coal plant would remain as a viable alternative. For this reason, we treat this subject in the next section on Present Alternatives. Power generation by means of gas turbines has not been considered in the past as a reliable form of base power supply. For overall comparisons, however, it is treated as a present alternative, though a second rank one. Hydroelectric power cannot be considered a viable present or past alternative to Kewaunee or a similar size facility. Geologically, the region offers no such opportunities; of the 15 hydroelectric stations now operated by WPS, only 62.5 megawatts total capacity is achieved.

Cooling Methods. The Kewaunee Plant will employ once-through cooling. Construction of this system has been completed. The original decision to employ a full return system was based not only on economic considerations, but also on a realistic appraisal of thermal effects. Approval from the State Department of Natural Resources was given on May 21, 1968. Further consideration of this system and actual biological and hydrological studies have confirmed the feasibility of the original plan. Other methods of cooling have been thoroughly studied however, and are, because of the controversy regarding this subject, treated as Present Alternatives in the next section.

Radwaste Disposal. The system as originally conceived more than met applicable current AEC standards. Regardless, the system has since been modified to employ even more effective elements of treatment. There is no real alternative to the system as a whole, but possible additions to the system which could reduce waste quantities to even small levels are continually under investigation. For this reason, further radwaste system additions are treated as present alternatives to the system as presently conceived.

Transmission Lines. One of the factors in the selection of a site for any generating station is its proximity to transmission lines. The amount of additional transmission lines required to transfer power generated into the overall system plays an important role in the economics of site selection. Therefore, it is difficult to separate the alternatives associated with transmission lines from the site selection procedure, except in terms of local variations in the route and the design of the transmission lines and towers. It has long been the policy of the Owners to select routes and designs that minimize the intrusion of transmission facilities on the landscape. This policy is illustrated by the Kewaunee facilities as shown in Figure 1.3-1. In any event construction of the transmission lines for the Kewaunee facility have been completed and any alternative routes would involve an additional impact to what may have already occurred. Therefore, present alternatives to the transmission lines are not considered feasible and are not subjected to a cost-benefit analysis.

Chemical and Sanitary Waste Treatment Systems. The systems presently designed for the Kewaunee Nuclear Plant for the disposal of chemical and sanitary wastes are discussed in previous sections of this report. These systems release extremely low concentrations of effluents to the environment. Alternatives to these systems are the type of add-on equipment that is available to reduce the concentrations still further. The sanitary system has been in operation for more than 3 years. No detectable amounts of chemicals or nutrients have been added to Lake Michigan as a result of its operation. Chemical effluents released from plant systems will be diluted by the circulating water system to insignificant concentrations. Operational data from existing plants in the area indicate that the addition of algaecides will be required only infrequently, on the order of one to two times per year. Therefore, the economic cost of reducing the chemical or sanitary effluent concentrations beyond that presently anticipated is not warranted in terms of reducing environmental cost, since this cost is already minimal. 2

2.5.4 Present Alternatives

From the preceding sections, particularly those discussions with respect to the need for power and the absence of any choice in the matter of whether to generate power or not, it is clear that the cost-benefit analysis of the station as it is presently designed supports its existence. The economic costs of the station include the capital and operating costs which are presently estimated to be approximately $137,000,000 in capital cost excluding fuel and $11,000,000 in annual operating costs, including fuel. This is very close to the projected costs in mills per kilowatt hour for a coal plant and far less than those for any other type of generation. The environmental costs are as described in detail in Section 2.3 of this report and summarized in Section 2.4, with the conclusion that they are relatively inconsequential. There is no question that the social and economic benefits (generation of electric power for which a demand exists as well as other secondary benefits such as the creation of jobs and the extensive broadening of the tax base for the benefit of the community), while subject to certain subjective evaluation, clearly outweigh the environmental costs.

2.5.4.1 The Limitations on Current Choices

In very broad terms, the alternatives which can significantly influence the impact of this facility on the environment and which are available for the Kewaunee Plant can be grouped as follows:

(1) Proceed as planned

(2) Modify the facility to change its environmental impact

(3) Abandon nuclear power generation altogether and develop additional power capacity from other energy sources, such as fossil fuel plants or others.

Other, even more basic choices, have already been eliminated in Section 2.5.3 by ratifying historical decisions using present day judgments. These alternatives involved consideration of purchasing power, other sites, and other forms of power generation.

The Kewaunee Plant is now about 70% complete. There is now a commitment of about $132,000,000 in the land and facility, much of which would be lost if an alternative from group (3) above were chosen. The choice of an alternative involving abandonment of this facility must reduce adverse environmental impact by a very large margin to be justified. The waste of irretrievable resources and capital must be recognized in any cost-benefit analysis evaluation of this choice. Nevertheless, it is necessary to examine these alternatives sufficiently to determine if such costly alternatives are justified by environmental impacts. In accordance with applicable Federal guidelines, these alternatives will be evaluated using the cost-benefit rationale.

2.5.4.2 The Cost-Benefit Rationale

The Federal Guidelines. The cost-benefit analyses in the Environmental Report require an approach outlined by the National Environmental Policy Act (NEPA), by the Federal Court of Appeals Calvert Cliffs decision, and by the AEC Appendix D to 10 CFR 50. In general, "the particular economic and technical benefits of planned action must be assessed and then weighed against the environmental costs; alternatives must be considered which would affect the balance of values".

Environmental Costs Defined. The AEC Appendix D guidelines for implementation of the Calvert Cliffs decision point out that the environmental impact may be beneficial as well as adverse; they suggest that the net environmental impact of an alternative is its environmental cost. It is not suggested that the environmental costs can, or should be, evaluated in monetary units. The Congress through NEPA, the courts through the Calvert Cliffs decision, and the AEC through Appendix D are objecting to those measures which may achieve economic or dollar-measured benefits but at an excessive adverse environmental impact. To devise artificial dollar measures for this environmental impact could be to distort the intent of NEPA, the court decision, and Appendix D. Environmental costs of an alternative are, therefore, its net environmental impact including both adverse and beneficial aspects.

Benefits Defined. The AEC guidelines require that the net environmental impact of an alternative be weighed against its "economic, technical, and other benefits." Most of an alternative's technical benefits, however, are benefits per se only as they affect its environmental impact on the one hand, or its economic benefits on the other hand. Therefore, technical benefits need not be considered as separate entities in this cost-benefit analysis: their significance will have been totally accounted for.

The guidelines do not describe "other benefits." Their import, however, is to insist that there is a weighing of the longer term environmental impact of each alternative against its shorter term advantages which, for a power plant, can probably be best described by the phrase, "economic and social benefits" of electrical power. It may be argued by some that the economic and social amenities to which electric power makes its contributions are already at too high a level for one segment of society, and that additional amenities are not, therefore, "benefits." There can be no argument, however, that these amenities are today at far too low a level for another much larger segment. For the U.S. as a whole, additions to these amenities are certainly benefits.

In evaluating power production alternatives, therefore, the benefits of each alternative, in the cost-benefit relationship, are its contribution to the economic and social benefits of electric power.

The Relationship Between Dollar Costs and Benefits. This relationship is complex; but except for the local variations, it applies to the entire U.S. electric power industry. Because of its industry-wide significance, it is preferable in the cost-benefit analysis to describe examples which show the nature of the relationship, leaving a full exploration of it to an industry-wide agency and the appropriate federal authorities.

Industrial customers in the owners' service areas use approximately 40% of the kilowatt hour sales. These customers are primarily in industries which use more electric energy than the all-industry average, as shown in Table 2.5-4. Obviously, the economic health of the industries listed is more than normally sensitive to the costs of power.

As another local example, the paper and pulp industries whose electric power costs constitute 4% of their product costs, pay more than double the electric bills of their Washington state competitors and 30% higher bills than their competitors in Georgia. Higher power costs certainly pose some threat to the continuation of this industry in Wisconsin. This is an example in the local industrial area of the impact that higher cost Kewaunee Plant alternatives may exert in reducing the economic and social benefits of electric power to the community.

TABLE 2.5-4

POWER COSTS TO BASIC INDUSTRIES

IN THE OWNERS SERVICE AREAS

Industry	KWH/Dollar Value of Shipment	% of Norm	% Cost of Purchased Power to Value of Shipment	% of Norm
All industry ave.	0.973	100	0.88	100
Pulp mills	7.028	722	4.00	454
Paper mills	4.966	510	4.00	454
Paper board mills	4.966	510	4.50	511
Pressed and molded pulp goods	2.328	239	2.70	306
Building, paper and board mills	4.482	460	4.00	454
Aluminum, rolling, and drawing	0.862	89	0.80	91
Electrometallurgical products	22.312	2293	11.30	1285

One of the factors contributing on a national scale to the serious U.S. balance of payment problems is the increasing imports of petroleum which is used for generating electricity. If the costs of nuclear power are not too high, nuclear power offers the best hope for reversing the trend of petroleum imports. The selection of nuclear power plant alternatives which cause large cost increases to achieve diminishing increments of environmental protection may deprive the U.S. economy of this much needed benefit which can accrue because of low cost nuclear power. This is an example of the influence of power costs on potential benefits to the national economy.

The waste-product recycling industry, which removes discarded aluminum cans, junk autos, throw-away bottles, etc., from our polluted environment, has a significant electric power requirement. Since this is a competitive industry, its health depends in part on dependable low cost power; high cost power may inhibit this industry's growth. This is an example of the influence of power costs on the success of our environmental improvement efforts. Another would be the high energy demands of modern sewage treatment systems.

In the cost-benefit analyses which follow, the dollar costs of alternatives are assumed to be inversely related to the economic and social benefits of dependable, low cost power. A linear relationship is assumed for simplicity in the absence of a more acceptable rationale.

Measurement of Environmental Cost. To compare the net environmental impact of one alternative with that of a different alternative requires some kind of scaling or ranking system that will accommodate such diverse factors as aesthetics and water quality. We are instructed to "quantify where possible". We have attempted this with some success, but the results are valid in only a general sense. The degree of subjectivity inherent in decisions regarding the relative importance of various impact factors is so large as to make the quantitative results misleading if improperly used. Quantification does, however, serve the purpose of narrowing overall comparisons down to a relatively simple set of numbers which can be tabulated more easily than the ideas which they represent.

In quantifying environmental cost, we assign an Importance Factor to each impact. This is the area of greatest subjectivity; no two people will exactly agree on the number used. Thus, when we rate aesthetics as having a certain fraction of the importance of thermal effects, we are making a judgment which is wide open to criticism and debate. Each impact is weighted in relation to the total decision framework.

A second judgment is required to rate the relative aesthetic, thermal, etc., impact of each alternative considered. In this regard, a Rating Factor is assigned which rates the impact of each alternative against the worst possible impact. To quantify the relative aesthetic impact of an alternative, therefore, we multiply the Rating Factor by the Importance Factor; the result is the Impact Level. To measure the total impact of one alternative on the whole environment, we sum up the impact levels. The process is illustrated as follows, using a value of 0 for least impact and 10 for the greatest possible impact.

Impact	Importance Factor	Alternate 1		Alternate 2	
		Rating Factor	Impact Level	Rating Factor	Impact Level
Aesthetics	30	1	30	10	300
Thermal	70	10	700	1	10
TOTAL IMPACT	100		730		310

The illustration would seem to show that Alternate 1 has a much greater environmental cost than Alternate 2, if the two impacts studies are the only ones of significance. However, another quantifier might feel that aesthetics are just as important as thermal impact and assign a value of 50 to each Importance Factor. The result changes to a total of 550 for each alternative.

The real value of the system described is its ability to reduce a lot of words and concepts to a simple form and to allow detection of particularly sensitive factors which could, if changed significantly, alter the ranking of alternatives. It is recommended that the charts, where they appear in subsequent sections, be viewed in this way.

2.5.4.3 Alternate Methods of Generation

General. Two principal methods of generation of 540 MWe of power have been considered: a coal-fired steam plant and a nuclear plant. No other methods of power generation open to the owners can provide the reliable base load capacity of the magnitude required. In this regard, however, gas turbines have been briefly considered as a possible alternative primarily to demonstrate that this method is not a viable substitute for the two principal alternatives.

Gas turbines now in use by the owners provide peaking power. The turbines are in use for relatively short periods; the high percentage of shutdown time allows for required maintenance. Continuous base load operation with turbines would mean that a total capacity substantially greater than the required output would be necessary to permit alternate shutdown and servicing. The fuel used, natural gas or fuel oil, is in relatively short supply, particularly in this part of the country. Natural gas is in great demand for domestic and other industrial use; demands imposed by a large user of natural gas such as a base load power plant would create serious problems in meeting other present needs; distribution facilities from the source to the site would have to be greatly expanded.

Gas turbine generation would not be without environmental cost. Waste heat is carried off by air; for a huge bank of turbines, this would actually result in climate effects, principally convection winds. Airborne pollutants consisting of some soot emission and organic hydrocarbons are not avoidable, although the effects would possibly be more localized than for a high-stack coal plant. Because there are no cooling water needs, the net local impact would probably be somewhat less than for a coal or nuclear plant. The overriding environmental factor would probably prove to be the impact of the new gas pipeline facilities required. In addition, rapid depletion of a valuable resource having other significant uses is an important consideration.

The foregoing, together with the reliability factor and overall costs even without considering the loss of $132,000,000 already invested in the Kewaunee Nuclear Power Plant, does justifiably eliminate gas turbines as a viable present alternative to base load power generation by coal or nuclear plant.

The environmental cost of the coal and nuclear alternatives are significant in several areas: atmospheric degradation, effects on water bodies, uses of land, the consumption of irreplaceable resources, and effects on the biota. A description of these impacts follows, together with an attempt to summarize by quantification.

Atmospheric Impact

When fossil fuels are burned, chemical oxidation occurs as combustible elements of the fuel are converted to gaseous products and the non-combustible elements to ash. Typically, more than 95 percent of these gaseous combustion products are not presently known to be harmful (oxygen, nitrogen, water vapor and carbon dioxide) and are therefore, not significant in terms of air pollution. The noxious gases (oxides of sulfur, the oxides of nitrogen and organic compounds including polynuclear hydrocarbons) are harmful to humans, plants, animals and certain inert materials.

The sulfur oxide emissions for a hypothetical 2-1/2 percent sulfur coal will be about 110 pounds of SO_2 per ton of coal burned, or about 200 tons of sulfur oxide per day for a 500 megawatt plant. Sulfur oxide removal equipment may be available to remove about 60 percent of the SO_2 from the effluent, leaving 80 tons per day emission. It is difficult to estimate the cost of this level of SO_2 emission reduction but for purposes of this report estimates for additional plant cost of $14,000,000 and annual operating cost of about $1,800,000 are made. The ground concentrations of SO_2 can be further reduced by careful plant siting and selection of stack height, effluent temperatures and exit velocities.

Nitrous oxides are produced at the rate of about 20 pounds of NO_X per ton of coal. For a 500 megawatt plant, the NO_X daily effluent output into the atmosphere is about 40 tons per day. Nitrogen oxides are by themselves relatively unimportant pollutants. However, in an atmosphere containing unsaturated hydrocarbons (which come from combustion of and evaporation of gasoline, kerosenes and oils) the nitrogen oxides react with the unsaturated hydrocarbons producing the odorous and visibility-restricting smogs.

Visible smoke emissions and soot can be greatly reduced from stacks with modern electrostatic precipitators. The visible emissions from the best and newest power plant stacks are almost exclusively condensed water vapor, rather than smoke. Ninety-nine and five-tenths (99.5) percent removal is possible.

The nuclear plant emits no chemically significant effluents into the atmosphere. It does emit radioactive effluents in amounts so small they cannot be distinguished from the background radiation at very modest distances from the reactor building.

<u>Effects on Water Body Quality</u>. The coal-fired steam generator and the nuclear-fired steam plant both require waste heat disposal systems. The requirement for heat dissipation is about fifty percent greater for the nuclear plant. The atmosphere can provide a heat sink by means of cooling towers; rivers and lakes can be sinks by once-through cooling; or cooling ponds can be used which are closed systems drawing from natural

rivers or lakes and needing only makeup water. Combinations of these systems are possible.

In addition to heat additions to lakes and rivers, depending upon the system selected, the nuclear plant will add very small amounts of radioactive material in its water returns to heat sinks. These will be in the cooling water return for once-through, or in the blowdown water from towers. Small amounts of chemical pollutants are associated with cooling water return for either a fossil or a nuclear plant.

<u>Uses of Land</u>

The land required for a nuclear plant is less than half that for a coal plant, assuming once-through cooling systems in each case. There are exclusion zones associated with a nuclear site; however, the restricted land can be used for activities such as agriculture whereas the land necessities of coal-fired plants for coal storage, transportation facilities such as rail and switchyard, and ash storage areas preclude the simultaneous other use of this land.

The land requirements for cooling systems are greater for nuclear plants because of less efficient use of heat. This becomes significant in the case of a cooling pond. In our comparison, however, we consider once-through systems in each case.

Coal-fired plants have historically had a low aesthetic rating. Even with attention to their design, the tall stacks, and coal and ash storage requirements mitigate against their achieving an aesthetic par with nuclear plants. This difference, however, would probably be reduced substantially if a natural draft cooling tower were to be required in lieu of once-through cooling for a nuclear plant.

Uses of Irretrievable Resources

The reserves of coal, gas and uranium are finite. Each production method expends irretrievable resources. The reserves of uranium fuel, however, will become much less critical with the development of the breeder reactor. Coal has uses as a chemical raw material that will limit its long term use as fuel.

Effects on Biota

Thermal effects result in some fish damage which, it is assumed, is in direct proportion to the quantity of waste heat. Other water quality effects are in about the same proportion. The actual biological effects of air-borne pollutants from a coal plant have never we consider once-through systems in each case.

Coal-fired plants have historically had a low aesthetic rating. Even with attention to their design, the tall stacks, and coal and ash storage requirements mitigate against their achieving an aesthetic par with nuclear plants. This difference, however, would probably be reduced substantially if a natural draft cooling tower were to be required in lieu of once-through cooling for a nuclear plant.

Uses of Irretrievable Resources

The reserves of coal, gas and uranium are finite. Each production method expends irretrievable resources. The reserves of uranium fuel, however, will become much less critical with the development of the breeder reactor. Coal has uses as a chemical raw material that will limit its long term use as fuel.

Effects on Biota

Thermal effects result in some fish damage which, it is assumed, is in direct proportion to the quantity of waste heat. Other water quality effects are in about the same proportion. The actual biological effects of air-borne pollutants from a coal plant have never been successfully assessed, particularly for new plants with efficient particulate control. It is clear, however, that overall air quality effects for a coal plant are significantly greater than for a nuclear plant and the resulting indirect effect on the biota are correspondingly greater. It is generally assumed that the effects would be in proportion to the degree to which each meets emission standards.

A Summation of the Environmental Costs

The atmospheric impact of the nuclear plant is significantly less than that of a coal plant. Water body effects are greater for the nuclear plant, but these ultimately depend on the heat disposal system selected as much as the energy source. In land use, the nuclear plant has the lesser impact. The principal irretrievable resource (fuel) spent by a coal plant is more critical than for a nuclear plant. The effects on aquatic biota are greater for the nuclear plant, but the air quality problem for a coal plant probably balances this overall. In balance it is concluded that there is no net adverse environmental impact for the nuclear plant when compared to a coal plant of similar capacity. These concepts are summarized in Table 2.5-5.

The table is based on the rationale for quantifying environmental cost described in Section 2.5.4.2. The actual totals are not

TABLE 2.5-5

COMPARISON OF TWO METHODS OF GENERATION

Environmental Impact	Importance Factor "I"	Coal Plant (Ideal Site)		Nuclear Plant (Full Return Cooling, Typical Lake Site)	
		Rating Factor "R"	Impact Level I x R	Rating Factor	Impact Level I x R
Land Use	10	10	100	5	50
Aesthetics	3	5	15	3	9
Water Quality (Including Thermal)	16	7	112	10	160
Air Quality	19	10	190	1	19
Resource Consumption	10	10	100	1	10
Safety	40	0	0	5	200
Fuel Transportation (General Impacts)	2	10	20	2	4
	100		537		452

significant. What is significant is that the differences in the totals for the two alternatives are not gross. The most sensitive factor for a nuclear plant is safety; the consequences of a serious accident are very great. But the probability of such an accident is so low that the rating factor assigned is probably much too high. Who will decide in terms of environmental cost? In summary, the attempt to quantify environmental cost does not even begin to suggest the abandonment of the Kewaunee Plant in favor of a coal plant. Even if Kewaunee were not started, there is no clear present net environmental advantage of one method over the other by the analysis.

Current Economic Analysis. The original projection of total energy costs, prepared when the Kewaunee project was committed, estimated 1972-80 total annual costs including operating costs and annual carrying charge on investment to be 5.25 mills/KW.hr. for a coal plant and 5.12 mills/KW.hr. for a nuclear plant. The most current projection of similar costs shows estimates of 8.12 mills/KW.hr. for a coal plant and 8.15 mills/KW.hr. for a nuclear plant.

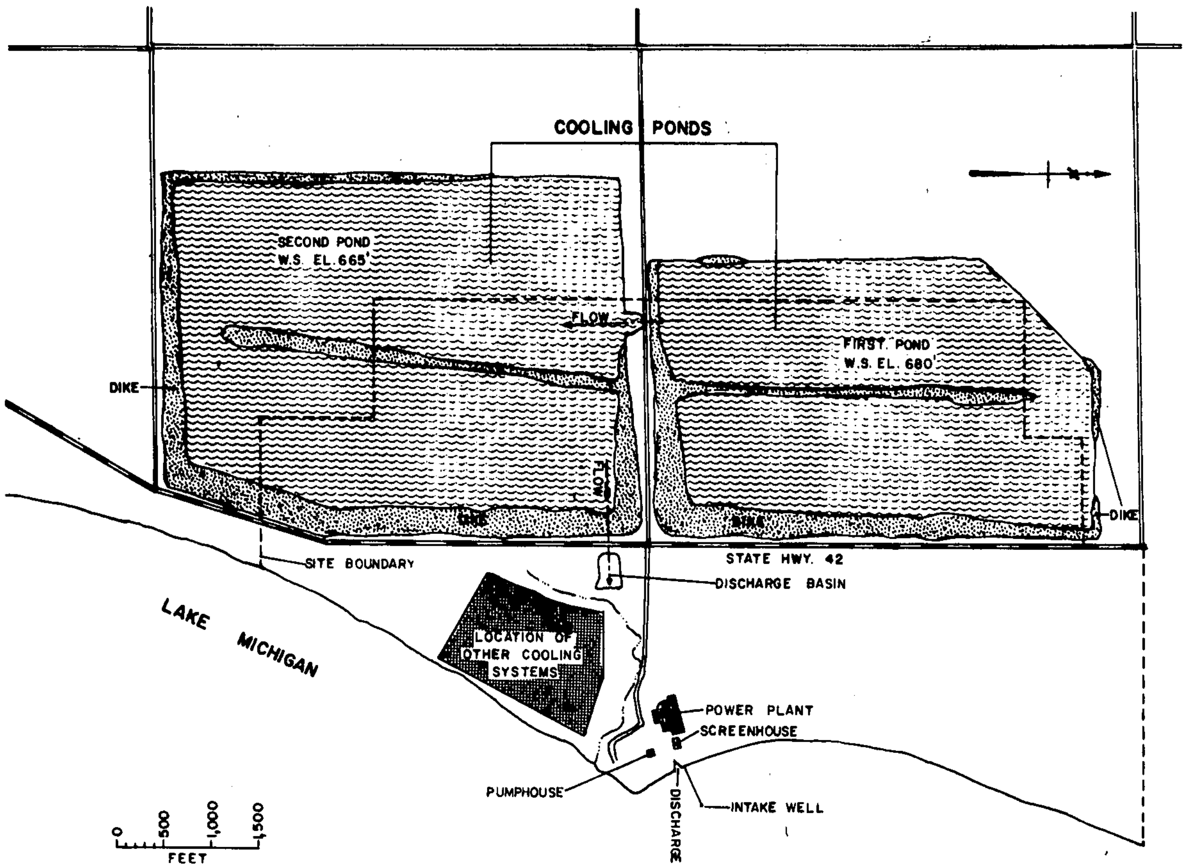
If the commited costs of the Kewaunee project, $132,000,000, were to be added to a replacement coal plant, the resulting cost of energy would be increased to 13.46 mills/KW.hr.

Conclusions. In balance it is concluded that there is no net adverse environmental impact for the nuclear plant, and certainly not an impact of sufficient margin to write off the $132,000,000 already invested in the Kewaunee Plant with the concomitant loss of the benefits of lower cost power to the company's customers.

2.5.4.4 Alternate Methods for Waste Heat Disposal

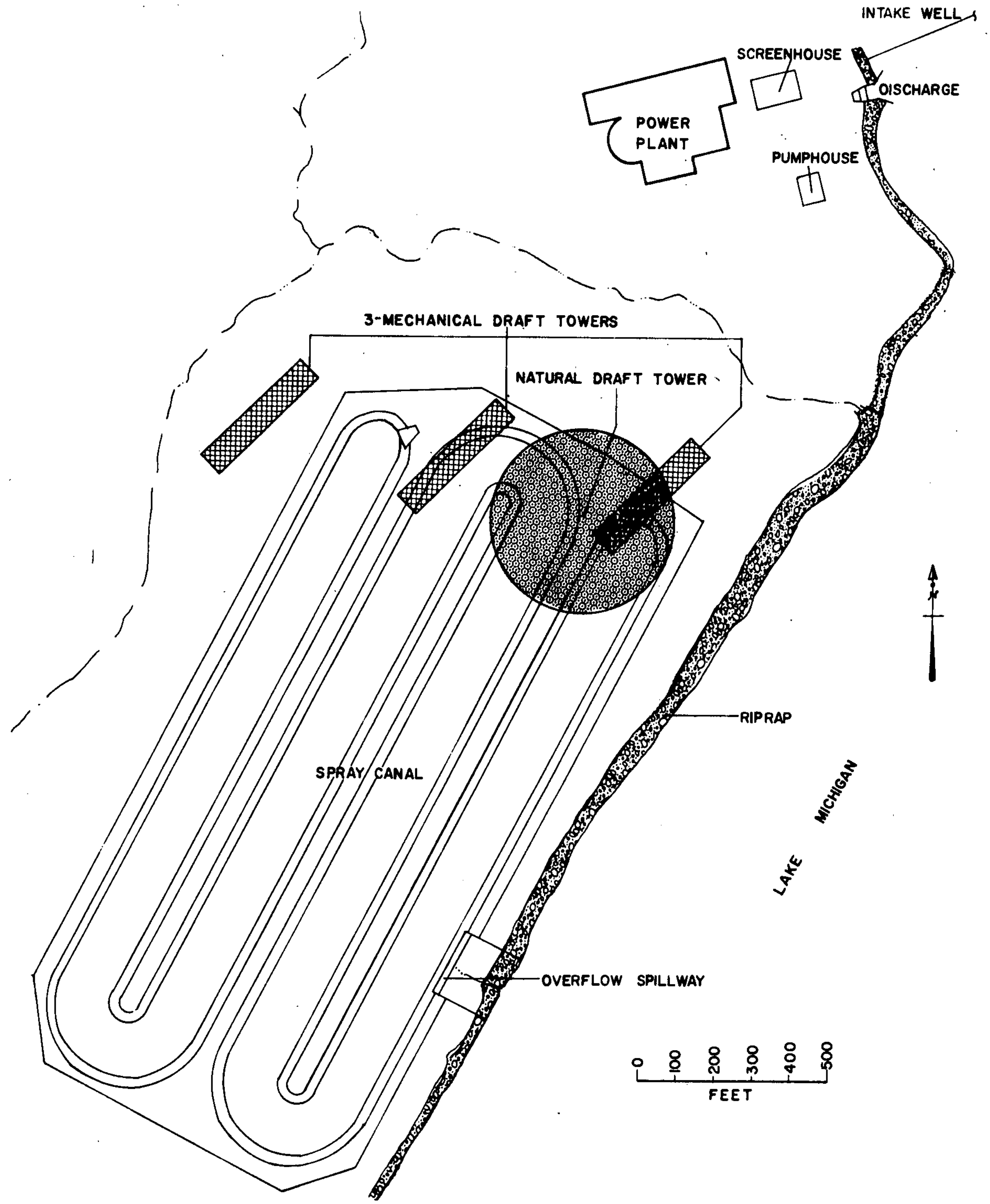
General. There are several practical methods for disposal of the waste heat developed by a nuclear power plant. These methods include both natural draft and mechanical draft cooling towers, closed cycle cooling ponds, once-through cooling, and variations of these such as spray canals, spray panels, etc. Also available are combinations of any two or more methods. Five alternative methods are evaluated for the Kewaunee plant using a cost-benefit analysis in which their environmental impact is weighed against the economic and social benefits of electric power recognizing the manner in which these benefits are adversely influenced by rising power costs. Figures 2.5-1 and 2.5-2 illustrate the relationship between each system and the plant location. Another cooling method, dry cooling towers, has an advantage of not adding moisture to the atmosphere. This method is quite inefficient, adds siginificantly to power costs and has not been developed to the point where it can handle the magnitude of heat disposal required for a nuclear plant. Dry towers will, therefore, not be considered in this evaluation. We also do not specifically consider combinations of systems; it is assumed that both the dollar cost and the environmental cost of two alternatives used in combination would lie somewhere between the alternatives considered.

The design objectives of each of the alternatives evaluated includes the following:



COOLING POND LAYOUT

FIGURE 2.5-1



ALTERNATE COOLING SYSTEMS

FIGURE 2.5-2

1. To dispose of 4×10^9 BTU per hour
2. To circulate through the steam condensers 420,000 gpm
3. To utilize those portions of the existing once-through systems which are applicable.

The paragraphs which follow include a description of each system to include technical features, environmental impact and the dollar costs of the system. This is followed by a discussion of the influence of cooling systems on radioactive waste disposal, and by the tables which summarize dollar costs and environmental impact for all systems.

To simplify the evaluation, all economic factors have been converted into terms of annual operating costs in dollars. These factors include capital investment, interest depreciation, operating costs, and effects on efficiency of the plant in terms of changes in electrical capacity and output. Once-through cooling is used as an economic baseline with annual costs assumed to be zero in this evaluation.

The options for plant water discharged into the Lake are similar for all cooling systems except once-through and these are discussed separately.

Natural Draft Cooling Towers. The natural draft cooling tower is 450 feet high, circular in all horizontal cross-sections, and hyperbolic in vertical cross-section. Diameters of the tower are 480 feet at the base narrowing to 200 feet at about 300 feet above grade, and broadening slightly at the top of the tower. The tower would be located about 1,000 feet from the existing plant.

Hot water from the condenser is pumped to the tower and cooled within the tower by exposure of the water to air as it cascades over baffle plates on the tower and is collected as cooled water in the base of the tower. The cooled water is returned to the steam condensers and then recycled. Water is lost from the system by evaporation and also from drift. Makeup water from the Lake is, therefore, required. Additional makeup water is added to the system from Lake Michigan and returned to the Lake as blowdown to prevent excessive accumulation of mineral content in the system. Chemicals are sometimes added to the water to prevent undesirable biological growth in the system. The unique characteristic of the natural draft tower is that the buoyancy of the warm moist air in the tower provides air intake at the bottom and draft in the tower. This is in contrast to the mechanical draft towers for which electric powered fans provide the necessary air movements.

Impact on the environment of natural draft towers is many faceted. Up to 7650 gpm of water is evaporated, and 1350 gpm of wind drifted water droplets are dispersed, from the top of the tower top at 450 feet above the ground. On most days of light wind speed, the warm moist plume will continue to rise above the tower top. Occasionally, the plume will react as a down wash on the leeward side of the tower. As the plume entrains ambient cold air, condensation may add to the air-borne mists such that the visible plume of water droplets extend some distance from the tower. In below freezing temperature suspended water droplets may remain unfrozen until they evaporate or till they impact an object and immediately freeze. With the natural draft tower this visible plume with its potential for visibility restriction and icing will rarely return to the ground, however.

The up to 1350 gpm of wind drift particles carry with them dissolved minerals, which, when the droplets evaporate, may deposit on the ground as mineral drift. In large quantities the mineral drift could be detrimental to biota and agriculture, an effect which is periodically mitigated by rainfall and run-off. The mineral drift is spread thin but over a wide area because of the high elevation of release. The blow-down water returned to the Lake influences mineral drift by reducing the build-up of concentration of minerals in the tower water from which the droplets are created. The known methods for calculating the deposition and effects of mineral drift are quite inadequate. For fresh water drift in regions of frequent and adequate rainfall like Wisconsin, mineral drift is likely to have less effect than in regions of high mineral content water with infrequent and less amounts of rainfall.

Biological effects accrue primarily from blow-down discharge into the Lake. A study by the Westinghouse Environmental Department evaluating the environmental aspects of cooling towers indicate that total losses in terms of ultimate fish damage would range between about 2 and 20 percent of that attributable to corresponding once-through cooling systems. For a natural draft tower, a small loss of wildlife habitat would occur; this is judged to be quite insignificant for this alternative because of the relatively small land area to be occupied by the structure.

The size of the natural draft tower would be a severe contrast to a landscape characterized by low rolling terrain and primarily small structures. The Kewaunee station itself, of course, is not small but it would be dwarfed by a natural draft cooling tower rising to a height of 450 feet. The highest point on the Kewaunee station, the top of the reactor silo is approximately 200 feet high. Though the hyperbolic shape of this type of tower eases the feeling of massiveness to some degree, the proportions remain aesthetically unfavorable.

In summary, natural draft cooling tower would dominate the scene for miles around and would detract considerably from the good visual form relationships currently established between Kewaunee station and the surrounding farmsteads.

The added construction costs of this tower are $16,902,000. These may be converted to an annual cost of $2,540,000 to include amortization and interest. Annual operating costs and loss of capacity due to less efficient cooling than the baseline once-through system are $2,037,000 per year. The total annual additional costs for the system above the baseline are $4,577,000 per year.

Mechanical Draft Cooling Towers. The mechanical draft towers would be constructed in three parallel banks oriented NNE to SSW in direction. Each bank is about 50 by 350 feet in area, and is lower in height than the reactor building. Hot water from the condenser cascades down over baffles from the top of the towers and air is blown up through the water by electrically powered fans. The cooled water is then recirculated to the condensers. The water budget of the towers is similar but not identical to that of natural draft towers, and about the same chemical treatments of water would be necessary.

The towers would evaporate up to 7650 gallons of water per minute and disperse up to 350 gpm of wind drift. Upon mixing with ambient air, much of the evaporation loss water condenses into a visible plume. This plume has little buoyancy and tends to move near the ground with the wind. The visible plume will frequently reach State Highway 42, considering applicable meteorological data; but considering the 60% offshore wind condition, the site is favorable in this regard. Restrictions of visibility can be quite serious in this plume. At temperatures below freezing, icing is likely through a large section of the visible plume. The extent of this plume will depend of course on factors of humidity, wind speed and air stability.

It is possible to mitigate plume effects by reducing fan speed during severe fogging and icing, which occurs mainly in winter when the cooling towers have a lower required cooling capacity. Additionally, it may be possible to entrain additional ambient air within the towers, reducing the output air to below 100% relative humidity, thus reducing the fog and ice impact.

The total mineral drift is less from the mechanical draft than the natural draft towers because the droplet volume only rises as high as 350 gpm. The spread of the drift, coming from three banks of towers, starts from a fairly broad source. The drift is not from an elevated release, but much of it may deposit on the ground before evaporation of droplet, or it may not go beyond the site boundary. Quantification of the mineral drift deposition volumes outside the site area on land surfaces is impossible. A qualitative judgment is that the deposition from mechanical draft towers must be less, and local concentrations are probably no higher than that from natural draft towers. The total mineral drift of mechanical towers is, of course, sensitive to the volume rate of blow-down water returned to Lake Michigan.

A typical mechanical cooling tower scheme employs three banks of nine towers each, running parallel to each other and essentially parallel to the shoreline in a field about 700 feet southwest of the generating plant. They would rise to heights averaging about 53 feet above ground level. The relatively wide spacing of the banks of towers and the elongated effect of the banks of nine units, would produce a horizontal linearity, having a low profile and controlled visual impact. Concrete bases with metal clad upper sections would allow integration with the existing plant and surroundings. The mechanical draft cooling towers would produce more noticeable "fog" than would other alternate systems. By contrast, the natural draft tower's fog would be high enough to be less perceptible. The low level fog from the mechanical draft units can be objectionable from an aesthetic standpoint as well as occasionally from a safety standpoint, considering Highway 42.

Blow-down water will result in some heat and mineral return to the Lake. The effects on the aquatic environment, in terms of fish damage, are roughly the same as for the natural draft tower as reported previously. The effects on wildlife due to habitat removal may also be considered roughly similar.

The added construction costs of the tower are $10,118,000 which is converted to an expense of $1,510,000 per year amortization and interest. Annual operating costs and cost due to reduced capacity and efficiency are $2,105,000 per year. The total additional costs above the baseline costs with a once-through system are $3,615,000 per year.

Closed Cycle Cooling Pond. To achieve the necessary cooling capacity, a pond area between 650 and 1500 acres is needed. The amount of land required for most efficient cooling is not now available at the Kewaunee site. Nevertheless, an analysis has been made of the environmental impact and the dollar costs of this alternative. Figure 2.5-1 shows the 650 acre system. Costs, however, are based on the most efficient 1500 acre system.

A multi-pond system is required. The ponds are built with internal dikes so that the warm water from the plant condensers enters a corner of one pond and makes a full circuit of its periphery before enterning the second pond. Dike-induced circuitous routing in each pond precedes final return of the water to the plant. During those circuitous routes, the water has had a long time to cool by natural evaporation and contact with the cooler air above it.

As with all other systems evaporation losses of water, makeup water, and blow-down are involved.

Evaporation losses from the ponds are 7650 gpm, as for each other system. There is no wind drift, so this is the total consumptive use of water. The frequency of fogging due to the cooling pond is much less than for all alternatives except once-through cooling. There may be occasions during very low wind circulation at night when the ponds would contribute to ground fog in its vicinity including State Highway 42. In these events, it will be impossible to determine whether or not the fog would have developed in the absence of the ponds. The ponds will not create an icing condition. Natural icing occurs when warm rain or drizzle falls into below freezing layers near the ground. The influence of the ponds could only be to mitigate the below freezing lower layer temperatures.

Probably the greatest impact upon the terrestrial ecosystem would be the removal of over 650 acres of field crop and pasture lands. Installation of the cooling pond will require more than the 908 acres presently owned. Hungarian partridge, rabbit, and ring-necked pheasant would essentially be eliminated from the area to be inundated. Deer would not be adversely affected by the location of the pond because their occurrence is rare.

The pond probably would be attractive to migratory waterfowl and shore birds for resting, feeding, and possibly nesting. Following excavation, the soil forming the pond bottom may provide substrate for aquatic vegetation and in turn, invertebrates.

The cooling pond method would have relatively little visual impact on the area. Surface water could be viewed as an aesthetic gain in most conditions, but this may be insignificant when proximate to a large natural lake. The total water surface area may range from 650 to 1500 acres. If a relatively smaller surface is used, two ponds will be built west of Highway 42 and flanking the county road running normal (east-west) to 42. The higher level primary pond, at 680 feet surface elevation, would spill to the lower level secondary pond, at 665 feet surface elevation, through a culvert underneath the county road. Dikes would surround both ponds. They would be more pronounced along their east or down-slope side bordering Highway 42, thus putting the ponds out of view of motorists on that highway. The elevations on Highway 42 range from 610 to 660 feet in this immediate area. Similarly, the ponds could not be seen from the surface of Lake Michigan. However, from county roads at more inland elevations above 700 feet, low angle views of the ponds would be possible.

If larger water surfaces were to be developed toward the projected optimum of 1500 acres, probably several inter-connected ponds would be employed. The visual effects described above would be similar, though broadened.

The capital costs for the ponds are the highest of all the cooling alternatives. The return water temperature is also high, with resultant penalty in reduced plant capacity and efficiency. Capital cost is $18,068,000 which is converted to an annual cost of $2,700,000 per year. Annual operating costs and loss-of-capacity costs are $2,675,000 per year. The total annual costs for cooling ponds above the baseline once-through system are $5,375,000 per year.

Spray Canal. The spray canal is a long canal 6500 feet long, trapezoid in cross section, with a bottom width of 140 feet. Floating self contained spray modules are distributed along its length. Water enters the canal from the condensers and moves slowly down the canal with cooling by natural evaporation. The spray heads at intervals spray water into the air and it falls back into the canal, the heads having significantly improved the cooling efficiency of the canal. At the end of the canal water returns to the condensers. The system is quite simple and easily maintained because the spray heads may be individually serviced without interference with other heads. This concept is quite new and needs additional study to determine the effects of ice on canal operation in winter.

The canals consume up to 7650 gpm of water by evaporation and up to 1350 gpm by wind drift. The plume from the spray ponds will rarely contain fog or cause icing because the water evaporation takes place over a wide area, and drier ambient air is continually being mixed with the broad plume, thereby inhibiting its formation of condensed moisture. The fog impact of the canal will be of the same nature as that of the cooling lake, but a little more severe because of the more intensive evaporation per unit of area.

The wind drift from the canal spray heads is as great in volume as from the natural draft tower. Yet this spray is very low and much of the mineral drift will fall out very close to the canal. To the extent that mineral drift is adverse, the maximum intensity of drift fallout will be greatest from this canal system, but the area covered will be much smaller than that associated with either type tower.

The biological impact of the canal solution will be proportional to the land area used so far as wildlife habitat is concerned. The advantages occuring from the waterfowl attraction of cooling pond will not apply to the canal because of the spray effects. Fish damage similar to that of cooling towers can be expected for the canal as a result of discharge to the lake.

The spray canal scheme would incorporate much less land usage than cooling ponds, but would introduce a heightened level of visual activity. At 40 foot intervals in the canal, spray modules would broadcast water in plumes about 40 feet in diameter and 25 feet in height. The sprays would be coarse enough to hold their form in most wind conditions.

A pumphouse similar to that required for the cooling pond scheme would be added to the building complex and a spillway would be added between the canal and Lake Michigan. Neither would have much visual impact in comparison to the existing elements on the site.

The capital investment in this system is $11,410,000 which is converted to $1,710,000 per year for amortization and interest. Costs for operation and loss of generating efficiency amount to $2,208,000 per year. The total annual costs for a spray canal over and above the baseline once-through system is $3,918,000 per year.

Once-Through Cooling System. In the once-through cooling system, up to 420,000 gpm of Lake Michigan water are withdrawn from the Lake, pumped through the condensers and warmed 20°F, and then returned to the Lake. In the winter at lower flow rates the thermal rise will reach about 30°F. The heat discharges into Lake Michigan by this system is up to 4×10^9 BTU per minute.

This is the cooling system which has been designed for the plant; construction has been completed. From an economic viewpoint, it is the least cost system. Its capital investment has been relatively small, its degradation of plant efficiency below baseline is zero, and its operating costs are low.

The primary environmental impact of the once-through system is its effects on Lake Michigan due to warming caused by its return flow. These effects and other pertinent aspects of the once-through system as designed are detailed in the foregoing sections of this report.

A Cost-Benefit Summary of Cooling Alternatives. The data concerning environmental impact and dollar costs of alternatives described herein are summarized in Table 2.5-6. The elements of environmental impact are fog and icing potential, effects on aquatic and terrestrial biota, aesthetics, land use, additional construction impact, water consumption, and resource use. A rating under each alternative for each element of impact has been estimated using the rationale described in Section 2.5.4.2.

Again, the effort to quantify is instructive in that it reduces complex concepts to a simpler form. Perhaps the format is over-simplified, but experiments with more detailed listing of impact factors has not produced significantly different results. As with the earlier effort to compare the effects of a coal plant with those of a nuclear plant, it is difficult to assign realistic importance and rating factors.

TABLE 2.5-6

COMPARISON OF FIVE METHODS OF COOLING

Applicable to the Kewaunee Plant

2

Environmental Impact	Relative Importance Factor I	Once-Through Cooling		Mechanical Draft Towers		Natural Draft Towers		Cooling Pond		Spray Canal	
		Rating Factor R	Impact Level IXR	R	IXR	R	IXR	R	IXR	R	IXR
Land Use Area consumed Wildlife habitat	18	1	18	3	54	3	54	10	180	4	72
Aesthetics	10	1	10	8	80	10	100	0	0	3	30
Aquatic Ecosystem Thermal & chemical water quality and fish damage in system	25	10	250	5	125	5	125	5	125	5	125
Climate Effects Fogging, icing	5	1	5	10	50	5	25	3	15	6	30
Construction Temporary effects of new construction	2	0	0	5	10	5	10	10	20	6	12
Water Consumption	10	1	10	5	50	10	100	3	30	10	100
Resource use (Fuel)	30	1	30	8	240	7	210	10	300	9	270
TOTAL IMPACT LEVELS COST* ABOVE BASELINE	100	0	323	3.62	609	4.58	624	5.38	670	3.92	639

* Cost is the annual cost above baseline in millions of dollars

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The impact considered to be of greatest significance in the alternate cooling decision is resource use. The use of any of the alternate cooling systems, other than the existing once-through system, involves a penalty in terms of lost generating capacity and operating efficiency. This results in an increased rate of fuel consumption, as well as reducing the amount of power available from the station. It has been estimated that cooling towers would result in an efficiency loss of 5 to 8 percent (Ref.55). For the Kewaunee Plant this would mean a reduction in capacity of approximately 37 MWe. Extrapolated to the total system growth this means that additional power generating facilities will have to be constructed sooner than would otherwise be required. The importance of this fact becomes evident when viewed in the light of total penalty that would be paid by all the power plants presently being built in the Lake Michigan area if cooling towers were installed. Therefore, the resource use factor must be viewed in broader terms than the other more local impacts and is of major importance in any decision to select alternate methods of cooling.

It is concluded that quantification attempts do not justify abandoning once-through cooling for the plant. Cost data further justify this conclusion.

2.5.4.5 Effect of Alternate Heat Disposal Methods on Liquid Radwaste Systems

Introduction

Kewaunee Nuclear Power Plant is designed to use Lake Michigan water for cooling the condensers. This circulating water is isolated from the nuclear systems, so the only radioactivity entering it is the controlled discharge from the liquid radwaste system. Intake and discharge structures have been built to circulate 413,000 gpm. This large flow, which was required to limit the temperature rise, provides dilution for small, measured releases of radioactivity.

Pioneer Service and Engineering Company, at the request of the WPS, studies alternative cooling methods for the Kewaunee site. The latest report, September 28, 1971, summarizes the findings of several reports over the past year. Data from that report on water blowdown rate and dilution flow are used here to evaluate effect of these alternate cooling methods on liquid radwaste disposal.

Summary and Conclusions

Elimination of the circulating water flow results in a higher concentration of released liquid radwaste. Dilution of the variable 7,000 to 15,000 gpm blowdown to a constant 40,000 gpm is useful to limit chemical treatment and temperature rise. At 40,000 gpm blowdown plus dilution, the present system will discharge 4 percent of 10 CFR 20 limit for various isotopes and 0.17 percent of 10 CFR 20 limit for tritium. One of the original circulating pumps may be operated to maintain 265,000 gpm flow for radioisotope dilution to a fractional percent of 10 CFR 20. Alternatively, polishing demineralizers can further purify the liquid radwaste before release into a flow of 40,000 gpm.

Factors Affecting Liquid Radwaste System

Four factors resulting from the change in cooling have an effect on the liquid radwaste system: blowdown, dilution flow, reduced capacity, and power consumption. The blowdown plus dilution flow has a direct bearing on the liquid radwaste system, since this is the flow available for dilution of the waste. Reduced generating capacity, caused by the higher condenser temperature, and power consumption of the cooling system have an indirect effect. As pointed out in the Alternatives to this plant (ER Section 2.5), power not produced here must come from somewhere else. Other sources, nuclear or conventional, would probably not release any less radiation than Kewaunee. Therefore, reducing the power available from Kewaunee results in a small but calculable increase in pollution.

The September 28, 1971 report conducted by Pioneer Service and Engineering Company discusses seven alternatives. Their differences are mininal with respect to the liquid radwaste system. The blowdown rate is the same for all, except for one system deliberately designed for minimum blowdown. As Table 2.5-7 shows, a minimum of 7,000 to 15,000 gallons per minute are required to prevent buildup of solids in the closed system. This spread depends on the rate of evaporation, which depends more on weather than choice of system. A fixed blowdown plus dilution rate of 20,000 gpm was considered desirable as minimizing the need for chemical treatment, while 40,000 gpm would eliminate any treatment.* These rates are fixed by adding dilution water as required to the blowdown water. A maximum of 262,000 gpm could be achieved by running one of the original circulating pumps. This pump, of course, uses considerable power. However, it keeps the radioisotope concentration at a fraction of a percent of 10 CFR 20 limits. The largest flow justifiable for any other reason, 40,000 gpm, results in a concentration of 4 percent of 10 CFR 20 limits.

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*More blowdown reduces the need for chemical treatment of recirculating water, while more dilution reduces the chemical and thermal impact of the blowdown water on the lake.

TABLE 2.5-7

EFFECT OF REDUCED WATER DISCHARGE

Blowdown and Dilution Discharge gpm	Radioactivity Release Relating to 10 CFR 20 Various Isotopes	Tritium	Reason for Water Discharge
7,000 to 15,000	12% to 5.6%	1% to 0.45%	Minimum Blowdown
20,000	4.2%	0.34%	Reduce Chemical Treatment
40,000	2.1%	0.17%	Eliminate Chemical Treatment
210,000	0.4%	0.032%	Radwaste Dilution

2.5.4.6 Radwaste System Alternatives

The purpose of the radwaste system is to collect all radioactive wastes, gases, liquids, and solids, to contain them until they can be treated, measure what is left over after treatment and provide a mechanism for controlled disposal. The design goals for the systems are to reduce radioactivity levels to levels that are "as low as practicable."

There are adverse environmental impacts associated with radioactive effluent releases which can be described in terms of injury to future generations (genetic doses) and to individuals living near the site. The dose to an individual is measured in terms of rem. The genetic dose is measured in man-rem, which is the sum of the exposures to all individuals in the population involved.

To provide a measure of the radiation levels which are hazardous to future generations and to living individuals, it is useful to examine the routine, ever-occurring background radiation levels. Mankind is continuously exposed to background radiation which varies with location and elevation but ranges in the neighborhood of 100 to 125 millirem per year in the United States. The man-rem dose from various sources in 1970 was described by W. D. Ruckelshaus, Administrator for the Environmental Protection Agency in terms of the data in Table 2.5-8. Dose from these sources can be compared with the estimated maximum man-rem dose from Kewaunee from Section 2.3.7.3

which is also given in Table 2.5-8. From this comparison, the contribution from Kewaunee to the genetic (man-rem) dose would appear to be insignificant.

TABLE 2.5-8

MAN-REM RADIATION DOSES PER YEAR FROM SEVERAL SOURCES IN THE UNITED STATES

Source (1970)	Man-rem/year
Natural background	27,000,000
Medical diagnostic x-rays	18,000,000
Weapons test fallout	1,000,000
All nuclear power stations	400
Kewaunee (Liquid and Gaseous Releases)	6

Although the genetic dose from Kewaunee appears to be insignificant, the dose to an individual is evaluated in terms of a cost-benefit analysis. In the discussions which follow, radiation doses will be described in units of the natural background radiation which is assumed to be one. A dose value of 2 means that added radiation is equal to the background radiation. A dose of 3 means that a dose twice natural background has been contributed by the facility. In all cases, the dose to the highest exposed individual is cited.

The radioactive waste systems to be examined include the Liquid Radwaste system and the Gaseous Radwaste System.

Liquid Radwaste

We can express environmental cost in terms of radiation dose to the highest exposed individual and compare this with dollars required for each increment of dose reduction. The unit of dose is natural background. For example a dose of 2 means that the added dose is equivalent to background and a dose of 3 means the added dose is twice background. The unit of benefit is some inverse function of the dollar cost required to reduce radioactivity in the effluent. Approximate dollar cost of adding additional evaporators and holdup tanks is $0.10/gallon for a 50 percent reduction in radioactivity. High purity can be achieved by using enough 50% stages. While one piece of equipment may equal many stages, the number of stages required determines the cost. If we assume that the total volume of liquid waste is 100,000 gallons/year then the cost/stage is $10,000/year. The cost-benefit analysis for adding more stages to get additional dose reductions is shown in Table 2.5-9 and Figure 2.5-3. As stages are added, the environmental cost (dose) drops rapidly at first then approaches natural background. Beyond stage 5 or 6 very little dose reduction is achieved but the dollars required for each unit of dose reduction increases sharply.

The system as designed for Kewaunee incorporates many of the features normally associated with "zero release" systems. These include separation of drains, treatment of the steam generator blowdown, and additional demineralizing capability. The system is expected to result in a maximum added dose of 0.35 mrem (0.003 background units) which is beyond stage 8. Additional dose reduction cannot be justified based on this cost-benefit analysis.

TABLE 2.5-9

ECONOMICS OF LIQUID RADWASTE SYSTEM

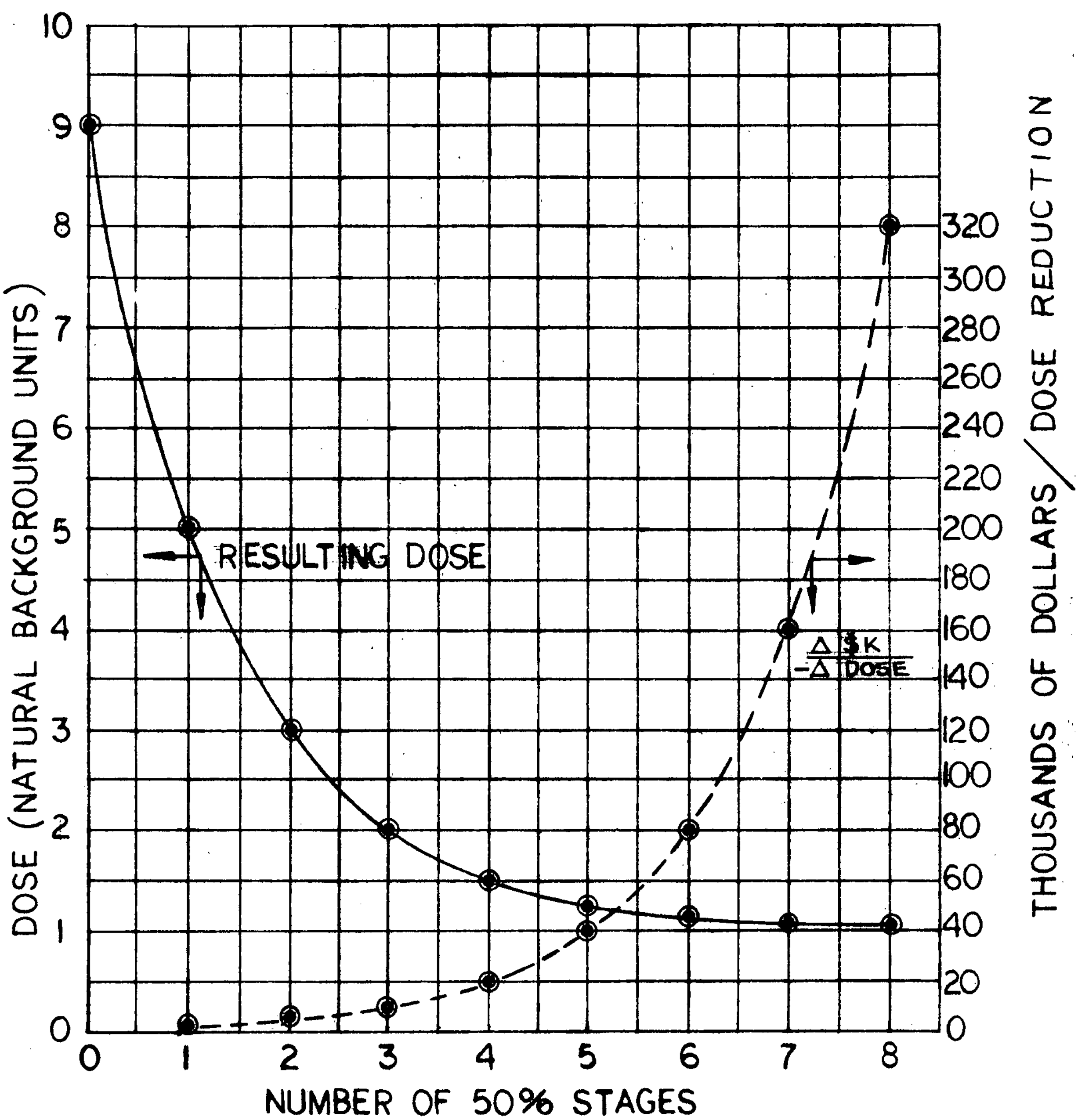
Number of Stages	Cost $ K	Released Concentration	Population Dose	Thousands of Dollars per Unit of Additional Dose Reduction
0	0	8	9	-
1	10	4	5	2.5
2	20	2	3	5
3	30	1	2	10
4	40	1/2	1-1/2	20
5	50	1/4	1-1/4	40
6	60	1/8	1-1/8	80
7	70	1/16	1-1/16	160
8	80	1/32	1-1/32	320

Concentration Unit = 10 CFR 20 Release

Dose Unit = Natural Background

$ K = $1,000

FIGURE 2.5-3 TOTAL DOSE (NATURAL RADIOACTIVITY PLUS LIQUID RADWASTE) AND INCREMENTAL COST OF PURIFICATION



Gaseous Radwaste

Table 2.5-10 shows the estimated amounts of Kr-85 and Xe-133 that remain in the hold-up tanks after a 45 day decay. The whole body dose contribution from a curie of Xe-133 is much larger than it is from a curie of Kr-85 due to its role in biologic processes. However, its decay time (half-life) is much less than Kr-85 and it becomes negligible after a 45 day decay period, as shown on Table 2.5-10. The dose to the highest exposed individual can be reduced less than 1/mrem/year from gaseous emissions by holding the gas 60 days instead of 45 days. The addition of hold-up tanks to provide longer decay cannot be justified on the basis of dose reduction and a cost-benefit analysis. In any case, the extremely low dose estimated from Kewaunee will actually be less than estimated since releases will normally occur only during periods of offshore winds.

Solid Radwaste

No cost-benefit is shown for solid radwaste, since it is packaged for disposal off-site in such a way that there is no hazard to the population. The environmental impact associated with transportation of the packaged radwaste is discussed in Section 2.9.

TABLE 2.5-10

CURIES OF RADIOACTIVE GAS REMAINING AFTER VARIOUS DECAY TIMES

Days Decay	$ K Cost	Total Curies	$ K/Curie Reduced (Latest Period)	Kr-85 Curies	Xe-133 Curies	Xe-135 Curies
0	0	253	-	3	150	100
2	0.2	105	0.0015	3	100	2
10	1.0	43	0.013	3	40	0
20	2.0	13	0.033	3	10	0
45	4.5	3.3	0.25	3	0.3	0
100	10	3.0	1.7	3	0	0
200	20	2.9	10.0	2.9	0	0

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

Short-term refers to that period over which the plant will operate (during which it will therefore "use" the local environment), and some period beyond, during which time certain of the plant's environmental effects may continue. Long-term productivity relates to those economic factors and secondary effects of power which directly affect man's "standard of living" and, ultimately, the "quality of human life" as measured in economic rather than environmental terms.

The Kewaunee project does, of course, use the environment. The environmental costs of power generation are significant for any form of power generation, as discussed in Section 2.5, Alternatives. The principal environmental effects are, however, largely reversible in the manner summarized in Section 2.7 which follows. The use of the environment is therefore truly short-term and the term "environmental cost" may therefore be misleading: cost is often thought of as referring to that which is permanently spent or consumed. In this case, the environment is not permanently spent or consumed with the principal exception of the consumption of fuel. The environmental cost, therefore, becomes primarily a temporary investment. To provide power, it has been necessary to invest a small amount of land and to anticipate the heating of a small portion of Lake Michigan. By discharge of wastes, principally into the lake, we are also affecting biota that ultimately benefit man in the form of food; this may also be termed an investment. Biological experts tell us that this latter investment is a small one; together with investments - principally future - that may be made relative to the same environment, the total investment will become larger and therefore more readily identifiable and quantifiable. Before those future investments become necessary, however, it is predicted that technology will have advanced to the degree that not only will the impact be more easily assessable, but that it can also be reduced or even eliminated altogether. Only through experience such as that gained by the operation of a station like Kewaunee are these advances possible. It becomes a link in a chain of events leading to the ultimate solution of what is now a problem of great social concern: the use of the environment for production of consumptive goods. This section will not attempt to repeat the degree to which the environment is being used; that is the subject which the major portion of this report treats. In summary, then, some aspects of environmental use are significant, others are discernable but relatively insignificant; and most can be reversed in the relatively short-term.

Long-term productivity as it relates to power generation is a subject which receives limited treatment in this report. It is a subject which not only requires a highly sophisticated economic analysis but which also relates to social priorities and human values. It is beyond the scope of this environmental report to rigorously assess the national and worldwide economic benefits of long-term productivity resulting from power generation capability. The power industry, its regulating bodies, and its principal consumers have addressed this problem at length but they are apparently only partially convincing. The public, however, clearly expresses its concern for power by its ever increasing demand for power. This demand bears no apparent relationship to concern for the environment. It is obvious that power is a key element in productivity; without power we could not even evolve the means by which human beings develop new ways of maintaining their standard of living. Pollution abatement itself is an important power consumer.

The foregoing is intended to document our society's desire for power and its need for power. It would be necessary to rather drastically alter the direction of the economy, as well as social values, to do with less power or to maintain power generation capability at present levels. This is not likely to be accomplished by society as a whole in the near term. Only a relatively few individuals in this generation and in this society have adopted or maintain a life style not so dependent on the production of consumables. It is therefore assumed, for the purposes of this report, that long-term productivity, whether it is to be enhanced or simply maintained, is vital to our society and that power beyond present levels is required, not merely desired.

In consideration of the foregoing, the relationship between short-term environment use and long-term benefit is not one for which a precise equation can be written. Pragmatically, the most realistic equation one can write would treat the present concern for productivity as a constant and the concern for environment use as a variable. They cannot therefore be equated, weighed or balanced in mathmatical terms. The problem reduces to one of selection of the least environmentally costly and most practicable alternatives or groups of alternatives which will permit the one side of the equation to remain at the (relatively) constant value which society has imposed. Section 2.5 demonstrates that this has been accomplished satisfactorily for the Kewaunee project in a manner consistent with AEC objectives and the spirit of the National Environmental Policy Act.

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

For the purposes of this discussion, resources are divided into three principal categories: Human, mineral, and environmental.

Human resources involve the time and effort required to design and build the plant as well as to operate it. This kind of resource is almost totally irretrievable, and were the plant never to operate at all much of that already expended would be lost. None of this resource is really salvagable except for the degree of experience gained in design and construction of the plant. The second category of resource is mineral and includes construction materials, water and, of greatest importance, fuel. The third category includes those environmental resources which we have already treated at length and in detail in prior sections of this report.

With regard to human resources, it would be difficult to demonstrate that any alternative method of producing power would directly involve significantly less human resource than a nuclear generating station. To evolve even more efficient methods of nuclear power generation will involve substantial time and effort, but will eventually lead to even lower rates of resource use per unit of power consumed. The least further consumption of human resources would be to proceed with the proposed action; any alternative would involve further - even duplicative - commitments of time and effort.

Of principal concern is the commitment of fuel resources to power production. We do not try to justify in a rigorous manner the critical nature of depletion of fossil fuel reserves in the world as a whole. This is obviously a principal reason why nuclear production of power is of vital importance to this society at this time. Even though known nuclear fuel reserves are not significantly different (in terms of the number of years to depletion) from fossil fuel reserves, it is apparent that as nuclear technology develops in the area of breeder reactors real reserves will expand. There is no such prospect for fossil fuels. On this basis, and under the premise that power must be produced, we consider the commitment of nuclear fuel resource to the production of power at Kewaunee or any other power plant to be a positive commitment and one which is favorable in the long-term. Only the various forms of hydroelectric power and the harnessing of solar energy can perhaps offer advantages over nuclear plants in regard to fuel resource commitment. The production of power by hydroelectric means, however, usually presents a very serious set of environmental problems. At any rate, suitable hydroelectric power sites are not available to the area served by Kewaunee. The use of solar energy for reliable electric power production has not yet proved feasible.

The commitment of construction materials has already been made for Kewaunee. Only if the Kewaunee plant were to be abandoned at this time, and completely different alternatives adopted, would additional resources of this kind be required.

As indicated in the preceding Section 2.6, use of the environment does not represent significant irreversible or irretrievable resource commitments, but rather a relatively short-term investment.

2.8 ACCIDENTS

2.8.1 General

This section evaluates the environmental impact of postulated accidents and occurrences (events) in accordance with guidelines and classification of accidents given in the AEC document "Scope of Applicants' Environmental Reports with Respect to Transportation, Transmission Lines, and Accidents" issued on September 1, 1971. The accident classifications are shown on Table 2.8-1.

The environmental impact of each postulated event 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 used to estimate release; however, the assumptions used to estimate dose are conservative.

In the following pages, at least one representative event for each of seven accident classes is described and its consequences evaluated. Where only one example is considered in a class, the postulated accident was selected from consideration of several possible accidents in that class on the basis that it conservatively represents a potential accident situation. The classes can be conveniently grouped on the basis of their likelihood of occurrence as follows:

TABLE 2.8-1

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 failures	Equipment failure Serious malfunction or human error
4	Events that release radioactivity into the primary system	Fuel failures during normal operation Transients outside expected range of variables
5	Events that release radioactivity into secondary system	Class 4 and 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

2

2.8.2 Accident Classes

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 neither 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. 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, 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 they entail little or no release to the environment, have no impact on the environment, 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 amounts 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. Each accident is treated separately in the following pages. The treatment consists of a brief description of the accident, a summary of the steps taken 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.

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. The extremely remote probability of occurrence of such successive failures makes the environmental risk so low as to be virtually non-existent, and for this reason Class 9 accidents can be excluded from consideration in accordance with the AEC September 1971 Guide.

2.8.3 Accident Meteorology

Dose calculations are based on the assumption that the wind is blowing onshore at the time of each incident. This is conservative since offshore winds that transport the gaseous effluent out over Lake Michigan occur approximately 60% of the time. A 50 percentile criterion was utilized to determine atmospheric dilution. The 50 percentile criterion was selected as being reasonable on the basis that it represents a condition which may be expected to be more severe 50% of the time and less severe the remaining 50% of the time; still, the conservative condition. This value was determined by considering seven atmospheric stability categories and nine wind speed ranges from 0.5 mph to greater than 23.5 mph. On-site data for the period January 2, 1969 to December 31, 1969 was used in this determination. Various stability conditions and wind speed groupings were used to determine values of X/Q at the site boundary and were listed in order of decreasing value along with a running cumulative frequency of occurrence of those conditions. This analysis established that the conservative value of X/Q at the site boundary is 4.8×10^{-5} sec/m^3. This determination was based on those winds blowing onshore only; i.e., from NNE clockwise through the southerly directions (direction from which the wind is blowing). The value was also determined by including calms in the more severe 50% category. The relative stability distributions at the Kewaunee site do not vary significantly with direction.

Based on the above analysis, Class F stability with a wind speed of 7 m/sec can be reasonably expected to represent the 50 percentile conditions for the Kewaunee Nuclear Plant. Doses were evaluated assuming a ground level release into the wake of the building. The wake correction factor for the building was taken to be 1170 m^2 (ca = 1170 m^2). All accidents were assumed to occur under conditions of invariant wind; i.e., the wind direction was steady for the duration of the release. The same stability and wind conditions were used to determine the population dose to a distance of 50 miles from the plant. For event categories 2 through 7, the population doses were based on the assumption that for the entire distance, wind direction was invariant and blowing toward the most populated area. Thus, doses as a result of any given accident are delivered only in one 22-1/2 degree sector. The average value of X/Q across this 22-1/2 degree sector was determined as a function of distance from the plant. This average value of X/Q was then used to determine the dose to the population living at that distance and the total population dose was determined by summing the product of dose times the number of people receiving that dose for the entire 22-1/2 degree sector for a distance to 50 miles from the plant.

For these short-term releases, population dose was maximized by assuming that at the time of the accident the wind was blowing from the east sector. Population for the year 2010 was used as a basis. All individual doses were determined at the minimum site boundary distance of 1200 meters.

For those accidents which result in a release over a long period of time (Category 8), credit was taken for the directional variability of the wind; i.e., over a long period of time it is not reasonable to assume that wind direction does not change. Therefore, the annual distribution of wind directions at the Kewaunee site was used and the population dose delivered in any 22-1/2 degree sector was determined by multiplying the population dose that would be delivered by an invariant wind times the frequency of observation of the wind into that sector. Population dose was then determined for all populated sectors around the Kewaunee plant.

2.8.4 Dose Calculations

For all accidents, individual and population exposures to the whole body were determined for submersion in the cloud of radioactive effluents. For those accidents where iodine was released, an individual thyroid dose to an adult at the site boundary was determined. In addition, the thyroid dose to a six month to one year old infant that would be delivered as a result of drinking milk from a cow which had been grazing at the site boundary following the accident was determined. It should be noted that it is possible to control the thyroid dose as a result of milk ingestion by stopping the consumption of contaminated milk if necessary.

2.8.4.1 Dose Results

The doses delivered as a result of the various categories of accidents are summarized in Table 2.8-2.

TABLE 2.8-2*

SUMMARY OF DOSES AND ENVIRONMENTAL EFFECT

Class	Representative Event	(mrem) Site Boundary Whole Body	Dose (mrem) Adult's Thyroid Via Inhalation	Dose (mrem) Child's Thyroid Via Milk	Population Dose (Man-Rem)	
2	Volume Control Tank Release	0.362	0	0	0.168	
3	Gas Decay Tank Release	1.98	0	0	0.92	
4	Fuel Defects	N.A.	N.A.	N.A.	N.A.	
5	Off-Normal Operation	0.633	1.2×10^{-2}	3.21	0.29	2
6	Refueling Accident Inside Containment	0.15	0.715	191.6	0.06	2
7	Refueling Accident Outside Containment	1.57	0.007	1.90	0.73	
8	SAR Accidents					
	a. LOCA	0.025	0.028	7.40	0.012	
	b. Steam Line Break	0.003	0.469	124	0.0014	2
	c. Steam Generator Tube Rupture	8.65	4.2×10^{-3}	1.10	4.02	
	d. Rod Ejection	1.1×10^{-4}	6.15×10^{-6}	1.63×10^{-3}	5.3×10^{-5}	2
	e. Gas Decay Tank Rupture	19.8	0	0	9.20	
	f. Volume Control Tank Rupture	3.58	0	0	1.67	

* Revised Table

2.8.5 Description of Accident Classes

Description 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. A low level of continuous leakage from components such as valve packing and stems, pump seals, flanges, etc., is also a possibility. 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 offsite effect.

A significant valve and/or pipe leak in the reactor coolant letdown line may occur during the lifetime of the plant. A representative 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. If such a leak were to occur, the Radiation Monitoring System 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.

The following assumptions are used in the evaluation of the environmental effect of the release of the volume control tank activity.

a.) The activity in the tank is based on 0.2% equivalent fuel defects.

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. Holdup in the auxiliary building is expected thus reducing even further the environmental effect of this occurrence. However, no credit is taken in this analysis. 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.

c.) Natural decay is neglected after the activity is released to the outside environment.

The 0.2% defect level is based on reactor operating experience with WPWR Zircaloy fuel.

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.

The released noble gas will be detected by the auxiliary building vent monitors 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.

The parameters used to calculate the noble gas activity in the volume control tank are given in Table 2.8-3. 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 149 curies of equivalent Xe-133.

TABLE 2.8-3

PARAMETERS FOR COMPUTING VOLUME CONTROL TANK

SPECIFIC ACTIVITY OF EQUIVALENT Xe-133

1. Core thermal power, MWt	1721.4
2. Fraction of fuel containing clad defect	0.002
3. Reactor coolant liquid volume, cu. ft.	6100
4. Reactor coolant average temperature, °F	578
5. Purification flow rate (maximum), gpm	40
6. Volume control tank volumes	
a. Vapor, cu. ft.	130
b. Liquid, cu. ft.	90

TABLE 2.8-3 (Cont.)

7. Fission product escape rate coefficients:

a. Noble gas isotopes, sec^{-1} — 6.5×10^{-8}

8. Reactor coolant system equilibrium activities

Isotope	uCi/cc
Kr-85	0.222
Kr-85m	0.292
Kr-87	0.174
Kr-88	0.570
Xe-133	34.8
Xe-133m	0.394
Xe-135	0.990

Description of Class 3 Events

Class 3 events cover equipment malfunction and human error which may result in the release of activity from the Waste Disposal 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.

The major collection point for activity outside the containment is the gaseous waste section of the Waste Disposal System. A representative example of a Class 3 event would be a malfunction or error which would allow initiation of activity release from the waste gas decay tank. This activity would leak into the auxiliary building atmosphere and pass through the auxiliary building vent to the outside atmosphere. The auxiliary building vent monitors 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.

The gas decay tanks contain the gases vented from the reactor coolant system, the volume control tank, and the liquid holdup tanks. Sufficient volume is provided in each of these tanks to store the gases evolved during a reactor shutdown.

Most of the gas received by the Waste Disposal System during normal operation is cover gas displaced from the chemical and volume control system and consists mostly of hydrogen and nitrogen. Special precautions are taken throughout the system to prevent in-leakage of oxygen-carrying gases. Out-leakage from the system is minimized by using Saunders patent diaphragm valves, bellows seals, self-contained pressure regulators and soft-seated packless valves throughout the radioactive portions of the system.

During operation, gas samples are drawn automatically from the gas decay tanks and automatically analyzed to determine their hydrogen and oxygen content. There should be no significant oxygen content in any of the tanks, and an alarm will warn the operator if any sample shows 2% or higher by volume of oxygen.

At least two valves must be manually opened to permit discharge of liquid or gaseous waste from the Waste Disposal System. One of these valves is normally locked closed. The control valve will trip closed on a high effluent radioactivity level signal. The system is controlled from a central panel in the auxiliary building. Malfunction of the system is alarmed in the auxiliary building, and annunciated in the control room.

Because of the conservative design, quality assurance, the close monitoring and sampling throughout the system, and the fact that the system components are not subjected to any high pressure or stresses, an accidental release of waste gases is highly unlikely.

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 equilibrium reactor coolant system activities.

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.

The auxiliary plant vent monitors 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.

The projected noble gas activity released to the environment is given in Table 2.8-4.

TABLE 2.8-4

NOBLE GAS ACTIVITY RELEASE

Isotope	Activity (Curies)
Xe-133	600.0
Xe-133m	6.8
Xe-135	17.0
Kr-85m	5.05
Kr-85	3.82
Kr-87	3.00
Kr-88	8.92

Description of Class 4 Events

This class is defined 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 defect level averaged over the life of the plant will be much less than the design value as is shown by 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 a pressurized water reactor. Nevertheless, this occurrence may result in activity levels which could affect the consequences in other accident classes which are covered in other appropriate sections of this report. Operational transients for the plant such as turbine trip, load changes, rod withdrawals and any other conceivable transient within accident conditions covered in other classes are not expected to increase the defect level.

Description 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. Radioactivity releases resulting from the events in this class require a concurrent occurrence of two independent events of significant fuel defects and substantial steam generator tube leakage. Since the simultaneous occurrence of these two independent events is remote, significant radioactivity release to the environment is unlikely. However, if the events should occur simultaneously, these concurrent faults would be evaluated continuously in terms of plant secondary system activity technical specification limits and corrective steps taken before any limit is approached.

In the unlikely event of significant transfer of radioactivity to the secondary system, the system would contain the fission products and radioactive corrosion products. The degree of fission and corrosion product transport into the second 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 condenser of gas effluent is monitored with a radiation monitor, it would alarm upon steam generator tube leakage and the resultant radioactivity releases. The blowdown is terminated upon receipt of a high radiation signal from the steam generator liquid sample monitor which may indicate primary-to-secondary leakage. The operator must evaluate secondary system activity in terms of plant technical specification limits. If the primary-to-secondary leak rate and the resultant releases are insignificant, the operator may continue to operate the plant until a convenient time is available to shutdown and repair the leaking steam generator.

An analysis has been performed of possible releases or radioactivity from the secondary system in the event of fuel defects with concurrent steam generator tube leakage. The analysis is based on the following assumptions:

1. 0.2% defective fuel

2. The primary-to-secondary leak rate is 1 gpm

3. No steam generator blowdown during off-normal operation and the condenser off gas discharge is the only release.

4. The period of off-normal operation is 1 day at full power.

5. Secondary system decontamination factors:

Steam generator water to steam

$$DF = 10 \frac{\text{uc/gm SG water}}{\text{uc/gm Steam}} \quad \text{(all halogens)}$$

$$DF = 1 \frac{\text{uc/gm SG water}}{\text{uc/gm Steam}} \quad \text{(all noble gases)}$$

Steam to condenser off-gas

$$DF = 10^4 \frac{\text{uc/gm Steam}}{\text{uc/cc Air}} \quad \text{(all halogens)}$$

$$DF = 1 \frac{\text{uc/gm Steam}}{\text{uc/cc Air}} \quad \text{(all noble gases)}$$

6. No noble gas accumulated in the steam generator water since these are continuously released from the condenser air ejector.

7. Air flow rate through air ejector is 15 scfm.

The first assumption is based on PWR operating experience. 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 one-day off-normal operation therefore will not result in blowdown release. The one-day off-normal operation at full power of the fourth assumption is the expected off-normal operational time. The operator can shut the plant down sooner if the releases are excessive. Assumption 5 is based on Reference 57.

The condenser off-gas flow rate of 15 scfm is the system maximum flow rate which is used for conservatism.

Description of Class 6 Events

Accidents which fall into Class 6 are related to refueling accidents inside the reactor containment and include fuel element mishandling and mechanical malfunctions or elements stuck in the transfer tube.

The only event in this accident class which may possibly 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 moved over any fuel elements being transferred or stored. 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.

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 only a small fraction will be released to the containment
atmosphere. For the first two (2) minutes following the accident, activity 2
is drawn through the containment purge line to the environment. After two (2) 2
minutes the purge line is isolated 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.

The possibility of the postulated 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.

Refueling operation experience that has been obtained with Westinghouse reactors has verified that no fuel cladding integrity failures have occured during any fuel handling operations involving over 50 reactor years of WPWR operating experience in which more than 2200 fuel assemblies have been loaded or unloaded.

The following assumptions are postulated for a calculation of the fuel handling accident:

a) The accident occurs at 100 hours 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 (14 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 (1% iodine).

e) The fuel pellet-cladding gap inventory of fission products in these rods will be released to the spent fuel pit water at the time of the accident.

f) The spent fuel pit 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 atmosphere above the water surface.

h) The purge line on the containment is isolated within two (2) minutes after the accident. The flow rate through this purge line is 33,000 cfm. 2

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 two minutes. 2

The above assumptions may be justified as follows:

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 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 rods in the dropped assembly. The rupture of the equivalent of one row of fuel rods is a conservative upper limit.

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 pool are released to the atmosphere atop the pool.

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. It is conservatively estimated that the purge line will be isolated within 2 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 will occur due to the accident, the leak rate from the containment is expected to be near zero.

Description of Class 7 Events

Accidents which fall into 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 may possibly 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 heavy objects can be moved over any spent fuel elements being transferred or stored. The shielding and shipping casks are designed to be dropped with no subsequent damage to the cask or the assembly. 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 have decayed to a negligible level.

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 on a small fraction will be released to the spent fuel area of building. The activity is then exhausted to the environment via the auxiliary building vent.

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. 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:

1) Fuel at rest is positioned by positive restraints in an eversafe, always subcritical, geometrical array, with no credit for boric acid in the water.
2) Fuel can be manipulated only one assembly at a time.
3) Violation of procedures by placing one fuel assembly in with any group of assemblies in racks will not result in criticality.

The assumptions a) through g) for Class 6 accidents are also postulated for calculation of the fuel handling accident outside the containment. The fraction of fission products released in gas is passed through HEPA and charcoal filters with 99.9% efficiency.

Description 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 safeguard features. For the purposes of this environmental report, the accidents are evaluated on a realistic basis, i.e., the engineeered safeguards would be available and would either prevent the progression of the accident or mitigate the consequences.

Description of Class 8 Event - Loss of Coolant

A LOCA is defined as the loss of primary system coolant due to the 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 can 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 beyond the capability 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:

a) 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.

b) 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 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 is transferred to the RCS fluid and then to the secondary system. The ECC signal terminates normal feedwater flow to the steam generators by closing the main feedwater line isolation valves and initiates auxiliary feedwater flow by starting the motor driven auxiliary feedwater pumps. If off-site power is available, steam may 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, some cladding failures may be expected 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 plateout effects 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 the 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 potential releases.

The following assumptions were used to evaluate this accident.

a) All the activity in the fuel pellet-clad (1% of core halogen and 0.8% of core noble gases) gap would be released.

b) Fuel clad perforation ranges from zero for small breaks to a maximum of 60%. The fuel rods represented in this 60%, however, generate 80% of the core power, so that 80% 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 1.53 hr^{-1} for elemental iodine.

e) The containment leak rate is 0.2% per day for the first 24 hours and 0.1% for the next 30 days.

f) The shield building annulus volume participation fraction is 0.90.

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 a steam line or due to a valve malfunction. The steam release results in an initial increase in steam flow which decreases during the accident as the steam pressure falls.

The nozzles are located in the steam lines inside the containment and to serve to limit the rate of release of steam through a break outside the containment.

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 condenser off gas.

The analysis for this accident is based on the following assumptions:

a) An equilibrium radioactivity in the secondary system of 0.2% equivalent fuel defects with a 20 gpd steam generator leakage occuring for 1 month prior to the accident.

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.

f) Ten percent of the total iodine inventory in the steam generator is available for release through the break.

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 off gas. The sequence of events following a tube rupture is as follows:

a) The operator will be notified within seconds by the condenser off gas vent monitor of a radioactivity release.

b) 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:

a) Automatic boration by high head safety injection pumps.

b) Restoration of discernible fluid level in the pressurizer by safety injection pump operation.

c) 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 over-pressure; (3) to minimize steam discharge from the affected steam generator.

Isolation of the affected steam generator will be achieved by:

a) Identifying the affected steam generator by observation of rising liquid level and use of the liquid sample activity monitor.

b) Closing the steam line isolation valve connected to the affected steam generator.

c) Securing the auxiliary feedwater flow to that steam generator.

d) Blowdown from all steam generators is terminated at the start of accident.

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.

Evaluation of this accident was based on the following assumptions:

a) Activity in primary coolant based on 0.2% equivalent fuel defects. The accident will cause no additional fuel damage.

b) Initial activity in the secondary system is based on a 20 gpd steam generator leak rate.

c) A total of 126,000 pounds of primary coolant are carried over to the secondary side.

d) An iodine decontamination factor of 10 $\frac{\text{uc/gm water}}{\text{uc/gm steam}}$ in the steam generator.

e) The faulty steam generator is isolated within 30 minutes.

f) An iodine decontamination factor of 10^4 $\frac{\text{uc/gm steam}}{\text{uc/cc air}}$ in the condenser.

g) Blowdown from all steam generators is terminated at the beginning of the accident.

Description of Class 8 Event - Rod Ejection Accident

A highly unlikely rupture of the 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 nuclear plant with chemical shim control is such that the severity of an ejection accident is inherently limited. The reactor is operated with the RCC assemblies inserted only far enough to permit load follow and reactivity changes caused by core depletion; Xenon transients are compensated by boron changes. Proper positioning of the rods is monitored by a control room alarm system. There are low and low-low level insertion minitors 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 temperatures for the worst ejected rod.

No clad or fuel 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. What fission products escape to the external environment do so through minute leaks in the containment structure.

Evaluation of this accident was based on the following assumptions:

a) Activity in primary coolant due to 0.2% equivalent fuel defects.

b) No additional fuel damage as a result of the accident.

c) Of the fission product activity in the primary coolant, 25% of the halogens and 100% of the noble gases are available for leakage from the containment vessel.

d) The remaining assumptions are the same as for the LOCA.

Description of Class 8 Event - Waste Gas Decay Tank Rupture 2

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, the volume control tank, and the liquid holdup tanks.

Most of the gas received by the waste disposal system during normal operation is cover gas displaced from the chemical and volume control system and consists mostly of hydrogen and nitrogen. Special precautions are taken throughout the system to prevent in-leakage of oxygen-carrying gases. Out-leakage from the system is minimized by using Saunders patent diaphragm valves, bellows seals, self-contained pressure regulators and soft-seated packless valves throughout the radioactive portions of the system.

During operation, gas samples are drawn automatically from the gas decay tanks and automatically analyzed to determine their hydrogen and oxygen content. There should be no significant oxygen content in any of the tanks, and an alarm will warn the operator if any sample shows 2% or higher by volume of oxygen.

Since components of the waste gas system are not subject to any high pressures or stresses and they are of class 1 seismic design, rupture or failure of any of the components is highly unlikely.

Because of the conservative design, extensive quality assurance, 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.

Evaluation of this accident is based on the following assumptions:

a) Operation with 0.2% equivalent fuel defects.

b) Noble gas release only.

c) The inventory of the tanks is based on the average equilibrium concentration over the life of the plant.

d) Only one of the tanks rupture.

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. It is physically located in the auxiliary building. Any leakage is collected by the building sump and pumped to the liquid waste system. The sump and basement volume are sufficient to hold the entire tank contents without overflowing to areas outside the building. No similar tanks have failed in W PWR operating experience.

Evaluation of this accident is based on the following assumptions:

a) Plant operation with 0.2% equivalent fuel defects.

b) Noble gas release only.

c) Tank inventory based on equilibrium values.

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 approach described for accidents and population data presented in Section 2.8.3. These doses are presented in Table 2.8-2.

Based on the evaluations of the various postulated accidents and occurrences and the resultant radiological results as tabulated on Table 2.8-1, it is concluded that the environmental impact from these accidents and occurrences is insignificant and inconsequential to the safe operation of this plant. In fact, the maximum man-rem realistically established as a result of any accident is well within the incremental exposure to the general public corresponding to variations in natural background.

2.9 FUEL TRANSPORTATION

2.9.1 Transportation of Nuclear Fuel to the Kewaunee Nuclear Plant

The first fuel load, composed of 121 fuel elements, will be transported from the Columbia, South Caroline, Westinghouse Nuclear Fuel Division Plant to the Kewaunee Nuclear Plant.

The elements will be transported by conventional truck, tractor-trailer, and will be shipped nominally between May 4, 1972 and June 12, 1972. Each weekly shipment will contain 28 or less elements.

The fuel will be shipped on a 24 hour basis with the elements being contained two per container, in fuel shipping containers designed to protect the fuel element from damage.

The description of the shipping container is as follows: Each shipping container contains one or two fuel elements with or without inserts.* The fuel elements are enclosed in a polyethylene wrapper and covered with reusable steel-foil reinforced corrugated paper board protective jackets. Each fuel element weighs approximately 1,260 pounds and each control rod 150 pounds. Of the 1,260 pounds, approximately 945 pounds are UO_2.

(*Inserts are one of the following: Rod Cluster Control Assemblies, Thimble Plug End Assemblies, and/or Burnable Poison Assemblies.)

The shipping container is a reusable metal container and is designed for leak tightness, humidity control, and shock and vibration isolation of fuel elements to protect them against damage during normal handling and shipping for a temperature range from -40° F to $+150^{\circ}$ F. The fuel elements are supported in a rigid frame which is shock-mounted to the container. All surfaces contacting the fuel elements are lined with a protective material.

The loaded container will weigh approximately 6,400 pounds. Each container has enough structural strength to support as much as twice its own loaded weight.

The container clearance dimensions for the 160 inch container are 47 inches high by 45 inches wide by 191 inches long. Shipping containers are named according to the fuel assembly support surface length available. Thus, the 160 inch shipping container has 160 inches of fuel element supporting surfaces.

The fuel for subsequent loading of 40 or less elements with inserts, will be shipped from either the Westinghouse Nuclear Fuel Plant in Columbia, South Carolina, or other qualified fuel fabricator's plant over a three week period to the Kewaunee Nuclear Plant. The shipping will be done by conventional tractor-trailer means on a 24 hour per day basis.

2.9.2 Spent Nuclear Fuel Transportation

The movement of spent nuclear fuel elements, between the Kewaunee Nuclear Plant and the Nuclear Fuel Services Reprocessing Plant (NFSRP) at West Valley, New York, is carried out under carefully controlled and regulated conditions. The fuel elements are carried in spent fuel shipping casks which are designed and licensed specifically for this purpose. A variety of transportation modes may be selected, i.e. truck, rail, or barge, however, trucking is most probable. In any case, all the applicable State and/or Federal regulations will be met. Specifically, the spent fuel casks and selected mode must meet all appropriate Federal, State, and local regulations with the major controlling criteria being provided by Title 10, Code of Federal Regulations, Chapter 1, Part 70 - Special Nuclear Material and Part 71 - Packaging of Radioactive Material for Transport, and Title 49, Code of Federal Regulations, Parts 1 - 199 of the Department of Transportation (DOT), Hazardous Material Regulations.

The above regulations define the overall design and operational criteria, both normal and accident, that must be met by any type of spent fuel shipping cask. The shipping casks used for shipping spent fuel from the Kewaunee Nuclear Plant to the NFSRP are designed under these regulations.

The casks are designed to carry from one to four PWR fuel elements. The cask is a circular cylinder approximately 17 feet in length.

and about six feet in diameter. Lead or depleted uranium gamma shielding is used in conjunction with a hydrogeneous neutron shield to provide radiation protection. Normal shipment of the spent fuel element from the reactor to the reprocessing plant will be without any detectable release of radioactive material. The radiation intensity emerging from the cask will be well within the safe limits established by the Federal standards. In the unlikely event of a severe shipping accident, in which the maximum hypothetical accident conditions are assumed to exist, the environmental release of radioactivity would at most be limited to inert gas and low activity coolant which would not pose a severe radiation hazard. The allowable increase in external radiation levels, because of possible shielding reduction, would similarly not allow an unreasonable hazard to exist. Therefore, the resulting environmental impact of transporting spent fuel elements to the reprocessing site is considered insignificant.

The shipment of spent fuel from the reactor site would normally be initiated 100 - 200 days after it is discharged from the reactor installation subject to both the reprocessing plants' detailed schedule and possible local weather or driving restrictions. The number of annual trips required from each reactor would be an inverse function of the casks' element capacity and would vary from 10 - 40 for a discharge of 40 elements and for casks with a capacity of from 4 to 1 PWR assemblies, respectively. It is anticipated that the cask would be loaded and shipped when convenient on a 24 hour/day, 7 day/week basis.

High standards are used in selecting drivers for transporting spent nuclear fuel to achieve the desired benefits of a safe, overall transport. Additionally, these high standards are used because of the inherent value of a shipping cask ($100,000 - $750,000) and its contents ($50,000 - $200,000). All drivers must meet the normal ICC requirements (medical, sight, etc.) plus specific restrictions of individual companies such as reasonably accident free records, no felony charges, etc. The drivers are provided instructions as to the normal operating condition of the shipping cask and the type of periodic inspections to make while in transit. Included is a simple radiation monitoring instrument which is normally supplied to the driver so that they can monitor radiation levels. Training and instructions are also provided to each driver to assure familiarity with emergencies or accident procedures to be followed. A detailed listing of appropriate emergency contracts, i.e., USAEC Radiological Emergency Teams, local and state police, etc., is also provided for each planned routing.

Routing from the Kewaunee Nuclear Plant to the NFSRP at West Valley, New York, will be as follows:

1. Local roads from the reactor plant to Route 42.
2. Route 42 to Route 141 at Manitowoc, Wisconsin
3. Route 141 to I-94 at Milwaukee, Wisconsin
4. I-94 to I-294 around Chicago to I-80
5. I-80 across Indiana and around Cleveland to I-271
6. I-271 to I-90 across Pennsylvania to Route 20

7. Route 20 into New York to Route 39 to Route 219

8. Route 219 to the county access road for the West Valley reprocessing plant site

Many alternate routes appear feasible with all being subject to change due to bridge restrictions, weather conditions, etc. If the spent fuel is shipped three elements or more at a time, the shipping will be by overweight shipping. Many states and local regions require overweight permits for such shipping and these permits are routinely issued for the weight ranges contemplated. The shipping of fuel by overweight trucks contributes to less than 2 percent of all overweight shipping. Other permits may be acquired in unique situations and shipping will be done in accordance with the requirements.

In summary, the environmental impact of the transportation of fuel to and from the Kewaunee Nuclear Plant will be insignificant.

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55. Wright, J., August 13, 1971. Testimony Before the Public Hearing to Consider Revising Thermal Standards for Lake Michigan to Conform with Recommendations of the Lake Michigan Enforcement Conference. Director, Environmental Systems Department, Westinghouse Electric Corporation.

56. National Register of Historic Places. 1969. U. S. Department of Interior National Parks Section.

57. Styrikovich, M.A., Martynova, O.I., Katkovska, K., Ya., Dubrovskii, I. Ya., and Smrinova, I.N. July 1964. "Transfer of Iodine from Aqueous Solutions to Saturated Vapor." Translated from Atemnaya Energiya, Vol. 17, No. 1, P. 45-49.

APPENDIX A

QUALIFICATIONS OF PRINCIPAL INVESTIGATORS

JOHN M. HECKARD

Geologist

Since 1960 Mr. Heckard has obtained broad experience in the following: 1) ground water development; 2) underground gas storage; 3) deep well disposal; and 4) environmental geology.

Mr. Heckard worked for six years for the State of Indiana, where he became head of the Ground Water Section. He has extensive knowledge of the procedures used in exploring for and developing ground water resources. He has participated in ground water projects in 15 states and several overseas locations. In addition, he has experience in the regulatory and administrative procedures of governmental agencies.

In addition to his experience with Earth Science Laboratories, Mr. Heckard was employed as a principal geologist by a firm specializing in the development of underground storage. He has participated in projects in the midwest and southeast.

Mr. Heckard has worked on deep well disposal projects in five states. In addition, while with the State of Indiana, he was responsible for inspecting and approving proposed wells.

Mr. Heckard has evaluated hydrologic and geologic conditions for nuclear power plants in 11 states. He has conducted several ground water contamination studies and has evaluated several dam sites.

WILLIAM M. GREENSLADE

Environmental Geology, Geohydrology

Mr. Greenslade is a project hydrogeologist with Dames & Moore. He received his B.S. in geological engineering in 1965 and his M.S. in hydrology in 1967, both from the MacKay School of Mines at the University of Nevada.

Mr. Greenslade's graduate work was supported by a research assistantship from the Desert Research Institute, Center for Water Resources Research. His thesis was an economic study of the factors involved in a comparison of the cost of groundwater versus surface water as a municipal supply.

Since joining Dames & Moore in 1967, Mr. Greenslade has been engaged in a variety of investigations. He has participated in several comprehensive geologic and hydrologic investigations of proposed nuclear power plant sites. He has also been engaged in the geologic exploration for construction aggregates. Mr. Greenslade has been involved in several detailed site selection surveys. He has also been engaged in numerous groundwater investigations and is familiar with both analog and digital modeling techniques for aquifer simulation. In 1969, Mr. Greenslade spent three months in Spain directing a groundwater supply investigation. His experience in groundwater development ranges over much of the United States and he is familiar with a variety of geohydrologic conditions.

Mr. Greenslade has recently been given responsibility for coordination of Dames & Moore's environmental studies. He has been a principal contributor to the environmental impact reports prepared by the firm. He has directed multidiscipline projects involving such specialists as biologists, agronomists, hydrologists, radioecologists, and engineers. He has been responsible for preparing proposals, schedules, budgets, technical reviews and client contacts.

Mr. Greenslade is a member of the Association of Engineering Geologists, American Water Resources Association, National Water Well Association, and Georgia Geological Society.

DONALD E. NELSON

Civil Engineer

Mr. Nelson is a civil engineer registered in several states and in British Columbia. He has been continuously associated with Dames & Moore since 1959, and became a principal in 1968. Mr. Nelson's primary fields of activity have been in foundation engineering, route studies, deep excavations, and environmental studies.

Mr. Nelson has served as a foundation consultant to numerous major industrial and commercial firms and to land developers. He has supervised site investigations for some of the Boeing Company's largest manufacturing facilities, a major grain terminal in Seattle's harbor, and several industrial parks built on marginal land.

Geologic evaluation of a 12-mile section of interstate highway, electrical transmission line route and foundation studies, gas pipeline alignment selection (including major river crossings) represent Mr. Nelson's experience in this field. Numerous smaller water and sewer projects for many municipalities are included.

Mr. Nelson has served as a consultant to the City of Seattle Engineering Department on problems related to deep excavations in urban areas and has supervised the investigation for and design of shoring for private developers of high-rise buildings in Seattle.

Environmental studies for a variety of projects have been coordinated by Mr. Nelson. He has developed particular interest in environmental problems associated with solid waste disposal and has particular experience with modern sanitary land fill methods.

GERALD A. PLACE

Agronomy

Land Use and Development

Doctor Place is a senior soils scientist on the environmental staff of Dames & Moore. He received his B.S. and M.S. degrees in soil science from the University of Arkansas in 1958 and 1960, respectively. In 1963, he received his Ph.D. from Purdue University, where his major field of study was soil chemistry and plant nutrition. He has studied extensively in physical and inorganic chemistry, biochemistry and plant physiology. He joined the University of Arkansas Agronomy Department in 1962 and attained the academic rank of associate professor. He was employed in this position until he accepted employment with Dames & Moore.

He has had ten years of professional experience as a soil scientist and agricultural specialist at Purdue University and the University of Arkansas that has included teaching, research and consultation with commercial growers and personnel of related industries. He has taught courses in introductory soil science and physical chemistry of soils. In his last year on the University of Arkansas staff, time was devoted to developing a course for an environmental science currriculum entitled "Soils and Man's Environment."

While on the staff of the University of Arkansas, Dr. Place was active in investigating certain aspects of environmental quality in agricultural ecosystems. He was the director of soils research projects on terrestrial ecology, land utilization and water use. Investigations included pollution problems of irrigation return flow; relationships of soil chemical, physical and mineralogical properties to engineering properties; reclamation of alkaline, saline and sodic soils; and chemical conversions in submerged soils. Facets of these studies were directed toward evaluating the effects of specific practices and substances, including the effects of chemicals of agricultural and nonagricultural origi- on environmental quality, ecosystems and the quality of products from agricultural ecosystems. Consideration was also given to environmental quality aspects of land use and development.

In addition to the above mentioned areas of responsibility, Dr. Place has experience in the use of ionizing radiation. Not only has he received formal instruction in bionucleonics, but he has utilized ionizing radiation in his M.S. and Ph.D. research program and at various times during his professional research activities.

Doctor Place has authored and co-authored over twenty journal articles and technical papers. He is an active member of several professional societies, including the American Society of Agronomy, Soil Science Society of America, and the International Soil Science Society.

W. RAY SEIPLE

Engineering Geology

Ray Seiple is a project geologist with Dames & Moore. Since joining the Los Angeles office of the firm in 1965 he has worked on several temporary assignments in Puerto Rico and for the New York, Atlanta, and Houston offices of Dames & Moore.

Mr. Seiple graduated from the University of Southern California with a B.S. in geology in 1960. He received his M.S. in engineering geology from the same university in 1968.

Prior to employment with Dames & Moore, Mr. Seiple was employed by Firestone Tire & Rubber Co. as a project engineer. While at Firestone Tire & Rubber Co., Mr. Seiple was responsible for design and development of fuel containers for the aerospace and defense product industry. He also was involved with the development and construction of inflatable rubber dams, reservoir linings, and dike-contained rubber storage tanks.

Since joining Dames & Moore, Mr. Seiple has been responsible for site evaluation studies for several dams, nuclear power plants, subdivisions, refineries and industrial sites. During these studies he performed geologic mapping, supervision of exploratory borings, soil and rock sample collections, laboratory testing, engineering analysis and report preparation.

Mr. Seiple headed up the field exploration team for one of the world's largest refinery complexes in Puerto Rico. He also served as the resident engineering geologist for the Walnut Canyon Dam in Orange County. The Walnut Canyon Dam is a 200-foot high earth fill dam. As the resident engineering geologist, Mr. Seiple was responsible for geologic mapping during construction, supervision of placement of all compacted fill, testing of filter and drain material, recommending and coordinating design changes with the State Division of Dam Safety, Boyle Engineering and the client, the City of Anaheim. After completion of construction, Mr. Seiple prepared the draft and cosigned the final report.

Mr. Seiple was also associated with construction supervision and geologic evaluation of features at the El Toro Dam in Orange County.

Mr. Seiple has served as project engineering geologist for the Buena Vista Aquatic Recreation Area Dam near Bakersfield, California, for the Pole Canyon Dam near Fillmore, California, and for the Whitewater Flood Control Dam near Palm Springs, California. The Buena Vista Aquatic Recreation Area Dam is presently in design stage. The Pole Canyon Dam was never constructed because our investigations indicated economically untreatable abutment and foundation problems. The Whitewater Flood Control Dam is still being investigated.

Not only has Mr. Seiple had dam site evaluation and construction supervision experience, but he has been involved with post dam construction problems. Mr. Seiple has performed post construction evaluations relative to seepage and potential slide development on the Olive Hills Dam and Tri-Cities Dam in Orange County, California. In addition, Mr. Seiple assisted in performing an evaluation of Lake Wohlford Dam in San Diego County under the Federal Power Commission Order No. 315. After the Baldwin Hill Dam failure, Mr. Seiple was involved with the investigation of the possible failure causes. Mr. Seiple also headed up the field investigation of determining the feasibility of raising the dam crest or other dam modifications, to increase the water storage capability of Puddingstone Dam near San Dimas, California.

Mr. Seiple is a registered geologist and a certified engineering geologist in the State of California, and he is also a member of Sigma Gamma Epsilon and the Association of Engineering Geologists.

ROBERT C. PENDLETON

Radiation Ecology

Doctor Pendleton is a consultant retained by Eberline Instrument Corporation to provide advice on Radiation Ecology. He received the B.S. Degree in Botany in 1946, M.S. in Plant Ecology in 1947, and Ph.D. in Radiation Ecology in 1952. All three degrees were conferred by the University of Utah. He was an Instructor of Biology at Weber College from 1947-50, Associate Research Professor at the University of Utah from 1950 to 1960, and Director, Department of Radiological Health at the University of Utah from 1960 to the present. He presently holds the academic rank of Associate Professor and teaches courses in Radiation Biology and Radiation Ecology. His research program has been concentrated on evaluating the environmental effects on the content of Cs-137 and Sr-90 in milk and comparing the levels of radioactive air pollutants from industry and fallout.

Doctor Pendleton has been active in advising a number of graduate students in their M.S. and Ph.D. programs in Radiation Ecology. He belongs to 12 professional societies and has published 39 articles in professional journals. Doctor Pendleton has also been actively participating on committees on the University of Utah campus, within the state of Utah, and on the national level.

ERIC L. GEIGER

Manager, Department of Nuclear Sciences

Mr. Geiger was born in 1930 in Lucedale, Mississippi. In 1952 he received a B.S. degree in Chemistry from the University of Southern Mississippi. He accepted an AEC Fellowship in Radiological Physics and transferred to Vanderbilt University for graduate study under this fellowship program. After the successful completion of this work, he received three months on-the-job training at the Oak Ridge National Laboratory.

In 1953 Mr. Geiger joined the Health Physics Section at the AEC-DuPont Savannah River Plant where he helped develop the environmental monitoring and bioassay program for that facility. In 1958 he went to the Nevada Test Site where he set up an on-site laboratory to support the comprehensive health and safety program there. In 1960 he transferred to Santa Fe to develop a service program for EIC, including analytical chemistry, environmental surveillance, and dosimetry. He contributed greatly to the groundwork necessary for EIC to be selected by the AEC for the radiological services contract in 1967. From 1967 to 1970 he helped develop the radiological control, radiation monitoring, instrument maintenance, decontamination, and other radiological services provided at customer's sites.

Mr. Geiger is a member of the American Chemical Society and the Health Physics Society. He is certified by the American Board of Health Physics.

ROBERT C. ERICKSON

Aquatic Ecologist

Doctor Erickson is a staff ecologist. He received his B.S. degree in Zoology from San Jose State College and his M.S. degree in fisheries from the College of Fisheries, University of Washington. He was awarded a Ph.C. and a Ph.D., also from the College of Fisheries. Research at the university centered around the effects of radioactive elements on the behavior, reproduction and growth of fish.

Areas of primary interest include aquatic ecology, fish behavior, sport fisheries and an evaluation of thermal and radioactive effluents on aquatic life.

His experience includes study in Alaska where he was responsible for collecting survival and growth data on sockeye salmon. Field surveys were an integral part of the investigation.

Doctor Erickson has participated in several studies related to the effects of radionuclides on aquatic life. His M.S. thesis was related to the effects of radioactive zinc on the swimming behavior of rainbow trout. This was conducted as an AEC Fellow at the Hanford Atomic plant site in Washington. His Ph.D. thesis described the effects of tritiated water on the growth, sexual behavior and mortality of the guppy. For three years he was a research assistant at the Laboratory of Radiation Ecology, University of Washington, where he collected and analyzed data from organisms along the Washington coast exposed to radioactive contamination from the Columbia River. In 1967, he was a member of the Bikini Resurvey Party, with responsibility for identifying the kinds and amounts of radionuclides present in plants and animals in the Bikini Test Site area.

Doctor Erickson has participated in multi-disciplined environmental investigations designed to evaluate the impact of a facility (such as a nuclear power plant or pipeline) on the aquatic system.

JOHN W. HATHORN III

Meteorology

Mr. Hathorn is a project meteorologist in the Meteorology Division of Dames & Moore. He joined the firm in October, 1968. He received his B.S. in meteorology from Florida State University in Tallahassee, Florida in 1963. During the summers he worked for the U.S. Weather Bureau in Port Arthur, Texas and Memphis, Tennessee, where he engaged in aviation and agricultural forecasting. He returned to Florida State to work on his M.S. which was completed in 1970. While in graduate school he held assistantships in the Upper Atmospheric and Hydrodynamic Laboratories.

In 1965 Mr. Hathorn became a duty forecaster at the Weather Bureau in Huntsville, Alabama, and then transferred to The Boeing Company as a research meteorologist in the Apollo/Saturn program. While working for Boeing he developed data reduction techniques to provide more accurate methods of measuring upper atmospheric winds. This endeavor required the use of digital filtering and data processing techniques that are just beginning to be used in the applied earth sciences. In addition he performed experimental and theoretical studies to determine the influence a tower has upon wind sensors that it supports.

Since joining Dames & Moore, he has participated on the meteorological portions of the Safety Analysis Report for a nuclear power plant for the Duke Power Company, Iowa Electric Light and Power Company and Pennsylvania Power and Light Company. He directed the meteorological work on the Preliminary Safety Analysis Reports (PSAR) for nuclear power plants for the Detroit Edison Company, Public Services Company of New Hampshire, Cincinnati Gas and Electric Company, and South Carolina Electric and Gas Company. Included within the scope of these Preliminary Safety Analysis Reports were determinations of the climatological conditions of the site and surrounding areas, including evaluations of the climatic influences upon proposed facilities and evaluations of the climatic diffusive capability of the atmosphere.

Mr. Hathorn has also developed techniques for evaluating meteorologic influences upon the design parameters of cooling systems (cooling towers and ponds) and the subsequent impact of the operation of the cooling system on the atmospheric environment. The various meteorologic influences affect the design capacity of a cooling system, its location and orientation with respect to structures at the facility, and its water consumption. The investigative techniques which he has developed for studying the impact of a cooling system include the evaluation of the fogging and icing frequencies of the plumes from cooling towers, the change in fog frequency in the vicinity of cooling ponds, and the alteration of the stability and diffusivity of the atmosphere in the vicinity of cooling ponds.

Mr. Hathorn has been project manager of the environmental studies that Dames & Moore has been conducting for The Salt River Project's large Navajo Generating Station near Page, Arizona. Initially the studies were to determine the amount of water required to cool the plant but were later expanded to include diffusion studies and a determination of the height of the plant's vent stacks. For this same plant he managed an air quality sampling study which required the sampling of chemical and particulate contaminants in the atmosphere on an hourly, daily, and monthly basis from both ground-based an airborne samplers.

Since the institution of a federal regulation requiring a report assessing the environmental impact of a nuclear power plant in operation, Mr. Hathorn has been a member of a team of environmentalists working to compile these reports. As the requirements for these environmental reports are still in the developmental stages at the government agencies, his association with this team has put him in a position of performing innovative work. He is a professional member of the American Meteorological Society and the Air Pollution Control Association.

HUBERT B. VISSCHER

Meteorology

Mr. Visscher is an associate of Dames & Moore and serves with the firm's Meteorology Division which he joined in 1970. He received his B.S. degree in economics from Northwestern University in 1936 but, as an officer in the U.S. Air Force during World War II, he entered the profession of meteorology.

He graduated with honors from the University of Chicago's Institute of Meteorology in 1943 and thereafter was assigned forecasting and weather service management duties in the United States, China, India, and Burma. After the war Mr. Visscher joined Eastern Air Lines as a terminal and route weather forecaster. In 1950 Mr. Visscher was transferred to the Operations and Research Section where he became deeply involved in meteorological research. He was named manager of Eastern's Upper Level Wind and Clear Air Turbulence Department in 1958.

Mr. Visscher joined Lockheed Aircraft Corporation in 1962 as a scientist and operations research specialist in meteorology. His investigations included studies of the turbulence conditions in thunderstorm and of other weather conditions affecting aircraft design requirements. In 1967 he was promoted to manager of the Military Market Research Department.

As a member of Dames & Moore's Meteorology Division, he has directed the meteorological analysis for a large new nuclear power plant in the Eastern U.S., and has been instrumental in expanding the scope of the firm's existing meteorological and climatological services.

Mr. Visscher is the author of a number of studies and papers in meteorology, operations research, and market research. He is a professional member of the American Meteorological Society.

GORDON REIL

Nuclear Engineering

Doctor Gordon Reil, a nuclear engineer, joined Southern Nuclear Engineer, Inc. in January 1970. His responsibility has been to advise users of nuclear power on the measurement and control of radioactivity releases.

Doctor Reil graduated with honors from the University of Florida in 1956 with a Bachelor of Science Degree in Chemical Engineering. He received the M.S. and Ph.D. in 1961 and 1967, respectively, from the University of Maryland.

Prior to employment with Southern Nuclear Engineering, Inc., he was employed from 1956 until 1970 by the Naval Ordinance Laboratory, White Oak, Maryland. During that time he served in the capacities of chemical engineer, physicist, and research physicist. He was responsible for conducting experimentation and theoretical studies on advanced radiation detection methods and detector applications, feasibility studies of nuclear power (reactors and isotopes) for naval applications, studies of the effects of nuclear weapons and fallout, preparation of magnetic materials and explosives.

Doctor Reil is a licensed Professional Engineer in the State of Maryland and is a member of the American Nuclear Society, Health Physics

Society, Instrument Society of America, and National Society of Professional Engineers. He has received 13 awards from the U.S. Naval Ordinance Laboratory, including the Meritorious Civilian Service Award in December, 1968. He has received one patent and applied for four others. Doctor Reil has published 23 articles concerning Environmental Radiation, Detectors, and Measurements.

FREDERICK B. LOBBIN

Nuclear Engineering

Mr. Lobbin received his B.S. degree in Nuclear Science from the New York State Maritime College and his M.S. degree in Nuclear Engineering from The Catholic University of America.

Mr. Lobbin joined Southern Nuclear Engineering, Inc., in March of 1971 and has been primarily associated with the Kewaunee Nuclear Power Plant project since that time. This association has included preparation of preoperational test procedures for various plant systems in addition to general licensing assistance. At Southern Nuclear Engineering, Mr. Lobbin is a Staff Engineer, and as such provides a wide variety of consulting services for nuclear power plant projects.

Prior to joining Southern Nuclear Engineering, Mr. Lobbin was employed by Hittman Nuclear & Development Corporation as a thermal-hydraulic analyst. During part of that time he was a project engineer responsible for the safety analysis of a small, multipurpose pressurized water reactor (SURFSIDE project) which was being planned for the New York State Atomic and Spare Development Authority. Additional responsibilities included Technical Specification revisions for the U.S. Savannah and the North Carolina State University PULSTAR research reactor. Mr. Lobbin also provided fuel fabrication quality assurance services for the PULSTAR reactor.

Mr. Lobbin is a member of the American Nuclear Society and the Society of the Sigma Xi. He also holds a U. S. Coast Guard license as a Third Assistant Engineer in the Merchant Marine.

APPENDIX B

MAJOR PERMITS AND APPROVALS

UNITED STATES
ATOMIC ENERGY COMMISSION
WASHINGTON, D.C. 20545

AUG 6 1968

Docket No. 50-305

Wisconsin Public Service
Corporation
P.O. Box 700
Green Bay, Wisconsin 54305

Attention: Mr. G. F. Hrubesky
Vice President

Gentlemen:

Provisional Construction Permit No. CPPR-50 is enclosed, together with a copy of a related notice which has been forwarded to the Office of the Federal Register for filing and publication.

The construction permit authorizes the Wisconsin Public Service Corporation, Wisconsin Power and Light Company, and Madison Gas and Electric Company to construct a pressurized water nuclear reactor designated as the Kewaunee Nuclear Power Plant on the licensees' site in the Town of Carlton, Kewaunee County, Wisconsin.

The construction permit has been issued pursuant to the Initial Decision of the Atomic Safety and Licensing Board. A copy of the decision has already been sent to you.

Sincerely,

Peter A. Morris

Peter A. Morris, Director
Division of Reactor Licensing

Enclosures:
As stated above

UNITED STATES ATOMIC ENERGY COMMISSION

DOCKET NO. 50-305

WISCONSIN PUBLIC SERVICE CORPORATION

WISCONSIN POWER AND LIGHT COMPANY

AND MADISON GAS AND ELECTRIC COMPANY

NOTICE OF ISSUANCE OF PROVISIONAL CONSTRUCTION PERMIT

Notice is hereby given that, pursuant to the Initial Decision of the Atomic Safety and Licensing Board, dated August 6, 1968, the Director of the Division of Reactor Licensing has issued Provisional Construction Permit No. CPPR-50 to Wisconsin Public Service Corporation, Wisconsin Power and Light Company, and Madison Gas and Electric Company for the construction of a pressurized water nuclear reactor, designated as the Kewaunee Nuclear Power Plant to be located on the licensees' site in the Town of Carlton, Kewaunee County, Wisconsin.

A copy of the Initial Decision is on file in the Commission's Public Document Room, 1717 H Street, N.W., Washington, D.C.

FOR THE ATOMIC ENERGY COMMISSION

Peter A. Morris

Peter A. Morris, Director
Division of Reactor Licensing

Dated at Bethesda, Maryland
this 6th day of August 1968.

UNITED STATES
ATOMIC ENERGY COMMISSION
WASHINGTON, D.C. 20545

WISCONSIN PUBLIC SERVICE CORPORATION
WISCONSIN POWER AND LIGHT COMPANY
AND
MADISON GAS AND ELECTRIC COMPANY

(Kewaunee Nuclear Power Plant)

DOCKET NO. 50-305

PROVISIONAL CONSTRUCTION PERMIT

Construction Permit No. CPPR-50

1. Pursuant to § 104 b. of the Atomic Energy Act of 1954, as amended (the Act), and Title 10, Chapter 1, Code of Federal Regulations, Part 50, "Licensing of Production and Utilization Facilities," and pursuant to the order of the Atomic Safety and Licensing Board, the Atomic Energy Commission (the Commission) hereby issues a provisional construction permit to Wisconsin Public Service Corporation, Wisconsin Power and Light Company, and Madison Gas and Electric Company (the applicants), for a utilization facility (the facility), designed to operate at 1650 megawatts (thermal), described in the application and amendments thereto (the application) filed in this matter by the applicants and as more fully described in the evidence received at the public hearing upon that application. The facility, known as the Kewaunee Nuclear Power Plant will be located at the applicant's site in the Town of Carlton, Kewaunee County, Wisconsin.

2. This permit shall be deemed to contain and be subject to the conditions specified in §§ 50.54 and 50.55 of said regulations; is subject to all applicable provisions of the Act, and rules, regulations and orders of the Commission now or hereafter in effect; and is subject to the conditions specified or incorporated below:

   A. The earliest date for the completion of the facility is September 1, 1971, and the latest date for completion of the facility is March 1, 1972.

   B. The facility shall be constructed and located at the site as described in the application.

   C. This construction permit authorizes the applicants to construct the facility described in the application and the hearing record in accordance with the principal architectural and engineering criteria set forth therein.

3. This permit is provisional to the extent that a license authorizing operation of the facility will not be issued by the Commission unless (a) the applicants submit to the Commission, by amendment to the application, the complete final

safety analysis report, portions of which may be submitted and evaluated from time to time; (b) the Commission finds that the final design provides reasonable assurance that the health and safety of the public will not be endangered by the operation of the facility in accordance with procedures approved by it in connection with the issuance of said license; and (c) the applicants submit proof of financial protection and the execution of an indemnity agreement as required by § 170 of the Act.

FOR THE ATOMIC ENERGY COMMISSION

Peter A. Morris

Peter A. Morris, Director
Division of Reactor Licensing

Date of Issuance: AUG 6 1968

DEPARTMENT OF THE ARMY
CHICAGO DISTRICT. CORPS OF ENGINEERS
219 SOUTH DEARBORN STREET
CHICAGO. ILLINOIS 60604

IN REPLY REFER TO:

NCCOD-S
69-10

12 December 1968

Wisconsin Public Service
Corporation
P. O. Box 700
Green Bay, Wisconsin 54305

Gentlemen:

Referring to your written request of 17 June 1968 signed by Mr. Nels E. Knutzen, Construction Engineer, inclosed is a permit issued this date authorizing the installation of a 120-inch I. D. submarine water intake pipe and intake structure and discharge facilities (the excess excavated material approximately 6,950 cubic yards, to be deposited on shore on Wisconsin Public Service Corporation's property) in Lake Michigan at the Town of Carlton, Kewaunee County, Wisconsin.

Strict compliance with all terms of the permit is requested. If any changes in the location or plans of the work are found necessary on account of unforeseen or altered conditions, or otherwise, revised plans should be submitted promptly to the District Engineer so that they may receive the approval by law before work thereon is begun.

It is requested that the results of any ecological studies that are undertaken be furnished the Federal Water Pollution Control Administration, Great Lakes Region, 33 East Congress Parkway, Room 410, Chicago, Illinois 60605.

The work will be inspected by Mr. Robert Mundelius, Project Engineer, Department of the Army, Kewaunee Project Office, Corps of Engineers, Kewaunee, Wisconsin 54216 or his authorized representative. It is requested that the Project Engineer be notified in writing at least five days in advance of the date of commencement of the work and of its completion so that inspections may be made while the work is under way and a final inspection made before the contractor has removed his equipment.

It is requested that your project engineer or contractor, or both be furnished a copy of the permit in order that its conditions may be fully known and understood.

Sincerely yours,

NORTON E. SAXTON
Acting Chief, Operations Division

1 Incl
Permit

DEPARTMENT OF THE ARMY

NOTE.—It is to be understood that this instrument does not give any property rights either in real estate or material, or any exclusive privileges; and that it does not authorize any injury to private property or invasion of private rights, or any infringement of Federal, State, or local laws or regulations, nor does it obviate the necessity of obtaining *State assent* to the work authorized. (See *Cummings* v. *Chicago*, 188 U.S., 410.)

NCCOD-S
69-10

PERMIT

DEPARTMENT OF THE ARMY
Chicago District, Corps of Engineers.
219 South Dearborn Street
Chicago, Ill. 60604 12 December, 1968

Wisconsin Public Service
Corporation
P. O. Box 700
Green Bay, Wisconsin 54305

Gentlemen:

Referring to written request dated 17 June 1968, signed by Mr. Nels E. Knutzen, Construction Engineer

I have to inform you that, upon the recommendation of the Chief of Engineers, and under the provisions of Section 10 of the Act of Congress approved March 3, 1899 (30 Stat. 1151; 33 U.S.C. 403), entitled "An act making appropriations for the construction, repair, and preservation of certain public works on rivers and harbors, and for other purposes," you are hereby authorized by the Secretary of the Army.

to install a 120-inch I.D. submarine water intake pipe and intake structure and discharge facilities (the excess excavated material, approximately 6,950 cubic yards, to be deposited on shore on Wisconsin Public Service Company property)

(Here describe the proposed structure or work.)

in Lake Michigan

(Here to be named the river, harbor, or waterway concerned.)

at the Town of Carlton, Kewaunee County, Wisconsin

(Here to be named the nearest well-known locality—preferably a town or city—and the distance in miles and tenths from some definite point in the same, stating whether above or below or giving direction by points of compass.)

in accordance with the plans shown in red on the drawing attached hereto marked: "Proposed Water Intake and Dredging in Lake Michigan at Kewaunee, County of Kewaunee, State of Wisconsin, Application By: Wisconsin Public Service Corporation, Dated: June 17, 1968."

(Or drawings: give file number or other definite identification marks.)

subject to the following conditions:

(*a*) That the work shall be subject to the supervision and approval of the District Engineer, Corps of Engineers, in charge of the locality, who may temporarily suspend the work at any time, if in his judgment the interests of navigation so require.

(*b*) That any material dredged in the prosecution of the work herein authorized shall be removed evenly and no large refuse piles, ridges across the bed of the waterway, or deep holes that may have a tendency to cause injury to navigable channels or to the banks of the waterway shall be left. If any pipe, wire, or cable hereby authorized is laid in a trench, the formation of permanent ridges across the bed of the waterway shall be avoided and the back filling shall be so done as not to increase the cost of future dredging for navigation. Any material to be deposited or dumped under this authorization, either in the waterway or on shore above high-water mark, shall be deposited or dumped at the locality shown on the drawing hereto attached, and, if so prescribed thereon, within or behind a good and substantial bulkhead or bulkheads, such as will prevent escape of the material in the waterway. If the material is to be deposited in the harbor of New York, or in its adjacent or tributary waters, or in Long Island Sound, a permit therefor must be previously obtained from the Supervisor of New York Harbor, New York City.

(*c*) That there shall be no unreasonable interference with navigation by the work herein authorized.

(*d*) That if inspections or any other operations by the United States are necessary in the interest of navigation, all expenses connected therewith shall be borne by the permittee.

(*e*) That no attempt shall be made by the permittee or the owner to forbid the full and free use by the public of all navigable waters at or adjacent to the work or structure.

(*f*) That if future operations by the United States require an alteration in the position of the structure or work herein authorized, or if, in the opinion of the Secretary of the Army, it shall cause unreasonable obstruction to the free navigation of said water, the owner will be required upon due notice from the Secretary of the Army, to remove or alter the structural work or obstructions caused thereby without expense to the United States, so as to render navigation reasonably free, easy, and unobstructed; and if, upon the expiration or revocation of this permit, the structure, fill, excavation, or other modification of the watercourse hereby authorized shall not be completed, the owners shall, without expense to the United States, and to such extent and in such time and manner as the Secretary of the Army may require, remove all or any portion of the uncompleted structure or fill and restore to its former condition the navigable capacity of the watercourse. No claim shall be made against the United States on account of any such removal or alteration.

(*g*) That the United States shall in no case be liable for any damage or injury to the structure or work herein authorized which may be caused by or result from future operations undertaken by the Government for the conservation or improvement of navigation, or for other purposes, and no claim or right to compensation shall accrue from any such damage.

(*h*) That if the display of lights and signals on any work hereby authorized is not otherwise provided for by law, such lights and signals as may be prescribed by the U.S. Coast Guard, shall be installed and maintained by and at the expense of the owner.

(*i*) That the permittee shall notify the said district engineer at what time the work will be commenced, and as far in advance of the time of commencement as the said district engineer may specify, and shall also notify him promptly, in writing, of the commencement of work, suspension of work, if for a period of more than one week, resumption of work, and its completion.

(*j*) That if the structure or work herein authorized is not completed on or before the thirty-first day of December, 19 71, this permit, if not previously revoked or specifically extended, shall cease and be null and void.

(k) That the permittee shall comply promptly with any valid regulations, conditions, or instructions affecting the work hereby authorized if and when issued by any Department of the Federal Government and/or State agency for the conservation or protection of fish and wildlife or abatement or prevention of water pollution. Such regulations, conditions, or instructions in effect or prescribed by any Department of the Federal Government or State agency are hereby made a condition of this permit.

By authority of the Secretary of the Army:

Edward E. Bennett

EDWARD E. BENNETT
Colonel, Corps of Engineers
District Engineer

Replaces edition of 1 Sep 48, which is obsolete. (*ER 1145-2-303*)
U.S. GOVERNMENT PRINTING OFFICE : 1968—O-312-340

PUBLIC SERVICE COMMISSION OF WISCONSIN

HILL FARMS STATE OFFICE BUILDING
MADISON, WISCONSIN 53702

October 17, 1967

ARTHUR L. PADRUTT, CHAIRMAN
WALTER J. COLE, COMMISSIONER
STANLEY E. GILBERTSON, COMMISSIONER

JOHN F. GOETZ, SECRETARY

FILE NO. CA-4759
2-WP-2570

Wisconsin Public Service Corp., Mr. L. G. Roemer, Pres., 1029 North Marshall Street, Milwaukee, Wisconsin 53201
Foley, Sammond & Lardner, Attorneys, Mr. Steven E. Keane, 735 North Water Street, Milwaukee, Wisconsin 53202
Wisconsin Power & Light Company, Mr. Donald L. Stokley, Secy., P.O. Box 192, Madison, Wisconsin 53701
Petersen, Sutherland, Axley & Brynelson, Mr. R. J. Sutherland, Atty., 122 West Washington Avenue, Madison, Wisconsin 53703
Madison Gas & Electric Company, Mr. Frederick D. Mackie, Pres., P.O. Box 1231, Madison, Wisconsin 53701
Stafford, Rosenbaum, Rieser & Hansen, Mr. William T. Rieser, Atty., 204 South Hamilton Street, Madison, Wisconsin 53703
Wisconsin Electric Power Company, P.O. Box 2046, Milwaukee, Wis.
Wisconsin Michigan Power Company, Mr. Alfred Gruhl, Pres., 231 West Michigan Street, Milwaukee, Wisconsin 53203
Mr. Robert H. Gorske, Attorney, 231 West Michigan Street, Milwaukee, Wisconsin 53203
Mr. William Otradovec, Clerk, Town of Carlton, Route 1, Kewaunee, Wisconsin 54216
Lorna M. Rudie, City Clerk, City Hall, Kewaunee, Wisconsin 54216
Mr. Donald L. Quistorff, Chrm., Kewaunee County Board, 617 Rose St., Kewaunee, Wisconsin 54216
Mr. Kenneth Krofta, Route 1, Kewaunee, Wisconsin 54216
Mr. Winnifred Smith, Winghaven - Route No. 1, Two Rivers, Wisconsin
Wis. Conservation Dept., Mr. Lewis Posekany, Room 80B Hill Farms State Office Building, Madison, Wisconsin 53702
Board of Health, State Office Bldg., 1 W. Wilson Street, Madison, Wisconsin 53702
Department of Resource Development, State Office Bldg., 1 W. Wilson Street, Madison, Wisconsin 53702

Joint Application of Wisconsin Public Service Corporation, Wisconsin Power and Light Company, and Madison Gas and Electric Company for Authority to Construct and Place in Operation a 527-Megawatt Neclear Generating Station	CA-4759

CA-4759
2-WP-2570

Joint Application of Wisconsin Public Service Corporation, Wisconsin Power and Light Company, and Madison Gas and Electric Company for a Permit to Build and Maintain Harbor and Water Supply Structures on the Bed of Lake Michigan	))))))	2-WP-2570

Gentlemen:

We enclose certified copy of Findings of Fact, Certificate, and Order issued in the above-entitled matters.

Very truly yours,

John F. Goetz

Secretary

jan

COMPARED WITH AND CERTIFIED BY ME TO BE A FULL, TRUE, AND CORRECT COPY OF THE ORIGINAL ON FILE IN MY OFFICE.

DATED OCT 1 7 1967

John T. Goetz
SECRETARY
PUBLIC SERVICE COMMISSION OF WISCONSIN

BEFORE THE

PUBLIC SERVICE COMMISSION OF WISCONSIN

Joint Application of Wisconsin Public Service Corporation, Wisconsin Power and Light Company, and Madison Gas and Electric Company for Authority to Construct and Place in Operation a 527-Megawatt Nuclear Generating Station	CA-4759
Joint Application of Wisconsin Public Service Corporation, Wisconsin Power and Light Company, and Madison Gas and Electric Company for a Permit to Build and Maintain Harbor and Water Supply Structures on the Bed of Lake Michigan	2-WP-2570

FINDINGS OF FACT, CERTIFICATE, AND ORDER

Wisconsin Public Service Corporation, 1029 North Marshall Street, Milwaukee 53201, Wisconsin Power and Light Company, P. O. Box 192, Madison 53701, and Madison Gas and Electric Company, P. O. Box 1231, Madison 53701, on March 22, 1967 filed a joint application with the Commission for authority under section 196.49, Statutes, and Chapter PSC 112, Wisconsin Administrative Code, to construct and place in operation a 527-megawatt nuclear electric generating station. Application granted with conditions.

The three utility companies also applied for a permit under sections 30.12 and 30.21, Statutes, to build and maintain harbor and water supply structures on the bed of Lake Michigan.

Pursuant to due notice, hearing was held on May 10, 1967 at Madison before Examiner Maurice H. Van Susteren.

Appearances:

Wisconsin Public Service Corporation by

Steven E. Keane, attorney
Theodore C. Bollinger, attorney
Milwaukee

Wisconsin Power and Light Company by

R. J. Sutherland, attorney
Eugene O. Gehl, attorney
Madison

Madison Gas and Electric Company by

William T. Rieser, attorney
Madison

In Support of the Applications:

Wisconsin Electric Power Company and
Wisconsin Michigan Power Company by

Robert H. Gorske, attorney
Milwaukee

Town of Carlton, Kewaunee County, by

Arden Koehler, chairman
Kewaunee

City of Kewaunee by

Thomas Kelliher, mayor
Kewaunee

Kewaunee County Board by

Donald L. Quistorff, chairman
Kewaunee

Appearances: (Continued)

As Interests May Appear:

Wisconsin State Board of Health by

William L. Lea, director, radiation protection division
Madison

Wisconsin Conservation Department (later "In Opposition") by

L. A. Posekany, chief biological engineer
Charles Bills, attorney

In Opposition:

Kenneth Krofta
Kewaunee

Winnifred Smith
Two Rivers

Of the Commission Staff:

R. E. Purucker, engineering department
W. A. Kuehlthau, engineering department
L. L. Smith, engineering department
J. R. Brady, accounts and finance department
R. G. Dudley, rates and research department

Findings of Fact

THE COMMISSION FINDS:

Wisconsin Public Service Corporation ("Public Service") operates, among other things, as an electric public utility in northeastern Wisconsin. It generates electric energy in three fossil-fuel, steam-electric generating plants and 15 hydroelectric generating plants.

Wisconsin Power and Light Company ("Power & Light") operates, among other things, as an electric public utility in central and southern Wisconsin. It generates electric energy in four fossil-fuel, steam-electric plants and eight hydroelectric generating plants. It is also installing a gas turbine electric generating unit near its Rock River steam plant.

Madison Gas and Electric Company ("Madison Gas") operates, among other things, as an electric public utility. It generates energy in one fossil-fuel steam electric generating plant and a gas turbine electric generating unit. It is installing a second gas turbine electric unit.

All three utilities are interconnected with each other either directly or through other utility systems.

Public Service and Power & Light joined in a power pool in December 1960 to coordinate installation and operation of generating and interconnecting facilities. Two electric generating units, one in operation at Green Bay and one under construction at Sheboygan, have been planned under this pooling agreement. A third unit of about 300-mw. capacity was anticipated to be needed about 1970-71.

Each of the three applicants here has, or will have, a need in the next few years for additional electric generating capacity. With power pooling and interconnections with nearby utilities, it is possible and practical to reduce the amount of reserve capacity which must be maintained. However, a reserve of 15% for planned and emergency outages must be maintained to insure adequate and reliable service. Based on capacity installed and under construction and on commitments for the purchase and sale of capacity, the three applicants individually and as a group have reasonably adequate capacity to supply estimated demands through 1971. The combined reserve will be approximately 14%. In 1972 supply purchase commitments will be reduced, and the reserve will drop to between 3 and 4% unless additional capacity is provided.

Continuing study showed the possibility of additional economies if a still larger unit were to be constructed. Comparison of different types of plant showed advantages for a nuclear-powered unit. Such a unit could not be installed in time to meet the deadline for additional capacity by 1970-71. However, the decision of Wisconsin Michigan Power Company to install a large nuclear unit at Two Creeks for operation at that time made capacity available in sufficient quantity to supply the deficiency until the unit here under consideration can be placed in service.

Public Service, which is the party designated to install the next unit under the aforesaid pooling agreement, could not alone undertake the obligation of such a large unit. Following negotiations, it was decided to join in a three-party venture with Power & Light and Madison Gas for the construction and installation of a 527-megawatt nuclear-powered electric generating plant on Lake Michigan at a site expected to be in section 25, township 22 north, range 24 east, town of Carlton, Kewaunee County, about 7 miles south of the city of Kewaunee.

The construction and operation of such facility will be made under the terms of an agreement which provides that the facility be owned by the companies as tenants in common with undivided ownership interests divided as follows:

Company	Percent
Wisconsin Public Service Corporation	41.2
Wisconsin Power and Light Company	41.0
Madison Gas and Electric Company	17.8

Until otherwise agreed to, the plant will be directed, operated, and maintained by Public Service with general policies to be established by an operating committee with representation from each of the three companies.

The proposed plant will employ a two-loop, closed-cycle, pressurized-water reactor. The operating condition in the reactor, as far as the water is concerned, will be 2,250 pounds per square inch absolute (p.s.i.a.), and a temperature of 607.5° F. The two steam generators will produce steam at 750 p.s.i.a. and 510.8° F. The turbine will exhaust to a condenser which will draw cooling water from an intake about 2,000 feet into Lake Michigan at a rate of 400,000 g.p.m. Maximum temperature rise will be about 20° F. Water will be returned to the lake through a discharge line with a group of nozzles designed to create rapid mixing of the warm discharge water with the surrounding cooler lake water. The turbine will have a guaranteed capacity of 559,593 kw. when operated at a back pressure of 1.5 inches of mercury absolute. The electric generator will be rated at 659,000-kv.-a. when operated at 19 kv., 85% power factor, and hydrogen cooling at 60 p.s.i.g. The installation will also include structures such as reactor containment building, turbine room, machine shop, screen house, circulating water intake and discharge system, an auxiliary system, a fuel-handling system, and an office.

Applicants will own land which abuts Lake Michigan at the site of the plant. They will construct, install, maintain, and operate all needed facilities upon and under the bed of the lake, such as intakes, pipes, and others as may be required for the intake and discharge of condenser cooling water. They will also construct, install, maintain, and operate such navigation improvements and harbor facilities required to enable water transportation of major items of plant equipment to the site. On April 24, 1967 the town board of the town of Carlton, Kewaunee County, issued a permit to applicants, pursuant to section 30.21, Wisconsin Statutes.

In determining that a nuclear plant be installed, the applicants made comparison studies of comparably sized fossil-fuel plants, as well as comparison studies respecting the effect of having smaller individual generating installations constructed by each of the applicants. These studies show that the nuclear installation would provide substantial savings to each of the applicants.

Electric power from the nuclear plant will be transmitted to various load centers over a 345-kv. transmission line tentatively planned to extend from the plant to Madison via Green Bay, North Appleton substation, Oshkosh, and Fond du Lac, with a tap to Sheboygan and a 5-mile connecting link south to the nearby Two Creeks nuclear plant of Wisconsin Michigan Power Company. The ownership of these lines will not be in tenancy in common but will be divided as provided in the Joint Power Supply Agreement made February 2, 1967.

It will be the responsibility of each company to obtain the necessary authorization for such segments of the line that it will own and operate.

The cost of the nuclear plant facility based on firm negotiated and bid prices for the major items is estimated at $83,000,000 exclusive of the nuclear fuel. Said amount is distributed as follows:

Land and land rights	$ 300,000
Structure and improvements	10,216,500
Reactor plant equipment	29,998,250
Turbogenerator units	20,049,959
Accessory electric equipment	3,577,000
Misc. power plant equipment	331,000
Station equipment	1,232,820
Omissions and contingencies	1,700,000
Engineering and design	3,000,000
General and administrative	1,450,000
Start-up costs	50,000
Misc. construction costs	692,000
Interest on construction	9,000,000
Escalation	1,402,471
Total	$83,000,000

No decision has been reached by applicants respecting a long-term commitment for fuel for the reactor. The reactor-supplying company will provide fabrication and fuel for the first core only. Studies are being made to determine the most economical fuel arrangement for the long term. Based on initial fuel commitment, the estimated average fuel cost will be 16 cents per million B.t.u.

Federal law requires that applicants obtain certain insurance coverage. Insurance will be taken out as supplied by two insurance pools, the Nuclear Energy Property Insurance Association and the Mutual Atomic Energy Reinsurance Pool, on applicants' owned property at the plant site. In addition, the applicants will carry $74,000,000 of third-party liability insurance with two insurance pools, the Nuclear Energy Liability Insurance Association and the Mutual Atomic Energy Liability Underwriters. These insurance policies will be supplemented by Atomic Energy Commission indemnity insurance created by the Price-Anderson amendment to the Atomic Energy Act, which provides for additional coverage, over and above the $74,000,000 amounting to $486,000,000. The total third-party insurance will be $560,000,000.

Application for a construction permit and licenses will shortly be filed by applicants with the Atomic Energy Commission.

The general public interest and public convenience and necessity require that the Wisconsin Public Service Corporation, Wisconsin Power and Light Company, and Madison Gas and Electric Company, as electric public utilities, purchase, construct, install, and place in operation:

(a) a nuclear powered electric generating plant of about 527-megawatt electric capacity in the town of Carlton, Kewaunee County;

(b) all intakes, pipes, tunnels, and associated facilities for a water supply system for the subject plant;

(c) such navigational improvements and harbor facilities as may be required for water transportation of plant supplies and equipment; and

(d) a 19/345-kv., 600-Mv.-a., step-up substation to supply 345-kv. electric transmission lines to be built separately by the several applicants at a total estimated cost of $83,000,000.

The construction and placing of the proposed facilities in service at the cost estimated will not impair the efficiency of the service of the three applicants, will not provide facilities unreasonably in excess of probable future requirements, and will not, when placed in operation, add to the cost of the service without proportionately increasing the value or available quantity thereof.

Conclusions of Law

THE COMMISSION CONCLUDES:

1. That the Commission has jurisdiction under section 196.49, Statutes, and Chapter PSC 112, Wisconsin Administrative Code, to issue a certificate authorizing Wisconsin Public Service Corporation, Wisconsin Power and Light Company, and Madison Gas and Electric Company to purchase, install, and place in operation the facilities hereinbefore mentioned at an estimated cost of $83,000,000 subject to such conditions as are necessary to meet the requirements of such section and chapter.

2. That the proposed pier, intake, and discharge cooling water facility constitutes structures and facilities of the type mentioned in section 30.21, Statutes; and the applicants have received an appropriate permit under section 30.21, Statutes, from the town board of the town of Carlton, Kewaunee County, authorizing applicants to place these cooling water facilities and other needed facilities upon the bed of Lake Michigan.

3. That applicants have also requested a permit under sections 30.12 and 30.21, Statutes, to build and maintain a harbor and water supply structure on the bed of Lake Michigan at the site of the proposed generating facility. Since July 1, 1967 the functions of the Public Service Commission respecting section 30.12, Statutes, have been transferred to the Department of Resource Development by Chapter 614, Laws of 1965. Hence, any application to the Public Service Commission for a permit under that section at this date cannot be acted upon for lack of jurisdiction. The application for a permit under that section, must now be acted upon by the Department of Resource Development. The jurisdiction of the Public Service Commission under section 30.21, Statutes, continues. However, no permit or authorization other than that obtained from the town of Carlton, Kewaunee County, on April 24, 1967 and this certificate here issued are necessary to enable applicants to exercise the rights and privileges granted by said section.

Certificate

THE COMMISSION THEREFORE CERTIFIES:

That Wisconsin Public Service Corporation, Wisconsin Power and Light Company, and Madison Gas and Electric Company, Wisconsin corporations, as electric public utilities, be and they hereby are authorized to purchase, construct, install, and place in operation:

(a) a nuclear power plant of approximately 527-megawatt electric capacity in the town of Carlton, Kewaunee County;

(b) all intakes, pipes, tunnels, and associated facilities for a water supply system for the subject plant; and

(c) such navigational improvements and harbor facilities as may be required for water transportation of plant supplies and equipment;

together with the necessary electric transformation and control equipment at a total estimated cost of $83,000,000; and that Wisconsin Public Service Corporation, Wisconsin Power and Light Company, and Madison Gas and Electric Company be and they hereby are granted a certificate of authority so to proceed, upon the conditions:

1. That the size, strength, and capacity of the individual components will be such as to safely accomplish the function in the application;

2. that a self-sufficient power supply be installed for emergency restarting of the plant without external power dependence;

3. that it provide the Commission with the detailed design of the nuclear facilities as they are submitted to the Atomic Energy Commission;

4. that it notify and obtain approval from this Commission before proceeding with any major change in design, size, cost, or location of the proposed facilities and that it obtain the necessary local permits;

5. that it obtain any needed permits from the Corps of Engineers United States Army;

6. that it provide this Commission with a copy of its application to, and notices of the dates

and subject matter of the various hearings before, the Atomic Energy Commission;

7. that it obtain any needed authorizations from the Atomic Energy Commission;

8. that each applicant cooperate with the State Board of Health in conducting environmental surveys in the plant area;

9. that each applicant inform this Commission of its decision with respect to the long-term supply of fuel for the plant; and

10. that the authorization herein granted is not final until proposed facilities for the adequate and proper transmission of power from the plant have been designed and authorized.

In prescribing the foregoing conditions, the Public Service Commission specifically recognizes that the control of radiation hazards from nuclear reactors is the responsibility and jurisdiction of the United States Government, or its agency the Atomic Energy Commission, and there is no intention thereby to intrude upon or in any way infringe on that responsibility or jurisdiction.

Order

THE COMMISSION THEREFORE ORDERS:

1. That the certificate be valid only if construction is started within 1 year of the date hereof.

2. That as part of the contracts the applicants require that the suppliers and subcontractors provide detailed information to permit quick and accurate cost breakdown and allocation for continuing property records and to meet the requirements of the prescribed Uniform System of Accounts.

3. That upon completion of the project, the applicants report the actual costs segregated by plant accounts.

4. That the Joint Power Supply Agreement of the three applicants, dated February 2, 1967, be accepted for filing.

5. That after the facilities are operative, the applicants notify the Wisconsin Department of Industry, Labor, and Human Relations whenever the reactor is refueled or opened for repair.

6. That jurisdiction is retained.

Dated at Madison, Wisconsin, October 17, 1967

By the Commission.

John F. Goetz
Secretary

PUBLIC SERVICE COMMISSION OF WISCONSIN

HILL FARMS STATE OFFICE BUILDING

MADISON, WISCONSIN 53702

ARTHUR L. PADRUTT
CHAIRMAN

WALTER J. COLE
COMMISSIONER

STANLEY E. GILBERTSON
COMMISSIONER

JOHN F. GOETZ
SECRETARY

February 8, 1968

FILE NO. CA-4863

Wisconsin Public Service Corporation, Mr. L. G. Roemer, President,
1029 N. Marshall Street, Milwaukee, Wisconsin 53202
Mr. Theodore C. Bolliger, Attorney, Foley, Sammond & Lardner, Attys.,
735 North Water Street, Milwaukee, Wisconsin 53202
Wisconsin Electric Power Company, 231 West Michigan Street, Milwaukee,
Wisconsin 53201
Mr. John G. Quale, V.P. & Gen. Counsel, Wisconsin Electric Power Co.,
P.O. Box 2046, Milwaukee, Wisconsin 53201
Mr. Van B. Wake, Attorney, 231 West Michigan Street, Milwaukee,
Wisconsin 53203

Application of Wisconsin Public Service Corporation for Authority to Construct, Operate, and Maintain a 345,000-Volt Electric Transmission Line from the Point Beach Nuclear Power Plant Near Kewaunee to Appleton and to Interconnect with Wisconsin Electric Power Company at the Point Beach and North Appleton Substation Terminals

Gentlemen:

We enclose certified copy of Findings of Fact, Certificate, and Order issued in the above-entitled matter.

Very truly yours,

John F. Goetz

Secretary

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COMPARED WITH AND CERTIFIED BY ME TO BE A FULL, TRUE AND CORRECT COPY OF THE ORIGINAL ON FILE IN MY OFFICE.

DATED FEB 8 1968

John S. Goetz
SECRETARY
PUBLIC SERVICE COMMISSION OF WISCONSIN

BEFORE THE

PUBLIC SERVICE COMMISSION OF WISCONSIN

Application of Wisconsin Public Service Corporation for Authority to Construct, Operate, and Maintain a 345,000-Volt Electric Transmission Line from the Point Beach Nuclear Power Plant Near Kewaunee to Appleton and to Interconnect with Wisconsin Electric Power Company at the Point Beach and North Appleton Substation Terminals — CA-4863

FINDINGS OF FACT, CERTIFICATE, AND ORDER

Wisconsin Public Service Corporation, 1029 North Marshall Street, Milwaukee 53201, on November 6, 1967 filed an application with the Commission for authority under section 196.49, Statutes, and Chapter PSC 112, Wisconsin Administrative Code, to construct, operate, and maintain a 345,000-volt electric transmission line from the Point Beach nuclear power plant under construction south of the city of Kewaunee in Kewaunee County to the North Appleton substation and to interconnect with Wisconsin Electric Power Company, 231 West Michigan Street, Milwaukee 53201, at the Point Beach and North Appleton substation terminals. Application granted with conditions.

Pursuant to due notice, hearing was held December 1, 1967 at Madison before Examiner George C. Gilday.

Appearances:

Wisconsin Public Service Corporation by

Theodore C. Bolliger, attorney
Milwaukee

In Support of the Application:

Wisconsin Electric Power Company by

Van B. Wake, attorney
Milwaukee

Of the Commission Staff:

W. A. Kuehlthau, engineering department
Gerald F. Wilke, rates and research department

Findings of Fact

THE COMMISSION FINDS:

Wisconsin Public Service Corporation operates as an electric public utility in a large portion of the northeast quadrant of the state. Its continuing growth requires that it provide additional electric capacity to supply the increasing demands of its electric customers.

The corporation has fifteen hydroelectric generating plants throughout its territory. It also has two diesel plant installations and three steam-electric generating stations. Wisconsin Public Service Corporation, in a joint venture with Wisconsin Power and Light Company and Madison Gas and Electric Company, is constructing a nuclear power electric generating plant on the shore of Lake Michigan in the town of Carlton, Kewaunee County, approximately seven miles north of the nuclear plant under construction by Wisconsin Electric Power Company and Wisconsin Michigan Power Company.

In addition to its own electric generating plants, Wisconsin Public Service Corporation has interconnections with other electric utilities including both Wisconsin Electric Power Company and Wisconsin Michigan Power Company over which energy is purchased and sold.

Following an overall study of the electric power production and transmission facilities and the load centers for use of power, an agreement has been reached for the construction of additional high-voltage transmission lines for the transmission of bulk quantities of electric energy from the atomic power plants under construction.

For its share of new facilities to be constructed at this time, Wisconsin Public Service Corporation will construct 60 miles of 345-kv., 3-phase electric transmission line from the Point Beach atomic power plant of Wisconsin Electric Power Company-Wisconsin Michigan Power Company northward to the nuclear plant site which applicant and two other companies own in the town of Carlton, Kewaunee County, then westward and northward to near Green Bay and then southwestward to interconnect again with the Wisconsin Electric Power Company at its North Appleton substation at which the applicant now has a lower voltage interconnection. The line will be connected to the Kewaunee nuclear plant when it is completed, and a stepdown substation will be constructed at Green Bay when demands increase to require additional capacity in that area. The first point where the applicant will receive energy off this line will be at the North Appleton substation.

Wisconsin Electric Power Company has also requested authorization for the two interconnections of the line with its facilities at Point Beach and at the North Appleton substation, Docket CA-4874. Wisconsin Electric Power Company will provide all of the facilities required to make the connections at both ends of the line.

The cost of the project proposed by Wisconsin Public Service Corporation is estimated at $4,296,900:

Land rights	$ 266,408
Clearing land and R.O.W.	253,517
Poles and fixtures	2,260,169
Overhead conductors and devices	1,516,806
	$4,296,900

The general public interest and public convenience and necessity require that Wisconsin Public Service Corporation, as an electric public utility, construct and place in operation approximately 60 miles of 345-kv., 3-phase electric transmission line interconnecting with the Wisconsin Electric Power Company's Point Beach nuclear plant at the east end and the Wisconsin Electric Power Company's North Appleton substation at the west end at a total estimated cost of $4,296,900.

The construction and placing in service of the proposed facilities at the cost estimated will not impair the efficiency of applicant's service, will not provide facilities unreasonably in excess of probable future requirements, and will not, when placed in operation, add to the cost of the service without proportionately increasing the value or available quantity thereof.

Conclusion of Law

THE COMMISSION CONCLUDES:

That the Commission has jurisdiction under section 196.49, Statutes, and Chapter PSC 112, Wisconsin Administrative Code, to issue a certificate authorizing Wisconsin Public Service Corporation to construct and place in operation the facilities hereinbefore mentioned at an estimated cost of $4,296,900 subject to such conditions as are necessary to meet the requirements of such section and chapter.

Certificate

THE COMMISSION THEREFORE CERTIFIES:

That the public interest and public convenience and necessity require that Wisconsin Public Service Corporation, as an electric public utility, construct and place in operation approximately 60 miles of 345-kv., 3-phase electric transmission line interconnecting with the Wisconsin Electric Power Company's Point Beach nuclear plant at the east end and the Wisconsin Electric Power Company's North Appleton substation at the west end at a total estimated cost of $4,296,900; and that such company be and it hereby is granted a certificate authorizing it to so proceed upon the condition that it notify and obtain approval from this Commission before proceeding with any substantial change in design, location, size, or cost.

Order

THE COMMISSION THEREFORE ORDERS:

1. That the certificate be valid only if construction is started within 1 year of the date hereof.

2. That as bids are received, a tabulation of the bids obtained and accepted be submitted to the Commission.

3. That upon completion of the project, the utility report the actual costs thereof, segregated by plant accounts.

4. That the sag calculations take into consideration the maximum conductor temperature that will be attained with the load permitted by the relay settings.

5. That the revision to the interconnection agreement of June 3, 1955 with the Wisconsin Electric Power Company be filed with the Commission as soon as it is determined.

6. That jurisdiction is retained.

Dated at Madison, Wisconsin, February 8, 1968

By the Commission.

John F. Goetz
Secretary

State of Wisconsin \ PUBLIC SERVICE COMMISSION

ARTHUR L. PADRUTT, CHAIRMAN
[redacted] COMMISSIONER
[redacted] COMMISSIONER

JOHN F. GOETZ, SECRETARY
HILL FARMS STATE OFFICE BUILDING
MADISON, WISCONSIN 53702

February 17, 1969

FILE NO. CA-4999

Wisconsin Public Service Corporation
Mr. P. D. Ziemer
Vice President and Treasurer
1029 North Marshall Street
Milwaukee, Wisconsin 53201

Wisconsin Electric Power Company
P. O. Box 2046
231 W. Michigan Street
Milwaukee, Wisconsin 53203

Application of Wisconsin Public Service Corporation for Authority to Construct a 345/138-kv. Stepdown Substation at the Kewaunee Nuclear Plant Site

Gentlemen:

We enclose certified copy of Findings of Fact, Certificate and Order issued in the above-entitled matter.

Very truly yours,

John F. Goetz

Secretary

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BEFORE THE

PUBLIC SERVICE COMMISSION OF WISCONSIN

Application of Wisconsin Public Service Corporation for Authority to Construct a 345/138-kv. Stepdown Substation at the Kewaunee Nuclear Plant Site	)	CA-4999

FINDINGS OF FACT, CERTIFICATE AND ORDER

The Wisconsin Public Service Corporation, 1029 North Marshall Street, Milwaukee 53201, On January 14, 1969 completed filing an application with the Commission for authority under section 196.49, Statutes, and Chapter PSC 112, Wisconsin Administrative Code, to construct a 345/138-kv. stepdown substation at the Kewaunee nuclear electric generating plant and replace existing conductors on the existing East Krok to Shoto 138,000-volt line at an estimated cost of $3,674,118. Application granted.

No hearing was held.

Findings of Fact

THE COMMISSION FINDS:

The Wisconsin Public Service Corporation operates as an electric public utility north of east-central Wisconsin. It, together with others, is constructing a nuclear electric generating plant near Kewaunee and will connect this supply to the existing 138,000-volt transmission system of the utility.

The connection between the source of supply and the transmission system will be accomplished by the installation of (a) 300,000 kv.-a. in transformation facilities complete with structures, protective and control equipment at the Kewaunee nuclear plant site, (b) two one-half-mile 345,000-volt transmission lines to connect with the nuclear plant, and (c) two 138,000-volt transmission lines 1.95 miles long to connect the new substation to the existing 138-kv. transmission line between the East Krok and Shoto substations.

This 138-kv. line, 20.4 miles long, has a single 477 MCM ACSR conductor per phase. It will be inadequate to safely carry the loads anticipated when the substation is placed in service, particularly under emergency conditions. It will, therefore, be reconductored using a single 795 MCM ACSR conductor per phase.

The total project is estimated to cost $3,674,118 distributed as follows:

	New 345-kv Const. 1 mi.	New 138-kv. Const. 3.9 mi.	Reconductor 138-kv. line 20.4 mi.	Total
Transmission Lines				
Land & land rights	--	$ 5,410	$ 1,927	$ 7,337
Clearing right of way	--	546	--	546
Poles, towers, and fixtures	$40,479	79,349	9,435	129,263
Conductors & devices	35,895	70,378	245,916	352,189
Removal costs	--	--	17,284	17,284
Salvage	--	--	(60,383)	(60,383)
Subtotals	$76,374	$155,683	$214,179	$446,236

Transmission Substation
300 MVA, 345/138-kv. autotransformer with switchgear, protective relaying and control equipment, steel structure, and miscellaneous equipment $3,227,882

TOTAL $3,674,118

The general public interest and public convenience and necessity require that Wisconsin Public Service Corporation, as an electric public utility, construct, install and place in operation, a 300 MVA, 345/138-kv. substation at its Kewaunee nuclear plant site, 345-kv. and 138-kv. connecting lines, and reconductor its 138-kv. East Krok-Shoto line with larger conductors as described above at a total net estimated cost of $3,674,118.

The construction and placing in service of the proposed facilities at the cost estimated will not impair the efficiency of applicant's service, will not provide facilities unreasonably in excess of probable future requirements, and will not, when placed in operation, add to the cost of the service without proportionately increasing the value or available quantity thereof.

Conclusion of Law

THE COMMISSION CONCLUDES:

That the Commission has jurisdiction under section 196.49, Statutes, and Chapter PSC 112, Wisconsin Administrative Code, to issue a certificate authorizing Wisconsin Public Service Corporation to construct and place in operation the facilities hereinbefore mentioned at a net estimated cost of $3,674,118, subject to such conditions as are necessary to meet the requirements of such section and chapter.

Certificate

THE COMMISSION THEREFORE CERTIFIES:

That the public interest and public convenience and necessity require that the Wisconsin Public Service Corporation, as an electric public utility, construct and place in operation a 300 MVA, 345/138-kv. substation at its Kewaunee nuclear plant site with 345-kv. and 138-kv. connecting lines and reconductor its 138-kv. East Krok-Mishicot line with larger conductors as described above at a total net estimated cost of $3,674,118; and that such company be and it hereby is granted a certificate authorizing it to so proceed upon the condition that it notify and obtain approval from this Commission before proceeding with any substantial change in design, location, size or cost.

Order

THE COMMISSION THEREFORE ORDERS:

1. That the certificate be valid only if construction is started within 1 year of the date hereof.

2. That as bids are received, a tabulation of the bids obtained and accepted be submitted to the Commission.

3. That upon completion of the project, the utility report the actual costs thereof, segregated by plant accounts.

4. That the sag calculations take into consideration the maximum conductor temperature that will be attained with the load permitted by the relay settings.

5. That jurisdiction is retained.

Dated at Madison, Wisconsin February 17, 1969

By the Commission.

John F. Goetz
Secretary

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

DIVISION OF RESOURCE DEVELOPMENT
MADISON, WISCONSIN 53702

May 21, 1968

Mr. Nels E. Knutzen
Construction Engineer
Kewaunee Nuclear Power Plant
Wisconsin Public Service Corporation
P. O. Box 700
Green Bay, Wisconsin 54305

Dear Mr. Knutzen:

The Division of Resource Development has reviewed the information received on March 25, 1968 pertaining to the circulating water intake and discharge proposed for the Kewaunee Nuclear Power Plant, Unit No. 1, Carlton, Wisconsin. The submittal involves a request of a partial approval for waste disposal in accordance with Section 144.555, Wisconsin Statutes.

It is proposed to discharge the industrial waste effluent from the plant into an outfall structure at the lakeshore. The velocity of the waste into the lake will be approximately 2 fps and the required mixing zone to dissipate the heated discharge is uncertain. The Lake Michigan Enforcement Conference is considering this type of problem in detail. Upon receipt of information of an adverse effect upon the aquatic environment we reserve the right to order changes in accordance with the conference findings.

This partial proposal covering the circulating water intake and discharge appears to comply with current requirements and is hereby approved in accordance with Section 144.555, Statutes, governing water pollution control.

This plan and report has been reviewed in accordance with Section 144, Wisconsin Statutes. Where necessary, the plan should be submitted to the Department of Industry, Labor and Human Relations, or other state or local agencies to insure conformance with applicable codes or regulations of such agencies.

The Division reserves the right to order changes or additions should conditions arise making this necessary. In case installation of this improvement has not been actually commenced within two years from date, this approval shall become void. After two years, therefore, new application must be made for approval of this or other plans before any construction work is undertaken.

By order of Freeman Holmer, Administrator

Thomas G. Frangos

Thomas G. Frangos, Director
Bureau of Water Resources

GLH/kl
Enc.
cc: Plumbing, Region 3

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

DIVISION OF RESOURCE DEVELOPMENT
MADISON, WISCONSIN 53702

PLEASE READ CAREFULLY
AND COMPLY WITH ALL
CONDITIONS OF APPROVAL

May 22, 1968

Mr. Nels E. Knutzen
Construction Engineer
Wisconsin Public Service Corp.
P. O. Box 700
Green Bay, Wisconsin 54301

Dear Mr. Knutzen:

The Division of Resource Development has examined a plan for the extension of sanitary sewer to the future gate house at the Kewaunee Nuclear Power Plant, Carlton, Wisconsin which was submitted under the seal of Levi C. Bird, Pioneer Service and Engineering Co., Chicago, Illinois and received for approval on May 20, 1968.

The outfall sewer for this extension and the other sewers at this facility were approved on April 15, 1968.

The proposed extension involves the installation of approximately 628 feet of 6 inch diameter vitrified clay sewer pipe. While it is deemed acceptable in this instance to install 6 inch diameter pipe, the slope indicated is insufficient to provide for cleansing velocities in the pipe. It is, therefore, required that adequate drop i.e., slope be provided to maintain a velocity of 2 fps or higher. Revised plans should be submitted showing the desired slope and the water main treatment.

The plan is hereby approved in accordance with Section 144.04, Statutes, as attested by affixing on it the stamp of approval, Number 68-250, subject to the following conditions:

1. That revised plans be submitted showing the required slope to permit cleansing velocities in the sewer.

2. That a competent resident inspector be provided during the course of construction.

3. That all storm and other clear water including that from roof drains, cistern overflows and building foundation drains be excluded from the sanitary sewer system, that street and building sewers be laid in such a manner as to minimize entrance of groundwater and that the building sewers and drains be installed to conform to the state plumbing regulations.

4. That the groundwater infiltration rate for the sanitary sewer not exceed 500 gallons per inch diameter per mile per day.

5. That the improvements be installed in accordance with the plan and the above conditions or subsequent essential and approved modifications.

This plan has been reviewed in accordance with Section 144.04, Wisconsin Statutes. Where necessary, the plan should be submitted to the Department of Industry, Labor and Human Relations or other state or local agencies to insure conformance with applicable codes or regulations of such agencies.

The Division reserves the right to order changes or additions should conditions arise making this necessary. In case installation of these improvements has not been actually commenced within two years from date, this approval shall become void. After two years, therefore, new application must be made for approval of this or other plans before any construction work is undertaken.

By order of Freeman Holmer, Administrator

Thomas G. Frangos

Thomas G. Frangos, Director
Bureau of Water Resources

GLH/kl
Enc.
cc: Engineer
Region 3
Plumbing

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

L. P. Voigt
Secretary

Div. of Environmental Protection

MADISON, WISCONSIN

August 29, 1968

PLEASE READ CAREFULLY AND COMPLY WITH ALL CONDITIONS OF APPROVAL

Mr. Nels Knutzen
Construction Engineer
Kewaunee Nuclear Power Plant
Wisconsin Public Service Corporation
P. O. Box 700
Green Bay, Wisconsin 54305

Dear Mr. Knutzen:

The plans and specifications for the Kewaunee Nuclear Power Plant of Carlton, Wisconsin, submitted under the seals of Levi C. Bird and John Michael Byrne, Pioneer Service and Engineering Company, Chicago, Illinois, showing location and construction details of sewage treatment facilities, and received for approval on April 29, 1968 with revisions received on August 6, 1968, have been examined by the Division of Environmental Protection, copy of the Division's report covering the review of the plans and specifications being attached. The plans and specifications are hereby approved in accordance with Section 144.04, Statutes, as attested by affixing on them the stamp of approval, Number 68-694, subject to the following conditions:

1. That the ejectors in the lift station be provided with throttling equipment on the air lines so as to reduce the pumping capacity.

2. That vertical pipes or bars be installed from the intermediate landing to the top of the lift station to prevent a man falling past the landing and that the lower ladder be extended approximately two feet above the landing.

3. That flow measuring equipment be provided.

4. That a certified operator be provided for this facility by January 1, 1969.

5. That 80 percent phosphorus removal be provided at this facility on or before December 1972.

6. That a competent resident inspector be provided during the course of construction.

7. That the improvements be installed in accordance with the plans and specifications and the above conditions, or subsequent essential and approved modifications.

These plans and specifications have been reviewed in accordance with Section 144.04, Wisconsin Statutes. Where necessary, the plans and specifications should be submitted to the Department of Industry, Labor and Human Relations or other state or local agencies to insure conformance with applicable codes or regulations of such agencies.

The Division reserves the right to order changes or additions should conditions arise making this necessary. In case installation of these improvements has not been actually commenced within two years from date, this approval shall become void. After two years, therefore, new application must be made for approval of these or other plans and specifications before any construction work is undertaken.

By order of Thomas G. Frangos, Acting Administrator, Division of Environmental Protection.

Carl J. Blabaum

Carl J. Blabaum, Acting Director
Bureau of Water Supply and
Pollution Control

CJB:ghh

Enc.

cc: Cons. Engr.
Region 3
Plbg.
I. L. & H. R.

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

L. P. Voigt
Secretary

BOX 450
MADISON, WISCONSIN 53701

June 5, 1969

PLEASE READ CAREFULLY
AND COMPLY WITH ALL
CONDITIONS OF APPROVAL

Mr. Nels E. Knutzen
Construction Engineer
Kewaunee Nuclear Power Plant
Wisconsin Public Service Corporation
P. O. Box 700
Green Bay, Wisconsin 54305

69 362

Dear Mr. Knutzen:

The Division of Environmental Protection has reviewed the information received on January 27, 1969, pertaining to the discharge of wastes from the Kewaunee Nuclear Power Plant, Unit No. 1, Town of Carlton, Kewaunee County, Wisconsin.

Previous submittals and approvals have been granted for the sanitary waste treatment facility (approval number 68-694 dated August 29, 1968) and for the circulating water intake and discharge (approval number 68-343 dated May 21, 1968) for this power plant.

On the basis of this review, correspondence and conferences with interested individuals the following revisions have been agreed upon or are felt necessary.

The temperature rise of the combined service water system and circulating water system is to be approximately 20 degrees F at the maximum summer time flow condition. Maximum discharge temperature is not to exceed 86 degrees F. Studies are being conducted regarding the effect of such warm water discharges on the receiving water courses. If information is forthcoming which indicates an adverse effect, this Division reserves the right to order changes in the proposed project as may be deemed necessary.

According to the engineer the on-site laundry and the hot shower are to be used infrequently for the decontamination of clothing and personnel. Wastes from these sources will be monitored for radioactivity and if contaminated will be processed in the waste evaporator. If not radioactively contaminated, they will be discharged to the sewer system for treatment with the sanitary wastes. It is essential that the operation of the sewage treatment facility not be jeopardized by excessive amounts of flow from this waste source. It has been indicated that amounts in excess of 50% of the design waste flow to the sewage facility will be discharged to Lake Michigan through the circulating water system. This may constitute an unacceptable waste discharge to the Lake. It is felt necessary that information be submitted to this office regarding the quantity and strength of these wastes when they are actually discharged to either the sewage treatment facility or to the Lake so that a determination may be made as to the acceptability of the proposed discharge procedure.

In conformance with the Federally called Lake Michigan Enforcement Conference it is required to limit the discharge of phosphorus to the Lake. It is therefore desirable to investigate alternatives to phosphate treatment for the control of hardness of lake water which may infrequently enter the secondary steam cycle due to excessive condenser leakage.

Floor drains in the turbine building are proposed to discharge through special sumps which are equipped with charcoal or coke filters for adsorption of organic wastes. These floor drain wastes are then to be directed to the circulating water discharge. It is felt that consideration should be given to discharging these wastes to the sanitary sewer system.

The information is hereby approved in accordance with Section 144.555, Statutes, governing water pollution control subject to the following conditions:

1. That the discharge temperature not exceed 86 degrees F.

2. That the operation of the sanitary sewage treatment facility not be jeopardized by excessive amounts of flow from the laundry facility.

3. That the quantity and strength of the wastes discharged from the laundry and hot showers be determined and submitted to this office for an evaluation of the acceptability of the proposed discharge procedure.

4. That alternatives be investigated to phosphate treatment for hardness control.

5. That consideration be given to directing the floor drains in the turbine building to the sanitary sewer system.

The information submitted including the report, sketches and general arrangement drawings have been reviewed in accordance with Section 144.44, Wisconsin Statutes. Where necessary, the information should be submitted to the Department of Industry, Labor and Human Relations or other state or local agencies to insure conformance with applicable codes or regulations of such agencies.

The Division reserves the right to order changes or additions should conditions arise making this necessary. In case installation of these improvements has not been actually commenced within two years from date, this approval shall become void. After two years, therefore, new application must be made for approval of the information submitted before any construction work is undertaken.

By order of Thomas G. Frangos, Administrator, Division of Environmental Protection

Carl J. Blabaum

Carl J. Blabaum, Acting Director
Bureau of Water Supply & Pollution Control

CJB:ghl
cc: Region 3
[illegible]

REVIEWED AND APPROVED BY THE DIV. OF ENVIRONMENTAL PROTECTION, DEPT. NATURAL RESOURCES, IN ACCORDANCE WITH SEC. 144.04, WIS. STATS., SUBJECT TO THE CONDITIONS SET FORTH IN THE LETTER OF APPROVAL.

THOMAS G. FRANGOS
ADMINISTRATOR
DATE:
JUN 5 1969

Section 144.555, Wisconsin Statutes
Report of Intended New Wastes

Wisconsin Public Service Corporation
Kewaunee Nuclear Power Plant
Town of Carlton
Kewaunee County, Wisconsin

RECEIVED
JAN 27 1969
Dept. Nat. Res.

Partial approval for the circulating water intake and discharge system has previously been granted under this Section of Statutes. This submittal is intended to cover all other wastes intended to be released from the Kewaunee Plant under this Section.

APPROVAL NO.
39 363

A description of the sources of wastes, impurities contained therein, temperatures, and estimated amounts of impurities, is given below:

1. Service Water System - the anticipated usage of service water for equipment cooling is 12,000 gpm under normal operating conditions. The returned service water will not contain any added impurities, but will experience a temperature rise on the order of 25°F-30°F. Grits removed from the Service Water by strainers in the system will be collected by diverting strainer backwash through a basket before the backwash water is returned to the lake.

2. Circulating Water System - as mentioned above, partial approval has been granted for the lakefront intake and discharge facilities associated with this system. Briefly, the system is designed for a total flow of 412,000 gpm with 12,000 gpm for the Service Water System and 400,000 gpm for condenser cooling service, during summertime operation. During wintertime operation approximately 280,000 gpm is required for condenser cooling service. During normal plant operation at full power the temperature of the condenser cooling water will be raised approximately 20°F with 400,000 gpm flow, & approximately 29°F with 280,000 gpm flow.

   Grit and debris will be removed from the circulating water by traveling water screens. The debris collected on the screens will be removed by water sprays. The debris and spray water will discharge through the same basket used for removal of the debris from the service water strainer backwash, before the spray water is returned to the lake.

   Chemicals for control of algae will be injected into the circulating water system at various times, depending on the water conditions and temperatures. We are presently planning an injection system for up to 600 gallons per week of sodium hypochlorite solution. Injections would be infrequent and of short duration if present water quality conditions continue at the site. Concentrations of free chlorine in the circulating water would depend on the chlorine demand.

3. Make-Up Water Treatment System - demineralized water is required to make up for losses from the Secondary Steam System and the Primary Coolant System. These losses result primarily from steam generator blowdown, with minor amounts required for air ejector losses and miscellaneous equipment leaks. The make-up water treatment system supplies this demineralized water by treating well water obtained from two deepwells located on the site. The make-up water system is designed for a flow rate of 125 gallons per minute, with normal make-up requirements expected to average 50 gallons per minute. The treatment system will

3. Make-Up Water Treatment System - (continued)
consist basically of ion exchangers, with the only treated wastes being the chemicals used for regeneration of the ion exchange resins. These wastes will be diverted to a waste neutralizing tank where sodium hydroxide or sulfuric acid can be added to bring the pH into the required range of 6 to 8. Backwash and rinse waters used in regeneration of the ion exchange resins will be diverted directly to the circulating water discharge since these waters are purer than the lake water with respect to dissolved or suspended solids, and thus would not contribute any new wastes to the lake.

Releases from the waste neutralizing tank (regenerant chemicals) will not result in concentrations of salts in the circulating water discharge in excess of 65 parts per million ($CaCO_3$ equivalent) above normal concentrations present in the circulating water; the increase will normally be in the range of 15 to 20 parts per million ($CaCO_3$ equivalent). An average release of regenerant chemicals would have a pH of 6.5 to 7.5, contain about 3,000 pounds of dissolved solids (primarily sodium sulfate) and would be 15,000 to 17,000 gallons. It is expected releases will average one every one and one half days.

There will not be any measurable quantities of solids discharged from this system since the raw water is taken from deep wells and has essentially a zero solids content. The temperature of the regenerant chemicals discharged will be essentially ambient or slightly above.

4. Plant Portable Water Softening System - in-plant water for various uses will be softened using a zeolite, salt regenerated water softener. The capacity of the softener is quite small (30-50 gpm) and as a result the regenerant salt requirements are relatively small. The regenerants will be released to the circulating water discharge without treatment and will result in a salt concentration increase of approximately 6 ppm in the discharge. Before dilution the salt concentration is approximately 10%. Under normal usage conditions of the softened water, there will be approximately two days between regenerations, with each regeneration resulting in a release of approximately 2500 gallons of regenerant water.

5. Steam Generator Blowdown - the pressurized water reactor concept being employed at Kewaunee uses a steam generator for exchange of heat between the primary coolant system and the secondary steam system. The steam generator serves as a barrier to the irradiated corrosion products and fission products that are found in the primary coolant system, and also as a source of steam for the turbine generator. On the steam side of the steam generator a "zero solids" chemical treatment will be used for pH control and oxygen scavenging, with pH controlled by using morpholine and oxygen scavenging through the use of hydrazine. However, because of corrosion products and condenser leaks, solids will be present in the feedwater supply to the steam generator. Since the steam generator acts as an evaporator, the solids are concentrated on the secondary side, and in order to maintain their concentration below a limit set by the manufacturer, it is necessary to blow down. As a result, the chemicals used for system chemistry control will be removed in the blowdown water, which is normally directed to the circulating water discharge. Since the hydrazine will react with oxygen to form nitrogen and hydrogen, and breaks down into those gases at the high temperatures encountered in the steam generator, it is expected that hydrazine discharge to the environs will be negligible. There will be a small amount of ammonia discharged through

5. Steam Generator Blowdown - (continued)
the blowdown tank vent to atmosphere, and the air ejector discharge vent to atmosphere, due to some break down of hydrazine to ammonia. Morpholine concentrations will be relatively small, and as a result, morpholine discharges will be minimal.

At various times in the life of the plant it can be expected that there will be periods of excessive condenser leakage, i.e., leakage of lake water into the secondary steam cycle. These periods would be of relatively short duration, however, and would be very infrequent. During these periods, phosphates will be used for control of the hardness ions present and as a result will be removed in the blowdown at concentrations that are not expected to exceed 50 to 60 ppm. The resulting concentration of phosphates in the circulating water discharge would be approximately 0.03 ppm, assuming a blowdown rate of 125 gpm. Alternatives to phosphate treatment will be investigated and,if found suitable,will be used in preference to the phosphates.

As mentioned above, the normal discharge path for the blowdown water is directly to the circulating water discharge. However, if leakage from the radioactive primary coolant system (through the steam generator tubes) to the secondary steam system should cause the radioactivity releases to the lake, as determined by sampling, to approach the limitations of Chapter 10, Code of Federal Regulations, Part 20, the blowdown would be diverted to the waste disposal system (described below) for removal of the radioactive contaminants before the liquids are released to the lake.

6. Waste Disposal System - the liquid waste disposal system is provided to process radioactive liquids, removing the radionuclides by an evaporation process, and thus allowing the pure separated water to be released to the lake after sampling, via the circulating water discharge. The radionuclides are concentrated by the evaporation process in a waste evaporation, the solids resulting from the evaporation process are commonly known as "evaporator bottoms" and are removed from the evaporator by pumps, placed in metal drums, mixed with cement, and sent off-site for burial in an AEC approved burial ground. A simplified flow diagram of the waste disposal system is attached (see Figure 1).

Equipment and floor drains in the Reactor Building and Auxiliary Building (see attached drawings 237127A - A-203 through A-213) will normally be radioactive and will,therefore , be processed through the Waste Disposal System before release of the liquids to the circulating water discharge. Under abnormal conditions, these liquids may not require processing through the waste evaporator due to low radioactivity levels. This condition could arise, for example, if excessive quantities of water are used from the service water system (lake water) for miscellaneous purposes. Under these conditions, the liquids would be released directly to the circulating water discharge.

All wastes from the potentially radioactive areas will be analyzed for radioactivity content prior to release to insure that the limits of 10 CFR 20 will not be exceeded. As an added precaution, all liquid releases will pass through a radiation monitor (which alarms high radioactivity in the liquid by an audible and visible signal in the main control room) to insure that inadvertent discharges or radioactivity above the allowed limits do not occur.

6. Waste Disposal System - (continued)

The main contaminant in the liquid releases from the waste disposal system will be dirt and grit, with very small quantities of boron present as boric acid. The amounts of both, however, will be quite small since they are removed by the processing of the wastes through the waste evaporator.

Absolute amounts of liquid releases through the system are very difficult to estimate since there are many variables which affect discharge quantities. The waste evaporator, however, sets the limit on the maximum amount of processing since the unit is designed to process 2 gallons per minute of waste. Thus the absolute maximum of processed wastes released in one year would be approximately one million gallons, assuming continous operation of the waste evaporator. The average boron concentration in these wastes could be as high as 50 parts per million. Using the above conservative release figure of one million gallons, this would result in a yearly boron release from the waste disposal system of approximately 400 pounds. Releases will be made in batches of 1,000 gallons at rates up to 50 gallons per minute, resulting in average boron concentrations of approximately 0.01 parts per million in the circulation water discharge. Temperature of these releases will range from ambient to 180°F.

7. Boric Acid Recycle System - the pressurized water reactor utilizes boric acid as a means of controlling reactor power level. During load changes, startups, maintenance shutdowns, etc., water containing the boric acid will be removed from the primary coolant system. The boron recycle system conserves both the water and boric acid by purifying in mixed bed demineralizers, filtering, and then processing in an evaporator. The concentrated boric acid and pure water will be the products removed from the evaporator and both will be stored for reuse. Discharges of this pure water will occasionally be made due to over-capacity within the system. There will be traces of boric acid present in this pure water (approximately 50 ppm), with a resulting boron concentration of approximately 0.01 ppm in the circulating water discharge assuming a release rate of 50 gpm. Any discharges from the boron recycle system to the circulating water discharge would pass through the radiation monitor in the waste disposal system, and will not exceed the limits of 10 CFR 20 for radioactivity content. The amount of boric acid discharged from this system is not expected to exceed 7,500 pounds per year.

8. Laundry and Hot Shower Drains - this system receives the drains from the on-site laundry, which is used for clothing decontamination, and from the infrequently used hot shower, provided for decontamination of personnel. The primary contamination in these waters is detergent from the laundry. Normally these wastes will not be radioactive and would not, therefore, require processing through the waste disposal system waste evaporator. In this case, the wastes would be discharged to the sewer system in amounts not to exceed 50% of the average daily sewage system design flow. In any event, the flows will not be allowed to affect proper operation of the sewage treatment plant. If disposal of these wastes becomes impossible through the sewage treatment plant, they will be directed to the circulating water system discharge.

If the wastes from this system are radioactive above the limits required for direct release, they will be processed through the waste evaporator before discharge to the circulating water discharge, thus removing nearly all of the contaminants.

8. Laundry and Hot Shower Drains - (continued)

On the average we are expecting about 100 gallons per week to be released from this system. However, during maintenance shutdowns the amounts could get as high as 5,000 gallons per week. Maintenance shutdowns are expected to occur once per year for a period of four to six weeks.

9. Turbine Building Miscellaneous and Floor Drains - the normal disposal of floor drains in the turbine building, including miscellaneous funnel drains, etc., will be into a sump in the turbine building. This sump is of a special design (see Figure 2) in that floor wastes will pass through a charcoal or coke filter before being pumped to the circulating water discharge. This will remove the major portion of the organic wastes which may be present from floors in the area, although the quantities will be small. The filters would also remove a major amount of any detergents that may be present in the floor drains from normal janitorial clean-up within the turbine building. Oil contamination in a major sense is not possible due to construction of special oil retaining sumps around that equipment whose catastrophic failure would result in large oil releases. It is thus expected that normal releases to the circulating water system from floor and miscellaneous drains in the turbine building will be minimal in all contaminants.