15.

Davis-Besse

DRAFT DETAILED STATEMENT

ON ENVIRONMENTAL CONSIDERATIONS

FOR THE DAVIS-BESSE NUCLEAR POWER STATION

OPERATED BY

TOLEDO EDISON COMPANY

AND

CLEVELAND ELECTRIC ILLUMINATING COMPANY

(DOCKET NO. 50-346)

Prepared by Argonne National Laboratory
for the U. S. Atomic Energy Commission

August 1972

SUMMARY AND CONCLUSIONS

This Draft Environmental Statement was prepared by the U. S. Atomic Energy Commission, Directorate of Licensing.

1. This action is administrative.
2. The proposed actions are the continuation of construction permit CPPR-80 and the issuance of an operating license to the Toledo Edison Company and the Cleveland Electric Illuminating Company for the start-up and operation of the Davis-Besse Nuclear Power Station located near Port Clinton in Ottawa County, Ohio (Docket No. 50-346).

   The Station will use a pressurized water reactor (PWR) to produce about 2633 megawatts (MW) of heat to generate about 872 MW of electricity. The turbine steam condenser will be cooled by water circulated through a single hyperbolic natural-draft cooling tower. Makeup water for the cooling tower will be taken from Lake Erie.
3. Summary of environmental impact and adverse effects:
   a. Approximately 150 acres of farmland have been removed from production of grain crops and converted to industrial use.
   b. There will be a temporary disturbance of the lake shore and lake bottom during construction of the Station water intake and discharge pipes and the temporary barge channel.
   c. Because of the location of the Station in a migratory bird flyway and close proximity to bird refuges, there is a possibility of occasional occurrences in which large numbers of birds are killed by flying into the cooling tower.

d. The cooling tower blowdown and service water which the Station discharges to Lake Erie, via a submerged jet, will be heated up to 20°F above lake water. The thermal plume resulting from the maximum thermal discharge will have an area of about 0.7 acres within the 3°F isotherm (above lake ambient).

e. There will be locally high levels of residual chlorine (up to 0.5 ppm) close to the Station discharge jet during the daily periodic chlorinations of the cooling tower circulating water.

f. The Station's natural-draft cooling tower will have an adverse visual impact on the surrounding areas.

g. There is a possibility that the cooling tower may augment natural fog within several miles of the Station - particularly in the winter months.

h. Slightly increased local snowfall close to the Station may result from the cooling tower plume in winter.

i. About 101 miles of transmission lines are being constructed, primarily over farmland, requiring about 1800 acres of land for the rights-of-way.

j. The Station will discharge approximately 150 microcuries per year of mixed isotopes and 260 curies per year of tritium to Lake Erie. An additional 740 curies per year of gaseous radioactive wastes will be discharged to the atmosphere.

k. A very low probability of risk of accidental radiation exposure to the public will be created.

l. An increase in the local economy will result from operation of the Station.

4. The principal alternatives considered are:
   a. Alternative fuels
   b. Alternative sites
   c. Purchase of power
   d. Alternative cooling systems
   e. Auxiliary cooling for service water and blowdown effluent
5. The following Federal, State and local agencies have been requested to comment on this Draft Environmental Statement:

   Council on Environmental Quality
   Department of Transportation
   Department of Commerce
   Department of Health, Education and Welfare
   Department of the Army, Corps of Engineers
   Federal Power Commission
   Department of the Interior
   Department of Agriculture
   Department of Housing and Urban Development
   Environmental Protection Agency
   Governor of the State of Ohio
   Ohio Department of Health
   Ohio Department of Natural Resources
6. This Draft Environmental Statement was made available to the public, to the Council on Environmental Quality, and to the other agencies noted above in October 1972.
7. On the basis of the analysis and evaluation set forth in this Statement, after weighing the environmental, economic, technical, and other benefits of the Davis-Besse Nuclear Power Station against the

environmental costs and considering the available alternatives, it is concluded that the actions called for are the continuation of construction permit CPPR-80 and the issuance of an operating license authorizing operation of the facility, subject to the following conditions for the protection of the environment:

a. The development of a terrestrial monitoring program to detect changes in the fauna in the vicinity due to operation of the cooling tower. It is suggested that such a program could focus on the barrier beach plant community at the site.

b. The development of a program to record any kills due to birds hitting the cooling tower and other Station structures. Emphasis should be placed on observations during adverse weather conditions and during the spring and fall migratory seasons. The program should start as soon as the cooling tower reaches its full height, and should also explore methods for reducing the problem in the event that large numbers of birds are killed.

c. The development of an aquatic monitoring program to measure the residual chlorine levels in the lake in the vicinity of the discharge jet. If the results of these measurements verify that the level is below the recommended EPA criteria outside a suitable mixing zone (to be established), the measurements can be discontinued, provided the applicant exercises suitable controls within the Station during chlorination.

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FOREWORD

This Draft Detailed Statement applies to the environmental considerations for the Davis-Besse Nuclear Power Station (Docket No. 50-346) under construction near Port Clinton, Ohio by the Toledo Edison Company, in partnership with the Cleveland Electric Illuminating Company. The currently scheduled start-up date is December 1974.

The National Environmental Policy Act of 1969 (NEPA) requires that all agencies of the Federal Government report on major federal actions significantly affecting the quality of the environment. These agencies are required to prepare a detailed statement which includes evaluation of the following items set forth in Section 102(2)(c) of the NEPA:

i. The environmental impact of the proposed action,

ii. Any adverse environmental effects which cannot be avoided should the proposal be implemented,

iii. Alternatives to the proposed action,

iv. Relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity,

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

In order to implement the NEPA, and to reflect the guidance of the Council on Environmental Quality and the "Calvert Cliffs decision" by the United States Court of Appeals, the Commission has revised

Appendix D of 10-CFR-50. This Statement was prepared in accordance with the provisions of the revised Appendix D by the Directorate of Licensing of the U. S. Atomic Energy Commission with assistance from Argonne National Laboratory.

The documents used in this review were the applicant's Environmental Report and Supplements, the applicant's Preliminary Safety Analysis Report (PSAR) and amendments thereto, testimony prepared by the applicant for show cause hearings, the Commission's Safety Evaluation and show cause hearing review, and the documents listed at the end of each chapter. All the material submitted by the applicant in support of his application, and other pertinent documents, are available for public inspection at the AEC Public Document Room, 1717 H Street Northwest, Washington, D. C. 20545.

The applicant must comply with all requirements of Section 21(b) of the Federal Water Pollution Control Act, as amended by the Water Quality Improvement Act of 1970 (Public Law 91-224).

All comments (to be sent to the Deputy Director for Reactor Projects, Directorate of Licensing) and the applicant's responses will be taken into account in the preparation of the AEC's final environmental statement for the Station. That final environmental statement will include a conclusion by the Director of Regulation or his designee as to whether, after weighing the environmental, economic, technical, and other benefits against environmental costs and considering available alternatives, the action called for is issuance or denial of the proposed operating license or its appropriate conditioning to protect environmental values.

A notice of AEC Consideration of Issuance of Facility Operating License for the Davis-Besse Nuclear Power Station will be published in the Federal Register. Mr. Robert G. West (301-973-7343) is the AEC Environmental Project Manager for this Draft Environmental Statement.

1. INTRODUCTION

1.1 STATUS OF PROJECT

The Toledo Edison Company (TEC) and the Cleveland Electric Illuminating Company (CEIC) are both privately owned public utility companies engaged in supplying electrical energy to the public. These two companies, hereafter referred to as the applicant, will jointly own the Davis-Besse Nuclear Power Station (the Station) as tenants in common, with TEC having a 52.5% share of ownership and CEIC owning the remaining 47.5%. TEC is responsible for the design, construction and operation of the Station. Both companies are members of the Central Area Power Coordination Group (CAPCO), a group of four electric utilities in Ohio and Pennsylvania that pool their generating and transmission capabilities, to benefit from the economy and increased reliability of large-scale operation. Currently, CAPCO has an installed generating capacity of about 11,000 MWe. The Davis-Besse Station is the fourth generating facility constructed under the CAPCO group agreement.

The Station is being constructed on 56 acres of a 954-acre tract, located in northwestern Ohio on the shore of Lake Erie in Ottawa County, about 21 miles east of Toledo, Ohio. The site terrain is virtually featureless and contains about 600 acres of marsh land, the remainder being, or having been, marginal farm land. The site has a 7500-foot frontage on Lake Erie, and is generally only slightly higher than the normal lake water level.

The Station will have a net electrical capacity of 872 MW and will utilize a pressurized water reactor (PWR) supplied by the Babcock & Wilcox Company. Most of the heat from the turbine steam condenser will be dissipated to the atmosphere by means of a natural-draft cooling tower, 490 feet high and 415 feet in diameter. Water for the Station will be drawn from Lake Erie via a submerged intake crib and a pipe buried under the lake bottom. Construction at the Station is now more than 20% complete and the current schedule calls for start up by December 1974.

On August 1, 1969, the applicant filed for all necessary AEC licenses to construct and operate the Station. On September 10, 1970 an AEC exemption was granted allowing the applicant to do below-grade work before issuance of the construction permit. The Advisory Committee on Reactor Safeguards (ACRS) reported favorably on the application on August 20, 1970, and the formal Safety Evaluation Report by the Division of Reactor Licensing (DRL) was issued on November 2, 1970. A construction permit stage public hearing before the Atomic Safety and Licensing Board (ASLB) was held on December 8-10, 1970. This hearing was contested and subsequent sessions were held, with the final one finishing on February 12, 1971. A favorable decision was reached by the ASLB on March 23, 1971 and Construction Permit No. CPPR-80 was issued by the AEC on March 24, 1971. The operating license application has not been filed yet.

As required by the Commission's implementation of the National Environmental Policy Act (NEPA) outlined in 10CFR-50, Appendix D, an Environmental Report (ER) was submitted on Aug 3, 1970. On November 5, 1971 the applicant submitted a two volume Environmental Report

Supplement as required under the amendments to 10 CFR 50. Although the applicant has sent copies of the ER and Supplement to various state agencies, no form comments have been received. The Commission has received comments on the ER from a number of Federal Agencies.1

1.2 SITE SELECTION

When the applicant began to seek a site for the Station, an option was acquired on an established privately owned game marsh (Darby Marsh) east of the present site, closer to Port Clinton. At the time, the U. S. Bureau of Sport Fisheries and Wildlife had recently acquired what is mostly the principal part of the marsh area of the present site, for development as a National Wildlife Refuge (Navarre Marsh). In order to provide a larger exclusion area for the Station (largely by acquisition of adjacent land, not owned by the Bureau, and available without relocation of the State highway) and to locate farther from Port Clinton, it was arranged to exchange the properties, but with a provision that the Bureau would have management under a long-term lease of the unused marsh areas at the Station as a wildlife refuge. The net result was the addition of over 600 acres to the area under Bureau management.

Three sites had previously been considered and rejected by the applicant. These were: (1) Bayshore where the applicant already has a fossil-fuel station (too close to Toledo for a nuclear station); (2) Darby Marsh (too close to Port Clinton for a nuclear station), which was exchanged for the present site, and (3) Erie Industrial Park (congested area not enough land available).

The present site is favorable for a nuclear station for a number of reasons: (1) the site is far enough from population centers to satisfy 10 CFR 100 siting requirements; (2) there is a readily available, steady supply of water - Lake Erie; (3) the site has favorable geological and hydrological features for a nuclear station; (4) the location in the applicant's service territory is favorable with respect to the load centers, (5) the site is readily accessible by water, road, and rail transportation.

There are no nearby sources of major air and water pollution since the surrounding area is predominantly rural and recreational.

Rather extensive contact has been made with local citizens, primarily by means of newspaper articles and information booklets. The Ottawa County Planning Commission was consulted and informed of the applicant's plans to use the present site.

1.3 STATUS OF APPLICATIONS AND APPROVALS

The following is a history of the required federal, state, and local permits that have been applied for by the applicant and which have either been received or are pending:

1.3.1 Federal

	Permit	Status
a.	U. S. Atomic Energy Commission Construction Permit No. CPPR-80.	Received on March 24, 1971

b. Army Corps of Engineers permit for dredging a temporary barge channel	Received on Aug 4, 1972
c. Army Corps of Engineers permit to construct offshore acilities (submerged water intake, intake pipe, discharge pipe, and rockfills) under the Rivers and Harbors Act of 1899.	Application filed on Aug 3, 1972
d. Army Corps of Engineers Permit for discharge of plant effluent to Lake Erie under the Refuse Act of 1899.	Application filed on Aug 3, 1972
e. Federal Aviation Administration approval for station (without cooling tower)	Received May 21, 1970
f. Federal Aviation Administration approval for cooling tower.	Received August 11, 1971

1.3.2 State of Ohio

a. Ohio Department of Industrial Relations approval of plans and specifications and building permit.	Received October 20, 1970
b. Ohio Department of Health permit for potable water supply to be used during construction period.	Received November 9, 1971

c. Ohio Department of Health permit for sewage treatment plant for construction period, and also for completed station.	Received June 21, 1971
d. Ohio Department of Health permit for installation of building sanitary and drain systems.	Received July 27, 1971
e. Ohio Department of Health approval of plans for treatment of wastes	Submitted August 1972
f. State Water Quality Certification.	Received March 21, 1972
g. Ohio Turnpike Commission permit for turnpike crossing with transmission line.	Received-date unknown
h. Ohio State Highway Department permits for transmission line crossings of state highways.	Received-date unknown
i. State Department of Highways permits for grade crossing of state highways for railroad spur.	Received-date unknown

1.3.3 Local

a. Ottawa County building permit.	Received October 14, 1970
b. Ottawa County Engineer permits for grade crossings of roads and highways for railroad spur.	Received-dates unknown

c. City of Oregon building permit and certificate of occupancy for transmission lines.	Received-date unknown

1.3.4 Public Hearings

a. Atomic Safety and Licensing Board (ASLB) Construction permit hearings	Commenced December 8, 1970 - finished February 12, 1971
b. Ohio Water Pollution Control Board hearing.	July 28 & 29, 1971
c. Atomic Safety and Licensing Board (ASLB) hearings as to whether the construction of Davis-Besse should be suspended until the final NEPA review.	May 2-4, 1972
d. Atomic Safety and Licensing Board (ASLB) hearing to receive evidence relating to environmental effects that may occur subsequent to NEPA review and relating to environmental effects of operation of the plant.	July 7 & 8, 1972

REFERENCE

1. Detailed Statement on the Environmental Considerations by the Division of Reactor Licensing U.S. Atomic Energy Commission Related to the Proposed Construction of Davis-Besse Nuclear Power Station by the Toledo Edison Company and the Cleveland Electric Illuminating Company, Nov 20, 1970.

2. THE SITE

The Davis-Besse site is located in Ottawa County, Ohio, on the southwest shore of Lake Erie, about 21 miles east of Toledo. This section of Ohio, bordering Lake Erie from Toledo to Port Clinton, is flat and marshy with maximum elevations only a few feet above the lake level, and is quite sparsely populated. The area was originally swamp forest and marshland, rich in wildlife but useless for settlement and farming. During the 19th century the land was cleared and drained, and has since been farmed quite successfully. Growing awareness of the commercial value of the marsh wildlife, particularly the muskrat, and of the economic benefits to be derived from wildfowl hunting, led to the beginnings of marsh management early in this century, and resulted in the restoration and preservation of some marsh areas. Today the terrain consists of farmland with marshes extending in some places as far as two miles inland from the sandy lakeshore ridge. More than half of the site area itself is marshland.

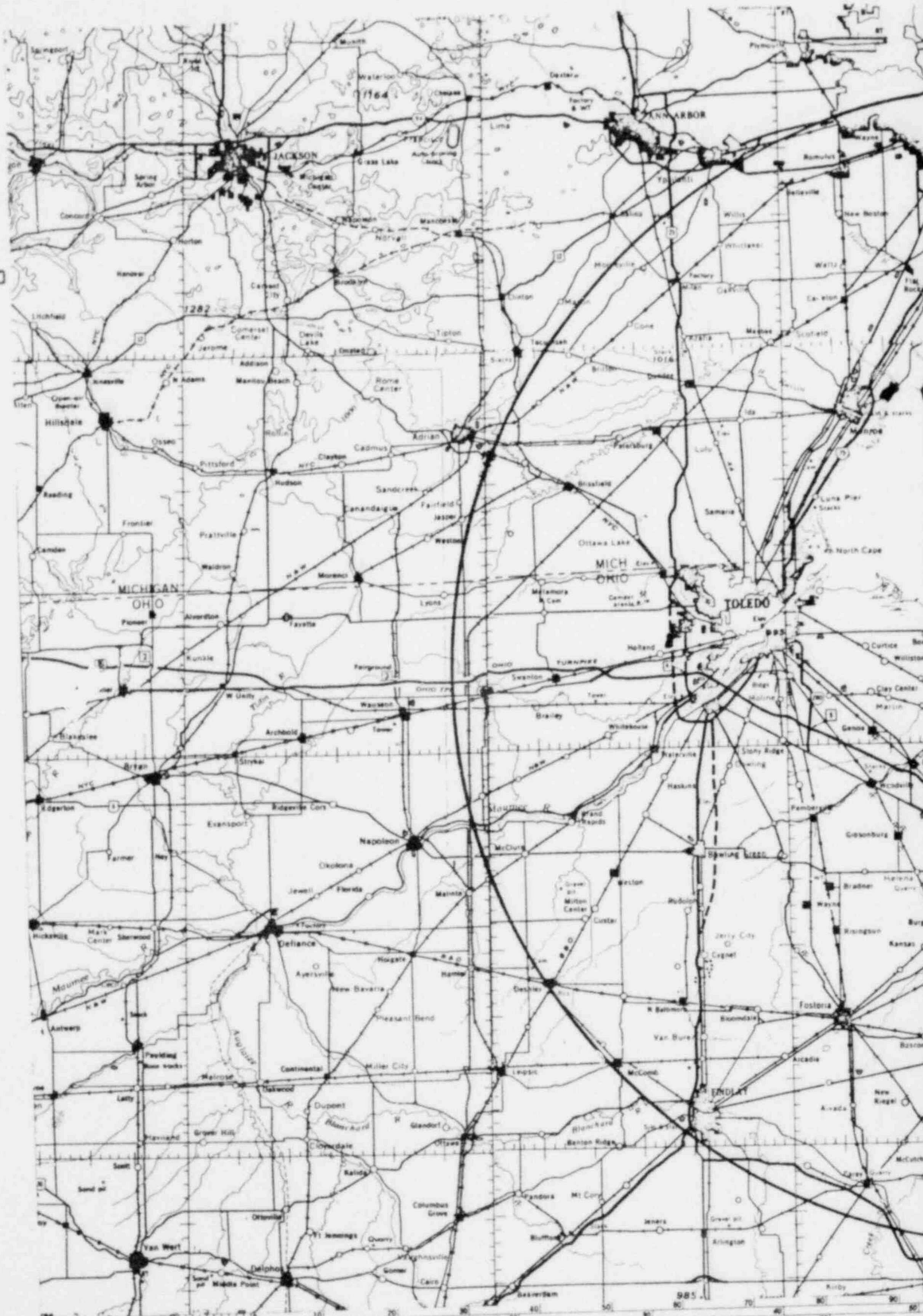
Although the farmland portion of the site is marginal, the marshes are an invaluable ecological resource, providing breeding grounds for a rich variety of wildlife and a refuge for migratory wildfowl. Extensive areas are now devoted to state and national wildlife refuges, public recreation areas and private hunting preserves. There are some residences along the lakeshore used mainly as summer homes, but the major resort area of the County is farther east, around Port Clinton, Sandusky, and the group of islands known as Put-in-Bay.

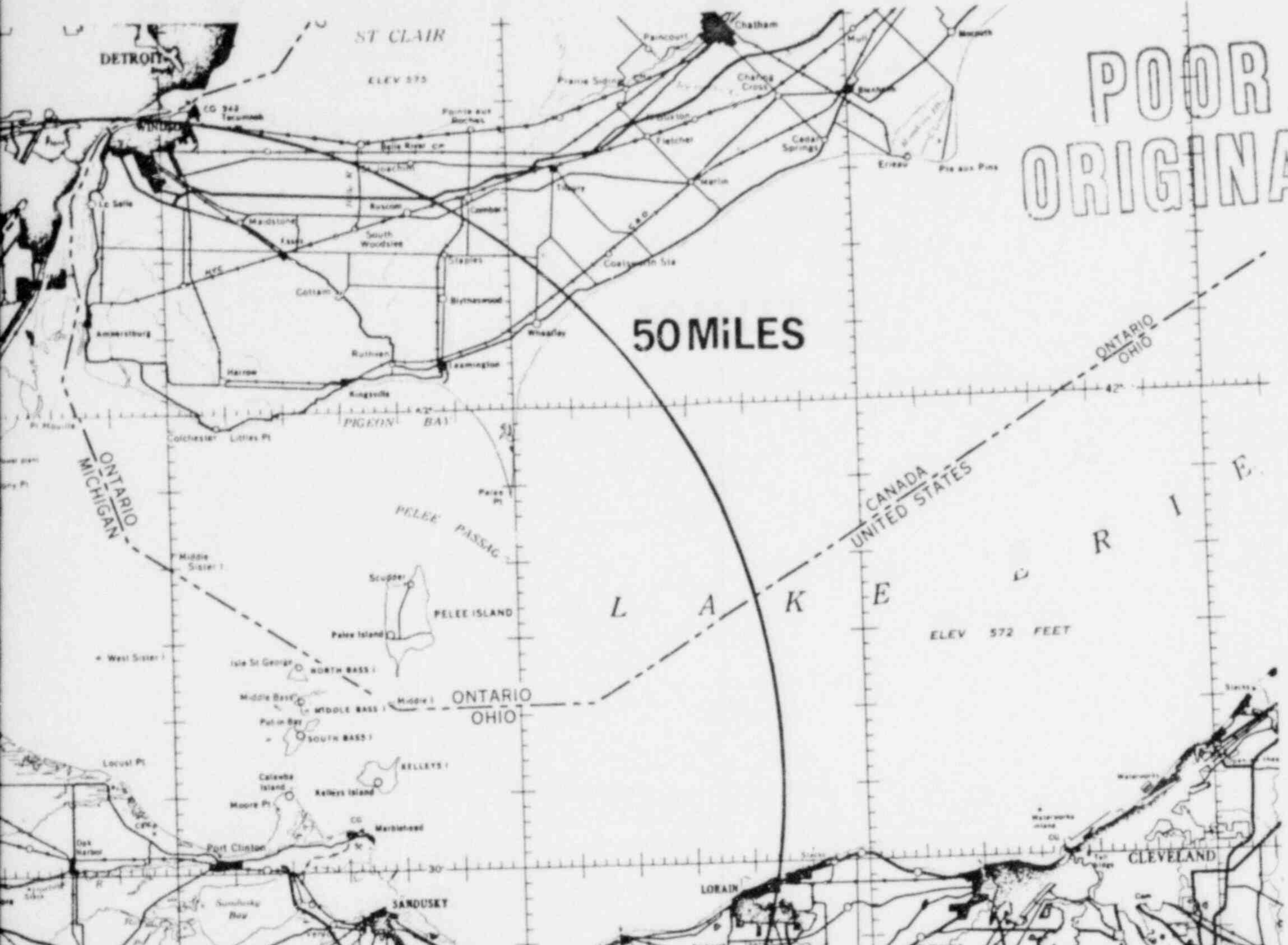
2.1 SITE LOCATION

Figure 2.1 is a map showing the location of the site with respect to nearby population centers, transportation facilities, and natural features. Fig. 2.2 is a local map showing the location of the site, nearby roads, railroads, conservation and recreation areas. Fig. 2.3 is an aerial photograph, taken early in construction, showing the site boundaries and marsh areas. Fig. 2.4 is a site plan showing the land acquisitions and future disposition of the various areas.

The 954-acre site is located in Carroll Township, Ottawa County, just north of the mouth of the Toussaint River and has a Lake Erie frontage of 7,250 feet. The coordinates of the cooling tower, as supplied by the Federal Aviation Administration, are 41o 35' 57" N and 83o 05' 28" W. The nearest population centers are Toledo, 21 miles WNW, and Sandusky, 21 miles SE, of the site. The nearest incorporated communities are Port Clinton, 7 miles SE, Oak Harbor, 6 miles SW, and Rocky Ridge, 7 miles WSW of the site. There are groups of cottages known as Sand Beach and Long Beach, used mainly during the summer months, along the lakeshore from the northern boundary of the site to Locust Point, about 2 miles to the northwest. Beyond Locust Point is the nearest public recreational area, Crane Creek State Park. The western boundary of the site is Ohio Route 2, a two-lane paved highway at this point, and there is another group of cottages close to the southwest corner of the site, where this highway crosses the Toussaint River.

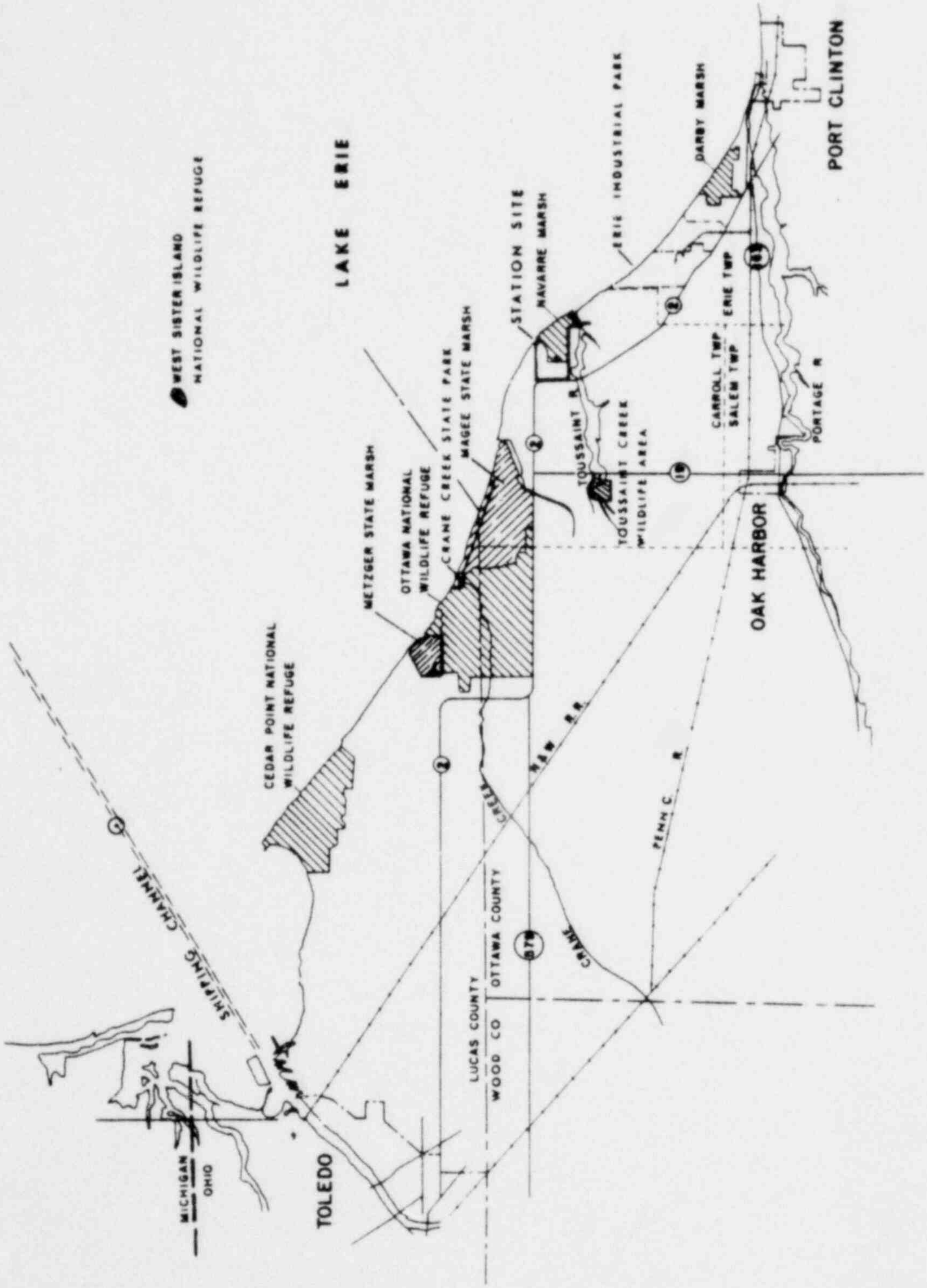
POOR ORIGINAL





POOR ORIGINAL

DAVIS-BESSE NUCLEAR POWER STATION
SITE LOCATION & GEOGRAPHIC
FEATURES 50 MILE RADIUS
Fig. 2.1

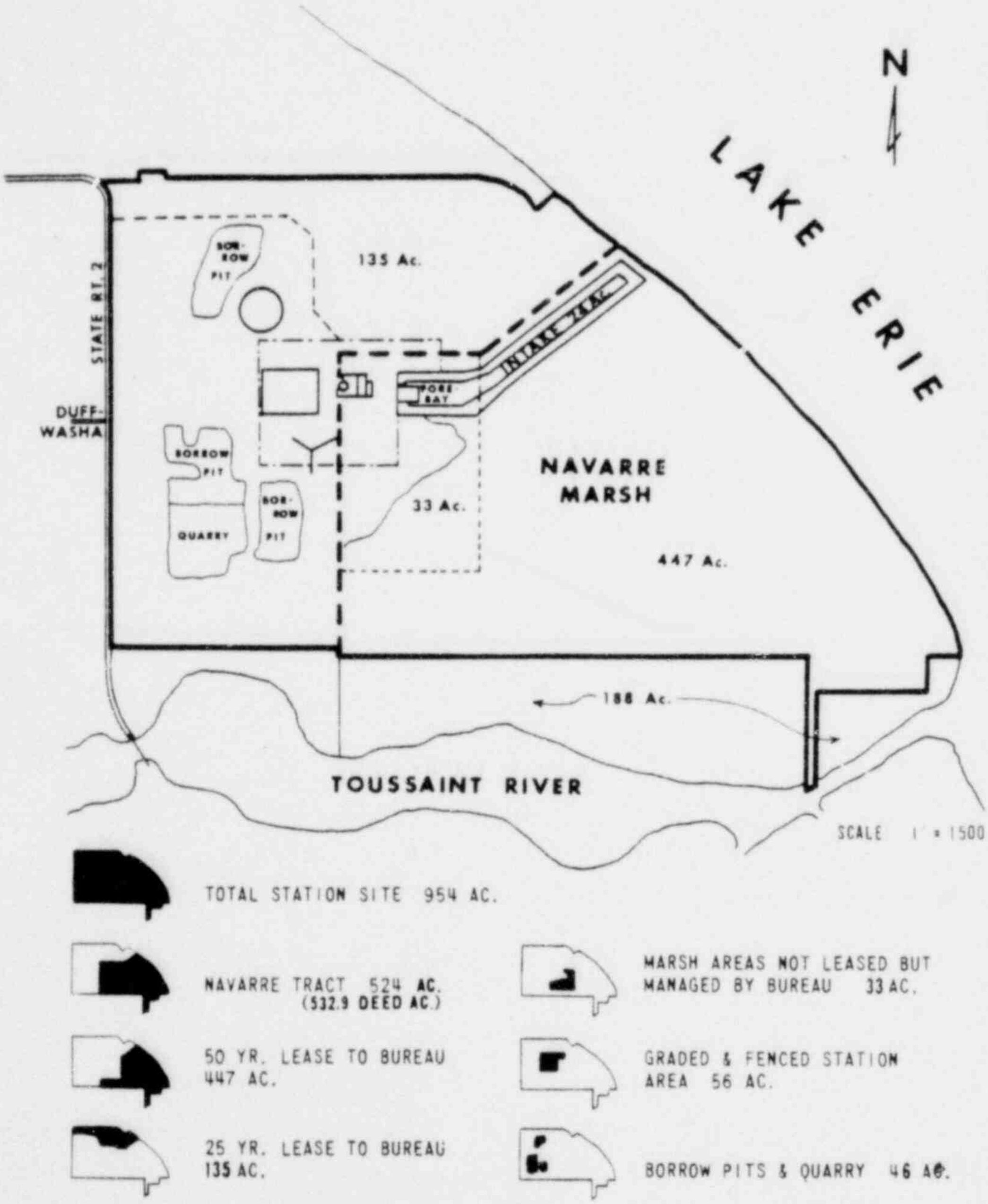


DAVIS-BESSE NUCLEAR POWER STATION
SITE LOCATION PLAN
Fig. 2.2

▮▮▮▮▮▮ SITE BOUNDARY

DAVIS-BESSE NUCLEAR POWER STATION

AERIAL PHOTOGRAPH
AUGUST 3, 1971
Fig. 2.3



DAVIS-BESSE NUCLEAR POWER STATION
SITE AREAS
Fig. 2.4

The site includes a tract known as Navarre Marsh (524 acres), mainly marshland, but including some upland where the main station structures are being built. This tract was acquired from the U.S. Bureau of Sport Fisheries and Wildlife, Department of Interior, in exchange for a similar marshland tract of about the same size known as Darby Marsh, on which the applicant had an option. Darby Marsh is about 5 miles southeast, close to the western limits of the City of Port Clinton. A Memorandum of Understanding was signed on October 4, 1967, and a binding agreement was accepted by the U. S. Government on January 30, 1968. Under the terms of this agreement the applicant undertook to lease back to the Bureau the unused portions (447 acres) of the original Navarre Tract. A 50-year lease was signed on November 1, 1968.

The remainder of the site was acquired from private owners in 13 parcels between December 1967 and July 1970. These acquisitions included 7 residences, and displaced a total of 25 people. A 135-acre marsh area, previously in private ownership, will be leased to the Bureau for 25 years. This lease agreement has not yet been signed. In addition, the Bureau has been given management of a further 33 acres of marshland without formal lease. These agreements will give the Bureau management of the entire marsh area of the site, with the exception of 24 acres used for the construction of the intake canal.

Under the terms of the agreements with the Bureau, the applicant has constructed an earthen dike along the northern boundary of the property to separate the site from the adjoining privately owned marsh, and to provide seasonal water level control for better management of the marsh as a wildlife refuge. Similar measures are employed in the other Federal and State refuges in the area.

The 954 acres of the site property include a drainage canal right-of-way to the Toussaint River near its point of discharge into Lake Erie. This canal carries storm water from the site, and, as a temporary measure, ground water pumped from the excavations during construction. In March 1971 the applicant purchased the remaining property between the southern site boundary and the river, a total of 188 acres, to prevent further development close to the site boundary and as further protection for the wildlife habitat. This tract is not part of the site proper, and is leased to a private concern for wildfowl hunting.

Of the property retained by the applicant, a total of 339 acres, the graded and fenced Station area will occupy 56 acres. At present a further 46 acres are occupied by borrow pits and a quarry from which fill and crushed rock have been obtained during construction. When pumping of water from the excavations is discontinued, these will fill with water to form ponds.

The Station buildings will be about 3000 feet from the lakeshore, and at least 2400 feet from any point on the site boundary. The various areas described above are shown in Fig. 2.4.

2.2 DEMOGRAPHY AND LAND USE

2.2.1 Residential

The area is sparsely populated; Ottawa County (county seat - Port Clinton) had a population of 35,323 in 1960, and this had increased to 37,099 by 1970 - an average population density of 146 persons per square mile. The population increased mainly in the western townships closest to the Toledo metropolitan area and in the resort areas around and to the east of Port Clinton, including the island communities of Put-in-Bay Township. The population of the rural townships in the middle of the county remained nearly stable or declined slightly in this ten-year period. Carroll Township, in which the site is situated, has the lowest population density of all the townships in the county (about 37 persons per square mile in 1970) and its population is declining, as shown in Table 2.1.

Toledo and Sandusky, both about 21 miles from the site, had populations of 383,818 and 32,674, respectively, in 1970. Fremont, 17 miles south of the site, had a 1970 population of 18,490.

There are no incorporated communities in Carroll Township, or within 5 miles of the site, and there are only three communities within 10 miles: Port Clinton, Oak Harbor, and Rocky Ridge. Past population trends and projections[1] for the 8 incorporated communities in Ottawa County are given in Table 2.2.

TABLE 2.1. Population and Projections for Ottawa County by Townships[1]

Township	Population (Census)				Population (Projected)	
	1940	1950	1960	1970	1980	1990
Allen	2,196	2,563	2,755	2,829	3,000	3,500
Bay	552	1,432	1,716	1,798	1,950	2,250
Benton	1,977	2,116	2,366	2,340	2,400	2,750
Carroll	1,336	1,519	1,570	1,355	1,350	1,350
Catawba Is.	462	780	1,769	2,882	4,000	4,900
Clay	2,638	3,278	4,331	4,918	5,700	6,700
Danbury	2,483	3,222	3,526	3,760	4,100	4,800
Erie	835	1,145	1,566	1,470	1,500	1,000
Harris	2,067	2,273	2,675	2,784	3,000	3,400
Portage	6,113	7,013	8,111	7,948	8,200	9,300
Put-in-Bay	609	598	462	507	600	650
Salem	3,092	3,530	4,476	4,508	4,700	5,400
County Total	24,630	29,469	35,233	37,099	40,500	46,600

TABLE 2.2. Populations and Projections for Incorporated Communities in Ottawa County[1]

Community	Distance (miles) and Direction	Population (Census)				Population (Projected)	
		1940	1950	1960	1970	1980	1990
Clay Center	14 W	*	590	446	370	390	410
Elmore	13 SW	1,103	1,215	1,302	1,316	1,520	1,780
Genoa	15 WSW	1,455	1,723	1,957	2,139	2,800	3,290
Marblehead	14 ESE	915	867	858	726	1,100	1,290
Oak Harbor	6 SW	1,925	2,370	2,903	2,807	3,030	3,490
Port Clinton	7 SE	4,505	5,541	6,870	7,202	7,450	8,430
Put-in-Bay	14 WNW	202	191	357	135**	160**	180**
Rocky Ridge	7 WSW	275	358	441	385	650	950

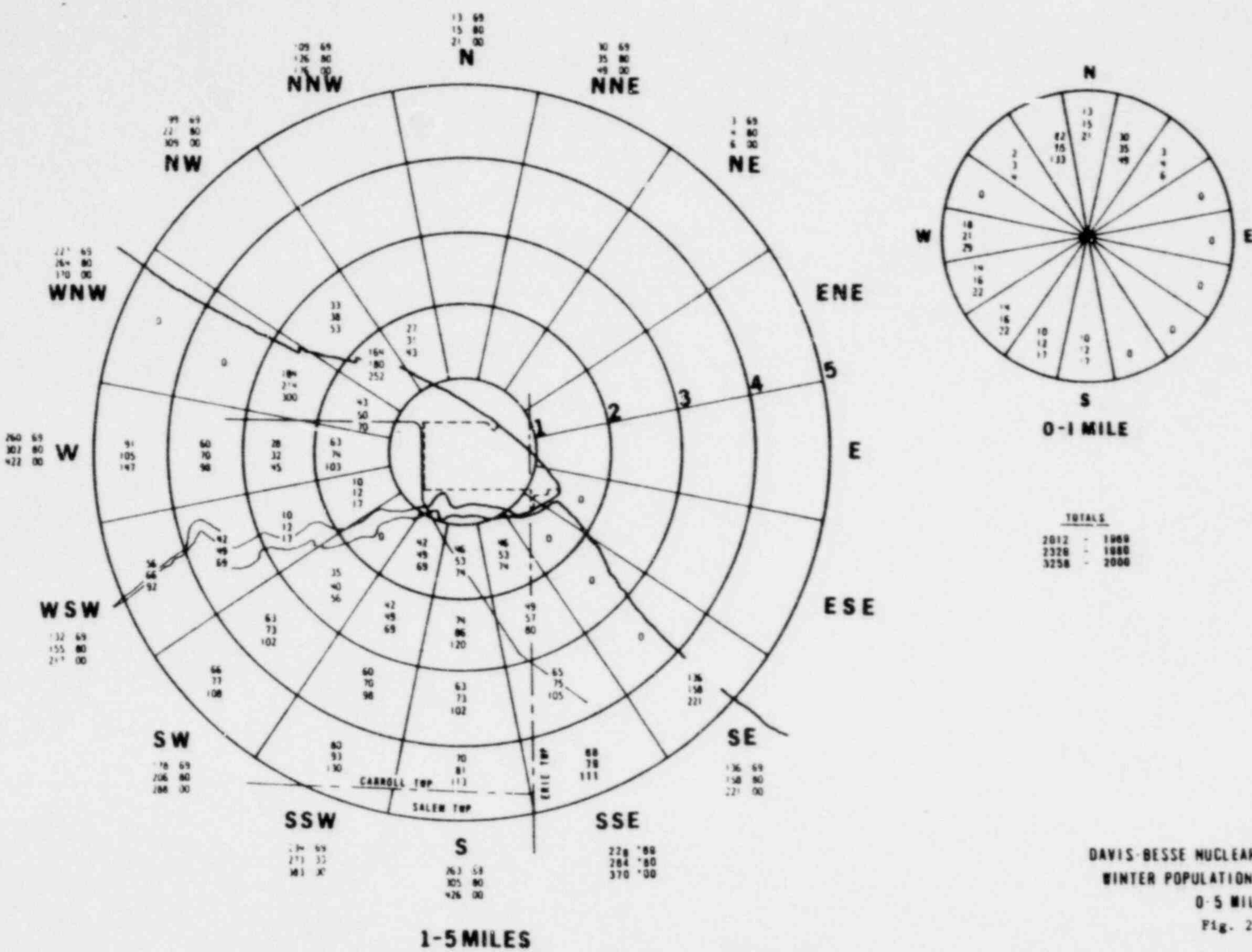
*Incorporated 1947.

**Note: The Planning Commission questions the 1970 census figure for Put-in-Bay Village, showing a large decrease between 1960 and 1970, and suggests that the 1970 figure should be 351. The Projections should be adjusted accordingly if this is so.

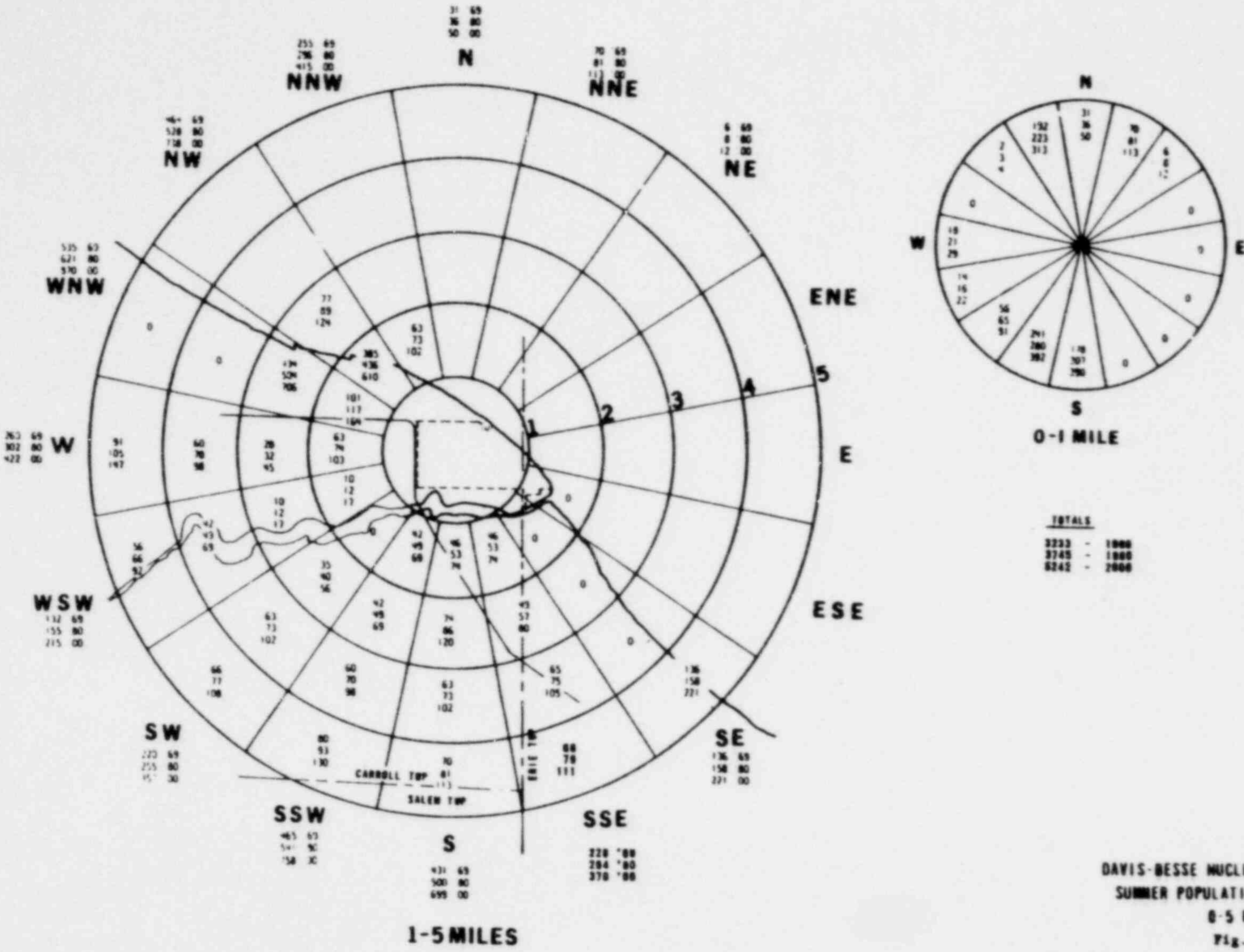
In addition to the permanent residents in the vicinity of the site, there is a small seasonal population in the cottages along the lakeshore and on the Toussaint River. The lakeshore cottages occupy the ridge between the lake and the marshes, and there is little space for further development. Figures 2.5 and 2.6 show the estimated populations within one-mile annuli from 0 to 5 miles from the site in winter and summer, respectively.[2] Figure 2.7 similarly shows the population distribution within 50 miles of the site according to the 1970 census. The 0-5 mile estimates were made by the applicant in 1969 by counting residences and using an average number of persons per residence. Year-round occupancy was deduced by inspection of electricity meter records for the summer and winter months. These estimates are probably still valid, since there has been no new construction and the local population is declining.

2.2.2. Industrial Population and Land Use - Zoning

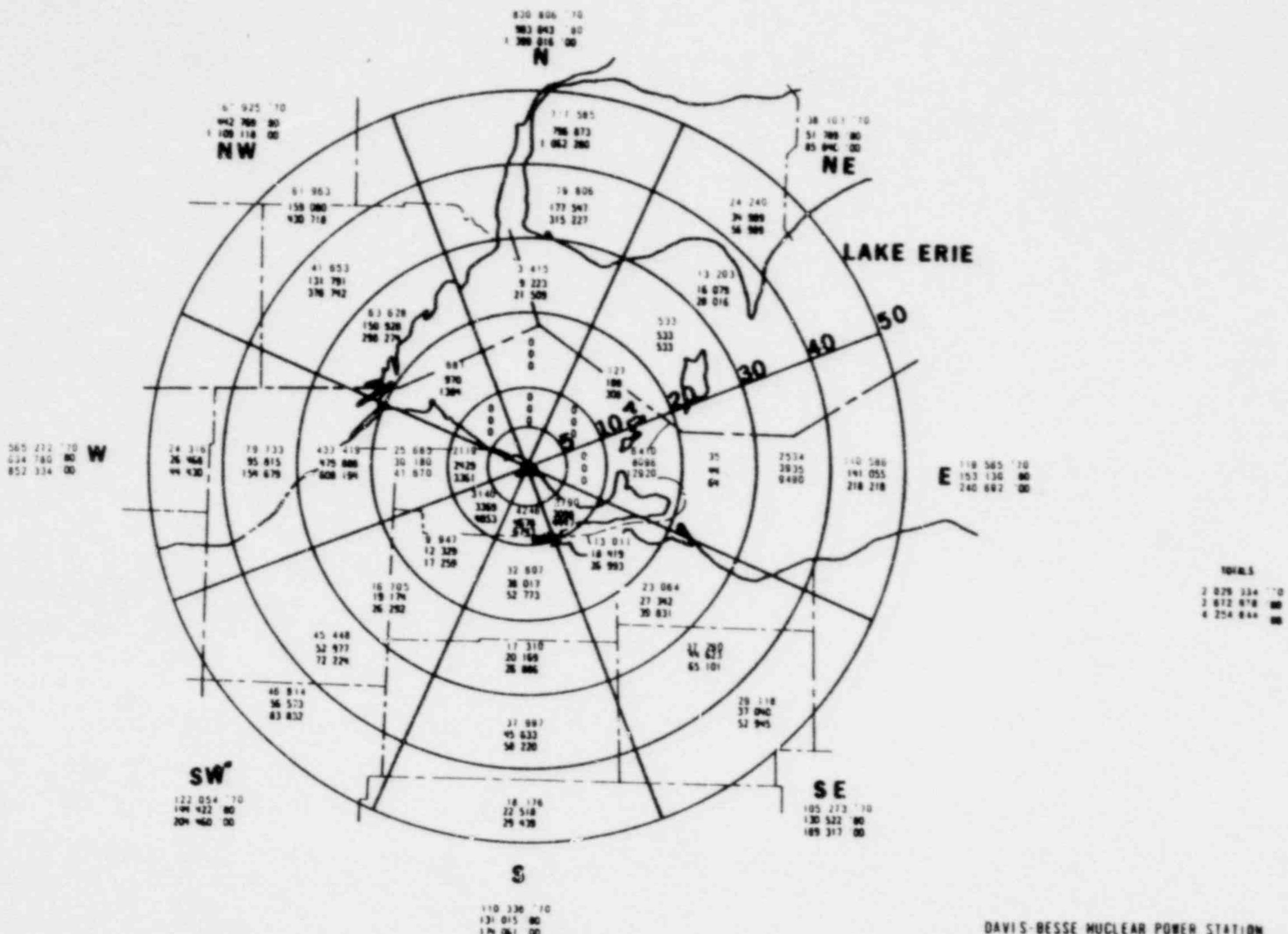
The only industries within 5 miles of the site are located in Erie Industrial Park, about 4 miles southeast. This property was known as the Erie Ordnance Depot until 1966 when the Army base was deactivated and sold to the Ottawa County Community Development Corporation, which in turn sold it to Uniroyal Inc. on a lease-purchase agreement. Besides Uniroyal, several other industries lease property in the Park. These companies, their product or service, and number of employees, are listed in Table 2.3. The total employment in the Industrial Park is about 850.



DAVIS-BESSE NUCLEAR POWER STATION
WINTER POPULATION DISTRIBUTION
0-5 MILES
Fig. 2.5



DAVIS-BESSE NUCLEAR POWER STATION
SUMMER POPULATION DISTRIBUTION
0-5 MILES
Fig. 2.6



5-50 MILES

DAVIS-BESSE NUCLEAR POWER STATION
POPULATION DISTRIBUTION
5-50 MILES
Fig. 2.7

TABLE 2.3. Companies in Erie Industrial Park

Company	Employment	Product or Service
Uniroyal Inc.	300	Coated Fabrics
USCO Services	250	Warehousing
Wilson Cabinets	80	Kitchen Cabinets
Ame Packaging	60	Plastic Bottles
DV Displays	50	Display Material
Snark Products	50	Styrofoam Boats
Milan Steel	30	Steel Buildings
Day Transportation	12	Local Cartage
Cadillac Gage	8	Military Testing
Bolus Trucking	4	Trucking

Zoning is a township and community responsibility. At present, six of the twelve townships and six of the eight incorporated communities in Ottawa County have zoning ordinances, as shown in Fig. 2.8. In general, the townships and communities with zoning ordinances are those with increasing populations--the western townships closest to Toledo and the resort areas around Port Clinton. The only zoning ordinance in the three townships closest to the site (Carroll, Erie, Salem) is that in the village of Oak Harbor.

The County's Zoning Study (1972)[3] points out the desirability of zoning in Carroll and Erie Townships to control industrial development which may be attracted to the area by the presence of the Davis-Besse Station and its railroad link to the Norfolk and Western main line.

2.2.3 Agricultural Land Use

The soil at the site is classified as the Toledo soil association group, a silty-clay glacial lake sediment. This soil, which predominates in Ottawa County, has poor drainage characteristics due to its impervious, clayey consistency, and artificial drainage is often difficult because of the low elevation above lake level.[4] With adequate drainage, however, this soil can be highly productive. Diversified crops raised within 5 miles of the site include corn, wheat, soybeans, oats, hay, pumpkins, sugar beets, tomatoes, peaches, apples, and grapes.

Detailed agricultural statistics are only available on a county basis. The site is located centrally on the northern boundary of Ottawa County,

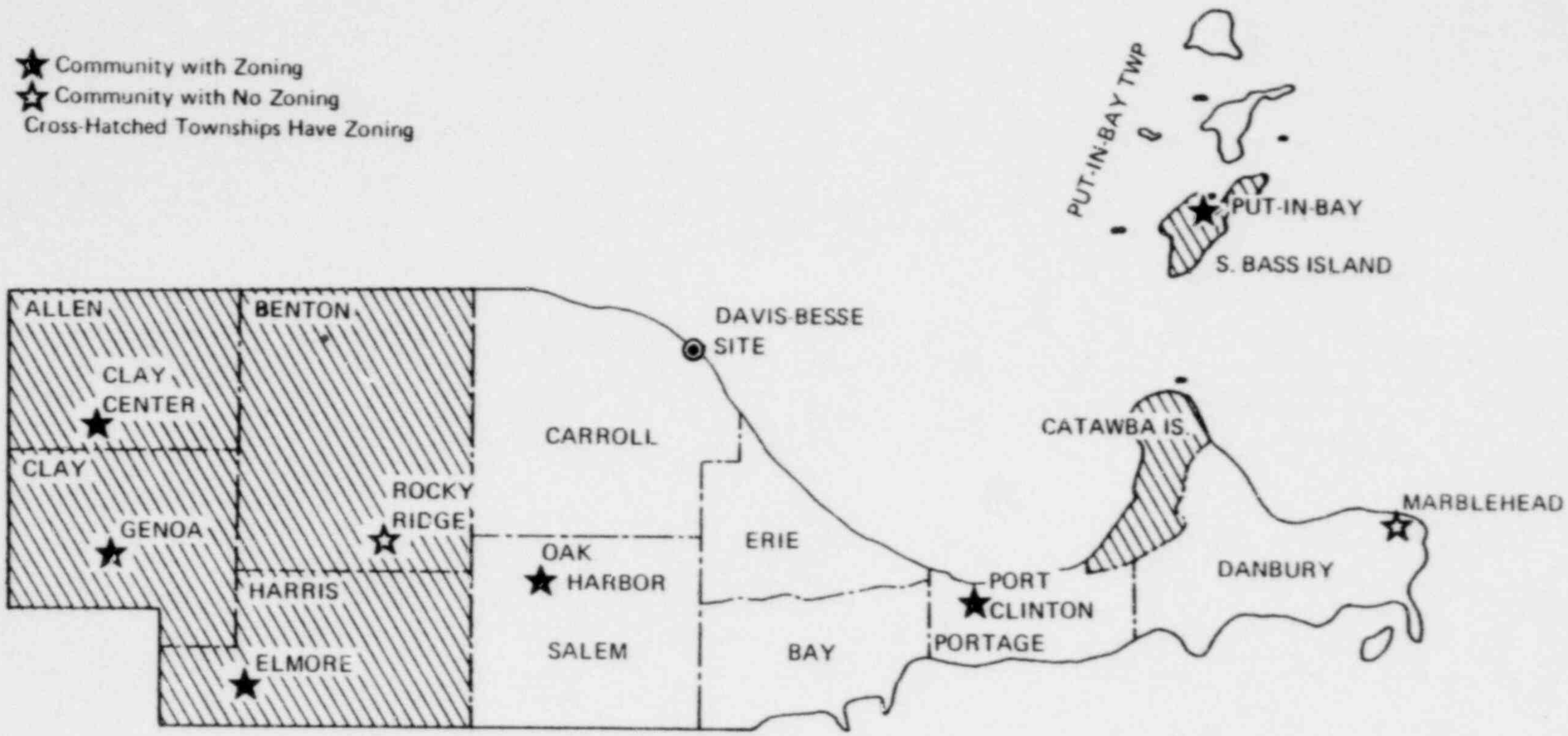


Fig. 2.8

OTTAWA COUNTY
TOWNSHIPS AND
INCORPORATED COMMUNITIES

and practically all the land within 10 miles of the site lies in this county. Table 2.4 gives the most recent statistics[5] for the major crops grown in Ottawa County in terms of acreage and yield, and also as percentages of the corresponding figures for the State of Ohio as a whole. Table 2.5 shows numbers of livestock in proportion to State totals, and Table 2.6 shows cash receipts from other farm products[6] on a similar basis. For comparison, Ottawa County represents 0.63% of the area of the State, and has 0.35% of the total State population. It is clear from these statistics that the major agricultural activities in the County are the raising of soybeans, wheat, oats, hay, fruit and vegetable crops. Livestock raising and dairy farming are not major activities.

The nearest dairy cattle and fruit orchards to the site are shown in Tables 2.7 and 2.8, respectively.

2.2.4 Recreation and Conservation Areas

Much of the lakeshore and marshland between Toledo and Port Clinton is devoted to recreation and conservation, under State or Federal management. These areas are shown in Fig. 2.2.

State Parks and Wildlife Areas

The State of Ohio, Department of Natural Resources, operates the following areas within 10 miles of the site.

TABLE 2.4. Major Crops in Ottawa County, 1971[5]

Crop	Acreage: Ottawa County	Acreage: Ohio State	Acreage: % of State	Production: Ottawa County	Production: Ohio State	Production: Unit	Production: % of State	Yield per Acre: Ottawa County	Yield per Acre: Ohio State
Corn	15,000	3,526,000	0.43	1,050,000	313,814,000	Bu	0.33	70.0	89.0
Soybeans	41,800	2,494,000	1.68	1,223,000	76,067,000	Bu	1.62	29.5	30.5
Wheat	12,600	981,000	1.28	504,000	42,674,000	Bu	1.18	40.0	43.5
Oats	4,900	520,000	0.94	377,000	34,840,000	Bu	1.08	77.0	67.0
Hay	13,700	1,570,000	0.87	37,700	3,180,000	Tons	1.19	2.75	2.03

TABLE 2.5. Livestock in Ottawa County, January 1, 1972[5]
(head)

	Ottawa County	Ohio State	% of State
All cattle and calves	6,500	2,244,000	0.29
Milk cows and heifers that have calved	1,500	444,000	0.34
Hogs	5,900	2,611,000	0.23

TABLE 2.6. Cash Value (dollars) of Farm Products, Ottawa County, 1970[6]

	Ottawa County	Ohio State	% of State
Greenhouse & Nursery	64,000	50,481,000	1.27
Vegetables & Fruits*	2,751,000	84,420,000	1.27
Other Crops**	1,114,000	34,173,000	3.26
Dairy Products	920,000	255,507,000	0.36
Poultry***	742,000	89,193,000	0.83
Sheep & Wool	22,000	11,691,000	0.19
Other Livestock	15,000	8,055,000	0.19

*Includes fresh market, processing and greenhouse vegetables, potatoes, nuts and berries.

**Includes barley, rye, tobacco, sugar beets, maple products, seed crops, popcorn, forest products and miscellaneous crops.

***Includes broilers, farm chickens, chicken eggs and turkeys.

TABLE 2.7. Dairy Cattle within 5 Miles of Site

Distance (miles)	Direction	Head
2.5	WSW	65
3.5	SSW	52
4	S	35

TABLE 2.8. Fruit Orchards within 5 Miles of Site

Distance (miles)	Direction	Acres
1.5	WNW	6
1.5	S	19
2	S	3
2.5	WSW	80
3	WSW	10
3	S	7
3	SSE	20
3.5	S	20
4	SSW	22
5	S	10
5.5	SSE	60

The Magee Marsh and Turtle Creek areas lie between 3 and 6 miles northwest of the site and cover more than 2,000 acres. Magee Marsh is a wildlife preserve with a headquarters and visitor center north of Route 2, about 6 miles west of the site. The public is admitted for fishing, nature study, and controlled hunting in season. Turtle Creek, a wooded area at the southern end of Magee Marsh offers boating and fishing. The annual attendance at these areas is estimated at 48,000, with a peak daily attendance of about 1,500.

Crane Creek State Park occupies the 2-1/2 mile stretch of lakeshore adjacent to Magee Marsh, a total area of 72 acres. It is a popular picnicking, swimming, and fishing area, and was used by about 230,000 visitors between July 1971 and June 1972. An average summer daily attendance is estimated at 2,500, with a possible peak of 5,000 on a very hot day.[7]

Toussaint Creek Wildlife Area (236 acres), about 4 miles WSW of the site, offers boating, fishing and hunting. The annual use is estimated at 5,220 user-days,[7] which probably indicates a peak daily attendance of between 100 and 200 people.

Federal Wildlife Refuges

The Wildlife Refuges operated by the U.S. Department of the Interior, Bureau of Sport Fisheries and Wildlife, are managed solely for the conservation of wildlife with special emphasis on migratory wildfowl, and are not open to the public.

The Ottawa National Wildlife Refuge covers about 4,500 acres from 4 to 9 miles WNW of the site, immediately west of Magee Marsh. Darby Marsh, and the unused portions of Navarre Marsh at the site, will be managed as units of this National Refuge.

West Sister Island in Lake Erie, about 10 miles north of the Site, is also a National Wildlife Refuge.

Private Hunting Marshes

The marsh areas immediately north and west of the site, and also to the southeast between the site and the Erie Industrial Park, are privately owned and are used by private and institutional hunting clubs. During the 1971 season these marshes within 5 miles of the site were used by about 300 hunters who killed about 1200 wildfowl.

Campgrounds

The only campground within 10 miles is located about 2 miles southeast of the site, south of the Toussaint River. This campground, with 90 campsites, is operated by Kampgrounds of America Inc. (KOA), and is open from May 15 through October 15. It is reached from Route 2 via county route 223.

There are no summer camps for children in the area.

2.2.5 Hospitals, Schools, Military Installations

Hospitals

There are no hospitals within 5 miles of the site. The nearest hospitals are Magruder in Port Clinton with 134 beds and Memorial in Fremont with 240 beds.

Schools

The site is in the Benton-Carroll-Salem School District, and this is the only District to benefit from the increased tax base resulting from the construction of the Station. The only school within 5 miles of the site is Carroll Township Elementary, with a 1971 enrollment of 240, about 3-1/2 miles southwest. A 10-mile radius includes Erie Township and the Port Clinton area of Portage Township, which are in the City of Port Clinton School District. Enrollments for schools within a 10-mile radius are given in Table 2.9 for the 1960-61 and 1970-71 school years. On a county-wide basis, the Planning Commission Study[4] indicates that the population in the 5-9 year age group reached a minimum about 1970. This minimum will progress through the school grades, reaching the high-school grades about 1980, and the total school enrollment is not expected to reach its 1970 value again before 1985. A new high school (capacity 1200) is planned for the Benton-Carroll-Salem District at Oak Harbor to reduce the present class size. By using the existing building for a middle school (grades 6, 7, 8), the District should have ample capacity to accommodate the projected increase in elementary school enrollment during the next 20 years.

TABLE 2.9. School Enrollments within 10 miles of Site 1961 and 1971[4]

District	Township	School	Enrollment 1961	Enrollment 1971
Benton-Carroll-Salem	Benton	Graytown El.	287	279
	Benton	Rocky Ridge El.	149	215
	Carroll	Carroll El.	315	240
	Salem	R.C. Waters El.	754	725
	Salem	Oak Harbor High	647	809
City of Port Clinton	Erie	Erie El.	167	135
	Portage	Bataan El.	717	560
	Portage	Jefferson El.	600	550
	Portage	Portage El.	351	335
	Portage	Port Clinton Jr. High	-	600
	Portage	Port Clinton High	770	1,050

Higher Educational Institutions

There are no colleges or technical institutes within 10 miles of the site. Bowling Green University operates a branch at Fremont within a 1971-72 enrollment of 62 (full-time equivalent). The Ohio State University operates a summer school at Put-in-Bay, which had a 1971 enrollment of 55. Outside the 20-mile radius, the nearest large campus is The University of Toledo with about 13,000 students, and there are several small colleges and technical institutes in the Toledo metropolitan area with enrollments of less than 1,000. Bowling Green University has a branch at Sandusky with a 1971 enrollment of 433.

Military Installations and Activities

Camp Perry, an Ohio National Guard training center is located 4-1/2 miles southeast of the site, adjacent to the Erie Industrial Park. At present, about 200,000 man-days of week-end training are conducted at Camp Perry per year, and this training involves small arms firing into a restricted area of Lake Erie. Camp Perry is also the site of the National Rifle Competition, held in August each year, with an attendance of about 1,000 persons.

After the deactivation of the Erie Ordnance Depot, ordnance test firing was continued by the Jet and Ordnance Division of TRW Inc. This Company has now left the Industrial Park, and the small amount of testing which still continues is carried out by the Cadillac Gage Company. These tests involve automatic weapons and mortars, the maximum caliber shell being

120 mm. An estimate by an official of the Company was that about 50,000 rounds of machine gun and 100 rounds of mortar shells are fired annually, in testing sessions on Tuesdays and Thursdays. The restricted areas used by Camp Perry and the Cadillac Gage Co. are designated as Areas I and II on the U.S. Department of Commerce navigational maps of Lake Erie, and as restricted area R-5502 by the Federal Aviation Administration.

2.2.6 Transportation

Highways

Ohio State Route 2, which forms the western boundary of the site, follows the lakeshore from Toledo to Cleveland. At the site, it is a 2-lane paved highway, but farther east it has been widened to form a 4-lane restricted-access bypass around Port Clinton and Sandusky. The Ottawa County Planning Commission's Development Plan[4] calls for the extension of this 4-lane section westward towards Toledo, as a restricted-access highway passing about 3 miles south of the site. The Ohio Turnpike passes about 13 miles south of the site, with an interchange at Fremont for Port Clinton.

Railroads

The Penn-Central and Norfolk & Western Railroads both pass through Oak Harbor, about 6 miles southwest of the site. To facilitate delivery of materials to the site, the applicant has constructed a 7-1/2 mile railroad extension to the Norfolk and Western main line, joining the railroad about 5 miles northwest of the Oak Harbor. The route of this extension was chosen to follow a transmission right-of-way.

Airports

The nearest major airport is Toledo Express, with an 8700 foot runway, southwest of Toledo and about 36 miles west of the site. Smaller airports within 20 miles of the site are shown in Table 2.10. The Federal Airway designated V-232 takes a southeasterly course from Toledo and passes about 7 miles southwest of the Site. The airspace over Lake Erie in the vicinity of the Site is restricted (area R-5502) because of firing activities from Camp Perry and the Erie Industrial Park. (see Section 2.2.5).

2.3 HISTORIC AND NATURAL LANDMARKS

The nearest National Monument is the Perry's Victory and International Peace Memorial Monument on South Bass Island, Put-in-Bay, 14 miles east of the site. Also included in the National Register of Historic Places is the Jay Cooke Home on Gibraltar Island, Put-in-Bay.

The nearest natural landmark is Glacial Grooves State Memorial. about 20 miles east of the site, on Kelley's Island, in Erie County, off Marblehead.

According to the Ohio Historical Society, consulted by the applicant, there are no known deposits of archaeological or geological interest on the site.

TABLE 2.10. Airports within 20 miles of Site

Name	Nearest Community	Distance (miles)	Direction	Longest Runway (feet)
Toledo	Toledo	20	W	4200
Chippewa	Williston (pvt)	12	W	2600
Haar	Elmore	13	SW	2600
Progress	Fremont	19	S	3500
Zimmerman	Fremont	16	S	2700
Slager	Fremont	19	S	2600
Jenkins	Fremont (pvt)	19	S	2800
Gibbs	Fremont (pvt)	13	SSE	2800
Keller	Port Clinton	13	SE	5000
Put-in-Bay	Put-in-Bay	13	E	2900

2.4 GEOLOGY

A generalized geologic section taken from excavation at the site is shown in Fig. 2.9.[8] The sequence consists broadly of glacial deposits over Silurian dolomitic bedrock, but the stratigraphy is somewhat more complex.

Organic deposits 2 to 3 feet deep in the marshes, and wave-deposited sands along the lakefront cover two primary glacial strata. The glacial sediments - an upper glaciolacustrine and a lower till - were deposited about 10,000 years ago during fluctuations in the water levels of Lake Erie, between the Carey Port Huron interval and the Valders substage. These sediments are composed of silty clays which have a low permeability.

The Silurian bedrock strata (Tymochtee and Greenfield Formations) extend 3000 to 5000 feet under the glacial deposits. These horizontally bedded sedimentary rocks slope east to west. Lithologically, they are classed as pervious argillaceous dolomites with shale partings and variable amounts of gypsum and anhydrites. These strata are jointed extensively and contain many solution cavities (vugs). The fissures and vugs may be due to ground water dissolution of gypsum.[9] While most vugs are <0.25 inches in diameter, it is possible that there are some fissures 1 to 2 feet wide and cavities as large as several cubic yards in volume. The lower members of the Tymochtee-Greenfield Formations are described as a gypsiferous dolomite (20% gypsum) and have the most solution cavities. Some of the fissures are debris-filled, and this probably occurred

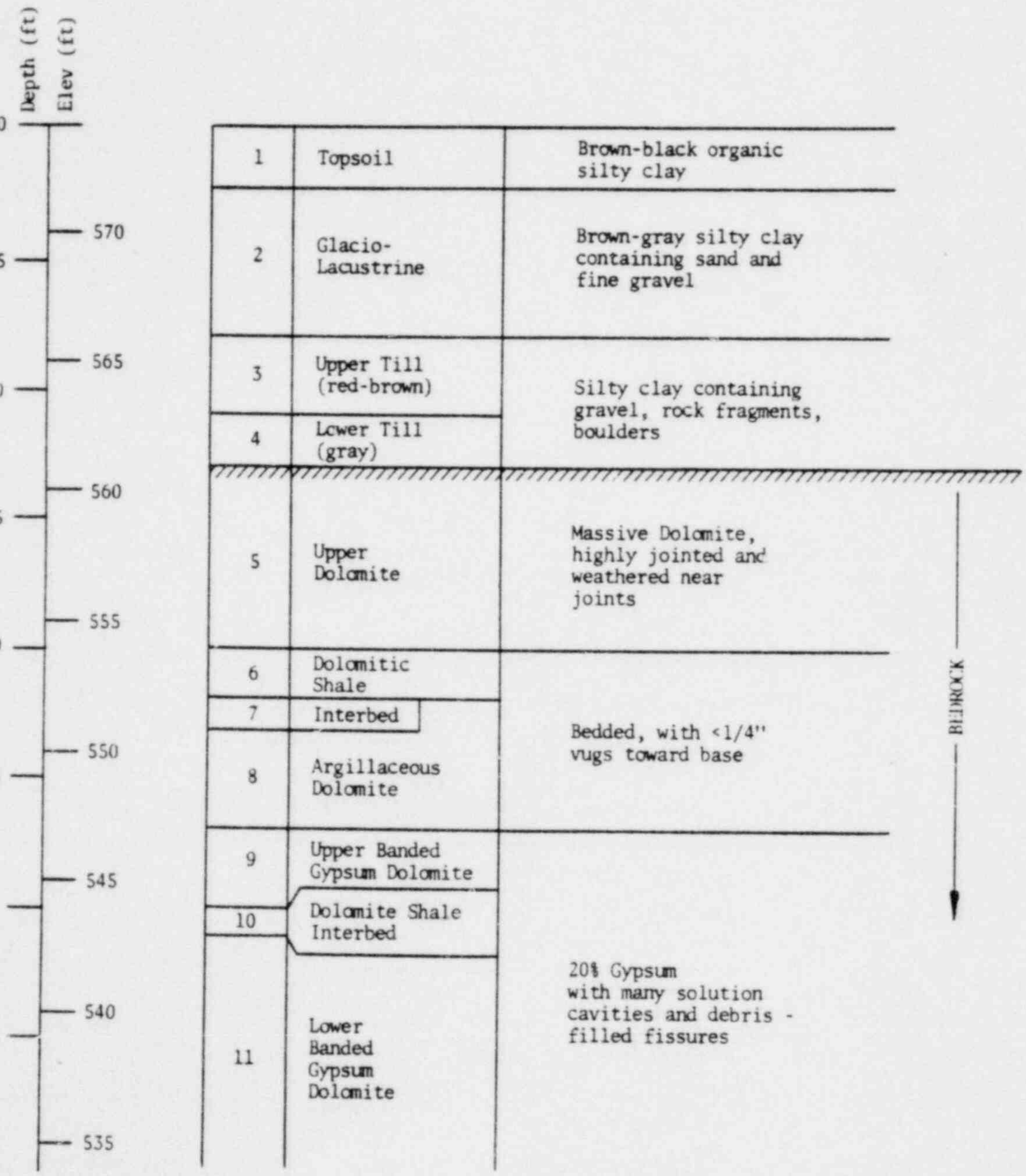


Fig. 2.9. Generalized Geologic Section at the Site.

due to collapse and filling of solution cavities as the Silurian sediments were being deposited.

The groundwater aquifers are in the vugs or solution cavities in the Silurian bedrock formations which begin about 10 feet below the surface. These water-bearing sediments are confined by the impervious glacial silty clay overburden. This situation produces an artesian head of about 10 feet above bedrock in the area of the site.

2.5 HYDROLOGY

2.5.1 Surface Waters

Lake Erie

The Station is located at Locust Point on the southern shore of the western basin of Lake Erie. The western basin is very shallow with a maximum depth of about 35 feet. A shallow epilimnion develops early during the season of natural heating in the spring, but since the basin is so shallow, wind action causes efficient vertical mixing and by June the water becomes vertically isothermal. During August the deeper waters occasionally have a thermocline for short periods.[10] The entire western basin freezes over early in the winter and stays frozen even during relatively mild winters.[11] Lake levels fluctuate both annually and over a period of many years. Yearly high levels occur in summer and lows in winter, with a total annual average fluctuation of 1.2 feet.[12] Local changes due to storm action, however, may be as great as 6 feet.[10]

The Detroit River, which empties into Lake Erie about 40 miles northwest of the site, provides 90% of the total inflow into the lake (188,000 cfs).[10] At Locust Point the Detroit River current, which crosses the western basin, diverges into eastern and western branches.[13,14] This provides a southeast drift of littoral sand from Locust Point to Port Clinton and a westward drift from Locust Point to Toledo. The presence of 3 or 4 sand bars parallel to the shore and close to the beach indicates a predominance of currents parallel to the beach.[13] Surface current velocities at Locust Point are about 2% of the wind velocity and vary with wind direction.[12]

The shoreline at Locust Point is very stable and is classified as a "non-critical erosion area, not protected."[15] The beach consists of sand and shell mixed. Immediately offshore, the underwater bottom consists of a shallow layer of sand with shell and clay intermixed which overlies stiff lake-clay. This sandy bottom varies from 3/16 to 1/8 mile wide, and beyond is a strip of stiff lake-clay exposed by wave action, which is 3/8 to 1/4 mile wide. About 9/16 miles offshore at the west edge of the property line, the bottom becomes sand again with increasing amounts of gravel as one goes further offshore. Eastward of the middle property line, the bottom becomes muddy sand.[13,14]

There have been measurable increases in total dissolved solids, calcium, chloride, sodium-potassium, sulfate, ammonia-nitrogen, and total nitrogen in Lake Erie over the past 60 years.[16] Water quality data are summarized in Table 2.11.[17]

TABLE 2.11. Lake Water Analysis

	Site Samples*	Toledo Intake**	Port Clinton Intake**
Calcium (Ca)	45	-	-
Magnesium (Mg)	11	-	-
Sodium (Na)	12	-	-
Chloride (Cl)		19.6	23.5
Nitrate (NO_3)	12	-	-
Sulphate (SO_4)		37.8	43.6
Phosphate (PO_4)	1.5	-	-
Silica (SiO_2)	2	-	-
Alkalinity as $CaCO_3$	101	91	95.6
Suspended Solids	131	16.7	57.5
Dissolved Solids		129	143
Dissolved Oxygen	10	9.8	10.6
pH	8.1	8.2	7.9

*Average of samples from November 1968 to October 1970 taken 50 to 100 feet from shore.

**Average of monthly values reported in "Lake Erie Ohio Intake Water Quality Summary 1969"; U. S. Department of Interior and Ohio Department of Health, June 1970.

General Note: All values in parts per million except pH.

Toussaint River

The Toussaint River is the largest tributary entering the lake near the site. The canal along the southern site boundary empties into the Toussaint River just before the river empties into Lake Erie. The river drains 143 square miles and has a slope of about 1 foot per mile.[18] Near its mouth, water levels are controlled mainly by the levels in Lake Erie.

2.5.2 Groundwater

At the site, the groundwater table elevation follows the lake levels. It is usually a few feet higher than the lake, and when the lake rises several feet during storms, the groundwater table elevation will rise commensurately. The groundwater table is relatively horizontal with a gradient of only 1 to 3 feet/mile (average of 2 feet/mile) toward the lake. During infrequent dry periods or when the lake is high, the groundwater flows away from the lake.[18] The rate of flow is similar to that in the local rivers and creeks.

The vugs and joints in the Silurian bedrock formations are the groundwater aquifers, but the impervious clayey soils and glacial deposits are not water-yielding sediments. Since the bedrock is at least 10 feet below the surface and overlaid by impervious deposits, the bedrock aquifer is under an artesian head of 10 feet above bedrock. These waters are sulfurous (containing more than 5 ppm H_2S) and hard and are not potable. However, they are used for farm and sanitary purposes.

Bedrock wells are usually less than 100 feet deep and yield up to tens of gallons per minute. Some municipal wells in the Toussaint River Basin can, on the other hand, yield 100 gpm. No information is available about the precise chemistry of the groundwater. The Station's drinking water will be taken from Lake Erie. Some cottagers along the lake obtain their drinking water from shallow beach wells in the lake sands, and some south of the site truck in water from central cisterns.

2.6 METEOROLOGY

The Davis-Besse site has a climate typical of the Greak Lakes region, classified as continental, with cold winters and warm, humid summers, but moderated by the proximity of Lake Erie. Because of its heat capacity, the lake remains cooler than the land in spring and early summer, and produces lake breezes which bring cool, humid air to the site, reducing afternoon temperatures and producing stable air conditions. Conversely, in fall and winter, when the lake is relatively warm, winds off the lake are warmed and humidified.

The passage of polar fronts and high and low pressure centers produces high average wind velocities and frequent changes of wind direction, which in the very flat terrain, produce adequate ventilation. In summer, the frequency of frontal passages is reduced, but convective showers in tropical air masses are common.

Meteorological observations with a 300-foot instrumented tower have been made at the site since October 1968. The data collected comprise wind speed, direction and variability at 20, 100 and 300-foot levels, and air temperatures at 5, 145 and 297-foot levels. No humidity or rainfall data are collected at the site. The duration of the temperature observations is too short to establish long-term averages, so data from Toledo Express Airport have been used. The airport is 36 miles west of the site and about 20 miles inland from Lake Erie.

2.6.1 Temperature

Table 2.12[19] gives the average monthly temperature statistics for Toledo over an 11-year period. The highest and lowest temperatures recorded at Toledo are 105°F (July 1936) and -17°F (January 1963).

2.6.2 Precipitation

Precipitation is moderate (31.4 inches annually at Toledo), and fairly evenly distributed throughout the year. Spring is the rainest season (9.35 in. average) and fall the driest (6.87 in. average). The mean annual snowfall at Toledo is 38.0 inches, and on the average there are 11 days with snowfalls greater than 1.0 inch. As much as 9.8 inches of snow has fallen in a 24-hour period. Monthly average precipitation statistics are given in Table 2.13.

2.6.3 Wind

A complete tabulation of the wind data collected at the site for 20, 100 and 300-foot levels is given in the applicant's Environmental Report.

TABLE 2.12. Temperature (°F) Data for Toledo (11 Years of Record)[19]

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Average Daily Max.	34	36	45	58	70	80	85	83	76	64	47	36	
Average Daily Min.	18	19	26	35	46	56	60	59	51	40	30	21	
Average Monthly	26	27	35	47	58	68	73	71	63	52	39	28	
Extreme Max.	62	68	80	87	95	97	96	98	95	91	76	65	98
Extreme Min.	-17	-10	-1	11	27	38	43	37	29	16	2	-11	-17
Degree-days	1200	1056	924	543	242	60	0	16	117	406	792	1108	6494
No. days T max. $\geq 90^\circ$	0	0	0	0	1	4	5	4	1	*	0	0	16
No. days T min. $\leq 32^\circ$	30	27	24	11	1	0	0	0	*	6	18	27	144

*More than 0 but less than 0.5 days.

TABLE 2.13. Precipitation, Toledo, Ohio

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Ave. Precip in.**	1.95	2.58	2.79	3.18	3.30	2.90	2.91	2.59	2.31	2.30	2.26	2.22	31.37
Max. in 24 hrs, miles**	1.78	2.26	2.69	2.93	3.57	3.44	2.47	4.58	5.98	3.10	2.68	2.07	
Days with thunder-storms***	*	*	2	5	5	7	7	7	4	1	1	*	40
Ave. Monthly snow-fall, inches***	8.5	7.9	6.7	2.2	*	0	0	0	0	*	3.4	7.3	36.0

*Less than 0.5 but greater than 0.

**Period of record, 1871-1966.

***Period of record, 1956-1966.

Figure 2.10 summarizes the data for the 300-foot level in the form of seasonal wind roses. On an annual basis, 62.3% of all winds are offshore (i.e. SE through S to WNW). The lowest proportion of offshore winds is in spring (54.6%), mainly because of the lake breeze effect.

2.6.4 Atmospheric Stability

The vertical mixing and turbulence of the atmosphere depends on hydrostatic stability as well as on wind velocity and surface topography. Hydrostatic stability is determined by the vertical temperature gradient, which is usually expressed as a <u>lapse rate</u>, the rate of <u>decrease</u> of temperature with height. An important value of this parameter is the rate at which a body of dry air cools adiabatically with increasing height. This adiabatic lapse rate corresponds to a decrease of 1.0°C per 100 meters or 5.5°F per 1000 feet. When the observed lapse rate is less than this value, the atmosphere is stable and vertical motions are damped, the extreme case being a negative lapse rate which occurs in a temperature inversion. When the lapse rate is greater than 1.0oC per 100 meters, the atmosphere is unstable and vertical mixing is rapid. When the humidity of the air approaches saturation, the adiabatic lapse rate is reduced because of the latent heat released in condensation. Observations of atmospheric stability at the site are made by comparing the temperatures at the 5- and 145-foot levels (1.5 and 46.0 meters). These observations are tabulated in the applicant's Environmental Report and are summarized in Table 2.14. It should be noted that the stability classes are defined in terms of true temperature gradient (<u>increase</u> of temperature with height), so that unstable conditions correspond to negative temperature gradients.

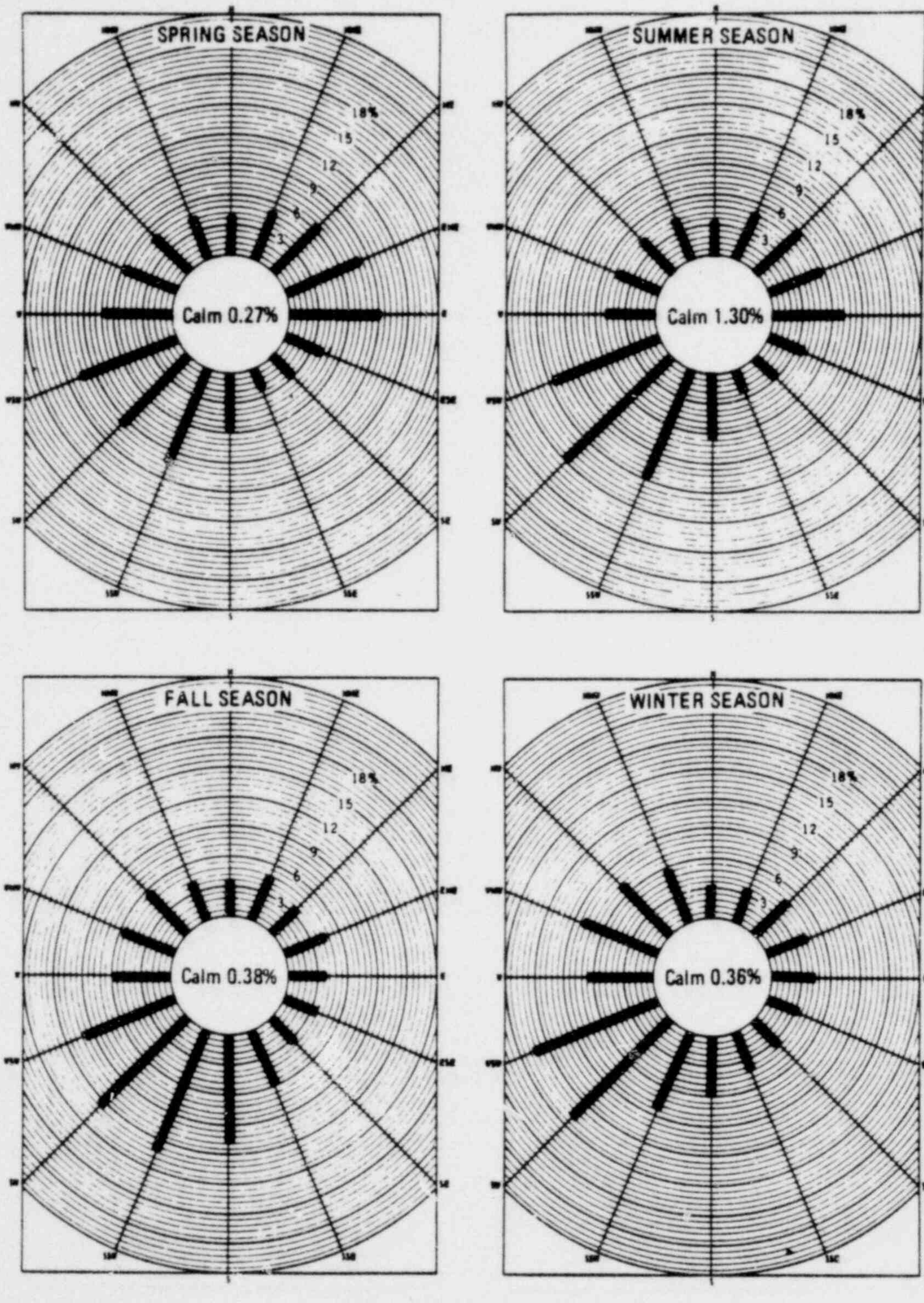


Fig. 2.10

SEASONAL WIND ROSES

DAVIS–BESSE – 300 FT. LEVEL

('68 – '70)

TABLE 2.14. Comparison of Stability Frequencies
(Percent of total hours)

Season	Mod. Stable	Slightly Stable	Neutral	Unstable
Fall	22.4	29.7	27.5	20.4
Winter	19.9	29.1	31.5	19.5
Spring	18.3	18.8	23.3	39.6
Summer	9.5	21.3	24.9	44.3

Stability classes defined as follows:*

Class	Temp. Gradient Range °C per 100 m
Unstable	<-1.5
Neutral	-1.5 to -0.5
Slightly Stable	-0.5 to +1.5
Moderately Stable	>+1.5

*Positive Temperature Gradient means increase of temperature with height.

2.7 ECOLOGY

2.7.1 Aquatic

Fish populations, bottom fauna, phytoplankton populations, and the chemical content of the waters of the western basin of Lake Erie have changed markedly in the past 50 years. Intensive agricultural activities and industrialization of the western basin's watershed have greatly increased the nutrient load, which has led to an acceleration of the eutrophication process in the lake. The biological and chemical changes indicating eutrophy (nutrient enrichment) in the western basin include: large oligochaete and midge larvae populations in the benthos; high plankton abundance with blooms of blue-green algae; warm water fish replacing characteristically cold water fish; and increases in total dissolved solids, calcium, chloride, sodium and potassium, sulphate, phosphorous, ammonia-nitrogen, and the degree and extent of oxygen depletion due to the increase in the oxygen demand of the sediments.[22,23]

Benthos

The bottom fauna of the western basin reflects the detrimental effects of heavy organic enrichment, siltation, and reduced dissolved oxygen levels. In summer, when quiescent warm periods often persist for several days, the bottom waters are prone to rapid oxygen depletion due to the high oxygen demand of the organically enriched sediments. The populations of pollution-sensitive organisms such as caddisfly larvae (Trichoptera) and burrowing mayfly nymphs (Ephemeroptera) have been greatly reduced. Prior to 1953, for example, mayflies dominated the benthos of western Lake Erie, but with the increased oxygen depletion of the bottom waters, the western basin populations have decreased to less than one percent of their former abundance.[24] On the other hand, the numbers of pollution-tolerant forms such as sludgeworms (Oligochaeta - Family Tubificidae) and midge larvae ("bloodworms" - Family Chironomidae = Tendipedidae) have increased greatly along the west side of the basin and in the island area. Organically-enriched environments characteristically support an unbalanced benthic community dominated by high numbers of sludgeworms.

Near the site at Locust Point chironomids and oligochaetes are the most abundant organisms in the benthos.[25,26] There are, however, a few mayfly nymphs and caddisflies, as well as a small number of snails (gastropods) which can tolerate a moderate level of pollution. Other organisms present are scuds (amphipods), fingernail clams (sphaerids), hydra, and leeches (Hirudinia). The sandy, wavewashed sediments near shore, where the station discharge structure will be located, do not support a large and diverse benthic community, as compared to areas further offshore.

Phytoplankton

In the western basin of Lake Erie, photosynthetic production is higher than in any other open water area of the Great Lakes.[27] Over the past 50 years phytoplankton abundance has increased almost threefold, the spring and fall maxima have lasted longer, the minima have become shorter and less pronounced, and there has been a shift in species dominance. Diatoms, which comprise 75 percent of the phytoplankton, dominate the spring and fall maxima. Melosira has replaced Asterionella as the domnant diatom in the spring, and the fall dominance has shifted from Synedra to Melosira to Fragillaria.[22,23,27] Certain species of Melosira and Fragillaria, as well as several other genera, often predominate in eutrophic lakes. Blue-green algae (which appear most often in nutrient enriched waters) and green algae have increased in abundance, particularly during the August-September peak. Blooms of blue-green algae, which float in mats on the water, begin to appear in late July or early August.

The applicant's consultant, Dr. Ayers has found the diatom Melosira, and to a lesser extent the diatoms Fragillaria and Diatoma, to be dominant in May at Locust Point.[26] Although phytoplankton was not rigorously counted in the State of Ohio's environmental evaluation F-41-R project[25] differences were noted between phytoplankton populations in June and July. Melosira and Pediastrum (a green alga) were the most common in June but scarce in July. Microystis (a blue-green alga) was the most abundant in July. Growths of attached nuisance algae, such as Cladophora, have not been noted near shore at the station due to the lack of a suitable rocky substrate. So far, no fouling of beaches by algal mats blown ashore during storms has been reported for the Locust Point area, but blue-green blooms occur all over the western basin and have been noted in the open water near Locust Point.

Zooplankton

A considerable increase in the crustacean zooplankton population, dominated by copepods and cladocerans, has been observed in western Lake Erie.[27] The maximum number of copepods increased from 70,000 to 126,000 per cubic meter from 1939 to 1967. Calanoid copepods, particularly Diaptomus spp. (known primarily as an inhabitant of ponds and warm eutrophic waters) and Eurytemora affinis, are less abundant than cyclopoid copepods such as Cyclops or Mesocyclops. However, Eurytemora (a brackish water form) is more abundant in the western basin than in the rest of the lake. The dominant cladocerans are Daphnia spp. in late spring and Bosmia sp. in late August. Daphnia is particularly important in terms of numbers and biomass. A greater variety of rotifers occurs in the western basin than in the other basins.

Ayer's study at Locust Point found that cladocerans (Daphnia retrocurva and Bosmia sp.) and copepods (particularly the cyclopoids) are the dominant zooplankton. Rotifers and ostracods are also present, but many small organisms such as rotifers were probably missed due to the sampling method. Ohio's F-41-R study indicated that a seasonal pattern is evident for most zooplankters, except calanoid copepods which remain consistently low. Cyclopoid copepods, cladocerans (Daphnia, Bosmia and Chydorus), and rotifers (several species) were dominant. Codonella, a loricate ciliate, was present but not counted. Sampling stations with the greatest zooplankton population showed no consistent pattern.

Fish

In the past 25 years, the fish populations of Lake Erie have changed greatly. However, despite the elimination of high value species such as cisco, whitefish, sauger and blue pike, the decline of the walleye, and recent discoveries of high mercury levels (particularly in walleye and white bass), commercial fishery production has remained around 50 million pounds per year because of the increasing catch of carp, sheepshead, yellow perch, and smelt.[23,28] The changes in fish populations in Lake Erie cannot be attributed to the sea lamprey. It has never been an important predator since there are few tributaries offering suitable spawning conditions.[23] Although the trout fishing in Lake Erie was never important commercially, its long-term decline and eventual disappearance indicates the development of an unsuitable environment,[29] since trout are intolerant of polluted or eutrophic conditions. The year marking the beginning of major changes in the benthos, 1955, was also a key year in the changes in walleye and blue pike populations.

Fish surveys, using gill nets and seines, during most of the open lake season for the past three years have shown carp and goldfish, followed by freshwater drum (sheepshead) and gizzard shad to be the most abundant fish off Locust Point.[25] The catch was greatest in May, June and October and lowest in August, indicating that the fish apparently move out to deeper water in the hottest summer months. The Ohio Department of Natural Resources has a Trawling Index Station (where numbers of young-of-year caught per hour of trawling is measured) near Crane Creek (about 4 miles northwest of the Davis-Besse). This index station ranks second for white bass and gizzard shad and third for walleye and alewife in relative lakewide abundance of young-of-the-year.[30] Examinations of fish stomachs indicate that the fish at Locust Point are actively feeding on the more abundant plankters and benthos in the area.[25] Chironomid larvae were the most common food items in most species in all months.
Table 2.15 lists species, economic classification, spawning conditions and food preferences of fish found near the Station.

TABLE 2.15. Fish in the Vicinity of the Station

	Spawning: Time	Water Temp.	Place	Diet	Economic Classification
Walleye (Stizostedion vitreum vitreum)	Mid-April to early May	37-45°F	Shallow waters, clean, hard, rock bottom	Invertebrates, but mainly perch, minnows, suckers	Sport, commercial, fine food
Carp (Cyprinus carpio)	Late April to June	65-68°F (most active)	Migrate up streams	Browses on bottom vegetation, aquatic insects, snails,	Commercial, coarse food
Goldfish (Carassius auratus)	Spring	>60°F	Soft bottom	Phytoplankton	Forage
Channel Catfish (Ictalurus punctatus)	April through August		Rapid waters of streams, holes in the banks	Aquatic insects, arthropods, fish, reptiles	Sport, commercial, fine food
Black Bullhead (Catfish) (Ictalurus melas)	May to June or	60-75°F	Less than 4 feet deep, protected from strong currents	Insects, entomostracans, plant debris, fish, frogs	Sport, fine food
White Bass (Roccus chrysops)	May to July		Shallows near shore	Prefer small fish (minnows), eat Daphnia, aquatic insects, plankton, crayfish	Sport, commercial, fine food
Yellow Perch (Perca flavescens)	Mid-April to May		3-8 feet deep	Zooplankton, aquatic insects, other fish	Sport, commercial, fine food
Alewife (Alosa pseudoharengus)	Late May to June or July	55-72°F	6-12 inches deep	Small crustaceans, aquatic insects, plankton	Forage
Gizzard Shad (Dorosoma cepedianum)	Early June to early July	67-72°F	Shallow water	Algae from bottom mud	Forage
Sheepshead (Freshwater Drum) (Aplodinotus grunniens)	May or June		Shallows, gravelly and sandy bottoms (planktonic eggs have been found in Lake Erie)	Mostly small fish & insect larvae, also mollusca, crustaceans, plankton, insects	Sport, fine food
Emerald Shiner (Notropis atherinoides)	June 25 - July 28 sometimes to August 15		Surface in open water	Microcrustacea, insects (aquatic and terrestrial)	Forage
Spottail Shiner (Notropis hudsonicus)	June 1 - 15 late June - early July	68°F	Clean sand	Mostly fingernail clams, algae	Forage
Smelt (Osmerus mordax)	May 1 - 15 sometimes also in late summer or early fall	37-54°F	Streams or lake shallows, sandy beaches	Plankton eater - Daphnia, Gammarus, fingernail clams, smelt young, shiners	Commercial, fine food
Trout-Perch (Percopis omiscomaycus)	June 1 - 15	66-71°F	Less than 3 feet deep, sandy gravel, rocks	Ostracods, Gammarus, Leptodora, chironomids, mayflies, other insects	Forage
Quillback (Carpiodes cyprinus)					Commercial, fine food
Sand Shiner (Notropis deliciosus)	June - July		Clean gravel and sand	Terrestrial and aquatic insects. Young - Bottom ooze diatoms.	Forage
Redhorse Sucker (Moxostoma spp.)	Spring		Shallows and in tributaries over gravel or stones	Bottom organisms	Coarse food
Crappie (Pomoxis spp.)	Late spring - early summer		Shallow waters		Sport, fine food

TABLE 2.15. (Contd.)

	Spawning: Time	Water Temp.	Place	Diet	Economic Classification
Logperch (*Perca caprodes*)	Spring		Moderately shallow waters - sand		Forage
Northern Pike (*Esox lucius*)	March - April	45-55°F	Warm, shallow waters over soft, weedy bottom (marshes, if accessible)	Young - Microcrustaceans, insects. Adults - Fish, salamanders, crayfish, mayflies.	Sport, commercial, coarse food
Bluegill (*Lepomis macrochirus*)	Spring		Shallow water		Sport, fine food
Johnny Darter (*Etheostoma nigrum*)	Spring		Moderately shallow, beneath flat stones or other objects, stone and gravel bottom		Forage

Data compiled from the following:

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Ohio laws limit the commercial fishery in the Locust Point area to trotline, seine and trap net gear. Trap net and seine gear harvest the bulk of the fish.[30] Only seven major commercial trap-net fisherman utilize the area. Carp, catfish, walleye, white bass and perch are the major species harvested (by weight). However, recent discoveries of mercury contamination have led to a five-year ban (1970-1975) on the sale of all walleye and of white bass larger than 10-1/4 inches. The average annual monetary value of the fish caught by trap net in the area is estimated at $179,155. Three commercial seine fishermen utilize the area, but one seine catches the bulk of the fish, which are predominantly carp and catfish. The average annual monetary value of these species is estimated at $13,121. Therefore, the value of the commercial fishery off Locust Point is approximately $200,000 per year.[30]

Sport species most actively sought in the Locust Point area, particularly in the reef areas a few miles out, are walleye, white bass, catfish and perch. The estimated value of the boat angler utilization of Lake Erie within five miles of the site is $3.1 million.[30] There is also considerable value in the inland sport fishery (mainly for carp and channel catfish) within five miles of the site, particularly in the Turtle Creek and the Toussaint River. Commercial fishermen fish heavily for carp in these streams in the spring, but, since only a sport fishing license is required, no records of the amounts harvested are available.

2.7.2 Terrestrial

The site area is approximately 950 acres, of which over 600 acres is managed marshland and the balance is poorly drained marginal farmland.

(See Section 2.1). Most of the farmland, formerly planted to wheat, has been removed from production due to construction of buildings, roads, parking lots, borrow pits, etc. Part of the remainder is lying fallow and part is planted to buckwheat during construction. Approximately 15 acres will be planted (probably to buckwheat) after completion of construction and farmed on a 3/4-1/4 basis (25% of the crop will be left on the fields for wildfowl forage).[31]

As no ecological studies of the marsh have been made, the following discussion is based on personal observations at the site, discussions with local marsh managers, and information contained in the Applicant's Environmental Report.

The southwest and west shore of Lake Erie includes 40,000 acres of marsh, most of which is owned by private clubs. Several marshes near the site, such as the State-owned Magee Marsh and the privately owned Winous Point Club (10 miles southeast of the site) are under intensive management for increasing waterfowl breeding population. The Magee Marsh breeding population, for instance, was increased from 54 pairs in 1953 to 275 pairs in 1963.[32] Other marshes are managed primarily for attracting large populations of migrating birds. Navarre Marsh is a natural lowland separated from Lake Erie by a stable barrier beach. The sandy beach is strewn with clam shells, small rocks, and pebbles washed ashore during storms. Grasses and other low plants and shrubs grow close to the high water line. Some willows are partially under water when lake levels are highest. Black willows and cottonwood are the most abundant trees on the older dikes and the barrier beach. Hackberry and sycamore are also common. Grape vines often form a dense understory.

Waterfowl management is essentially control of plant succession based on the seasonal needs of waterfowl. Intensive and economical management is best achieved by control of water levels, since fluctuation of water levels has a marked influence on the succession of aquatic plants. Marsh managers in Ohio obtain the best results from drawdowns (by use of dikes and/or pumps) in May to create a nesting habitat for the summer, and reflooding in the fall to attract large numbers of fall migrants. Partial reduction of water levels (rather than complete drying of the soil) exposes knolls used for nesting and leads to an interspersion of suitable submerged, emergent and shoreline vegetation. For example, the northern section of the site marsh, which is temporarily connected with the privately owned section north of the dike, was partially drawn down this spring (1972). Dense growths of smartweed (a good waterfowl food) developed along the dike and other exposed areas. Partially flooded areas developed dense stands of emergents such as bulrush, watermilfoil, and spikerush. In the large southern section of the marsh, however, the water was not drawn down and less desirable waterlilies and arrowhead cover most of the formerly open water areas.

Manipulation of water levels often makes it easier to control trouble-some animals such as snapping turtles, which attack ducklings, or carp, which can cause great damage to water plants while rooting around in the sediments for food.[32] Roiling of the water and destruction of waterfowl habitat is often associated with large populations of carp. In addition, large numbers of carp which obtain access to the marsh during their spring spawning runs are often left stranded by receding water levels. Their decaying carcasses cause noxious odors and often make the area unsuitable for nesting waterfowl.

Mallards, black ducks and blue-winged teal are the most abundant nesting waterfowl at the site. Artificial roosts are often used to attract wood ducks. The most abundant waterfowl during spring and fall migrations include mallards, widgeons, blue-winged teal, black ducks, Canada geese, wood ducks, shovelers, coot, green-winged teal, gadwalls, canvasbacks and redheads. The area is also used by whistling swans and large numbers of warblers. Other birds which are common during the summer are redwinged blackbirds, swallows, warblers, sea gulls, common egrets, mourning doves, wrens, starlings, black-night crowned heron and great blue heron. Pheasant might occasionally be found in upland areas. Endangered species which occasionally utilize the area are the Kirtland's warbler, bald eagle, sandhill crane, wood ibis and peregrine falcon.

Other animals in the area are muskrat (very common), opossum, woodchuck, raccoon, skunk, weasel, mink, and red fox. Cottontail rabbits and fox squirrel are probably present, but in limited numbers. Several snakes, turtles, frogs, toads and salamanders live in the marsh. Fish which spawn in the marsh, in addition to carp, are bullheads, gizzard shad, and goldfish. Snails, spiders, and several insects such as horseflies, widges, damsel flies, mayflies, dragon flies, grasshoppers, bugs and beetles are common marsh inhabitants.

2.8 BACKGROUND RADIOLOGICAL CHARACTERISTICS

The radiological characteristics of the area surrounding the Station are not unusual. Natural and man-made background in the area is typical for Midwestern States, that is, 140 millirem per year.[33] Some 25 radiological monitoring stations have been active in the area for nearly two decades[34] so that a considerable backlog of data is available. A list of the major stations and their more recent reports is presented in Table 2.16. These stations have monitored not only Lake Erie, but also surface, ground, and tap waters in the area, as well as milk, dietary, and atmospheric concentrations. Thus, any changes introduced by the operation of the Station will have an extensive backlog of information for comparison.

A small-scale study of tritium has been reported for Lake Erie waters offshore of the Station.[35] This study gave values several-fold larger than the norm for Lake Erie or its western basin. These may have been occasioned by short-term releases of tritium from the nearby NASA reactor at Plum Brook, or from the Enrico Fermi I reactor near Monroe, Michigan. However, in view of the methodology used in these studies and the normal variations in reported Lake Erie tritium values, it is more probable that the elevated values reported (range 350 - 1,800 pCi/l, mean about 1,100 pCi/l) are largely happenstance, and would not be observed in other studies. In any case, the highest of these values lies well below values observed in other natural waters in the U.S.

TABLE 2.16. Radiological Surveillance Locations in the Region of the Station

Location	Reporting Period	Measurement*	Range	Mean
Cleveland, Ohio	Sept 1970-Feb 1972	PM, Sr-90	6-11	9
Cleveland, Ohio (Cuyahoga River)	March 1971 and June 1971	SW gross alpha (d)	≤0.2-1	
		SW gross alpha (s)	2	2
		SW gross beta (d)	3-7	5
		SW gross beta (s)	4-[illegible]	21
Cleveland, Ohio (Lake Erie)	1971	TW gross alpha (d)	0	0
		TW gross alpha (s)	0	0
		TW gross beta (d)	≤5	5
		TW gross beta (s)	≤5	5
	July 1967-Dec 1971	DS, Sr-90	5-14	9
Painesville, Ohio	July 1969-Feb 1972	SA	0-8	1
		P	0-305	27
	Jan 1970-Dec 1971	TWT	0-0.6	0.2
Sandusky, Ohio	1967-1969	TW gross alpha (d)	0	0
		TW gross alpha (s)	0	0
		TW gross beta (d)	3	3
		TW gross beta (s)	7	7
Columbus, Ohio	July 1969-Feb 1972	SA	0-3	1
		P	0	0
		TWT	0-0.6	0.2
Youngstown, Ohio	1967-1969	TW gross alpha (d)	0	0
		TW gross alpha (s)	0	0
		TW gross beta (d)	3-8	5
		TW gross beta (s)	0	0
Lorain, Ohio	1967-1969	TW gross alpha (d)	0	0
		TW gross alpha (s)	0	0
		TW gross beta (d)	5	5
		TW gross beta (s)	0	0
Monroe, Michigan	Sept 1970-Feb 1972	PM, Sr-90	0-9	6
	Jan 1970-Dec 1971	TWT	0-0.6	0.2

TABLE 2.16. (Contd.)

Location	Reporting Period	Measurement*	Range	Mean
Detroit, Michigan	Sept 1970-Feb 1972	PM, Sr-90	7-8	8
	1967-1969	TW gross alpha (d)	0	0
		TW gross alpha (s)	0	0
		TW gross beta (d)	3	3
		TW gross beta (s)	0	0
Lansing, Michigan	Sept 1970-Feb 1972	PM, Sr-90	4-11	9
	July 1969-Feb 1972	SA	0-2	1
		P	1-20	9
	Jan 1970-Dec 1971	TWT	0	0
Erie, Pennsylvania	Sept 1970-Feb 1972	PM, Sr-90	0-25	10
Buffalo, New York	Sept 1970-Feb 1972	PM, Sr-90	5-10	7
	July 1969-Feb 1972	SA	0-1	1
Buffalo, New York (Lake Erie)	Mar-June 1971	SW gross alpha (d)	<0.2	<.2
		SW gross alpha (s)	<0.2	<.2
		SW gross beta (d)	2-3	3
		SW gross beta (s)	10-11	11
Windsor, Ontario, Canada	Sept 1970-Feb 1972	PM, Sr-90	4-12	5
	July 1969-Feb 1972	SA	0-0.4	0.1
		P	0.4-11.9	4

*PM - Pasteurized milk (pCi/l).
SW - Surface water (pCi/l).
TW - Tap water, gross alpha and beta (pCi/l).
TWT - Tap water, tritium (nCi/l).
SA - Surface air (pCi/m^3).
P - Precipitation (nCi/m^2).
DS - diet sampling (pCi/kg).
d - Dissolved.
s - Suspended.

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3. THE STATION

3.1 EXTERNAL APPEARANCE

An architectural rendering of the completed Station as it will appear is presented in Fig. 3.1. A layout of the site and the Station is presented in Fig. 3.2. The plant, cooling tower, and switchyard are located in the west central portion of the site. Figure 3.3, a photograph of the Station during construction taken in April 1972, shows the various buildings and structures.

The rectangular turbine building, to be painted blue, is about 200 feet long, 150 feet wide and 104 feet high (above grade); the L-shaped auxiliary building, to be painted white, is roughly 200 feet long on each leg and 54 feet high; the containment building is a cylindrical, natural concrete structure about 140 feet in diameter and 225 feet high. The cooling tower, also natural concrete, will be 493 feet high and 415 feet in diameter at the base. The major visible structures will be the cooling tower, the containment building, the turbine building, and the auxiliary building.

In clear weather the cooling tower will probably be visible for more than ten miles on the flat terrain around the Station. During the daylight hours four high intensity flashing white (strobe) lights on the top of the tower will be operating. The nighttime lighting will be four flashing red lights at the top and midpoint, respectively, and four steady red lights at the three-quarter point. The other Station structures will be

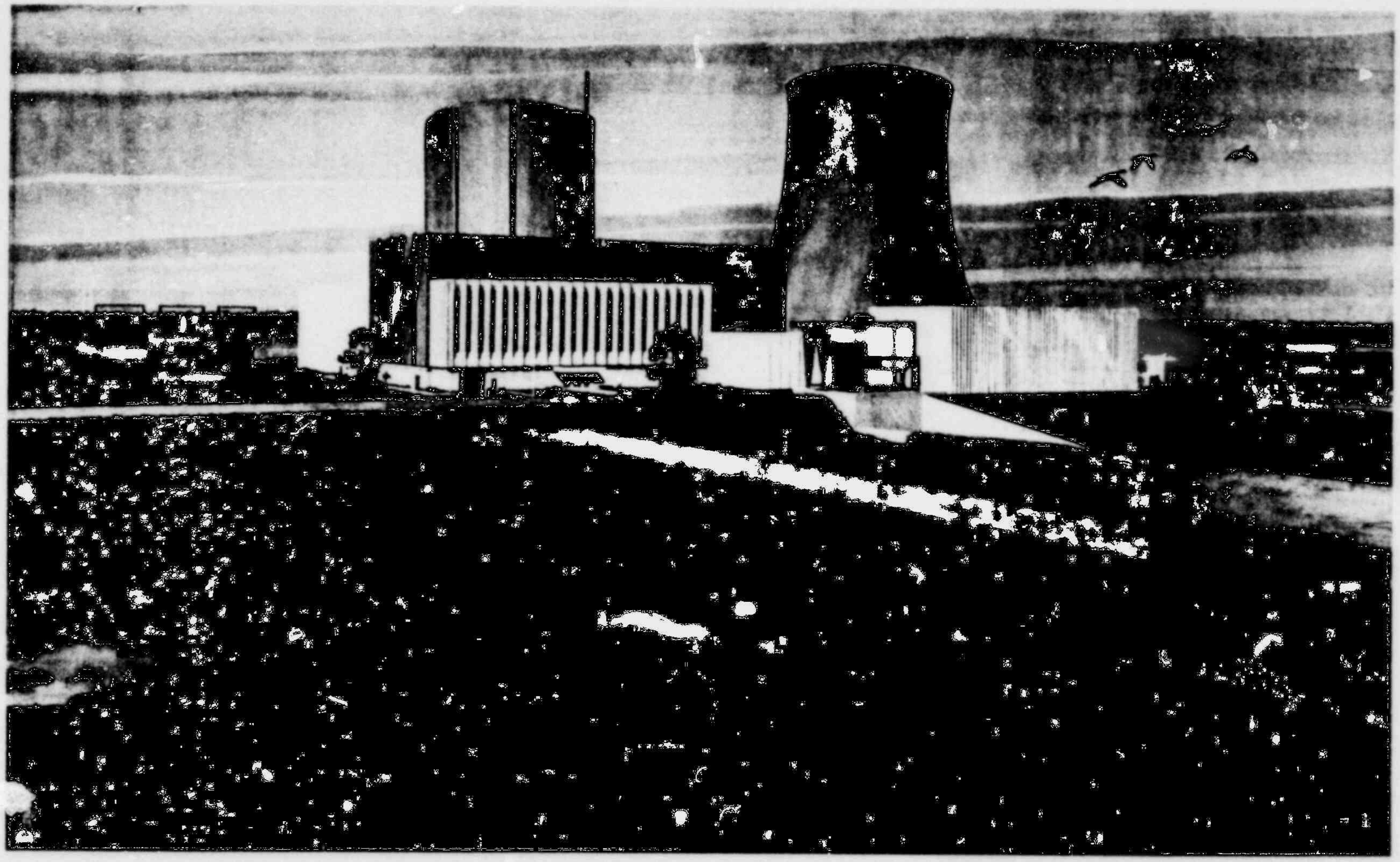

Fig. 3.1. Architectural Rendering of Completed Davis-Besse Nuclear Power Station.

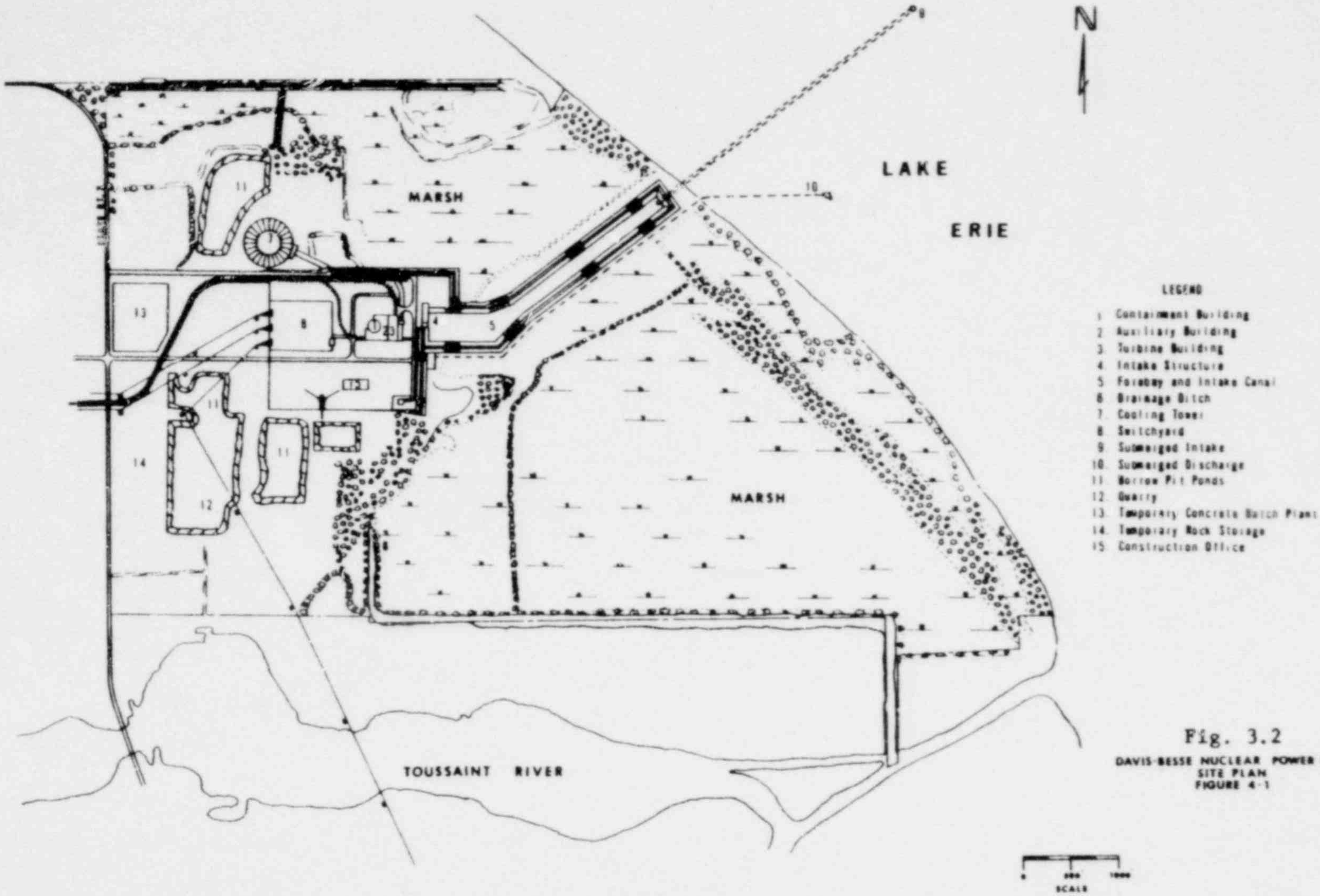

Fig. 3.2

DAVIS-BESSE NUCLEAR POWER STATK
SITE PLAN
FIGURE 4-1

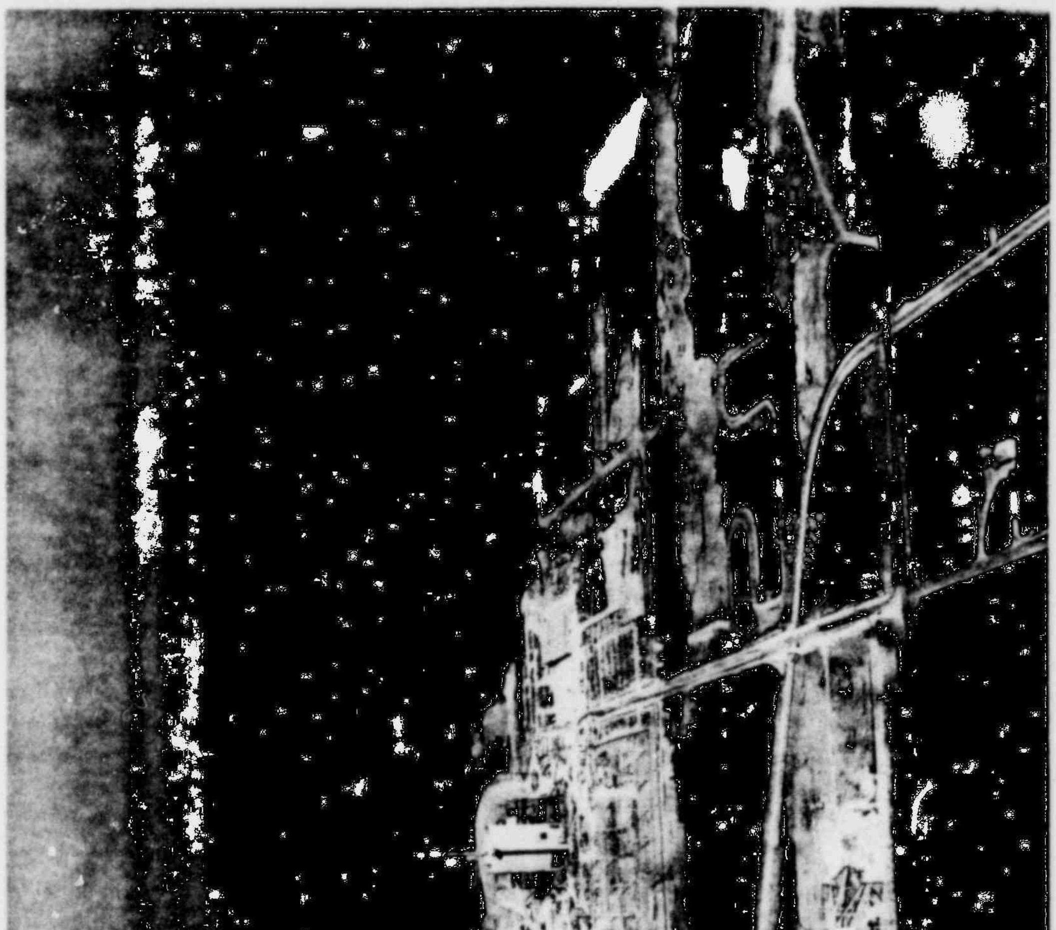

Fig. 3.3. View of Station during Construction (looking east).

visible for perhaps two miles. The applicant has stated that landscaping plans will be formulated later.

3.2 REACTOR AND STEAM-ELECTRIC SYSTEM

The nuclear reactor for the Station will be of the pressurized water type (PWR) and will be supplied by the Babcock & Wilcox Company. Bechtel Company is the architect engineer and construction manager for the Station.

The reactor is designed for a power output of 2,633 MWt, the license application rating, corresponding to an approximate net Station output of 872 MWe. The reactor is expected to be capable of an ultimate output of 2,722 MWt, which corresponds to a turbine-generator rating of approximately 906 MWe.

Except for the nuclear steam supply system, the Station operates on the same principle as fossil-fueled power plants, namely by converting thermal energy to electrical energy via a Rankine steam cycle. During operation, the uranium-235 in the slightly enriched uranium dioxide fuel elements undergoes fission and produces heat. The core reactivity is controlled by a combination of 49 control rod assemblies, and by a neutron absorber (boric acid) dissolved in the coolant-moderator. The control rods, used for short-term control, are cadmium-indium-silver alloy encapsulated in stainless steel tubes. Long-term reactivity is controlled by adjusting the concentration of boric acid in the coolant-moderator water.

Heat generated in the reactor fuel elements is transferred by the pressurized water coolant-moderator to the steam generators.

Two outlet coolant loops are connected in parallel to the reactor vessel. Each loop contains one steam generator, two coolant pumps (there are two return lines from each steam generator), and the interconnecting piping. A pressurizer is connected to one of the loops. Heated reactor coolant water is pumped from the reactor outlet through the steam generator and back to the reactor inlet. The normal operating pressure for the reactor vessel is 2200 psia and the average coolant exit temperature is 608°F.

Each steam generator is a vertical straight tube-and-shell unit which produces steam at a shell-side operating pressure of 1065 psia.

Steam flows from the steam generator to an 1800 rpm tandem compound four-flow exhaust turbine operating in a closed condensing cycle with six stages of feedwater heating. The turbine drives a direct coupled electric generator. The turbine-generator is manufactured by the General Electric Co.

3.3 HEAT DISSIPATION SYSTEMS

3.3.1 Cooling Tower

A natural-draft counterflow cooling tower approximately 490 feet high and 415 feet in diameter at the base will be used to dissipate 98% of the total heat from the condenser (and other plant sources) to the atmosphere by means of evaporative cooling (see Fig. 3.4). The remaining 2% of the heat is discharged to Lake Erie in the blowdown from the cooling tower system. Condenser cooling water will be pumped through the cooling tower at the rate of 480,000 gpm, using four circulating pumps each with a capacity of 120,000 gpm. The condenser cooling water flows from these pumps to and through the condenser, through two 9-ft diameter buried pipes to the cooling tower, through the cooling tower, and through an open channel from the cooling tower back to the circulating pumps; the only water losses from this system are those due to evaporation and blowdown. The temperature rise across the condenser and the drop through the cooling tower will be 26°F at full Station power, corresponding to a heat rejection to the atmosphere of 6.21×10^9 BTU per hour.

3.3.2 Other Cooling Water Systems

In addition to the major heat load from the turbine exhaust condensers, there are several other cooling systems (i.e., turbine room, component and containment) that transfer heat from other portions of the plant. These systems, which include the reactor decay heat (shutdown cooling) heat exchangers, the spent fuel pool heat exchangers, the closed loop component cooling water heat exchangers, the turbine plant recirculated cooling water heat exchangers, and the containment cooling heat exchangers, are supplied with cooling water by the service water system. A simplified flow diagram of the plant cooling and makeup water flow is shown in Fig. 3.5. The makeup water for cooling tower evaporation,, drift, and blowdown is obtained from the service water pumping system.

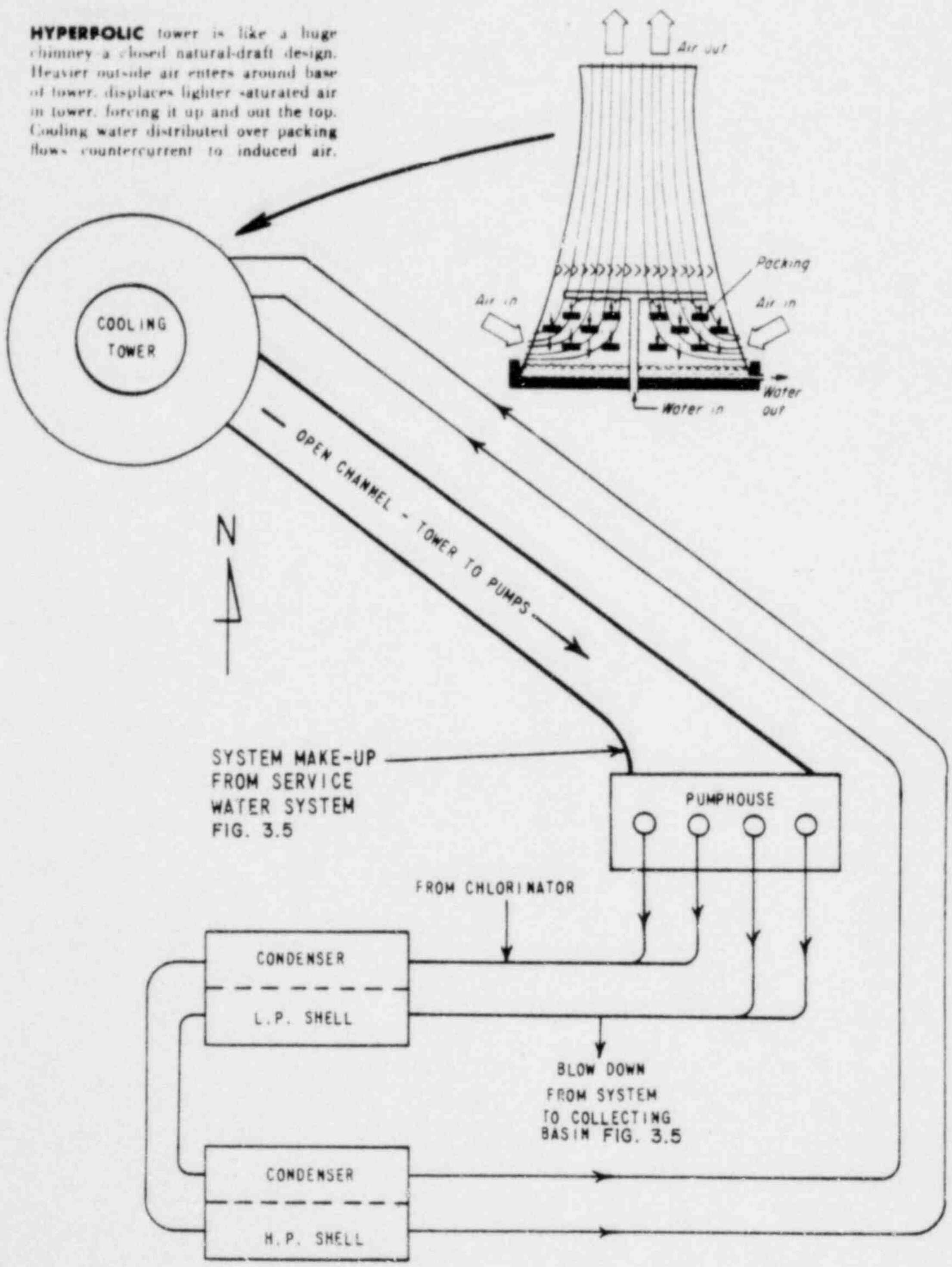

Fig. 3.4. Davis-Besse Nuclear Power Station Close: Condenser Cooling Water System Diagram.

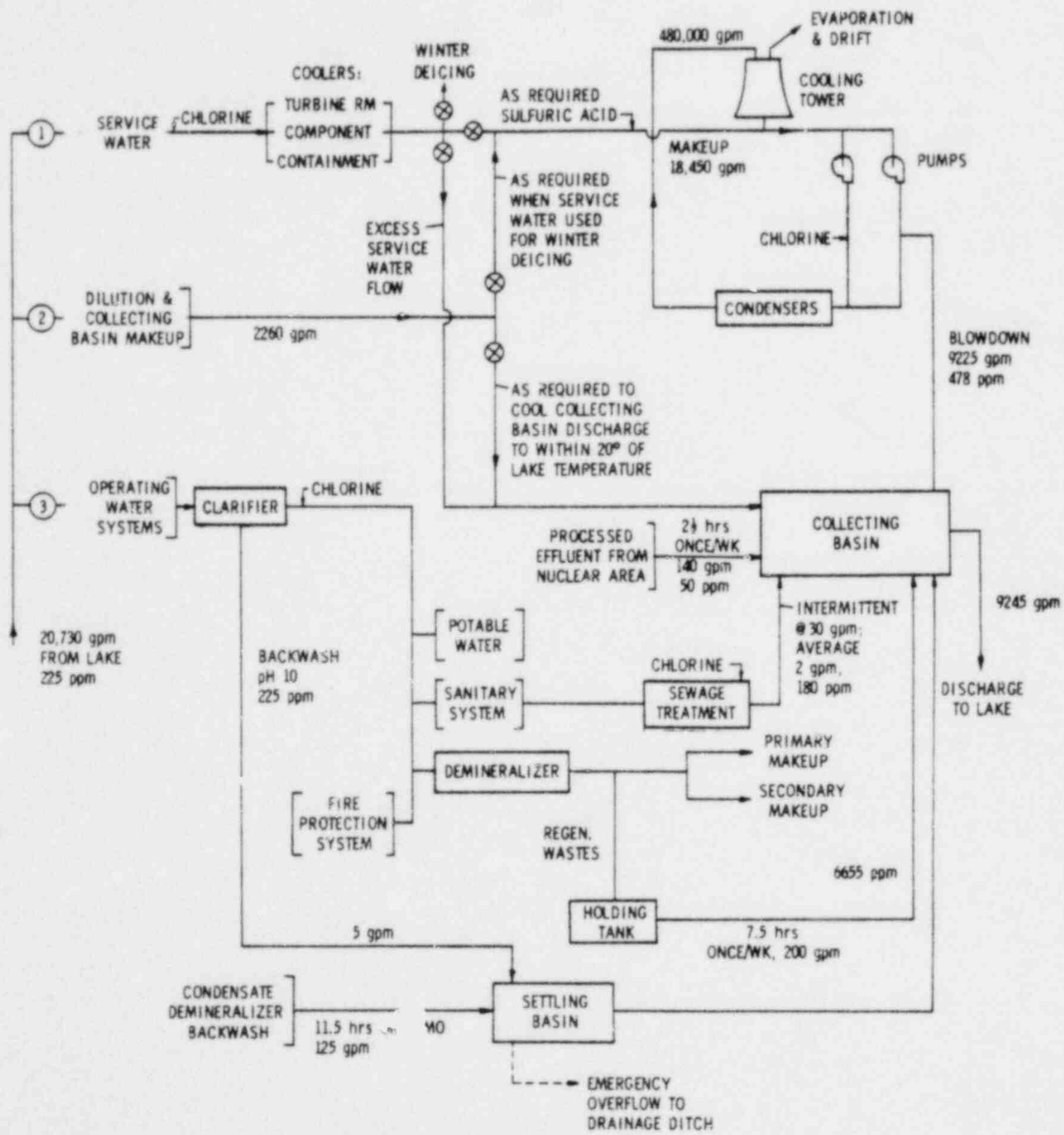

Fig. 3.5. Station Water Use Diagram.

The average makeup flow is approximately 18,450 gpm, which includes an average 9,225 gpm evaporated from the cooling tower and 9,225 gpm average blowdown from the cooling tower pump discharges. The balance of the 20,730 gpm average intake flow is used to dilute the Station discharge to the lake (so that the maximum effluent temperature will not exceed $20^{o}F$ above ambient) and to supply the operating water systems (demineralizer, Station potable water supply, etc.).

Intake Crib

All the water used in the Station is drawn from Lake Erie into a submerged intake crib about 3000 feet offshore; the intake orifice will be on a contour 11 ft below the Lake Erie low water datum (568.6 feet) at a current water depth of about 14 ft (see Figure 3.6). This intake consists of an octagonal crib made of timber with slots in the top so that water enters the crib downward through the slots. At the design intake flow of 42,000 gpm, the maximum intake velocity will be 0.5 ft/sec, but the actual intake velocity will be about 0.25 ft/sec at the nominal flow rate of ~21,000 gpm. The applicant is planning to install a bubble screen to discourage fish from entering the crib, but it has not been designed yet.

Icing of the intake crib is not expected to occur, because similar wooden cribs currently operating on Lake Erie have not been troubled by icing. If a heavy slab of ice should block the top of the crib, enough water to satisfy the Station's needs would enter through the porous rockfill surrounding it. The semicircular rockfill partially around the intake

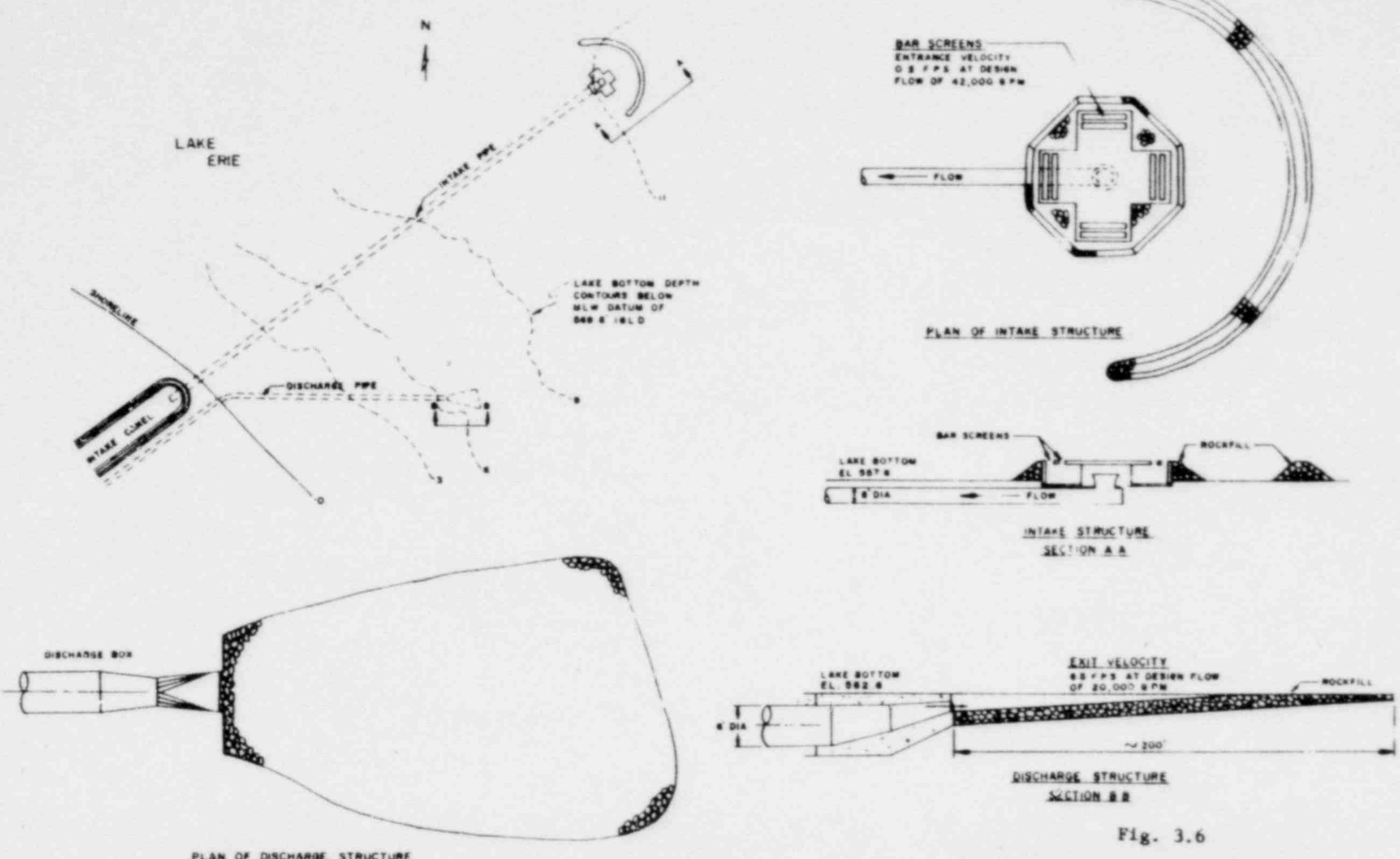

Fig. 3.6

DAVIS-BESSE NUCLEAR POWER STATION
SUBMERGED INTAKE & DISCHARGE ARRANGEMENTS

crib but spaced away from it has two purposes: (1) to prevent large chunks of ice from being driven into the crib by wind and wave action, and (2) to reduce the velocity of incoming water so that suspended sand settles out before it gets to the intake crib.

Water drawn into the crib enters an 8-ft diameter intake pipe buried beneath the lake bottom (Fig. 3.6). At the maximum intake flow of 42,000 gpm, the water velocity in the intake pipe will be about 1.8 ft/sec. This pipe brings the water to an intake canal which is separated from the lake by a beach and beachfront dike. The canal functions as a long reservoir where water is stored for Station use (See Figure 3.2). Water flows by gravity from the intake crib to the intake canal. The intake canal extends from the beachfront dike to the Station water intake structure; the canal widens into a forebay near the Station intake structure (See Fig. 3.7). At the design flow of 42,000 gpm, the water velocity in the intake canal is estimated to be about 0.11 ft/sec.

Intake pumps and screens

The three pumps, located in three bays in the intake structure, supply all the water used by the Station. However, before the water reaches these pumps, it passes through a trash rack (4 inch x 26 inch openings) and then through traveling screens with 1/4-inch square openings to prevent fish or small debris from entering the pump wells. The traveling screens have backwash sprays which remove entrained material, and the entrained material is sluiced through a trough to a holding basin with overflow weir discharge, so that debris or fish removed from the screens

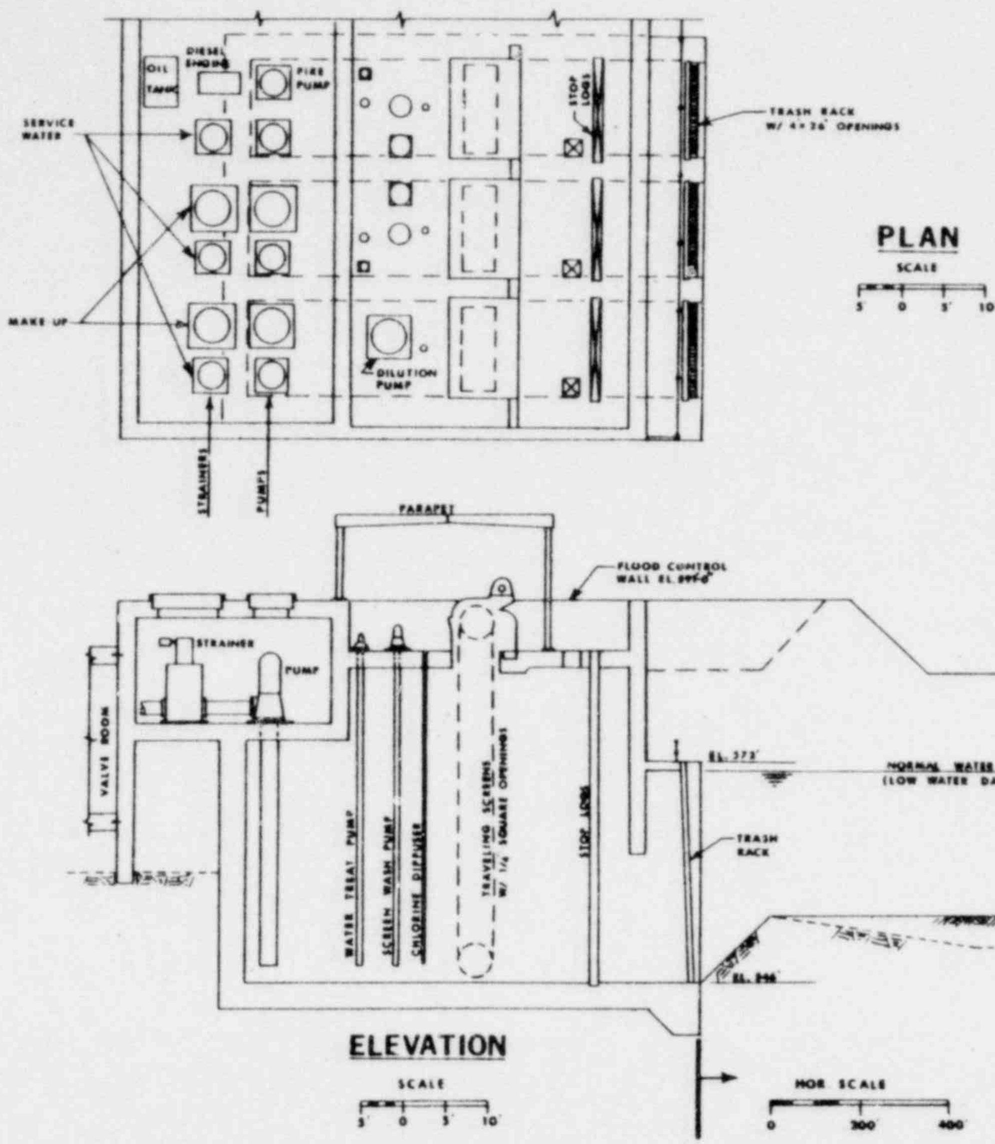

Fig. 3.7
DAVIS-BESSE NUCLEAR POWER STATION
INTAKE STRUCTURE ARRANGEMENT

can be monitored and identified. From these pumps the water goes into the service and operating water systems, or is fed directly to the collecting basin for dilution purposes (See Fig. 3.5).

Discharge structure

All Station effluents (except storm water drainage, turbine building and non-radioactive auxiliary building drains, which go to the Toussaint River) will be mixed in the collecting basin prior to discharge into Lake Erie. Most of this mixture will be cooling tower blowdown and its associated dilution water. The collecting basin has a small volume compared with the flowrates into it, and therefore has no holdup capacity but merely serves to mix the various effluent streams. From the collecting basin a buried pipe, six feet in diameter, runs parallel to the intake canal on its eastern side and extends about 1300 feet eastward out under the lake, where it terminates with a 4.5 ft wide x 1.5 ft high slot-type jet discharge (See Figure 3.6). The discharge is located at a current water depth of about 9 ft (6 ft below the Lake Erie low water datum). The elevation of the collecting basin will provide the necessary head for discharge through the discharge pipe to the lake under all conditions of water level. The slot-type discharge will have an exit water velocity of about 6.5 ft/sec at the design maximum discharge flow of 20,000 gpm. The nominal water velocity will be 4.5 ft/sec at the expected discharge rate of 13,000 gpm, thus promoting rapid entrainment and mixing with the lake water. The lake bottom will be riprapped with rock for about 200 feet in front of the slot discharge to minimize scouring of the lake bottom and the water turbulence that would result.

3.3.3 Thermal Discharges to Lake Erie

Seasonal variations in Station water consumption and temperature of blowdown to the lake must be considered. The amount of local heating of the lake depends on the volume of blowdown and on the temperature difference between it and the lake. The cooling tower blowdown is taken from the cold water side of the loop and its temperature is dependent on the wet-bulb temperature of the air. Thus, the heat discharged to the lake depends on the difference between atmospheric wet-bulb temperature and lake temperature. This temperature difference varies considerably with the season of the year, as shown by the data in Table 3.1. Some lake water will be used to dilute the blowdown so that the effluent to the lake will never be more than 20°F above lake water temperature. A summary of quantities of cooling tower blowdown, dilution water, total discharge to the lake and heat added to the lake is presented in Table 3.2.

During winter months a portion of heated service water will be discharged to the intake canal forebay to prevent ice build-up at the Station intake structure.

Thermal Plume Analysis

The discharge of heated service water and cooling tower circulating water blowdown from the Station submerged discharge structure (1200 ft offshore) will generate a thermal plume in the lake. The applicant's consultant, Dr. Pritchard, estimates the maximum area of this plume at the surface to be 0.21 acres (within the 3°F isotherm).[1] It is stated on

TABLE 3.1. Temperature Difference between Station Cooling Tower Blowdown Water and Ambient Lake

	Minimum	Average	Maximum
January	-3	11.2	29
February	3	17.0	25
March	9	16.0	23
April	10	19.1	30
May	5	15.0	23
June	3	14.0	22
July	6	12.1	20
August	5	10.0	14
September	-5	5.0	14
October	6	17.0	23
November	7	17.1	30
December	8	18.2	30

Note

Atmospheric wet-bulb temperatures (taken at the onsite meteorology tower) were used to determine the cooling tower blowdown temperatures. The lake water temperatures were subtracted to obtain these numbers.

TABLE 3.2. Station Flow Rates and Heat Inputs to Lake Erie by Months

	Water Flow Rates (gpm)					
	Cooling Tower Blowdown*	Process & Misc.	Dilution Water**	Combined Flow	Heat Input (10^6 BTU/min)	Temperature Rise Above Lake (°F)
January	7,500	20	4,080	11,600	116	20.0
February	8,200	20	2,780	11,000	110	20.0
March	8,500	20	1,980	10,500	105	20.0
April	9,200	20	4,580	13,800	138	20.0
May	10,000	20	1,480	11,500	115	20.0
June	10,000	20	980	11,000	110	20.0
July	10,400	20	0	10,420	104	20.0
August	10,400	20	0	10,420	73	14.0
September	10,000	20	0	10,020	70	14.0
October	9,500	20	2,080	11,600	116	20.0
November	9,000	20	4,480	13,500	135	20.0
December	8,000	20	4,680	12,700	127	20.0

*The variation in cooling tower blowdown is due to the seasonal variation in evaporation from the tower. The tower is operated so that blowdown equals evaporation loss at all times.

**Dilution water flow is based on the quantity required to limit the maximum combined effluent discharge temperature to 20°F above Lake Erie temperature.

page 6 of reference 1 that a detailed description of the computational model used to predict the discharge thermal plume is to be found in the document, "Design and Siting Criteria for Once-Through Cooling Systems," presented by Dr. Pritchard at the Meeting of the American Institute of Chemical Engineers in March 1971.[2]

We have written a computer program which codes the model equations specified in that reference. The inclusion of the vertical spreading phenomenon, which is only cursorily discussed in that paper, was done following the same technique Pritchard employed in his previous theoretical model studies of Zion and Waukegan.[3,4] The resulting program was run for Sub-Case-I-B and Sub-Case-II-B* featuring the current rectangular slot design. Our results and those reported by Dr. Pritchard differed significantly. First, the distance from the orifice to the longitudinal position the plume reaches the surface is predicted to be about 100 feet by Pritchard for all cases and subcases, but about 500 feet by our computer program. Employing the modified Koh and Fan analysis,[5] the circular jet of Cases I and II reaches the surface at 54 feet (the actual value should really be more than 54 feet since Koh and Fan assume no surface interference effects). This is one discrepancy with Pritchard's prediction that presently cannot be reasonably resolved. The next, but related, question involves the quasi-two dimensionality of the Pritchard

*Sub-Case-I-B is a heat discharge of 88 x 10^6 Btu/hr (volume flow rate of 9220 gpm at 19.1°F above lake temperature). Sub-Case-II-B is a heat discharge of 138 x 10^6 Btu/hr (volume flow rate of 13,800 gpm at 20°F above lake temperature).

model. As represented in all his previous papers, the model yields constant temperatures and velocities with depth at any given surface location in the plume. Consequently, for distances beyond the plume intersection with the surface, the plume thickness should be a constant 8 feet, independent of surface temperature. This is not observed, however, in the tables on pages 25 and 27 of reference 1. Moreover, the vertical temperature isotherms sketched in Fig. 4-13 in the reference are not representative of a quasi-two-dimensional model such as Pitchard's. The plume predictions also do not represent or assess the partial spreading of the heated effluent in the directions opposite to the discharge direction, once the plume has reached the surface.

The major discrepancies between our Pritchard code and the results reported by Pritchard in reference 1 are in area and isotherm length-width predictions. For Sub-Case-I-B, the 3^{o}F isotherm will have an area of 0.6 acres, a length of 347 feet and a width of 87 feet, according to our computer code, whereas Pritchard's results, in reference 1, show 0.16 acres, an isotherm length of 129 feet and a width of 62 feet. For Sub-Case-II-B, the values are 0.66 acres for the 3^{o}F isotherm, a length of 336 feet and a width of 91 feet, according to the code; but 0.21 acres, 159 feet long and 66 feet wide, as predicted in reference 1. These discrepancies are typical. The use in the program of Pritchard's own estimates for the distance of the plume to reach the surface yielded even larger differences when these new adjusted computer runs were made: the areas and lengths given above are much smaller than those predicted in reference 1. One further point is of interest: the ratio of lengtn to width to a given isotherm is equal to 4 as described in reference 2, yet this ratio varies significantly in the results in reference 1.

We can only conclude that Dr. Pritchard has altered his standard model for the Station calculations in ways not documented in reference 1 or in his previously published works. Therefore we estimate that the maximum surface area (within the $3^{o}F$ isotherm) from the station discharge of heated water, based on Pritchard's analytical model documented in reference 2, will be about 0.7 acres.

3.4 RADIOACTIVE WASTE SYSTEMS

During the operation of the Davis-Besse Nuclear Power Station, radioactive material will be produced by fission and by neutron activation reactions of metals and material in the reactor coolant. Small amounts of gaseous and liquid radioactive wastes will enter the plant waste streams which will be processed and monitored within the plant to minimize the quantity of radionuclides released to the atmosphere and into Lake Erie under controlled conditions. The radioactivity that may be released during operation of the facility will be in accordance with the Commission's regulations as set forth in 10 CFR Part 20 and 10 CFR Part 50.

The waste handling and treatment systems for the plant are discussed in the Preliminary Safety Analysis Report and the Applicant's Environmental Report dated August 3, 1970, Supplement to Environmental Report dated November 5, 1971, and supplementary information dated April 21, 1972.

In these references, the applicant has prepared an analysis of his treatment systems and has estimated the annual effluents. The following analysis is based on the Staff's model, adjusted to apply to this plant, and uses somewhat different operating conditions. The staff's calculated effluents are therefore, different from the applicants.

The waste treatment systems described in the following paragraphs are designed to collect and process on a batch basis the liquid, gaseous, and solid wastes that may contain radioactive materials. Samples of the radioactive gases or liquids will be collected at points within and at the end of the radwaste treatment systems and the wastes recirculated for additional decontamination if required. Instruments will monitor and record the radiation from controlled discharges and will activate alarms and control valves if the radiation is above a preset level. The principal assumptions and conditions used to determine the expected releases of radioactive materials in liquid and gaseous effluents are detailed in Table 3.3.

3.4.1 Liquid Waste

The Davis-Besse design has four primary systems for collection and treatment of liquids. These are Make-Up and Purification, Clean Liquid Radioactive Waste (high purity), Miscellaneous Liquid Radioactive Waste (low purity), and Condensate Purification. The interrelationship of these systems is shown schematically in Figure 3.8.

The Make-Up and Purification System will maintain the water quality and boron concentration of the primary coolant. To control the radioactivity of the primary coolant during normal operation, a portion of the reactor

TABLE 3.3. Principal Conditions and Assumptions Used in Determining Releases of Radioactivity in Effluents from the Station

Thermal Power	2772 MWt
Plant Factor	0.8
Failed Fuel*	0.25%*
Total Steam Flow	11.8×10^6 lbs/hr
Number of Steam Generators	2
Weight of Steam - each Generator	5,100 lbs
Weight of Liquid - each Generator	49,900 lbs
Steam Generator Blowdown	0
Weight of Primary Coolant	525,400 lbs
Primary Coolant Volumes	
Degassed per year	12
Primary Coolant Gas Holdup Time	60 days
Containment Volume	2.86×10^6 ft^3
Containment Purges per year	4
Primary to Secondary Leak	20 gpd
Primary Coolant Leak to the Auxiliary Bldg.	20 gpd
Primary Coolant Leak to the Containment	40 gpd
Shimrod Bleed Flow Rate	0.37 gpm
Letdown Flow Rate	45 gpm
Partition Coefficients for Iodine gas/liquid	
Steam Generator Internal	0.01
Condenser Air Ejector	0.0005
Coolant Leak to Containment	0.1
Coolant Leak to Auxiliary Bldg.	0.005
Miscellaneous Waste Evaporator	0.01
Emergency Ventilation D.F.	100
Liquid Waste Holdup Time	
Clean Radioactive Wastes	36 days
Miscellaneous Radioactive Wastes	20.5 days

Total Decontamination Factors

	I	Cs,Rb	Y	Mo,Tc	Others
Shim Bleed	10^5	4×10^3	10^3	10^4	10^6
Clean Liquid Wastes	10^4	2×10^3	10^3	10^4	10^5
Miscellaneous Wastes	10^3	10^4	10^4	10^5	10^4

*This value is constant and corresponds to 0.25% of the operating power fission product source term.

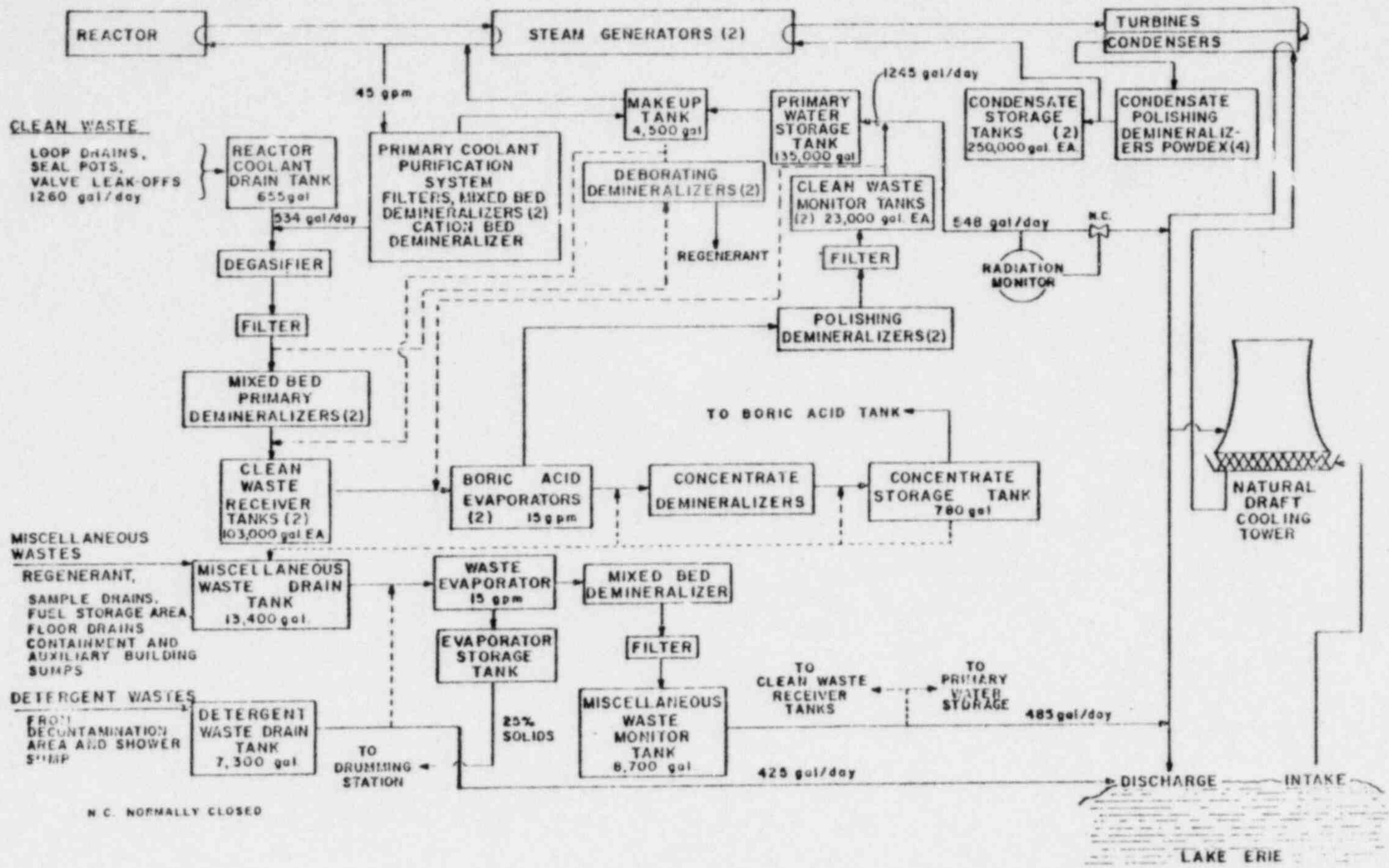

Fig. 3.8. Station Liquid Radwaste Systems

coolant will be bled continuously through letdown coolers, a mixed-bed purification demineralizer (Li_3-BO_3 form) and filter, and then routed to the primary coolant make-up tank. A separate cation demineralizer will be used intermittently in conjunction with or in lieu of the mixed-bed demineralizer for cesium and lithium control. Near the end of the core life the primary coolant letdown will be processed through the purification demineralizer, filter, and deborating demineralizer back to the primary coolant make-up tank. Basically this closed system contributes only to the solid radioactive wastes of the station in the form of spent demineralizer resins.

For major boron control, 0.37 gpm of shim bleed will be diverted to the Clean Liquid Radioactive Waste System. The shim bleed may come from the purification demineralizers or from the make-up tank. The design basis process cycle will consist of passing the coolant through a degasifier, filter, and mixed-bed demineralizer (H^+-OH^- form) into a clean waste receiving tank. The waste will then be fed to a boric acid evaporator (15 gpm) with the distillate passing through a mixed-bed polishing demineralizer and filter into the clean waste monitoring tank. Based on the analytical data, the processed waste will be either diverted to the primary water storage tank, recycled or released to the mixing basin through a normally closed valve and monitoring station that automatically records, alarms, and closes the valve above a preset radiation level. The 70 gallons per minute discharge will be diluted with the 20,000 gallon per minute circulating water. The applicant assumed a 0.8 mixing factor for a dilution factor of 228 in the mixing basin before discharge to Lake Erie with which we agreed. The clean liquid radioactive waste system will also process primary coolant collected in the reactor coolant drain tank from the coolant system and pump seal drains, valve steam leaks and the chemical waste tank.

Concentrates from the boric acid evaporator will be fed through a mixed-bed demineralizer into a storage tank. From this tank the liquid will be either sent to the boric acid storage tank, the solid waste drumming station or the Miscellaneous Liquid Radioactive Waste System described in the following paragraph. In our evaluation we assumed that 70 percent of the clean liquid radioactive waste stream will be reused and that 30 percent will be discharged to Lake Erie.

The Miscellaneous Liquid Radioactive Waste System will be designed to process radioactive liquids collected in the miscellaneous waste drain tank and the detergent waste drain tank. Sources of the liquids stored in the miscellaneous drain tank for batch processing will be containment vessel and auxiliary building sumps, component cooling water relief valves, drains from the fuel storage area and laboratory, boric acid concentrate tank and the deborating demineralizer. These aerated non-detergent wastes will be fed to a 15 gpm evaporator with the distillate passing through a mixed-bed demineralizer and filter to a monitoring tank. Liquid from this tank will be either discharged to Lake Erie, recycled, or diverted to the primary water storage tank depending upon the purity. Evaporator concentrates will be mixed with cement at the drumming station. The applicant estimated an equivalent 48,000 gallons/year of primary coolant will be decontaminated in this system and discharged to Lake Erie through the discharge monitoring station. The applicant also assumed 100% of all liquid waste from the miscellaneous liquid radioactive waste system would be discharged to Lake Erie. We agree with these assumptions and they were used in calculating release contributions from this system.

Detergent wastes from the hot shower sump, laundry and decontamination area will be collected in a tank, analyzed and handled accordingly. Normally, detergent wastes will be filtered and discharged to Lake Erie through the monitoring station without treatment. High specific activity wastes will be processed in the MLRW system before discharge. We assumed the activity of the potential detergent effluents to be a small fraction of the total discharged to the environment.

The staff's estimated annual release of radioactivity in liquid wastes was calculated to be a fraction of the values shown in Table 3.4. However, to compensate for equipment downtime and expected operational occurrences the values have been normalized to 5 curies per year. Based on previous experience, the staff has estimated the annual release of tritium will be approximately 1000 curies per year. The applicant has estimated an annual release, exclusive of tritium, to be about 0.45 curie per year.

3.4.2 Gaseous Wastes

During power operation of the plant, radioactive materials released to the atmosphere in gaseous effluent will include low concentrations of fission product noble gases (krypton and xenon), halogens (mostly iodines), tritium contained in water vapor and particulate material including both fission products and activated corrosion products. The

TABLE 3.4. Calculated Annual Radionuclide Release in Liquid Wastes from the Station*

Nuclide	Curies/yr	Nuclide	Curies/yr	Nuclide	Curies/yr
Rb-86	0.0012	Rh-103m	0.00008	Cs-136	0.16
Rb-88	0.0004	Rh-105	0.00001	Cs-137	0.58
Sr-89	0.0064	Rh-106	0.00003	Ba-137m	0.55
Sr-90	0.00002	Sb-127	0.000002	Ba-140	0.00052
Sr-91	0.00001	Te-125m	0.00007	La-140	0.00054
Y-90	0.00014	Te-127m	0.00057	Ce-141	0.00011
Y-91m	0.00001	Te-127	0.00058	Ce-143	0.00001
Y-91	0.045	Te-129m	0.0051	Ce-144	0.00008
Y-93	0.00002	Te-129	0.0032	Pr-143	0.00008
Zr-95	0.00011	Te-131m	0.00027	Pr-144	0.00008
Zr-97	0.000007	Te-131	0.00005	Nd-147	0.00003
Nb-95	0.00012	Te-132	0.001	Pm-147	0.00001
Nb-97m	0.000006	I-130	0.00049	Cr-51	0.000004
Nb-97	0.000006	I-131	2.37	Fe-55	0.000006
Mo-99	0.14	I-132	0.013	Co-58	0.00004
Tc-99m	0.13	I-133	0.25	Co-60	0.000004
Ru-103	0.00008	I-135	0.015	Np-239	0.000008
Ru-106	0.00003	Cs-134	0.72	Total	~5
				Tritium	~1000

*Radionuclides having a release rate less than 10^{-6} curies per year have not been listed.

various systems for the processing of radioactive gaseous waste and ventilation paths are shown schematically in Figure 3.9.

The primary sources of gaseous waste will originate from the degassing of primary coolant discharged to the Clean Liquid Radioactive Waste system, displacement of nitrogen cover gas from liquid storage tanks, miscellaneous tank vents and the miscellaneous liquid waste evaporator. During reactor operation, vent valves on the Make-Up and Purification system will be closed and the system operated at a positive pressure. Thus the inventories of gaseous products, except krypton-85, will reach equilibrium levels which will tend to minimize the total yearly release of gaseous radioactivity. Normally, these gases, except those from the waste evaporator, will be collected in the waste gas surge tank, compressed into decay tanks, and held for 60 days decay. The contents of the tanks will be discharged through a HEPA, a charcoal adsorber, filter and a radiation interlock monitoring system during a uniform release over a 30 day period. Due to the extended holdup time, Kr-85 becomes the major constituent released to the atmosphere from this system. The less contaminated cover gas may be tanked separately from other gases and recycled. The applicant estimates that one of five tanks discharged in a year might require release after 30 days decay at which time only 2 percent of the initial activity will be present. In our evaluation, we have assumed an average 60 day holdup time for all tanks discharged.

The miscellaneous liquid waste evaporator will be used for detergent wastes as well as non-detergent wastes if necessary and will be continuously vented through a charcoal adsorber to the Station vent. The applicant estimates that 48,000 gal/yr. of primary coolant will be

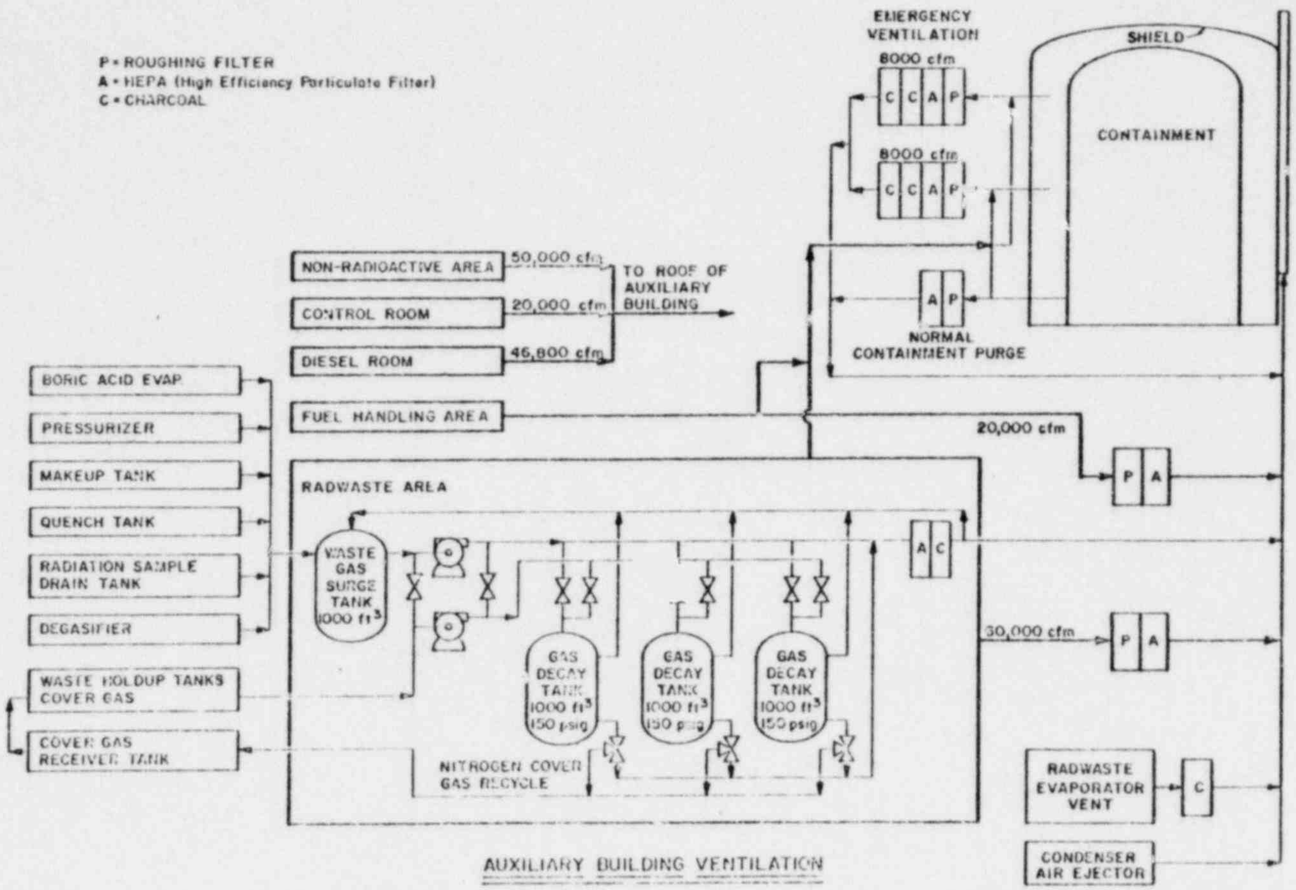

Fig. 3.9. Some Ventilation and Radioactive Gas Paths at the Station

processed in the waste evaporator with a gas/liquid iodine partition coefficient of 0.001. The iodine releases for the waste evaporator, shown in Table 3.5, reflect our assumption of an iodine partition coefficient of 0.01 gas/liquid in the evaporator, a DF of 10 for the charcoal adsorber and a 20 day decay for accumulation time with two thirds of the source from containment leaks and one third from auxiliary building leaks.

Other sources of radioactive gases which are not considered sufficiently concentrated to warrant collection and storage originate from the containment building purges, primary coolant leaks to the auxiliary building, condenser air ejector exhaust contaminated by primary to secondary leakage when fuel cladding defects exist and steam leaks in the turbine building.

Radioactive gases may be released inside the reactor containment building when the components of the primary system are opened to the building atmosphere for operational reasons or when minor leaks occur in the primary system. The containment building has no internal clean up system; however, before entry the containment atmosphere will be purged through a prefilter and high efficiency particulate filter (HEPA) to the station vent. The applicant has stated in the PSAR that one of two parallel Emergency Ventilation Systems, consisting of a prefilter, HEPA filter and two charcoal adsorbers in series, will be used for normal containment purges if indicated by pre-purge analyses. In our evaluation we assumed that it will be necessary to purge the containment building 4 times per year through the Emergency Ventilation System.

TABLE 3.5. Calculated Annual Release of Radioactive Materials in Gaseous Effluent from the Nuclear Power Station (curies per year)

Isotope	Containment* Purge	Auxiliary Building	Condenser Air Ejector	Waste Gas System 60 Day Holdup	Miscellaneous Waste Evaporator	Total
Kr-83m		1	1			2
Kr-85m		6	6			12
Kr-85	22	11	11	710		754
Kr-87		3	3			6
Kr-88		10	10			20
Xe-131m	2	6	6	5		19
Xe-133m	1	11	11	12		35
Xe-133	160	945	945	9		2059
Xe-135		16	16			32
Xe-138		2	2			4
Total						2943
I-131	0.004	0.08	0.008		0.02	0.12
I-133	0.0005	0.09	0.009			0.1

*Assumes single pass through 2 charcoal adsorbers of emergency vent system during purge.

The condenser air ejector exhaust will be discharged to the station vent without treatment. Air from the turbine building will exhaust through roof vents and auxiliary building air will be discharged to the Station vent through a prefilter and HEPA filter.

Additional sources of potentially contaminated air are the fuel storage area, penetration rooms, drumming station, and decontamination area. Normally, the ventilation air in these areas will be through a HEPA filter to the station vent. A second Emergency Ventilation System identical to the one described for the containment building will be used to exhaust these areas when conditions warrant. We assumed that under normal operating conditions the Emergency Ventilation System would not be used.

The plant will be provided with once-through steam generators and will be operated without blowdown.

The calculated releases from primary and secondary sources are shown in Table 3.5. The applicant estimated an annual release of 1650 curies per year of noble gases and 0.005 curie per year of iodine. The staff's calculated annual releases based on a 40 gallon per day leak to the containment and a 20 gallon per day leak to the auxiliary building were 2950 curies per year of noble gases, and 0.12 curie per year of I^{131}.

3.4.3 Solid Wastes

Solid wastes will consist of high level radioactive spent demineralizer resins, evaporator concentrates and filters and miscellaneous low activity level wastes such as clothing, plastic, paper, rags, glass, wood, metal, concrete and ceramics.

The spent resins and evaporator concentrates will be stored in tanks for additional processing. Periodically, batches will be sent to the solid waste disposal drumming station located in the auxiliary building where the material will be mixed with cement, drummed and stored for offsite burial.

All dry solid miscellaneous wastes will be hydraulically compacted into drums and stored for offsite burial. The non-compressibles will be sealed in the containers.

Based on operating experience at other plants and the capacity of the drumming station, the applicant estimated 500 drums of high level and 150 drums of low level waste (4800 $ft.^3$) will be shipped annually to a licensed burial ground. All solid waste will be packaged and shipped in conformance with all applicable AEC and DOT regulations.

Our estimated annual disposal based on the operating experience of similar plants is 235 drums of high level wastes and 600 drums of dry compacted waste. The total activity after 180 days decay has been estimated at 2500 curies per year.

3.5 CHEMICAL AND BIOCIDES SYSTEMS

3.5.1 System Description

All plant water discharges are sent to a common collecting basin from which there is one discharge to Lake Erie. The pertinent water circuits are shown in Figure 3.5. In addition to the recirculating cooling water, carrying heat from the condensers to the cooling tower for discharge to the atmosphere, there are three pumping systems using lake water:

(1) Service water is pumped through systems from which heat must be removed. Since there are times when the service water flow rate will exceed the appropriate makeup rate for the recirculating cooling water, it has been made possible to discharge any excess into the collecting basin.

(2) A separate circuit is established for dilution and collecting basin makeup water. When the service water effluent is routed to the forebay area, this water is used for makeup to the recirculating cooling water system. As stated earlier, there are times when the temperature of the blowdown from the recirculating water system is greater than 20^{o} above ambient lake temperature. At these times some water from the dilution and collecting basin makeup system is pumped directly into the collecting basin in order to drop the temperature to 20^{o} above lake temperature.

(3) Operating water is clarified, chlorinated, and used for several purposes. It provides potable and sanitary system water, maintains the level of the water in the fire protection system, and

supplies the makeup water demineralizer, which provides makeup to the reactor primary and secondary water systems.

A settling basin is provided to contain the solids backwashed from the clarifier used in the operating water circuits and the solids from the secondary water-steam system condensate demineralizer backwash. The overflow from the settling basin is pumped into the collecting basin although there is an emergency overflow to the drainage ditch which leads to the Toussaint River. Various solutions from drains and other discharges in the nuclear waste monitor tanks (See Fig. 3.8) are checked for chemical content and radioactivity, then discharged occasionally into the collecting basin.

3.5.2 Chemicals Added

All the makeup to the recirculating system (cooling tower) is partially neutralized with sulfuric acid, releasing carbon dioxide, and thereby reducing the amount of scale formed in the condenser and the cooling tower. The applicant's present plan is to operate at a pH of 7.3 (the pH of the lake water is about 8.1). The only other chemical added to the circuits is elemental chlorine. This is added as follows: 1) To the service water in four 30-minute periods per day (at a level required to maintain 0.5 ppm free residual chlorine) for defouling the heat exchangers; 2) To the recirculating cooling water system directly upstream of the condensers in four 30-minute periods per day (to maintain 0.5 ppm free residual chlorine); 3) To the operating water at the clarifier, where it gradually decays in the fire protection system, goes to the sewage treatment plant, or is removed in the makeup demineralizer;

and 4) To the effluent from the sewage treatment system which is chlorinated continuously to maintain one ppm free residual chlorine.

3.5.3 Chemicals Discharged

The chemicals discharged to the lake are listed in Table 3.6.

Cooling Tower Circuit

The recirculating cooling water blowdown contains the major fraction of all chemicals discharged. Due to the evaporation of water in the cooling tower the concentration of dissolved solids in the recirculating water is slightly greater than double that in the lake (the concentration factor is not exactly 2X, even though the blowdown rate is equal to the evaporation rate, because of the addition of sulfuric acid and the loss of carbon dioxide). Except for the fact that the sulfate is slightly higher and the carbonate slightly lower, the ratios of the various chemicals are the same as in lake water.

The chlorine added for defouling the condensers and the cooling tower surfaces is sampled at a point just downstream of the condensers. Chloramines are produced by reaction of free dissolved chlorine (present as the hypochlorite ion and hypochlorous acid) with ammonia and organic amines present in the water and produced in the system by the growth of micro-organisms. Some chloramines are quite volatile (notably $NHCl_2$) so that they are lost by evaporation in the cooling tower, and to a slight extent in the return from the tower to the circulating pumps. Knowledge of this loss is needed to estimate the concentration of chloramines in

TABLE 3.6. Summary of Chemicals Discharged to Lake Erie by the Station

Origin	Chemicals	Concentration at Origin (ppm)	Concentration in Discharge to Lake (ppm)	Total Quantity Discharged (Tons/Year)
Recirculating cooling water blowdown	Normal Lake Erie dissolved solids; excess produced by cooling tower evaporation. Predominantly carbonates, sulfates and chlorides of calcium and magnesium	253	252	9661
	chlorine: free	0.5	0.5[b]*	2.2[d]
	combined (chloramines)	0.07[a]	.03[c]*	0.1
Service water	chlorine: free	0.5	Unknown: depends on rates of excess flow directly to collecting basin at times of chlorination.	
	combined (chloramines)	0.9[e]		
Nuclear area effluent (Radwaste)	Miscellaneous non-toxic	50	0.8*	0.2
Sewage treatment system	Dissolved solids, reduction from that in lake	-45	-0.1*	-0.2
	Chlorine: free	1	0.003*	0.004
	combined	Unknown		
Makeup demineralizer Regeneration wastes	$CaSO_4$	915	20*	18
	$MgSO_4$	490	11*	10
	Na_2SO_4	3630	79*	71
	Na_2CO_3	1110	24*	22
	NaCl	350	8*	7
	Na_3PO_4	30	1*	0.6
Settling basin	Normal lake water from clarifier backwash; no excess	0	0	0
	Deficit dissolved solids in condensate demineralizer backwash	-225	-3*	-1.0

*While actually discharging.

TABLE 3.6 (Contd.)

Notes for Table 3.6

[a]This concentration calculated as steady-state value in the system during chlorination, after sterilization. Makeup water contains 0.37 ppm ammonia nitrogen; half of all chloramines in system assumed lost by evaporation for each pass through the cooling tower.

[b]A small amount of free chlorine will be lost (by chemical reaction) before discharge to the lake. In the absence of knowledge of this amount, no reduction is made in the numbers in the table (See text).

[c]Half the concentration entering the cooling tower is assumed to be lost in the tower.

[d]An allowance of 1.6 hours was made for full decay of chlorine in the recirculating water system. Each of the four daily chlorination periods was therefore assumed to discharge the equivalent of the full concentration for 1/2 hr during chlorination and 0.8 hour after chlorination.

[e]While actually discharging. Chlorine content of chloramines calculated equivalent to 0.37 ppm ammonia nitrogen in lake water.

the system during chlorination. Based on experience in other cooling towers it was decided to assume loss of one half of the chloramines in the system during flow of the total coolant through the cooling tower. With 0.37 ppm ammonia nitrogen continuously brought into the recirculating water system in the makeup 18,450 gpm (avg), the evaporative loss leads to a calculated steady state concentration (approximate concentration of chloramines when there is free chlorine present) of 0.07 ppm chloramines, after sterilization by the maintained level of free chlorine.

In the calculation of yearly discharges it was necessary to estimate the fraction of the time that chlorine would be discharged from the recirculating cooling water system. A calculation was made of the reduction in concentration of free chlorine by dilution in the makeup-blowdown operation, and by reaction with the chlorine demand (1.4 ppm) in the makeup water. The volume of water in the system was taken as 11.2 million gallons, the makeup rate 18,450 gpm, and the blowdown rate 9225 gpm. The calculation indicated that about 3.2 hours will be required for complete loss of free chlorine. Not included in the calculations was the loss expected in the cooling tower, and particularly in the open channel between the cooling tower and the recirculating pumps (Fig. 3.4). In the presence of sunlight, free chlorine is converted to dilute hydrochloric acid and oxygen, at a rate depending on light intensity and chlorine concentration. Under the conditions of the experiments of Hancil and Smith,[6] a 60-second exposure to the light would reduce the free chlorine concentration more than 2000-fold. If because of the depth of the water local portions of dissolved chlorine received light at that intensity for 10% of the time there would be a factor of

2 reduction. As an approximation and a compromise of the unknown loss by day, and none by night, the time of persistence of chlorine after the termination of chlorination was taken as 0.8 hours.

Excess Service Water

Some chlorine would be released to the lake from the service water that was diverted to the collecting basin during periods of service water chlorination. Flowrates at such periods are unknown; they are expected to be small, since service water flowrates are expected typically to be equal to the recirculating water makeup rate.

Sewage Treatment

The effluent from the sewage treatment system has a lower concentration of dissolved solids than the lake water. Negative numbers are used in Table 3.6 to reflect this.

Makeup Demineralizer Wastes

When the makeup demineralizer is regenerated, the salts previously removed from lake water are released in a neutralized solution, together with sodium sulfate that comes from the unused portions of the sodium hydroxide and sulfuric acid used in regeneration. Except for the sodium sulfate, the chemicals returned to the lake are those removed earlier.

Secondary System Blowdown

The secondary (turbine) system contains ammonia (1.2 mg/l), hydrazine (0.02 mg/l) and dissolved solids at a concentration less than 0.02 mg/l. There will be no blowdown from this system under normal operating conditions. If necessary, this system will be drained to the collecting basin.

Cooling Tower Drift

At the maximum anticipated drift, 0.01%, the cooling tower is expected to emit water droplets containing 275 pounds of dissolved solids per day. As the water evaporates, its solids will deposit on the land in the vicinity of the cooling tower. The estimated chemical composition of the drift and the solids deposited is shown in Table 3.7. For all constituents except sulfate and bicarbonate, concentrations were taken to be twice those in lake water. The sulfate level was calculated to be twice lake concentration plus the amount added for pH control. This quantity was estimated by attributing the excess of the average total dissolved solids content of recirculating water (478 ppm) over twice that in the lake water (450 ppm) to the difference in weight between sulfate added and equivalent carbon dioxide discharged to the air. The concentration of the bicarbonate is required to make up the total dissolved solids value. These figures are approximately correct, since the total number of chemical equivalents of the anions varies from the total of the cations by only 8%, and low-concentration solutes have not been included.

TABLE 3.7. Cooling Tower Salts Discharged in Drift

Constituent	Concentration in Drift (ppm)	Percentage of total	Deposits (pounds/day)
Total dissolved solids	478	100.0	275
Calcium	90	18.8	51.7
Magnesium	22	4.6	12.7
Sodium	24	5.0	13.7
Chloride	44	9.2	25.3
Nitrate	24	5.0	13.7
Sulfate	126	26.4	72.6
Phosphate	3	0.6	1.7
Silica	2	0.4	1.1
Bicarbonate	143	29.9	82.2

In addition, some carbon dioxide will be released as a gas. This depends upon the quantity of acid added to the makeup water and the resulting fracr on of the carbonate that is released to the atmosphere in the form of carbon dioxide gas. The applicant's estimate of 1.5 tons per day (533 tons per year) is consistent with the 1.3 tons/day estimated as the equivalent of the sulfuric acid added to the makeup water in the calculations in the preceding paragraph.

Also, chloramines will be lost by evaporation from the cooling tower. The quantities cannot be estimated accurately; however, the addition of chlorine to the 0.37 ppm ammonia nitrogen in the circulating water system makeup produces 0.86 ppm chlorine in the form of chloramines. If all except the steady state value of 0.07 ppm (See Table 3.6) is released to the atmosphere, the chlorine content of the mixed chloramines will be 15 pounds during the two hours each day that chlorine is added to the system.

3.6 SANITARY AND OTHER WASTE SYSTEMS

The secondary sewage treatment plant is designed to serve a total of 360 plant employees and visitors. About 3,000 gallons per day of treated effluent is expected to be discharged to the collecting basin (See Figure 3.5). This effluent will be chlorinated continuously, so as to maintain 1 ppm residual free chlorine.

The trash from the water-intake screens and nonradioactive solids from the clarifier and condensate demineralizer will be packaged for commercial disposal.

3.7 TRANSMISSION LINES

Three new high voltage transmission lines are being built for the Station. Two of the lines will go to Toledo Edison substations and the third will go to an Ohio Edison substation (See Fig. 3.10). Power is generated at 25 kV by the Station generator and stepped up to 345 kV by the main power transformer in the Station switchyard. Each of the three 345 kV lines leaving the switchyard will be a single circuit bundle conductor line in vertical configuration with two shield wires on double-circuit towers. Double-circuit towers are being provided so that a second circuit can be added to each line if additional generating facilities are ever built at the site.

The transmission line towers are of the lattice steel type with tower heights varying from 120 to 190 feet (averaging about 150 feet). The base dimension of a typical tower is 40 ft x 40 ft. The towers were kept as low as possible by using high strength conductors to reduce line sags, thereby giving lower line profiles. The towers have a dull metallic finish.

The Bay Shore line will be about 21 miles long, extending from the Station switchyard west and then northwest to Toledo Edison's Bay Shore substation. The right of way is 150 feet except where it parallels the existing Bay Shore to Ottawa 138-kV line. In this region, the right of way is 145 feet, contiguous to the existing 100 feet for the 138 kV line. The Lemoyne line will be about 21 miles long, extending from the Station switchyard west and then southwest to Toledo Edison's Lemoyne


MAUMEE BAY
Harbor View
BAY SHORE SUB.
OREGON
TOLEDO
Ottawa Hills
Bono
Curtice
Williston
Northwood
Rossford
Walbridge
MAUMEE
Trowbridge
Clay Center
Martin
Millbury
Moline
Elliston
PERRYSBURG
Latcho
Lime City
Genoa
Rockton
Perrysburg Hts
Stony Ridge
Lemoyne
LEMOYNE SUB.
Elmore
Dowling
Haskins
Dunbridge
Luckey
Woodville
Sugar Ridge
Pemberville
Scotch Ridge
Gibsonburg
BOWLING GREEN
New Rochester
Rollersville
Helena
Portage
Bradner
Millersville
Wayne
Rudolph
Mermill
DAVIS-BESS

SE 345KV. LINES

Fig. 3.10

Davis-Besse Nuclear Power Station
Transmission Lines

substation with a 150 foot right-of-way. The Beaver line will be about 59 miles long, extending from the Station switchyard south and then southeast to Ohio Edison's Beaver substation (not shown on Fig. 3.10). The portion of the Beaver line under this project extends from the Station about Station about 15 miles south and southeast to a tie point on the boundary between Toledo Edison and Ohio Edison. The remaining 44 miles, in Ohio Edison territory, are being constructed under a separate project. Approximately 1800 acres, primarily flat agricultural land, are required for the rights of way.

Effort was made in design of the transmission system to minimize the impact and optimize the compatibility of the transmission facility with the environment. The lines are routed to avoid paralleling existing major highways. Some paralleling of State Route 2 does occur near the Station, but here the Bay Shore line is located over one-half mile from the road and the Beaver line is approximately one-half mile away. At all major road crossings (state highways, U. S. highways, or interstate highways) the rights-of-way consist of either cultivated fields or orchards. The rights-of-way will be left natural at these road crossings. Efforts were made to avoid crossing the major highways at or near intersections. The Lemoyne line does cross State Route 163, 175 feet from the intersection of Billman Road, but this is the only exception.

In an effort to reduce the number of utility corridors across the countryside, the Bay Shore line is located adjacent to the existing Bay Shore-to-Ottawa line for about 11.6 miles and parallels the Lemoyne line for about 2.2 miles upon entering the Station. In addition, the railroad spur that serves the Station and interconnects with the Norfolk and Western Railroad is installed on the Lemoyne line right-of-way for about 7.8 miles.

Although the "Environmental Criteria for Electric Transmission Systems" (by Departments of Interior and Agriculture) was published well after the design and planning of the Station transmission lines was started, the applicant states good design practices followed were consistent with the Criteria. Herbicides will not be used to maintain the rights-of-way.

REFERENCES

1. "Davis-Besse Nuclear Power Station, Supplement to Environmental Report," Vol. 1, Appendix 4B.

2. D. W. Pritchard, "Design and Siting Criteria for Once-Through Cooling Systems," Chesapeake Bay Institute, The Johns Hopkins University, March 1971.

3. D. W. Pritchard, "Predictions of the Distribution of Excess Temperature in Lake Michigan Resulting from the Discharge of Condenser Cooling Water from the Zion Nuclear Power Station," April 1970.

4. A. J. Policastro, J. V. Tokar, "Heated Effluent Dispersion in Large Lakes, State-of-the-Art of Analytical Modeling, Part 1. Critique of Model Formulations," Argonne National Laboratory, ANL/ES-11, (1972).

5. M. A. Shirazi, and L. R. Davis, "Workbook of Thermal Plume Prediction, Volume 1, Submerged Discharge," National Environmental Research Center, Corvallis, Oregon, April 1972.

6. V. Hancil, J. M. Smith, Ind. Eng. Chem. Process Design Develop. 10, 515-523 (1971).

4. ENVIRONMENTAL EFFECTS OF SITE PREPARATION AND STATION AND TRANSMISSION LINE CONSTRUCTION

4.1 EFFECT ON LAND USE

The Station structures include the reactor containment building, turbine building, auxiliary building, and cooling tower, as shown in the Station layout in Figure 3.2. The Station, not including cooling tower, will occupy 56 acres of the 954-acre site. In addition, there will be almost 46 acres of ponds resulting from filling of the borrow pits.* The Station facilities, including the borrow pits and quarry, were constructed on farmland, requiring removal of very few trees. At the time construction began, 80 acres were classified as agricultural. Currently 15 acres remain under cultivation in the southwest portion of the site. The main Station area was graded up to an elevation 6 to 12 feet above the original grade. The marsh area was disturbed only for construction of the intake canal. The discharge pipe will be buried along the edge of the intake canal and the marsh will not be further disturbed by its installation.

Off-site transmission facilities are constructed largely over flat farmland; only about 4.7 miles of wooded area will require clearing out of a

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*One of the borrow pits is being used as a construction refuse dump. This pit, as well as another used as a dump, will be filled and compacted, i.e., not used as a pond.

total of 57 miles* of right-of-way. Routes were selected to minimize conflict with present uses of the land. The rights-of-way were selected to avoid unnecessary removal of homes or other usable buildings, disturbance of forested areas, interference with radio and television facilities, or traversal through towns, villages, cemeteries, schools, playgrounds, manufacturing facilities, parks, or other recreational facilities. Marshland, creeks and rivers were avoided where possible because they are areas of wildlife concentrations. The Bay Shore transmission line was routed south of State Highway 2 to bypass Metzger Marsh, Ottawa National Wildlife Refuge, Magee Marsh and the open expanses of water at the mouth of Turtle Creek. The Lemoyne line was routed north of Toussaint River and Creek to avoid crossing that stream and to bypass Toussaint Creek Wildlife area. The Beaver line was routed west and south of Sandusky Bay to avoid the marsh areas and coves located along the edge of the bay. Therefore no government-designated marsh areas or wildlife refuges were crossed.

The routes selected do not pass near any natural or historic landmarks. The only government-designated scenic area crossed is that section of State Highway 163 where it parallels the Portage River. The Beaver line crossing of this area was selected at a point where the Scenic Highway was not adjacent to the Portage River and at one of the narrow points of the river to reduce the crossing span and adjacent tower heights.

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*Does not include the 44-mile extension of the Beaver line being constructed by Ohio Edison (see Section 3.7).

During construction, excess excavated materials will be graded around the base of each tower to conform with the existing lay of the land. Construction areas will be filled or leveled to minimize erosion and to leave the entire right of way in as close to natural condition as possible.

4.2 EFFECT ON WATER USE

4.2.1 Temporary Barge Channel

The applicant's preferred method of delivery of the reactor pressure vessel to the site is by barge. This will require dredging of a temporary barge channel in Lake Erie connecting with the intake water canal. Accordingly, the applicant has applied to the U. S. Army Corps of Engineers for a permit to dredge and maintain a temporary (100 days, from beginning of dredging to completion of backfilling) barge channel to a depth of 3.6 feet below the Lake Erie low water datum (LWD) of 568.6 feet MSL at the site, to connect to the existing intake water canal (Figure 4.1). The channel is to be approximately 650 feet long, 50 feet wide and 1.8 feet deep (average), and will require the removal of approximately 3300 cubic yards of material (75% sand-25% hard (glaciolacustrine) clay) from the lake bottom. The removed material will be stored at the edge of the channel and replaced on the lake bottom after delivery of the reactor vessel.

An earlier dredging plan submitted by the applicant, which involved dredging a deeper channel and removal of about 34,000 cubic yards of

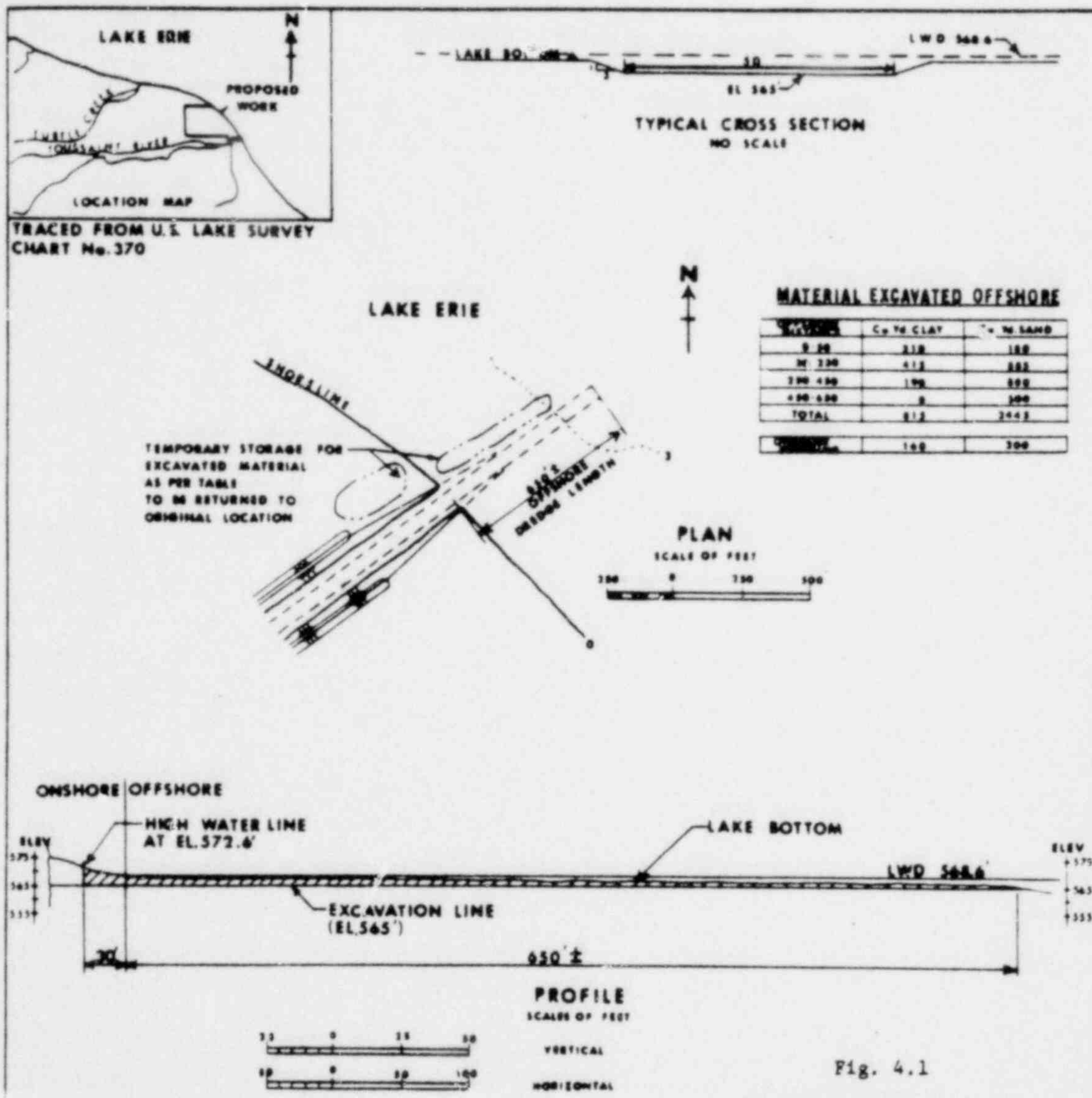

Fig. 4.1

PROPOSED DREDGING IN LAKE ERIE
AT DAVIS-BESSE NUCLEAR POWER STATION
TEMPORARY BARGE CHANNEL

COUNTY OF OTTAWA STATE-OHIO
APPLICATION BY THE TOLEDO EDISON CO.

DATE MARCH 7, 1972

sand and clay,[1] was opposed by local property owners. The opposition centered on alleged erosion damage to the beach and inland marsh areas, increased turbidity of the lake water, and introduction of pollutants (dissolved from the dredgings). The applicant has since modified the plans to take advantage of the currently high water level of the lake* and, as described above, requiring a greatly reduced amount of dredging. A new application was submitted to the Corps of Engineers[2] and the permit was issued on Aug 4, 1972.

A study by the applicant's consultant, Dr. Herdendorf,[3] concluded that there would be no lasting adverse environmental effects from the proposed dredging and that the time proposed for the operation (beginning in the third quarter of 1972) is optimal, since the lake storms are less severe during this period. He also concludes that the dredging will not cause shoreline erosion because of the rather unusual lake current situation at Locust Point, wherein the sand transported to the east and west by littoral drift is replenished by sand carried in from the offshore lake bottom. A recent study by the Corps of Engineers[4] also lists the Lake Erie shoreline around Locust Point as a non-critical erosion area. Dr. Herdendorf further states that water turbidity will be minimal and that the chemical nature of the sediments, mainly ancient lake and glacial clays, means that they are unpolluted, in contrast to materials dredged from harbors. Because of the low chemical oxygen demand of the sediments, they will not cause measurable oxygen depletion when placed in suspension temporarily.

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*The lake level is currently averaging ~3 feet above the LWD.

The Ohio Department of Natural Resources and the Ohio Department of Health have provided the water quality certification required before the Corps of Engineers can issue a permit. The state certification gives approval to the project and lists some procedures, primarily aimed at reducing water turbidity and restoring the shoreline to its original condition, which the applicant should follow.[5] All the beach areas and the lake bottom will be restored to their natural condition after backfilling of the barge channel.

4.2.2 Intake and Discharge Pipelines

Dredging and backfilling of the trenches for the intake and discharge piping present potential impacts of the same nature as those discussed above for the dredging of the temporary barge channel. However, in the case of the pipeline the trenches will be deeper, resulting in the removal of underlying glacial till (a hard clay containing some sand and gravel) in addition to the sand and glaciolacustrine clay which will be removed for the barge channel. In this case, also, Dr. Herdendorf concludes that the proposed construction will result in no lasting damage.[6] His conclusion is based on an analysis similar to that for the barge channel and experience with similiar projects on Lake Erie. All beach areas and the lake bottom will be restored to their natural condition after installation of the piping.

The pipeline construction will require 4 to 5 months to complete and will cover the period from late spring to early fall 1973. Accordingly, The Ohio State University Center for Lake Erie Research (CLEAR) has started to conduct a monitoring program to assess the effects of the temporary barge channel construction, which will be completed before the pipeline construction starts.[6] The data from this program will presumably aid in developing procedures to further minimize the impact of the pipeline construction. The applicant filed a permit application with the Corps of Engineers for this construction on Aug 1, 1972.

4.2.3 Ground Water and Storm Water Drainage Systems

The main Station area storm drain system prevents storm run-off from the construction area from entering the marsh. All exposed earth surfaces drain into the borrow pits, thus preventing silt from reaching any waterway.

All the ground water which is pumped out of the excavations during construction is eventually discharged to the Toussaint River, after passing through an aeration pond and the drainage ditch connecting it to the river. The aeration pond provides for reduction of the H_2S content (naturally about 5ppm in the ground water, of the effluent to less than 0.1 ppm. It is not desirable for water with this high a concentration of H_2S to enter the river. The pumping and discharge of ground water will, of course, cease when the construction of foundations is completed.

Artesian pressure in the rock aquifer forces water to flow into the excavations for foundations in the bedrock. Since these excavations must be kept dry they are continually pumped; however, the resulting water flow leads to a reduction of the rock aquifer water table.

Reduction of the water table level off-site has been minimized by grouting the upper bedrock layer at the perimeter of the excavations, thereby reducing the water flow into the excavations. Upon completion of the foundations the excavations will be backfilled and pumping will no longer be necessary. The water table will then return naturally to the normal level. The small (temporary) change in the water table has not affected the wells in the vicinity of the site.

4.3 EFFECTS ON SITE ECOLOGY

As the result of an exchange arrangement and long-term lease agreement with the Bureau of Sport Fisheries and Wildlife, there has been a net addition of more than 600 acres of marsh under Bureau management to serve as a wildlife refuge. The arrangement with the Bureau of Sport Fisheries and Wildlife has resulted in the following actions to enhance the area as a wildlife refuge. 1.) A dike was constructed through the marsh (Figure 2.4) at the northern edge of the site boundary in late summer of 1971; this season was chosen to avoid interference with nesting and migratory wildfowl. The dike separates the site refuge area from an adjoining private marsh, permitting water level control for improved marsh management. 2.) Existing dikes on the Navarre Marsh were in poor repair when the site was acquired; these have been repaired. The banks of the intake canal have also been seeded and planted to prevent erosion. 3.) The applicant will install permanent water pumps to control water levels for operation by the Bureau as part of the marsh management program. 4.) Construction workers have been kept out of the marsh areas.

Operation of on-site borrow pits, the quarry, and the concrete batch plant have eliminated major sources of heavy truck traffic frequently associated with large construction projects. In cooperation with the Ohio Department of Highways, State Route 2 was widened at the construction road entrance to provide turning and passing lanes, as a means of expediting traffic flow in and out of the site. On-site parking is provided for all construction workers. The dirt roads on the site are wet down during dry periods to reduce dust.

After construction is completed, the quarry and borrow pit areas will be allowed to fill with water and the surrounding areas will be landscaped.

4.4 EFFECTS ON THE COMMUNITY

Site preparation at the Station began in May 1970 and construction started in September 1970, after receipt of an exemption from the Commission. Construction has proceeded in accordance with applicable federal, state, and local regulations, and necessary approvals, certifications, and licenses have been obtained in accordance with those requirements (see Section 1.3). The state of major construction at the Station as of April, 1972 is shown in the photograph of Figure 3.3. Overall, construction is about 21% complete (as of June 1972) and commercial operation is scheduled for December, 1974. This is based on the following timetable:

Completion of turbine and auxiliary buildings - third quarter, 1972

Completion of containment building - fourth quarter, 1972.

Delivery and installation of reactor vessel and steam generators - fourth quarter, 1972.

Installation of piping - 1972 and 1973.

Delivery of turbine - second quarter, 1973.

The status of transmission line construction, as of June 1, 1972, is as follows:

Activity	Bay Shore Line	Lemoyne Line	Beaver Line*
Right-of-way secured	100%	83%	40%
Tree clearing completed	100%	90%	5%
Tower foundations	100%	35%	2%
Tower erection	100%	0%	0%
Cable installation	50%	0%	0%

Currently, there is a construction force of approximately 890 at the site; however, the construction force will peak at approximately 1600-1700 workers during 1973. Most of the workers come from Port Clinton, Toledo, Fremont, and Sandusky. However, since this local area will not be able to supply the total peak anticipated work force, workers from outside the area will move into communities in the vicinity of the Station during the peak construction period. At the present employment level of 890, the monthly payroll is approximately $1,785,000 and it will vary roughly in proportion to the work force. There is no present or anticipated strain on the school systems or housing in the area. To date, the work at the Station has taken up the slack caused by lower than normal construction activity in the area.

*Tie to Ohio Edison.

Section 4. References

1. Application by Toledo Edison Company to the Corps of Engineers for Construction of an Off-shore Barge Channel in Lake Erie - Davis-Besse Nuclear Power Station, Aug 19, 1971.
2. Application by Toledo Edison Company to the Corps of Engineers for Proposed Dredging in Lake Erie at Davis-Besse Nuclear Power Station - Temporary Barge Channel, March 7, 1972.
3. C. E. Herdendorf, "Anticipated Environmental Effects of Dredging a Temporary Barge Channel at the Davis-Besse Nuclear Power Station," a report to the Toledo Edison Company, March, 1972.
4. Great Lakes Region Inventory Report, National Shoreline Study, Department of the Army, Corps of Engineers North Central Division, August 1971.
5. Letter, W. B. Nye, Director, Ohio Department of Natural Resources to Col. M. B. Snoke, Detroit District Engineer, U. S. Army Corps of Engineers, June 19, 1972.
6. C. E. Herdendorf, "Anticipated Environmental Effects of Constructing Water Intake and Discharge Pipeline in Lake Erie at the Davis-Besse Nuclear Power Station," a report to the Toledo Edison Company, July, 1972.

5. ENVIRONMENTAL EFFECTS OF STATION OPERATION

5.1 EFFECT ON LAND USE

Operation of the Station will produce a very small effect on land use. The marsh areas within the site boundaries originally totalled about 640 acres, and of this, only the 24 acres excavated for the intake canal will be permanently altered. The remaining marsh areas, more than 600 acres, will be preserved as a National Wildlife Refuge and the water level control measures provided by the applicant will enhance the value of these areas. Further, the 188 acres of marsh between the site and the Toussaint River have been protected against undesirable development through acquisition by the applicant.

Of the remaining non-marsh area, about 100 acres remain in their original state as woodland and low grassland, and about 230 acres are upland, formerly used for farming. Most of this farmland will be occupied by Station structures, ponds formed by filling of the borrow pits and quarry, and paved or landscaped areas around and between these features. A small area (about 15 acres), adjacent to Route 2 will be farmed by a custodial employee, and a quarter of the buckwheat crop will be left as food for wildfowl.

The presence of the Station will not affect access to the lake, lakeshore, or surrounding land areas. Prior to acquisition by the applicant, the site area was privately or Federally owned, and the public had no access to the lakeshore. Sand Beach and Long Beach cottage communities are reached by a side road from Route 2, about a mile northwest of the site entrance, and this has not been affected.

The Station, with its large concrete cooling tower and vapor plume, in spite of whatever architectural merit it may possess, will inevitably be regarded by most people as an extraneous feature of the landscape. Its visual impact will be felt particularly by observers on Route 2, on the lake, and in the Sand Beach and Toussaint River cottage areas. The applicant has stated that all possible efforts will be made to improve the appearance of the Station by landscaping, but a landscaping consultant has not yet been retained. The nearest public recreational areas are Crane Creek State Park and the Toussaint Creek Area, about 3 and 4 miles away, respectively. Owning to the very flat terrain, the cooling tower will be visible in clear weather for 10 miles or more, but its visual impact on these areas should not be overpowering. Except for periods of lake breeze, the prevailing winds will most frequently carry the vapor plume over Lake Erie.

5.2 EFFECT ON WATER USE

5.2.1 Water Flow Plan

All water used at the Station is drawn from Lake Erie. The supply is used for:

1. Service water system,
2. Dilution and cooling tower makeup system, and

3. Operating water system.*

The major streams discharged from the plant to a collecting basin and thence to the lake are:

1. Cooling tower blowdown,
2. Sanitary sewage, and
3. Industrial waste (includes treated radwaste).

Storm water runoff goes to the Toussaint River via the drainage ditch (see Section 3). The storm drain system also carries drainage (resulting from nonradioactive equipment leaks) from the turbine and auxiliary buildings. Storm water runoff and building drainage passes through an oil interceptor before reaching the drainage ditch.

5.2.2 Water Consumption

The only significant consumptive use of water is the evaporative and spray loss from the cooling tower, which varies between 7500 and 10,400 gpm (average rate of 9225 gpm, 21 cfs), depending upon climatic conditions. This is about 0.1 percent of the lake average natural evaporation rate of 25,000 cfs** and, thus, does not have a significant impact on the overall water balance.

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*The operating water system is the source of: potable water, sanitary system water, demineralized water supply for primary and secondary system make-up, and fire protection system water.

**Report to the International Commission on the Pollution of Lake Erie, Lake Ontario and the International Section of the St. Lawrence River - Volume 2. Lake Erie, 1969.

5.2.3 Thermal Discharges

Approximately 98% of the waste heat produced by the Station is discharged to the atmosphere via the cooling tower. The remaining 2% is discharged to Lake Erie with the cooling tower blowdown. The resulting maximum heat load to the lake is 138 million BTU/hr (13,800 gpm at a temperature 20oF above ambient lake temperature). The maximum load will occur during April (Table 3.2).

The subject of applicable water quality criteria for Lake Erie is somewhat confused and has not yet been completely resolved. The Ohio Department of Health, Water Pollution Control Board, first defined these criteria on April 11, 1967 by applying existing stream water criteria as the minimum standards for Lake Erie waters in Ohio. These stream water criteria were revised in October 1967 and submitted to the Secretary of the Interior for approval (this was before the establishment of the Federal EPA). With the exception of the temperature and dissolved oxygen criteria, these amended criteria were approved by the Department of Interior on March 4, 1968. On April 14, 1970 the Ohio Water Pollution Control Board issued new stream water criteria, defining Aquatic A (warm water fish population) criteria as applicable to Lake Erie. These criteria are reproduced in Appendix A. They established stricter standards for dissolved oxygen, pH, and temperature, specifying a maximum temperature rise of 5oF at any point, but were qualified by the phrase "except for areas necessary for the admixture of waste effluents with stream water," thus acknowledging the necessity for a mixing zone.

On April 8, 1971 the applicant applied to the Board for certification for the purposes of Section 21(b) of the Federal Water Pollution Control Act, and submitted a report and plan covering the proposed discharges to Lake Erie. This report and plan was amended in July 1971, and includes the thermal plume calculations made by Dr. Pritchard, the applicant's consultant. These calculations are discussed in Section 3. On March 21, 1972, certification was received from the Board, and it must be presumed that this implictly accepts Dr. Pritchard's thermal plume calculations as a reasonable mixing zone. However, our independent calculations, also discussed in Section 3, predict that the thermal plume will be considerably larger than indicated by Dr. Pritchard's calculations.

Just before this certification was issued, on March 14, 1972, the Water Pollution Control Board adopted amended stream water criteria, stating in the preamble that certain changes were made in response to recommendations of the EPA. This latest resolution removes Lake Erie from the list of waters to which the criteria apply, but does not change the criteria for warm water fisheries. Thus, the Station's discharge water complies with the State criteria published in April 1970, but the EPA has not approved these criteria as applicable to Lake Erie, nor issued any alternative criteria.

5.2.4 Scouring of Lake Bottom

The Stations liquid effluents are discharged from a submerged jet at a maximum exit velocity of 6.5 feet/sec to promote rapid mixing and dilution. Since the lake bottom for about 200 feet downstream of the exit, is lined with rockfill, we do not expect any scouring of the sandy bottom with attendant turbidity during normal operation. However, there will probably be some turbidity for short periods after start up, due to materials which have settled in front of the discharge during shut down.

5.2.5 Chemical Effluents

The major chemical wastes (exclusive of liquid radioactive wastes and treated sewage) are a neutralized solution of sodium sulfate and other salts (originally removed from lake water) from the makeup demineralizer regeneration and residual chlorine from treatment of condenser cooling and service water. If operating problems of corrosion and scaling require it, it is planned to use an orthophosphate corrosion inhibitor at a concentration of about 2 ppm.

Water will be discharged to Lake Erie from the collecting basin. The concentration of dissolved solids in the effluent will be controlled at approximately twice that of Lake water by adjustment of the flow rates to maintain the blowdown rate equal to the rate of evaporation. The average concentration of dissolved solids in the effluent is expected to be about 478 ppm based upon the intake water concentration of 225 ppm and the incremental addition of 253 ppm (see Table 3.3). The pH will be lower than the lake water, that is, 7.3 compared to 8.1.

The composition of the waste resulting from demineralizer regeneration is given in Table 3.3. This stream is mixed with cooling tower blowdown so that its contribution to the effluent dissolved solids concentration is about 143 ppm during the approximately 4% of the time it is discharging.

The condenser cooling system will be chlorinated four times a day for 30-minute intervals, discharging about 0.5 ppm residual free chlorine. Total quantity discharged is 2.3 tons/year. Cooling tower aeration increases the dissolved oxygen concentration of the effluent over that of lake water.

5.2.6 Treated Sewage Effluent

The sewage treatment plant provides primary and secondary treatment for sanitary wastes. All effluents are chlorinated. Chlorine content will be 1 ppm. The effluent will have no coliform bacteria and a B.O.D. of about 14 ppm.

5.2.7 Summary of Liquid Wastes

The liquid wastes discharged from the Station are summarized in Table 3.6. The composition of lake water in the vicinity of the Station is given in Table 2.11. Federally approved chemical and biological standards (except for dissolved oxygen) are in Appendix A. It is apparent that the discharges are well within the specified limits. Discharge of an effluent containing 478 ppm (calculated from the data in Table 3.3) of nontoxic chemicals before dilution into shore waters of an average concentration of 225 ppm is considered to have no measurable effect on human uses (potable water supplies, recreation) of the lake.

5.3 COOLING TOWER EFFECTS

5.3.1 Choice of Cooling System

It has been decided to use a single large natural-draft cooling tower in a closed-circuit cooling system to dissipate nearly all the condenser heat directly to the atmosphere rather than to Lake Erie as originally planned. Although this decision alleviates concern regarding the effects of the additional thermal load on Lake Erie, a closed-circuit system involves some loss of thermal efficiency and may have undesirable meteorological effects.[1,2,3] Since this will be the first natural-draft cooling tower to be operated on the shores of the Great Lakes, there is no closely related experience on which to base predictions.

Natural draft cooling towers rely primarily on evaporation of water for their cooling effect and transfer large quantities of water vapor and heat to the atmosphere at high rates, from a small area. Before this moisture and heat can be completely dissipated by mixing with large volumes of ambient air, condensation is likely to occur and to produce a visible vapor plume. Apart from the shading of sunshine by a visible plume, possible additional adverse effects include increased incidence of ground-level fog and icing conditions, an increase of cloudiness and increased precipitation downwind. Theoretical approaches to the complex situations involved are not yet adequate to permit accurate predictions to be made, but practical experience indicates that of the available alternatives (spray ponds and canals, and mechanical-draft cooling towers), hyperbolic natural-draft towers are least apt to create ground-level fogging and icing. The reason for this is that the moist air is discharged at a considerably greater height (nearly 500 feet for the Station tower) where wind speeds are normally higher, turbulence is less, and moisture deficits are greater than at ground level. Further, a natural-draft tower releases the warm, moist air as a nonturbulent upward stream with considerable momentum and buoyancy, which under most conditions continues to rise well above the top of the tower before it becomes diffuse and is carried horizontally by the wind.

5.3.2 Possible Atmospheric Effects

The air leaving the top of the tower is practically saturated with water vapor, and, as it rises, it carries along and mixes with a considerable volume of cooler, unsaturated ambient air. Since the saturation vapor pressure decreases rapidly and nonlinearly with decreasing temperature, the mixed effluent usually becomes supersaturated as soon as it leaves the tower, and minute droplets condense out to form a visible plume - the primary atmospheric impact. The latent heat released by condensation adds to the buoyancy of the plume so that it continues to rise and mix with more ambient air until it dissipates by evaporation, merges with existing cloud cover, or reaches a maximum height depending on temperature, humidity, wind velocity and atmospheric stability. In the latter case, as the plume is carried downwind, further mixing and dispersion take place, reducing buoyancy, and eddies may also cause local downward movement. However, mixing with unsaturated air and adiabatic heating on descent cause evaporation of the droplets, and under normal conditions, in reasonably flat country, the visible plume eventually dissipates without returning to ground level.[1-7] The length of the visible plume will depend on Station load and meteorological conditions but will be greater at lower temperatures in winter, because of the reduced capability of air to hold water vapor.

After the visible plume has evaporated, a region of slightly higher humidity remains, and it has been suggested that this humid air may diffuse downwards and produce surface fog or augment natural fog. It has also been suggested that a small amount of water, carried out of the tower as droplets rather than vapor, may descend to ground level and evaporate into nearly saturated air to cause fog. These droplets, or drift, have been reduced to a very small proportion of the water throughput in modern tower designs. It may further be predicted that if fogging conditions exist and the temperature at ground level is below 32°F, ice will be deposited on the ground. However there have been no reports of icing from natural draft cooling tower plumes.

A further possible meteorological effect is that the plume will develop into a cumulus cloud while still visible or as a result of changes in meteorological conditions after it evaporates to invisibility. The increased cloudiness in the downwind area might increase precipitation or even trigger storms. Precipitation, particularly snowfall, might also be increased by falling through the humid air layer left by the plume.

The most thorough review of the effects of cooling towers on local fog, cloud, and precipitation is in the recent paper by Huff _et al._[1]

Additional relevant articles are those by Decker[2] and Zeller et al.[3]

Finally, the drift loss, due to entrained water droplets, contains appreciable quantities of dissolved solids which must eventually be deposited on the ground, with possible adverse effects on vegetation.

5.3.3 Experience with Natural-Draft Cooling Towers

The possible adverse effects are listed above without regard to actual experience. In fact, although well-documented data on cooling-tower effects are limited, the available information suggests that most of these postulated effects do not occur sufficiently frequently to be attributed definitely to cooling-tower operation.

Large natural-draft cooling towers have only been in operation in the U. S. for about 10 years. However, in Western Europe, particularly in Great Britain, such towers have been in operation for several decades. In an unpublished report, dated June 1968, the British Central Electricity Generating Board reported its findings on the environmental effects of cooling towers, and stated that although visible plumes sometimes persist for several miles downwind, altering sunshine in the area, no measurable changes in relative humidity at ground level have been detected. Cumulus clouds have sometimes been formed, but no cases of showers or increased precipitation have been definitely attributed to the cooling-tower plumes. These observations are particularly relevant in view of the fact that Great Britain has a cool, humid climate with frequent fog.

Most of the available information on operating natural-draft towers in the U. S. is derived from observations at the Paradise (Kentucky) Steam Plant and at the Keystone (Pennsylvania) Power Plant (1800 MWe). Observations have been made at Paradise[4,5] for two years and at Keystone[6,7,8] for four years. At Paradise plumes as long as 10 miles have been observed, and at Keystone, Hosler[6] has reported the only observation of a plume descending to the ground.

At Keystone, plumes from the 325-ft towers were photographed daily for six months from January through July 1969.[7] The photographs were taken in early morning, normally the time of maximum plume length. On 81.5% of all days, complete evaporation of the plume was observed. On 16.5% of the days the plume merged with existing cloud cover, and plumes on the remaining days (2.0%) were classified as "special cases," such as cloud building. Of the cases where complete evaporation was observed, the plume length was nearly always less than 5 tower heights (1625 ft), and only exceeded 15 tower heights (4875 ft) on 2.6% of these days. These reports plus observations reported elsewhere[1,2,38] show that the visible plumes from natural-draft cooling towers almost always evaporate completely before reaching ground level, and thus fogging and icing are not problems.

5.3.4 Predictions for the Station Cooling Tower

Plume Lengths

The applicant's consultant has developed an analytical model to predict the extent and behavior of the visible plume from the cooling tower.[9]

This model consists of three main sections: (a) initial state of the plume (exit velocity, temperature and humidity of the effluent, ambient air temperature, humidity and wind velocity), (b) a buoyant plume rise formula to predict the rise and growth of the plume, and (c) standard dispersion calculations of the downwind transport and dilution of the plume. It is stated that hour-by-hour calculations were made, using five years of meteorological information gathered at Toledo Express Airport, but the detailed results of these calculations are not presented. It is concluded that the average length of visible plume will be 1.5 miles and that plumes longer than 5 miles will occur about 3% of the time. Experience with operating cooling towers[1,2,5,7,8] suggests that these predictions are probably conservative (i.e., that the visible plumes will probably be shorter than predicted). The prevailing winds at the site are offshore, especially during the winter season when the longest plumes would be expected (See Section 2.6), indicating that the plume will frequently be over the lake.

Ground - Level Fog and Icing

Lake breezes and temperature inversions are common at the site, especially in spring and early summer when Lake Erie is cold compared to the land. Under these conditions, a deep (up to 3,000 ft) inversion forms over the lake and the plume could be trapped and carried downwind for many miles with little mixing or evaporation. The base of the plume would be 500 to 600 feet above ground level as it moved inland. As the layer of stable air moves inland, surface heating by solar radiation creates a layer of turbulence and mixing which grows thicker and would eventually reach the height of the plume.[10,11] In this region, portions of the plume descending towards the ground would evaporate rapidly by mixing with warmer, drier air and by adiabatic compression. Isolated sections of visible plume could be brought to the ground by eddies, but these evaporating puffs should not greatly impair visibility. However, since there are no cooling towers operating in areas subject to lake breezes there are no data for predicting the frequency of fog at the Station.

Another mechanism by which surface fog could be formed by the cooling tower is by means of the downward dispersion of water vapor into a nearly saturated surface air layer. The applicant's consultant has considered this and the analytical model predicts a very small increase in the incidence of fog; less than 1 hour per year, compared to an average of 831 hours of natural fog.[9] Natural fogs are fairly frequent close to lakes and rivers where cooling towers are usually located, and are generally associated with surface cooling and stable lapse rates. These conditions would tend to keep vertical dispersion to very low levels. Photographs taken at cooling tower installations[8] often show the plume leaving the tower and rising, completely separated from the natural surface fog which is caused by surface cooling. Thus it seems unlikely that fogs caused by downward dispersion of water vapor will be produced by operation of the Station. Also the drift losses from the Station cooling tower will be too small to create surface fog.

As stated, there have been no reported cases of icing from natural-draft cooling towers. In addition to the low frequency of plumes intersecting trees, structures, etc., the droplets are usually too small (diameter less than 100 microns) to create a layer of ice.

Using the conservative assumption that icing will occur whenever induced fogging conditions exist with air temperature below 32°F, the applicant has concluded that additional icing at a given location will be less than 1 minute per year.[9]

Cloud Formation and Increase of Precipitation

Aynsley[8] has reported that cooling-tower plumes can create cumulus clouds under certain meteorological conditions. He concludes that this is a "rare occurrence" and that these man-made clouds only precede natural cloud formation. It is not now possible to predict whether or not cooling tower plumes can cause any increase in rainfall amounts.[1,6,13,14,15]

There are at least three reported occurrences of snow showers or ice crystals being generated by cooling towers.[12] In all three, the amounts of precipitation were very small.

Drift

The applicant assumes a maximum value of 0.01% for the drift loss from the cooling tower. In view of recent measurements of drift losses from towers with drift eliminators (where drift was only 0.001 to 0.005% of the circulating water),[16] the actual value will probably be considerably less than this. Under most weather conditions the drift droplets will be carried along with the visible plume and evaporate completely, leaving their solid residue as extremely small particles which will remain airborne and disperse over a very large area before being carried to to the ground by precipitation. For this reason, deposition of salts close to the Station will probably be much less than the estimated maximum given in Section 3.5. This is supported by a recent theoretical and observational study of drift from a salt-water cooling tower.[17]

5.4 EFFECT ON TERRESTRIAL ENVIRONMENT

No measurable changes in the terrestrial biota are expected from increased fogging, icing and precipitation, from decreased solar radiation reaching the ground or from the drift fallout. It is doubtful that the increases in fogging, icing and precipitation, for example, will be measurable. Based on conservative estimates of 0.01% drift and deposition of all dissolved solids in the drift within 5 miles of the tower, yearly deposition of chemicals such as chlorides, sulfate, nitrate, calcium and sodium will be less than a few percent of the normal deposition of these substances in rainwater.[18,19] The total deposition of trace elements, such as zinc, over the lifetime of the plant will be several orders of magnitude less than the amount normally contained in the upper millimeter of soil.[20,21]

No herbicides will be used in maintenance of the Station's transmission rights-of-way. The pesticides and herbicides which the applicant has indicated may be used on lawn areas of the Station include the pesticide Johnson's "Buggy Whip" and the herbicides Pramitol 5 PS, Agrico 10-6-4 and Greenfield Two-Way Green Power.[22] The piperonyl butoxide and pyrethrins in Johnson's "Buggy Whip" should present no environmental problem.[23] Pramitol (which contains triazines) is registered for use around buildings, industrial areas, ditches, etc. by the EPA, which means its toxicity is minimal. Triazines present no known danger to warm-blooded animals. They degrade rapidly and adhere to soil so there is no leaching problem.[24,25] Both the Agrico 10-6-4 and Greenfield Two-Way Green Power, on the other hand, contain 2,4,5-T (2,4,5-trichlorophenoxy propionic acid) which is not registered for home use, use on recreational areas, or use in or near aquatic areas.[24] Therefore, we recommend that these two herbicides not be used at the Station.

The site is within a flyway for migatory birds, songbirds as well as waterfowl. The cooling tower and transmission lines are potential obstruction to migrating birds, who might be killed or wounded by flying into these structures when they are forced by adverse weather to fly under low clouds. Several accounts of nocturnal migrant mortality at television towers, tall buildings or monuments, and airport ceilometers* have been reported in the literature.[26-34] Major kills (several thousand in one night) are generally associated with peak periods of migrations (particularly in the fall, when total numbers of migrating birds are much larger than in the spring), where the birds started migrating under favorable weather conditions with good tail winds, encountered a weather front with low, deep cloud cover, possibly with fog or mist, and were forced to fly low. Ceilometer lights or the navigational lights on tall (generally about 1000 feet) television towers apparently attract the

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*A ceilometer is a device used for measuring the cloud-cover depth and height by beaming a collimated light vertically and using triangulation to obtain the distance above ground.

birds, who become confused and fly into the ground, buildings, or, in particular, the guy wires of television towers. From an extensive study by Stoddard at a TV tower in Florida, it appears that intervals between major kills will average several years.[32] Small losses, however, can occur intermittently during peak periods of migration,[31] even on clear nights with good visibility.[32]

The cooling tower at the station is not as tall as the television towers or other buildings that have major mortalities, nor does it have guy wires, which are, apparently, particularly lethal. At Eau Claire, Wisconsin, for instance, there was no evidence of bird casualties at an old 500-foot pyramidal type tower. Shortly after a new 1000-foot guy-wired tower was built, the first heavy mortality occurred.[29] Transmission lines have horizontal wires, or course, but they are much lower than the television towers. Therefore, major kills of nocturnal migrants are not expected to occur. Occasional mortalities may occur, but these are not expected to be significant compared to the numbers that die from other migrational hazards.

The transmission lines are not expected to be an electrical hazard to birds, either. Studies of bird electrocutions on power lines[35-37] indicate that the lower voltage distribution lines (under 60 kV), particularly the three-phase, 4-carrier lines with spacing less than 6 feet between the phase conductors and ground wire, are the lines involved in bird electrocutions, not the higher voltage transmission lines.

5.5 EFFECTS ON AQUATIC ENVIRONMENT

The major environmental impacts on the aquatic ecosystem will be mechanical, thermal and chemical effects resulting from the intake of water from Lake Erie, passage through the station, and discharge back into the lake.

5.5.1 Intake Effects

The water intake crib will be about 3,000 feet from shore in 11-15 feet of water (depending on lake level). Since the vertical downflow through the slots in the intake crib will be a maximum of 0.5 feet/second, entrainment of fish has probably been minimized. Experience at the Indian Point Power Plant on the Hudson River indicates that the number of entrained small fish remains relatively constant at intake velocities up to about 1.0 feet/second, at which point the number increases greatly.[38] Adult fish should be able to avoid being drawn into the intake, although young fish or weak adults swimming too near the intake will probably be entrained.[39,40] From trawling catches of young-of-the-year near Crane Creek (6 miles northwest of the station)[41] and fish spawning habits (Table 2.15), gizzard shad and alewife are likely to be the most abundant young fish near the intake crib. It is questionable whether the bubble screen the applicant proposes to install at the intake will be effective in deflecting fish away from the intake.[38,42] Most fish that are entrained in the intake water will be removed by the traveling screens located in the intake structure at the end of the intake canal.

5.5.2 Station Passage Effects

Planktonic organisms contained in the intake water and fish fry and eggs small enough to pass the 1/4-inch openings in the traveling screens will be subjected to mechanical, thermal and chemical damage during passage through the Station. On the average an organism will spend about 20 hours in the Station, during which time it will go through periods of chlorination (which alone will probably cause 100% mortality) and several trips through condensers and pumps where it will be subjected to mechanical abrasion and thermal shock. We estimate that the probability of an organism leaving the cooling tower circulating water system after only one pass is only 2%. Therefore, practically every organism entrained in the intake water will be killed.

5.5.3 Discharge Effects

Water from the Station's collecting basin will be discharged into Lake Erie. This water will generally be warmer than Lake Erie (except for a few days in the fall when it will probably be a few degrees cooler) and will contain the same dissolved solids as normal in Lake Erie water, but at approximately twice the concentrations. Dissolved oxygen concentrations will be near lake levels.

The bottom near the discharge in Lake Erie will be covered with riprap, but few benthic organisms will be eliminated due to the scarcity of organisms in the area. There should be no increase in turbidity.

Under the present plans for chlorination, the station will discharge chlorinated water for 4 periods each day. During each period up to 0.5 ppm free chlorine will be discharged for about 1/2 hour and continuously decreasing amounts for about 0.8 hours thereafter. This level of chlorine (0.5 ppm) is probably toxic to most aquatic organisms, including fish.[43,44] The EPA recommendations for residual chlorine in receiving waters for the protection of freshwater aquatic life is that intermittent discharges should contain no more than 0.1 ppm residual chlorine, not to exceed 30 minutes per day, or 0.05 ppm, not to exceed 2 hours per day.[43]

Toxic levels of chlorine in the lake will probably be confined to a small area near the discharge. The chlorinated water will be diluted immediately upon discharge into the lake. During daylight hours, some residual chlorine will be converted to nontoxic substances by rapid photochemical reactions. Of most importance, however, is the fact that the free chlorine will react very rapidly with the chlorine demand of the entrained lake water, thereby quickly reducing chlorine to nontoxic levels. If the chlorine demand of the lake water is 1.4 ppm, and if approximately half of this (0.7 ppm) is assumed to be "fast acting" in terms of reducing chlorine to nontoxic substances, when the discharge water (containing 0.5 ppm free chlorine) is mixed with 71% of its own volume, essentially all free chlorine will be converted to nontoxic substances within seconds. Using plume temperature data and assuming that reduction in temperature difference is entirely by dilution (a fairly accurate assumption in the distances under consideration), we estimate that enough lake water will be entrained within about 50 feet of the discharge slot to convert all free chlorine to nontoxic substances. Therefore, EPA recommendations will probably be met outside a small mixing zone in the lake. However, it is suggested that the applicant consider reducing the free chlorine discharged by having an intermittent rather than continuous blowdown of cooling tower water. By suspending blowdown during chlorination periods, and for a short time thereafter, chlorine levels can be reduced in the cooling tower by natural decay processes (see Appendix B).

Under conditions of maximum heat discharge (138×10^6 BTU/hr), the plume of water warmer than 3°F above ambient will cover about 0.7 acres and of water warmer than 1°F above ambient will cover less than 4 acres (our estimates using Pritchard's model, see Section 3). Plankton and small fish in the lake water entrained into the plume could be damaged by thermal stress or buffeting or exposure to toxic levels of chlorine. Their residence time in the plume will be short (less than 15 minutes to the 1°F isotherm)* and it is doubtful that any measurable increases in biological activities such as photosynthesis or rates of decay will take place during this short period.

During the winter, the warm water plume may be expected to attract fish. These fish might be subjected to cold shock should a cold water upwelling occur or should the station have to shut down suddenly. It is doubtful whether any fish will be residing within 50 feet of the discharge because of the high velocity of the discharge. No fish should

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*Based on our estimates of plume size and Pritchard's formula for temperature-time exposure relationships.[45]

therefore be subjected to sudden toxic concentrations of chlorine. In any case, no precise estimate of the number of fish expected to congregate in the plume (and, therefore, no estimate of the number of fish which might be killed) can be made.

5.5.4 Summary

It is unlikely that there will be major adverse biological effects due to the intake of lake water and discharge of heated, sometimes chlorinated, water. Any organisms (e.g., plankton) killed during passage through the station or in the discharge plume in the lake will not be lost to the ecosystem. They will be fed upon by fish congregating in the plume, or they will go through the decay processes and be recycled. It is doubtful that the number killed as a result of Station operation will have any effect on the fish population as a whole.

5.6 RADIOLOGICAL EFFECTS ON BIOTA OTHER THAN MAN

During normal operation of the Station, small quantities of radioactive materials will be released to the environment. The maximum rates of release that will probably be permitted the Station, under the provisions of 10CFR50 proposed Appendix I, have been covered in Section 3. While such maximum releases constitute a meaningful basis for setting limits, they are of little utility in the evaluation of probable radiological impacts over the four-decade life of the Station. Such evaluations require analyses of the probable history of releases over the Station lifetime, of physical, chemical and biological equilibria, integrated effects, etc.

A systems analysis of the Station, and its environment, was performed using the ARIP program package.[46] The results of this analysis are shown, in part, in Table 5.1, for liquid-borne releases, and Table 5.2, for airborne releases. These have been used as the basis for evaluating the probable environmental impact of Station releases on the local biota and on man. For purposes of comparison, results obtained for the maximum release rates of Section 3 have also been presented.

Dose rates have been included in Table 5.3 for all of the biota in the vicinity of the Station. These include phytoplankton, zooplankton, benthic organisms, terrestrial and aquatic plants, and local and migratory birds and mammals. Other terrestrial organisms will receive doses intermediate between those of terrestrial plants and birds. Doses at the effluent outlet, or in the western basin of Lake Erie, are applicable only to aquatic forms. Navarre Marsh has been chosen to represent the maximum doses to be expected on land, or at the aquatic-terrestrial interface. Doses in all other terrestrial areas will be lower than those given for Navarre Marsh. In each case the doses given are those for the limiting species, i.e., the species that are critical for this particular area, by reason of showing the maximum bioaccumulation effects. Inspection of the table shows that these doses are, in fact, quite low for all of the biota in the area. This is true even in the event of the maximum releases specified in Section 3. At these dose levels no deleterious effects are anticipated for any of the biota in the area.[47,48]

TABLE 5.1. Annual, Average, Radioactive Liquid Releases from the Station

Nuclide	Halflife (sec)	Release, μCi	Concentration, μCi/cc
Cr-51	2.4 (+6)	1.7 (-2)	4.2 (-16)
Mn-54	2.5 (+7)	2.5 (-3)	6.1 (-17)
Fe-55	8.2 (+7)	5.0 (-3)	1.2 (-16)
Co-58	6.2 (+6)	1.5 (-1)	3.6 (-15)
Co-60	1.7 (+8)	7.5 (-2)	1.8 (-15)
Sr-89	4.4 (+6)	4.6 (-2)	1.1 (-15)
Sr-90	9.2 (+8)	2.5 (-3)	6.0 (-17)
Nb-95	3.1 (+6)	1.2 (-0)	2.9 (-14)
Mo-99	2.4 (+5)	4.6 (+1)	1.1 (-12)
Tc-99m	2.2 (+4)	9.9 (-1)	2.4 (-14)
Ru-103	3.4 (+6)	5.6 (-1)	1.4 (-14)
Ru-106	3.2 (+7)	2.8 (-2)	6.7 (-16)
I-129	4.9 (+14)	3.8 (-7)	9.3 (-21)
I-131	7.0 (+5)	2.6 (+1)	6.4 (-14)
I-133	7.5 (+4)	4.3 (+1)	1.0 (-12)
I-135	2.4 (+4)	1.7 (+1)	4.2 (-13)
Te-132	2.8 (+5)	7.4 (-1)	1.8 (-14)
Cs-134	6.6 (+7)	2.7 (-3)	6.5 (-17)
Cs-136	1.2 (+6)	4.9 (-1)	1.2 (-14)
Cs-137	1.0 (+9)	5.2 (-0)	1.3 (-13)
Ba-140	1.1 (+6)	6.0 (-2)	1.5 (-15)
Ce-141	2.9 (+6)	2.9 (-3)	7.0 (-17)
Ce-144	2.5 (+7)	2.0 (-3)	4.8 (-17)
Transuranics	-	6.0 (-6)	1.4 (-19)
All others	-	7.1 (-0)	1.7 (-13)
Grand total, exclusive of tritium, 150 μCi/year.			
Tritium	3.9 (+8)	2.6 (+8)	6.3 (-6)

TABLE 5.2. Annual, Average, Radioactive Airborne Releases from the Station

Nuclide	Halflife (sec)	Releases, μCi/year			
		Main Gas	Purges	Leakage	Total
Kr-83m	6.47 (+3)	0.0	9.7 (+3)	5.9 (+6)	5.9 (+6)
Kr-85m	1.62 (+4)	0.0	8.6 (+4)	1.9 (+7)	1.9 (+7)
Kr-85	3.36 (+8)	2.7 (+8)	1.5 (+5)	7.4 (+4)	2.7 (+8)
Kr-87	4.68 (+3)	0.0	2.7 (+4)	2.3 (+7)	2.3 (+7)
Kr-88	9.97 (+3)	0.0	1.6 (+5)	5.9 (+7)	5.9 (+7)
Kr-89	1.91 (+2)	0.0	1.5 (+2)	1.4 (+1)	1.6 (+2)
Kr other	3.3 (+1)	0.0	2.3 (+0)	0.0	2.3 (+0)
Xe-129m	6.91 (+5)	8.6 (+0)	1.1 (-1)	4.5 (-1)	9.1 (+0)
Xe-131m	1.04 (+6)	3.8 (+7)	1.2 (+5)	3.4 (+5)	3.8 (+7)
Xe-133m	2.03 (+5)	1.9 (+2)	1.8 (+5)	2.6 (+6)	2.8 (+6)
Xe-133	4.55 (+2)	1.3 (+8)	1.6 (+7)	1.0 (+8)	2.4 (+8)
Xe-135m	9.18 (+2)	0.0	1.0 (+3)	1.1 (+6)	1.1 (+6)
Xe-135	3.29 (+4)	0.0	1.1 (+5)	1.1 (+7)	1.1 (+7)
Xe-138	1.02 (+3)	0.0	3.7 (+3)	4.6 (+6)	4.6 (+6)
Xe-other	2.34 (+2)	0.0	6.3 (+2)	7.1 (+2)	1.3 (+3)
I-129	4.93 (+14)	3.7 (-3)	2.5 (-4)	1.4 (-6)	3.9 (-3)
I-131	7.03 (+5)	2.0 (+3)	2.2 (+3)	9.4 (+1)	4.3 (+3)
I-other	7.49 (+4)	6.5 (-15)	1.5 (+2)	6.0 (+1)	2.1 (+2)
Particulates	>6.9 (+6)	1.0 (-15)	1.0 (-13)	3.5 (-7)	3.5 (-7)

Grand Totals: Halogens and Particulates = 2.2 (-4) I-131 Eq. Ci/year
Noble Gases = 2.1 (+3) Kr-85 Eq. Ci/year

TABLE 5.3. Doses to Biota in the Vicinity of the Station

Organism	Maximum Dose Rates, mrem/yr			Annual Average Dose, mrem		
	Effluent	Lake Erie W. Basin	Navarre Marsh	Effluent	Lake Erie W. Basin	Navarre Marsh
Aquatic Plants	58	5.1 (-3)	11	1.3	6.0 (-3)	2.4 (-1)
Aquatic Invertebrates	187	2.6 (-2)	37	1.3	6.0 (-3)	2.4 (-1)
Aquatic Vertebrates	211	3.0 (-2)	41	1.3	6.0 (-3)	2.4 (-1)
Terrestrial Plants	-	-	5.6	-	-	1.4 (-1)
Terrestrial Invertebrates	-	-	5.6	-	-	1.4 (-1)
Birds	-	-	1.0	-	-	3.0 (-2)
Mammals	-	-	0.8	-	-	2.2 (-2)

A diagrammatic representation of some of the pathways utilized in this evaluation is included in Figure 5.1. In addition, equilibration between geosphere, hydrosphere and atmosphere was considered, as well as the various trophic levels to and from birds, mammals, etc. in the biosphere.

5.7 RADIOLOGICAL EFFECTS ON MAN

The methodology above was then extended to man. Direct doses to the human population via atmospheric dispersion of Station releases are given in Table 5.4 at the Station boundary, and for the population within the 160 sectors extending to 50 miles. These are subdivided into the critical organ doses attendant on releases of halogens and particulates (e.g., I-131), and of noble gases (e.g., Kr-85). These are given because they represent the limiting cases of human hazard (e.g., carcinogenesis). Genetically significant doses, for example, will be one to two orders of magnitude lower.

The maximum airborne doses are found in the northeast sector at, or near, the boundary. This sector is also inhabited, so that the maximum value, 0.021 mrem/yr, represents an actual dose. Direct doses in all sectors are completely dominated by the noble gas component. Hunters, anglers, park and marsh visitors, and other persons in the area temporarily will receive doses at this rate or less, with an annual dose markedly less than 0.021 mrem. The annual, population-integrated, commitment over the 50-mile radius will be 0.3 manrem. In the event of maximum releases at the rates given in Section 3, the dose rates will be 0.06 mrem/yr and 0.8 manrem/yr, respectively.

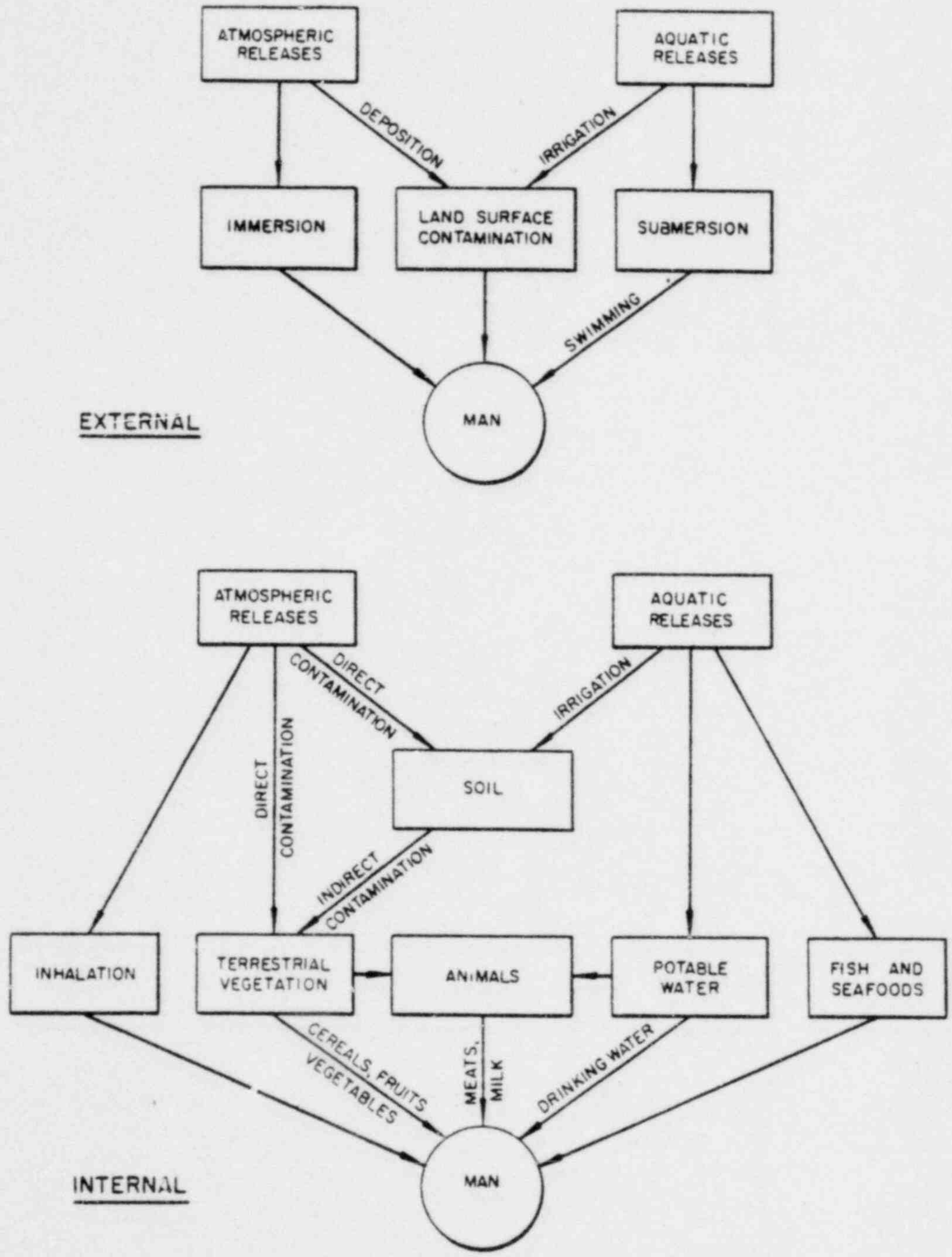

Fig. 5.1. Pathways for External and Internal Exposure of Man from Atmospheric and Aquatic Releases of Radioactive Effluents.

TABLE 5.4. Population Doses Due to Airborne Releases from the Station

Distance, mi Direction		Boundary	0-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
N	a)	40	40	22	12	7.9	5.6	2.8	1.1	0.5	0.4	0.3
	b)	13	13	7.2	4.0	2.5	1.8	0.90	0.36	0.20	0.12	0.09
	c)	0	0.7	0	0	0	0	0	0	0.8	12	43
	d)	12	12	6.6	3.6	2.3	1.7	0.82	0.33	0.17	0.11	0.08
	e)	0	0.06	0	0	0	0	0	0	4.6	100	479
NNE	a)	54	54	30	16	11	7.6	3.8	1.5	0.76	0.49	0.35
	b)	17	18	9.8	5.4	3.4	2.5	1.2	0.50	0.25	0.16	0.12
	c)	0	1.4	0	0	0	0	0	0	1.2	13	35
	d)	16	16	8.9	4.9	3.2	2.3	1.1	0.45	0.23	0.15	0.11
	e)	0	0.08	0	0	0	0	0	0	4.6	77	300
NE	a)	64	64	36	20	13	8.9	4.4	1.7	0.90	0.57	0.42
	b)	21	21	11	6.3	4.1	2.9	1.4	0.58	0.30	0.19	0.14
	c)	0	16	0	0	0	0	0	0	0.08	1.9	2.8
	d)	18	19	11	5.8	3.7	2.6	1.3	0.52	0.27	0.17	0.13
	e)	0	0.01	0	0	0	0	0	0	.27	10	20
ENE	a)	59	60	33	18	12	8.4	4.1	1.6	0.85	0.54	0.39
	b)	19	19	11	6.0	3.9	2.7	1.4	0.54	0.28	0.18	0.13
	c)	0	0	0	0	0	0	0	0.10	0.07	1.1	2.0
	d)	18	18	9.9	5.4	3.5	2.5	1.2	0.50	0.25	0.16	0.12
	e)	0	0	0	0	0	0	0	0.19	0.27	6.1	15.0
E	a)	33	33	18	10	6.5	4.6	2.3	0.91	0.47	0.30	0.22
	b)	11	11	5.9	3.3	2.1	1.5	0.75	0.29	0.15	0.10	0.07
	c)	0	0	0	0	0	0	0	1.0	0	0.09	2.9
	d)	9.7	9.8	5.5	3.0	1.9	1.4	0.68	0.27	0.14	0.09	0.06
	e)	0	0	0	0	0	0	0	3	.02	1.0	41
ESE	a)	31	32	17	9.7	6.2	4.4	2.2	0.87	0.44	0.29	0.20
	b)	10	10	5.7	3.2	2.0	1.4	0.71	0.28	0.15	0.09	0.07
	c)	0	0	0	0	0	0	0	0.96	0	0.13	6.9
	d)	9.3	9.4	5.2	2.9	1.8	1.3	0.65	0.26	0.13	0.08	0.06
	e)	0	0	0	0	0	0	0	3	0.02	1.3	100

TABLE 5.4. (Contd.)

Distance, mi Direction		Boundary	0-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
SE	a)	29	29	16	9.0	5.7	4.1	2.0	0.81	0.41	0.26	0.19
	b)	9.4	9.5	5.3	2.9	1.9	1.3	.65	2.6	0.14	0.09	0.06
	c)	0	0	0	0	0	0.21	1.0	2.4	1.9	1.7	1.3
	d)	8.6	8.7	4.8	2.7	1.7	1.2	0.60	0.24	0.12	0.08	0.06
	e)	0	0	0	0	0	0.16	1.5	9.2	14	20	20
SSE	a)	23	24	1.3	72	46	32	16	0.64	.33	0.21	0.15
	b)	7.5	7.6	4.2	2.3	1.5	1.1	0.52	0.21	0.11	0.07	0.05
	c)	0	0	0.22	0.13	0.11	0.08	0.08	1.9	1.5	1.7	0.87
	d)	6.9	6.9	3.8	2.1	1.4	0.97	0.48	0.19	0.10	0.06	0.04
	e)	0	0	0.05	0.05	0.07	0.08	1.5	9.2	14	25	17
S	a)	19	19	10	5.7	3.7	2.6	1.3	0.51	0.26	0.17	0.12
	b)	6	6.1	3.3	1.8	1.2	0.84	0.42	0.17	0.09	0.06	0.04
	c)	0	1.2	0.17	0.16	0.09	0.07	0.98	3.2	0.86	1.1	0.49
	d)	5.5	5.5	3.1	1.7	1.1	0.77	0.38	0.15	0.08	0.05	0.04
	e)	0	0.21	0.05	0.09	0.07	0.08	2.3	19	10	20	12
SSW	a)	23	23	12	7.1	4.5	3.2	1.6	.63	.32	.20	.15
	b)	7.4	7.4	4.1	2.2	1.5	1.0	.52	.20	.11	.07	.05
	c)	0	2.1	.20	.11	.10	.10	1.2	4.0	1.1	1.8	.52
	d)	6.8	6.8	3.8	2.1	1.3	.95	.47	.19	.10	.06	.04
	e)	0	.28	.05	.05	.07	.09	2.3	19	10	26	12
SW	a)	24	24	13	7.4	4.7	3.3	1.6	.65	.34	.22	.15
	b)	7.7	7.7	4.3	2.4	1.5	1.1	0.54	0.21	0.11	.07	.05
	c)	0	0.50	0	0.09	0.11	0.08	0.91	1.3	1.1	1.4	.86
	d)	7.0	7.1	3.9	2.2	1.4	1.0	.50	.20	.10	.06	.05
	e)	0	.06	0	.04	.07	.08	1.7	6.1	10	20	17
WSW	a)	26	26	14	8.0	5.1	3.6	1.8	.72	.37	.24	.17
	b)	8.3	8.4	4.7	2.6	1.7	1.2	.58	.23	.12	.08	.06
	c)	0	.13	.06	.03	.08	.08	1.0	1.4	1.1	2.6	2.3
	d)	7.7	7.7	4.3	2.4	1.5	1.1	.53	.21	.11	.07	.05
	e)	0	.02	.01	.01	.05	.07	1.7	6.1	9.2	33	40

TABLE 5.4. (Contd.)

Distance, mi Direction		Boundary	0-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
W	a)	30	31	17	9.4	6.0	4.3	2.1	.84	.43	.27	.20
	b)	9.9	9.9	5.5	3.0	2.0	1.4	.69	.27	.14	.09	.07
	c)	0	.21	.41	.10	.14	.14	.84	3.9	28.0	4.1	1.1
	d)	9.0	9.1	5.0	2.8	1.8	1.3	.63	.25	.13	.08	.06
	e)	0	.02	.07	.03	.07	.10	1.2	.4	200	45	16
WNW	a)	18	18	10	5.6	3.6	2.6	1.3	.50	.26	.16	.12
	b)	5.9	5.9	3.3	1.8	1.2	.83	.41	0.16	.08	.05	.04
	c)	0	0	.38	.92	0	0	.50	2.3	23	2.7	.40
	d)	5.4	5.4	3.0	1.7	1.1	.76	.38	.15	.08	.05	.04
	e)	0	0	.12	.50	0	0	1.2	14	279	51	10
NW	a)	15	15	8.4	4.6	3.0	2.1	1.0	.41	.21	.14	.10
	b)	4.9	4.9	2.7	1.5	1.0	.70	0.33	.13	.07	.05	.03
	c)	0	.01	1.2	.13	0	0	0	.06	6.9	4.5	1.9
	d)	4.4	4.5	2.5	1.4	.90	.62	.31	.12	.06	.04	.03
	e)	0	0	.43	.09	0	0	0	.48	100	100	59
NNW	a)	19	19	11	6.0	3.8	2.7	1.3	.53	.27	.17	.13
	b)	6.2	6.3	3.5	1.9	1.2	.88	.43	.17	.09	.06	.04
	c)	0	1.4	.25	0	0	0	0	.08	4.6	1.8	4.2
	d)	5.7	5.7	3.2	1.8	1.1	.80	.40	.16	.08	.05	.04
	e)	0	.22	.07	0	0	0	0	.48	.51	32	100

Total = 0.28 Man rem/year

a) Dose from halogens + particulates, mrem/yr x 10^6
b) Dose from noble gases, mrem/yr x 10^3
c) Manrem/yr x 10^3
d) Dispersion Factor x 10^8
e) Sector Population, in Thousands

The nearest dairy herd is pastured about two miles to the south, and this also represents the nearest probable pasturage. Annual dose to a child's thyroid via the air-cow-milk iodine pathway will be less than 0.024 mrem, or less than 1.3 mrem/yr in the event of maximum releases at the rates given in Section 3.

Direct and indirect doses to man via waterborne radionuclides are given in Table 5.5. These include doses to permanent residents of the area (e.g., via public water supplies at distances up to 50 miles from the Station), to temporary residents, hunters, anglers, boaters, swimmers, etc., and to consumers of foods produced in the area. The maximum, cumulative, annual dose received by any member of the population, via normal liquid releases from the Station, would be less than 0.03 mrem. Under conditions of maximum release the corresponding rate would be 0.3 mrem/yr. The corresponding population doses would be 1.2 manrem/yr, and 8.4 manrem/yr, respectively.

Direct dose rates from radioactive fuel and/or radionuclides stored at or released from the Station will be less than one mrem/yr at the closest approach to the Station. This dose drops off very rapidly with distance, however, so that the total annual population dose from this source will be less than one manrem. This source is independent of Station releases.

In summary, the radiological characteristics of the Station and its environs are such as to limit human doses and dose rates to a very small fraction of the natural background. The fraction is less than 1% in nearby sectors, and much less than that at a distance. Deleterious

TABLE 5.5. Population Doses due to Liquid Releases from the Station

Pathway	Population, Man Years/yr	Dose, mrem/yr				
		Bone	Thyroid	Gastrointestinal Tract	Whole Body	Critical Organ
Camp Perry, tap water	2.0 (+3)	1.3 (-8)	2.4 (-6)	1.6 (-8)	1.6 (-3)	1.6 (-3)
Port Clinton, tap water	1.5 (+4)	4.6 (-9)	8.8 (-7)	5.7 (-9)	5.6 (-4)	5.6 (-4)
Sandusky, tap water	3.6 (+4)	1.8 (-9)	3.4 (-7)	2.2 (-9)	2.2 (-4)	2.2 (-4)
Oregon/Toledo, tap water	7.0 (+5)	1.8 (-9)	3.4 (-7)	2.2 (-9)	2.2 (-4)	2.2 (-4)
Monroe, tap water	2.5 (+4)	1.2 (-9)	2.3 (-7)	1.5 (-9)	1.5 (-4)	1.5 (-4)
Pointe Aux Peaux, tap water	2.0 (+2)	9.8 (-10)	1.8 (-7)	1.2 (-9)	1.2 (-4)	1.2 (-4)
Lorraine, tap water	3.0 (+2)	8.4 (-10)	1.6 (-7)	1.0 (-9)	1.0 (-4)	1.0 (-4)
Dietary, commercial	2.1 (+6)	3.6 (-6)	7.5 (-7)	7.3 (-6)	4.8 (-4)	4.9 (-4)
Dietary, sport	7.6 (+2)	7.2 (-5)	1.5 (-5)	1.5 (-4)	9.6 (-3)	9.8 (-3)
Recreation, direct	5.5 (+2)	5.1 (-5)	5.1 (-5)	5.1 (-5)	5.1 (-5)	5.1 (-5)
Recreation, immersion	2.4 (+2)	0	0	0	4.4 (-3)	4.4 (-3)
Recreation, inhalation	3.0 (+2)	4.6 (-6)	6.5 (-6)	6.5 (-6)	6.5 (-6)	6.5 (-6)
Local wells	2.0 (+2)	3.8 (-8)	7.4 (-6)	4.8 (-8)	4.7 (-3)	4.7 (-3)
Total Risk, Manrem/yr		0.0076	0.0019	0.016	1.2	1.2
Ratio, Maximum/Average		2.7 (+5)	7.1 (+5)	3.0 (+4)	7	7

effects on the human population would not be anticipated since much higher dose rates, extended over the lifetime of significant segments of the U. S. population, have failed to show any evidence of human hazard.[49]

5.8 EFFECTS ON THE COMMUNITY

The Station's full-time operating staff will number 89. Most of these workers will be recruited from outside the immediate area of the Station, and they will probably live in the Toledo area, or in the local communities of Oak Harbor and Port Clinton. This small number of workers and their families, dispersed among several communities, is unlikely to impose a noticeable load on hospitals, schools, or other community services, and their incomes will not significantly affect the local economy.

The Benton-Carroll-Salem school district will benefit greatly from the increased tax base produced by the Station. Property taxes on the Station will amount to about $4,100,000 annually, of which the greater part, about $3,450,000, will go to the school district. The present annual revenue of the school district is about $800,000. Carroll Township general fund will receive about $287,000, and Ottawa County about $385,000 annually. In addition, the Ohio State excise tax will amount to about $4,300,000 annually.

There is a possibility that the presence of the Station and its railroad link may attract new industry to the area with more significant social and economic effects. The area possesses the main requisites (except plentiful power and transportation) for heavy industry and manufacturing. The land is flat, with good foundation stability, isolated and downwind from residential areas, yet reasonably close to large population centers. These are, in fact, some of the characteristics which made the area suitable for the construction of the Station. There are at present no zoning regulations in the area, and the extent to which such development should be permitted or controlled will be the responsibility of the local authorities.

5.9 EFFECTS OF TRANSPORTATION OF NUCLEAR FUEL AND SOLID RADIOACTIVE WASTE

The nuclear fuel for the Station is slightly enriched uranium in the form of sintered uranium oxide pellets encapsulated in zircaloy fuel rods. Each year in normal operation, about 59 fuel elements are replaced.

5.9.1 Transport of New Fuel

The applicant has indicated that new fuel will be shipped by truck in AEC-DOT approved containers which hold two fuel elements per container. About 5 truckloads of 6 containers each will be required each year for replacement fuel and about 15 truckloads for the initial loading. The applicant has not identified the source of the fuel.

5.9.2 Transport of Irradiated Fuel

Fuel elements removed from the reactor will be unchanged in appearance and will contain some of the original U-235 (which is recoverable). As a result of the irradiation and fissioning of the uranium, the fuel element will contain large amounts of fission products and some plutonium. As the radioactivity decays, it produces radiation and "decay heat." The amount of radioactivity remaining in the fuel varies according to the length of time after discharge from the reactor. After discharge from a reactor, the fuel elements are placed under water in a storage pool for cooling prior to being loaded into a cask for transport.

The applicant has not identified the site to which the irradiated fuel will be sent for reprocessing. For calculating purposes, the Staff estimates the shipping distance to be 700 miles.

Although the specific cask design has not been identified, the applicant states that the irradiated fuel elements will be shipped by rail in approved casks. The cask will weigh perhaps 70 to 100 tons. To transport the irradiated fuel, the applicant estimates 6 shipments per year with 10 fuel elements per cask and 1 cask per carload. An equal number of shipments will be required to return the empty casks.

5.9.3 Transport of Solid Radioactive Wastes

The applicant has not identified where the waste will be shipped for disposal. For calculating purposes, the Staff has assumed a shipping distance of 300 miles.

The applicant estimates that about 1800 cu. ft. of waste to be mixed with concrete and 900 cu. ft. of low level waste to be compacted will be generated by the operation of the reactor. The solidified and compacted wastes will be replaced in drums for shipment and disposal. The applicant estimates about 9 truckloads of waste in drums will be shipped from the plant each year.

5.9.4 Principles of Safety in Transport

The transportation of radioactive material is regulated by the Department of Transportation and the Atomic Energy Commission. The regulations provide protection of the public and transport workers from radiation. This protection is achieved by a combination of standards and requirements applicable to packaging, limitations on the contents of packages and radiation levels from packages, and procedures to limit the exposure of persons under normal and accident conditions.

Primary reliance for safety in transport of radioactive material is placed on the packaging. The packaging must meet regulatory standards[50] established according to the type and form of material for containment, shielding, nuclear criticality safety, and heat dissipation. The standards provide that the packaging shall prevent the loss or dispersal of the radioactive contents, retain shielding efficiency, assure nuclear criticality safety, and provide adequate heat dissipation under normal conditions of transport and under specified accident damage test conditions. The contents of packages not designed to withstand accidents are limited, thereby limiting the risk from releases which could occur in an accident. The contents of the package also must be limited so that the standards for external radiation levels, temperature, pressure, and containment are met.

Procedures applicable to the shipment of packages of radioactive material require that the package be labeled with a unique radioactive materials label. In transport the carrier is required to exercise control over radioactive material packages including loading and storage in areas separated from persons and limitations on aggregations of packages to limit the exposure of persons under normal conditions. The procedures carriers must follow in case of accident include segregation of damaged and leaking packages from people and notification of the shipper and the Department of Transportation. Radiological assistance teams are available through an inter-Governmental program to provide equipment and trained personnel, if necessary, in such emergencies.

Within the regulatory standards, radioactive materials are required to be safely transported in routine commerce using conventional transportation equipment with no special restrictions on speed of vehicle, routing, or ambient transport conditions. According to the Department of Transportation (DOT), the record of safety in the transportation of radioactive materials exceeds that for any other type of hazardous commodity. DOT estimates approximately 800,000 packages of radioactive materials are currently being shipped in the United States each year. Thus far, based on the best available information, there have been no known deaths or serious injuries to the public or to transport workers due to radiation from a radioactive material shipment.

Safety in transportation is provided by the package design and limitations on the contents and external radiation levels and does not depend on controls over routing. Although the regulations require all carriers of hazardous materials to avoid congested areas[51] wherever practical to do so, in general, carriers choose the most direct and fastest route. Routing restrictions which require use of secondary highways or other than the most direct route may increase the overall environmental impact of transportation as a result of increased accident frequency or severity. Any attempt to specify routing would involve continued analysis of routes in view of the changing local conditions as well as changing of sources of material and delivery points.

5.9.5 Exposures During Normal (No Accident) Conditions

New Fuel

Since the nuclear radiations and heat emitted by new fuel are small, there will be essentially no effect on the environment during transport under normal conditions. Exposure of individual transport workers is estimated to be less than 1 millirem (mrem) per shipment. For the 5 shipments, with two drivers for each vehicle, the annual cumulative dose would be about 0.01 man-rem per year. The radiation level associated with each truckload of cold fuel will be less than 0.1 mrem/hr at 6 feet from the truck. A member of the general public who spends 3 minutes at an average distance of 3 feet from the truck might receive a dose of about 0.005 mrem per shipment. The dose to other persons along the shipping route would be extremely small.

Irradiated Fuel

Based on actual radiation levels associated with shipments of irradiated fuel elements, we estimate the radiation level at 3 feet from the rail car will be about 25 mrem/hr.

Train brakemen might spend a few minutes in the vicinity of the car at an average distance of 3 feet, for an average exposure of about 0.5 millirem per shipment. With 10 different brakemen involved along the route, the annual cumulative dose for 6 shipments during the year is estimated to be about 0.03 man-rem.

A member of the general public who spends 3 minutes at an average distance of 3 feet from the rail car, might receive a dose of as much as 1.3 mrem. If 10 persons were so exposed per shipment, the annual cumulative dose would be about 0.08 man-rem. Approximately 210,000 persons who reside along the 700-mile route over which the irradiated fuel is transported might receive an annual cumulative dose of about 0.04 man-rem. The regulatory radiation level limit of 10 mrem/hr at a distance of 6 feet from the vehicle was used to calculate the integrated dose to persons in an area between 100 feet and 1/2 mile on both sides of the shipping route. It was assumed that the shipment would travel 200 miles per day and the population density would average 330 persons per square mile along the route.

The amount of heat released to the air from each cask will be about 250,000 Btu/hr. For comparison, 115,000 Btu/hr is about equal to the heat output from the furnace in an average size home. Although the temperature of the air which contacts the loaded cask may be increased a few degrees, because the amount of heat is small and is being released over the entire transportation route, no appreciable thermal effects on the environment will result.

Solid Radioactive Wastes

Under normal conditions, the average radiation dose to the individual truck driver is estimated to be about 10 mrem per shipment. If the same driver were to drive 15 truckloads in a year, he could receive an estimated dose of about 150 mrem during the year. The annual cumulative dose to all drivers for 9 shipments during the year, assuming 2 drivers per vehicle, would be about 0.2 man-rem.

A member of the general public who spends 3 minutes at an average distance of 3 feet from the truck might receive a dose of as much as 1.3 mrem. If 10 persons were so exposed per shipment, the annual cumulative dose would be about 0.1 man-rem. Approximately 90,000 persons who reside along the 300-mile route over which the solid radioactive waste is transported might receive an annual cumulative dose of about 0.02 man-rem. These doses were calculated for persons in an area between 100 feet and 1/2 mile on either side of the shipping route, assuming 330 persons per square mile, 10 mrem/hr at 6 feet from the vehicle, and the shipment traveling 200 miles per day.

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6. EFFLUENT AND ENVIRONMENTAL MEASUREMENT AND MONITORING PROGRAMS

6.1 OPERATIONAL EFFLUENT MONITORING PROGRAM

6.1.1 Chemical Effluents

The objectives of monitoring chemical effluents are to ensure that planned chemical discharges are not exceeded, to develop data that can be used in the design of new operational procedures, and to aid in the interpretation of the results of other studies such as the biological monitoring program. The applicant has indicated that samples of the collecting basin effluent, which is discharged to Lake Erie, will be taken for analysis on the following schedule:[1]

Weekly	Monthly
1. pH	1. B.O.D.
2. Suspended Solids	2. C.O.D.
3. Total Volatile Solids	3. Ammonia (as N)
4. Dissolved Solids	4. Kjeldahl Nitrogen
5. Total Solids	5. Organic Nitrogen
6. Conductivity	6. Total Coliform
7. Turbidity	7. Oil & Grease
8. Phosphorus (as P)	8. Mercury
9. Oxygen	9. Arsenic
	10. Nitrate (as N)
	11. Alkalinity (as $CaCO_3$)
	12. Zinc
	13. Sulfate
	14. Color

15. Total Hardness
16. Calcium
17. Magnesium
18. Sodium
19. Potassium
20. Manganese
21. Iron
22. Chromium
23. Chlorides

In addition, we suggest that residual chlorine in the collecting basin effluent be monitored during chlorination and for short periods thereafter.

Since the effluents from certain station drains are diverted into the Toussaint River together with storm water runoff, we recommend additional routine monitoring of the drainage ditch outflow for turbidity and of the storm drain discharge to ensure that no significant quantity of toxic (or otherwise objectionable) chemicals is discharged.

6.1.2 Radioactive Effluents

A continuous record of the Station's radioactive releases will be provided by monitoring the radioactive effluent streams. Since the Final Safety Analysis Report (FSAR) for the Station has not yet been completed, the applicant has not prepared the detailed specifications for the monitoring system.

6.2 ENVIRONMENTAL MONITORING PROGRAMS

6.2.1 Terrestrial Monitoring Program

The applicant is sponsoring a preoperational terrestrial plant and animal survey. Work began this summer (1972) and will continue into next year with a survey of spring flowers, migratory birds, etc.[2,3] This survey is simply an inventory -- not an ecological study. While useful in obtaining a picture of the types of organisms present (which is helpful to any further ecological study), simple preoperational, and presumably also operational, inventories are not sufficient to determine Station effects on the terrestrial ecosystem.

A terrestrial monitoring program should be developed. As previously stated, no discernible effects due to the operation of the cooling tower are expected. However, the long-term additive effect of increases in atmospheric moisture, for example, could increase soil moisture content, which in turn affects vegetation, and thus the total ecosystem. A terrestrial study, carried out over a period of several years, could include the establishment of permanent sample plots on the barrier beach at the Station and control plots at one of the other preserved marshes along that section of Lake Erie. Seasonal surveys of the flora on the sample plots could be taken. These studies should be started as soon as possible in order to obtain a good record of normal variations before the Station begins operating. In addition, a program should be developed to determine whether the predictions of lack of meteorological effects from operation of the cooling tower are accurate.

Finally, since no definite conclusions on bird mortality at the cooling tower can be reached based solely on experience at TV towers and airport ceilometers (see Section 5.4), the applicant is sponsoring a program for intensive monitoring of the cooling tower area during both the spring (mid-April to late May) and fall (late August to early October) song-bird migrations.[4] The program will involve daily inspection and collection of dead birds and all-night monitoring when adverse weather conditions are predicted. Consideration will be given to devices or techniques (sonic devices, lighting, etc.) to reduce the probability of bird strikes should they be found to occur. This study, which should be continued for more than just one year, should indicate whether or not the cooling tower presents a hazard to migratory birds, and if it is a hazard, what corrective measures can be taken.

6.2.2 Aquatic Monitoring Program

Aquatic preoperational and operational studies (completed and proposed) are summarized in Table 6.1. The 6-year F-41-R project[5] should provide a good picture of seasonal variations and trends and any gross changes due to Station operation. Phytoplankton are not being quantified, but it is doubtful whether any change in phytoplankton populations could ever be detected because of their normally patchy distributions. Apparently, discrete water masses of different origins with different plankton contents move with alongshore currents past the Station. It is questionable whether a method could be devised to sample a particular water mass before it came under the influence of the Station's discharge and to follow and sample it afterwards. The benthic community, on the

TABLE 6.1. Aquatic Preoperational and Operational Studies at the Station (Completed and Proposed)

	Phytoplankton	Zooplankton	Benthos	Fish*	Physical and Chemical	Bathymetric
John C. Ayers, *et al.* Great Lakes Research Division, The University of Michigan	May & October 1969	May & October 1969	May & October, 1969			October 1968
Project F-41-R (U.S. Bureau of Sport Fisheries and Wildlife, Ohio Department of Natural Resources, The Ohio State University	(-----1969-1975-----	-----1969-1975-----)	(1969-1975)	(1969-1975)		
	June & July 1969 (only qualitative)	June & July 1969	April & May 1967 thru 1969 (egg pump on reefs)	June thru October, 1969 (monthly)	July & August 1970 (Oxygen & temperature)	1972 (4-5 times)
		May thru October 1970 (monthly)	June thru October, 1969 (monthly)	May thru October, 1970 (monthly)	1972 (weekly) (several parameters)	
		April & May, 1971**	May thru October, 1970 (monthly)	1972 (monthly)		
			April & May 1971**			
	1972 -----(monthly)-----	1972 -----(monthly)-----	1972 (monthly)			

*Includes analysis of food items in fish stomachs.
**All of 1971 data not available as of draft writing of this report.

Notes: 1) Water current measurements were taken by Dr. Ayers in July, August, and September 1968.
2) Sediment information has been obtained from U.S. Geological Survey. Also, benthos sampling will, in effect, be sampling of sediments.

other hand, is stationary. In a benthic study, there is a better chance of distinguishing Station effects from normal variations. Also, by studying fish, and particularly the food items in their stomachs, one could hope to detect changes in their eating habits and/or changes in the populations of the organisms they eat. Should these studies disclose any changes after the Station is operating, it should be determined whether or not the changes were due to Station operation.

In the absen e of precise data on the effects of residual free chlorine discharges, and to aid in defining a mixing zone, it is recommended that the applicant monitor concentrations of residual chlorine in the lake near the discharge jet.

6.2.3 Radiological Monitoring Program

The radiological monitoring program for the Station began in July, 1972 under a plan elaborated by the NUS Corp. of Rockville, Md. and implemented by Industrial Biotest Laboratories of Northbrook, Illinois. This starting date should assure about two years of pre-operational monitoring with the full complement of 25 sampling locations (Fig. 6.1). In addition, about 25 sampling stations have been operational, within a 150-mile radius of the Station, for up to 20 years (Section 2.8). Also, several environmental research efforts have graced the immediate area of the Station within recent years making preliminary measurements of tritium and fission radionuclides, and at least one of these will be going c· into the post-operational period. Thus, the adequacy of baseline data for future comparisons seems assured.

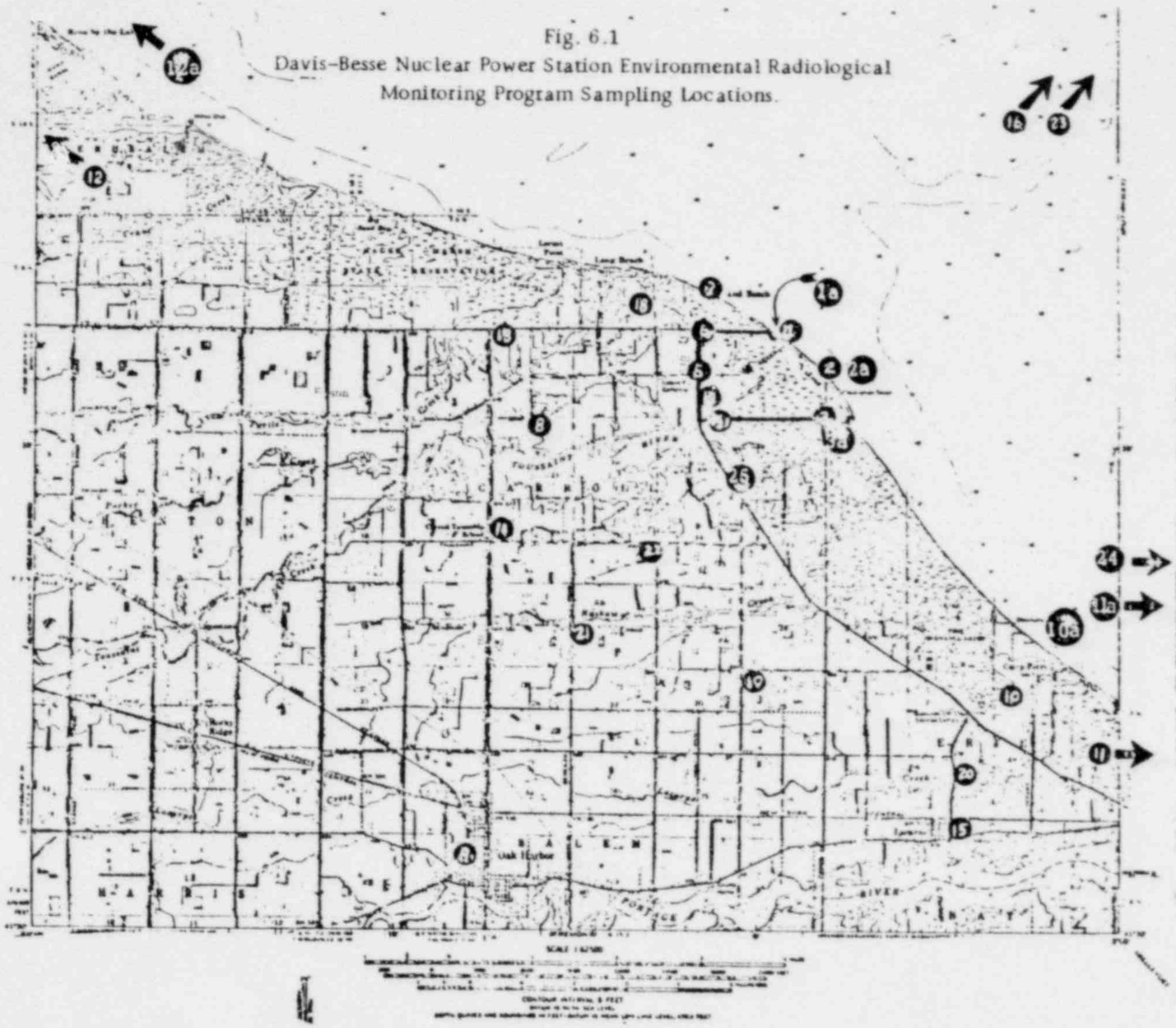

Fig. 6.1
Davis-Besse Nuclear Power Station Environmental Radiological Monitoring Program Sampling Locations.

The State of Ohio has no sampling program in the immediate vicinity of the Station at this time, but there are plans to undertake sampling in this area in the future. Thus, even if the planned Ohio program is not in operation by Station startup, it will provide valuable operational data.

The Station radiological monitoring program is outlined in Table 6.2 (and the sampling locations are shown in Figure 6.1). It would be difficult to fault this program, and it appears to be excellently conceived for the proper monitoring of levels in all of the significant man/biota exposure pathways. We would suggest, however, that some system of prompt notice be set up between the in-plant monitoring network and both the environmental monitoring program and the Environmental Protection Agency of the State of Ohio. In this way abnormal Station operation or noteworthy incidents can promptly be brought to their attention, to enable them to document fully the consequent trail of environmental impact, if any.

TABLE 6.2. Radiological Monitoring Program

Sample Type	No. of Sampling Stations	Sampling Frequency	Analyses
Air, particulates	10	W	GA, GB, SA, Sr-90
Air, halogens	10	W	I-131, SA
Ambient radiation	16	M	D
Surface water, raw	6	W	GA, GB, SA, tritium, Ra, Sr-90
Ground water	5	Q	GA, GB, SA, tritium, Ra, Sr-90
Precipitation	2	M	GB, tritium
Lake River sediments	3	Q	GA, GB, SA, Sr-90
Fish	Various	Q	GB, SA, Sr-90, K-40, Cs-137
Clams	Various	Q	GB, SA, Sr-90, K-40, Cs-137
Crops and vegetation	4	BA	GA, GB, SA, K-40, I-131, Cs-137
Milk	5	M	GB, SA, Sr-89/90, Ba/La-140, I-131, Cs-137
Domestic meat	1	BA	GB, SA, thyroid I-131, K-40
Wildlife	Various	BA	GB, SA, Sr-90, thyroid I-131, K-40
Soil	4	BA	GB, SA, K-40
Tap water	3	W	GA, GB, SA, tritium, Sr-90, Ra

Type of analysis: GB = gross beta, GA = gross alpha, SA = gamma spectral analysis,
D = dose of gamma + hard beta.

Frequency: W = Weekly, Q = Quarterly, BA = twice yearly.

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7. ENVIRONMENTAL EFFECTS OF ACCIDENTS

7.1 PLANT ACCIDENTS

A high degree of protection against the occurrence of postulated accidents in the Station is provided through correct design, manufacture, and operation, and the quality assurance program used to establish the necessary high integrity of the reactor system, as considered in the Commission's Safety Evaluation for the Station, dated November 2, 1970. Deviations that may occur are handled by protective systems to place and hold the plant in a safe condition. Notwithstanding this, the conservative postulate is made that serious accidents might occur, in spite of the fact that they are extremely unlikely; and engineered safety features are installed to mitigate the consequences of these postulated events.

The probability of occurrence of accidents and the spectrum of their consequences to be considered from an enivronmental effects standpoint have been analyzed using best estimates of probabilities and realistic fission product release and transport assumptions. For site evaluation in the Commission's safety review, extremely conservative assumptions were used for the purpose of comparing calculated doses resulting from a hypothetical release of fission products from the fuel against the 10 CFR Part 100 siting guidelines. The computed doses that would be received by the population and environment from actual accidents would be significantly less than those presented in the Safety Evaluation.

The Commission issued guidance to the applicant on September 1, 1971, requiring the consideration of a spectrum of accidents with assumptions as realistic as the state of knowledge permits. The applicant's response was contained in the "Davis-Besse Nuclear Power Station Supplement to Environmental Report," dated November 5, 1971.

The applicant's report has been evaluated, using the standard accident assumptions and guidance issued as a proposed amendment to Appendix D of 10 CFR Part 50 by the Commission on December 1, 1971. Nine classes of postulated accidents and occurrences ranging in severity from trivial to very serious were identified by the Commission. In general, accidents in the high potential consequence end of the spectrum have a low occurrence rate, and those on the low potential consequence end have a higher occurrence rate. The examples selected by the applicant are presented in Table 7.1 and are reasonably homogeneous in terms of probability within each class, although we consider the rupture of the waste gas decay tank as more appropriately in Class 3 and the steam generator tube rupture as more appropriately in Class 5. Certain assumptions made by the applicant do not exactly agree with those in the proposed Annex to Appendix D, but the use of alternative assumptions does not significantly affect overall environmental risks.

Commission estimates of the dose which might be received by an assumed individual standing at the site boundary in the downwind direction, using the assumptions in the proposed Annex to Appendix D, are presented in Table 7.2. Estimates of the integrated exposure that might be delivered to the population within 50 miles of the site are also presented in Table 7.2. The man-rem estimate was based on the projected population around the site for the year 2000. (The projected population was based on 1960 census data.)

TABLE 7.1. Classification of Postulated Accidents and Occurrences

Classes	AEC Description	Applicant's Example (s)
1	Trivial incidents	Not considered
2	Miscellaneous small releases outside containment	Spills or leakage of reactor coolant
3	Radwaste system failures	Heat exchanger leaks, uncontrolled release of contents of a gas decay tank, failure of pumps to shut off
4	Events that release radioactivity into the primary system (BWR)	Fuel cladding defects
5	Events that release radioactivity into primary and secondary system (PWR)	Fuel cladding defects and steam generator leak
6	Refueling accidents inside containment	Dropped spent fuel assembly
7	Accidents to spent fuel outside containment	Dropped spent fuel assembly
8	Accident initiation events considered in design-basis evaluation in the Safety Analysis Report	Steamline break accident, steam generator tube rupture, waste gas decay tank rupture, loss-of-coolant accident, various reactivity accidents, various reactor coolant releases
9	Hypothetical sequences of failures more severe than Class 8	Not considered

TABLE 7.2. Summary of Radiological Consequences of Postulated Accidents

Class	Event	Estimated Fraction of 10 CFR Part 20 at Site Boundary*	Estimated Dose to Population in 50 Mile Radius (man-rem)
1.0	Trivial incidents	**	**
2.0	Small releases outside containment	**	**
3.0	Radwaste system failures		
3.1	Equipment leakage or malfunction	0.052	7.2
3.2	Release of waste gas storage tank contents	0.20	29
3.3	Release of liquid waste storage tank contents	0.006	0.8
4.0	Fission products to primary system (BWR)	N.A.	N.A.
5.0	Fission products to primary and secondary systems (PWR)		
5.1	Fuel cladding defects and steam generator leaks	**	**
5.2	Off-design transients that induce fuel failure above those expected and steam generator leak	0.001	0.17
5.3	Steam generator tube rupture	0.068	9.5

TABLE 7.2 (Contd.)

Class	Event	Estimated Fraction of 10 CFR Part 20 at Site Boundary*	Estimated Dose to Population in 50 Mile Radius (man-rem)
6.0	Refueling accidents		
6.1	Fuel bundle drop	0.011	1.5
6.2	Heavy object drop onto fuel in core	0.19	26
7.0	Spent fuel handling accident		
7.1	Fuel assembly drop in fuel storage pool	0.007	0.95
7.2	Heavy object drop onto fuel rack	0.027	3.8
7.3	Fuel cask drop	N.A.	N.A.
8.0	Accident initiation events considered in design basis evaluation in the Safety Analysis Report		
8.1	Loss-of-coolant accidents		
	Small break	0.1	29
	Large break	0.1	51
8.1(a)	Break in instrument line from primary system that penetrates the containment	N.A.	N.A.
8.2(a)	Rod ejection accident (PWR)	0.01	5.1

TABLE 7.2 (Contd.)

Class	Event	Estimated Fraction of 10 CFR Part 20 at Site Boundary*	Estimated Dose to Population in 50 Mile Radius (man-rem)
8.2(b)	Rod drop accident (BWR)	N.A.	N.A.
8.3(a)	Steamline breaks (PWR's outside containment)		
	Small break	<0.001	<0.1
	Large break	<0.001	<0.1
8.3(b)	Steamline breaks (BWR)	N.A.	N.A.

*Represents the calculated fraction of a whole body dose of 500 mrem or the equivalent dose to an organ.
**These releases are expected to be in accord with proposed Appendix I for routine effluents (i.e., 5 mrem/yr to an individual from all sources).

To rigorously establish a realistic annual risk, the calculated doses in Table 7.2 would have to be multiplied by estimated probabilities. The events in Classes 1 and 2 represent occurrences which are anticipated during Station operation and their consequences, which are very small, are considered within the framework of routine effluents from the Station. Except for a limited amount of fuel failures and some steam generator leakage, the events in Classes 3 through 5 are not anticipated during plant operation but events of this type could occur sometime during the 40 year Station lifetime. Accidents in Classes 6 and 7 and small accidents in Class 8 are of similar or lower probability than accidents in Classes 3 through 5 but are still possible. The probability of occurrence of large Class 8 accidents is very small. Therefore, when the consequences indicated in Table 7.2 are weighted by probabilities, the environmental risk is very low. The postulated occurrences in Class 9 involve sequences of successive failures more severe than those required to be considered in the design basis of protection systems and engineered safety features. Their consequences could be severe. However, the probability of their occurrence is so small that their environmental risk is extremely low. Defense in depth (multiple physical barriers), quality assurance for design, manufacture, and operation, continued surveillance and testing, and conservative design are all applied to provide and maintain the required high degree of assurance that potential accidents in this class are, and will remain, sufficiently small in probability that the environmental risk is extremely low.

Table 7.2 indicates that the realistically estimated radiological consequences of the postulated accidents would result in exposures of an assumed individual at the site boundary to concentrations of radioactive materials within the Maximum Permissible Concentrations (MPC) of Table II of 10 CFR Part 20. The table also shows that the estimated integrated exposure of the population within 50 miles of the plant from each postulated accident would be orders of magnitude smaller than that from naturally occurring radioactivity, which corresponds to approximately 424,000 man-rem/yr based on a natural background level of 0.1 rem/yr. When considered with the probability of occurrence, the annual potential radiation exposure of the population from all postulated accidents is an even smaller fraction of the exposure from natural background radiation and, in fact, is well within naturally occurring variations in the natural background. It is concluded from the results of the realistic analysis that the environmental risks due to postulated radiological accidents are exceedingly small.

7.2 TRANSPORTATION ACCIDENTS

Based on recent accident statistics,[1] a shipment of fuel or waste may be expected to be involved in an accident about once in a total of 750,000 shipment-miles. The staff has estimated that only about 1 in 10 of those accidents which involve Type A packages or 1 in 100 of those involving Type B packages might result in any leakage of radioactive material. In case of an accident, procedures which carriers are required[2] to follow will reduce the consequences of an accident in many cases. The procedures include segregation of damaged and leaking packages from people, and notification of the shipper and the Department of Transportation. Radiological assistance teams are available through an inter-Governmental program to provide equipped and trained personnel. These teams, dispatched in response to calls for emergency assistance, can mitigate the consequences of an accident.

7.2.1 New Fuel

Under accident conditions other than accidental criticality, the pelletized form of the nuclear fuel, its encapsulation, and the low specific activity of the fuel, limit the radiological impact on the environment to negligible levels.

The packaging is designed to prevent criticality under normal and severe accident conditions. To release a number of fuel assemblies under conditions that could lead to accidental criticality would require severe damage or destruction of more than one package, which is unlikely to happen in other than an extremely severe accident.

The probability that an accident could occur under conditions that could result in accidental criticality is extremely remote. If criticality were to occur in transport, persons within a radius of about 100 feet from the accident might receive a serious exposure but beyond that distance, no detectable radiation effects would be likely. Persons within a few feet of the accident could receive fatal or near-fatal exposures unless shielded by intervening material. Although there would be no nuclear explosion, heat generated in the reaction would probably separate the fuel elements so that the reaction would stop. The reaction would not be expected to continue for more than a few seconds and normally would not recur. Residual radiation levels due to induced radioactivity in the fuel elements might reach a few roentgens per hour at 3 feet. There would be very little dispersion of radioactive material.

7.2.2 Irradiated Fuel

Effects on the environment from accidental releases of radioactive materials during shipment of irradiated fuel have been estimated for the situation where contaminated coolant is released and the situation where gases and coolant are released.

Leakage of contaminated coolant resulting from improper closing of the cask is possible as a result of human error, even though the shipper is required to follow specific procedures which include tests and examination of the closed container prior to each shipment. Such an accident is highly unlikely during the 40-year life of the plant.

Leakage of liquid at a rate of 0.001 cc per second or about 80 drops/hour is about the smallest amount of leakage that can be detected by visual observation of a large container. If undetected leakage of contaminated liquid coolant were to occur, the amount would be so small that the individual exposure would not exceed a few mrem and only a very few people would receive such exposures.

Release of gases and coolant is an extremely remote possibility. In the improbable event that a cask is involved in an extremely severe accident such that the cask containment is breached and the cladding of the fuel assemblies penetrated, some of the coolant and some of the noble gases might be released from the cask.

In such an accident, the amount of radioactive material released would be limited to the available fraction of the noble gases in the void spaces in the fuel pins and some fraction of the low level contamination in the coolant. Persons would not be expected to remain near the accident due to the severe conditions which would be involved, including a major fire. If releases occurred, they would be expected to take place in a short period of time. Only a limited area would be affected. Persons in the downwind region and within 100 feet or so of the accident might receive doses as high as a few hundred millirem. Under average weather conditions, a few hundred square feet might be contaminated to the extent that it would require decontamination (that is, Range I contamination levels) according to the standards[3] of the Environmental Protection Agency.

7.2.3 Solid Radioactive Wastes

It is highly unlikely that a shipment of solid radioactive waste will be involved in a severe accident during the 40-year life of the plant. If a shipment of low-level waste (in drums) becomes involved in a severe accident, some release of waste might occur but the specific activity of the waste will be so low that the exposure of personnel would not be expected to be significant. Other solid radioactive wastes will be shipped in Type B packages. The probability of release from a Type B package, in even a very severe accident, is sufficiently small that, considering the solid form of the waste and the very remote probability that a shipment of such waste would be involved in a very severe accident, the likelihood of significant exposure would be extremely small.

In either case, spread of the contamination beyond the immediate area is unlikely and, although local clean-up might be required, no significant exposure to the general public would be expected to result.

7.2.4 Severity of Postulated Transportation Accidents

The events postulated in this analysis are unlikely but possible. More severe accidents than those analyzed can be postulated and their consequences could be severe. Quality assurance for design, manufacture, and use of the packages, continued surveillance and testing of packages and transport conditions, and conservative design of packages ensure that the probability of accidents of this latter potential is sufficiently small that the environmental risk is extremely low. For those reasons, more severe accidents have not been included in the analysis.

Section 7. References

1. Federa. Highway Administration, "1969 Accidents of Large Motor Carriers of Property," December 1970; Federal Railroad Administration Accident Bulletin No. 138, "Summary and Analysis of Accidents on Railroads in the U.S.," 1969; U.S. Coast Guard, "Statistical Summary of Casualties to Commercial Vessels," December 1970.
2. 49 CFR §§ 171.15, 174.566, 177.861.
3. Federal Radiation Council Report No. 7, "Background Material for the Development of Radiation Protection Standards; Protective Action Guides for Strontium 89, Strontium 90, and Cesium 137," May 1965.

8. EVALUATION OF THE PROPOSED ACTION

8.1 THE NEED FOR POWER

As stated, the Toledo Edison Company (TEC) and the Cleveland Electric Illuminating Company (CEIC) will own the Station as tenants in common and will share in the expenditures for the construction, operation, and in the energy produced in the ratio 52.5%, TEC; 47.5%, CEIC. Both TEC and CEIC are members of the Central Area Power Coordination Group (CAPCO). CAPCO is a power pool consisting of TEC, CEIC, Duquesne Light, and Ohio Edison, along with its subsidiary, Pennsylvania Power. The total CAPCO service territory (Figure 8.1) includes about 7.2 million people in a 14,000 square mile area; CAPCO serves about 2 million customers. The CAPCO companies share generation and transmission facilities and function as though they were one single system, and there are plans to establish a common load dispatching center in the near future. The Davis-Besse Unit will be the fourth generating unit to be installed under the CAPCO agreement, and it will be the second nuclear unit (Beaver Valley Unit 1 will be the first). The Davis-Besse Unit will become part of the CAPCO pool generating capacity; and consequently, during its initial period of operation, its output will be distributed as follows:

Ohio Edison	280 MW
CEIC	314 MW
TEC	277 MW

Subsequently, however, the entire Station capacity will be allotted to TEC and CEIC.

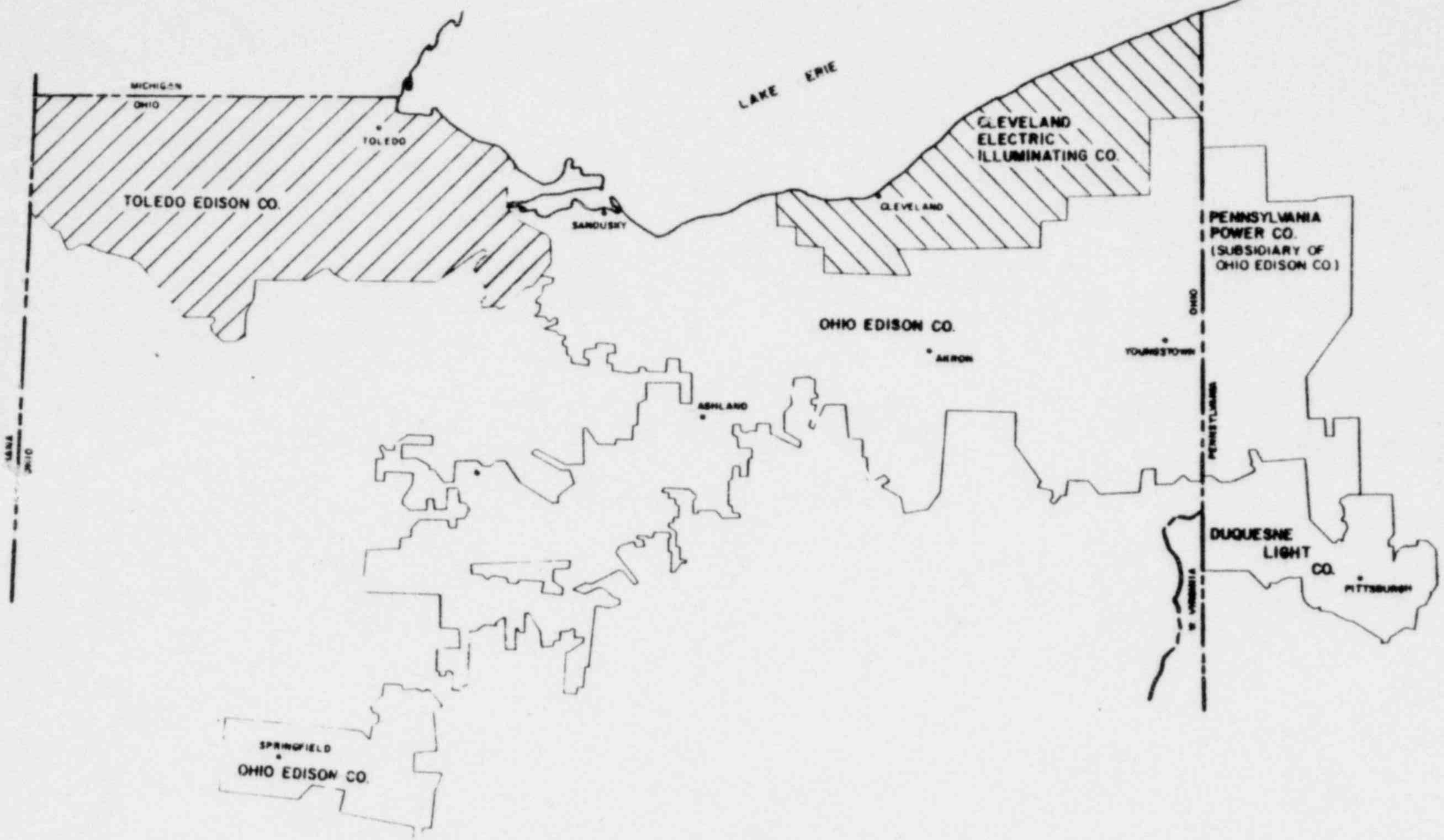

Fig. 8.1. Service Territory of CAPCO and Member Companies.

TEC has a service territory of about 2500 square miles in northwestern Ohio (Figure 8.1). This service territory includes a population of about 720,000 people (1971). At the end of 1971, TEC served 208,448 residential customers, 20,708 commercial customers, and a group of 4239 customers including industrials, other utilities, and municipalities. A breakdown of the actual 1971 load is: residential, 23.3%; commerical, 12.7%; industrial, 50.0%; other utilities, 4.9%; all others, 9.1%. Total 1971 sales were approximately 5879 million kilowatt hours.

CEIC has a service territory of about 1700 square miles in northeastern Ohio (Figure 8.1). This service territory includes a population of about 2.1 million people (1971). At the end of 1971, CEIC served 505,889 residential customers; 50,285 commerical customers; 7122 industrial customers; and 453 miscellaneous customers. A breakdown of CEIC's actual 1971 load is: residential, 25.1%; commercial, 22.3%; industrial, 48.5%; all other customers 4.1%. Total 1971 sales were approximately 14,065 million kilowatt hours.

The projected system summer peak loads and generating capacities for TEC and CEIC through 1976 are presented in Tables 8.1 and 8.2, respectively. Although it is difficult to present a meaningful picture of the reserves situation for each of the companies individually, because CAPCO operates almost as a single utility system in meeting the load demand, the data in the Tables do indicate some trends. As shown by the last column in each Table, both companies have percentage reserves below the Federal Power Commission's (FPC) recommended level of 20%, even if all the projected capacity increases come on line as scheduled. Since both companies

TABLE 8.1. Projected TEC System Load and Generating Capacity*

Year	Projected Peak Summer Load (MWe)	Scheduled Dependable Capacity (MWe)	Projected Net Power Purchases (MWe)	Available Capacity (MWe)	Projected Reserves (MWe)	Reserve Capacity (%)
1971	1054 (actual)	1013	165	1178	124	11.8
1972	1160	1103	153	1256	96	8.3
1973	1246	1203	153	1356	110	8.8
1974	1334	1215**	219	1434	100	7.5
1975	1389	1441	147	1614	225	16.2
1976	1503	1609	129	1738	235	15.6

*Data for this table taken from References 1, 2, and 3.

**Davis-Besse-1 (Nuclear) on line (December); the initial share allotted to TEC is 277 MWe, although this increases in subsequent years.

TABLE 8.2. Projected CEIC System Load and Generating Capacity*

Year	Projected Peak Summer Load (MWe)	Scheduled Dependable Capacity (MWe)	Projected Net Power Purchases or (Sales) (MWe)	Available Capacity (MWe)	Projected Reserves (MWe)	Reserve Capacity (%)
1971	2750 (actual)	3235	**	3235	485	17.6
1972	2930	3400	**	3400	470	16.1
1973	3120	3597	**	3597	477	15.3
1974	3310	3710***	18	3728	418	12.6
1975	3500	4140	(41)	4099	599	17.1
1976	3700	4430	*	4430	730	19.7

*Data for this table taken from References 4 and 5.

**Data unavailable.

***Davis-Besse-1 (Nuclear) on line (December); the initial share allotted to CEIC is 314 MWe, although this increases in subsequent years.

experience peak loads in summer, their winter reserve situation will presumably be better than that shown in the Tables. The projected TEC load growth rate, reflected by the data in Table 8.1 is 7.5%. This compares with a growth rate for the Toledo area, TEC's load center, of 6.7%, projected by the Federal Power Commission (FPC).7 Similarly, the load growth data for CEIC in Table 8.2 correspond to a rate of 6.2%, which compares with the FPC projected value of 5.9% for the Cleveland, Ashtabula load center.[7] Therefore it appears that the load growth projections for CEIC and TEC are slightly in excess of, but in rough agreement with, the FPC estimates.

A more meaningful picture of the reserves situation with and without Davis-Besse is presented in Table 8.3, which gives CAPCO load and capacity data through 1980. The CAPCO projected summer peak* given in the Table reflects a growth rate of about 6%. This compares with the FPC estimate of 6.7% for the East Central region, power supply area 9, which includes most of the CAPCO service territory.7

Therefore, it appears that the CAPCO load growth projections are reasonable. As shown by the reserve capacity percentages in the last column, the most critical period for CAPCO is the summer of 1974 when the reserves are only 5.6%. Since Davis-Besse is not scheduled to come on line until the following winter, the earliest time when it will likely be available will be for the summer 1975 peak. As shown by the data in the table, 1975 summer reserves will be 17.0% and 9.6%, respectively, with

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*As with TEC and CEIC, CAPCO experiences its peak loads in summer.

TABLE 8.3. Projected CAPCO System Loads and Generating Capacity[1]

Year	Projected Peak Summer Load (MWe)	Scheduled Dependable Capacity (MWe)	Projected Net Power Purchases (MWe)	Available Capacity (MWe)	Projected Reserves (MWe)	Reserve Capacity (%) With Davis-Besse	Reserve Capacity (%) Without Davis-Besse
1971	8,747 (actual)	10,422	*	10,422	1675	-	19.1
1972	9,693	11,060[a]	439	11,499	1806	-	18.6
1973	10,353	10,960[b]	445	11,405	1052	-	10.2
1974	11,071	11,046[c]	646	11,692	621	-	5.6
1975	11,804	13,489[d]	324	13,813	2009	17.0	9.6
1976	12,527	14,429[e]	291	14,720	2193	17.5	10.6
1977	13,285	14,429	293	14,722	1437	10.8	4.3
1978	14,086	15,305[f]	241	15,276	1190	8.4	2.3
1979	14,941	16,186[g]	195	16,381	1440	9.6	3.8
1980	15,840	17,066[h]	200	17,266	1426	9.0	3.5

*Data unavailable.

[a]Eastlake - 5 (Coal) on line (August) + 650 MWe.

[b]Various peaking units on line (October), + MWe.

[c]Beaver Valley - 1 (Nuclear) on line (October), + 856 MWe; Davis-Besse-1 (Nuclear) on line, (December), + 872 MWe.

[d]Mansfield - 1 (Coal) on line (April), + 825 MWe.

[e]Mansfield - 2 (Coal) on line (April), + 825 MWe.

[f]Beaver Valley - 2 (Nuclear) on line (January), + 880 MWe.

[g]Undetermined, + 880 MWe.

[h]Undetermined, + 880 MWe.

[i]Data for this table taken from References 3 and 6.

and without Davis-Besse, assuming all the other units come on line as scheduled. Thus it appears that CAPCO is critically dependent upon Davis-Besse, Beaver Valley-1, and Mansfield-1 for meeting the summer 1975, and thereafter, peak loads.

The CAPCO companies are all members of the East Central Area Reliability coordination agreement (ECAR). ECAR is one of the nine regional power groups th[illegible] make up the National Electric Reliability Council. ECAR is made up [illegible]es located in eight east-central states, with a combined capa[illegible] of about 56,000 MWe (Dec. 1971), serving about 32 million people in an area of about 194,000 square miles. The stated objectives of ECAR are: (1) to assure an adequate supply of electric energy to meet present and future needs; (2) to achieve maximum reliability and continuity of service; and (3) to accomplish these objectives while protecting and preserving the environment.

The feasibility of the alternative of purchasing the power which would be supplied by the Davis-Besse Station from within the ECAR territory is discussed in Section 9.

8.2 ADVERSE ENVIRONMENTAL EFFECTS WHICH CANNOT BE AVOIDED

The following is a listing of the major items which comprise the total environmental impact of the Station operating as currently designed. The impacts are categorized under the major headings of land, aquatic, and radiological effects.

8.2.1 Land Effects

Construction of the Station has removed 150 acres of marginal farmland from production of grain crops for the forseeable future. On the other hand, by virtue of the agreements between the applicant and the Bureau of Sport Fisheries and Wildlife, about 600 acres of marshland have been placed under management as an additional wildlife refuge area. The lakeshore along the site property was privately owned and, hence, access was restricted prior to construction of the Station and will remain so in the future; therefore, there is no change in land access because of the Station presence. Construction of the temporary barge channel and the Station water intake and discharge piping will, however, temporarily disturb the lake shore and lake bottom at the site. While this will cause some disruption of the beach and temporary water turbidity for a few months, permanent effects are very unlikely. An additional 1800 acres, primarily farmland, are directly affected by the construction of the off-site transmission lines for the Station, although the land use is not changed substantially since only that needed for construction of the towers themselves is removed from farm production.

The presence of the Station, particularly the cooling tower, will change the appearance of the lake front and marshland. The addition of the approximately 500 foot high natural draft cooling tower and visible vapor plume will adversely affect the view for recreational boaters on Lake Erie, the few local residents with summer homes along the lake shore, and persons using the nearby recreational areas and campgrounds. In addition, the following adverse environmental effects of the cooling tower effluent are possible:

1. Increased natural fog within or to five miles inland may be expected whenever onshore circulation of cool air from Lake Erie creates an inversion layer during spring and summer months (lake effect) that inhibits the rise of the moisture plume from the cooling tower. This is not expected to occur more than a few hours per year.
2. Slight additional snowfall in the immediate area of the Station may be expected from the growth of snowflakes during their fall through the cooling tower moisture plume.

It is improbable that major mortalities of nocturnal migrants (mainly songbirds), such as have occurred at airport ceilometers or television towers, will occur at the Station cooling tower. However, under certain adverse weather conditions during major migrations, such kills are possible, and certainly occasional mortalities of a few birds may occur. No quantitative estimate of mortalities can be made due to lack of experience with tall cooling towers and, in particular, in combination with the unique situation of a cooling tower situated on a large lake within a migratory bird flyway.

8.2.2 Aquatic Effects

Essentially all the organisms (plankton, fish eggs, very small fish) which are drawn into the Station intake will be killed. However, because of the low water velocity at the intake crib, very few adult fish will be drawn in. Also, some small fish and plankton entrained in the discharge water plume will be disabled as a result of buffeting, thermal shock, or sublethal exposure to chlorine.

There is a net consumption of water from Lake Erie, due to evaporation of water in the Station cooling tower, which amounts to 0.1% of the total natural evaporation from the surface of the lake.

8.2.3 Radiological Effects

The release of radioactive wastes during normal Station operation results in a dose from airborne gaseous radioactivity of 0.021 mrem/year at the site boundary. The integrated dose to the population within 50 miles of the Station is 1.5 man rem/year, including the contribution from all sources (gases and liquids). This is approximately 10^{-4}% of the natural background radiation which this population group receives. The estimated dose rate to fish, vertebrates, and plants due to the liquid discharges is about 0.24 mrem/year, which is approximately 0.2% of the natural background.

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

The marshlands along the Lake Erie shore are such a valuable ecological resource that the case for their conservation is undisputable. The use of the site for a generating station will in no way conflict with this goal. In fact, the arrangements which have been made between the applicant and the U. S. Bureau of Sport Fisheries and Wildlife will further the interests of conservation by increasing the extent and improving the quality of the marshland available as a wildlife refuge.

The removal of about 150 acres of marginal farmland from cultivation will have an insignificant effect on the agricultural productivity of the area, and this land could conceivably be restored to its original condition, at considerable expense, for use as farmland or for some other purpose such as public recreation. However, the expenditure of many millions of dollars for this purpose seems unlikely, even after the end of the useful life of the present equipment, if the need for power still demands the existence of a large generating station in this area. The applicant points out that, historically, boilers become obsolescent before turbine generators. Advances in technology will undoubtedly produce more efficient nuclear generators during the design life of the present equipment (40 years) and the applicant's tentative prediction is that the present reactor and steam generators will be replaced by an advanced design, operating at higher temperature and pressure, and driving a high pressure topping type turbine ahead of the existing turbine generator. Such improvements could extend the life of the station to 75 years or more. In that case, present-day estimates of decommissioning procedures and costs would be of doubtful validity.

8.4 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

As mentioned in Section 8.3, the arrangements involved in the acquisition of the site will enhance rather than detract from the ecological resources of the marshland. With the exception of the work on the intake canal, already completed, the construction work has not disturbed the marsh areas, and there is no evidence of any undesirable effects on the wildfowl population. Dredging operations for the temporary barge channel and the permanent water intake are expected to produce some slight short-term damage to aquatic life in the immediate vicinity, but no lasting effect on the aquatic environment is expected.

As in any large industrial project, considerable mineral resources in the form of steel and concrete are committed to the construction of the Station. The concrete is irretrievable, but with the exception of the reactor vessel, much of the metal can be recovered as scrap for re-use at the end of the Station's useful life. The uranium-235 consumed during operation will be irretrievable, but a nearly comparable quantity of plentiful uranium-238 will be converted to fissionable plutonium-239. Of this plutonium, a small fraction will be consumed by fission in the reactor reducing slightly the consumption of uranium-235, while the remainder will be recovered during fuel reprocessing and will contribute to the general reserves of fissionable material. The energy used in enriching the uranium-235 in the fuel and in the fabrication of the Station components represents an irretrievable commitment of other (principally fossil) fuels.

The water evaporated by the cooling tower (about 10,000 gpm) represents an insignificant loss from Lake Erie. Some of this water will eventually return to the Great Lakes system as precipitation over the watersheds of rivers flowing into the lakes, while the remainder will find its way into the Atlantic Ocean.

REFERENCES

1. Davis-Besse PSAR, Amendment No. 12, Appendix C.
2. Toledo Edison Co., Annual Report - 1971.
3. Davis-Besse Nuclear Power Station - Testimony on Behalf of the Toledo Edison Company and Cleveland Electric Illuminating Company, April 4, 1972.
4. Davis-Besse PSAR, Amendment No. 12, Appendix D.
5. Cleveland Electric Illuminating Co., Annual Report - 1971.
6. Report by ECAR Bulk Power Members to the Federal Power Commission, Volume I, Load Projections and Resource Planning, April 1972.
7. The 1970 National Power Survey, Part II, Federal Power Commission, December 1971, pp. II-2-15 and II-2-16.

9. ALTERNATIVE ENERGY SOURCES AND SITES

The need for additional power within the service areas of the applicant and the CAPCO pool was discussed in Section 8.1. It is shown there that additional power equal to the 872 MWe expected from the Station will be needed to maintain adequate generating reserve from 1974 on. Alternative sources of power are considered in this section:

1. The purchase of power from other companies;
2. The construction of a generating plant at a different site;
3. The construction of a non-nuclear plant at the Station site.

Full acceptance of any one of these alternatives would imply that the proposed Station should be abandoned. In that event, little of the sunk economic costs (money already spent or irrevocably committed) could be salvaged. According to the applicant,[1] the estimated loss if the Station were abandoned at year-end 1972 is about $118 million. Similarly, most of the environmental impacts associated with construction (but not operation) of the Station are "sunk" because they have already occurred.

9.1 PURCHASE OF POWER

The purchase of power by the applicant and/or other CAPCO members from other Power Companies would be a reasonable alternative to completion and operation of the Station only if (1) sufficiently firm long-term commitments for power could be achieved to allow adequate system reliability for CAPCO and if (2) the vendor companies had no need to construct additional generating plants, since such construction would merely transfer environmental impacts to other localities.

The major producers of power (including CAPCO) within the East-Central region are members of ECAR, a fact-gathering and coordinating organization. As shown in Table 9.1, ECAR members as a group face a continuing need for additional generating capacity comparable to that of CAPCO. It may be seen that the projected annual peak load increases exceed 6.5 percent and that the projected net additions to generating capacity exceed 5.4 percent or 4900 MWe for each year in this period.

The 19 corporately independent ECAR members form 12 systems or pools for which ECAR maintains peak load and generating capacity projections. Of these, Ohio Valley Electrical Company (OVEC) is exceptional in that it serves a single customer, the U.S. Atomic Energy Commission Gaseous Diffusion Center near Portsmouth, Ohio. OVEC's load is essentially constant, with rare changes which are scheduled years in advance. Each of the other 11 ECAR reporting entities projects annual peak-load growth of not less than 5.8 percent for each of the years 1972-1981. As shown in Table 9.2 for the five years 1972-1976, none of the 11 systems or pools projects gross new generating capacity of less than 36 percent of its 1971 year-end capacity. In the aggregate, 31,367 MWe of new capacity is projected with the retirement of 2590 MWe of obsolescent capacity (chiefly coal-fired plants) for a net increase in capacity over the years 1972-1976 of 29,047 MWe or 54 percent of the ECAR-less-OVEC capacity at year-end 1971. (OVEC capacity is projected as unchanged through 1981.) The absence of exceptions other than OVEC and the homogeneity of the projections over the 11 distinct systems or pools make it clear that if the expected generating capacity of the Station were replaced by purchases from other power companies

TABLE 9.1. Projected ECAR Load and Generating Capacity

Year	Summer Peak Load (MWe)	Increase		Year End Capacity (MWe)	Increase	
		MW	(Percent)		MW	(Percent)
1972	48,561			61,425	5184	9.2
1973	52,584	4023	8.3	68,491	7066	11.5
1974	56,531	4247	8.1	73,497	5006	7.3
1975	61,404	4573	8.0	79,426	5929	8.1
1976	66,052	4648	7.6	85,288	5862	7.4
1977	70,694	4642	7.0	90,656	5368	6.3
1978	75,984	5290	7.5	95,573	4917	5.4
1979	81,462	5478	7.2	101,678	6105	6.4
1980	87,010	5548	6.8	108,566	6888	6.8
1981	92,782	5772	6.6	115,331	6765	6.2

Based on ECAR Bulk Power Members Report to the Federal Power Commission Pursuant to Docket R-362, Order 383-2, April 1972

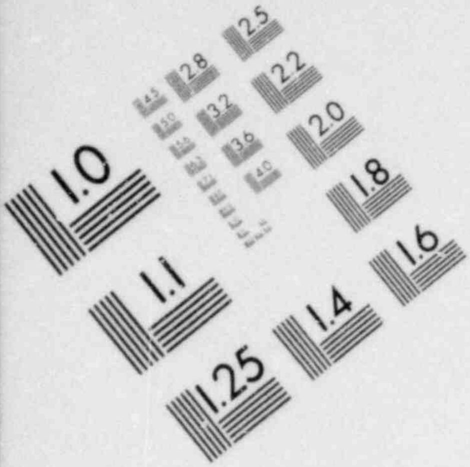
TABLE 9.2. Five Year Projections for ECAR Pools

Pool or Company	Year	Projected Peak Load (MWe)		Five Year Increase (Percent)		Projected Capacity As of January 1 (MWe)	Five Year Increase (Percent)	Projected Obsolete Capacity Removed (MWe)
		Summer	Winter	Summer	Winter			
A.P.S.	1972	3,675	4,140			4,735		270
	1977	5,275	5,860	44	42	6,430	36	270
A.E.P.	1972	9,412	10,521			12,573		
	1977	13,438	14,540	43	38	19,739	57	424
CAPCO	1972	9,693	9,421			10,622		
	1977	13,285	12,648	37	34	14,668	38	405
C.G.E.	1972	2,400	1,940			2,354		
	1977	3,580	3,030	49	56	3,951	68	0
C.S.O.E.	1972	1,567	1,282			1,563		
	1977	2,488	2,010	59	57	2,719	74	86
D.P.L.	1972	1,670	1,575			1,717		
	1977	2,565	2,510	54	59	2,631	53	19
K.I.P.	1972	5,641	5,292			5,946		
	1977	8,712	8,146	54	54	9,187	55	4
L.G.E.	1972	1,456	1,007			1,571		
	1977	2,134	1,342	47	33	2,381	52	0
M.P.	1972	10,305	10,055			10,866		
	1977	14,845	14,045	44	40	18,033	66	1,112
N.I.P.S.	1972	1,856	1,795			1,400		
	1977	2,851	2,658	43	48	2,400	57	0
S.I.G.E.	1972	530	345			495		
	1977	765	510	44	48	750	52	0

Based on ECAR Bulk Power Members Report to the Federal Power Commission Pursuant to Docket R-362, Order 383-2, April 1972

TABLE 9.2. (Contd.)

Explanation of abbreviations: A.P.S.-Allegheny Power System; A.E.P.-American Electric Power System; CAPCO-Central Area Power Coordination Group (Cleveland Electric Illuminating Co., Duquesne Light Co., Ohio Edison Co., Toledo Edison Co.); C.G.E.-Cincinnati Gas and Electric Co.; C.S.O.E.-Columbus and Southern Ohio Electric Co., D.P.L.-Dayton Power and Light Co.; K.I.P.-Kentucky-Indiana Pool (East Kentucky Power Cooperative, Kentucky Utilities Co., Indianapolis Power and Light Co., Public Service of Indiana, Inc.); L.G.E.-Louisville Gas and Electric Co.; M.P.-Michigan Pool (Consumers Power Co., Detroit Edison Co.); N.I.P.S.-Northern Indiana Public Service Co.; S.I.G.E.-Southern Indiana Gas and Electric Co.



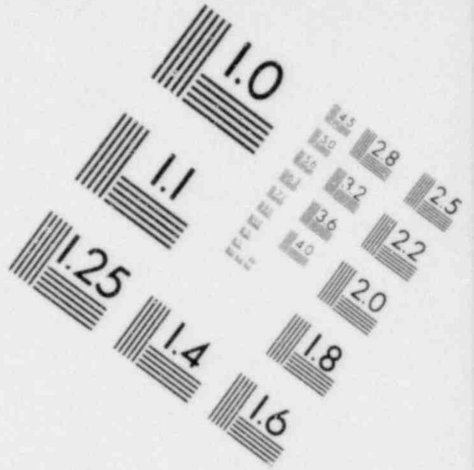
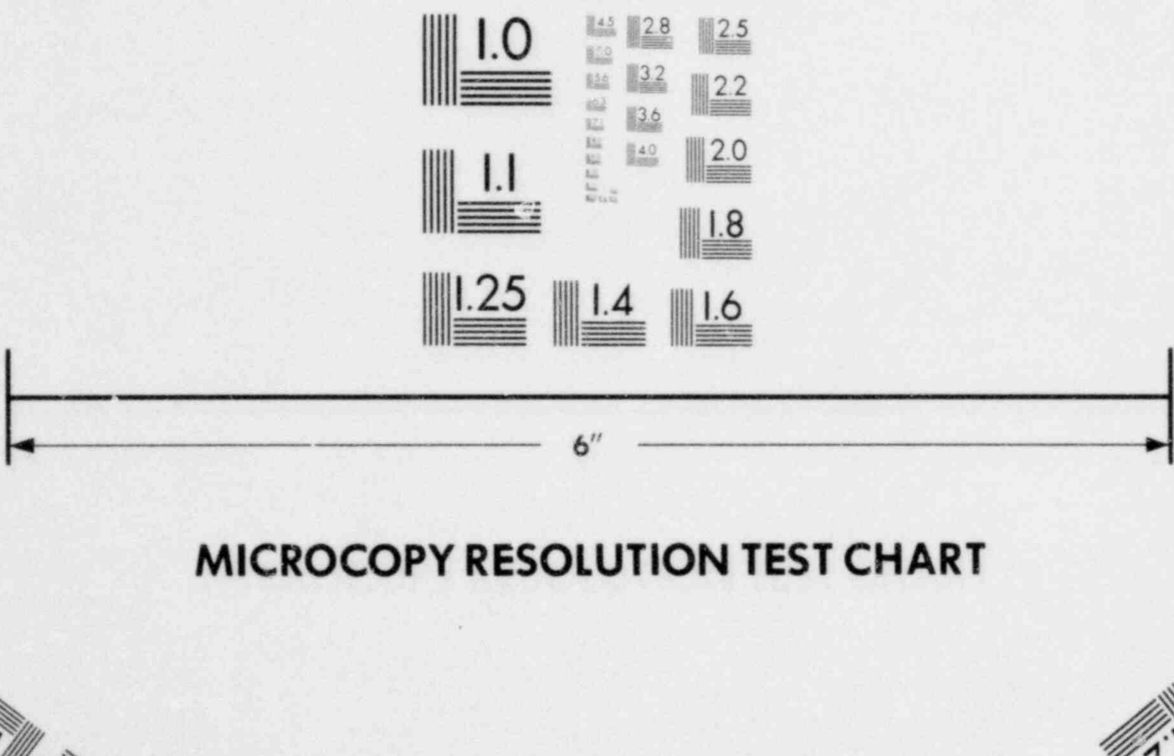
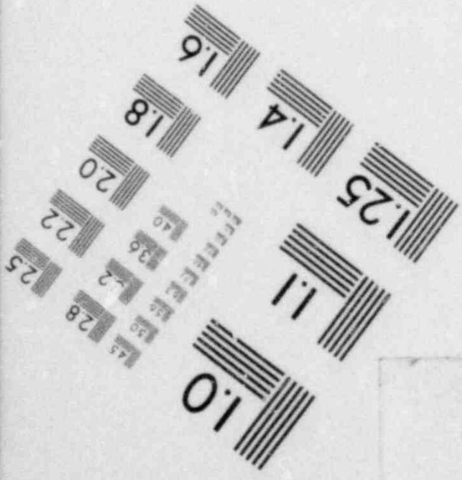
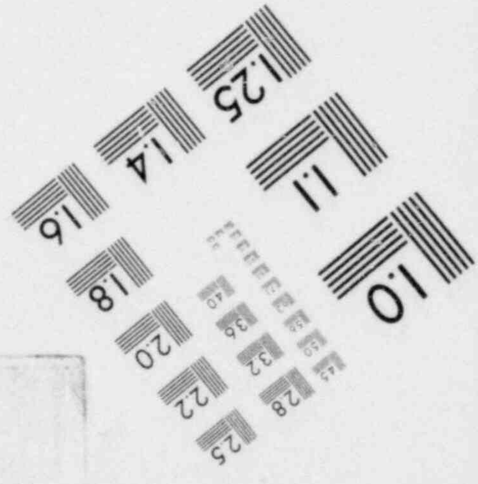


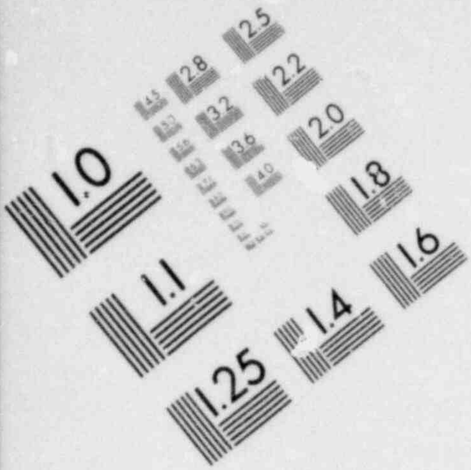
IMAGE EVALUATION TEST TARGET (MT-3)



MICROCOPY RESOLUTION TEST CHART







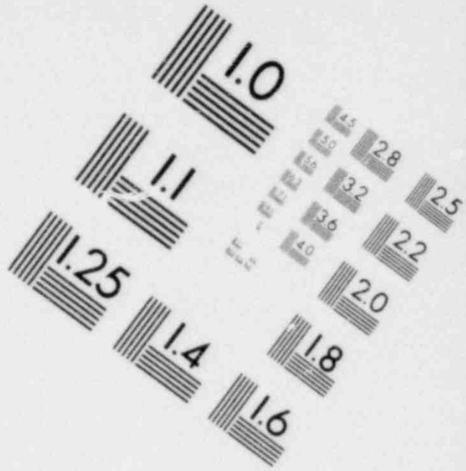
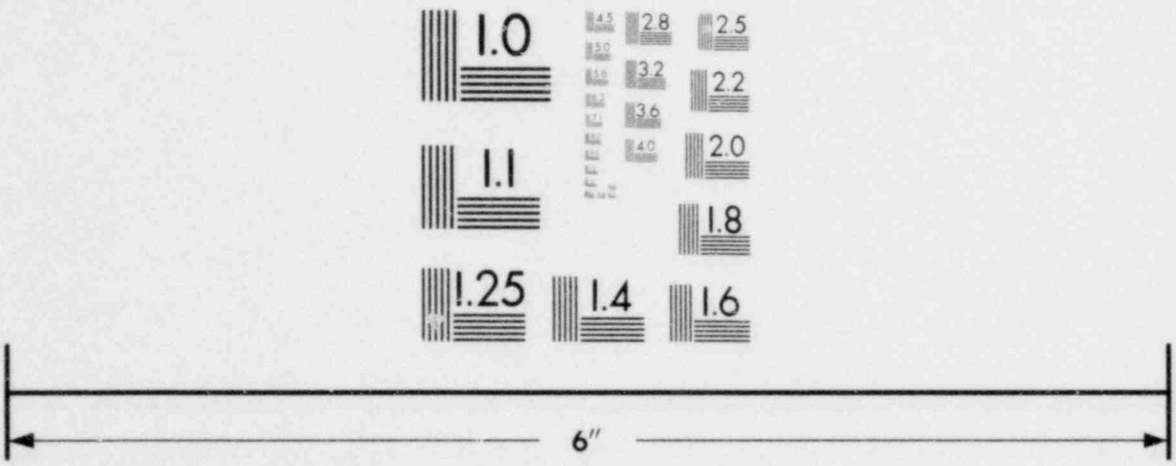


IMAGE EVALUATION TEST TARGET (MT-3)



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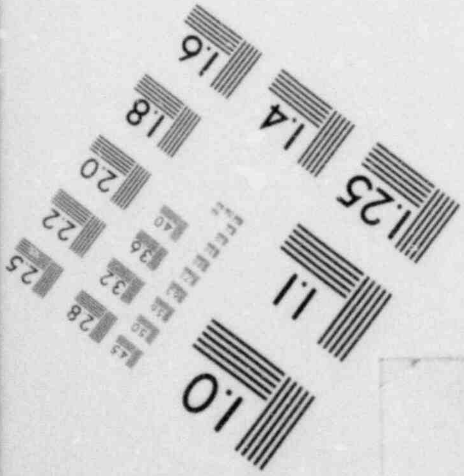

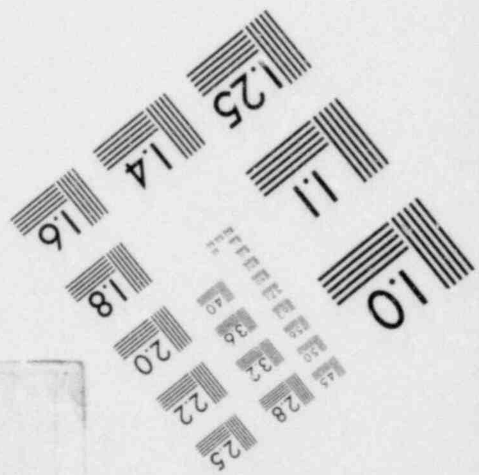

within the ECAR region, the consequence would be augmented construction elsewhere or delay of the retirement of obsolete coal-fired plants within the region. Since the environmental impact of either consequence compares with that expected from the Station, we conclude that the purchase of power is not a reasonable alternative to the completion and operation of the Station.

9.2 ALTERNATIVE SITES

The applicant's study of possible sites, described in Section 1.2, assumed that the contemplated plant would use once-through cooling and therefore was limited to the area near the Lake Erie shoreline. Only two sites, the Darby Marsh and the Navarre Marsh, were identified as possibly available and as meeting the AEC criteria for nuclear-plant sites. During the study, the U.S. Government acquired the Navarre Marsh. Consequently, the applicant acquired an option on the 489-acre Darby Marsh tract. However, the Navarre Marsh appeared the better site and the applicant and the U.S. Bureau of Sport Fisheries and Wildlife negotiated an exchange agreement. Under the agreement, the Government acquired the Darby Marsh as a National Wildlife Refuge and the applicant received the Navarre Marsh tract. However, the Government also received the use and control, as a wildlife refuge, of over 600 acres at the Navarre Marsh site. The applicant also agreed to construct one dike, to repair others, and to install pumps so that the marsh water level may be controlled. The high ground portion of the Navarre Marsh site is being use for construction of the Station.

The later decision by the applicant to change the Station design to closed-cycle cooling greatly reduced the needed water supply. In principle, many other site possibilities could then have been considered. However, in order to avoid delaying completion of the plant and because the Navarre Marsh site appeared generally satisfactory, the applicant did not reopen the study of possible sites. We judge that the site is suitable and that any small environmental advantage which might have been gained by such a study in 1970 is now greatly outweighed by the economic penalty and the delay which would be involved in reopening the study at the present stage of construction.

9.3 ALTERNATIVE MEANS OF POWER GENERATION

Potential hydroelectric capacity approaching 872 MWe does not exist within the CAPCO service area. Natural gas is not available in the area in adequate quantity for large generating stations. For base-load (24 hours per day) operation fuel costs for an oil-fired steam plant would be about double those for a coal-fired plant. Fuel costs for oil-fueled gas turbines would be even higher. The remaining commercially practicable alternative to the proposed nuclear steam-turbine plant is a coal-fired steam-turbine plant. Most present generating plants in the East Central area are of this type.

Two environmental impacts associated with nuclear plants are substantially reduced for coal-fired plants. Because of higher thermodynamic efficiency and because some of the heat passes up the stack with other combustion products, fossil-fuel plants release only about

60 percent as much waste heat to the plant condenser cooling water as do nuclear plants of the same electrical output capacity. Also, although the release of radioactivity from current nuclear plants leads only to minor increments to the natural radiation levels, coal-fired plants release even less and oil-fired plants release virtually none.

Coal-fired plants, however, produce combustion products including dust, sulfur dioxide, and oxides of nitrogen in substantial amounts and these are a significant source of air pollution. The comparative environmental impacts expected for the reference plant and for a coal-fired plant of the same generating capacity are given in Table 9.3. Combustion products are estimated on the basis that the coal-fired plant just meets the Environmental Protection Agency standards for new plants.[2]

The estimated economic costs associated with the reference plant and with an alternative coal-fired plant of the same capacity are presented in Table 9.4. Capital costs of coal-fired capacity is estimated at \$200 per KWe and coal costs at \$0 per 10^6 BTU.* In order to achieve comparability among costs which would be incurred at different times,

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*The estimates come from another applicant in the East Central area. They appear reasonable in relation to estimates published by the Federal Power Commission[3] when the latter are corrected for inflation and the rapid increase in minehead coal prices during recent years.

TABLE 9.3. Comparative Environmental Impacts for Reference and Coal-fired Plants

Category	Reference: 872 MWe Nuclear Plant	872 MWe Coal-fired Plant with Cooling Tower
Land use:		
Plant (excluding cooling tower)	56 acres	Similar to reference
Fuel storage	minor	15 acres
Total plant	150 acres (without exclusion area)	150 acres
Releases to air:		
Radioactivity	2.0 curies/day	small
Dust	none	7.3 tons/day
Sulphur dioxide	none	87.5 tons/day
Nitrogen oxides	none	51 tons/day
Releases to water:		
Heat	265 billion BTU/day*	159 billion BTU/day*
Radioactivity:		
tritium	0.6 curies/day	none
other	150 microcuries/year	none
Chemical:		
chlorine	13 lbs/day	13 lbs/day
salts	700 lbs/day	450 lbs/day**
Water consumed	10 million gal/day	6 million gal/day
Fuel:		
consumed	26 tons/year	2.5 million tons/year
transported	5 truckloads/year	350 trainloads/year
Wastes	6 carloads/year	250,000 tons/year
Aesthetic	Inoffensive except for 493-ft cooling tower	Similar to reference plus 15 acre coal pile, 300 ft stack.

*Assumes 80% load factor.

**This chemical discharge could be increased about tenfold if ash-sluicing effluent is discharged.

TABLE 9.4. Comparative Economic Costs for Reference and Alternative Plants (in Millions of Dollars)

	872 MWe Reference (Nuclear) Plant-First Operation January 1, 1975		872 MWe Coal-Fired Plant-First Operation January 1, 1979	
Construction Cost:				
Total		$321		$174
Sunk	$193		0	
Incremental	128		$174	
Salvage Allowance	0		-75	
Net Incremental	128		99	
Present Worth of Net Incremental Cost		128		70
Allowance for Loss of Power		12		165
Annual Operating Cost:				
Fuel	8.3		24	
Other	2.1		2	
Total	10.4		26	
Present Worth of Capitalized Operating Cost		105		273
Decommissioning Allowance	30		5	
Present Worth		2		0
Present Worth of Incremental Life-of-Plant Cost		247		508
Present Worth of Total Life-of-Plant Cost		440		508
Annualized Equivalent of Life-of-Plant Cost				
Incremental		23.5		48.4
Total		41.9		48.4

all costs are reduced to present worth* at the assumed time of first operation, January 1, 1975. The discount rate used is 8.75 percent which is representative of the overall before-Federal-income-tax rate required for payment of interest on bonds and stock dividends by investor-owned power companies. Estimated construction costs for the reference plant are those provided by the Applicant. These figures normally include "interest during construction" so no present-worth adjustment need be made. To compute the present worth of the stream of payments for fuel and other operating costs, a life of 30 years is postulated.

In order to assess the comparative costs of completing the reference plant or constructing the alternative coal-fired plant, only the costs incurred after the hypothetical time of decision should be considered; i.e., the sunk prior costs are "water over the dam." Costs that would be incurred after the assumed decision point, January 1, 1973, are labeled incremental costs in the table.

Since the alternative plant could not be operational until about January 1, 1979, the cost of providing power for four years from other sources should be charged against it. An estimated rate of 8 mills per kilowatt hour is used. However, the postulated combination of four years purchase and 30 years plant life provides power for 34 years. To place the reference plant on a comparable basis, the purchase of power for four years after 30 years of plant life is postulated.

*The present worth at a given time of a future payment is equal to the sum which, drawing interest from the given time at the assumed discount rate, would just suffice to meet the payment when due.

It may be seen from Table 9.3 that the estimated economic penalty for the hypothesized change to a coal-fired plant is about \$261 million or 59 percent of the total life-to-plant cost of the reference plant. These figures are present worths as of January 1, 1975. On an annualized basis, the penalty is about \$25 million per year during the postulated 30 years of operation.

The coal-fired plant would discharge less heat to Lake Erie and less radioactivity to the atmosphere than the reference plant. However, as assessed in Sections 5 and 8, the impacts of these discharges are very small for the reference plant. We judge their effect to be clearly outweighed by the air pollution intrinsic to the coal-fired plant and therefore consider the reference plant to be, on balance, the better with respect to environmental impact. Considering the loss of reliability to the CAPCO pool during the four-year delay and the large economic penalty to the applicant, which is ultimately paid by the public, there is no doubt that the reference plant is the preferred alternative.

9.4 SUMMARY

Three alternatives to the completion and operation of the proposed Station have been considered. <u>Purchase of power</u> is not a reasonable alternative action because all of the possible vendors of power face the same need for new generating capacity as the applicant and the CAPCO pool. The construction of an equivalent plant at <u>a different site</u> offers no promise of significant environmental gains to balance either the large economic penalty or the threatened delay to a reliable supply of electric power. The most reasonable alternative means of power generation, a coal-fired steam plant, would impose more serious environmental costs than the proposed plant as well as a severe economic penalty and a loss of reliability within the CAPCO pool. Therefore, completion and operation of the Station is the recommended action. Possible modifications of the proposed design are considered in the following section.

REFERENCES

1. Benefit-Cost Discription of Alternative Designs for the Davis-Besse Nuclear Station, July, 1972 (supplement to the Applicant's Environmental Report).
2. Environmental Protection Agency Regulations on Standards of Performance for New Stationary Sources (40 CFR 60, 36 FR 24876; December 23, 1971).
3. Federal Power Commission, The 1970 National Power Survey. See Table 19.3, p. I-19-4 for plant costs; Table 4.2, p. I-4-3, and Fig. 4.9, p. I-4-28 for coal costs.

10. PLANT DESIGN ALTERNATIVES

In this section we consider possible modifications to the reference design which might change significantly the balance between economic and environmental costs.

10.1 COOLING SYSTEM ALTERNATIVE

Thermal electric generating plants require the removal of from 5300 to 7100 BTU waste heat for each kilowatt hour of electrical energy generated, the higher figure being typical of current nuclear plants. The best established methods of large-scale cooling involve either (a) the transfer of water (as vapor) and heat to the atmosphere by direct evaporation in "wet" cooling towers, spray ponds or canals or (b) the warming of a stream or lake. In the latter case, the heat is eventually transferred to the atmosphere, chiefly by evaporation although radiative and convective processes play some part. Another means of heat transfer, the "dry" cooling tower, serves to transfer heat directly to the atmosphere without evaporation of coolant (in the same manner as an automobile radiator). Dry towers have been used for relatively small thermal electric plants in arid regions, particularly abroad, but the high coolant-return temperature in hot weather results in condenser back-pressure which is too high for any large (over 300 MWe) steam turbines currently available.[1]

The preliminary design of the Station was based on once-through cooling with Lake Erie water, and the Navarre Marsh site was acquired on that assumption. The applicant's later decision to incor orate a closed-cycle cooling system because of uncertainty as to the regulatory standards which might apply at the time of completion of the Station (discussed in Section 5) was made on the basis that the Navarre Marsh site would continue to be used, since any change of site might have delayed the plant for several years.

Among the closed-cycle alternatives, the applicant's choice appears to have been based on the expectation that the probability of fog and icing, particularly at the Station itself and at the nearby State Highway 2, would be least for a natural-draft tower (because the moisture release occurs 500 ft. above ground level). The estimated economic costs did not differ greatly for the several closed-cycle choices, as shown in Table 10.1. Although aesthetic impact is greatest for the natural-draft tower because of its great size, we concur in the applicant's choice among closed-cycle means.

The choice between once-through and closed-cycle cooling was made by the applicant in 1970 primarily on the basis of economic contingencies which do not appear in Table 10.1, namely the risk of serious delay in operation of the Station or the later imposition of a requirement to backfit the plant with a closed-cycle cooling system. One or both of these contingencies might have arisen because of changing Federal or State regulations or because of the vigorous opposition by a segment of the public to once-through cooling anywhere on the Great Lakes (which indeed is the subject of an unresolved controversy within and among Federal regulatory agencies).

TABLE 10.1. Comparative Economic Costs for Alternative Cooling Systems (Millions of Dollars)

	Once-Through	Natural-Draft Tower	Mechanical-Draft Towers	Spray Canal	Cooling Pond
Incremental construction cost if chosen in 1970:					
Direct	base	6.77	5.1	4.1	10.75
IEC* at 33%	base	2.23	1.7	1.5	3.55
Total	base	9.0	6.8	5.6	14.3
If chosen in 1972:					
Direct	9.2	base	6.1	5.6	11.6
IEC* at 33%	3.0	base	2.0	1.9	3.8
Total	12.2	base	8.1	7.9	15.4
Lost-capacity allowance ($250/kW)	base	6.25	7.35	8.53	base
Incremental maintenance cost-capitalized (8.75%, 30 years)	base	-.21	.32	.58	.42
Gross incremental cost					
If chosen in 1970	base	15.0	14.5	14.7	14.8
If chosen in 1972	6.2	base	9.8	17.0	15.8

Based on Table B.1, p. B-17, Benefit-Cost Description of Alternative Designs for the Davis-Besse Nuclear Power Station (supplement to the Environmental Report).

*Interest during construction, escalation, and contingency.

Because much of the construction cost for the closed-cycle system is now sunk, there would now be an economic penalty estimated at $6.2 million (see Table 10.1) attached to a change to once-through cooling, apart from the risks feared by the applicant. The environmental balance between the alternatives appears nearly even. In our judgement, the damage to Lake Erie ecology from a well designed once-through system would probably be small in terms of aquatic populations and species balance. On the other hand, enhancement of fog and ice by the natural-draft tower will probably be undetectable, and the danger of high mortality among migratory birds through collision with the tower appears to be small. The cooling tower will have a considerable visual impact, which will probably be regarded as adverse by a majority of the public. On balance, and mainly because of the uncertainty in predictions about lake ecology, we judge the closed-cycle system to have the smaller probable impact. We therefore support the applicant's choice.

10.2 INTAKE SYSTEM ALTERNATIVES

The applicant has proposed to modify the makeup-water intake in Lake Erie in order to reduce the water velocity from 1.5 to 0.5 feet per second.[2] He also proposes the addition of an air-bubble screen. Both modifications are intended to reduce the probability that small fish will be drawn in and killed on the intake screens. We judge these modifications to be desirable, although the effectiveness of existing bubble-screens is doubtful.

10.3 DISCHARGE SYSTEM ALTERNATIVES

In the reference design, as much as 13,800 gallons per minute of diluted blowdown water will be discharged to Lake Erie, at a temperature no more than 20°F above that of the lake. The resulting thermal plume will have an estimated area within the 3°F isotherm of 0.34 acres according to the applicant's estimate, although our calculation using the model of the applicant's consultant gave a higher figure (0.7 acre). Since the discharge orifice is 5000 feet from the mouth of the Toussaint River and 16,250 feet from the nearest reef that is believed to be a fish-spawning area, no detectable effect on aquatic life is expected.

The applicant has considered the possibility of cooling the blowdown stream by a mechanical-draft tower, spray canal, or small cooling pond.[3] The maximum heat discharge and plume area would be reduced by 50 percent for the tower or spray canal, by 20 percent for the pond. Estimated costs are $1.025, $1.115, $0.735 million, respectively (including allowance for maintenance expense and loss of capacity). We judge that the environmental advantage of further reducing the already small heat discharge (about 2% of the total condenser heat) is outweighed by the cost of the modifications and the possible terrestrial effects, however small, of the auxilary cooling system.

10.4 CHEMICAL DISCHARGE SYSTEMS

The only appreciable discharges of chemicals from the reference design plant will be about 13 pounds per day of chlorine and 700 pounds per day of sodium, calcium, and magnesium sulfates and carbonates. According to the evaluation in Section 5, the environmental effects of the chlorine will be confined to a very small area within about 50 feet of the discharge jet. No detectable effect on the lake ecology is expected. However, a procedure which might greatly reduce or even eliminate the discharge of chlorine is suggested in Appendix B. The salt discharge consists essentially of chemicals already present in Lake Erie, at only about twice their lake concentrations.

Since the environmental impacts of these releases are insignificant, we judge that consideration of alternatives (other than that suggested in Appendix B) is not warranted.

10.5 BIOCIDE SYSTEM

Chlorine is the only biocide that will be used in the Station. Its contribution to the chemical waste has been discussed in Section 10.3 above. As an anti-fouling water treatment, chlorine performs very well at quite low concentrations, and its use for this purpose is well-established. No suitable alternative treatment can be suggested. An alternative method of operation designed to minimize the discharge of chlorine is described in Appendix B.

10.6 SANITARY WASTE SYSTEM

The sanitary waste system is of sound, modern design. It has been approved by the Ohio State Department of Health, and permits for its construction and operation have been obtained. We consider that its impact on lake water quality will be negligible, and that no alternatives need be considered.

Sections 10.7, 10.8, 10.9 to be supplied by AEC Regulatory.

10.10 TRANSMISSION SYSTEM

It is not practicable in the present state of technology to transmit power on the required scale through underground cables. Overhead transmission lines are therefore an inevitable adjunct of large generating stations. The height and spacing of the conductors, and of the towers required to support them, are determined by the transmission voltage, which in turn is chosen by balancing economic costs of conductors, towers, and land acquisition against transmission losses. The applicant's choice of 345 kV follows accepted practice for the load capacity required. Three transmission routes were selected to connect the Station with the applicant's distribution system and with the other utilities of the CAPCO group. The total length of lines to be constructed in the applicant's service area is about 57 miles. The design of the system and the choice of routes are described in Section 3.7 and in Appendix 4A of the Applicant's Environmental Report Supplement. All applicable local, state, and federal standards and guidelines have been complied with, and the necessary approvals and permits have been obtained (Section 1.3).

We consider that, in the design of towers and choice of routes, the applicant has taken account of aesthetic, social and environmental values by avoiding as far as is feasible the removal of dwellings, proximity to communities or community services (e.g., schools, parks, radio and television transmitters), following of highways, disturbance of forested areas, and interference with public enjoyment of recreational, conservational, and scenic areas, although some impact on these amenities is inevitable. We judge that no feasible alternatives would produce sufficient benefit to outweigh the costs already expended or committed.

REFERENCES

1. J. P. Rossie, E. A. Cecil, and R. O. Young, Cost Comparison of Dry-Type and Conventional Cooling Systems for Representative Nuclear Generating Plants, USAEC Report TID-26007. Appendix B, p. 110.
2. Benefit-Cost Description of Alternative Designs for the Davis-Besse Nuclear Station, July, 1972 (supplement to the Applicant's Environmental Report), p. 47.
3. Reference 2, p. 45.

11. BENEFIT-COST SUMMARY

11.1 BENEFITS

The primary benefits from completion and operation of the Station will be the generation of about 6.1 billion kilowatt hours per year of electrical energy and increased reliability within the CAPCO pool because of 872 MWe additional generating capacity. About 51 percent of the power will be sold to industrial users, 19 percent to commercial users, and 25 percent to residential users.

Indirect local and regional benefits will include a revenue of about $4 million per year in taxes to local governmental bodies and a similar amount to the State of Ohio. Some 89 persons will be employed in the operation of the Station. The preservation and improvement of all marsh areas on the site for wildlife and the addition to the National Wildlife Refuge System of over 500 acres of prime waterfowl habitat is another indirect benefit of some importance.

11.2 ENVIRONMENTAL COSTS

11.2.1 Land Use

150 acres of farmland has been removed from use by construction of the Station. Access to the lakeshore at the site was restricted by private ownership in the past and will remain so. Construction of the Station intake and discharge piping and of the temporary barge channel has

disturbed the lakeshore and bottom; however, the applicant will restore the shore and bottom grade and, so far as possible, the soil character so that long-term effects are unlikely. Although 1800 acres of off-site land, mainly farmland, will be used for transmission lines, only that required for the towers themselves will be removed from farm use.

The 500-foot natural-draft cooling tower and vapor plume of the Station will be conspicuous on the lakeshore landscape. A small increase (probably undetectable) in the duration of naturally occurring fog inland of the Station may occur. Similarly total snowfall in the vicinity of the Station may be slightly increased.

11.2.2 Water Use

The net consumption of Lake Erie water by the Station (as evaporation from the cooling tower) will be about 5 billion gallons per year. Natural evaporation from the lake surface is 1000-fold greater so that no detectable change in the lake level will result. About 900 billion BTU per year of waste heat will pass to Lake Erie with the blowdown water; the effects will be undetectable outside of a very few acres of thermal plume.

11.2.3 Biological Effects

Virtually all of the organisms drawn into the Station intake will be killed. These will include plankton, fish eggs, and very small fish but almost no adult fish. Since the rate of water intake at the Station will be only about 0.015 percent of the flow through the lake, and the annual intake will only be about 0.006 percent of the lake volume, no detectable effect on aquatic populations or species balance is expected. While some birds will almost certainly be killed from time to time by collision with the cooling tower, it is unlikely that major bird kills will occur.

11.2.4 Radiological Effects

The total dose from operation of the Station to the entire population within 50 miles is estimated to be 1.5 man-rem per year, distributed among about 2 million people who live within this area. The dose to individuals in areas near the plant will be less than 1 percent of that due to natural background; in more distant areas it will be much less than 1 percent of background.

11.3 BENEFIT-COST BALANCE

The Station as designed is expected to have only a small impact on the environment. The identified benefits and costs are listed in Table 11-1.

We have considered these benefits and costs in detail. We judge that the benefits from completion and operation of the Station will greatly exceed the costs.

TABLE 11-1. Benefit-Cost Summary for Davis-Besse Nuclear Station

Benefits	
Primary benefits:	
Electrical energy to be generated	6.11 billion kilowatt-hours per year
Generating capacity contributing to reliability of electrical power in the CAPCO service area	872,000 kilowatts
Secondary local benefits:	
Employment of operating staff	89 persons
State and local taxes paid	$8 million per year
Conservation	Over 500 acres of water fowl habitat
Environmental Costs	
Land Use:	
Farmland for station	150 acres
Transmission line right-of-way	1800 acres
Water Use:	
Water evaporated	9000 gallons per minute (average)
Lake Erie surface area within 3°F excess isotherm of thermal plume	0.7 acres
Chemicals discharged to lake	13 pounds per day of chlorine; 700 pounds per day of salts occurring naturally in lake water
Radiological Impact:	
Normal operation:	
Cumulative population dose (50-mile radius)	1.5 man-rem per year
Whole-body dose to nearby residents	Less than 1 percent of natural background
Biological Impact:	Small destruction of aquatic life--no significant effect on Lake Erie ecology; possible lethal collisions of night-flying migrant birds with 500-ft. cooling tower--expected to be rare.

APPENDIX A

WATER POLLUTION CONTROL BOARD
OHIO DEPARTMENT OF HEALTH
COLUMBUS, OHIO

RESOLUTION ESTABLISHING AMENDED CRITERIA OF STREAM-WATER QUALITY FOR VARIOUS USES ADOPTED BY THE BOARD ON APRIL 14, 1970

WHEREAS, Section 6111.03, of the Ohio Revised Code, provides, in part, as follows:

"The water pollution control board shall have power:

(A) To develop programs for the prevention, control and abatement of new or existing pollution of the waters of the state; ...." and

WHEREAS, Primary indicators of stream-water quality are needed as guides for appraising the suitability of surface waters in Ohio for various uses; and

WHEREAS, The stream-water quality criteria for various uses and minimum conditions applicable to all waters adopted by the Board of June 14, 1966, have been amended by the Ohio River Valley Water Sanitation Commission; and

WHEREAS. The criteria adopted by the Board on October 10, 1967, have been further amended by the Ohio River Valley Water Sanitation Commission;

THEREFORE BE IT RESOLVED, That the following amended stream-water quality criteria for various uses, and minimum conditions applicable to all waters, and policies for protection of high quality waters and for water quality design flow, are hereby adopted in accordance with amendments of the Ohio River Valley Water Sanitation Commission, and the recommendations of the Federal Water Pollution Control Administration.

AND BE IT FURTHER RESOLVED, That the amended stream-water quality criteria for various uses, for minimum conditions, for protection of high quality waters, and, for water quality design flow, be made applicable to the following waters of the state:

1. Maumee, Tiffin, St. Joseph, and St. Marys River Basins;
2. Lake Erie & Interstate Waters thereof;
3. Great Miami, Whitewater, and Wabash River Basins;
4. Ashtabula River, Conneaut and Turkey Creeks;
5. Ohio River of Ohio-West Virginia and Ohio-Kentucky;
6. North Central Ohio Tributaries of Lake Erie;
7. Scioto River Basin;
8. Little Miami River Basin;
9. Rocky, Cuyahoga, Chagrin, and Grand River Basins;
10. Muskingum River Basin;
11. Hocking River Basin.

MINIMUM CONDITIONS APPLICABLE TO
ALL WATERS AT ALL PLACES AND AT ALL TIMES

1. Free from substances attributable to municipal, industrial or other discharges, or agricultural practices that will settle to form putrescent or otherwise objectionable sludge deposits.

2. Free from floating debris, oil, scum and other floating materials attributable to municipal, industrial or other discharges, or agricultural practices in amounts sufficient to be unsightly or deleterious.

3. Free from materials attributable to municipal, industrial or other discharges, or agricultural practices producing color, odor or other conditions in such degree as to create a nuisance.

4. Free from substances attributable to municipal, industrial or other discharges, or agricultural practices in concentrations or combinations which are toxic or harmful to human, animal, plant or aquatic life.

PROTECTION OF HIGH QUALITY WATERS

Waters whose existing quality is better than the established standards as of the date on which such standards become effective will be maintained at their existing high quality, pursuant to the Ohio water pollution control statutes, so as not to interfere with or become injurious to any assigned uses made of, or presently possible, in such waters. This will require that any industrial, public or private project or development which would constitute a new source of pollution or an increased source of pollution to high quality waters will be required, as part of the initial project design, to provide the most effective waste treatment available under existing technology. The Ohio Water Pollution Control Board will cooperate with other agencies of the state, agencies of other states, interstate agencies and the Federal Government in the enforcement of this policy.

WATER QUALITY DESIGN FLOW

Where applicable for the determination of treatment requirements the water quality design flow shall be the minimum seven consecutive day average that is exceeded in 90 percent of the years.

STREAM-QUALITY CRITERIA

FOR PUBLIC WATER SUPPLY

The following criteria are for evaluation of stream quality at the point at which water is withdrawn for treatment and distribution as a potable supply:

1. Bacteria: Coliform group not to exceed 5,000 per 100 ml as a monthly average value (either MPN or MF count); nor exceed this number in more than 20 percent of the samples examined during any month; nor exceed 20,000 per 100 ml in more than five percent of such samples.

2. Threshold-odor Number: Not to exceed 24 (at 60 deg. C.) as a daily average.

3. Dissolved solids: Not to exceed 500 mg/l as a monthly average value, nor exceed 750 mg/l at any time.

4. Radioactivity: Gross beta activity not to exceed 1,000 picocuries per liter (pCi/l), nor shall activity from dissolved strontium-90 exceed 10 pCi/l, nor shall activity from dissolved alpha emitters exceed 3 pCi/l.

5. Chemical constituents: Not to exceed the following specified concentrations at any time.

Constituent	Concentration (mg/l)
Arsenic	0.05
Barium	1.0
Cadmium	0.01
Chromium (hexavalent)	0.05
Cyanide	0.025
Fluoride	1.0
Lead	0.05
Selenium	0.01
Silver	0.05

FOR INDUSTRIAL WATER SUPPLY

The following criteria are applicable to stream water at the point at which the water is withdrawn for use (either with or without treatment) for industrial cooling and processing:

1. Dissolved oxygen: Not less than 2.0 mg/l as a daily-average value, nor less than 1.0 mg/l at any time.

2. pH: Not less than 5.0 nor greater than 9.0 at any time.

3. Temperature: Not to exceed 95 deg. F. at any time.

4. Dissolved solids: Not to exceed 750 mg/l as a monthly average value, nor exceed 1,000 mg/l at any time.

FOR AQUATIC LIFE A

The following criteria are for evaluation of conditions for the maintenance of a well-balanced, warm-water fish population. They are applicable at any point in the stream except for areas necessary for the admixture of waste effluents with stream water:

1. Dissolved oxygen: Not less than an average of 5.0 mg/l per calendar day and not less than 4.0 mg/l at any time.

2. pH:

   A. No values below 6.0 nor above 8.5.

   B. Daily fluctuations which exceed the range of pH 6.0 to pH 8.5 and are correlated with photosynthetic activity may be tolerated.

3. Temperature:

   A. No abnormal temperature changes that may affect aquatic life unless caused by natural conditions.

   B. The normal daily and seasonal temperature fluctuations that existed before the addition of heat due to other than natural causes shall be maintained.

   C. Maximum temperature rise at any time or place above natural temperatures shall not exceed 5 deg. F. In addition, the water temperature shall not exceed the maximum limits indicated in the following table.

WATERS	Maximum Temperature in Deg. F. During Month											
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
All waters except Ohio River	50	50	60	70	80	90	90	90	90	78	70	57
Main Stem-Ohio River	50	50	60	70	80	87	89	89	87	78	70	57

4. Toxic substances: Not to exceed one-tenth of the 48-hour median tolerance limit, except that other limiting concentrations may be used in specific cases when justified on the basis of available evidence and approved by the appropriate regulatory agency.

FOR AQUATIC LIFE B

The following criteria are for evaluation of conditions for the maintenance of desirable biological growths and, in limited stretches of a stream, for permitting the passage of fish through the water, except for areas necessary for admixture of effluents with stream water:

1. Dissolved oxygen: Not less than 3.0 mg/l as a daily-average value, nor less than 2.0 mg/l at any time.

2. pH: Not less than 6.0 nor greater than 8.5 at any time.

3. Temperature: Not to exceed 95 deg. F. at any time.

4. Toxic substances: Not to exceed one-tenth of the 48-hour median tolerance limit, except that other limiting concentrations may be used in specific cases when justified on the basis of available evidence and approved by the appropriate regulatory agency.

FOR RECREATION

The following criterion is for evaluation of conditions at any point in waters designated to be used for recreational purposes, including such water-contact activities as swimming and water skiing:

Bacteria: The fecal coliform content (either MPN or MF count) not to exceed 200 per 100 ML as a monthly geometric mean based on not less than five samples per month; nor exceed 400 per 100 ML in more than ten percent of all samples taken during a month.

FOR AGRICULTURAL USE AND STOCK WATERING

The following criteria are applicable for the evaluation of stream quality at places where water is withdrawn for agricultural use or stock-watering purposes:

1. Free from substances attributable to municipal, industrial or other discharges, or agricultural practices that will settle to form putrescent or otherwise objectionable sludge deposits.

2. Free from floating debris, oil, scum and other floating materials attributable to municipal, industrial or other discharges, or agricultural practices in amounts sufficient to be unsightly or deleterious.

3. Free from materials attributable to municipal, industrial or other discharges, or agricultural practices producing color, odor or other conditions in such degree as to create a nuisance.

4. Free from substances attributable to municipal, industrial or other discharges or agricultural practices in concentrations or combinations which are toxic or harmful to human, animal, plant or aquatic life.

APPENDIX B

DEVELOPMENT OF BLOWDOWN SCHEDULE TO PREVENT DISCHARGE OF EXCESSIVE CHLORINE FROM RECIRCULATING COOLING WATER SYSTEMS

The decay and buildup of chemical species in the recirculating condenser-cooling tower circuit was analyzed by using the following equation for the rate of change of the content of a solute,

$$V\frac{dc}{dt} = c_M M - cB - cFR, \tag{1}$$

where, V is the volume of the system, c is the concentration in the system at the time t, c_M is the concentration in the makeup at rate M, B is the blowdown rate, R is the recirculation flowrate and F is the fraction of the solute lost (by evaporation or chemical reaction, e.g., light-catalyzed reduction of free chlorine) per pass through the system.

Integrating (1) and solving for c gives:

$$c = \frac{c_M M - (c_M M - A\ c_o)e^{-\frac{A}{V}t}}{A}, \tag{2}$$

where c_o, is the solute concentration at time zero, and $A \equiv B + FR$. The use of equation 2 involves the assumption that the composition in all parts of the system is the same, therefore, for rapid changes, the applicability would be poor.

For the present case, we wish to examine the possibility of operating with no blowdown for periods when the concentration of residual chlorine in the recirculating system is in excess of some quantity declared to be the maximum permissible. For purposes of the calculation, we shall use 0.1 ppm, the maximum figure declared by the EPA to be without harm to the aquatic ecology if discharges are limited to 30 minutes per day.

Assuming that the chloramines are predominantly produced by reaction between the ammonia nitrogen in the makeup water and the free chlorine added, the concentration reaches the level of 0.021 ppm in the 30-minute chlorination period, if none are lost by aeration in the cooling tower (see Table B.1). Actually, it is expected that a significant amount will be lost; in Section 3 of this Statement, we have chosen 50% as a conservative estimate of the fraction of chloramines lost in one pass through the cooling tower.

In Table B.1 are shown calculated values of the expected chloramine concentrations (actually ppm chlorine present in the form of chloramines) at the end of 30 minutes and four other times to be developed below. The equivalent concentration in the incoming water was the ammonia nitrogen. Only at the longest times and lowest evaporative losses is the 0.1 ppm criterion exceeded. Accordingly, the free chlorine concentration will be examined for its limitations.

The planned procedure is to maintain 0.5 ppm residual free chlorine during the chlorination periods. Following the time when chlorination is stopped, the free chlorine concentration will decline by reduction to chloride by reaction with chlorine-demand constituents in the makeup water and by reduction to chloride by reaction with water, including

TABLE B.1. Calculated Chloramine Buildup in Station Recirculating System (concentrations in parts per million)

Fraction Lost per Pass	Time, minutes				
	30	66.45	89.78	201.3	376.9
0	0.021	0.047	0.064	0.143	0.267
0.1	0.020	0.041	0.053	0.096	0.133
0.5	0.016	0.025	0.028	0.033	0.033
0.9	0.013	0.017	0.018	0.018	0.018

Assumptions: Makeup rate = 9225 gpm
Blowdown rate = 0
Makeup concentration = $0.34 \times \frac{35.46}{14} = 0.861$ ppm
Volume = 11.2 million gallons
Recirculating flowrate = [illegible]80,000 gpm
Initial concentration, zero

the catalytic effect of light. The fraction lost by reaction with water per pass through the system is not known, and may vary, depending on time of day and sunlight intensity. Calculations were therefore made of the times required for the concentration to decline from 0.5 to 0.1 ppm (at the same four values of the loss fraction that had been employed for Table B.1), with the results shown in Table B.2. Adding 30 minutes to each of these times gives the length of the period during which blowdown would be prohibited.

During such periods of no blowdown, the total dissolved solids content would increase in the average case to the values shown in the fourth row of Table B.2 (calculated using 239 ppm make-up concentration and 478 ppm initial cooling tower concentration). Chlorinating four times a day allows 360 minutes each time for periods of prohibited discharge and recovery to some chosen reference concentration. Selecting the value given in the ER for the average TDS, 478 ppm, led to the calculated required blowdown rates shown in the last row of Table B.2.

Note for the circumstances chosen, it would never be possible to blowdown if there was no significant loss of free chlorine by reaction with water, because the rate of addition of chlorine-demand constituents in the makeup water would require more than 330 minutes to decrease the free chlorine level to 0.1 ppm. Of course, employment of a less stringent discharge criterion would alleviate this problem. Also, selecting operating conditions so as to encourage the chlorine-water reaction (e.g., establish no-blowdown decay periods for daylight hours only, use shallow trough for return of water from cooling tower to recirculating

TABLE B.2. Calculation of Blowdown Rates as a Function of Free Chlorine Losses

	Case 1	Case 2	Case 3	Case 4
Fraction of free chlorine lost during each pass through the system	0	0.1	0.5	0.9
Time (in minutes) for free chlorine to decay from 0.5 to 0.1 ppm	346.9	171.3	59.78	36.45
Period of prohibited blowdown (minutes)	376.9	201.3	89.78	66.45
Total dissolved solids built up during period of prohibited blowdown (ppm)	552.2	517.6	495.7	491.1
Recovery time (minutes)	Impossible	158.7	270.22	323.55
Required blowdown rate (gpm)	-	19390	11880	10840

pumps) would be helpful. The service water used for cooling tower makeup should not be chlorinated during the prohibited blowdown periods. Schedules could be the same for chlorination of service water and recirculating cooling water.

For the three feasible cases calculated, the blowdown rates do not seem unreasonable, being at worst somewhat greater than twice the presently-expected average blowdown rate. With care in planning and design, operation is probably feasible under blowdown restrictions for periods when the residual chlorine in the recirculating cooling water is in excess of a chosen level.

There would appear to be no substantial problem to such a general procedure if chlorine were destroyed after a no-blowdown period of chlorination by the controlled addition of a chemical such as sodium sulfite. Apparently, reasonable blowdown rates would then prevent the development of excessive total dissolved solids concentration.