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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

IN THE MATTER OF:	:	DOCKET NO. 50-346-ML
	:	
TOLEDO EDISON COMPANY, et al.,	:	ASLBP NO. 86-525-01-ML
	:	
DAVIS-BESSE NUCLEAR POWER STATION,	:	
UNIT NO. 1	:	

PETITION FOR LEAVE TO INTERVENE

Now comes the State of Ohio, by and through counsel, and moves the Commission for leave to intervene as a party in the above-captioned matter pursuant to Section 2.714 of the Nuclear Regulatory Commission's Rules of Practice. The State supports this Petition with the following memorandum, which sets forth the information required by the Federal Register notice of March 14, 1986.

This petition is submitted to the Nuclear Regulatory Commission by Attorney General Anthony J. Celebrezze, Jr. at the request of Governor Richard F. Celeste, on behalf of the State of Ohio and its agencies and departments including, but not limited to, the Ohio Department of Natural Resources and the Ohio Environmental Protection Agency.

The technical information set forth in the following memorandum has been compiled by geologists, wildlife specialists, environmental scientists, and other technical personnel of the above-named agencies.

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Because Toledo Edison's submissions in support of its proposed burial of waste at Davis-Besse do not provide adequate protection to the natural resources of the surrounding area, Ohio urges the Nuclear Regulatory Commission to revoke its approval of Toledo Edison's application and to deny the company authorization to bury this waste at the Davis-Besse site. Should the Commission decide not to deny the application at the present time, the Commission should, at the very least, revoke its approval and require that adequate testing and data collection be performed before considering the merits of the application. The State has described the necessary testing and data collection in the succeeding memorandum.

I. THE INTEREST OF OHIO IN THIS PROCEEDING

The State of Ohio holds all natural resources, including the air, land, and water located within state boundaries, in trust for the use of the citizens of the State. See Article II, Section 36 of the Ohio Constitution, which empowers the State to conserve natural resources within the State. As the trustee of these natural resources, the State has a fiduciary duty to its citizens to ensure that the resources are protected from damage or ruin, and to preserve them for the use and enjoyment of both present and future generations of Ohioans. The courts of Ohio have recognized this fiduciary duty on numerous occasions. See, for example, State v. Bowling Green, 38 Ohio St. 2d 281 (1974) (protection of wildlife, including fish); McNab v. Cleveland Park Board, 108 Ohio St. 497 (1923) (conservation of stream, lakes, and wetlands); State v. Newport Concrete Co., 44 Ohio App. 2d 121 (Hamilton Cty. App. 1975) (preservation of public watercourses). This power to protect natural resources has been specifically applied to Lake Erie and adjoining areas. Shooting Club v. Slaughterbeck, 96 Ohio St. 139 (1917); Sporting Club v. Miller, 118 Ohio St. 360 (1928). The United States Supreme Court has historically recognized that a state has "standing in court to protect the atmosphere, the water, and the forests within its territory".... Hudson County Water Company v. Mc Carter, 209 U.S. 349, 355, 28 S.Ct. 529, 531 (1908).

Because the Davis-Besse Power Station is situated in the midst of extensive, invaluable state natural resources, the State of Ohio has a vital interest in ensuring that conditions at the plant do not endanger these natural resources or jeopardize the well-being of Ohioans who depend on these natural resources. Davis-Besse is located on the western basin of Lake Erie, in Ottawa County, near Oak Harbor, only twenty miles east of Toledo, Ohio.

Besides its proximity to Lake Erie, the plant is also near an array of rivers, wetlands, wildlife refuges, parks, woodlands, and farm areas. The Sandusky, Toussaint, Maumee, Portage, and other rivers and streams of importance drain into the Lake in this region. Ottawa National Wildlife Refuge, Crane Creek State Park, Magee Marsh, Turtle Creek, the Toussaint Creek Wildlife Area, Metzger State Marsh, and Darby Marsh are all located within five miles of the plant. At least two private hunting clubs, as well as numerous campgrounds and marinas, are also situated near the facility. The table attached hereto as Exhibit A, taken from the Toledo Edison certificate application for Davis-Besse units 2 and 3, lists these and other recreational areas that were located within five miles of the site as of the early 1970's. The map attached as Exhibit B shows the location of some of these areas.

Much of the natural areas located near Davis-Besse consist of wetlands. These wetlands are extremely important to the State for the following reasons:

1. These wetlands provide shelter, food, and breeding grounds for fish. The survival of the bulk of coastal game fish depends on wetlands.
2. These wetlands are sources of food and habitat for mammals and birds, including rare and endangered species.
3. These wetlands are storage areas for storm and flood waters, absorbing sudden surges of flood water and then releasing them slowly.
4. These wetlands shield coastal areas from wave action, erosion, and storm damage.
5. These wetlands absorb and filter sediment, nutrients, and other pollutants from the water, thus purifying it.
6. These wetlands purify and recharge the groundwater.
7. These wetlands produce oxygen.
8. These wetlands serve a host of human needs,

including scientific study, education, and recreation (e.g. nature and wildlife observation, hunting, fishing and trapping).

Because of the important functions served by wetlands, Presidential Executive Order 11990 and the federal Clean Water Act have mandated the preservation of wetlands. Despite the importance of wetlands, however, much of Ohio's wetlands have already been destroyed by filling, draining, and other degradation. Between 1954 and 1974 alone, approximately 40% of the wetlands along Lake Erie have disappeared. Obviously, Ohio has a great stake in protecting the remaining wetlands including the wetlands in the vicinity of Davis-Besse.

The Western Basin of Lake Erie provides commercial and sportfishing resources. Approximately 11.8 million pounds of fish are taken from Lake Erie each year, the majority of which spawn in the Western Basin. Included in the Western Basin's supply are walleye, freshwater drum, yellow perch, white bass, white perch, channel catfish, and smallmouth bass. The Lake and its coastal areas, including those near Davis-Besse, are thus an invaluable source of food and recreation to the State. See Exhibit C for more detailed information on the fish resources of the Western Basis.

The richness of the Western Basin's resources is also illustrated by the abundance of aquatic life, mammals, amphibians, reptiles, and benthic macroinvertebrates which have been observed on the Davis-Besse site and in refuges near the site. See also pages 1305-C-71 et seq. from the Davis-Besse

Certificate Application, which has extensive lists of species found in the area and which is attached as Exhibit D. The Davis-Besse area is located on two major migratory flyways for waterflow and other birds. See page 6 of attached Exhibit E.

Among the rich natural resources in close proximity to Davis-Besse, special mention must be made of Navarre Marsh. Navarre Marsh is located right on the Davis-Besse site, and adjoins Lake Erie. The Toussaint River also flows along the marsh.

The resource values of the Navarre Marsh are well-recognized as it is a component of the National Wildlife Refuge System, administered by the Ottawa National Wildlife Refuge. Canada goose production on the Navarre Marsh has steadily increased, with the Navarre sub-flock growing faster than the overall flock. Estimated production increase from the 1978-82 average to the 1983-85 average is 71 percent. During the period of 1981-82, average biweekly migration surveys (9/1-1/15) indicated that the migratory waterflow use of the Navarre Marsh exceeded 8,500 ducks and 4,000 Canada Geese.

Endangered species which can occur in the vicinity of Navarre Marsh include: American peregrine falcon, Falco peregrinus anatum; Sharp-shinned hawk, Accipiter striatus velox; Bald eagle, Haliaeetus leucocephalus; King rail, Rallus e. elegans; Kirtland's warbler, Dendroica kirtlandii; Upland sandpiper, Bartramia longicauda; Common Tern, Sterna h. hirundo. The Bald Eagle and the Common Tern have actually been observed on or over the Davis-Besse site. See page 1305-C-6 of the Davis-Besse Certificate Application, attached as Exhibit F.

A study performed for Toledo Edison by Dames and Moore shows that Navarre Marsh is thought to be one of the feeding areas upon which herons and egrets from the Sister Islands in Lake Erie depend. These islands are the nesting areas for several species of wading birds. One of these islands, West Sister Island, is considered critical to the survival of great numbers of great blue herons, black-crowned night herons, and great egrets. See the Dames and Moore study, attached as Exhibit E, for more detail. Navarre Marsh is also a host to numerous other nesting and migrating birds, as shown by the lists in Exhibit D. Ohio, therefore, has a vital interest in protecting Navarre Marsh from damage.

In short, Ohio has a very large stake in ensuring that waste disposal at Davis-Besse does not adversely degrade the surrounding environment. This environment includes the natural resources in the vicinity of the site (e.g. wildlife refuge within one to five miles of the site), those immediately adjacent to the site (e.g. Lake Erie and the Toussaint River) and those situated on the site itself (e.g. Navarre Marsh). Many thousands of Ohioans work, live and vacation in this area of the State, and depend on these natural resources in doing so. The State seeks status as a party in order to protect these interests.

Ohio's principal concerns of relevance in this proceeding are the potential health, safety and environmental problems associated with the proposed burial of low-level radioactive dredgings, including the non-radioactive chemical constituents thereof, on site at the Davis-Besse Nuclear Power Station complex. These concerns are addressed in more detail below.

II. STATE INTERESTS WHICH MAY BE AFFECTED

Radiation is a carcinogen, a mutagen, and a teratogen. That is, it can cause cancer, mutations, and birth defects in humans and animals upon exposure. For more detailed information, see Exhibit G, which is Volume I, Chapter 3 of the Radionuclides Background Information Document for Final Rules. This document was compiled by the United States Environmental Protection Agency while writing regulations for radioactive air pollution. The scientific organizations dealing with the health effects of radiation exposure agree that high levels of radiation cause cancer and mutations and that it is reasonable to assume that the risks of cancer and mutations are proportional to the radiation dose. See 48 Fed. Reg. 15076, 15077 (April 6, 1983), the U.S. EPA notice of proposed air pollution rulemaking, (attached as Exhibit H). In other words, the scientific data available conclusively proves that death and illness results from high exposure to radiation, and does not rule out health problems from low-level exposure to radiation. Because the data on low-level exposure is limited and almost impossible to develop, governmental bodies find it necessary to assume that even low doses of radiation can cause health problems. This is known as the "no threshold" theory of regulating dangerous pollutants. Id.

Because any radiation dose, for regulatory purposes, is assumed to cause some harmful effects, governmental agencies and advisory bodies have adopted a policy of keeping exposure to radiation as low as reasonably achievable (ALARA). In other words, governmental policy is to avoid any exposure to unnecessary radiation regardless of the size of the dose. This policy is endorsed by the NRC. See page 3 of the J. Stewart Bland Consulting report attached to the Toledo Edison letter of July 14, 1984 to John Stolz of the NRC. The Toledo Edison Application, therefore, must be considered in light of the policy to avoid radiation contamination where avoidance can be accomplished.

Toledo Edison has submitted an application requesting NRC approval to bury low-level radioactive waste on the Davis-Besse site. The proposed disposal area is located in a low area directly adjacent to Navarre Marsh. Because the Applicant has supplied the Commission with little actual data concerning the geologic and groundwater characteristics of the disposal area, migration of waste contaminants through the soil into the groundwater cannot be ruled out. Being in a 100 year floodplain, the proposed burial site is subject to flooding and possible lake wave action which could wash the waste from the burial site. As a result, disposal of this waste could result in the contamination of groundwater under the site, Navarre Marsh, the Toussaint River, Lake Erie, and the wetlands, wildlife refuges, and/or other natural resources situated along the lake.

The natural resources of the State described in Section I above thus could be exposed to the radioactive constituents of this waste. It should be noted that, while Toledo Edison states that the radioactive content of the waste is very low, both the company and the NRC are concerned enough about its potential harm to seek reduced exposure of company employees to the waste. See page 4 of the Commission's Environmental Assessment and Finding of No Significant Impact.

The natural resources of the State and the people who use them are also entitled to protection from unnecessary exposure to radiation if the waste can be handled in a manner that provides more assurance of safety, to the environment, there is no excuse for not doing so. Toledo Edison should handle the waste in the safest possible manner regardless of whether the radiation levels are high or low.

While the burial proposal may or may not reduce workers exposure to radiation, it poses a greater threat to the resources described in Section I of this petition. Approval of the burial proposal violates the ALARA guideline by posing unnecessary risks to the public.

Besides considering the radioactive aspects of the waste, the Commission must also insure that the nonradiological components of this waste are managed or disposed in a manner protective of health, life, and property. 42 U.S.C. Section 2114(a), (b). Therefore, the Commission must safeguard the public and the environment from the chemical constituents of the waste.

The Toledo Edison application does not adequately insure protection against any potential chemical effects of the waste. The only information submitted by the company on chemical constituents is found in attachment 1 of the company's letter to NRC of July 30, 1984. In response to NRC's question 3, the company stated that there are no known chemical contaminants in the waste which make it unsuitable for this disposal. However, as the company has informed the State, the waste has not been tested for chemical contaminants. The data safety sheets for the resins contain little information about the chemical components of the resins in the waste. See Exhibit I. Therefore, testing of the waste, including both the water treatment sludge and the condensate demineralizer backwash, is necessary before the NRC can approve burial of this waste on-site.

In sum, the State of Ohio has a very large interest in the natural resources of the area which may be affected by disposal of low-level waste in the proposed burial area. As a result, the State has standing to protect these interests under the Atomic Energy Act. 42 U.S.C. Section 2239. Therefore, the State of Ohio should be granted status as a party in this matter. As a party, the State will request that the NRC approval of the burial site be revoked. The following sections of this memorandum spell out the deficiencies of the Applicant's burial proposal with greater specificity.

III. ASPECTS OF THE REQUEST FOR APPROVAL TO BE LITIGATED AND RELIEF REQUESTED

The State of Ohio contends that the proposal is unsatisfactory from the standpoint of public health and welfare and environmental quality. Much of the evidence upon which the NRC approval of the burial site is based is inadequate at best. The environmental effects of such a project have yet to be adequately addressed and fully understood. The existence of these unknowns calls for revocation of the Approval or at the very least for protective measures or continued study and monitoring.

A. GROUNDWATER CONTAMINATION

1. Site Geology - Problems

Licensee's groundwater migration analysis (letter from Toledo Edison to the NRC, January 29, 1985) is based merely on assumptions of site geology. No actual testing of the disposal site has been performed. Toledo Edison has presented no credible evidence as to site-specific geology which would affect the migration of radioactive and other unspecified wastes from the site. Toledo Edison has made unsupportable geological assumptions without specific on-site testing of the disposal site. Indeed, Toledo Edison's evaluation is so cryptic that it does not even support the siting of a conventional sanitary landfill, much less a burial site for radioactive, chemical and other types of waste. Information on the depositional history and geologic nature of the Davis-Besse region developed by the professional geologic staff of the Ohio Department of Natural Resources' Division of Geological Survey suggests that Toledo Edison's assumptions on-site geology are in substantial error.

Petitioner is concerned that the actual site characteristics could result in much higher levels of contamination than what is indicated in the analysis. It appears that the licensee assumed that the disposal site geology was the same as that presented in Toledo Edison's OPSC Application, Sec. 1302-B. (Exhibit J). No geologic data has been obtained for the disposal site itself. (See Toledo Response to question 5 in Exhibit P). However, the geology at the Davis-Besse site consists of a complex sequence of unconsolidated glaciolacustrine and glacial till sediments overlaying a shallow carbonate and evaporite bedrock sequence. All of these units contain materials and discrete partings, fractures, joints, vugs and other voids which would provide pathways for the migration of radiological and other waste materials into both ground and surface water supplies. The glacial sediments described in Toledo Edison's application are described as "glaciolacustrine deposit" six to twelve feet thick, over a "till deposit," also six to twelve feet thick. Yet licensee has provided no credible evidence as to specific characteristics to substantiate this assertion. Experience in north-central Ohio reveals that glaciolacustrine sediments consist of thin layers of clayey silt or silty clay; these are often separated by layers of sand that are mostly very thin, but can be up to a foot thick locally. Horizontal water flow rates (permeability) in these sediments can be several orders of magnitude greater than vertical flow, as is seen in large local water seeps along horizontal zones in exposures and excavations. These zones, essentially <u>mini-aquifers</u>, could direct a significant water flow down-grade from the proposed disposal pit into either Navarre Marsh or to the Toussaint River at Locust Point, 500 feet away, where Licensee assumes that homes are supplied by surface water from the river.

2. <u>Site Geology - Relief Requested</u>

In light of the foregoing it would appear that the site is not appropriate for burial of waste. If, however, the Commission does not revoke its approval, Licensee should be required, at a minimum, to take the following actions:

a) Make a series of test borings to a depth of at least 50 feet on a grid that would cover the disposal site and potential downgradient problem areas. Detailed geologic descriptions should be made of all materials encountered.

b) Continuous samples should be recovered by boring or other techniques that would allow recove[illegible] of undisturbed geologic samples of all [illegible]rials encountered. No sampling method that would d[illegible]o the permeability in joints, fractures or other geologic discontinuities should be used.

c) All samples should be tested for natural permeability and porosity, as well as grain size distribution. All borings should be tested for in-situ permeability.

d) An analyses of jointing and fracturing of the bedrock and glacial material should be made with specific reference to ground water flow paths and interaction with the waste site.

e) Any earth materials to be used for cover, dikes, liners or other similar uses should also be tested for porosity, permeability, and grain size. Mineralogy of the unconsolidated materials should be determined with specific emphasis on potential volume changes such as swelling or fissuring which could endanger the security of the disposal site.

f) A materials map showing the thickness, porosity, and permeability should be made for each distinct glaciolacustrine and glacial till unit.

g) A map indicating the position of both the natural water table and the previously mapped near-surface perched water table as well as the piezometric surfaces should be made for the site and adjacent areas.

h) An analysis should be made of all potential off-site migration routes, flow rates, and the potential for contamination of surface and groundwater should be developed.

i) Licensee should be required to install a water level recorder in a monitoring well at the site location and monitor ground water levels for a period of time prior to disposing of any byproduct material.

3. Soil Permeability - Problems

The U.S. Department of Agriculture Soil Survey of Ottawa County indicates that the soils at the proposed site contain a near-surface perched water table for a large part of the year. (Exhibit K). These soils also have a higher permeability in the surface layer, allowing horizontal movement of water just under the surface. Both the glaciolacustrine and till deposits are reported (OPSC appl., Sec. 1302-B, Exhibit J) to be "fissured." These fissures are joints in the relatively consolidated glacial sediments. The materials are also described as "gray and brown." The brown colors indicate oxidation by relatively rapid water movement along the joints or the mini-aquifers described above; gray material is in the interiors of the joint-bounded blocks or clayey layers, where water movement is slower. The permeability of 10^{-6} cm/sec reported by Toledo Edison represents a laboratory test performed on a small piece of till from the interior of a till block; permeability along the joints can be several orders of magnitude greater. This could allow rapid movement downward of leachate from the disposal pit into the highly permeable fractures and solution channels of the underlying dolomite aquifer. Once in this aquifer, contamination could spread far beyond the immediate area. There are numerous groundwater wells located within a short distance of the proposed site (see Exhibit L). The well log drilling reports (Exhibit M) indicate that static level-depth water occurred from 4 to 10 feet below the surface. Drilling reports indicate that the wells are between 35 feet to 125 feet in depth with casing lengths ranging from 16 feet to 52 feet in depth (Exhibit M). These logs also indicate that bedrock is only 10 to 20 feet below land surface with static water at even shallower levels.

4. <u>Soil Permeability - Relief Requested</u>

In light of the foregoing, Davis-Besse is not an appropriate site for burial of waste. If, however, the Commission determines that it should not revoke its approval, Licensee should be required, at a minimum, to take the following actions:

a) An analyses of jointing and fracturing of the bedrock and glacial material should be made with specific reference to groundwater flow paths and interaction with the waste site.

b) A map showing the position of both the natural water table and the previously mapped near-surface perched water table as well as the piezometric surfaces should be made for the site and adjacent areas.

c) An analysis should be made of all potential off-site migration routes, flow rates, and the potential for contamination of surface and groundwater.

d) Licensee should be required to determine the existence of any other groundwater wells within a 21-mile radius of the site as well as the groundwater gradient to each.

e) Licensee should be required to install water level recorders in monitoring wells at the site location as well as in all existing groundwater wells in order to monitor groundwater levels and contaminants for a period of one year prior to disposing of any byproduct material.

f) Licensee should be required to monitor groundwater contamination of Navarre Marsh and Lake Erie since permeability along fissures could result in contaminants entering lake Erie and/or Navarre Marsh.

5. Suitability of Soil for Landfill - Problems

According to the United States Department of Agriculture 1985 Soil Survey of Ottawa County, Ohio (Exhibit K), the soils on the proposed burial site at the Davis-Besse nuclear power station are Nappanee silty clay loam and Toledo silty clay. Nappanee silty clay loam is a deep, somewhat poorly drained soil formed in water-modified glacial till on lake plains. The surface texture is silty clay loam and the subsoil and substratum are silty clay. This soil is a poor choice for area sanitary landfills because of wetness and pondings. The high clay material is hard to compact and cracks on drying, causing fissures in the landfill. Furthermore, Nappanee silty clay loam and Toledo silty clay are extremely poor cover for landfills since the soil is hard to pack and is susceptible to erosion from wind and water.

6. Suitability of Soil - Relief Requested

In light of the foregoing, it is apparent that the site is not appropriate for burial of waste. However, if the Commission determines it should not revoke its approval:

a) Licensee should be required to select a land disposal site with optimum landfill soil types.

7. Geochemical Reactions Between Waste and Subsurface - Problems

Licensee has given no consideration to potential geochemical reactions between the waste material and the confining geologic materials. This proposal, which calls for very near-surface disposal of the waste, is within the zone of maximum oxidation and therefore reduction reactions could potentially mobilize constituents within the waste. Environmental acids (sulfuric, nitric, carbonic, and humic) in the perched water table continually dissolve calcium, magnesium, and other materials from the geologic materials. Water containing these elements could enter the waste and could then selectively displace radioactive ions such as cesium from the resins and sludges, thus allowing a higher concentration of radioisotopes in the groundwater that leaves the site.

8. Geochemical Reactions - Relief Requested

In light of the foregoing it is apparent that the site is not appropriate for waste burial. However, if the Commission does not revoke its approval, Licensee should be required, at a minimum, to perform the following tests:

a) Geochemical testing should be performed to evaluate the effect of all chemical wastes on the geologic material present on the site. Such testing should pay particular attention to conditions which could cause either chemical or physical changes in the geologic materials which could result in increased migration from the site or the creation of leachates (such as heavy metals or other deleterious elements) which would have furher deleterious effect. Induced volume changes in the sedimentary cover should be specifically addressed.

b) All data generated by this study should be analyzed and presented in a coherent package to support the Toledo Edison conclusion that the site does, in fact, meet acceptable geological standards for protection of both ground and surface waters from radiological and other waste hazards.

c) Licensee should be required to analyze each element in the sludge and determine its potential soluability and potential oxidation and inert qualities.

d) Licensee should be required to test and analyze any chemical reactions that have occurred in the present disposal site (settling basins).

IV. FLOODING AND STORM DAMAGE

1. Problems

An additional problem with the proposed site concerns the dangers associated with flood and storm damage. The proposed site is less than a mile from the lake Erie shore and is in a known flood prone area (see Exhibits N and O). As recently as November 1972 a severe storm devastated this area. Since much of the shoreline at the Davis-Besse facility was undeveloped marsh in 1972, descriptions of damages are somewhat limited. However, it has been reported that at Sand Beach, which is slightly over one mile away, waves carried so much sand over protective dikes, dunes, and seawalls that roads were covered by up to three feet of sand. See Information Circular 39 "The November 1972 Storm on Lake Erie" published by Div. of Geological Survey, ODNR (Exhibit P). In nearby areas such as Sand Beach, waves cut into sand and clay banks as far as 10 feet, partially destroying the natural barrier and eroding much land. Widespread flooding took place where waves and high water breached dikes and structures protecting low-lying areas. State Route 2, near the entrance to Sand Beach, was barely passable after the storm. The elevation at Sand Beach is approximately 575 feet, almost the identical elevation of the proposed site. Given that lake levels <u>are even higher now than in 1972</u> there is the very real and serious danger that the site could be damaged by further storms. According to a Damage Survey Report Form dated 12/21/72 signed by Daniel R. Stower, ODNR, three hundred (300) feet of dike at the Toussiant Wildlife Area were destroyed (See Exhibit R). This wildlife area is 3 1/2 miles <u>upstream</u> of the Davis-Besse site, indicating that even more severe damage could be expected at the proposed disposal site.

The U.S. Army Corp of Engineers 1977 Report on Great Lakes Open Coast Flood levels estimated the 500 year level to be 576.7 feet (Exhibit S). Lake Erie now stands at 573.6 feet (see Exhibit T) nearing the 500 year estimate. The ODNR Divisions of Geological Survey and Division of Water estimate a storm creating a rise in extra levels of three (3) feet occurs every two to three years. In view of extremely high lake levels and the frequent occurrence of storms in the Davis-Besse area, the potential for an all time record damaging storm is very great. This issue has not been publicly or adequately addressed by Toledo Edison. Toledo Edison has provided no plan for dealing with floods or wave action which could breach the disposal site.

2. Flooding - Relief Requested

In light of the foregoing it is apparent that this site is not appropriate for waste burial. However, should the Commission not revoke its approval, the Licensee should, at a minimum, prepare a plan that would include, but not be limited to:

a) A detailed analysis of past flood and wave damage in a five-mile radius of the proposed site.

b) The potential for future storm events of damaging proportions should be taken into account when developing safety and contingency plans.

c) An evaluation of dike failures in the area should be made in order to determine the reliability of various structures to withstand severe storms.

d) A dike design detailing engineering parameters and safety factors should be prepared for any dikes proposed as protective structures for the proposed site.

e) A contingency plan should be developed for dealing with flooding or breaching of the site security by storms. Such as plan should deal with mitigation of waste migration and waste handling during period of inaccessibility to the site.

f) All flood and storm data should be analyzed and presented in a fashion allowing for a detailed evaluation of the suitability of the proposed site to withstand storm and flood events without danger to the disposal site.

V. WILDLIFE PROTECTION

1. Problems

The proposed burial site is located adjacent to Navarre Marsh, a rich wildlife and fish resource. The Licensee has not ascertained with any degree of certainty that the low-level radiation or potential geochemical reactions associated with the burial project will not result in adverse impact to fish and precious wildlife resources.

2. Relief Requested

In the view of the fact that this resource rich area provides a valuable source of food to the general public, it is apparent that the site is not appropriate for waste burial. However, if the Commission does not revoke its approval, the Licensee should be required at a minimum to do the following:

a) The Licensee should be required to develop a plan to monitor all resident species of fish and wildlife in the area for any adverse impacts either from low-level radiation or chemical reactions.

b) The Licensee should be required to develop a plan to determine what effects the present temporary disposal method (the settling ponds) has had on resident species of fish and wildlife before permitting the permanent disposal of waste on-site.

c) The Licensee should be required to develop a plan to detemine the parameters of assimilation of waste materials into the food chain through the uptake of ground water by local vegetation.

d) The Licensee should be required to develop a plan to determine what effects any geochemical reactions of the wastes will have on chemical assimilation of vegetation and resident species of fish and wildlife.

VI. NEPA CONSIDERATIONS, 42 U.S.C. 4321 et seq.

A. Necessity of an Environmental Impact Statement

The Petitioner contends that an Environmental Impact Statement pursuant to 42 U.S.C. 4321 et seq. is required before Toledo Edison's proposal can be implemented. NEPA imposes environmental responsibilities on all agencies of the federal government. Section 102 (2)(A) of NEPA requires federal agencies to "utilize a systematic, interdisciplinary approach which will insure the intergrated use of the natural and social sciences and environmental design arts in planning and decision-making which will have an impact on man's environment". This mandate was ignored by the "Environmental Assessment and Finding of No Significant Impact" of October 8, 1985. The decision of no significant impact appears to be nothing more than a foregone conclusion to be rationalized. It is quite clear that the decision not to prepare an EIS was not based on full consideration of all relevant factors, especially those addressed above. These factors and concerns clearly illustrate that the proposal under consideration is "major", will "significantly affect the quality of the human environment" and is "federal". Actions may be "major" although expenditures are modest and planning minimal. NEPA calls for strict compliance. Calvert Cliffs Coordinating Committee v. Atomic Energy Commission, 404 U.S. 942 (1971). Section 101 of NEPA speaks of the need to assure all Americans "safe, healthful, productive and esthetically and culturally pleasing surroundings." This mandate has been clearly violated by the failure of the NRC to prepare an Environemtnal Impact Statement. As outlined above, the effects of the proposal will be significant and therefore require preparation of an EIS.

1. Relief Requested:

The NRC should be required to prepare an Environmental Impact Statement exhaustively examining the environmental impacts of this proposal.

B. Alternative to Proposed Action

Section 102(2)(e) of NEPA requires each agency to "study, develop, and describe appropriate alternatives to recommended courses of any action in any proposal which involves unresolved conflicts concerning alternative uses of available resources." The stringency of this directive demands emphasis. It is not limited to major federal actions as in Section 102(2)(C). It requires not only the study of appropriate alternatives, but also that they be "developed". This directive imports no mere lip service to and discussion of alternatives; it presumes a degree of serious consideration, some preliminary research, contingency planning, and the assignment of personnel and equipment to pursue the possibilities. Conservation Council of North Carolina v. Froehlke, 340 F. Supp. 222, 227-28 (M.D. N.C., 1972). It is without doubt that the burial site and surrounding area represents a valuable and scarce resource to the State of Ohio. There was no assessment made of any environmental impacts whatsoever for this rich resource area. The "Environmental Assessment" prepared by the NRC was limited solely to radiological impacts that would directly affect human health. (See Section I). Section 102 (2)(E) was clearly ignored when the NRC concluded that no alternatives need to be evaluated. This was the conclusion of the "Environmental Assessment and Finding of No Significant Impact" of October 8, 1985. This conclusion is an indisputable violation of Section 102(2)(E). The NRC did not consult with any other agency of the federal government or with any agency of the State of Ohio when preparing the "Environmental

Assessment" and when deciding how to use this valuable Ohio resource. No alternatives were examined.

1. Relief Requested

In light of the foregoing, it is apparent that this rich natural resource area is totally unsuitable for use as a waste burial site. However, if the Commission should not revoke its approval of the proposal, the NRC should be required to:

a) Comply with the directive of Section 102 (2)(e) of the National Environmental Policy Act by "describing", "developing" and "studying" all appropriate alternatives.

b) Examine the alternative of off site disposal of these contaminated byproducts.

The Licensee has admitted to the petitioner that the cost of disposing of these materials offsite is a mere $72,000 over the entire operating life of the Davis-Besse facility. Additionally the amount of material to be dredged and disposed of represents only 200 cubic feet of material per year. (See "Disposal of Low-Level Radioactively Contaminated Secondary-Side Clean-Up Resins in the On-Site Settling Basins at the Davis-Besse Nuclear Power Station" May 1983).

The petitioner maintains that the alternative of packaging and shipping these byproduct materials offsite represents the most appropriate alternative. The balance is between a mere $72,000 spent over a more than forty year period and environmental damage to an important environmental resource of incalculable amounts.

VII. ENDANGERED SPECIES

The Petitioner contends that Section 7 of the Endangered Species Act of 1973 has been violated by NRC approval of the proposal in question. Section 7 requires all federal departments and agencies, among other things, to take steps "necessary to ensure that actions authorized, funded, or carried out by them do not jeopardize the continued existence of [listed] endangered species and threatened species or result in the destruction or modification of habitat of such species which is determined by the Secretary, after consultation as appropriate with the affected states, to be critical." Action may "jeopardize" the continued existence of a species by setting in motion a chain of events that reduce chances for survival. National Wildlife Federation v. Coleman, 529 F. 2d 359, 372 (5th Cir. 1976). Habitat can be destroyed or modified not only by direct intrusion but by predictable indirect effects. Id. There has been no consultation as directed by Section 7. Many endangered species inhabit the vicinity of the proposed burial site, including: American peregrine falcon, Falco peregrinus anatum; Sharp-shinned hawk, Accipiter striatus velox; Bald eagle, Haliaeetus leucocephalus; King rail, Rallus e. elegans; Kirtland's warbler, Dendroica kirtlandii; Upland sandpiper, Bartramia longicauda; Common tern, Sterna h. hirundo. The directive of Section 7 must be realized before the proposal in question can be approved.

1. Relief Requested

It is apparent from the foregoing that the proposed site is not appropriate for a waste burial site. However, if the commission does not revoke the approval, the NRC:

a) Must be required to comply with the mandate of Section 7.

VIII. COMPLIANCE WITH OHIO REVISED CODE

A. UNSUITABILITY AS LANDFILL - NO PLANS SUBMITTED

At present the Licensee has submitted no plans for a disposal site as required by Ohio Administrative Code Section 3745-27. What is apparent from the licensee's proposal is that the procedures the Licensee envisions will not satisfy the requirements of Ohio's Solid Waste Disposal Regulations.

B. REQUIREMENTS OF OHIO ADMINISTRATIVE CODE

1. Ohio's regulations require that solid waste disposal cannot occur less than five (5) feet above the seasonal high level groundwater table. The licensee has proposed to bury the dredged material between two(2) and five (5) feet below the surface. While the licensee has asserted that the ground water level at the site is between eight (8) and ten (10) feet below the surface, this is the location of the aquifer or saturated zone and the seasonal high level ground water table or upper surface of zone saturation lies above the aquifer.

2. Ohio Administrative Code Section 3745-27-06 prohibits the siting of a sanitary landfill in a floodway absent a waiver. A floodway is defined as the area needed to convey a hundred year flood. The proposed burial site is situated in a floodway (see Exhibits N ansd O).

3. Ohio Administrative Code 3745-27-09 requires that at least two feet of well compacted final cover material, be placed over all waste materials deposited in a sanitary landfill. The Licensee is proposing a clay cover of only four inches.

4. Request for Relief

The Licensee must, at the very least:

a) Determine the seasonal high level ground water table level;

b) Provide information analyzing and describing the chemical and physical nature of the dredged materials as well as the state in which it is to be disposed of; and

c) provide an analysis of the nature of the organic polymers used in its deminerlizer process.

IX. SECTION 401 OF CLEAN WATER ACT

It is not clear from the Licensee description of the proposed burial site, whether or not the burial site is to be located in a wetland. (See also, Exhibit Q). If the area is found to be a wetland, the Licensee must obtain a section 401 Water Quality Certification from the Ohio Environmental Protection Agency pursuant to the Federal Water Pollution Act, 33 U.S.C. 1251 as amended.

1. Relief Request

The Licensee should be, at the very least, required to:

a) determine whether or not the proposed burial site will be located in a wetland; and

b) if the site is determined to be located in a wetland, the Licensee must be required to obtain a 401 Water Quality Certificate from the Ohio Environmental Protection Agency before any disposal on-site can occur.

X. POWER SITING CERTIFICATION

Ohio Revised Code Section 4906.05 requires the Licensee to obtain a "Certificate of Environmental Compatibility and Public Need" whenever a "substantial addition" is added to a major utility facility. A "substantial addition" is defined in Ohio Administrative Code Section 4906-1-01(V) as a modification of a utility facility which modification in itself constitutes, inter alia, substantial environmental impact. As outlined above, there can be no doubt but that this "modification" or disposal burial site represents a substantial environmental impact.

1. Requested Relief

a) The Licensee must apply for and obtain a Certificate of Environmental Compatibility and Public Need before it may dispose of any byproduct material on-site.

XI. CONCLUSION

For all of the foregoing reasons, petitioner urges that Licensee's proposal not be approved.

Additionally, Petitioner urges the Administrative Law Judge to select a date and place for a public hearing. This matter of on-site disposal of byproduct materials has raised a great deal of public concern. A public airing of these issues will provide all parties with the opportunity to openly and publicly address these serious concerns. This is not a matter which should be shrouded in paper submissions and technical jargonese. The people of Ohio deserve and demand an opportunity to have their very real concerns addressed openly and in a manner in which they can participate and have a voice.

It is ironic that at the 1980 Public Hearing before Power Siting Board for certification of Units 2 and 3, Mr. Roe of Toledo Edison promised Ohioans that there would be no burial of any "nuclear waste around the Davis-Besse facility". See Exhibit U, an excerpt from the Power Siting Board Public Hearing on the certificate for Units 2 and 3. But in the intervening years it appears a situation has arisen where project justifications and economic and technical consideration have swallowed up the environmental impact analysis. For all of the above reasons, the NRC needs to consider all the circumstances and the people of Ohio need to be an integral part of this consideration.

Respectfully submitted,

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CERTIFICATE OF SERVICE

I hereby certify that a copy of the foregoing Petition for Leave to Intervene was sent by regular U.S. Mail, postage prepaid, this 14th day of April, 1986, to:

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Nuclear Regulatory Commission
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JACK A. VAN KLEY
Assistant Attorney General

EXHIBIT A

TABLE 1305-E-4

RECREATION AREAS WITHIN 5 MILES

	No.*	Name	Distance, Direction	Attendance
State Parks	1.	Magee Marsh and Turtle Creek	3 W	48,000 annually (7)
	2.	Crane Creek State Park	2-5 WNW	364,284 (8) (July 72-June 73)
	3.	Toussaint Creek Wildlife Area	3-5 WSW	5,220 (7)
Private Hunting Marshes	4.	Toussaint Hunting Club	3 SE (6)	100 members
	5.	Rockwell Corp. Hunt Club	3 SE	not available
Campgrounds	6.	KOA - Paradise Acres	2 SSE	6,600 Car (6) nights/yr
	7.	Camp Sabroski	4 WSW	3,004/yr (6) (1972) 1,496 (June-August)
	8.	E & C Camp Site	2 SSE	5 spaces
	9.	Anderson's Camp	2 SSE	6 spaces
	10.	East Side Marina	2 WNW	43 spaces
	11.	Turtle Point Marina	2 WNW	44 spaces

* Numbering is used to identify sites on the map of recreation areas shown in Figure 1305-F-1.

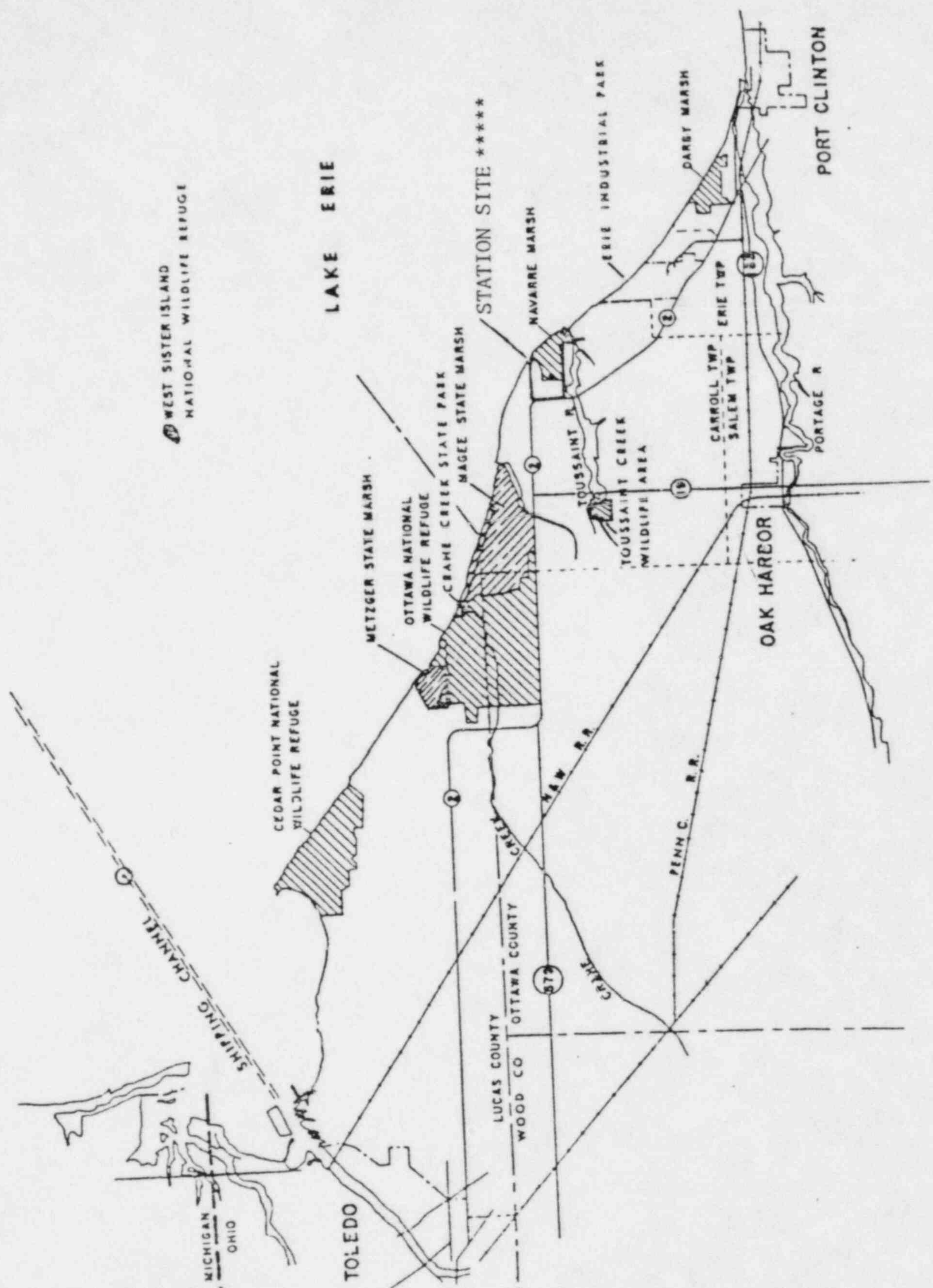
TABLE 1305-E-5

WATER RECREATION WITHIN 5 MILES

Water Body	No.*	Facility	Type	Location	Water Activities
Toussaint River	12.	Brow Boat Docks	Private	1 mi S	Boating
	13.	Flora's Little Place	Private	1 mi S	Boating
	14.	Rice Boat Rentals	Private	1 mi S	Boating
	15.	Toussaint Creek Wildlife Area	Public	3.5 mi WSW	Boating & Fishing
Turtle Creek Bay	16.	Turtle Creek Access	Public	3 mi W	Boating & Fishing
Lake Erie	17.	Al's Harbor	Private	1.5 mi NW	Boating
	18.	Crane Creek State Park	Public	2.5 mi WNW	Boating, Fishing & Swimming
	19.	East Side Fishery & Marina	Private	2 mi WNW	Boating & Fishing
	20.	Lake View Motel	Private	2 mi WNW	Fishing
	21.	Turtle Point Marina	Private	2 mi WNW	Boating

* Numbering is used to identify sites on the map of recreation areas shown in Figure 1305-F-1.

EXHIBIT B

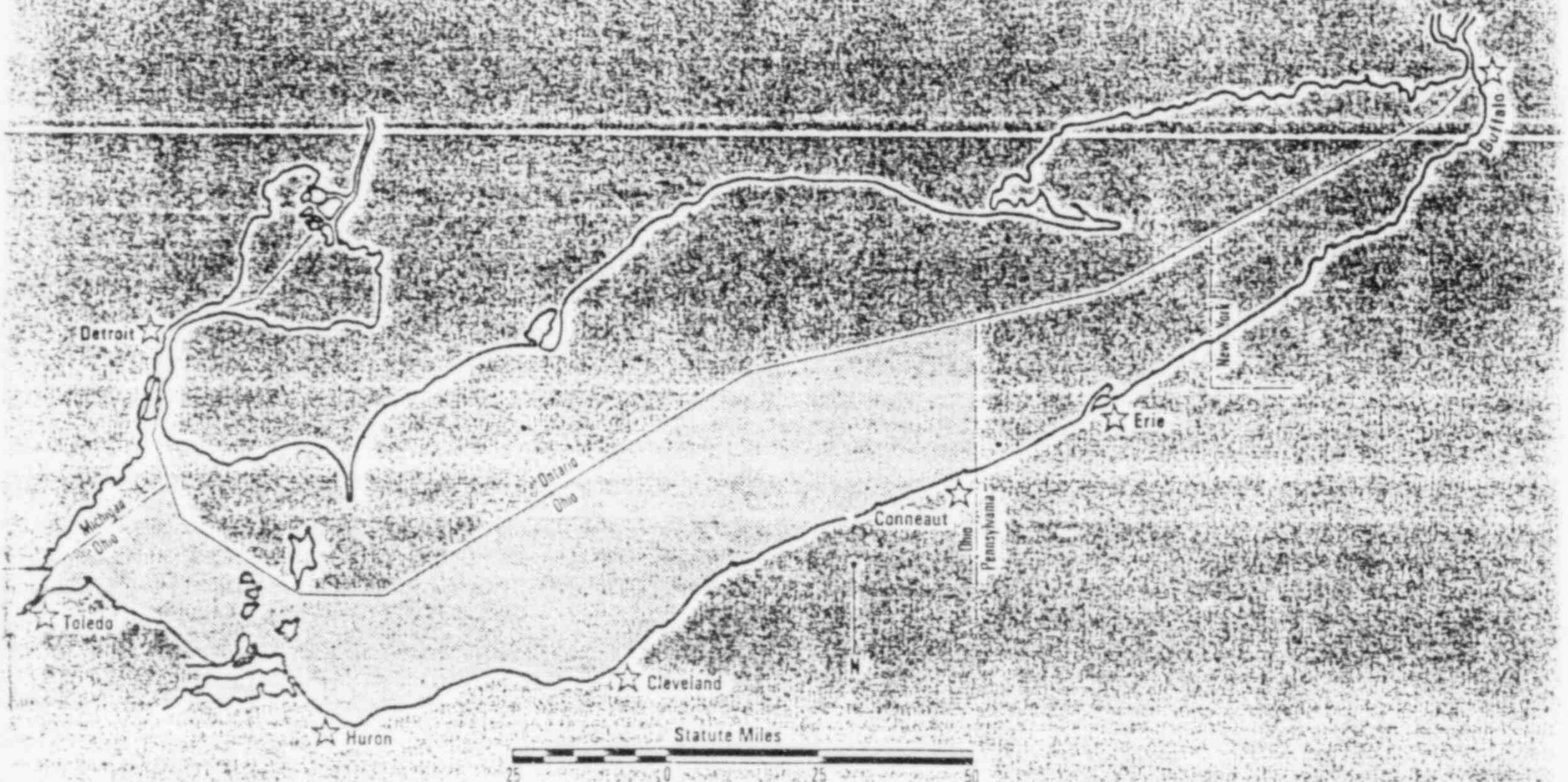


DAVIS-BESSE NUCLEAR POWER STATION
SITE LOCATION PLAN

EXHIBIT C

STATUS AND TREND HIGHLIGHTS OHIO'S LAKE ERIE FISH AND FISHERIES

March 1985



Prepared By:
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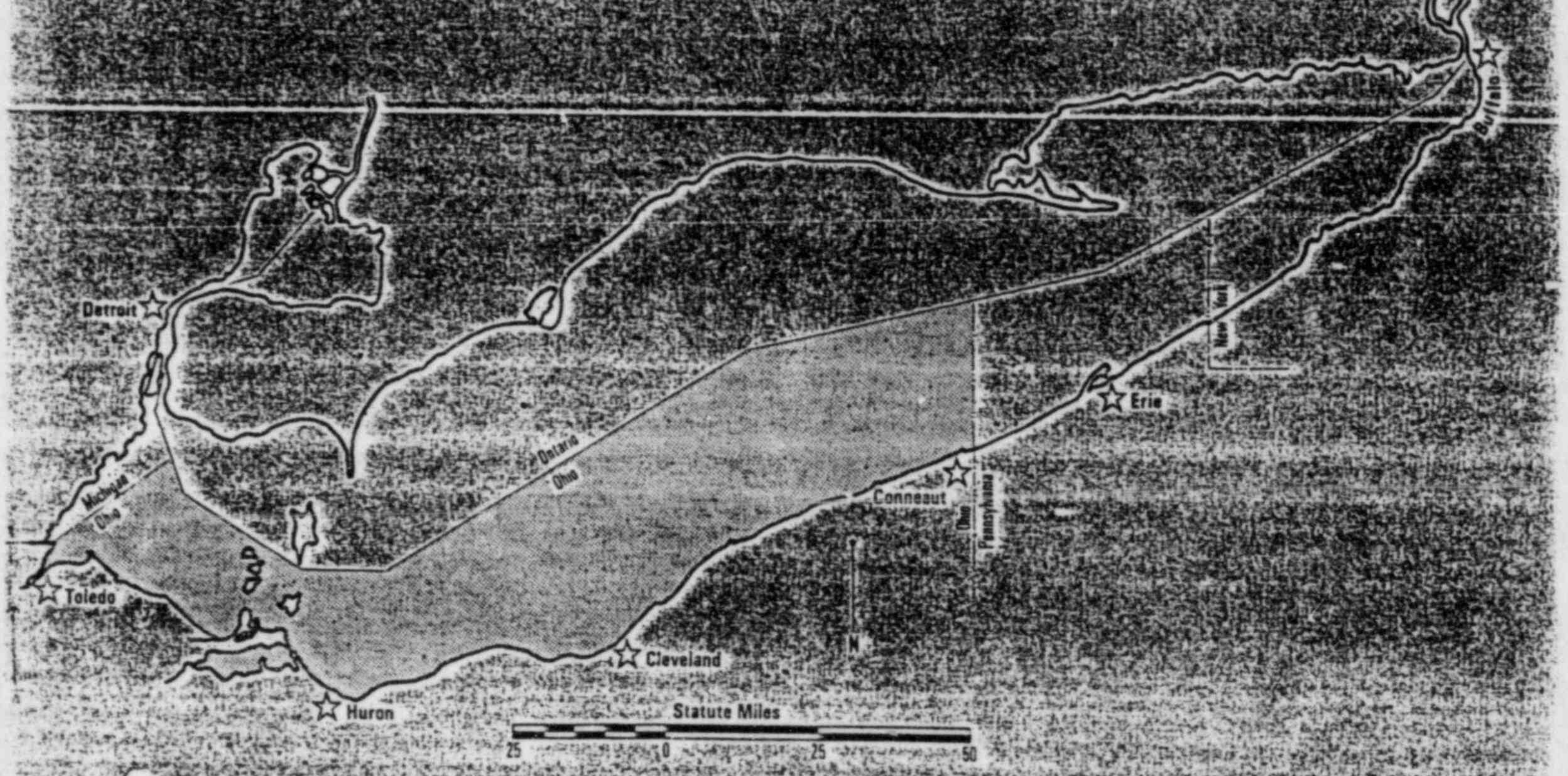
OHIO

STATUS AND TREND HIGHLIGHTS
OHIO'S
LAKE ERIE FISH AND FISHERIES

March 1985



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Ohio Department of Natural Resources
Division of Wildlife

STATUS AND TREND HIGHLIGHTS OF OHIO'S LAKE ERIE FISH AND FISHERIES[1]

January 1985

Lake Erie Fisheries Unit Staff
Sandusky, Ohio

INTRODUCTION

A primary statutory responsibility of the Ohio Division of Wildlife is to perpetuate and improve the fishery resources, while allowing wise use to benefit people. The Lake Erie Fisheries Unit contributes to meeting this responsibility by collecting and analyzing information on Lake Erie's fishery resource, thus, improving the Division's capability to make sound management decisions. More specifically, the Unit conducts scientific studies which are designed to maintain baseline inventory and harvest data for major sport and commercial fishes. Inventory and harvest assessments are used to monitor present fish stocks and provide insight into future changes of fish populations.

ASSESSMENT METHODS

The status of major fish species in Ohio's Lake Erie waters is determined by various methods of measuring fish populations and sport and commercial harvests. Population and harvest data are presented by geographical Districts I, II, and III as shown in Figure 1.

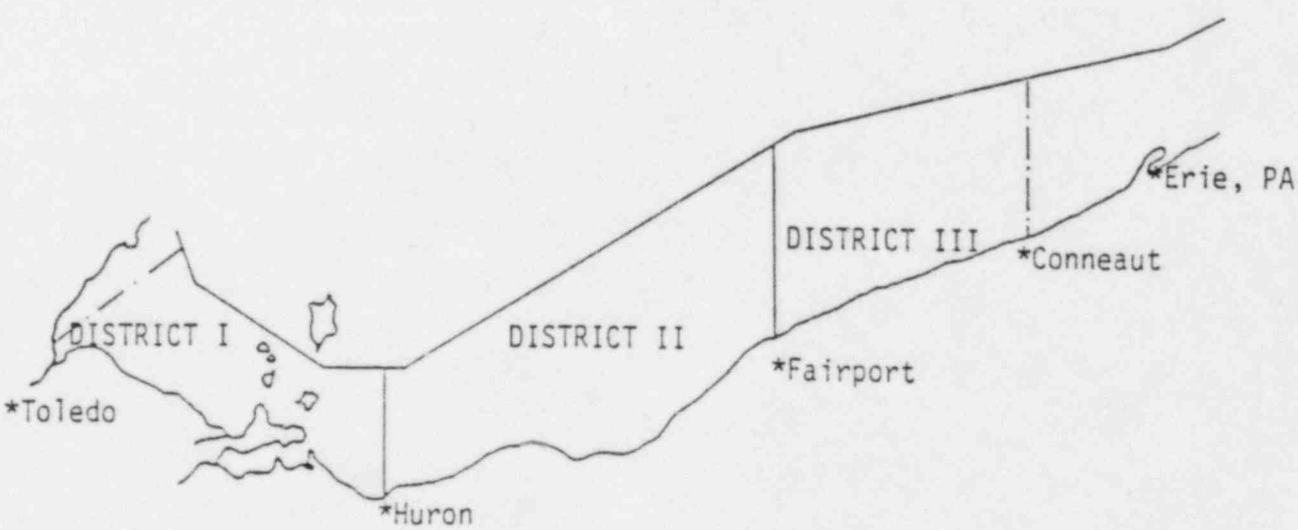

Figure 1. Locations of geographic Districts I, II, and II, Ohio waters of Lake Erie.

[1]Contribution from Federal Aid in Fish Restoration Project F-35-R.

Fish Populations

Methods used to assess fish populations include standard inventory trawl and gill net fishing gears annually fished at specific locations and seasons to measure abundance, sizes, and ages of fish present. This index information reflects annual trends in fish populations.

Sport Harvest

Hours fished and numbers of each species harvested are recorded by survey clerks interviewing boat and shore anglers from March through October. Sizes and ages of fish harvested are determined by sampling a weekly portion of the angler catch. Charter boat harvests are also measured from monthly catch reports submitted by licensed charter guides.

Commercial Harvest

Fish harvests are determined from monthly reports submitted by licensed commercial trap net, seine, and trotline fishermen. Sizes and ages of fish captured and/or harvested are determined by sampling portions of the commercial catch.

POPULATION ASSESSMENTS

Young-of-the-year Abundance

Trawling Surveys

Annual summer western basin young-of-the-year index values for major species are presented in Table 1. These index values provide the first estimate of year class abundance. Annual index values for walleye, gizzard shad, alewife, and freshwater drum are calculated from this summer survey. Annual index values for young-of-the-year yellow perch, white bass, emerald and spottail shiners are determined from lakewide fall trawling surveys (Tables 2-5). The 1984 assessments are as follows:

Walleye

The index ranked fourth highest during the past ten years, being exceeded only by the exceptionally high 1977, 1980, and 1982 year classes. (Figure 2). This 1984 year class will first enter the fisheries in 1986.

Gizzard Shad

There was a relatively high index value for gizzard shad. Young-of-year gizzard shad are an important forage species in Lake Erie. Shad abundance was reflected by the increased young-of-year shad occurrence in walleye diets from 1983 to 1984.

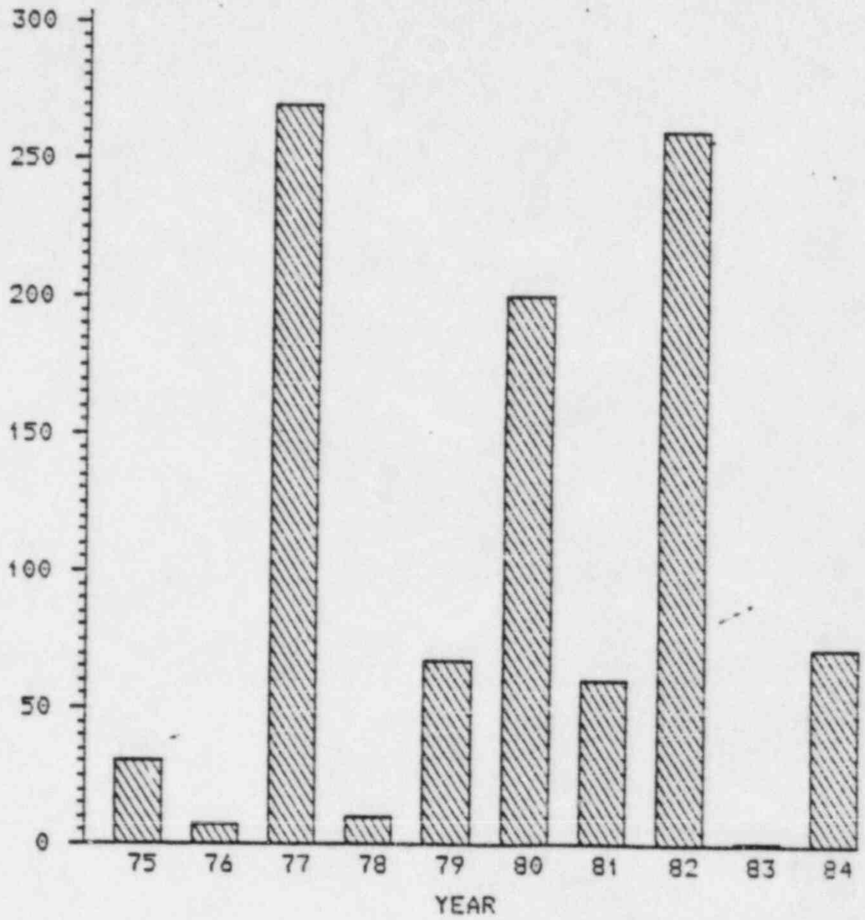

Figure 2. Western Lake Erie young-of-the-year walleye trawling index, number per trawling hour.

Alewife

The index value was below annual averages. Overall abundance of this forage species has generally decreased during the past six years.

Freshwater Drum

The index value was the lowest recorded.

Yellow Perch

The overall summer index value was relatively high (Table 1). However, late summer trawl catches declined rapidly and subsequently fall index values were comparatively low. The fall western basin (District I) and the central basin (Districts II and III) index values remained below most other years since 1979 (Table 2).

White Bass

The western basin (District I) index value was low, whereas the central basin (Districts II and III) index value was similar to previous annual index values (Table 3).

Shiners

Spottail and emerald shiner summer and fall index values for all age groups were the lowest recorded (Tables 4 and 5).

White Perch

Both summer and fall index values were the highest recorded. The white perch fall index was second only to gizzard shad and was 15X higher than in 1983. White perch is a recent invader into Lake Erie, therefore, the limited three-year index data is not presented in tables. Obviously, radical partitioning of the existing forage base is currently taking place. Work on diet overlap between the white perch and native lake species, primarily drum and yellow perch, is ongoing.

Yearling and Adult Abundance

Trawling and Gill Net Surveys

Annual index values of abundance for yearling and adult age groups of major species are determined from lakewide gill net and trawl surveys during the fall. The 1984 assessments are as follows:

Walleye

The yearling index is the lowest value ever recorded and reflects the exceptionally poor 1983 year class. The estimated 1985 fishable population, which is derived from multi-agency lakewide data, is projected at 22 million fish (Figure 3). Walleyes from the 1982 year class compose nearly 85% of age 1 and older fish in the population (Table 6).

Yellow Perch

Yearling indices were the lowest ever recorded in each district, owing to the poor 1983 year class. Adult indices were above average in each district, largely because the abundant 1982 year class accounted for nearly 60% (lakewide average) of the age 2 and older population (Table 7).

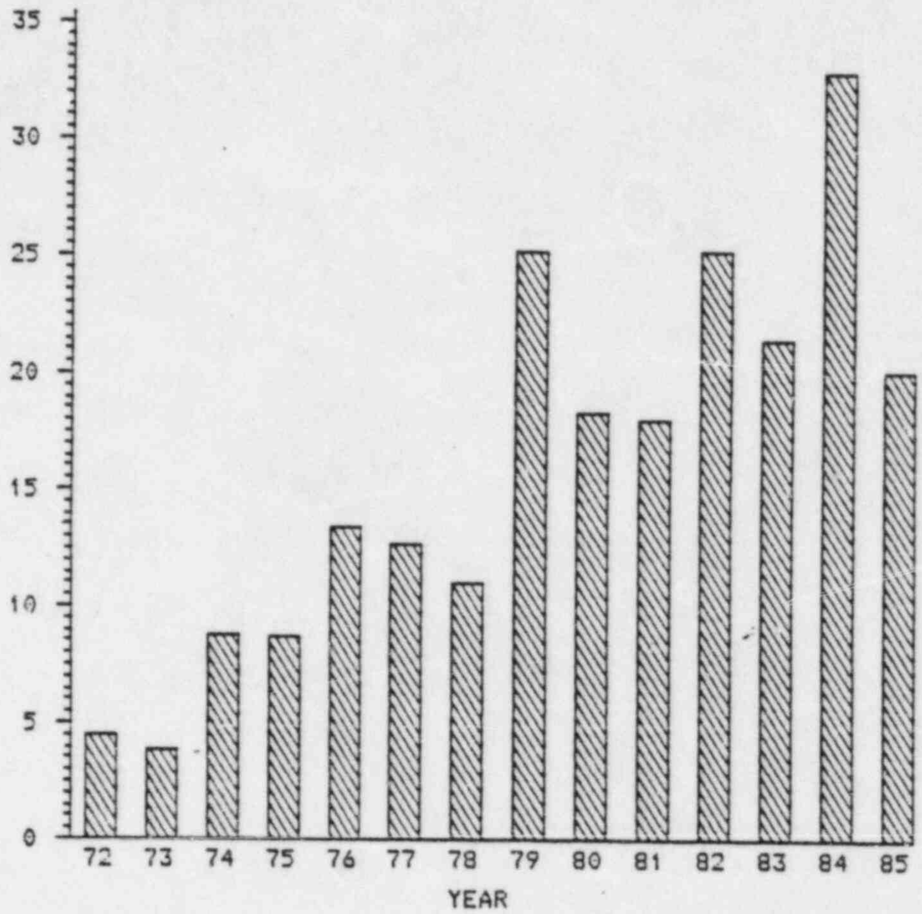

Figure 3. Western Lake Erie fishable walleye population (Age 2 and older fish) in millions of fish.

White Bass

The yearling index was the lowest recorded value. Adult indices are up from last year but still remain less than those observed from 1978 to 1982. Much of the present population consists of individuals from the 1982 (56%) and 1981 (32%) year classes (Table 8).

Size of Yearling and Adult Fish

Lakewide fall survey data is used to determine the size and weight for yearlings and adults of the major fish species.

Walleye

A decline in the growth rates of immature walleyes has continued. Age 1 and age 2 fish were significantly smaller in 1984 than in previous years (Figure 4). This is not true for older, sexually mature walleyes. Inter-basin growth differences were also apparent in 1984, age 1 through age 3 walleyes are significantly smaller in District I as opposed to District II in both length and weight (Table 9).

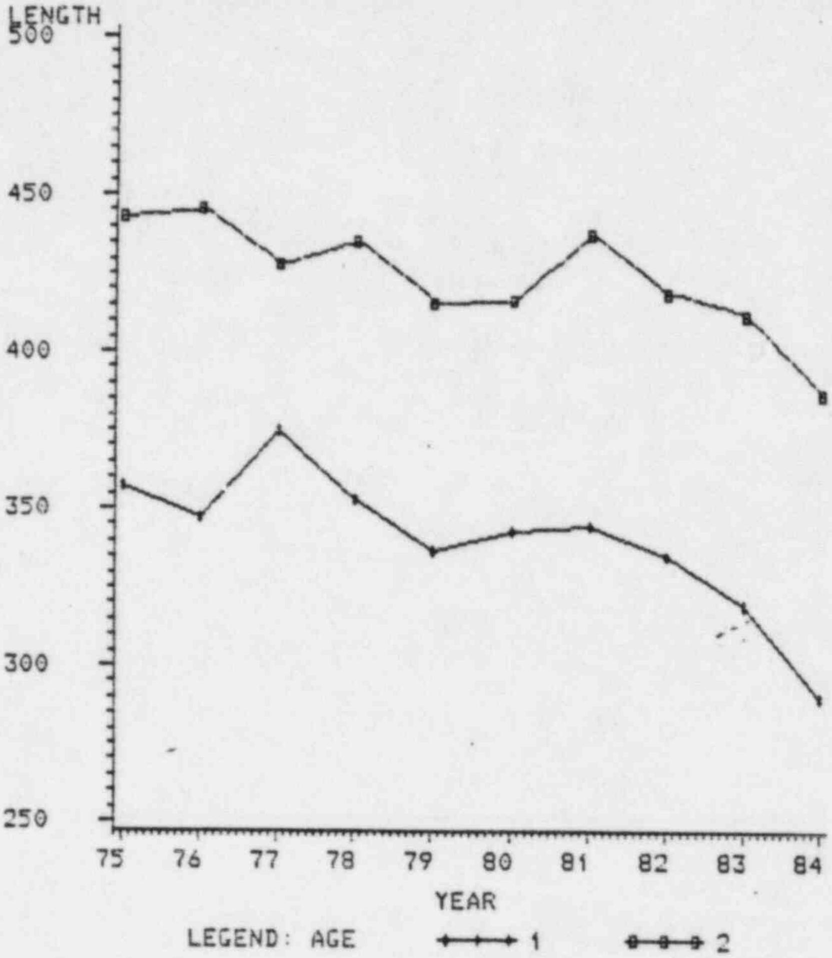

Figure 4. Western Lake Erie walleye growth (mm) for Age 1 and 2 fish.

Yellow Perch

Adult yellow perch growth rates were slightly higher in 1984 than in 1983. Limited data suggests growth of yearling perch decreased in 1984. Interbasin growth differences continue with central basin fish (Districts II and III) being larger than western basin fish (District I) at respective ages (Table 10).

White Bass

Growth rates were similar to those of 1983 at age. Interbasin growth differences were not apparent (Table 11).

COMMERCIAL AND SPORT HARVESTS - 1984

The Ohio Lake Erie fish harvest in 1984 was 11.2 million pounds. The sport harvest was 7.8 million pounds and the commercial harvest 3.3 million pounds. The sport harvest was composed primarily of yellow perch and walleye, while the commercial harvest was mostly white bass, freshwater drum and "other" species (Table 12).

Commercial Fish Harvests

Ohio's 1984 commercial fish harvest of 3.3 million pounds was a 16% reduction from the 3.9 million pounds harvested in 1983. Total annual commercial harvest by species for the period 1980-1984 is presented in Table 13.

Yellow Perch

The 1984 yellow perch commercial landings of only 40,055 pounds was primarily by western basin trap nets. There was a complete closure on Ohio's commercial gill net fishery in 1984. Restrictive rehabilitative regulations during the past several years had previously reduced the commercial landings from 2.8 million pounds in 1980 to 266,156 pounds in 1983.

White Bass

The 949 thousand pounds of white bass landed in 1984 was a 15% increase over the 828 thousand pounds landed in 1983. Although spring trap net catch rates have increased in recent years, the annual harvest remains well below the 1980 harvest of 1.5 million pounds when the commercial size limit was increased from 9 to 11 inches. Seasonal harvests of white bass have a pronounced influence on market prices.

Channel Catfish

Ohio's commercial harvest of 303 thousand pounds of channel catfish was the highest since a 1973 regulation which increased the minimum size limit from 14 to 15-1/2 inches. The 1984 spring catch rates were the highest recorded since 1973.

White Perch

The commercial harvest of 131 thousand pounds of white perch in 1984 was a 17% increase over the 112 thousand pounds landed in 1983. Annual harvests of white perch have continued to increase since the 200 pounds first recorded in 1980. Future harvest will increase due to abundance levels and development of wholesale markets.

Rough Species

Carp, freshwater drum, and gizzard shad continue to be a major portion of the annual commercial harvest, comprising 50% of the 1984 commercial harvest.

Sport Fish Harvests

The sport harvest of 4.1 million walleye was the highest in the ten years that catches have been measured. White bass, smallmouth bass, freshwater drum, and channel catfish harvests were the lowest for the same time series. Although the yellow perch sport harvest nearly doubled from 5.1 million in 1983 to 9.5 million in 1984, it still remained slightly below previous annual harvests. The white perch harvest of 140 thousand increased 300% over the 1983 harvest (Table 14).

Distribution of Harvest

Nearly 95% of the lakewide harvest was yellow perch and walleye, with boat anglers harvesting 97% of the catch. The western basin catch was nearly 70% of the lakewide catch. Yellow perch, walleye, white bass, white perch, freshwater drum, channel catfish, and smallmouth bass were harvested in descending order. Yellow perch, freshwater drum, and white perch were predominant in the shoreline catches (Table 15).

Sport Angler Effort

Total angler effort was approximately 10.6 million hours (Table 16). Central basin effort increased to over 3.5 million hours due to the excellent walleye fishery. Angler effort was greatest in June and July during the peak of the walleye fishery (Table 17).

Sport Angler Success

The sport angler success (catch rates) for yellow perch and walleye was greatest in the western basin (District I); for white bass, the central basin (District II); and for smallmouth bass, central basin (District III) boat anglers (Table 18).

Ages and Size of Harvest

Biological sampling of angler creels reflects acceptable sizes for the Lake Erie fishery (Tables 19-23). Ninety percent or better of all yellow perch, walleye, white bass, and smallmouth bass harvested during 1984 were ages 2 through 4. The predominant size ranges of these sport harvested fish were yellow perch 7 to 10 inches, walleye 13 to 19 inches, white bass 10 to 13 inches, and smallmouth bass 12 to 16 inches. The sport angler harvest of white perch was dominated by ages 1 through age 3 at 6 to 8 inches.

Sport Harvest Trends of Major Species (1975-1984)

Yellow Perch

The sport harvest of 9.5 million yellow perch in 1984 was an improvement over the 5.4 million harvested in 1983. Previous to the low 1983 harvest there was a rather stable six-year period (1977-1982) when harvests averaged nearly 12.1 million fish and ranged narrowly from 10.4 to 15.7 million fish (Figure 5). Although the 1984 annual catch rates and harvests were the highest recorded, the angler effort for perch was the lowest recorded (Table 24). These data suggest a shift in angler preference to the increasingly available walleye.

Walleye

A record 4.1 million walleye were harvested from Ohio Lake Erie waters in 1984. Annual walleye harvests have rapidly increased from 112 thousand fish in 1975 to 2.2 million fish in 1977 (Figure 6). Annual harvests since 1978 have ranged from 1.7 million to the record 4.1 million in 1984. Central basin harvest (Figure 7), effort, and catch rates have increased dramatically over the past two years (Table 25).

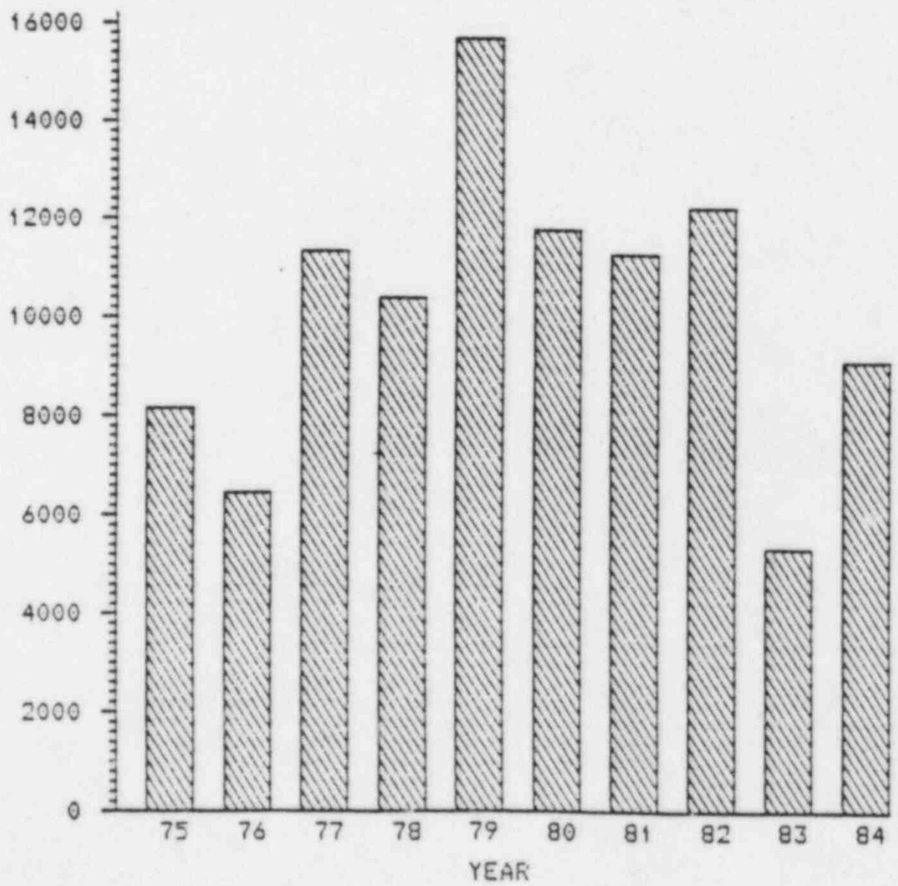

Figure 5. Lake Erie sport harvest of yellow perch, 1975-1984, in thousands of fish.

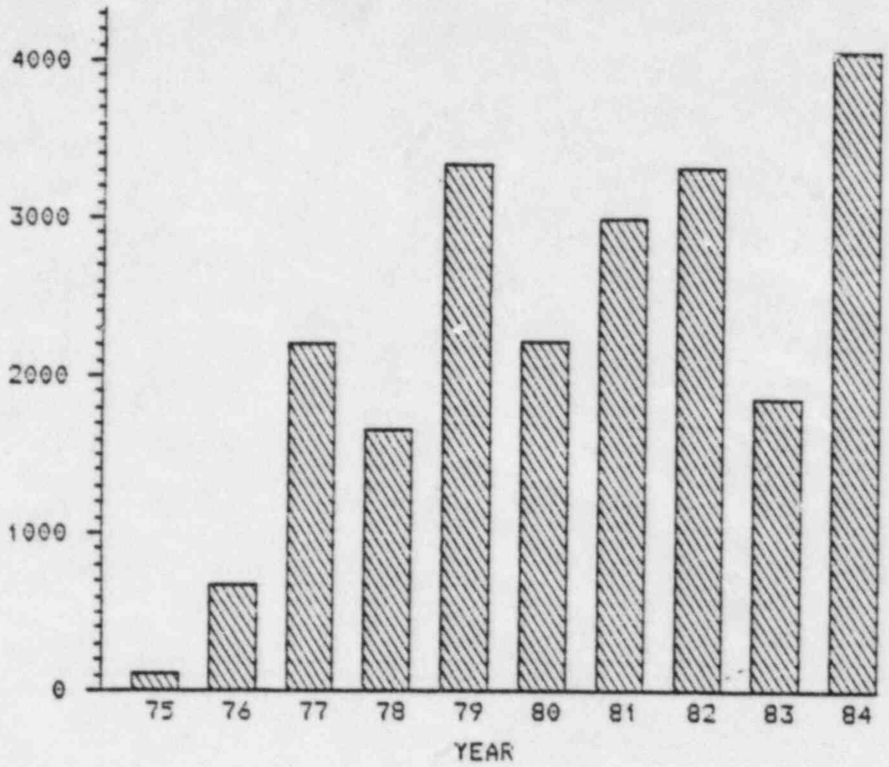

Figure 6. Lake Erie sport harvest of walleye, 1975-1984, in thousands of fish.

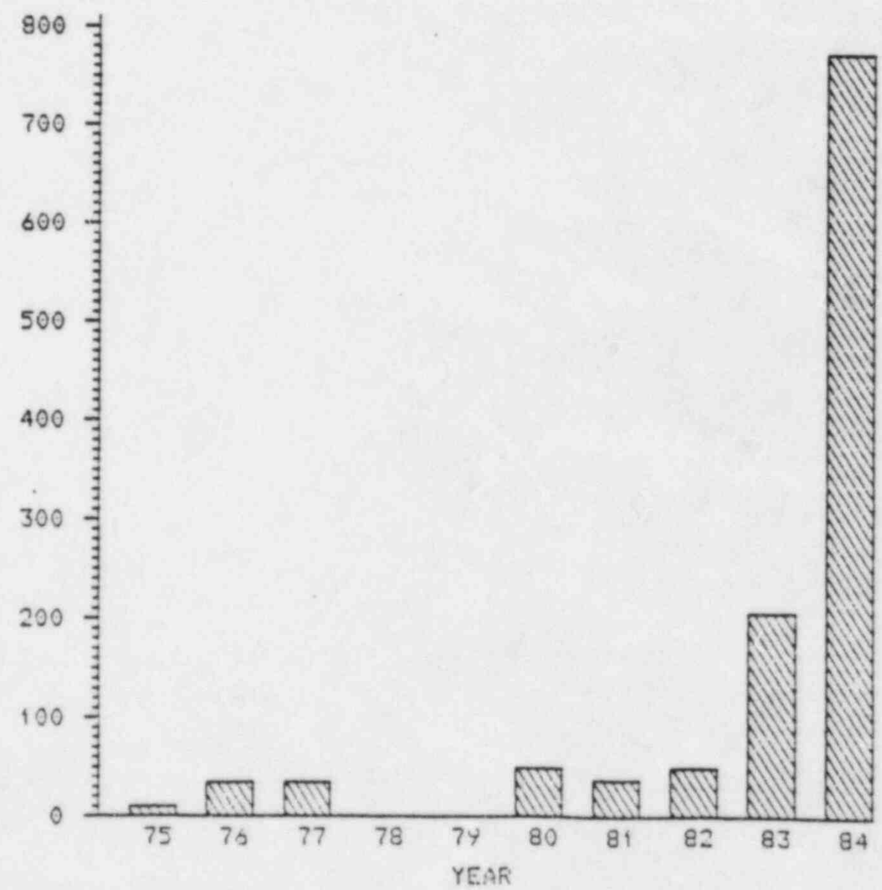

Figure 7. Sport angler harvest of walleye from Huron to Fairport, Ohio, 1975-1984, in thousands of fish.

White Bass

The harvest of less than 750 thousand white bass in 1984 was a decrease from the record harvest of 2.8 million in 1982 and 1.7 million in 1983. Angler hours seeking white bass have declined from the high of 1 million angler hours in 1982 to 340 thousand hours in 1984 while catch rates declined to less than two fish per angler hour in 1984 (Table 26).

Smallmouth Bass

The 1984 harvest of 32 thousand smallmouth bass was one of the lowest annual harvests recorded. This low harvest was due in part to adverse spring weather conditions. Angler efforts from 1975 to 1984 in the western basin have ranged widely from 18 to 141 thousand hours. The 1984 effort at 75 thousand hours was near the annual average during the past ten-year period (Table 27).

Table 1. Young-of-the-year per trawling hour, Ohio's western Lake Erie and Sandusky Bay (summer trawling June through August).

Year	Walleye	Yellow perch	White bass	Freshwater drum	Spottail shiner	Gizzard shad	Alewife	White perch
1970	44	1,038	2,180	207	511	788	350	--
1971	3	499	713	163	1,145	6,607	2,744	--
1972	70	764	938	244	320	1,825	586	--
1973	15	312	1,097	274	571	9,313	6,165	--
1974	81	2,507	1,504	172	586	11,013	5,192	--
1975	30	238	2,907	994	270	2,252	142	--
1976	7	242	1,746	286	387	3,880	2,626	--
1977	270	1,777	3,548	716	866	5,049	54	--
1978	10	67	1,314	530	573	11,512	1,584	--
1979	67	548	781	4,088	1,051	10,770	591	--
1980	200	1,870	6,788	876	179	7,632	193	--
1981	60	624	7,754	417	398	18,146	293	--
1982	260	1,365	1,270	207	329	2,554	5	--
1983	<1	28	671	301	114	6,540	356	606
1984	71	1,780	4,516	91	61	10,305	361	276

Table 2. Fall young-of-the-year yellow perch indices (number per hour trawling).

Year	District I	District II	District III
1970	464	124	32
1971	220	44	196
1972	212	4	< 4
1973	20	80	20
1974	32	52	8
1975	300	72	12
1976	42	103	4
1977	741	717	22
1978	113	13	1
1979	1070	174	155
1980	834	137	158
1981	181	404	50
1982	1122	320	62
1983	7	1	1
1984	157	145	48

Table 3. Fall young-of-the-year white bass indices (number per hour trawling).

Year	District I	District II	District III
1970	360	112	128
1971	180	68	176
1972	92	24	<4
1973	8	108	168
1974	20	40	<4
1975	20	28	32
1976	19	28	60
1977	51	38	106
1978	24	66	30
1979	74	22	31
1980	62	65	143
1981	59	34	47
1982	12	148	263
1983	5	3	3
1984	15	45	170

Table 4. Fall emerald shiner abundance (number per hour trawling).

Age Group	Year	District I	District II	District III	Lakewide
Young-of-the-year	1970	244	2,468	220	792
	1971	1,796	12,696	1,880	4,664
	1972	324	112	0	160
	1973	1,984	1,168	116	1,216
	1974	2,480	196	772	1,340
	1975	124	28	476	196
	1976	50	181	70	96
	1977	7,482	316	677	3,298
	1978	26	458	598	346
	1979	24	117	4,037	1,184
	1980	64	60	333	112
	1981	173	513	1,099	607
	1982	534	29	9	216
	1983	282	15	13	116
	1984	7	2	7	5
Yearling and Adult	1970	2,740	3,820	364	2,220
	1971	608	6,044	2,932	2,736
	1972	488	84	128	256
	1973	200	3,512	1,520	1,520
	1974	484	516	1,364	744
	1975	416	364	2,524	1,004
	1976	30	153	293	149
	1977	478	61	728	441
	1978	18	513	893	450
	1979	6	93	165	79
	1980	59	60	137	81
	1981	57	13	128	66
	1982	38	7	7	19
	1983	44	7	32	29
	1984	1	1	1	1

Table 5. Fall spottail shiner abundance (number per hour trawling).

Age Group	Year	District I	District II	District III	Lakewide
Young-of-the-year	1970	452	16	388	320
	1971	856	1,052	220	712
	1972	68	0	0	24
	1973	1,068	140	1,000	784
	1974	296	32	192	192
	1975	244	12	44	120
	1976	126	102	139	122
	1977	562	61	1,439	702
	1978	131	1	108	80
	1979	22	53	453	153
	1980	60	54	230	108
	1981	281	426	57	254
	1982	457	6	3	178
	1983	29	1	5	13
	1984	138	0	50	64
Yearling and Adult	1970	244	116	556	316
	1971	156	304	260	228
	1972	536	<4	20	212
	1973	228	116	88	152
	1974	116	80	304	204
	1975	564	196	48	308
	1976	58	25	35	41
	1977	128	62	279	158
	1978	61	174	264	160
	1979	174	72	370	192
	1980	53	23	131	66
	1981	159	194	98	150
	1982	84	50	149	101
	1983	44	8	47	34
	1984	25	0	6	10

Table 6. Fall walleye bottom gill net catches for Ohio's western basin (number per standard gill net survey).

Survey Year	Age Group I	II	III	IV	V	VI	VII	VIII	IX	Total
1973	127	36	63	12	2	2	1	--	--	243
1974	129	45	7	22	3	1	--	--	--	207
1975	269	44	24	5	11	3	--	--	--	356
1976	112	69	12	18	1	14	1	--	--	227
1977	21	171	45	8	4	--	7	--	--	256
1978	362	10	81	29	1	7	2	3	--	495
1979	85	109	7	36	11	2	--	--	--	250
1980	120	89	85	8	9	2	1	--	--	314
1981	64	28	25	17	3	2	--	--	1	140
1982	68	78	22	10	20	1	2	1	--	202
1983	82	22	28	11	9	4	1	--	1	158
1984	12	370	24	16	7	7	5	1	--	442

Table 7. Fall trawling indices of Ohio's Lake Erie yellow perch population (number per hour trawling).

Survey Year	Age Group I	II	III	IV	V	VI	VII	Age II-V+
District I								
1973	36	140	32	0	0	0	0	172
1974	20	140	152	8	0	0	0	300
1975	248	36	164	8	0	0	0	208
1976	291	200	70	36	9	0	0	315
1977	38	192	67	4	9	0	0	272
1978	706	62	143	92	21	0	0	318
1979	91	521	110	13	5	0	0	649
1980	246	34	117	18	12	1	0	184
1981	200	79	49	55	6	1	0	190
1982	31	44	20	13	5	0	0	82
1983	65	51	101	37	17	2	0	208
1984	7	147	71	71	9	3	0	301
District II								
1973	52	44	9	3	0	0	0	56
1974	76	40	40	4	0	0	0	84
1975	124	44	48	4	0	0	0	261
1976	232	119	35	11	0	0	0	165
1977	46	70	22	5	0	0	0	97
1978	1118	181	68	14	2	0	0	265
1979	32	111	11	2	0	0	0	124
1980	85	5	3	0	0	0	0	8
1981	538	205	32	25	6	0	0	268
1982	126	117	25	8	0	0	0	150
1983	98	102	124	30	5	0	0	261
1984	14	180	56	29	4	0	1	270
District III								
1973	12	80	5	3	8	0	0	96
1974	32	8	4	0	0	0	0	12
1975	120	64	8	4	0	0	0	76
1976	35	14	4	2	0	0	0	20
1977	39	30	4	2	1	0	0	37
1978	83	73	2	1	0	0	0	76
1979	19	55	4	1	0	0	0	60
1980	19	3	1	1	0	0	0	5
1981	137	20	4	1	0	0	0	25
1982	64	59	5	0	0	0	0	64
1983	67	17	8	1	0	0	0	26
1984	3	36	9	6	1	0	0	52

Table 8. Fall bottom gill net indices of Ohio's western basin white bass population (number per standard gill net survey).

Survey Year	Age Group I	II	III	IV	V	VI	VII	VIII	IX	Total
1973	13	75	48	15	4	1	--	--	--	156
1974	20	5	58	47	17	4	2	--	--	153
1975	58	20	1	28	11	1	--	--	--	119
1976	35	90	16	6	13	5	--	1	--	166
1977	51	16	8	1	--	--	--	--	--	76
1978	422	22	2	4	8	--	1	--	--	459
1979	58	131	12	3	--	--	--	--	--	204
1980	80	68	54	1	1	2	--	--	--	206
1981	143	28	14	6	2	--	--	--	--	193
1982	95	107	4	3	1	--	--	--	--	210
1983	33	29	10	1	--	1	--	--	--	74
1984	5	95	54	12	2	2	--	--	--	170

Table 9. Mean length (mm) and weight (g) of all walleyes collected during October 1984 gill net surveys.

District I

Sex		Age Group I	II	III	IV	V	VI	VII	VIII
male	length	286	379	448	493	526	537	559	--
	weight	222	530	913	1252	1533	1624	1993	--
	N	9	397	32	24	8	6	2	
female	length	293	397	485	537	564	617	655	620
	weight	238	594	1126	1602	1846	2499	2967	2910
	N	12	278	22	21	5	5	5	1
combined	length	290	386	463	513	540	573	628	620
	weight	231	556	1000	1416	1653	2022	2689	2910
	N	21	675	54	45	13	11	7	1

District II

Sex		Age Group I	II	III	IV	V	VI	VII	VIII
male	length	324	392	449	497	545	610	--	--
	weight	289	584	927	1351	1682	2090	--	--
	N	3	210	12	14	2	1		
female	length	300	411	497	531	585	605	--	--
	weight	270	666	1245	1511	2246	2515	--	--
	N	2	246	24	13	1	1		
combined	length	314	402	481	513	558	608	--	--
	weight	281	628	1139	1428	1870	2303	--	--
	N	5	456	36	27	3	2		

Table 10. Mean length (mm) and weight (g) of yellow perch collected during October 1984 trawling surveys.

District I

Sex		Age Group I	II	III	IV	V	VI	VII
male	length	128	157	175	186	193	190	--
	weight	20	44	64	77	79	79	--
	N	3	35	25	21	2	1	
female	length	120	163	183	197	196	--	--
	weight	20	50	74	90	94	--	--
	N	2	34	19	23	3		
combined	length	122	160	178	192	195	190	--
	weight	20	47	68	84	88	79	--
	N	5	69	44	44	5	1	

District II

Sex		Age Group I	II	III	IV	V	VI	VII
male	length	124	175	197	205	221	--	--
	weight	20	65	97	108	143	--	--
	N	7	142	47	29	3		
female	length	123	184	207	215	202	--	354
	weight	22	77	109	117	98	--	620
	N	10	120	32	10	1	--	1
combined	length	123	179	201	207	216	--	354
	weight	21	71	102	110	132	--	620
	N	17	262	79	39	2	--	1

District III

Sex		Age Group I	II	III	IV	V	VI	VII
male	length	125	178	200	220	231	--	--
	weight	24	77	107	142	170	--	--
	N	2	22	4	4	1		
female	length	144	191	221	240	--	--	--
	weight	33	87	151	202	--	--	--
	N	1	14	5	2			
combined	length	131	183	212	226	231	--	--
	weight	27	81	129	162	170	--	--
	N	3	36	9	6	1		

Table 11. Mean length (mm) and weight (g) of white bass collected in gill nets during October 1984.

District I

Sex		Age Group I	II	III	IV	V	VI
male	length	261	293	315	322	358	348
	weight	248	360	475	482	671	518
	N	3	58	45	5	3	1
female	length	264	306	331	355	366	372
	weight	264	407	561	703	765	766
	N	3	67	58	16	2	1
combined	length	263	300	324	347	361	360
	weight	256	385	524	650	708	642
	N	6	125	103	21	5	2

District II

Sex		Age Group I	II	III	IV	V	VI
male	length	256	297	316	343	--	--
	weight	220	382	476	611	--	--
	N	1	24	19	2	--	--
female	length	--	309	331	--	382	--
	weight	--	445	569	--	582	--
	N	--	15	27	--	1	--
combined	length	256	302	325	343	382	--
	weight	220	406	531	611	882	--
	N	1	39	46	2	1	--

Table 12. Total 1984 Ohio Lake Erie sport and commercial harvests of major species.

Species	Sport Numbers	Sport Pounds	Commercial Pounds	Total Pounds
Walleye	4,087,618	4,634,267	--	4,634,267
Yellow Perch	9,494,236	2,325,483	40,055	2,365,538
White Bass	746,515	488,630	948,946	1,437,576
Channel Catfish	76,994	77,792	302,967	380,759
Smallmouth Bass	31,770	48,697	--	48,697
Freshwater Drum	169,636	232,643	583,446	816,089
White Perch	139,952	29,942	131,413	161,355
Other	--	--	1,330,156	1,330,156
Total Pounds		7,837,454	3,336,983	11,174,437

Table 13. Ohio Lake Erie commercial fish landings, 1980-1984 (thousands of pounds).

Species	1980	1981	1981	1983	1984
Buffalo	29	32	35	44	59
Bullhead	51	100	63	64	66
Carp	1,369	2,047	903	927	800
Catfish	253	263	217	213	303
Freshwater Drum	904	1,051	745	870	583
Gizzard Shad	487	25	162	499	272
Goldfish	83	7	11	13	7
Quillback	80	96	113	99	108
Suckers	33	39	42	50	20
White Bass	1,571	1,035	608	828	949
White Perch	<1	3	27	112	131
Yellow Perch	2,785	1,995	245	266	40
Total	7,646	6,693	3,172	3,987	3,337

Table 14. Total Lake Erie sport angler harvest (thousands of fish), 1975-1984.

Year	Yellow perch	Walleye	White Bass	Smallmouth bass	Freshwater drum	Channel catfish	White perch
1975	8,151	112	2,008	39	990	226	--
1976	6,410	671	1,121	33	576	241	--
1977	11,194	2,201	1,510	25	458	171	--
1978	10,403	1,652[a]	--	--	--	--	--
1979	15,679	3,351[a]	--	--	--	--	--
1980	11,806	2,213	730	39	393	245	--
1981	10,935	2,995	1,499	41	419	130	--
1982	12,449	3,329	2,861	87	330	190	44
1983	5,390	1,866[b]	1,725	72	311	98	43
1984	9,494	4,088	747	32	181	87	140

[a]Estimates for walleye do not include central basin catch.

[b]Estimates for walleye and white bass do not include spring river fishery.

Table 15. Lake Erie sport harvest of major species (in numbers), May through October, 1984.[a]

Species	District	Boat (numbers)	Shore (numbers)	Total (numbers)
Yellow perch	I	6,042,100	223,677	6,265,777
	II	2,522,304	83,564	2,605,868
	III	266,283	15,893	282,176
Walleye	I	2,710,454	3,428	2,713,882
	II	764,320	10,160	774,480
	III	173,056	2,763	175,819
White bass	I	167,382	10,771	178,153
	II	84,937	31,471	116,408
	III	15,082	2,227	17,309
Smallmouth bass	I	12,202	754	12,956
	II	3,468	346	3,814
	III	7,907	1,019	8,926
Freshwater drum	I	39,614	23,246	62,860
	II	25,070	61,997	87,067
	III	11,104	8,605	19,709
Channel catfish	I	46,429	16,150	62,579
	II	7,898	4,048	11,946
	III	1,865	604	2,469
White perch	I	53,644	17,395	71,039
	II	18,101	22,318	40,419
	III	5,239	3,096	8,335

[a]River and charter harvests not included.

Table 16. Angler hour estimates for the Lake Erie sport fisheries, 1975-1984.

Year	Ice	Rivers	Districts I	II	III	Charter	Total
1975	11,877	382,876	3,748,582	2,541,769	628,627	53,000	7,366,731
1976	48,431	302,973	4,440,032	1,567,203	416,911	53,000	6,828,550
1977	72,719	341,025	6,426,413	1,560,752	503,394	124,000	9,028,303
1978	--[b]	188,334[a]	3,536,000[a]	--[b]	--[b]	163,000	--
1979	--[b]	279,195[a]	5,282,329[a]	--[b]	--[b]	218,000	--
1980	--[b]	330,714	7,790,280	1,739,280	756,289	250,000	10,866,563
1981	--[b]	564,563	9,583,247	1,252,749	901,127	402,000	12,703,686
1982	--[b]	622,415	9,487,110	2,208,701	566,752	563,818	13,448,796
1983	--[b]	--[b]	6,520,288	2,256,939	496,621	561,597	9,835,445
1984	--[b]	415,000	5,817,714	2,821,851	793,559	718,686	10,566,810

[a]Western basin walleye estimates only.

[b]No survey.

Table 17. Lake sport angler hours by statistical district, angler type and month during May through October, 1984.

Month	District I		District II		District III		Totals
	Boat	Shore	Boat	Shore	Boat	Shore	
May	348,533	38,749	79,732	44,511	24,608	6,710	542,843
June	1,573,219	56,220	369,003	104,270	155,057	29,286	2,287,055
July	1,849,279	58,295	883,519	125,891	157,793	25,174	3,099,951
August	838,518	48,620	392,063	82,530	148,797	15,759	1,526,287
September	542,610	47,580	345,389	72,438	125,379	25,957	1,159,353
October	383,986	32,105	274,869	47,636	64,633	14,406	817,635
Subtotals	5,536,145	281,569	2,344,575	477,276	676,267	117,292	9,433,124
Totals	5,817,714		2,821,851		793,559		

Table 18. Angler hours seeking and catch rates by statistical district and angler type for yellow perch, walleye, white bass and smallmouth bass, 1984.

Species		District I		District II		District III		Totals
		Boat	Shore	Boat	Shore	Boat	Shore	
Yellow perch	Angler hours seeking	985,607	173,992	726,839	167,270	120,568	29,034	2,203,310
	Catch rate	6.18	1.33	3.64	0.37	1.96	0.65	
Walleye	Angler hours seeking	4,301,773	5,461	1,500,998	59,038	453,942	9,641	6,330,853
	Catch rate	0.62	0.02	0.45	0.08	0.37	0.21	
White bass	Angler hours seeking	40,724	5,842	52,943	36,245	7,360	1,702	144,816
	Catch rate	1.43	0.56	1.50	0.55	0.63	1.71	
Smallmouth bass	Angler hours seeking	74,525	520	2,681	581	16,318	4,471	99,096
	Catch rate	0.12	--	--	--	0.24	0.20	

Table 19. Yellow perch lake harvest, percent age composition, and mean weight, length and age by statistical district, 1984.

Lake Fishery		Age Group								Total	Weight (grams)	Length (mm)	Age	N
		I	II	III	IV	V	VI	VII	VIII					
District I	(No.)	13,398	1,356,055	2,601,386	2,073,160	171,275	17,144	32,714	645	6,265,777	95	192	3.7	766
	(%)	0.2	21.6	41.5	33.1	2.7	0.3	0.5	0.01					
	length (mm)	165	181	196	197	202	228	245	235					
District II	(No.)	--	770,101	963,247	706,242	127,774	5,446	33,058	--	2,605,868	143	218	3.2	737
	(%)		29.6	37.0	27.1	4.9	.2	1.3						
	length (mm)		204	220	229	259	295	314						
District III	(No.)	--	84,541	84,776	84,938	22,040	410	802	4,669	282,176	154	225	3.3	256
	(%)		30.0	30.0	30.1	7.8	.1	.3	.2					
	length (mm)		205	235	255	265	275	335	305					
Total	(No.)	13,398	2,210,697	3,649,409	2,864,340	321,089	23,000	66,574	5,314	9,153,821	110	200	3.6	1,759
	(%)	0.1	24.2	40.0	31.3	3.5	0.3	0.7	0.1					

Table 21. White bass lake harvest, percent age composition, and mean weight, length, and age by statistical district, 1984.

Fishery		I	II	III	IV	V	VI	VII	Total	Weight (grams)	Length (mm)	Age	N
River													
Maumee	(No.)		44,378	64,102	21,702	2,961	1,974	1,974	137,091	337	282	3.0	139
	(%)		32.4	46.8	15.8	2.2	1.4	1.4					
	length (mm)		249	293	325	355	370	355					
Sandusky	(No.)	1,974	143,023	113,200	17,880	--	1,974		278,051	279	267	2.6	140
	(%)	0.7	51.4	40.7	6.4		0.7						
	length (mm)		256	293	324		355						
Subtotal	(No.)	1,974	187,401	177,302	39,582	2,961	3,948	1,974	415,142	298	272	2.7	279
	(%)	0.5	45.1	42.7	9.5	0.7	1.0	0.5					
Lake													
District I	(No.)	375	37,189	117,512	21,441	--	818	818	178,153	327	283	2.9	256
	(%)	0.2	20.9	65.7	12.0		0.5	0.5					
	length (mm)	275	269	292	322		355	425					
District II	(No.)	--	45,573	63,345	6,180	1,310	--	--	116,408	246	268	2.7	137
	(%)		39.2	54.4	5.3	1.1							
	length (mm)		269	294	342	365							
District III	(No.)	411	7,476	7,375	1,817	--	165	115	17,309	307	278	2.7	162
	(%)	2.4	43.2	42.6	10.5		0.7	0.7					
	length (mm)	235	253	291	339		315	375					
Subtotal	(No.)	786	90,238	188,232	29,438	1,310	933	933	311,870	296	277	2.8	555
	(%)	0.3	28.9	60.4	9.4	0.4	0.3	0.3					
Total	(No.)	2,760	277,639	365,534	69,020	4,271	4,881	2,907	727,012				
	(%)	0.4	38.2	50.2	9.5	0.6	0.7	0.4					

Table 22. Smallmouth bass lake harvest, percent age composition, and mean weight, length, and age by statistical district, 1984.

Lake Fishery		II	III	IV	V	VI	VII	VIII	IX	Total	Weight (grams)	Length (mm)	Age	N
District I	(No.)	1,591	4,288	3,841	1,395	595	673	280	293	12,956	691	333	4.0	130
	(%)	12.3	33.1	29.7	10.8	4.6	5.2	2.2	2.3					
	length (mm)	269	304	349	380	399	413	440	475					
District II	(No.)	327	714	1,476	611	549	86	51	--	3,814	534	311	4.2	43
	(%)	8.6	18.8	38.7	16.0	14.4	2.3	1.3						
	length (mm)	265	307	344	387	412	428	440						
District III	(No.)	990	1,880	3,384	1,362	1,057	152	101	--	8,926	680	331	4.1	102
	(%)	11.1	21.1	37.9	15.3	11.8	1.7	1.1						
	length (mm)	265	307	344	387	412	428	440						
Total	(No.)	2,908	6,882	8,701	3,368	2,201	911	432	293	25,696	664	329	4.0	275
	(%)	11.3	26.8	33.9	13.1	8.6	3.5	1.7	1.1					

Table 20. Walleye lake harvest, percent age composition, and mean weight, length and age by statistical district, 1984.

Fishery		Age Group I	II	III	IV	V	VI	VII	VIII	IX	X	Total	Weight (grams)	Length (mm)	Age	N
River																
Maumee	(No.)		1,477	8,420	10,224	3,534	1,579	2,092	548	925	--	20,899	989	457	4.3	407
	(%)		5.1	29.1	35.4	12.2	5.5	7.2	2.2	3.2						
	length (mm)		340	410	475	532	542	596	619	670						
Sandusky	(No.)		1,427	1,035	534	307	159	208	-	70	--	3,740	688	399	3.4	243
	(%)		38.2	27.7	14.3	8.2	4.3	5.6		1.9						
	length (mm)		354	411	468	528	577	618		664						
Subtotal	(No.)		2,904	9,455	10,758	3,841	1,738	2,300	648	995	--	32,639	955	485	4.2	650
	(%)		8.9	29.0	33.0	11.8	5.3	7.0	2.0	3.0						
Lake																
District I	(No.)	37,835	1,823,100	368,734	267,098	96,718	45,439	55,084	17,069	2,805	--	2,713,882	485	362	2.6	892
	(%)	1.4	67.2	13.6	9.8	3.6	1.7	2.0	0.6	0.1						
	length (mm)	306	330	416	463	538	585	552	610	705						
District II	(No.)	909	556,314	73,237	92,689	20,549	9,044	12,372	4,283	5,083	--	774,480	506	369	2.6	489
	(%)	0.1	71.8	9.5	12.0	2.7	1.2	1.6	0.6	0.7						
	length (mm)	325	340	443	497	557	565	615	675	695						
District III	(No.)		130,693	12,703	14,244	7,024	1,966	7,198	264	1,288	439	175,819	473	360	2.7	415
	(%)		74.3	7.2	8.1	4.0	1.1	4.1	0.2	0.7	0.2					
	length (mm)		342	438	484	569	611	632	675	685	705					
Subtotal	(No.)	38,744	2,510,107	454,674	374,031	124,291	56,449	74,654	21,616	9,176	439	3,664,181	489	363	2.6	1,796
	(%)	1.1	68.5	12.4	10.2	3.4	1.5	2.0	0.6	0.3	0.01					
Total	(No.)	38,744	2,513,011	464,129	384,789	128,132	58,187	76,954	22,264	10,171	439	3,696,820				
	(%)	1.0	68.0	12.6	10.4	3.5	1.6	12.1	0.6	0.3	0.01					

Table 23. White perch summer lake harvest, percent age composition, and mean weight, length, and age by statistical district, 1984.

Fishery		Age Group I	II	III	IV	V	Total	Weight (grams)	Length (mm)	Age	N
River											
Maumee	(No.)	--	1,083	509	--	--	1,592	100	188	2.3	25
	(%)		68.0	32.0							
	length (mm)		178	209							
Sandusky	(No.)	--	8,708	6,962	2,748	149	18,567	122	191	2.7	12[illegible]
	(%)		46.9	37.5	14.8	0.8					
	length (mm)		176	199	226	195					
Subtotal	(No.)		9,791	7,471	2,748	149	20,159	120	191	2.7	153
	(%)		48.6	37.1	13.6	0.7					
Lake											
District I	(No.)	13,069	50,197	7,518	150	105	71,039	94	178	1.9	358
	(%)	18.4	70.7	10.6	0.2	0.1					
	length (mm)	164	187	213	232	265					
District II	(No.)	7,760	27,317	4,852	490	--	40,419	89	175	1.9	87
	(%)	19.2	67.6	12.0	1.2						
	length (mm)	164	191	212	225						
District III	(No.)	--	5,474	2,795	66	--	8,335	112	189	2.4	87
	(%)		65.7	33.5	0.8						
	Length (mm)		182	203	255						
Subtotal	(No.)	20,829	82,988	15,165	706	105	119,793	93	178	1.9	532
	(%)	17.4	69.3	12.7	.6	0.1					
Total	(No.)	20,829	92,779	22,636	3,454	254	139,952				
	(%)	14.9	66.3	16.2	2.5	.2					

Table 24. Yellow perch sport harvest, angler effort, and catch rates by statistical district or fishery, 1975-1984.

	Year	District I	District II	District III	Charter	Total
Harvest (thousands of fish)	1975	5,571	2,057	430	93	8,151
	1976	5,271	903	175	61	6,410
	1977	9,401	1,272	364	157	11,194
	1978	8,976	1,427[a]	*a*	--	10,403
	1979	13,528	2,151[a]	*a*	--	15,679
	1980	10,476	1,122	208	--	11,806
	1981	10,100	551	284	--	10,935
	1982	9,491	2,286	451	221	12,449
	1983	4,122	1,037	113	118	5,390
	1984	6,266	2,606	282	340	9,494
Effort (thousands of hours)	1975	2,434	1,487[a]	*a*	93	4,014
	1976	1,899	888[a]	*a*	61	2,848
	1977	2,566	1,098[a]	*a*	157	3,821
	1978	--	--	--	--	--
	1979	--	--	--	--	--
	1980	2,683	914	246	--	3,843
	1981	2,676	438	236	--	3,350
	1982	3,037	1,277	309	59	4,682
	1983	1,498	740	187	41	2,466
	1984	1,160	894	150	76	2,280
Catch Rate	1975	2.6	1.8[a]	*a*	3.1	
	1976	3.5	1.6[a]	*a*	3.6	
	1977	4.5	2.0[a]	*a*	5.6	
	1978	--	--	--	--	
	1979	--	--	--	--	
	1980	4.3	1.5	.6	--	
	1981	3.8	1.7	.6	--	
	1982	3.8	2.3	1.9	3.0	
	1983	3.2	1.5	.6	2.7	
	1984	6.2	3.6	2.0	5.3	

[a]District II and III data were combined.

Table 25. Walleye sport harvest, angler effort, and catch rates by statistical district or fishery, 1975-1984.

	Year	District I	District II	District III	Charter	River	Total
Harvest (thousands of fish)	1975	70	10	1	6	25	112
	1976	588	34	2	31	16	671
	1977	2,058	35	2	87	19	2,201
	1978	1,488	--	--	132	32	1,652
	1979	3,073	--	--	236	42	3,351
	1980	1,922	49	24	175	43	2,213
	1981	2,607	38	48	239	23	2,995
	1982	2,959	49	8	272	41	3,329
	1983	1,371	208	27	260	--	1,866
	1984	2,714	775	176	391	32	4,088
Effort (thousands of angler hours)	1975	581	82	--	15	200	878
	1976	1,653	203	--	31	66	1,953
	1977	3,325	186	--	91	69	3,671
	1978	--	--	--	123	137	260
	1979	--	--	--	196	279	475
	1980	4,591	279	222	225	201	5,518
	1981	6,684	308	454	237	198	7,881
	1982	6,828	258	136	412	242	7,876
	1983	4,562	660	158	485	--	5,865
	1984	4,307	1,560	464	632	195	7,158
Catch Rate	1975	.12	.12[a]	a	.43	.14	
	1976	.32	.16[a]	a	.99	.15	
	1977	.61	.20[a]	a	.96	.15	
	1978	.44	--	--	1.07	.29	
	1979	.57	--	--	1.20	.15	
	1980	.41	.15	.08	.78	.19	
	1981	.32	.13	.10	.67	.10	
	1982	.47	.18	.07	.62	.15	
	1983	.30	.24	.13	.54	--	
	1984	.62	.45	.37	.62	.15	

[a]District II and III data were combined.

Table 26. White bass sport harvest, angler effort, and catch rates by statistical district or fishery, 1975-1984.

	Year	District I	District II	District III	Rivers	Charter	Total
Harvest (thousands of fish)	1975	214	1,405	177	170	42	2,008
	1976	219	577	26	293	6	1,121
	1977	106	1,080	43	272	9	1,510
	1978	--	--	--	--	--	--
	1979	--	--	--	--	--	--
	1980	103	377	123	127	--	730
	1981	119	887	87	406	--	1,499
	1982	429	1,985	99	337	11	2,861
	1983	751	856	82	--	36	1,725
	1984	178	117	17	415	20	747
Effort (thousands of angler hours)	1975	100	572[a]	a	120	5	797
	1976	124	271[a]	a	160	2	555
	1977	89	323[a]	a	186	--	598
	1978	--	--	--	--	--	--
	1979	--	--	--	--	--	--
	1980	51	166	61	131	--	409
	1981	10	217	21	384	--	632
	1982	25	568	84	330	10	1,017
	1983	60	250	29	--	7	346
	1984	47	89	9	195	.3	340
Catch Rate	1975	1.4	2.0[a]	a	1.4	3.8	
	1976	1.8	2.1[a]	a	1.8	2.8	
	1977	1.5	3.2[a]	a	1.5	3.4	
	1978	--	--	--	--	--	
	1979	--	--	--	--	--	
	1980	1.1	2.5	1.8	1.0	--	
	1981	2.1	6.2	2.3	1.2	--	
	1982	--	4.6	2.6	1.0	--	
	1983	2.8	4.2	2.6	--	4.7	
	1984	1.6	1.5	1.7	1.8	3.0	

[a]District II and III data were combined.

Table 27. Smallmouth bass sport harvest, angler effort, and catch rates by statistical district or fishery, 1975-1984.

	Year	District I	District II	District III	Charter	Total
Harvest (numbers of fish)	1975	14,000	9,700	10,300	5,300	39,300
	1976	27,700	1,900	1,900	1,700	33,200
	1977	15,300	3,100	4,200	2,700	25,300
	1978	--	--	--	--	--
	1979	--	--	--	--	--
	1980	13,300	4,500	19,500	1,700	39,000
	1981	12,600	4,700	20,300	3,700	41,300
	1982	64,100	3,000	16,000	4,300	87,400
	1983	45,900	6,400	13,200	6,900	72,400
	1984	13,000	3,800	8,900	6,100	31,800
Effort (angler hours)	1975	81,000	53,900[a]	a	5,300	140,200
	1976	104,500	87,900[a]	a	3,700	196,100
	1977	45,700	25,700[a]	a	2,100	73,500
	1978	--	--	--	--	--
	1979	--	--	--	--	--
	1980	33,300	6,500	20,500	2,400	62,700
	1981	17,600	7,700	69,800	2,300	97,400
	1982	105,200	9,300	20,700	21,400	156,600
	1983	140,500	5,700	24,100	12,200	182,500
	1984	75,000	3,300	20,800	10,800	109,900
Catch Rate	1975	.12	.16[a]	a	.94	
	1976	.13	.13[a]	a	.53	
	1977	.11	.05[a]	a	1.26	
	1978	--	--	--	--	
	1979	--	--	--	--	
	1980	.34	.08	.26		
	1981	.23	.10	.19	.48	
	1982	.35	.03	.25	.21	
	1983	.16	.33	.22	.40	
	1984	.12	--	.24	.38	

[a]District II and III data were combined.

EXHIBIT D

TABLE 1305-C-28 (Page 1 of 10)

SEASONAL ABUNDANCE OF BIRDS FOUND ON THE OTTAWA, CEDAR POINT, AND WEST SISTER ISLAND SECTIONS OF THE NATIONAL WILDLIFE REFUGES (52)

Common Name	Scientific Name†	Season††				Nest Locally
		Spring	Summer	Fall	Winter	
Common Loon	Gavia immer	o**		o	r	
Horned Grebe	Podiceps auritus	u		u	o	
Eared Grebe	Colymbus nigricollis	r		r		
*Pied-billed Grebe	Podilymbus podiceps	c	o	c	r	+
White Pelican	Pelecanus erythrorhynchos	r	r	r		
Double-crested Cormorant	Phalacrocorax auritus	o	o	o	r	
*Great Blue Heron	Ardea herodias	c	c	c	u	+
*Green Heron	Butorides virescens	c	c	c		+
Little Blue Heron	Florida caerulea	r	o	o		
Cattle Egret	Bubulcus ibis	u	u			+
*Great Egret	Casmerodius albus	c	c	c	x	+
Snowy Egret	Egretta thula	x	r	r		

† Names are according to A.O.U. Check-list of North American Birds (53) and the thirty-second supplement to the A.O.U. Check-list (54)

†† Spring = March-May
Summer = June-August
Fall = September-November
Winter = December-February

** a = abundant - a common species which is very numerous
c = common - certain to be seen in suitable habitat
u = uncommon - present, but not certain to be seen
o = occasional - seen only a few times during a season
r = rare - seen at intervals of 2 to 5 years
x = accidental - has been seen only once or twice
* = Observed on or over the Davis-Besse Site

Common Name	Scientific Name†	Season††				Nest Locally
		Spring	Summer	Fall	Winter	
*Black-crowned Night Heron	Nycticorax nycticorax	c†	c	c	o	+
Yellow-crowned Night Heron	Nyctanassa violacea	r	r			
*Least Bittern	Ixobrychus exilis	u	u	u	x	+
American Bittern	Botaurus lentiginosus	u	u	u	r	+
Glossy Ibis	Plegadis falcinellus	o	o			
Mute Swan	Cygnus olor	r	r	r	r	
Whistling Swan	Olor columbianus	a	x	c	o	
*Canada Goose	Branta canadensis	a	c	a	a	+
Brant	Branta bernicla	x		r		
Barnacle Goose	Branta leucopsis		x	x	x	
White-fronted Goose	Anser albifrons			x	x	
Snow Goose	Chen caerulescens	o		c	u	
Fulvous Tree Duck	Dendrocygna bicolor			x		
*Mallard	Anas platyrhynchos	a	a	a	a	+
*Black-Duck	Anas rubripes	a	c	a	a	+
*Gadwall	Anas strepera	c	u	c	r	+
*Pintail	Anas acuta	a	u	a	c	+
*American Green-winged Teal	Anas crecca carolinensis	c	u	c	o	+
*Blue-winged Teal	Anas discors	c	c	a	x	+
European Wigeon	Anas penelope	r		r	x	
*American Wigeon	Anas americana	a	u	a	o	+
*Northern Shoveler	Anas clypeata	c	u	c	r	+
*Wood Duck	Aix sponsa	c	c	a	r	+
*Redhead	Aythya americana	c	u	c	o	+
Ring-necked Duck	Aythya collaris	c	x	c	r	
*Canvasback	Aythya valisineria	a	x	a	c	
Greater Scaup	Aythya marila	u		u	r	
*Lesser Scaup	Aythya affinis	a	u	c	u	+
*Common Goldeneye	Bucephala clangula	c		c	c	
Bufflehead	Bucephala albeola	c		c	u	
Oldsquaw	Clangula hyemalis	r		r	r	
King Eider	Somateria spectabilis			x		

TABLE 1305-C-28 (Page 3 of 10)

Common Name	Scientific Name†	Season†† Spring	Summer	Fall	Winter	Nest Locally
White-winged Scoter	Scoter melanitta	o†		o	o	
Surf Scoter	Melanitta perspicillata	o		o	o	
Black Scoter	Melanitta nigra			o	r	
*Ruddy Duck	Oxiyura jamaicensis	a	u	c	u	+
Hooded Merganser	Lophodytes cucullatus	c	u	c	u	+
*Common Merganser	Mergus merganser	a	r	a	a	
Red-breasted Merganser	Mergus serrator	u		u	r	
*Turkey Vulture	Cathartes aura	c	u	u		+
Goshawk	Accipiter gentilis	r		r	r	
Sharp-shinned Hawk	Accipiter striatus	c		u	r	
*Cooper's Hawk	Accipiter cooperii	u	u	u	u	+
*Red-tailed Hawk	Buteo jamaicensis	c	c	c	c	+
Red-shouldered Hawk	Buteo lineatus	u	u	u	o	+
Broad-winged Hawk	Buteo platypterus	c		c		
Rough-legged Hawk	Buteo lagopus	u		u	c	
Golden Eagle	Aquila chrysaetos	r		r	r	
*Northern Bald Eagle	Haliaeetus leucocephalus alascanus	u	u	u	u	+
Marsh Hawk	Circus cyaneus	u	u	u	u	+
*Osprey	Pandion haliaetus	u	r	u		
Gyrfalcon	Falco rusticolus	x		x	x	
American Peregrine Falcon	Falco peregrinus	r		r	r	
Merlin	Falco columbarus	r		r	r	
*American Kestrel	Falco sparverius	c	c	c	c	+
*Bobwhite	Colinus virginianus	u	u	u	u	+
*Ring-necked Pheasant	Phasianus colchicus	c	c	c	c	+
Sandhill Crane	Grus canadensis	r		x		
King Rail	Rallus elegans	o	o	o	r	+
Virginia Rail	Rallus limicola	o	o	o	r	+
*Sora	Porzana carolina	c	u	c	r	+
Yellow Rail	Coturnicops noveboracensis	x		x		
Black Rail	Laterallus jamaicensis	x		x		+
*Common Gallinule	Gallinula chloropus	c	c	c	x	+

TABLE 1305-C-28 (Page 4 of 10)

Common Name	Scientific Name†	Season†† Spring	Summer	Fall	Winter	Nest Locally
*American Coot	*Fulica americana*	a†	c	a	u	+
Semipalmated Plover	*Charadrius semipalmatus*	c	x	c		
Piping Plover	*Charadrius melodus*	r	r	r		+
Wilson's Plover	*Charadrius wilsonia*		x			
*Killdeer	*Charadrius vociferus*	c	c	c	r	+
American Golden Plover	*Pluvialis dominica*	c	u	u		
Black-bellied Plover	*Squatarola squatarola*	c	u	u		
Ruddy Turnstone	*Arenaria interpres*	c	u	c		
*American Woodcock	*Philohela minor*	u	u	u		+
Common Snipe	*Capella gallinago*	c	c	c	r	+
Whimbrel	*Numenius phaeopus*	r	r	r		
Upland Sandpiper	*Bartramia longicauda*	u	u	u		+
*Spotted Sandpiper	*Actitis macularia*	c	c	c		+
Solitary Sandpiper	*Tringa solitaria*	c	c	c		
Willet	*Catoptrophorus semipalmatus*	r	x	r		
Greater Yellowlegs	*Tringa melanoleucus*	c	c	c		
Lesser Yellowlegs	*Tringa flavipes*	c	c	c		
Red Knot	*Calidris canutus*	u	o	o		
Pectoral Sandpiper	*Calidris melanotos*	c	c	c		
White-rumped Sandpiper	*Calidris fuscicollis*	r	r	r		
Baird's Sandpiper	*Calidris bairdii*	r	r	r	x	
Least Sandpiper	*Calidris minutilla*	c	c	c		
*Dunlin	*Calidris alpina*	a	c	a	r	
Short-billed Dowitcher	*Limnodromus griseus*	c	c	c		
Long-billed Dowitcher	*Limnodromus scolopaceus*	u	u	u		
Stilt Sandpiper	*Micropalama himantopus*	x	u	u		
Semipalmated Sandpiper	*Calidris pusillus*	a	c	c		
Western Sandpiper	*Calidris mauri*	r	r	r		
Buff-breasted Sandpiper	*Tryngites subruficollis*	r	r	r		
Marbled Godwit	*Limosa fedoa*	r	r	r		
Hudsonian Godwit	*Limosa haemastica*	x	r	r		
*Sanderling	*Crocethia alba*	o	c	c	x	
American Avocet	*Recurvirostra americana*	r		r		
Red Phalarope	*Phalaropus fulicarius*			r	x	

TABLE 1305-C-28 (Page 5 of 10)

Common Name	Scientific Name†	Season†† Spring	Summer	Fall	Winter	Nest Locally
Wilson's Phalarope	Stegenopus tricolor	o†	o	o		
Northern Phalarope	Lobipes lobatus	o	o	o	x	
Parasitic Jaeger	Stercorarius parasiticus		x	r		
Skua	Catharacta skua			x		
Glaucous Gull	Larus hyperboreus	r	x	r	r	
*Iceland Gull	Larus glaucoides			r	r	
Great Black-backed Gull	Larus marinus	c	u	c	c	
*Herring Gull	Larus argentatus	a	c	a	a	+
*Ring-billed Gull	Larus delewarensis	a	c	a	a	+
Franklin's Gull	Larus pipixcan	x	r	r	x	
Bonaparte's Gull	Larus philadelphia	c	o	a	a	
Forster's Tern	Sterna forsteri	r	o	u		
*Common Tern	Sterna hirundo	c	c	c	x	+
Least Tern	Sterna albifrons		x	x		
*Caspian Tern	Hydroprogne caspia	u	c	c		
Black Tern	Chlidonias niger	c	c	c		+
*Mourning Dove	Zenaida macroura	c	c	c	c	+
*Yellow-billed Cuckoo	Coccyzus americanus	u	u	u		+
*Black-billed Cuckoo	Coccyzus erythropthalmus	o	o	o		+
Groove-billed Ani	Crotophaga sulcirostris			x		
Barn Owl	Tyto alba	u	u	u	u	+
*Screech Owl	Otus asio	c	c	c	c	+
*Great Horned Owl	Bubo virginianus	c	c	c	c	+
Snowy Owl	Nyctea scandiaca	o		o	o	
Barred Owl	Strix varia	r	r	r	r	+
Long-eared Owl	Asio otus	o	o	o	o	+
Short-eared Owl	Asio flammeus	o		o	o	
Saw-whet Owl	Aegolius acadicus	o	x	o	r	+
Whip-poor-will	Caprimulgus vociferus	u		r		
*Common Nighthawk	Chordeiles minor	c	a	c		+
*Chimney Swift	Chaetura pelagica	c	u	a		+
*Ruby-throated Hummingbird	Archilochus colubris	u	u	u		+

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Common Name	Scientific Name†	Season††				Nest Locally
		Spring	Summer	Fall	Winter	
*Belted Kingfisher	Megaceryle alcyon	c†	c	c	o	+
*Yellow-shafted Flicker	Colaptes auratus auratus	c	c	c	u	+
Red-bellied Woodpecker	Centurus carolinus	u	u	u	u	+
*Red-headed Woodpecker	Melanerpes erythrocephalus	c	c	c	u	+
*Yellow-bellied Sapsucker	Sphyrapicus varius	c		c	r	
*Hairy Woodpecker	Dendrocopos villosus	u	u	u	u	+
*Downy Woodpecker	Dendrocopos pubescens	c	c	c	c	+
*Eastern Kingbird	Tyrannus tyrannus	c	c	c		+
Western Kingbird	Tyrannus verticalis		x	x		
*Great Crested Flycatcher	Myiarchus crinitus	c	c	c		+
*Eastern Phoebe	Sayornis phoebe	u	u	u		+
*Yellow-bellied Flycatcher	Empidonax flaviventris	u		u		
Acadian Flycatcher	Empidonax virescens	r	r	r		+
Traill's Flycatcher	Empidonax alnorum	c	c	c		+
*Least Flycatcher	Empidonax minimus	c	c	c		+
*Eastern Wood Pewee	Contopus virens	c	c	c		+
Olive-sided Flycatcher	Nuttallornis borealis	u	u	u		
Horned Lark	Eremophila alpestris	c	u	c	c	+
*Tree Swallow	Iridoprocne bicolor	c	a	a	x	+
*Bank Swallow	Riparia riparia	c	a	c		+
*Rough-winged Swallow	Stelgidopteryx ruficollis	c	c	c		+
*Barn Swallow	Hirundo rustica	c	c	c		+
*Cliff Swallow	Petrochelidon pyrrhonata	u	r	u		+
*Purple Martin	Progne subis	c	c	c		+
*Blue Jay	Cyanocitta cristata	a	c	c	c	+
Black-billed Magpie	Pica pica	x			x	
*Common Crow	Corvus brachrhynchos	c	u	c	u	+
*Black-capped Chickadee	Parus atricapillus	u		u	u	
*Tufted Titmouse	Parus bicolor	u	u	u	u	+
*White-breasted Nuthatch	Sitta carolinensis	o	o	o	o	+
Red-breasted Nuthatch	Sitta canadensis	u		u	u	

TABLE 1305-C-28 (Page 7 of 10)

Common Name	Scientific Name†	Season†† Spring	Summer	Fall	Winter	Nest Locally
*Brown Creeper	Certhia familiaris	u†		u	u	
*House Wren	Troglodytes aedon	c	c	c	x	+
*Winter Wren	Troglodytes troglodytes	u		u	u	
Bewick's Wren	Thryomanes bewickii	x	x	x	x	
*Carolina Wren	Thryothorus ludovicianus	r	r	r	r	+
*Long-billed Marsh Wren	Telmatodytes palustris	c	c	c	r	+
*Short-billed Marsh Wren	Cistothorus platensis	r	r	r	x	+
Mockingbird	Mimus polyglottos	r	r	r	r	+
*Gray Catbird	Dumetella carolinensis	c	c	c	r	+
*Brown Thrasher	Toxostoma rufum	c	c	c	r	+
*American Robin	Turdus migratorius	c	a	c	u	+
*Wood Thrush	Hylocichla mustelina	u	u	o		+
Hermit Thrush	Catharus guttata	c		c	r	
Swainson's Thrush	Catharus ustulata	c		c		
Gray-cheeked Thrush	Catharus minima	u		u		
*Veery	Catharus fuscescens	u	u	o		+
Eastern Bluebird	Siala sialis	u	u	u	r	+
*Blue-gray Gnatcatcher	Polioptila caerulea	c	u	c		+
*Golden-crowned Kinglet	Regulus satrapa	c		c	u	
*Ruby-crowned Kinglet	Regulus calendula	c		c	r	
Water Pipit	Anthus spinoletta	u		u	r	
Bohemian Waxwing	Bombycilla garrulus				x	
*Cedar Waxwing	Bombycilla cedrorum	c	u	c	u	+
Northern Shrike	Lanius excubitor	r		r	r	
Loggerhead Shrike	Lanius ludovicianus	o	o	o	r	+
*Starling	Sturnus vulgaris	a	a	a	a	+
White-eyed Vireo	Vireo griseus	c		o		
Yellow-throated Vireo	Vireo flavifrons	u	u	u		+
Solitary Vireo	Vireo solitarius	u		u		
*Red-eyed Vireo	Vireo olivaceus olivaceus	c	c	c		+
*Philadelphia Vireo	Vireo philadelphicus	u		u		
*Warbling Vireo	Vireo gilrus	c	c	c		+
*Black and White Warbler	Mniotilta varia	c		c		
*Prothonotary Warbler	Protonotaria citrea	u	u	u		+

Common Name	Scientific Name†	Season†† Spring	Summer	Fall	Winter	Nest Locally
Worm-eating Warbler	Helmitheros vermivorus	r†		x		
Golden-winged Warbler	Vermivora chyrysoptera	u		u		
*Blue-winged Warbler	Vermivora pinus	u	r	u		+
*Tennessee Warbler	Vermivora peregrina	c		c		
Orange-crowned Warbler	Vermivora celata	o		o	x	
*Nashville Warbler	Vermivora ruficapilla	c		c		
Northern Parula	Parula americana	o		o		
*Yellow Warbler	Dendroica petechia	c	c	c		+
*Magnolia Warbler	Dendroica magnolia	c	x	c		
Cape May Warbler	Dendroica tigrina	c		c		
*Black-throated Blue Warbler	Dendroica caerulescens	c		c		
*Myrtle Warbler	Dendroica coronata	a		a	o	
*Black-throated Green Warbler	Dendroica virens	c		c		
Cerulean Warbler	Dendroica cerulea	u	x	o		+
*Blackburnian Warbler	Dendroica fusca	c		c		
Yellow-throated Warbler	Dendroica dominica	x				
*Chestnut-sided Warbler	Dendroica pensylvanica	c	o	c		+
Bay-breasted Warbler	Dendroica castanea	c		c		
*Blackpoll Warbler	Dendroica striata	c		c		
*Pine Warbler	Dendroica pinus	o		o	x	
Prairie Warbler	Dendroica discolor	o		o		
*Palm Warbler	Dendroica palmarum	c		c		
*Ovenbird	Seiurus aurocapillus	c	c	c		+
Northern Waterthrush	Seiurus noveboracensis	c		c		
Louisiana Waterthrush	Seiurus motacilla	r	x	x		
*Kentucky Warbler	Oporornis formosus	r	r	r		
*Connecticut Warbler	Oporornis agilis	r		r		
Mourning Warbler	Oporornis philadelphia	u		u		
*Common Yellowthroat	Geothlypis trichas	c	c	c	r	+
*Yellow-breasted Chat	Icteria virens	u	u	u		
Hooded Warbler	Wilsonia citrina	r	r	r		+
Wilson's Warbler	Wilsonia pusilla	c		c		

TABLE 1305-C-28 (Page 9 of 10)

Common Name	Scientific Name†	Season††				Nest Locally
		Spring	Summer	Fall	Winter	
Canada Warbler	<u>Wilsonia canadensis</u>	c†		c		
*American Redstart	<u>Setophaga ruticilla</u>	c	r	c		+
*House Sparrow	<u>Passer domesticus</u>	a	a	a	a	+
*Bobolink	<u>Dolichonyx oryzivorus</u>	u	u	u		+
*Eastern Meadowlark	<u>Sturnella magna</u>	c	c	c	u	+
Western Meadowlark	<u>Sturnella neglecta</u>	u	u	u		+
Yellow-headed Blackbird	<u>Xanthocephalus xanthocephalus</u>	r	x	x		
*Red-winged Blackbird	<u>Agelaius phoeniceus</u>	a	a	a	a	+
Orchard Oriole	<u>Icterus spurius</u>	r	r	r		+
*Baltimore Oriole	<u>Icterus galbula</u>	c	u	u	x	+
Rusty Blackbird	<u>Euphagus carolinus</u>	c		c	u	
Brewer's Blackbird	<u>Euphagus cyanocephalus</u>	o		o	r	
*Common Grackle	<u>Quiscalus quiscula</u>	a	a	a	u	+
*Brown-headed Cowbird	<u>Molothrus ater</u>	c	c	c	u	+
Scarlet Tanager	<u>Piranga olivacea</u>	c	[illegible]	c		+
Summer Tanager	<u>Piranga rubra</u>	r	x	x		
*Cardinal	<u>Cardinalis cardinalis</u>	c	c	c	c	+
*Rose-breasted Grosbeak	<u>Pheucticus ludovicianus</u>	c	r	c		+
*Indigo Bunting	<u>Passerina cyanea</u>	c	c	c		+
Dickcissel	<u>Spiza americana</u>	u	u	u		+
Evening Grosbeak	<u>Hesperiphona vespertina</u>	o		o	o	
Purple Finch	<u>Carpodacus purpureus</u>	u	x	u	u	
Hoary Redpoll	<u>Acanthis hornemanni</u>	x		x		
Common Redpoll	<u>Acanthis flammea</u>	o		o	o	
Pine Siskin	<u>Spinus pinus</u>	u		u	o	
*American Goldfinch	<u>Spinus tristis</u>	c	c	c	c	+
Rufous-sided Towhee	<u>Pipilo erythrophthalmus</u>	c	c	c	u	+
*Savannah Sparrow	<u>Passerculus sandwichensis</u>	c	c	c	x	+
*Grasshopper Sparrow	<u>Ammodramus savannarum</u>	o	o	o		+
Henslow's Sparrow	<u>Ammodramus henslowii</u>	x	x			
Le Conte's Sparrow	<u>Ammospiza le conteii</u>	x		r		
Sharp-tailed Sparrow	<u>Ammospiza caudacuta</u>	r		r		
Vesper Sparrow	<u>Pooecetes gramineus</u>	u	u	u	x	+

TABLE 1305-C-28 (Page 10 of 10)

Common Name	Scientific Name[†]	Season[††] Spring	Summer	Fall	Winter	Nest Locally
*Slate-colored Junco	Junco hyemalis	c[†]		c	u	
Oregon Junco	Junco hyemalis organus	o		o	o	
*Tree Sparrow	Spizella arborea	c		c	c	
*Chipping Sparrow	Spizella passerina	u	u	u		+
*Field Sparrow	Spizella pusilla	u	u	u	r	+
Harris' Sparrow	Zonotrichia querula	x		x		
*White-crowned Sparrow	Zonotrichia leucophrys	c	x	c	u	
*White-throated Sparrow	Zonotrichia albicollis	c	x	c	u	
*Fox Sparrow	Passerella iliaca	c		c	r	
Lincoln's Sparrow	Melospiza lincolnii	u		u	x	
*Swamp Sparrow	Melospiza georgiana	u	r	c	o	+
*Song Sparrow	Melospiza melodia	c	c	c	u	+
Lapland Longspur	Calcarius lapponicus	u		u	u	
Snow Bunting	Plectrophenax nivalis	c		c	c	

TABLE 1305-C-29

RESULTS OF BREEDING BIRD CENSUS FOR DAVIS-BESSE STUDY AREA CIRCUIT, SUMMER 1974

Species	No. of individuals observed		
	25 June	26 June	2 July
Great Blue Heron*	16	6	4
Great Egret*	4	5	1
Black-crowned Night Heron*	50	50	50
Mallard		5	4
Black Duck			1
Wood Duck		1	1
Killdeer	3	2	2
Herring Gull*	3	1	
Ring-billed Gull	8	3	4
Mourning Dove	4	6	5
Yellow-billed Cuckoo	7	5	5
Black-billed Cuckoo		1	
Great Horned Owl			2
Ruby-throated Hummingbird	1	2	2
Yellow-shafted Flicker			3
Hairy Woodpecker		2	2
Downy Woodpecker	6	4	
Eastern Kingbird			1
Great Crested Flycatcher	3	2	1
Eastern Wood Pewee	2	3	1
Tree Swallow*	11	7	6
Barn Swallow*		3	
Purple Martin*	3		
House Wren	20	20	25
Winter Wren	1		
Gray Catbird	4	6	5
Brown Thrasher		1	1
American Robin	2	6	6
Cedar Waxwing*	2	4	
Starling*		10	25
Red-eyed Vireo	4	1	2
Prothonotary Warbler		1	
Yellow Warbler	abundant	abundant	abundant
Common Yellowthroat	3	2	1
Yellow-breasted Chat	3	3	2
American Redstart	-	2	2
Red-winged Blackbird	abundant	abundant	abundant
Oriole	1	3	2
Common Grackle*	8	4	10
Brown-headed Cowbird	2	-	1
Cardinal	2	4	5
Rose-breasted Grosbeak	1	-	-
Indigo Bunting	4	4	2
American Goldfinch	2	1	4
Song Sparrow	5	6	5

*Species that did not breed on site. Frequently these were flocks of birds feeding on-site but nesting and roosting off site.

TABLE 1305-C-30

AVERAGE MONTHLY WATERFOWL CONCENTRATIONS ON THE NAVARRE MARSH[31]
(Page 1 of 2)

Species	Jan. 72*	Jan. 73*	Feb. 72**	Feb. 73*	Mar. 72	Mar. 73	Apr. 72	Apr. 73	May 72	May 73	June 72	June 73	July 72	July 73	Aug. 72	Aug. 73	Sept. 72	Sept. 73
American Coot	--	--	--	--	25	25	233	25	100	25	100	25	75	35	75	125	685	400
[illegible]	--	--*	1	--	60	30	41	1	0	0	0	25	0	0	0	0	0	0
Canada Goose	--	--	--	--	300	150	88	16	2	3	6	7	6	33	0	40	1	100
Ducks: Mallard	--	--	--	--	190	100	65	20	20	15	20	20	30	30	25	200	35	250
Black	--	--	--	--	275	150	96	15	0	0	0	0	5	0	5	0	15	0
Gadwall	--	--	--	--	10	0	5	6	0	0	0	0	0	0	0	0	0	0
Pintail	--	--	--	--	5	16	4	6	0	0	0	0	0	0	0	0	0	0
Green-winged Teal	--	--	--	--	5	0	5	6	0	0	0	0	0	10	10	25	5	5
Blue-winged Teal	--	--	--	--	45	50	34	20	0	0	20	10	20	20	50	100	60	75
[illegible]	--	--	--	--	17	20	23	5	0	0	0	0	0	0	0	0	150	30
Northern Shoveler	--	--	--	--	4	5	1	1	0	0	0	0	0	0	0	0	5	75
Wood Duck	--	--	--	--	1	10	5	10	10	15	15	20	15	30	25	30	60	15
Redhead	--	--	--	--	12	5	3	6	0	0	0	0	0	0	0	0	0	0
Ring-necked Duck	--	--	--	--	1	0	6	0	0	0	0	0	0	0	0	0	10	0
Canvasback	--	--	--	--	20	10	13	6	2	0	0	0	0	0	0	0	0	0
Lesser Scaup	--	--	--	--	11	0	18	0	2	0	0	0	0	0	0	0	5	0
Bufflehead	--	--	--	--	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ruddy	--	--	--	--	3	0	1	0	0	0	0	0	0	0	0	0	0	0
Common Merganser	--	--	--	--	45	30	131	10	0	0	0	0	0	0	0	0	0	0
Hooded Merganser	--	--	---	--	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Total Ducks	--	--	--	--	644	390	430	85	34	30	55	50	70	90	115	355	350	450
Total Waterfowl	0	0	1	0	1,049	595	762	121	136	58	161	107	151	158	190	520	1,036	950
Total Waterfowl Use-days[1]	0	0	29	0	32,519	16,445	22,863	3,630	4,216	1,798	4,830	3,210	4,681	4,898	5,890	16,120	29,580	28,500

*Marsh ice covered
**Data available for only November and December 1971
1 Use-day = 1 bird present on 1 day

TABLE 1305-C-30 (Page 2 of 2)

Species	Oct. 72	Oct. 73	Nov. 71[b]	Nov. 72	Nov. 73	Dec. 71[b]	Dec. 72[a]	Dec. 73	Years Total 71[b]	Years Total 72	Years Total 73
American Coot	3,575	908	0	2,000	50	0	--	1	0	6,865	1,611
Swans	0	0	26	0	0	9	--	0	35	95	56
Canada Goose	5	150	2	0	150	150	--	75	152	408	718
Ducks: Mallard	125	300	1,360	60	100	343	--	20	1,703	585	1,055
Black	135	50	532	140	75	270	--	20	802	671	310
Gadwall	75	10	30	20	0	0	--	0	30	114	10
Pintail	10	50	250	110	0	0	--	0	250	134	60
Green-winged Teal	0	0	45	30	0	0	--	0	45	55	40
BW/Cinn Teal	20	0	0	0	0	0	--	0	0	249	275
Am Wigeon	550	400	0	500	0	0	--	0	0	1,240	455
Northern Shoveler	5	25	20	20	0	0	--	0	20	35	110
Wood Duck	30	30	30	10	0	0	--	0	30	171	160
Redhead	5	0	0	10	0	0	--	0	0	27	5
Ring-necked Duck	10	0	70	10	0	0	--	0	70	37	0
Canvasback	0	0	0	0	0	0	--	0	0	35	10
Lesser Scaup	10	0	235	10	0	0	--	0	235	56	0
Bufflehead	0	0	0	0	0	0	--	0	0	0	0
Ruddy	0	0	10	40	0	0	--	0	10	47	0
Common Merganser	0	0	25	0	0	0	--	0	25	176	40
Hooded Merganser	0	0	0	0	0	0	--	0	0	1	0
Total Ducks	975	865	2,607	960	175	613	--	40	--	3,633	2,530
Total Waterfowl	4,555	1,915	2,635	2,960	375	772	0	116	--	11,001	4,915
Total Waterfowl Use-days	141,205	59,365	79,050	238,800	11,250	23,932	0	3,596		484,610	150,812

TABLE 1305-C-31

ANNUAL WATERFOWL USE-DAYS* FOR THE NAVARRE MARSH[55]

Period	Ducks	Geese	Swans	Coots	Total
Sept. 1, 1972 through Aug. 31, 1973	100,390	7,701	1,710	199,385	309,186
Sept. 1, 1971 through Aug. 31, 1972	144,122	11,663	2,965	22,498	181,248
Sept. 1, 1970 through Aug. 31, 1971	92,202	5,617	8,556	46,340	152,715
Sept. 1, 1969 through Aug. 31, 1970	134,352	5,306	4,173	64,382	208,213
Sept. 1, 1968 through Aug. 31, 1969	123,170	5,425	4,886	31,600	165,081

*1 use-day = 1 bird present on 1 day

TABLE 1305-C-32

MAMMALS THAT COULD OCCUR WITHIN THE REGION OF THE DAVIS-BESSE PLANT SITE AND THOSE THAT HAVE BEEN OBSERVED ON THE PLANT SITE(65,66,78,79)

Common Name *	Scientific Name *
**Opossum	Didelphis virginiana
Masked Shrew	Sorex cinereus
**Short-tailed Shrew	Blarina brevicauda
Least Shrew	Cryptotis parva
Starnose Mole	Condylura cristata
Eastern Mole	Scalopus aquaticus
Keen's Myotis	Myotis keenii
Little Brown Bat	Myotis lucifugus
Indiana Bat	Myotis sodalis
Small-footed Myotis	Myotis leibii
Silver-haired Bat	Lasionycteris noctivagans
Eastern Pipistrel	Pipistrellus subflavus
**Big Brown Bat	Eptesicus fuscus
Red Bat	Lasiurus borealis
Hoary Bat	Lasiurus cinereus
Evening Bat	Nycticeius humeralis
**Eastern Cottontail	Sylvilagus floridanus
Eastern Chipmunk	Tamias striatus
**Woodchuck	Marmota monax
Thirteen-lined Ground Squirrel	Spermophilus tridecemlineatus
Eastern Gray Squirrel	Sciurus carolinensis
**Fox Squirrel	Sciurus niger
**Red Squirrel	Tamiasciurus hudsonicus
Southern Flying Squirrel	Glaucomys volans
Deer Mouse	Peromyscus maniculatus
**White-footed Mouse	Peromyscus leucopus
**Meadow Vole	Microtus pennsylvanicus
Pine Vole	Microtus pinetorum
**Muskrat	Ondatra zibethica
Southern Bog Lemming	Synaptomys cooperi
**Norway Rat	Rattus norvegicus
**House Mouse	Mus musculus
**Meadow Jumping Mouse	Zapus hudsonius
Coyote	Canis latrans
**Red Fox	Vulpes vulpes
**Raccoon	Procyon lotor
Least Weasel	Mustela nivalis
Long-tailed Weasel	Mustela frenata
**Mink	Mustela vison
Badger	Taxidea taxus
**Striped Skunk	Mephitis mephitis
**White-tailed Deer	Odocoileus virginianus
**Gray Fox	Urocyon cinereoargenteus

* Names according to Jones et al.,(56)

** Observed on the Davis-Besse Site

TABLE 1305-C-33

AMPHIBIANS AND REPTILES THAT COULD OCCUR WITHIN THE REGION OF THE DAVIS-BESSE SITE, AND THOSE THAT HAVE BEEN OBSERVED ON THE SITE[14]

Common Name[29]	Scientific Name[29]
**Common Snapping Turtle	Chelydra serpentia
Stinkpot	Sternothaerus odoratus
†Spotted Turtle	Clemmys guttata
Eastern Boxturtle	Terrapene carolina carolina
Map Turtle	Graptemys geographica
**Midland Painted Turtle	Chrysemys picta marginata
**Blanding's Turtle	Emydoidea blandingi
Eastern Spiny Softshell	Trionyx spinifer spinifer
**Five-lined Skink	Eumeces fasciatus
**Northern Watersnake	Natrix sipedon sipedon
**Northern Brown Snake	Storeria dekayi dekayi
**Eastern Garter Snake	Thamnophis sirtalis sirtalis
**Butler's Garter Snake	Thamnophis butleri
Eastern Ribbon Snake	Thamnophis sauritus sauritus
Eastern Hognose Snake	Heterodon platyrhinos
Northern Ringneck Snake	Diadophis punctatus edwardsi
Blue Racer	Coluber constrictor foxi
Smooth Green Snake	Opheodrys vernalis
**Fox Snake	Elaphe vulpina
Black Rat Snake	Elaphe obsoleta obsoleta
Eastern Milk Snake	Lampropeltis doliata triangulum
Eastern Massasauga	Sistrurus catenatus catenatus
Mudpuppy	Necturus maculosus
Blue Spotted Salamander	Ambystoma laterale
Marbled Salamander	Ambystoma opacum
Spotted Salamander	Ambystoma maculatum
Tiger Salamander	Ambystoma tigrinum tigrinum
Red Spotted Newt	Diemictylus viridescens viridescens
Red Backed Salamander	Plethodon cinereus cinereus
Two-lined Salamander	Eurycea bislineata bislineata
American Toad	Bufo americanus
Fowler's Toad	Bufo woodhousei fowleri
**Cricket Frog	Acris crepitans blanchardi
**Northern Spring Peeper	Hyla crucifer
Gray Treefrog	Hyla versicolor
Western Chorus Frog	Pseudacris triseriata triseriata
Bullfrog	Rana catesbeiana
Green Frog	Rana clamitans melanota
Northern Leopard Frog	Rana pipiens pipiens
Pickerel Frog	Rana palustris
Wood Frog	Rana sylvatica

* Names according to Conant[14]

** Observed on the Davis-Besse Site

† Rare and endangered in Ohio[7]

TABLE 1305-C-34

PHYTOPLANKTON SPECIES FROM LOCUST POINT, MAY 15-16, 1969[57]

Chrysophyta	Chlorophyta
Diatoma tenue v. elongatum	Ulothrix spp.
Melosira binderana	Pediastrum duplex
Melosira granulata	Scenedesmus abundans
Synedra ulna	Scenedesmus quadricauda
Synedra acus	Dictyosphaerium pulchellum
Fragilaria intermedia	Ankistrodesmus spp.
Fragilaria capucina	Ankistrodesmus falcatus
Fragilaria crotonensis	Scenedesmus spp.
Asterionella formosa	Micractinium pusillum
Cyclotella spp.	Oocystis solitaria
Navicula spp.	Lagerheimia longiseta
Tabellaria fenestrata	Golenkinia radiata
Surirella spp.	Actinastrum hantzschii
Nitzschia spp.	Closteriopsis longissima
Stephanodiscus spp.	Cyanophyta
Cymbella spp.	
Gomphonema spp.	Oscillatoria spp.

TABLE 1305-C-35

PHYTOPLANKTON SPECIES FROM LOCUST POINT, OCTOBER 1969 (57)

Chrysophyta

Coscinodiscus spp.
Coscinodiscus rothii var. subsalsa
Cyclotella spp.
Melosira granulata
Melosira binderana
Melosira sp.
Stephanodiscus niagarae
Stephanodiscus sp.
Fragilaria intermedia
Fragilaria crotonensis
Fragilaria construens
Fragilaria capucina
Fragilaria pinnata
Synedra sp.
Nitzschia spp.
Surirella sp.
Navicula sp.
Amphora ovalis
Diatoma vulgare
Meridion circulare

Chlorophyta

Coelastrum sphaericum
Coelastrum microporum
Coelastrum reticulatum
Coelastrum sp.
Chlamydomonas spp.
Pediastrum duplex
Pediastrum simplex
Pediastrum spp.
Dictyosphaerium pulchellum
Dictyosphaerium ehrenbergianum
Ankistrodesmus falcatus
Ankistrodesmus spp.
Scenedesmus abundans
Scenedesmus sp.
Scenedesmus acuminatus
Scenedesmus bijuga
Scenedesmus dimorphus
Scenedesmus incrassatulus
Scenedesmus quadricauda
Scenedesmus armatus
Scenedesmus arcuatus
Scenedesmus acutiformis
Staurastrum sp.
Ulothrix spp.
Oocystis spp.
Oocystis borgei
Oocystis solitaria
Schroederia sp.
Schroederia judayi
Schroederia setigera
Actinastrum hantzschii
Closterium sp.
Closteriopsis longissima
Tribonema spp.

Chlorophyta (continued)

Cosmarium sp.
Nephrocytium sp.
Lagerheimia longiseta
Gloeocystis spp.
Gloeocystis major
Tetraedron sp.
Tetraedron caudatum
Tetraedron lunula
Tetraedron minimum
Tetraedron trigonum
Selenastrum bibraianum
Selenastrum sp.
Dimorphococcus sp.
Dimorphococcus lunatus
Kirchneriella sp.
Kirchneriella lunaris
Kirchneriella elongata
Crucigenia quadrata
Crucigenia spp.
Quadrigula lacustris
Golenkinia radiata
Tetrastrum spp.
Sorastrum spinulosum
Treubaria setigerum
Sorastrum sp.

Cyanophyta

Oscillatoria spp.
Anabaena spp.
Anabaena circinalis
Aphanizomenon flos-aquae
Aphanizomenon sp.
Gomphosphaeria spp.
Gomphosphaeria lacustris
Chroococcus sp.
Aphanocapsa sp.
Microcystis aeruginosa
Merismopedia sp.
Chroococcus limneticus
Chroococcus dispersus
Dactylococcopsis smithii
Coelosphaerium sp.
Coelosphaerium naegelianum

Pyrrophyta

Mallomonas sp.
Peridinium sp.
Cystodinium sp.

Cryptophyta

Cryptomonas spp.

Euglenophyta

Euglena sp.

TABLE 1305-C-36

FREQUENCY OF OCCURRENCE (%) OF ZOOPLANKTERS IN SAMPLES FROM LOCUST POINT, JULY-NOV., 1972 (18)

	July	Nov.	Total	% freq. occ.
Rotifera				
Keratella cochlearis	26	8	75	88.2
K. quadrula	18	8	29	34.1
Polyarthra sp.	18	7	70	82.3
Asplanchna sp.	1	3	38	44.7
Brachionus sp.	22	6	36	42.3
Trichocerca sp	17	0	34	40.0
Monommata sp.	1	1	6	7.0
Pompholyx sp.	2	0	3	3.5
Kellicottia sp.	0	1	2	2.3
Euchlanis sp.	0	2	2	2.3
Copepoda				
Nauplii	29	8	85	100.0
Cyclopoids	29	8	81	95.2
Calanoids	11	3	27	31.7
Cladocera				
Daphnia retrocurva	28	1	63	74.1
D. galeata	1	0	11	12.9
D. parvula	0	0	3	3.5
D. pulax	0	1	2	2.3
Bosmina sp.	29	7	75	88.2
Leptodora kindti	2	0	6	7.0
Total Samples	29	8	85	

TABLE 1305-C-37

SPECIES LIST OF MACROINVERTEBRATES
COLLECTED FROM 1969 TO 1972

Coelenterata

Hydra sp.
Platyhelminthes
Glossiphoniidae
Erpobdellidae
Oligochaeta
Tubificidae
Aulodrilus sp.
Branchiura sowerbyi
Limnodrilus cervix
Limnodrilus hoffmeisteri
Limnodrilus maumeensis
Limnodrilus udekemianus
Peloscolex ferox
Potamothrix moldaviensis
Potamothrix vejdovskyi
Naididae
Nais sp.
Pristina sp.
Stylaria sp.
Uncinais uncinata
Nematoda
Bryozoa
Arthropoda
Crustacea
Isopoda
Asellidae
Asellus sp.
Amphipoda
Gammaridae
Gammarus sp.
Talitridae
Hyalella azteca
Decapoda
Astacidae
Orconectes virilis
Insecta
Ephemeroptera
Caenidae
Caenis sp.
Trichoptera
Psychomyiidae
Athripsodes sp.
Oecetis sp.
Leptoceridae
Polycentropus sp.
Limnephilidae
Diptera
Chironomidae
Chironomus (s.s.) sp.
Cryptochironomus sp.
Polypedilum sp.
Pseudochironomus sp.
Tanytarsus sp.
Procladius sp.
Coelotanypus sp.
Cricotopus sp.
Psectrocladius sp.
Mollusca
Gastropoda
Physidae
Physa sp.
Planorbidae
Gyraulus sp.
Pleuroceridae
Pleurocera-Goniobasis sp.
Hydrobiidae
Bythinia sp.
Amnicola sp.
Valvatidae
Valvata sp.
Pelecypoda
Sphaeriidae
Pisidium sp.
Sphaerium sp.
Unionidae
Amblema plicata
Lampsilis ventricosa
Lampsilis radiata
Leptodea fragilis
Ligumia recta
Proptera alatus
Quadrula pustulosa

TABLE 1305-C-38

FREQUENCY OF OCCURRENCE (%) OF BENTHIC MACROINVERTEBRATES IN LOCUST POINT SAMPLES, JULY-NOVEMBER, 1972(18)

Type	July	Aug.	Sept.	Oct.	Nov.	Total	% Freq. Occ.
Hydra sp.	0	0	0	10	0	10	11.6
Hirudinea							
Glossiphoniidae	2	3	0	0	1	6	6.9
Erpobdellidae	0	0	0	0	1	1	1.1
Oligochaeta							
Limnodrilus cervix	4	1	0	0	0	5	5.8
L. hoffmeisteri	2	4	0	1	0	7	8.1
L. claparedianus	1	1	0	1	0	3	3.4
Potamothrix vejdovskyi	1	1	0	1	0	3	3.4
P. moldaviensis	6	3	0	3	1	13	15.1
Branchyura sowerbyi	5	3	0	3	2	13	15.1
Nais	3	0	0	5	1	9	10.4
Pristina sp.	0	0	0	3	0	3	3.4
Uncinais uncinata	0	0	0	4	0	4	4.6
Naididae	1	0	0	0	0	1	1.1
immature	14	9	3	11	7	44	51.1
Nematoda	0	2	0	0	0	2	2.3
Amphipoda							
Gammarus fasciatus	7	3	0	5	6	21	24.4
Ephemeroptera							
Caenis sp.	2	0	0	1	1	4	4.6
Trichoptera							
Limnephilidae	1	0	0	0	0	1	1.1
Chironomidae							
Chironomus (s.s.) sp.	2	1	0	13	1	17	19.7
Cryptochironomus sp.	8	1	1	9	4	23	26.7
Polypedilum sp.	2	6	0	3	2	12	15.1
Pseudochironomus sp.	2	0	0	0	1	3	3.4
Tanytarsus sp.	5	0	2	5	1	13	15.1
Procladius sp.	1	1	0	4	0	6	6.9
Coelotanypus sp.	0	0	0	2	1	3	3.4
Cricotopus sp.	0	0	0	0	1	1	1.1
Pelecypoda							
Amblema plicata	1	0	0	0	0	1	1.1
Ligumia recta	0	1	0	0	1	2	2.3
Leptodea fragilis	0	1	0	0	0	1	1.1
Pisidium sp.	0	0	0	0	1	1	26.8
Nothing	7	10	3	2	1	23	26.8
Total Samples	29	28	5	16	8	86	

TABLE 1305-C-39

BENTHIC MACROINVERTEBRATES FROM STATIONS WITH A BEDROCK AND LARGE BOULDER SUBSTRATE (D6-11, D6-10, D6-9, D6-8), MAY THROUGH OCTOBER 1969 AND 1970, EXPRESSED AS PERCENT OF THE TOTAL NUMBER OF ORGANISMS

	1969					1970				
Genera	6/17	7/17	8/15	9/23	10/29	5/8	6/8	7/7	8/6	9/16
Hydra	89	0	0	19	0	4	4	1*	1*	No Sample Taken
Planariidae	5	3	30	13	20	9	9	3	4	
Oligochaeta (immature)	1	30	18	27	22	65	2	10	5	
Limnodrilus Hoffmeisteri	0	4	1	1	1	-0-	1**	1**	1**	
Nais	0	1	0	2	0	0	2	0	0	
Gammarus	1	39	26	10	2	1	44	62	48	
Hyalella azteca	0	3	2	3	0	0	5	2	1	
Chironomus (s.s.)	0	1**	1	2	1	0	16	1	2	
Cryptochironomus	0	2	1	1**	0	1	0	1**	1	
Tanytarsus	0	1**	8	1**	0	0	0	0	1**	
Procladius	0	5	1	2	4	0	1	1	1	
Coelotanypus	0	1**	1**	1	8	0	0	0	0	
Polycentropus	1**	0	2	1	5	1	1**	1**	1**	
Amnicola	3	0	0	6	0	0	10	10	18	
Bythinia	0	0	4	3	18	0	0	0	1**	
Pleurocera-Goniobasis†	2	1	0	1**	0	0	0	0	2	
Physa	1	0	0	1	0	0	0	3	2	
Sphaerium	0	2	0	5	1	0	1	1	2	
Pisidium	0	0	0	3	4	0	1	0	4	
Valvata	0	0	0	0	8	0	1	0	5	

*Tubb, 1972[19]
**Indicates less than 1%
†Cannot distinguish genera with certainty.

TABLE 1305-C-40

BENTHIC MACROINVERTEBRATES FROM STATIONS WITH A CLAY-GRAVEL SUBSTRATE (D6-13, D6-14, D6-15, D5-2), MAY THROUGH OCTOBER, 1969 AND 1970, EXPRESSED AS THE MEAN NUMBER OF ORGANISMS/m^2(19)

Genera	1969					1970					
	6/17	7/17	8/15	9/23	10/29	5/8	6/8	7/7	8/6	9/16	10/7
Hydra	0	4	0	0	0	0	108	0	0	0	0
Hirudinea	0	0	0	0	0	9	6	0	0	3	0
Oligochaeta (immature)	1	95	46	116	28	249	396	810	396	465	198
Limnodrilus Hoffmeisteri	0	2	2	0	0	0	0	0	0	3	9
L. maumeensis	0	1	1	0	0	0	0	0	0	0	6
L. claparedianus-cervix	1	3	0	0	0	21	18	18	3	3	18
Potamothrix moldaviensis	0	15	47	1	0	21	3	30	6	18	18
Branchyura sowerbyi	0	0	0	0	0	9	9	0	0	18	3
Stylaria	0	0	0	2	0	0	0	12	9	12	0
Gammarus	15	9	0	0	3	3	6	9	9	6	15
Chironomus (s.s)	1	1	5	5	3	0	3	0	27	117	24
Cryptochironomus	6	14	7	3	4	24	6	0	9	0	21
Pseudochironomus	3	2	2	0	4	0	0	0	0	0	3
Polypedilum	0	11	9	2	0	15	66	9	12	12	24
Tanytarsus	0	12	2	14	0	27	6	6	48	192	9
Procladius	3	4	4	0	3	3	0	3	3	17	6
Coelotanypus	1	0	2	1	0	0	0	0	0	3	0
Caenis	10	8	0	0	1	6	6	0	0	3	3
Oecetis	0	2	0	0	1	0	0	0	0	0	0
Amnicola	0	0	0	1	0	0	12	0	0	0	0
Bythinia	0	1	0	0	0	0	3	0	0	0	0
Sphaerium	2	1	1	1	1	3	0	0	0	0	0
Pisidium	0	0	0	2	0	0	3	0	0	0	0

TABLE 1305-C-41

BENTHIC MACROINVERTEBRATES FROM STATIONS WITH A GRAVEL AND SMALL ROCK SUBSTRATE (D6-7, D6-6, D6-5, D6-4, D5-3, D5-4), MAY THROUGH OCTOBER. 1969 AND 1970 EXPRESSED AS THE MEAN NUMBER OF ORGANISMS/m^2(19)

	1969					1970					
Genera	6/17	7/17	8/15	9/23	10/29	5/8	6/8	7/7	8/6	9/16	10/7
Hydra	21	198	1	3	0	0	500	92	2	0	36
Planariidae	7	35	0	11	20	0	4	16	0	30	26
Hirudinea	0	3	1	3	4	2	2	14	12	8	8
Oligochaeta (immature)	131	413	19	411	112	906	874	1214	1397	3393	4248
Limnodrilus hoffmeisteri	10	3	1	2	0	38	46	26	42	52	54
L. maumeensis	3	3	1	1	1	0	16	14	14	34	4
L. claparedianus-cervix	1	1	0	1	0	24	10	26	10	118	14
Potamothrix moldaviensis	33	22	13	1	0	70	42	112	78	28	35
Branchyura sowerbyi	3	1	0	3	0	0	2	4	2	369	4
Nais	0	0	0	6	0	0	0	0	0	6	0
Stylaria	0	11	1	7	0	0	0	50	52	6	0
Gammarus	17	19	7	13	21	4	68	66	56	58	70
Chironomus (s.s.)	28	0	5	11	3	0	407	2	160	602	92
Cryptochironomus	10	9	11	7	19	24	16	13	18	4	86
Pseudochironomus	1	0	3	2	3	7	8	2	0	0	6
Polypedilum	6	0	23	2	1	8	12	2	26	2	38
Tanytarsus	2	29	43	45	0	0	0	2	104	315	76
Procladius	5	3	6	28	4	0	0	4	2	38	82
Coelotanypus	2	0	1	7	0	0	0	0	2	24	14
Polycentropus	0	1	0	3	0	0	0	0	0	0	0
Caenis	1	0	0	0	0	0	0	0	2	0	2
Oecetis	0	1	0	1	0	0	0	0	0	0	0
Amnicola	0	0	0	9	0	2	10	6	8	8	0
Bythinia	3	3	1	4	4	0	4	0	0	0	0
Pleurocera-Goniobasis*	1	15	0	0	1	0	0	0	4	0	0
Physa	1	0	0	0	0	0	0	6	2	2	0
Sphaerium	0	0	0	0	0	0	16	1	6	8	0
Pisidium	5	1	0	19	0	6	6	0	10	20	16

*Cannot distinguish genera with certainty

TABLE 1305-C-42

BENTHIC MACROINVERTEBRATES FROM STATIONS WITH A SILT, SAND, AND DETRITAL SUBSTRATE (D6-12, C6- 1, D6-16, D6-17, D6-18, D6-19), MAY THROUGH OCTOBER, 1969 AND 1970, EXPRESSED AS THE MEAN NUMBER OF ORGANISMS/m^2(19)

Genera	1969					1970					
	6/17	7/17	8/15	9/23	10/29	5/8	6/8	7/7	8/6	9/16	10/7
Hydra	7	0	No Sample Taken	0	0	0	4	0	0	0	0
Hirudinea	0	0		0	0	0	2	2	0	0	0
Oligochaeta (immature)	329	778		.25	2212	635	1307	1012	2836	6737	6489
Limnodrilus hoffmeisteri	21	82		0	12	56	34	42	52	132	172
L. maumeensis	45	72		1	9	8	102	156	100	160	70
L. claparedianus-cervix	17	23		0	18	82	118	114	78	345	306
Potamothrix moldaviensis	43	77		0	10	12	50	108	190	26	108
Branchyura sowerbyi	10	3		1	138	154	244	248	259	569	1192
Chironomus	86	24		10	126	345	126	291	499	1273	1124
Cryptochironomus	15	7		3	63	12	2	8	4	4	52
Polypedilum	23	1		0	15	0	2	6	4	8	2
Tanytarsus	3	92		0	9	2	0	0	4	14	4
Procladius	45	10		0	15	155	54	0	16	12	16
Coelotanypus	19	0		9	9	8	6	12	14	108	86
Caenis	1	3		0	0	0	0	0	0	0	0
Sphaerium	0	4		0	0	0	2	0	0	0	0
Gammarus	0	5		0	6	2	0	8	6	24	4

TABLE 1305-C-43

FAMILIES AND SPECIES OF FISHES CAPTURED IN THE LOCUST POINT AREA, 1969-1972

Family	Common Name	Scientific Name
Lepisosteidae	Longnose gar	*Lepisosteus osseus*
Amiidae	Bowfin	*Amia calva*
Clupeidae	Alewife	*Alosa pseudoharengus*
	Gizzard shad	*Dorosoma cepedianum*
Salmonidae	Coho salmon	*Oncorhynchus kisutch*
Osmeridae	Rainbow smelt	*Osmerus mordax*
Esocidae	Northern pike	*Esox lucius*
Catostomidae	Golden redhorse	*Moxostoma erythrurum*
	White sucker	*Catostomus commersoni*
	Spotted sucker	*Minytrema melanops*
	Quillback	*Carpiodes cyprinus*
	Bigmouth buffalo	*Ictiobus cyprinellus*
Cyprinidae	Carp	*Cyprinus carpio*
	Goldfish	*Carassius auratus*
	Silver chub	*Hybopsis storeriana*
	Emerald shiner	*Notropis atherinoides*
	Spotfin shiner	*Notropis spilopterus*
	Spottail shiner	*Notropis hudsonius*
Ictaluridae	Brown bullhead	*Ictalurus nebulosus*
	Yellow bullhead	*Ictalurus natalis*
	Channel catfish	*Ictalurus punctatus*
	Stonecat	*Noturus flavus*
Percichthyidae	White bass	*Morone chrysops*
Centrarchidae	White crappie	*Pomoxis annularis*
	Black crappie	*Pomoxis nigromaculatus*
	Rock bass	*Ambloplites rupestris*
	Smallmouth bass	*Micropterus dolomieui*
	Largemouth bass	*Micropterus salmoides*
	Green sunfish	*Lepomis cyanellus*
	Orange-spotted sunfish	*Lepomis humilis*
Percidae	Yellow perch	*Perca flavescens*
	Walleye	*Stizostedion vitreum vitreum*
	Logperch	*Percina caprodes*
Sciaenidae	Freshwater drum	*Aplodinotus grunniens*

TABLE 1305-C-50

BIRD SPECIES RECOVERED AT DAVIS-BESSE SITE DURING FOUR SEASONS OF OBSERVATIONS
(Page 1 of 2)

Species	Fall 1972 CT	Fall 1972 ST	Fall 1972 MT	Fall 1972 Total	Spring 1973 CT	Spring 1973 ST	Spring 1973 MT	Spring 1973 Total	Fall 1973 CT	Fall 1973 ST	Fall 1973 MT	Fall 1973 Total	Spring 1974 CT	Spring 1974 ST	Spring 1974 MT	Spring 1974 Total	TOTAL
Sora rail										1		1					1
American coot															1	1	1
Ring-billed gull										1		1					1
Herring gull															1	1	1
Yellow-bellied flycatcher										1		1					1
Least flycatcher					1			1									1
Acadian flycatcher													1			1	1
Unidentified flycatcher															1	1	1
Bluejay															1	1	1
Domestic pigeon															1	1	1
Yellow-shafted flicker.														1		1	1
Brown creeper									1			1					1
Long-billed marsh wren		1		1						1		1					2
Carolina wren													1			1	1
Gray catbird					5			5		1		1	4		2	6	12
Brown thrasher							1	1									1
American robin															1*	1	1
Wood thrush					2			2									2
Grey-cheeked thrush													1			1	1
Swainson's thrush													2			2	2
Veery					1			1							1	1	2
Golden-crowned kinglet									15	2		17					17
Ruby-crowned kinglet	1			1		1		1	16	7		23					25
Starling						1		1									1
Red-eyed vireo													5		2	7	7
Philadelphia vireo		1		1									2			1	3
Warbling vireo										1		1					1
Black and white warbler					2			2					3			3	5
Blue-winged warbler					3			3									3
Tennessee warbler										2		2	4	2	2	8	10
Nashville warbler					1			1		3		3	15		3	18	22
Yellow warbler	1		1	2	2		1*	3					1		4	5	10
Magnolia warbler									3	7		10	25	1	2	28	38
Myrtle warbler		1		1					1			1	4		1	5	7
Black-throated green warbler		1		1					1	1		2	1			1	4
Black-throated blue warbler													1		1	2	2

CT = Cooling Tower
ST = Unit I Station (including shield, turbine, and auxiliary buildings)
MT = Meteorological Tower
* = Guard house

TABLE 1305-C-5C

BIRD SPECIES RECOVERED AT DAVIS-BESSE SITE DURING FOUR SEASONS OF OBSERVATIONS
(Page 2 of 2)

Species	Fall 1972				Spring 1973				Fall 1973				Spring 1974				TOTAL
	CT	ST	MT	Total	CT	ST	MT	Total	CT	ST	MT	Total	CT	ST	MT	Total	
Blackburnian warbler										1		1	5			5	6
Chestnut-sided warbler					1			1	1			1	5		2	7	9
Bay-breasted warbler													2			2	2
Blackpole warbler										2		2					2
Pine warbler									1	3		4					4
Ovenbird					1			1	1	1		2	5	1	4	10	13
Northern waterthrush													1			1	1
Kentucky warbler							1	1					1			1	2
Connecticut warbler									1			1					1
Yellowthroat	1	1		2	6	1		7	2	1		3	10			10	22
Hooded warbler															1	1	1
Wilson's warbler					1			1	1			1					2
Canada warbler														1		1	1
Redstart										4		4	12	1	1	14	18
Unidentified warbler	1			1					1			1					2
House sparrow							1	1						3		3	4
Bobolink															4	4	4
Red-winged blackbird															1	1	1
Baltimore oriole															1	1	1
Scarlet tanager															1	1	1
Rose-breasted grosbeak													1		2	3	3
Indigo bunting					1			1									1
Rufus-sided towee															1	1	1
Savannah sparrow					1		1	2						1	2	3	5
Grasshopper sparrow					1			1					1		1	2	3
Field sparrow					1	1	1	3									3
White-crowned sparrow									1			1					1
White-throated sparrow					2			2									2
Fox sparrow													1			1	1
Swamp sparrow													1			1	1
Song sparrow					2			2					1		2	3	5
Unidentified sparrow										1		1					1
Unidentified bird									10	6		16	1		1	2	18
TOTAL BIRDS	4	5	1	10	34	4	6	44	56	47		103	117	11	48	176	333

CT = Cooling Tower
ST = Unit 1 Station (including shield, turbine, and auxiliary buildings)
MT = Meteorological Tower

EXHIBIT E

APPENDIX A 1305-C

RELATIONSHIP OF NAVARRE MARSH TO CORMORANT, HERON, EGRET, GULL, AND TERN POPULATIONS ON THE ISLANDS IN THE WESTERN BASIN OF LAKE ERIE

FOR

THE TOLEDO EDISON COMPANY

PREPARED BY

DAMES & MOORE

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INTRODUCTION

Purpose

The general purpose of this report, prepared for the Toledo Edison Company, is to present the results of a comprehensive investigation of available information relating to bird-island-marsh relationships in the western basin of Lake Erie.

The Ohio Power Siting Commission, in its response to the Toledo Edison Company's Letter of Intent of June 7, 1974, for Units No. 2 and 3 at the Davis-Besse Nuclear Power Station, has expressed concern over bird populations that inhabit islands in the western basin of Lake Erie and may use Navarre Marsh as a feeding area. More specifically, the Power Siting Commission has stated that the Toledo Edison Company's request for waiver (in the above Letter of Intent) of the Rules and Regulations under PSC 13-05 (c)(1)(b) would be granted subject to the following conditions: "A comprehensive study shall be undertaken by the Company and the resulting data made available concerning the movement and feeding of bird populations which are found on lake islands in the western basin of the Lake. This study shall specifically address the habits of populations common to West Sister, Middle Sister, and East Sister Islands, and the role of Navarre Marsh as a common feeding ground."

The above qualification, i.e. "populations common to West Sister, Middle Sister, and East Sister Islands", limits the discussion to bird species that are known to nest on the Sister Islands. Although passerines and waterfowl have been known to nest on one or more of the Sister Islands (Hoffman, 1974), all the available information is directed to the more common species of birds nesting on the Islands, particularly the herons, egrets, gulls, terns, and cormorants. The relationship between other islands in the western basin of Lake Erie with the Navarre Marsh as well as other marshes along the shores of the basin will also be discussed.

Description of Study Area

The study area includes the western basin of Lake Erie (Figure 1), which can roughly be described as that portion of Lake Erie, approximately 1,700 square miles, that lies west of a north-south line extending from Point Pelee, Ontario, to Sandusky, Ohio. The physical characteristics of the western basin differ considerably from the remainder of Lake Erie. It contains many shoals, reefs, and islands and is relatively shallow. Its average depth is little more than 24 feet with the deeper areas lying close to the Canadian shore. Shallow water is found around the islands and the bays along the Michigan and Ohio shorelines. In the central and eastern basins, maximum water depths range from 60 to 210 feet.

There are approximately 37,200 acres of wetland along the shoreline of Ohio, Michigan, and Ontario within the western basin of Lake Erie. Estimates of these acreages are Ohio - 25,000, Michigan - 8,500, and Ontario - 3,700.

Twenty-two islands, all within 12 miles of the mainland, are located within the western basin. Most of the islands are clustered between Point Pelee, Ontario, and Marblehead, Ohio. Several of these islands are very small (10 are less than 10 acres in size) and 13 are uninhabited. Pelee Island, Ontario, is the largest and is approximately 19 square miles in size. Six of the islands (Starve, Rattles, North Harbor, Chick, Little Chicken, and Lost Ballast) are merely projections of reefs above water and are very sparsely vegetated or are devoid of vegetation. The Rattles Islands lie off the northwest tip of Rattlesnake Island; North Harbor Island lies just north of East Sister Island. The very small islands, which are only a few feet above the water, are frequently overswept by wave action. Ligas (1952) reported that Little Chicken Island was not more than 5 feet above the lake level at its highest point. Present lake levels are approximately 2 feet higher than the 1952 levels (U.S. Department of Commerce, 1974). The size of these smaller, low-lying islands, and the type and amount of vegetation growing upon them is strongly influenced by the fluctuating lake levels. Since this report pertains primarily to the three Sister Islands, they will be described in more detail.

West Sister Island - West Sister Island is an uninhabited island, located 9 miles north of Navarre Marsh. It was proclaimed a National Wildlife Refuge in 1938 (Ligas, 1952). The island is now under consideration for inclusion in the National Wilderness Preservation System. Information on the vegetation presented here is summarized from the West Sister Island Wilderness Proposal (Bureau of Sport Fisheries and Wildlife, undated).

Hackberry trees cover over 75 percent of the 85-acre island. The remaining area is composed of open grasslands, bordered by chokecherry, and American plum. No marsh is present on the island. An unmanned lighthouse is maintained by the Coast Guard.

East Sister Island - East Sister Island is located in Ontario, 13 miles northeast of Navarre Marsh. It was recently established as a Provincial Nature Reserve by the Ontario Ministry of Natural Resources. The island is approximately 40 to 50 acres in size and is covered by woody vegetation dominated by elms (12 inches in diameter) on the western third; large elms, maples, poplars, chokecherries, and hickories on the central third; and a mixed stand of small trees, shrubs, and vines on the eastern third (Ligas, 1952). As on West Sister Island, no marsh is present, and the island is uninhabited.

Middle Sister Island - Middle Sister is a small (approximately 8 acres), privately owned island in Ontario, 17 miles north-northeast of Navarre Marsh. Tall hackberry trees were the major vegetation present when Ligas (1952) studied in the area. No marsh is present.

METHODS

A literature search was conducted that encompassed a review of various journals, indices, abstracting services, Department of Natural Resource publications, the Environmental Reports for Davis-Besse Unit No. 1, and for Units No. 2, and 3, and other miscellaneous publications. In conjunction with this search, individuals from Ohio State University, Bowling Green State University, the Ohio Department of Natural Resources, the Michigan Department of Natural Resources, the Ontario Ministry of Natural Resources, and Michigan State University, plus several private individuals, were contacted. Each specialist was questioned concerning the bird-island-marsh relationship and whether he was aware of other studies that had been conducted or were presently in progress.

Information specifically concerning the feeding grounds of the birds that use the islands of Lake Erie's western basin for nesting is limited. The information that was encountered was quite general in nature, and yielded little quantitative data.

The extent of marsh habitat in the western basin of Lake Erie was estimated by using the appropriate topographic maps for Ohio, Michigan and Ontario (see MAPS CITED). The estimate was restricted to those marshes associated with the shores along the lake and rivers that support marshes contiguous with the Lake Erie shoreline. These estimates may be slightly high due to the early dates on some of the topographic maps (see MAPS CITED). Widespread draining and/or filling of marshes over the years may have reduced the acreage considerably.

DISCUSSION

The importance of the western basin of Lake Erie as a nesting and migrational area for birds has long been recognized by ornithologists.

Campbell (1968) identified two migration pathways crossing the area. One route follows across the islands from Marblehead, Ohio, near Sandusky to Point Pelee, Ontario. The other follows along the Ohio shoreline northward into Michigan. These two routes conform to a general description, by Pettingill (1970), of migration routes that occur near bodies of water.

Scharf (1971) summarized the "critical nesting and migrational areas" of the Great Lakes areas within the United States. He listed several critical areas near Monroe, Michigan and Toledo and Sandusky, Ohio. Critical areas, as defined by Scharf, are those that serve as concentration points for nesting or migrating species. West Sister Island, North Bass Island, and Stoney Island (approximately 7 1/2 miles up the Detroit River from Lake Erie) are considered critical areas for the great blue heron, black-crowned night heron and great egret. Point Mouille, Sterling State Park, Bolles Harbor, Woodtick Peninsula, and Darby Marsh were considered critical nesting areas for common and/or black terns. Ballast Island, Gull Island's shoal, and Starve Island (near South Bass Island) were cited as critical nesting areas for herring gulls and ring-billed gulls.

Early published literature concerning the birds of the western basin of Lake Erie consists primarily of species lists (Baird, 1901; Jones, 1902; and Hicks, 1938). The ecological relationships between these species and the basin received only minimal discussion. A more recent list was completed and updated by Campbell (1968 and 1973). Each of these authors presented only superficial nesting records. The list of birds expected to be found on the islands was then generated from these lists and from the knowledge of the basic feeding habits of the birds.

In 1974 at least five islands had nesting colonies of one or more of the following: double-crested cormorants, great egrets, great blue herons, black-crowned night herons, or herring gulls (Table 1). This information was confirmed by personal communications.

Island Bird Populations

Ligas (1952) studied the migration, nesting, ecology, and feeding habits of fish-eating birds on the islands of the western basin of Lake Erie. Nesting data from his study have been condensed and are presented in Table 2. Judging from the information obtained through recent conversations with local authorities, the nesting populations have declined since Ligas' study. Declining populations also occurred during Ligas' study (see Starve Island, Table 2), but he offered no conclusions for the change in status. The precise location and magnitude of recent changes are unknown due to the lack of quantitative data.

Since the Sister Island group is of particular interest in this study, each island will be treated separately.

West Sister Island - Ligas (1952) reported that 6 nests of great egrets and 100 nests of great blue herons were on the island in 1946. In 1951 the same species plus black-crowned night herons were present, but the number of nests were not counted (Table 2).

Hoffman (1972) in a quarterly report for a study concerning the relationships of environmental pollutants with herons in Lake Erie, mentioned that there were 1,100 active nests of great blue herons, black-crowned night herons, and great egrets; this fact was corroborated by Mr. M. Block (Curator of Birds, Emeritus - Toledo Zoological Park).

East Sister Island - Great blue heron nesting colonies of 100, 85 and 117 nests in 1949, 1950, and 1951, respectively (Table 2), were reported by Ligas (1952). He makes no mention of any other species.

Simpson (1974) in a study of the reproduction of three fish-eating birds in southeastern Ontario, stated that three species (great blue heron, great egret, and black-crowned night heron) were nesting on the island in 1972. He estimated 250 nesting individuals on the Island in 1972, a substantial but unexplained increase over Ligas' estimate. Mr. R. Lincoln (Biologist, Ministry of Natural Resources, Chatham, Ontario) also reported that great egrets, great blue herons, and black-crowned night herons nested there in 1974; however, no quantitative data were presented.

Middle Sister Island - In 1949, 100 nests of common terns were reported by Ligas (1952). However, in 1951 he reported only 15 nests, and five herring gull nests. Herring gulls were reported nesting on Middle Sister

Island in 1952, as were 12 black-crowned night herons (Table 2). Mr. P. Plato (Conservation Officer, Ministry of National Resources, Tillbury, Ontario) reported that no herons or egrets were nesting there in 1974; however a "few" herring gulls nests were present.

Studies on the feeding habits of the islands' bird populations have been limited and somewhat contradictory, but it is generally accepted that there is not enough food on the islands to sustain the nesting birds there, and additional food must be sought off the islands.

Ligas (1952) reported food habits determined by direct field observations, stomach analysis, and examination of foods regurgitated by nestling birds. He concluded that the commercial fishing industry of western Lake Erie provided a vital supply of food for gull, tern, and heron populations in the western basin. During the months of June, July, and August when large amounts of food are required for the nestlings, Ligas reported that discarded (undersized) yellow perch, Storer's chub, yellow pike perch, and sheepshead, were the principal food of fish-eating birds in the western basin. Simpson (1974) also reported that during the nesting season most of the food given to nestlings was dead fish from either natural die-off, or undersized or rough fish discarded by commercial fishermen. Species most commonly taken were yellow perch, sheepshead, and goldfish.

The results of these two studies suggest that the herons and egrets of the islands might rely primarily on the natural die-off of fish or discarded fish in Lake Erie as a food source rather than the mainland marshes, particularly during the nesting season. Hoffman (1974), however, found the remains of crayfish in the regurgitated food of great blue herons, black-crowned night herons and great egrets taken on West Sister Island during various months of sampling. The particular species of crayfish found occurs within the mainland marshes but not on West Sister Island. Therefore, the great blue heron, black-crowned night heron and great egret of West Sister Island are expected to at least partially utilize the mainland marshes for a food source, even during the nesting season when the pace of food gathering is hastened.

Hoffman also noted that birds leave and return to West Sister Island from all directions in their apparent search for food, but although the population as a whole seemed to disperse in all directions, it was not known if particular individuals continually sought a favorite feeding area.

After the nesting season, the nesting colonies begin to disperse and many birds, at least the great egret, move to roosts in the mainland marshes. During this time, the marshes become more important as sources of food.

Navarre and Other Mainland Marshes

The western basin of Lake Erie includes 37,200 acres of marsh, most of which is owned by private shooting clubs. The Bureau of Sport Fisheries and Wildlife manage approximately 8,000 acres of marshland within 15 miles of

Navarre Marsh (Figure 1). Included in this total are the 4,807-acre Ottawa National Wildlife Refuge, 480-acre Darby Marsh, 2,250-acre Cedar Point National Wildlife Refuge, and the 533-acre Navarre Marsh itself. Other nearby managed marshes include the 30-acre Metzger State Marsh, 2,250-acre Magee State Marsh and the privately owned Winous Point Club (10 miles southeast of Navarre). The Ottawa National Wildlife Refuge manages their lands primarily for attracting large populations of migrating waterfowl through the use of dikes and other water control systems.

Several species of waterfowl including mallards, blue-winged teal, and wood ducks are known to nest on the Ottawa National Wildlife Refuge. Other marsh birds common to the Refuge are herons, egrets, bitterns, gulls, and terns. Data showing frequency of occurrence of this latter group of birds is shown in Table 4. This table is based upon 4 years of data, published in the Environmental Report for Davis-Besse Units No. 2 and 3 (Toledo Edison Company, 1974a). This data shows that great blue herons, herring gulls, and ring-billed gulls were the species present most frequently on the Refuge.

The bulk of the area at Navarre is covered by a freshwater marsh that is surrounded and transected by earthern dikes. Cottonwood, black willow, rough leafed dogwood, staghorn sumac, river-bank grape and several grasses are common on the dikes. Wherever there is standing water throughout most of the year, cattail, softstem bulrush, white water lily, milfoil, sago pondweed and curly-leafed pondweed are abundant. The plant communities on the dikes and in the marsh proper will probably change constantly as the dikes are repaired and the marsh is managed in the future (U.S. Atomic Energy Commission, 1973). Faunal species associated with this marsh include a variety of crustaceans, amphibians and fish, all major constituents of the diets of herons and egrets (Martin, and others, 1951).

Mallards, black ducks and blue-winged teal are the most abundant nesting waterfowl at the Navarre Marsh. Other birds that are common during the summer are redwinged blackbirds, swallows, warblers, gulls, common egrets, mourning doves, wrens, starlings, black-night crowned heron and great blue heron (U.S. Atomic Energy Commission, 1973).

Dr. W. B. Jackson of the Bowling Green State University Environmental Studies Center is currently conducting a terrestrial monitoring program within Navarre Marsh. This data (Table 5) from two bird survey routes also indicated that great blue herons, black-crowned night herons, great egrets, and mixed flocks of gulls were the most abundant species in the area.

Presently, Navarre Marsh is under consideration for an intensive management plan. An arrangement between the Toledo Edison Company and the United States Department of the Interior, Bureau of Sports Fisheries and Wildlife, calls for the management of Navarre Marsh as part of the Ottawa National Wildlife Refuge. Toledo Edison has supplied funds that have been used for the construction of dikes and installation of pumps for water level control and the maintenance of these facilities. Two distinct marsh management plans are being proposed (Toledo Edison Company, 1974b) by Toledo

Edison. Simply stated, they call for either (1) promoting a semi-natural cattail marsh by maintaining water in the marsh throughout the year, or (2) maintaining an early successional wet soils marsh, which would be flooded in fall, winter, and spring.

In the opinion of Dr. Robert Meeks (1974) of Winous Point Club, a marsh management plan can greatly affect the "attractiveness" of a marsh to species such as the great blue heron, great egret and black-crowned night heron. Extensive mudflats and shallows during most of the summer would favor those species, whereas early draw downs and fall flooding, in contrast, would favor waterfowl. Bent (1963) indicates that marshes with water levels less than 2 feet deep will provide the best opportunities for feeding by herons and egrets.

SUMMARY AND CONCLUSIONS

A wide variety of bird species can be found on the islands in the western basin of Lake Erie, particularily during migration. These islands serve as a resting area and a "land bridge" for species moving northward from Ohio to Ontario. Common populations of the islands, however, are generally limited to fish-eating bird species.

Fourteen islands in the western basin of Lake Erie have supported nesting colonies of cormorants, herons, egrets, gulls, and/or terns since 1945. The principle nesting species on West Sister, Middle Sister and East Sister Islands are the great blue heron, great egret and black-crowned night heron.

The lack of marshland on the islands limits the available food required by herons and egrets. Consequently, they must leave the island and seek food in the mainland marshes or the open waters of Lake Erie, in order to sustain themselves and their nestlings. Ligas (1952) and Simpson (1974) reported that the island bird populations relied primarily on natural fish die-offs and fish discarded by commercial fisherman for their source of food. Hoffman (1974) however, indicated that great blue herons, great egrets and black-crowned night herons do, at least partially, use the mainland marshes for feeding.

Although the island bird populations are known to disperse and return in all directions in apparent search for food (Hoffman, 1974), it is not known whether particular individuals repeatedly seek a favored feeding ground.

It is expected that egrets and herons from the islands would feed in Navarre Marsh. Navarre Marsh is in close proximity to the islands and contains crustaceans, fish and amphibians, favored foods of herons and egrets (Martin, and others, 1951). Furthermore, great blue herons, great egrets, and black-crowned night herons have been identified in Navarre Marsh (Toledo Edison Company, 1974a). However, Navarre Marsh is only a small part of the 37,200 acres of marshland in the western basin of Lake Erie, and is not particularly unique; those species are also commonly seen feeding in most of the larger marshes. Therefore, it must be concluded that Navarre Marsh is only one of many common feeding grounds available to the island birds.

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Amherstburg, Sheet 40 J/3 East Half, 1:50000 Topographic: Department of National Defense, Canada.

Essex, Sheet 40 J/2 East, 1:50000 Topographic: Department of National Defense, Canada.

Essex, Sheet 40 J/2 West, 1:50000 Topographic: Department of National Defense, Canada.

Pelee, Sheet 40 G/15 East, 1:50000 Topographic: Department of National Defense, Canada.

Pelee, Sheet 40 G/15 West, 1:50000 Topographic: Department of National Defense, Canada.

Table 1. Presence of nesting cormorants, herons, egrets, and gulls on the islands of western Lake Erie.

	Bird Species[a]					
Island	Double-crested cormorant	Great egret	Great blue heron	Black-crowned night heron	Herring gull	Authority[b]
Big Chicken	X				X	Robert Lincoln
East Sister		X	X	X	X	Robert Lincoln
Middle Sister					X	Pierce Plato
Pelee				X		Paul Pratt
West Sister		X	X	X	X	Jim Carroll

[a] The "X" indicates that these birds are likely nesting on the island in 1974; no population estimate was given.

[b] Position and affiliation of these authorities are listed in Appendix C.

Table 2. Location and population estimates for cormorants, herons, egrets, gulls, and terns nesting on the islands of western Lake Erie.[a]

	Bird Species																			
	Double-crested cormorant		Great egret		Great blue heron		Green heron		Black-crowned night heron		American bittern		Least bittern		Herring gull		Common tern		Black tern	
Island	No. Nests	Year	No. Nests	Year	No. Nests	Year	No. Nests	Year	No. Nests	Year	No. Nests	Year	No. Nests	Year	No. Nests	Year	No. Nests	Year	No. Nests	Year
Big Chicken	2	1951													3	1948				
	2	1952													405	1949				
															510	1950				
															138	1951				
East Sister					100	1949														
					85	1950														
					117	1951														
Green																	1	1950		
																	3	1951		
																	4	1952		
Kelleys							4	1951												
Little Chicken	10	1949																		
	16	1950																		
	10	1951																		
	4	1952																		
Lost Ballast																	12	1949		
																	33	1950		
																	33	1951		
																	15	1952		
Middle Bass							2	1951											1	1949
Middle Sister									12	1952					5	1951	100	1949		
															NE[b]	1952	15	1951		
North Bass							4	1951	NE[b]	1950	NE[b]	1947			1	1951			1	1947
									167	1951									1	1951
North Harbor															6	1951	15	1949		
															8	1952	30	1950		
Pelee							NE[b]	1950	100	1950							21	1950	1	1950
																	27	1951	1	1952
Rattlesnake															1	1950	45	1949		
															1	1951	39	1950		
															2	1952	62	1951		
																	46	1952		
Starve															2	1951	100	1949		
															4	1952	18	1950		
																	14	1951		
																	2	1952		
West Sister			6	1946	100	1946			NE[b]	1951										
			NE[b]	1951	NE[b]	1951														

[a] Based on [illegible]a (1952).

Table 3. Herons and egrets nesting on East Sister Island.[a]

Species	Number of Individuals or Nests	Year
Great blue herons and black-crowned night herons	800 nests	1954[b]
Great egrets	8 pairs	1972
	10 individuals	1971
Great blue herons	250 individuals	1972
	200 nests	1971
Black-crowned night herons	250 pairs	1972
	300 nests	1957
	200 nests	1971

[a] Based on Simpson (1974).

[b] This is the year the data were reported; it may not be the year the data were collected.

Table 4. Monthly presence of cormorants, herons, egrets, gulls, and terns, Ottawa National Wildlife Refuge, 1969 through 1972[a].

Species	Month[b]											
	J[c]	F	M	A[c]	M	J	J	A	S	O	N	D[c]
Double-crested cormorant				1	1			1	1	2	1	1
Great blue heron	3	3	4	3	4	4	4	4	4	4	4	3
Green heron				2	4	4	4	2	4	2		
Little blue heron					1	1	1	1				
Cattle egret				1	2	1	1		1	2		
Great egret			3	3	4	4	4	4	3	4	4	
Snowy egret				1								
Black-crowned night heron			1	2	4	4	4	4	4	4	1	
Yellow-crowned night heron					1			1				
Least bittern					2	1	2	1	2			
American bittern				2	3	2	1		1	1		
Glossy ibis					2							
Glaucous gull				1								
Iceland gull			1									
Great black-backed gull	1	3	4	3	1	1	1	1		3	3	3
Herring gull	2	3	4	3	4	4	4	4	3	4	4	3
Ring-billed gull	1	3	4	3	4	3	4	4	4	4	4	3
Franklin's gull								1				
Bonaparte's gull		1	1	2	3					1	3	3
Forster's tern							1	2	4	3	3	
Common tern				2	3	3	4	4	4	1	4	
Caspian tern				2	3		2	4	4			
Black tern					2	1	3	3				

[a] Based on data presented in the Davis-Besse Nuclear Power Station Units No. 2 & 3 Environmental Report, Chapter 2, Appendix 2E (Toledo Edison Company 1974a).

[b] Number of years in the 4-year period each species was observed.

[c] Only 3 years' data were available.

Table 5. Numbers of herons, egrets, gulls, and terns at Navarre Marsh[a].

Species	Study Area Circuit			Mud Flats Circuit	
	Aug. 8	Aug. 9	Aug. 20	Aug. 9	Aug. 20
Great blue heron	6	1	1	250	385
Green heron	2	2	1	0	1
Great egret	4	3	8	130	170
Black-crowned night heron	75	75	100	0	14
Gulls[b]	0	0	0	200	150
Herring gull	0	0	2	0	0
Ring-billed gull	2	0	0	0	0
Common tern	4	0	2	0	2

[a] Based on unpublished data of Dr. William B. Jackson, Bowling Green State University.

[b] Mixed flocks of herring and ring-billed gulls.

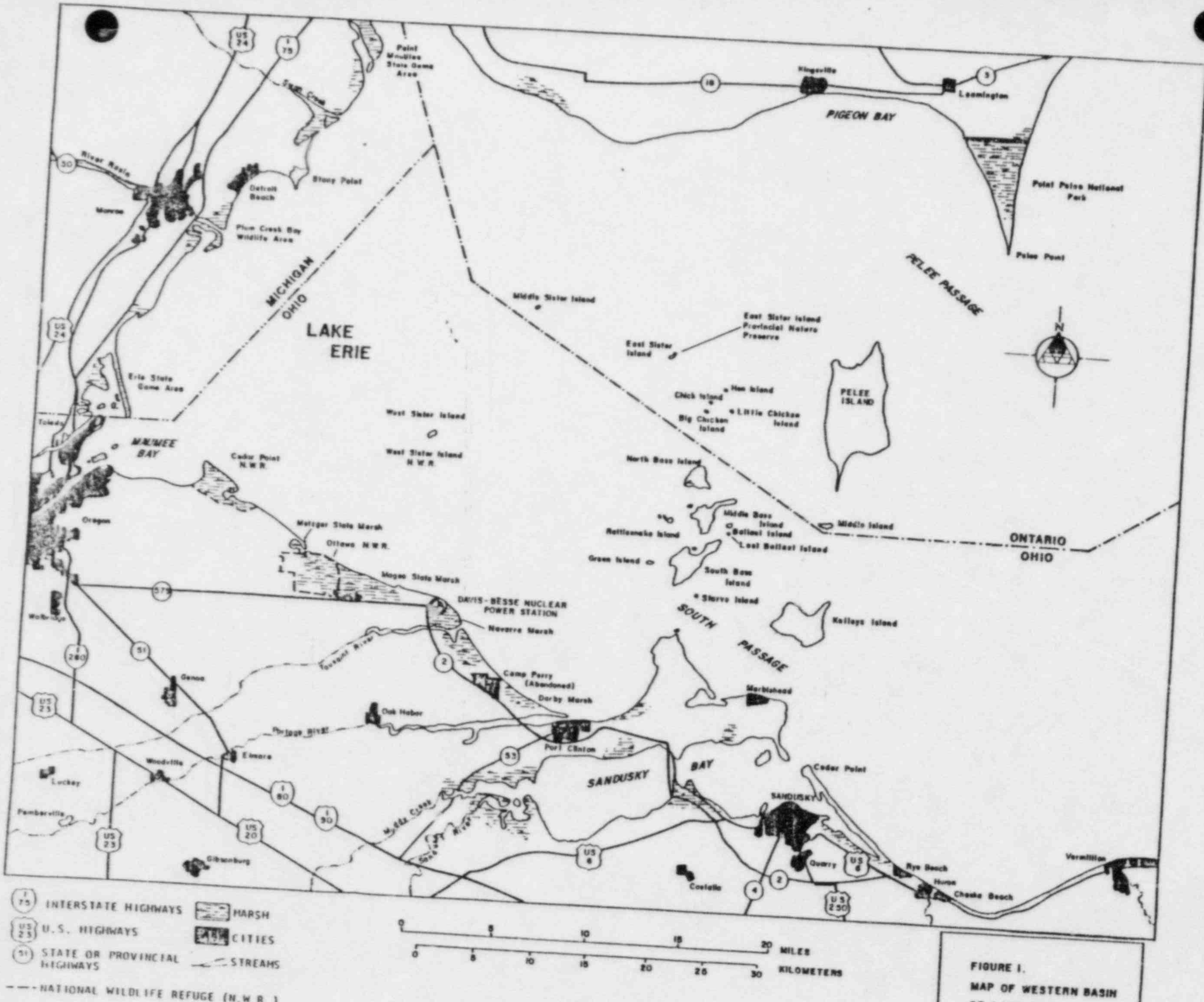

FIGURE I.
MAP OF WESTERN BASIN
OF LAKE ERIE

APPENDIX A.

Scientific Names of Plants Used in Text.

Common Name	Scientific Name
Cattail	*Typha* spp.
Poplar	*Populus* spp.
Hickory	*Carya* sp.
Elm	*Ulmus* sp.
Hackberry	*Celtis occidentalis*
American plum	*Prunus americana*
Chokecherry	*Prunus virginiana*
Maple	*Acer* sp.

APPENDIX B.

Scientific Names of Birds Used in Text.

Common Name	Scientific Name
Double-crested cormorant	Phalacrocorax auritus
Great blue heron	Ardea herodias
Green heron	Butorides virescens
Little blue heron	Florida caerulea
Cattle egret	Bubulcus ibis
Great egret	Casmerodius albus
Snowy egret	Leucophoyx thula
Black-crowned night heron	Nycticorax nycticorax
Yellow-crowned night heron	Nyctanassa violacea
Least bittern	Ixobrychus exilis
American bittern	Botaurus lentiginosus
Glossy ibis	Plegadis falcinellus
Canada goose	Branta canadensis
Mallard	Anas platyrhynchos
Blue-winged teal	Anas discors
Wood duck	Aix sponsa
American coot	Fulica americana
Glaucous gull	Larus hyperboreus
Iceland gull	Larus glaucoides
Great black-backed gull	Larus marinus
Herring gull	Larus argentatus
Ring-billed gull	Larus delawarensis
Franklin's gull	Larus pipixcan
Bonaparte's gull	Larus philadelphia
Forster's tern	Sterna forsteri
Common tern	Sterna hirundo
Caspian tern	Hydroprogne caspia
Black tern	Chlidonias niger

APPENDIX C.

Specialists Consulted During the Course of the Study.

Name	Position	Affiliation
Mr. M. Block	Curator of Birds, Emeritus	Toledo Zoological Park, Toledo, Ohio
Dr. T. Bookhout	Unit Leader	Ohio Cooperative Wildlife Research Unit, Ohio State University, Columbus, Ohio
Mr. J. Carroll	Refuge Manager	Ottawa National Wildlife Refuge, Oak Harbor, Ohio
Mr. E. Fick	Marsh Manager	Davis-Besse Nuclear Power Station, Toledo Edison Company, Ohio
Mr. J. Foote	Wildlife Biologist	Point Mouille District Office, Michigan Department of Natural Resources, Mouille, Michigan
Dr. M. Giltz	Professor of Zoology	Ohio State University Columbus, Ohio
Mr. B. Gray	Assistant Naturalist	Rondeau Provincial Park, Rondeau Park, Ontario
Mr. R. Hoffman	Graduate Student	Ohio State University Columbus, Ohio
Dr. W. Jackson	Director	Environmental Studies, Bowling Green State University, Bowling Green, Ohio
Mr. V. Lang	General Biologist	Division of Ecological Services, U.S. Fish and Wildlife Service, East Lansing, Michigan
Mr. R. Lincoln	Fish and Wildlife Biologist	Ministry of Natural Resources, Chatham, Ontario

APPENDIX C (continued)

Name	Position	Affiliation
Dr. R. Meeks	Superintendant Biologist	Winous Point Shooting Club Sandusky, Ohio
Mr. B. Morin	Naturalist	Point Pelee National Park, Leamington, Ontario
Mr. S. Odonell	Assistant Naturalist	Rondeau Provincial Park, Rondeau Park, Ontario
Mr. P. Plato	Conservation Officer	Ministry of Natural Resources, Tillbury, Ontario
Mr. P. Pratt	Naturalist	Rondeau Provincial Park, Rondeau Park, Ontario
Dr. H. Prince	Assistant Professor	Fisheries and Wildlife Department, Michigan State University, East Lansing, Michigan
Dr. L. Putnam	Professor	Zoology Department, Ohio State University, Columbus, Ohio
Mr. D. Ross	Naturalist	Point Pelee National Park, Leamington, Ontario
Mr. J. Sieh	Biologist	Division of Planning and Administration, U.S. Fish and Wildlife Service, East Lansing, Michigan
Mr. J. Weeks	Research Biologist	Sportsman's Migratory Bird Center, Ohio Department of Natural Resources, Oak Harbor, Ohio

EXHIBIT F

Forested and shrubby areas of the Davis-Besse site provide habitat for a
number of songbirds (as noted in Tables 1305-C-28 and 29). Even though no
1 raptors were known to nest on the site, suitable habitat is present and
several species were observed during non-breeding periods. Small mammals
and birds constitute the main diet of the raptors and woodland areas
provide buds and some fruits as food for the passerine species. The
open fields are presently disturbed and are producing only a small
number of desirable seed plants.

Seven species that are listed on the Ohio or United States Endangered
Species Lists[6,7] could occur on the site. They are the American peregrine
falcon, sharp-shinned hawk, bald eagle, king rail, Kirtlands warbler,
upland sandpiper, and common tern. Of these, only the bald eagle and
1 common tern have been observed on or over the site.

Mammals

The Davis-Besse site lies within the geographic ranges of 43 of the 74
species of mammals that occur in the Great Lakes Region.[8-11] Onsite
study using direct observation, sign, and trapping verified the presence
of 19 species. The more common species on the site included opossum,
eastern cottontail, woodchuck, white-footed mouse, muskrat, Norway rat,
and raccoon. A list of mammals observed on the site is provided in
Table 1305-C-32.

The white-footed mouse is the principal small mammal species that occurs
in the wooded areas on the site. Quantitative sampling of the grid on the
beach ridge during spring of 1974 resulted in only one capture after 378
trap-nights effort (see Section 1305-C.1.c for a description of the live-
1 trapping grid). The fall sampling in the same area resulted in 28 captures
(15 individuals) with 504 trap-nights effort. Trapping in the woodland
near the Unit No. 1 cooling tower (woodlot A) in spring 1974 resulted in
four captures with 30 trap-nights effort.

The muskrat was once the most abundant large mammal on the site. Its
numbers, however, have been reduced, because the high water levels from
both the water manipulation and natural causes within the marsh have
limited the distribution of cattail and other emergent aquatic plants.
During the period of January through March 1973, a trapper removed 670

EXHIBIT G

Chapter 3: HAZARD IDENTIFICATION

The adverse biological reactions associated with ionizing radiations, and hence with radioactive materials, are carcinogenicity, mutagenicity, and teratogenicity. Carcinogenicity is the ability to produce cancer. Mutagenicity is the property of being able to induce genetic mutation, which may be in the nucleus of either somatic (body) or germ (reproductive) cells. Teratogenicity refers to the ability of an agent to induce or increase the incidence of congenital malformations as a result of permanent structural or functional deviations produced during the growth and development of an embryo (these are more commonly referred to as birth defects).

Ionizing radiation causes injury by breaking constituent body molecules into electrically charged fragments called "ions" and thereby producing chemical rearrangements that may lead to permanent cellular damage. The degree of biological damage caused by various types of radiation varies according to how close together the ionizations occur. Some ionizing radiations (e.g., alpha particles) produce intense regions of ionization. For this reason they are called high-LET (linear energy transfer) particles. Other types of radiation [such as high-energy photons (x-rays)] that release electrons that cause ionization and beta particles are called low-LET radiations because of the sparse pattern of ionization they produce. In equal doses, the carcinogenicity and mutagenicity of high-LET radiations are generally an order of magnitude or more greater than for low-LET radiations.

Radium, radon, radon daughters, and several other naturally occurring radioactive materials emit alpha particles; thus, when these materials are ingested or inhaled, they are a source of high-LET particles within the body. Man-made radionuclides are usually beta and photon emitters of low-LET radiations. Notable exceptions to this generalization are plutonium and other transuranium radionuclides, most of which emit alpha radiation.

3.1 Evidence That Radiation Is Carcinogenic

The production and properties of x-rays were demonstrated within one month of the public reporting of Roentgen's discovery of x-rays. The first report of acute skin injury was made in 1896 (Mo67). The first human cancer attributed to this radiation was reported in 1902 (Vo02). By 1911, 94 cases of radiation-related skin cancer and 5 cases of leukemia in man had been reported in the literature (Up75). Efforts to study this phenomenon through the use of experimental animals produced the first reported radiation-related cancers in experimental animals in 1910 and 1912 (Maa10, Maa12). Since that time, an extensive body of literature has evolved on radiation carcinogenesis in man and animals. This literature has been reviewed most recently by the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), and by the National Academy of Sciences Advisory Committee on the Biological Effects of Ionizing Radiations (NAS-BEIR Committee) (UNSCEAR82, NAS80).

Identification of the carcinogenicity of radioactive emissions followed a parallel course. The first association of inhaled radioactive material and carcinogenesis in man was made by Uhlig in 1921 in a study of radon exposure and lung cancer in underground miners in the Erz Mountains (Uh21). This association was reaffirmed by Ludewig and Lorenser in 1924 (Lu24)). Ingestion of radioactive materials was also demonstrated to be a pathway for carcinogenesis in man. As early as 1925 ingested radium was known to cause bone necrosis (Ho25), and in 1929 the first report was published on the association of radium ingestion and osteogenic sarcoma (Mab29).

The expected levels of exposure to radioactive pollutants in the environment are too low to produce an acute (immediate) response. Their effect is more likely to be a delayed response, in the form of an increased incidence of cancer long after exposure. An increase in cancer incidence or mortality with increasing radiation dose has been demonstrated for many types of cancer in both human populations and laboratory animals (UNSCEAR77,82). Studies of humans exposed to internal or external sources of ionizing radiation have shown that the incidence of cancer increases with increased radiation exposure. This increased cancer, however, is usually associated with appreciably greater doses and exposure frequencies than those encountered in the environment. Malignant tumors most often appeared long after the radiation exposure, usually 10 to 35 years later (NAS80, UNSCEAR82). The tumors appeared in various organs. In the case of internal sources of radiation due to radioactive materials, the metabolism of the materials generally leads to their deposition in specific organs and results in a higher-than-normal risk of cancer in these organs.

Whereas many, if not most, chemical carcinogens appear to be organ- or tissue-specific, ionizing radiation can be considered pancarcinogenic. According to Storer (Stb75): "Ionizing radiation in sufficiently high dosage acts as a complete carcinogen in that it serves as both initiator and promoter. Further, cancers can be induced in nearly any tissue or organ of man or experimental animals by the proper choice of radiation dose and exposure schedule." Radiation-induced cancers in humans have been reported in the following tissues: thyroid, female breast, lung, bone marrow (leukemia), stomach, liver, large intestine, brain, salivary glands, bone, esophagus, small intestine, urinary bladder, pancreas, rectum, lymphatic tissues, skin, pharynx, uterus, ovary, mucosa of cranial sinuses, and kidney (UNSCEAR77,82; NAS72,80; Be77, Ka82, Wa83).

A number of studies of populations exposed to high levels of radiation have identified which organs are at greatest risk following radiation exposure. Brief discussions of these findings follow.

1. Atomic Bomb Survivors - The survivors of the atomic bomb explosions at Hiroshima and Nagasaki, Japan, were exposed to whole-body external radiation doses of 0 to more than 200 rads.* An international group has been observing the population since 1950. The most recent reports published by this group (Ka82, Wa83) indicate that an increase in cancer mortality has been shown for many cancers, leukemia, thyroid, breast, lung cancer, esophogeal and stomach cancer, colon cancer, cancer of urinary organs, and multiple myeloma.

2. Ankylosing Spondylitics - A large group of patients were given x-ray therapy for ankylosing spondylitis of the spine during the years 1934 to 1954. X-ray doses usually exceeded 100 rad. British investigators have been following this group since about 1957. The most recent review of the data shows excess cancers in irradiated organs, including leukemia, lymphoma, lung and bone cancer, and cancer of the pharynx, esophagus, stomach, pancreas, and large intestine (UNSCEAR77, NAS80).

3. Mammary Exposure - Several groups of women who were exposed to x-rays during diagnostic radiation of the thorax or during radiotherapy for conditions involving the breast have been studied. Although most of the groups have been followed only a relatively short time (about 15 years), a significant increase in the incidence of breast cancer has been observed (UNSCEAR77). The dose that produced these effects averaged about 100 rads.

4. Medical Treatment of Benign Conditions - Several groups of persons who were medically treated with x-rays to alleviate some benign conditions have been studied. Excess cancer has developed in many of the organs irradiated (e.g., breast, brain, thyroid, and probably salivary glands, skin, bone, and pelvic organs) following doses ranging from less than 10 to more than 100 rads (UNSCEAR77). Excess leukemia has also occurred in some groups. The followup period for most groups has been short, often less than 20 years.

5. Underground Miners - Studies of excess cancer mortality in U.S. underground miners exposed to elevated levels of radon started in the 1950's and 1960's. Groups that have worked in various types of mines, including uranium and fluospar, are being studied in the United States, Canada, Great Britain, Sweden, China, and Czechoslovakia. Most of the miners studied have been subjected to high rates of exposure; however, a recent review indicates increased incidence of lung cancer has been observed in some miners exposed

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* The rad is the unit of dose in common use; 1 rad equals 100 ergs of absorbed energy per gram of material.

at cumulative levels approximating those that can occur wherever high environmental concentrations of radon are present (NAS80). The dose response shown in all the study groups is nearly proportional to the dose (NAS80).

6. Ingested or Injected Radium - Workers who ingested Ra-226 while painting clock dials have been studied for 35 to 45 years, and patients who received injections of Ra-226 or Ra-224 for medical purposes have been studied for 20 to 30 years (NAS72,80). Excess incidence of leukemia and osteosarcoma related to Ra-224 exposure has been observed. Calculated cumulative average doses for these study groups ranged from 200 to 1700 rads. A study now under way that deals with exposure levels under 90 rads should provide additional data (NAS80).

7. Injected Thorotrast - Medical use of Thorotrast (colloidal thorium dioxide) as an x-ray contrast medium introduced radioactive thorium and its daughters into a number of patients. Research studies have followed patients in Denmark, Portugal, Japan, and Germany for about 40 years and patients in the United States for about 10 years (UNSCEAR77, NAS80). An increased incidence of liver, bone, and lung cancer has been reported in addition to increased anemia, leukemia, and multiple myeloma (In79). Calculated cumulative doses range from tens to hundreds of rads.

8. Diagnostic X-ray Exposure During Pregnancy - Effects of x-ray exposure of the fetus during pregnancy have been studied in Great Britain since 1954, and several retrospective studies have been made in the United States since that time (NAS80, UNSCEAR77). Increased incidence of leukemia and other childhood cancers may be induced in populations exposed to absorbed doses of 0.2 to 20 rads *in utero* (NAS80, UNSCEAR77).

Not all of the cancers induced by radiation are fatal. The fraction of fatal cancers is different for each type of cancer. The BEIR-3 committee estimated the fraction of fatal cancers by site and sex (NAS80). Estimates of cancers by site ranged from about 20 percent fatal in the case of thyroid cancer to 100 percent fatal in the case of liver cancer. They concluded that, on the average, females have 2.00 times as many total cancers as fatal cancers following radiation exposure, and males have 1.5 times as many (NAS80). Although many of the radiation-induced cancers are not fatal, they still are costly and adversely affect the persons life style for the remainder of his or her life span. Just how these costs and years of impaired life should be weighed in evaluating the hazards of radiation exposure is not certain. In this assessment, only the risk of fatal carcinogenesis is addressed.

In addition to the evidence that radiation is a pancarcinogen and as such can induce cancers in nearly any tissue or organ, it can also induce cancer by any route of exposure (dermal, inhalation, ingestion, and injection).

Inhalation is likely to be the major route of environmental exposure to airborne radioactive pollutants, and the principal organ at risk is likely to be the lung. Some radiation exposure to airborne pollutants by the ingestion route is possible, however, as these pollutants are deposited on soil, on plants, or in sources of water. Ingestion of inhaled particulate also occurs. Some radionuclides may also cause whole-body gamma radiation exposure while airborne or after deposition on the ground.

Estimates of cancer risk are based on the absorbed dose of radiation in an organ or tissue. Given the same type of radiation, the risk for a particular dosage would be the same, regardless of the source of the radiation. Numerical estimates of the cancer risk posed by a unit dose of radiation in various organs and tissues are presented in Chapter 8. The models used to calculate radiation doses from a specific source are described in Chapters 6 and 7.

The overwhelming body of epidemiological (human) data makes it unnecessary to base major conclusions concerning the risk of radiation-induced cancers on evidence provided by animal tests; however, these data are relevant to the interpretation of human data (NAS80) and contribute additional evidence to the epidemiological data base for humans. Radiation-induced cancers have been demonstrated in several animal species, including rats, mice, hamsters, guinea pigs, cats, dogs, sheep, cattle, pigs, and monkeys. Induced through multiple routes of administration and at multiple dose levels, these cancers have occurred in several organs or tissues. These animal studies have provided information on the significance of dose rate compared with the age of the animals at exposure, the sex of the animals, and the genetic characteristics of the test strain. They have shown that radiation-induced cancers become detectable after varying latent periods, sometimes several years after exposure. The studies further show that the total number of cancers that eventually develop varies consistently with the size of the dose each animal receives. Experimental studies in animals have also established that the carcinogenic effect of high-LET radiation (alpha radiations or neutrons) is greater than that of low-LET radiation (x-rays or gamma rays).

A number of researchers have induced transformations in mammalian tissue culture, including the embryo cells of mice and hamsters (Bo84, Ke84, Ha84, Gu84). Researchers have found that the DNA molecule is the carrier of radiation-induced transformations and that the radiation causes alterations in specific segments of genetic information (Bo84). Kennedy and Little have postulated that radiation-induced cell transformation is a two-step process (Ke84). In the first step, an alteration frequently occurs in a large fraction of the cells exposed to a large dose (600-rad) or to a low dose (100-rad) and a promoting agent. The second step is a rare event that occurs in one cell out of the million cells that are produced from the irradiated cells and involves the malignant transformation of that cell. This transformation occurs randomly during the growth stage of irradiated cultures. A significant finding of this research is that the process involved in the malignant transformation of mouse embryo cells caused by radiation is similar to that caused by chemical carcinogens. Another major finding of recent research (Gu84) is that DNA from radiation-induced mouse tumors contains an activated oncogene that can transform specific types of cultured cells when introduced into these cells. The researchers also found that a difference in only one base in the oncogene was responsible for the transformation. Thus, radiation can induce tumors even when only a small change in the DNA occurs as a result of irradiation.

In like concentrations, radioactive materials are quite potent when compared with chemical carcinogens. Chromosome aberrations in cultured human peripheral lymphocytes have been demonstrated at Rn-222 alpha doses of about 48 mrads/y with an external gamma dose of about 100 mrads/y (Po77). Use of the dose conversion factor of these same investigators (Fi71) translates to a continuous exposure of about 0.042 pg/m^3 of Rn-222 and its daughters. Moreover, studies of underground miners have demonstrated significant increases in the incidence of lung cancer at 50 cumulative working level months of Rn-222 exposure occurring across a 17-year average period of exposure.* This is equivalent to about 0.1 of the working level of Rn-222 and its daughters in residential atmospheres. An equivalent air concentration would be about 20 nCi/m^3 of Rn-222 or 0.130 pg/m^3 of Rn-222 and its daughters. (For a more detailed discussion of working level exposures, see Chapter 8.)

3.2 Evidence That Radiation is Mutagenic

Radiation can change the structure, number, or genetic content of the chromosomes in a cell nucleus. These genetic radiation effects are classified as either gene mutations or chromosomal aberrations. Gene mutations refer to alterations of the basic units of heredity, the genes. Chromosomal aberrations refer to changes in the normal number or structure of chromosomes. Both gene mutation and chromosomal aberrations are heritable; therefore, they are considered together as genetic effects. Mutations and chromosomal aberrations can occur in somatic (body) or germ (reproductive) cells. In the case of germ cells, the mutagenic effect of radiation is not seen in those persons exposed to the radiation, but in their descendents.

Mutations often result in miscarriages or produce such undesirable changes in a population as congenital malformations that result in mental or physical defects. Mutations occur in many types of cells; no tendency toward any specific locus or chromosome has been identified. For this reason, they can affect any characteristic of a species. A relatively wide array of chromosome aberrations occur in both humans and animals.

Early experimental studies showed that x-radiation is mutagenic. In 1927, H. J. Muller reported radiation-induced genetic changes were reported in animals, and in 1928, L. J. Stadler reported such changes in

*Personal communication from E. P. Radford to Dr. Neal Nelson (ORP), 1981.

plants (Ki62). Although genetic studies were carried out in the 1930's, mostly in plants and fruit flies (Drosophila), the bulk of the studies on mammals started after the use of nuclear weapons in World War II (UNSCEAR58).

Very little quantitative data are available on radiogenic mutations in humans, particularly from low-dose exposures, for the following reasons: these mutations are interspersed over many generations, some are so mild they are not noticeable, and some mutagenic defects that do occur are similar to nonmutagenic effects and are therefore not necessarily recorded as mutations. The bulk of data supporting the mutagenic character of ionizing radiation comes from extensive studies of experimental animals, mostly mice (UNSCEAR77,82; NAS72,80). These studies have demonstrated all forms of radiation mutagenesis--lethal mutations, translocations, inversions, nondisjunction, point mutations, etc. Mutation rates calculated from these studies are extrapolated to humans (because the basic mechanisms of mutations are believed to be the same in all cells) and form the basis for estimating the genetic impact of ionizing radiation on humans (NAS80, UNSCEAR82). The vast majority of the demonstrated mutations in human germ cells contribute to both increased mortality and illness (NAS80, UNSCEAR82). Moreover, the radiation protection community is generally in agreement that the probability of inducing genetic changes increases linearly with dose and that no "threshold" dose is required to initiate heritable damage to germ cells.

A considerable body of evidence has been documented concerning the production of mutations in cultured cells exposed to radiation. Such mutations have been produced in Chinese hamster ovary cells, mouse lymphoma cells, human diploid fibroblasts, and human blood lymphocytes. Many of the radiation-induced specific types of mutations produced in human and Chinese hamster cultured cells are associated with structural changes in the X chromosome. Evidence suggests that these mutations may be largely due to deletions in the chromosomes. Thacker, Stretch, and Stephens found that human, mouse, and Chinese hamster cells all exhibit the same fixed probability of radiation-induced mutations (Th77). Analysis of published data on x- or gamma radiation-induced mutations in cultured cells of humans and mice show that when the induced mutation frequencies are plotted against log of survival, the relationship is linear. This relationship suggests that mutation frequency curves can be predicted from a knowledge of survival curves for each cell type.

Mutagenicity in human somatic cells has been demonstrated on the basis of chromosome aberrations detected in cultured lymphocytes. Chromosome aberrations in humans have been demonstrated in lymphocytes cultured from persons exposed to ingested Sr-90 and Ra-226 (Tu63); inhaled/ingested Rn-222, U-nat, or Pu-239 (Br77); or inhaled Rn-222 (Po78); and in atomic bomb survivors (Aw78). Although no evidence of health impact currently exists, these chromosome aberrations demonstrate that mutagenesis is occurring in somatic cells of humans exposed to ionizing radiation.

Evidence of mutagenesis in human germ cells (cells of the ovary or testis) is less conclusive. Studies have been made of several populations exposed to medical radiation, atomic bomb survivors, and a population in an area of high background radiation in India (UNSCEAR77). Although these studies suggest an increased incidence of chromosomal aberrations in germ cells following exposure to ionizing radiation, the data are not convincing (UNSCEAR77).

Investigators who analyzed the data on children born to survivors of the atomic bombings of Hiroshima and Nagasaki found no statistically significant genetic effects due to parental exposure (Sc81). They did find, however, that the observed effects are in the direction of genetic damage from the bomb radiation exposure. They also were able to calculate that an average doubling dose* of 156 rems of ionizing radiation will produce a 100 percent increase over the spontaneous mutation rate. The average doubling dose in mice is generally estimated to be much lower, about 30 to 40 rems. These doses apply to acute radiation exposure. Extensive experiments with mice indicate that the genetic yield from low-level, chronic exposures to radiation is about one-third that of acute radiation (Sc81). In a later report, the same researchers estimated an acute doubling dose of 250 rems (Sa82).

The incidence of serious genetic disease due to mutations and chromosome aberrations induced by radiation is referred to as genetic detriment. Serious genetic disease includes inherited ill health, handicaps, or disabilities. Genetic disease may be manifest at birth or may not become evident until some time in adulthood.

Researchers have attempted to measure genetic detriment due to radiation exposure by using indices such as years of life lost, relative length of hospitilization or medical care necessary, or time lost from work. Measures of genetic detriment have several shortcomings. For example, they do not differentiate with regard to the range of severities of a disease; nor do they include a measure of the impact of a disease on the family, health care centers, schools, and society in general. For example, measures of genetic detriment based on years of life lost is much higher for Down's syndrome than for Huntington's disease, largely because of the much higher incidence of Down's syndrome. The difficulty experienced by the families of those suffering from each genetic disease is not accounted for, however. Those genetic diseases that necessitate long-term stays in institutions may pose burdens on society that are inversely related to mortality.

Carter and the U.N. Committee (Ca80,82; UNSCEAR82) have provided approximate estimates of genetic detriment in a developed country. As shown in Table 3-1, dominant genetic diseases usually rank relatively low because their onset is late in life.

Using utilization of hospital services as an index of genetic detriment, researchers have found that children with dominant or recessive diseases or congenital malformations are, on the average, admitted

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* A doubling dose is one that will produce a 100 percent increase over the spontaneous mutation rate.

to hospitals 5 to 7 times more often in their first year of life (Tr77). Children with any of these three types of genetic diseases spend considerably more time in the hospital than other children.

Radiation-induced genetic detriment thus includes impairment of life, shortened life span, and increased hospitalization. Only estimates of the frequency of radiation-induced genetic impairment are presented in Chapter 8 of this document. Although the numbers represent rough approximations, they are relatively small in comparison with the magnitude of detriment associated with spontaneously arising genetic diseases (UNSCEAR82).

Table 3-1. Estimates of genetic detriment in a developed country (UNSCEAR82)

Criteria for genetic determinant	Genetic diseases, listed in the order of severity (greatest to least)
Years of impaired life	Chromosomal X-linked Recessive Dominant Irregularly inherited
Years of life lost	Recessive Irregularly inherited X-linked Dominant
Degree of life impairment	Recessive Chromosomal X-linked Dominant
Impaired life weighted for degree of impairment	Recessive Chromosomal X-linked Dominant

3.3 Evidence That Radiation Is Teratogenic

Teratogenicity is the malformation of cells, tissues, or organs of a fetus resulting from physiologic and biochemical changes. Radiation is a well-known teratogenic agent. Case reports of radiation-induced teratology were made as early as 1921 (Sta21). By 1929, an extensive review of a series of pregnancies yielded data indicated that 18 of the children born to 76 irradiated mothers had abnormally small heads (microcephally) (Mu30). Although the radiation dose in these cases is not known, it was high.

Early experimental studies (primarily in the 1940's and 1950's) demonstrated the teratogenic properties of x-rays in fish, amphibia, chick, mouse, and rat embryos (Ru53). These experiments showed that the developing fetus is much more sensitive to radiation than the mother and provided data on periods of special sensitivity and dose-response. The malformations produced in the embryo depend on which cells, tissues, or organs in the fetus are most actively differentiating at the time of radiation. Embryos are relatively resistant to radiation-induced teratogenic effects during the earliest stages of their development, and are most sensitive during development of the neuroblast (these cells eventually become the nerve cells). These experiments showed that different malformations could be elicited by irradiating the fetus at specific times during its development.

Substantial evidence points to the ability of radiation to induce teratogenic effects in human embryos as well. In a recent study of mental retardation in children exposed in utero to atomic bomb radiation in Hiroshima and Nagasaki, researchers found that damage to the child appears to be related linearly to the radiation dose that the fetus receives (Ot84). The greatest risk of damage occurs at 8 to 15 weeks, which is the time the nervous system is undergoing the most rapid differentiation and proliferation of cells. They concluded that the age of the fetus at the time of exposure is the most important factor in determining the extent and type of damage from radiation. A numerical estimate of mental retardation risk due to radiation is given in Chapter 8.

3.4 Uncertainties

Although much is known about radiation dose-effect relationships at high-level doses, uncertainty exists when dose-effect relationships based on direct observations are extrapolated to lower doses, particularly when the dose rates are low. As described in Chapter 8, the range of extrapolation varies depending on the sensitivity of the organ system. For breast cancer, this may be as small as a factor of four. Uncertainties in the dose-effect relationships are recognized to relate to such factors as differences in quality and type of radiation, total dose, dose distribution, dose rate, and radiosensitivity (including repair mechanisms, sex, variations in age, organ, and state of health). The range of uncertainty in the estimates of radiation risk is examined in some detail in Chapter 8.

The uncertainties in the details of mechanisms of carcinogenesis, mutagenesis, and teratogenesis make it necessary to rely on the considered judgments of experts on the biological effects of ionizing radiation. These findings, which are well documented in publications by the National Academy of Sciences and the United Nations Scientific Committee on the Effects of Atomic Radiation, are used by advisory bodies such as the International Council on Radiation Protection and Measurements (ICRP) in developing their recommendations. The EPA has considered all such findings in formulating its estimate of the relationship between radiation dose and response.

Estimates of the risk from ionizing radiation are often limited to fatal cancers and genetic effects. Quantitative data on the incidence of nonfatal radiogenic cancers are sparse, and the current practice is to assume that the total cancer incidence resulting from whole-body exposure is 1.5 to 2.0 times the mortality. In 1980, the NAS-BEIR Committee estimated the effects of ionizing radiation directly from epidemiology studies on the basis of both cancer incidence and the number of fatal cancers induced per unit dose (NAS80). The lifetime risk from chronic exposure can be estimated from these data, either on the basis of (1) relative risk (i.e., the percentage of increase in fatal cancer), or (2) absolute risk (i.e., the number of excess cancers per year at risk following exposure). The latter method results in numerically smaller estimated risks for common cancers, but a larger estimated risk for rare cancers.

3.5 Summary of Evidence That Radiation is a Carcinogen, Mutagen, and Teratogen

Radiation has been shown to be a carcinogen, a mutagen, and a teratogen. At sufficiently high doses, radiation acts as a complete carcinogen, serving as both initiator and promoter. With proper choice of radiation dose and exposure schedule, cancers can be induced in nearly any tissue or organ in both humans and animals. At lower doses, radiation produces a delayed response in the form of increased incidence of cancer long after the exposure period. This has been documented extensively in both humans and animals. Human data are extensive and include atomic bomb survivors, many types of radiation-treated patients, underground miners, and radium dial workers. Animal data include demonstrations in many mammalian species and in mammalian tissue cultures. A significant finding from tissue culture studies is that radiation induces cancers by a process that is similar to that of chemical carcinogens. Further, DNA altered by radiation can cause transformation of other cultured cells when introduced to normal cells, even when the change in the DNA is very small.

Evidence of mutagenic properties of radiation comes mostly from animal data, in which all forms of radiation-induced mutations have been demonstrated, mostly in mice. Tissue cultures of human lymphocytes have also shown radiation-induced mutations. Data on humans are less conclusive; however, estimates of genetic detriment due to radiation exposure have been made by the use of measures such as years of life lost or years requiring hospitalization.

Evidence that radiation is a teratogen has been demonstrated in animals and in humans. A fetus is most sensitive to radiation during the early stages of organ development (between 8 and 15 weeks for the human fetus). The radiation-induced malformations produced depend on which cells are most actively differentiating.

In conclusion, evidence of the carcinogenic, mutagenic, and teratogenic properties of radiation is very substantial. These health effects pose a detrimental risk to exposed persons.

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EXHIBIT H

federal register

Wednesday
April 6, 1983

Part II

Environmental Protection Agency

National Emission Standards for Hazardous Air Pollutants; Standards for Radionuclides

ENVIRONMENTAL PROTECTION AGENCY

CFR Part 61

FRL 2324-3]

National Emission Standards for Hazardous Air Pollutants; Standards for Radionuclides

AGENCY: Environmental Protection Agency (EPA).

ACTION: Proposed Rule and Announcement of Public Hearing.

SUMMARY: On November 8, 1979, EPA listed radionuclides as a hazardous air pollutant under the provisions of Section 112 of the Clean Air Act. Pursuant to Section 112, EPA is proposing standards (including appropriate reporting requirements) for sources of emissions of radionuclides in four categories: (1) Department of Energy (DOE) Facilities, (2) Nuclear Regulatory Commission licensed facilities and non-DOE Federal facilities, (3) underground uranium mines, and (4) elemental phosphorous plants.

The Environmental Protection Agency (EPA) has identified several additional source categories that emit radionuclides and has determined there are good reasons for not proposing standards at this time for these categories. They are the following: (1) coal-fired boilers, (2) the phosphate industry, (3) other extraction industries, (4) uranium fuel cycle facilities, uranium mill tailings, management of high level waste, and (5) low energy accelerators.

DATES: Comments may be received on or before May 30, 1983.

Public Hearings. An informal public hearing will be held on April 28, 29, and 30, 1983 in Washington, D.C. The exact time and location of the hearing can be obtained by calling the Office of Radiation Programs at (703) 557-0704. Requests to participate in the informal hearing should be made by April 20, 1983. Written statements may be entered into the record before, during, or within 30 days after the hearing.

ADDRESSES: All written comments should be submitted to the Central Docket Section (A-130), U.S. Environmental Protection Agency, Washington, D.C. 20460, Attention: Docket No. A-79-11. This docket containing information used by EPA in developing the proposed standards, is available for public inspection between 8:00 a.m. and 4:00 p.m., Monday through Friday at EPA's Central Docket Section, West Tower Lobby, Gallery One, Waterside Mall, 401 M Street SW., Washington, D.C. 20460.

Separate sections of the docket have been established for each category of radionuclide emissions to air. Comments specific to a proposed action should be addressed to the following docket sections:

Section III A—Department of Energy Facilities
Section III B—Nuclear Regulatory Commission Licensed Facilities and non-DOE Federal Facilities
Section III C—Underground Uranium Mines
Section III D—Elemental Phosphorous Plants
Section III E—Coal-fired Boilers
Section III F—Phosphate Industry
Section III G—Other Extraction Industries
Section III H—Uranium Fuel Cycle Facilites, Uranium Mill Tailings, and Management of High Level Waste
Section III I—Low Energy Accelerators

Requests to participate in the informal hearing should be made in writing to Richard J. Guimond, Director, Criteria and Standards Division (ANR-460), U.S. Environmental Protection Agency, Washington, D.C. 20460. All requests for participation should include, at least, an outline of the topics to be addressed in the opening statements and the names of the participants. Presentations should be limited to 15 minutes each.

A Background Information Document has been prepared that contains, for each source category, projected doses and risks to nearby individuals and to populations, descriptions of current control technology, and descriptions and costs of emission control technologies. Single copies of the Background Information Document for the proposed standards may be requested in writing from the Program Management Office (ANR-458), U.S. Environmental Protection Agency, Washington, D.C. 10460, or by calling (703) 557-9351.

FOR FURTHER INFORMATION CONTACT: Terrence A. McLaughlin, Chief, Environmental Standards Branch (ANR-460), U.S. Environmental Protection Agency, Washington, D.C. 20460, (703) 557-8977.

SUPPLEMENTARY INFORMATION:

I. Overview of the Proposed Standards

A. Basic Terms Used in This Notice

All matter is made up of atoms: their nuclei contain protons and neutrons. The number of protons in an atom determines the identity of the element. For example, the element with 6 protons is called carbon. Atoms can contain different numbers of neutrons. The total number of protons and neutrons in an atom is called the atomic weight.

The nuclei of atoms of chemical elements with certain atomic weights are unstable by nature. Such nuclei can disintegrate spontaneously in predictable ways and are said to be radioactive. Atoms with nuclei that disintegrate are called radionuclides. For example, carbon atoms with 8 neutrons disintegrate, whereas carbon atoms with 6 neutrons are stable. The number of disintegrations which will occur in a given amount of time is termed activity; the unit of activity is the curie. One curie equals 37,000,000,000 disintegrations per second.

Some radionuclides are found in nature; others are made in reactors and accelerators. This notice concerns facilities which handle or produce all types of naturally occurring and manmade radionuclides in a manner that results in their being released into the air.

B. Background

In 1977, Congress amended the Clean Air Act (the Act) to address airborne emissions of radioactive materials. Before 1977, these emissions had been either regulated under the Atomic Energy Act or unregulated. Section 122 of the Act required the Administrator of EPA, after providing public notice and opportunity for public hearings (provided by 44 FR 21704, April 11, 1979), to determine whether emissions of radioactive pollutants cause or contribute to air pollution that may reasonably be anticipated to endanger public health. On December 27, 1979, EPA published a **Federal Register** Notice listing radionuclides as hazardous air pollutants under Section 112 of the Act (44 FR 76738, December 27, 1979). To support this determination, EPA published the report titled *Radiological Impact Caused By Emissions of Radionuclides into Air in the United States—Preliminary Report* (EPA 520/7-79-006), Office of Radiation Programs, U.S. Environmental Protection Agency, Washington, D.C. (August 1979).

Section 122(c)(2) of the Act directed that, once EPA listed radionuclides to be regulated under the Act, EPA and the Nuclear Regulatory Commission (NRC) were to enter into an interagency agreement with respect to those facilities under NRC jurisdiction. Such a memorandum of understanding was effected on October 24, 1980, and was subsequently published in the Federal Register (45 FR 72980, November 3, 1980). When EPA began developing standards for Department of Energy (DOE) facilities, a similar memorandum of understanding was negotiated with DOE. This memorandum of understanding was signed in October 1982, and a copy has been placed in the Docket for public review.

On June 16, 1981, the Sierra Club filed suit in the U.S. District Court for the Northern District of California pursuant to the citizens' suit provision of the Act (Sierra Club v. Gorsuch, No. 81-2436 WTS). The suit alleged that EPA had a nondiscretionary duty to propose standards for radionuclides under Section 112 of the Act within 180 days after listing them. In March 1982, the Court granted the Sierra Club motion for partial summary judgment on the liability issue, and, on September 30, 1982, the Court ordered EPA to publish proposed regulations establishing emission standards for radionuclides, with a notice of hearing, within 180 days of the date of that order.

EPA is proposing standards for certain sources of radionuclide emissions to air and is proposing not to regulate other sources. To EPA's knowledge, these comprise all source categories that release potentially regulatable amounts of radionuclides to air. The deadline established by the Court for this rulmaking has required EPA to proceed with less information than it would like. As always, EPA invites comments and will consider them carefully to ensure that the Agency's decisions are the best possible ones.

C. Estimates of Health Risk

Agencies can never obtain perfect data but have to make regulatory decisions on the basis of the best information available. Although additional study may be suggested to clarify the health implications from exposure to radiation at relatively low levels, EPA is concerned about the potential detrimental effects to human health caused by radiation based on the best scientific information currently available. EPA believes its estimates of doses to humans and the potential human health risks constitute an adequate basis for decisionmaking.

The information used by the Agency in estimating the hazards to health due to exposure to radiation is summarized in the following reports: *The Effects on Populations of Exposure to Low Levels of Ionizing Radiation* (1972) and *Health Effects of Alpha Emitting Particles in the Respiratory Tract* (1976) by the BEIR Committee, the report of the United Nations Scientific Committee on the Effects of Atomic Radiation entitled *Sources and Effects of Ionizing Radiation* (1977), and *Publication 26* (1977) by the International Commission on Radiological Protection. These bodies agree that high levels of radiation cause cancer and mutations and that, when formulating radiation protection standards and guidance, it is reasonable to assume that the risks of cancer and mutations are proportional to radiation dose. Background information on the risk associated with radon emissions can be found in an EPA report titled *Indoor Radiation Exposure Due to Radium-226 in Florida Phosphate Lands*, (EPA 520/4-78-013) (1978).

In concert with the recommendations of these reports, even for relatively low doses, EPA has assumed a linear, nonthreshold, dose-effect relationship as a reasonable basis for estimating the public health hazards due to exposure to radiation. This means that any radiation dose is assumed to pose some risk of damage to health and that the risk associated with low doses is directly proportional to the risk that has been demonstrated at higher doses. EPA believes this assumption is reasonable for public health protection in light of presently available information. However, EPA recognizes that the data available preclude neither a threshold for some types of damage below which there are no harmful effects nor the possibility that low doses of gamma radiation may be less harmful to people than the linear model implies.

As used in this notice, the term "dose to an individual" means an estimate of the dose rate in units of dose equivalent per year (rem/y) to the whole body or to a specified body organ due to exposure to radiation at a given level for the person's lifetime (70 years). These dose rates are a measure of, although not directly proportional to, the individual's risk of fatal cancer. The term "lifetime risk to an individual" means an estimate of the potential probability of premature death due to cancer caused by radiation exposure at a given level for the person's lifetime. There are also risks of nonfatal cancer and serious genetic effects, depending on which organs receive the exposure to radiation. The risks of nonfatal cancer and genetic effects cannot be accurately estimated, but neither risk is larger than the fatal cancer risk. EPA considers all these risks when it makes regulatory decisions on limiting emissions by restricting dose rates or exposures to radionuclide concentrations.

As used in this notice, the term "dose to population" means an estimate of the summed dose received by all persons in a population living within a given distance of the source, typically within 80 kilometers, due to a one year release of radionuclides (person-rem per year of operations). A person-rem is a total amount of exposure received by a large group equivalent to one person receiving an exposure of one rem. The term "risk to population" means an estimate of the number of potential fatal cancers that might occur in the population living within a given distance of the emission source, typically within 80 kilometers. The risk is related to the amount of radionuclides that are emitted during a year of operation. Part of the population risk is likely to occur some time after the radionuclides are emitted because: (1) There is a delay between release and exposure as the radionuclides move through environmental pathways and (2) there is a latent period between exposure and the onset of the disease. The dose to populations for a specific organ is related to, although not directly proportional to, the risks of fatal cancer, nonfatal cancer, and serious genetic effects. EPA considers all fatal and nonfatal risks in making regulatory decisions on whether standards are needed to protect the general public. As used in this notice, the term "health effect" means potential fatal cancers. Additional information on risk can be found in the Draft Background Information Document.

EPA must make numerous assumptions when estimating the radiation dose to individuals and population groups and the likely risk this might present to health. The assumptions introduce uncertainties in the estimates of radiation doses and health risks. All individual risk calculations assume that individuals reside at a single location for a 70 year life and are exposed to a constant source of radionuclide emissions for the entire time, factors such as radionuclide uptake by vegetation, consumption of locally produced crops and milk, and meteorology are quite site specific and can influence the actual risk to any given individual. Individual characteristics such as age, physiology, physical activity level, amount of time spent indoors, and eating habits can influence the rate and amount of radionuclides affecting the individual and, thus, the risk of that person.

EPA's risk estimates are "best estimates" considering the above factors. EPA believes that the estimates are within a factor of ten of the actual health risks to individuals if the assumptions are valid for the particular situation under consideration.

D. Summary of the Proposed Standards

EPA is proposing specific standards for sources in four categories: (1) DOE facilities, (2) NRC-licensed facilities and non-DOE Federal facilities, (3) underground uranium mines and (4) elemental phosphorous plants.

An indirect emission standard is proposed for all DOE facilities that will restrict emissions from each site to the amount that would cause an annual dose equivalent to 10 millirem (mrem) to the whole body and 30 mrem to any organ of any individual. This emission standard will keep the radiation doses relatively low both to nearby individuals and to populations living around the sites. In addition, EPA expects these facilities to continue to comply with the current Federal Guidance requirement that emissions be limited to as low as practicable levels and has proposed a reporting requirement to describe emission control technology.

An indirect emission standard is proposed for NRC licensees and non-DOE Federal facilities that will restrict emissions from each site to the amount that would cause an annual dose equivalent of 10 mrem to any organ of any individual. This emission standard will keep radiation doses relatively low to nearby individuals and populations in the vicinity of the site. The term "NRC licensees" includes those facilities licensed by the NRC and by States under agreement with the NRC.

An indirect emission standard is proposed for underground uranium mines that will restrict the increase in annual average concentration of radon-222 at places people can live to 0.2 picocurie per liter (pCi/1). A person living in a house for a long time in an area exposed to this concentration might still be subject to a significant estimated level of risk. However, neither control technology nor other methods to reduce radon emissions from these mines are available at reasonable cost; thus, more restrictive controls are not reasonable. The proposed standard will reduce risk to people living closest to the mines; protection of the health of regional and more distant populations is of less concern because most mines are located in remote areas.

An emission standard is proposed for elemental phosphorous plants that will limit annual emissions of polonium-210 from each site to 1 curie. While other radionuclides are emitted from these plants, polonium-210 is the major contributor to the maximum individual risk. Limiting polonium-210 will control the others. Such a standard will keep radiation doses relatively low to both individuals and populations.

While one of the above standards limits stack emissions directly, the other three limit stack emissions indirectly by specifying dose or concentration limits to be achieved. EPA believes this is a reasonable approach, given the extreme diversity of DOE facilities and NRC licensees and the fact that randon-222 emissions from uranium mines are not amenable to controls. The form of the proposed standards follows well developed and widely accepted practices in radiation protection. The use of procedures developed primarily to control chemicals would, in this context, be unworkable.

E. Basis for the Proposed Standards

In the Federal Register of May 18, 1960, President Eisenhower directed Federal agencies to follow the Radiation Protection Guidance of the Federal Radiation Council (FRC). When EPA was established, the Federal Radiation Council was abolished, and its responsibilities were transferred to EPA. EPA has considered this Guidance in establishing emission standards under Section 112 of the Clean Air Act, and the Agency's approach is compatible with it. For the purposes of this rulemaking, key elements of the Guidance are:

1. There should not be any man-made radiation exposure without the expectation of benefit resulting from such exposure.

2. The term "Radiation Protection Guide" should be adopted for Federal use. This term is defined as the radiation dose which should not be exceeded without careful consideration of the reasons for doing so; every effort should be made to encourage the maintenance of radiation doses as far below this guide as practicable.

3. For the individual in the population, the basic Radiation Protection Guide for annual whole body dose in 0.5 rem. This Guide applies when the individual whole body doses are known. As an operational technique, where the individual whole body doses are not known, a suitable sample of the exposed population should be developed whose Protection Guide for annual whole body dose will be 0.17 rem per capita per year.

4. There can be no single permissible or acceptable level of exposure without regard to the reason for permitting the exposure. It should be general practice to reduce exposure to radiation, and positive efforts should be carried out to fulfill the sense of these recommendations. It is basic that exposure to radiation should result from a real determination of its necessity.

5. There can be different Radiation Protection Guides with different numerical values, depending upon the circumstances.

6. The Federal agencies shall apply these Radiation Protection Guides with judgment and discretion to assure that reasonable probability is achieved in the attainment of the desired goal of protecting man from the undesirable effects of radiation. The Radiation Protection Guides provide a general framework for the radiation protection requirements. It is expected that each Federal agency, by virtue of its immediate knowledge of its operating problems, will use these Guides as a basis upon which to develop detailed standards tailored to meet its particular requirements.

EPA believes that the following points in these guides are of particular importance: (1) There should be benefits from exposure to radiation; (2) Exposures should be kept as low as practicable; and (3) It is appropriate to have different standards with different values, depending on the circumstances.

These Guides apply to Federal agencies to the extent that they are not incompatible with more specific legislative directives. The Clean Air Act directs EPA to establish emission standards for hazardous pollutants and directs EPA to propose these standards at a level which, in the Administrator's judgment, will protect the public health with an ample margin of safety. Congress did not describe the degree of protection that provides an ample margin of safety, nor did it describe what factors the Administrator should consider in making these judgments. Therefore, EPA considers those factors it believes are necessary to make reasonable judgments on whether standards are needed and, if so, at what level they should be established.

If a hazardous pollutant under review has been shown to possess a threshold level below which no deterimental health effects are likely, it might be relatively easy to establish an emission standard. For example, the Agency might select an appropriate safety factor, divide the threshold level by this factor, and establish an emission standard that corresponds to the reduced level. This regulatory strategy would provide reasonable assurance that no detrimental effects would result from exposure to the hazardous pollutant.

This approach is not feasible or reasonable for radionuclides. This is because the risk of cancer from exposure to radiation has not been shown to have a threshold level. Consequently, if EPA applied the approach previously described, the Agency would likely conclude that the standard should be established at zero emissions. They only way to meet such a standard would be to close all facilities emitting radionuclides because it is impossible to reduce radionuclide emissions to zero through control technology. If this approach were adopted, society would be harmed greatly since it would have to forgo the benefits of industries that emit radionuclides. Therefore, to allow society to continue to benefit from these activities, EPA must establish emission standards for radionuclides at a level that may present some human health risk. The Agency is not aware of any single level of risk that would be generally acceptable or consititute an ample margin of health protection. Some argue that an increase in cancer risk not exceeding one in 1000 due to a specific cause is acceptable, whereas others argue that an increase in risk of one in one million is unacceptable. EPA believes it should adopt an approach that will allow those various factors that influence society's health and well being to be weighed in assessing each source category. To accomplish this, EPA has decided to consider the following factors in making its judgments:

1. The radiation dose and risk to nearby individuals;
2. The cumulative radiation dose and risk to populations in the vicinity of the source;
3. The potential for radiation emissions and risk to increase in the future;
4. The availability, practicality, and cost of control technology to reduce emissions; and
5. The effect of current standards under the Act or other applicable legislative authorities.

By considering these factors, EPA will be able to provide public health protection that is consistent with the intent of the Federal Radiation Protection Guides and Clean Air Act.

The first three factors are used to assess the likely impact of emissions on the health of individuals and large populations and to estimate the potential for significant emissions in the future. The fourth factor enables EPA to assess whether state-of-the-art control technologies are currently in use and whether there are any practical means of reducing emissions through control technology or other control strategies. The last factor allows EPA to assess whether regulations or standards that have been established to control particulates or other pollutants are also minimizing releases of radionuclides.

The dose and risk to the individuals nearest a site are often the primary considerations when evaluating the need to control emissions of radionuclides. Controlling maximum individual dose assures that people living nearest a source are not subjected to unreasonably high risk. Further, protecting individuals usually provides an adequate level of protection to populations living further away from the source. Estimating the maximum individual dose and risk allows a comparison of the potential impact of one source to other sources.

EPA believes that cumulative population dose and risk also need to be examined. The cumulative radiation dose and risk to surrounding populations are determined by adding together all of the individual doses and risks that everyone within a certain radius (usually 80 km) of an emission source receives. This factor can sometimes be more important than the maximum individual risk in deciding whether controls are needed, particularly if an extremely large population may be exposed. The aggregate dose and population risk can be of such magnitude that it would be reasonable to require a reduction in the total risk even though, if the maximum individual dose were considered alone, one might conclude that no further controls are needed.

In addition, EPA believes that the potential for emissions and risk to increase in the future needs to be considered even though the current projected maximum individual and population risks are very low. An emission standard might be appropriate because the facilities now, or may in the future, handle large quantities of radionuclides that could escape into the air if improperly controlled. Alternatively, when the amount handled by a facility is small or is decreasing, and there is no potential for large releases now or in the future, standards may not be needed.

The availability and practicality of control technology are important in judging how much control of emissions is warranted. For this rulemaking, EPA believes that the standard should be established at a level that will require best available technology with allowance for variation in emissions, once a determination is made that additional controls are necessary. Additional actions, such as requiring development of new technology, closure of a facility, or other extreme measures may be considered if significant emissions remain after best available technology is in place or if there are significant emissions and there is no applicable control technology. EPA is defining best available technology as that which, in the judgment of the Administrator, is the most advanced level of controls adequately demonstrated, considering economic, energy, and environmental impacts. The technological and economic impacts associated with retrofits are considered when determining best available technology for existing sources.

Finally, EPA believes it is reasonable to consider whether other EPA standards are achieving approximately the same goal as the Act, i.e., protecting public health with an ample margin of safety. In cases where other standards are providing comparable control for radionuclides, EPA believes it is appropriate not to propose redundant standards under the Act. There would be no benefits because the public health would already be protected with an ample margin of safety, but there could be unnecessary costs associated with implementing an additional standard.

EPA considered each of the relevant factors in making determinations for each source category that was reviewed. These factors were not quantitatively balanced through the use of formulas to derive emission limits. Rather, they were qualitatively weighed before deciding whether a standard was needed and, if so, what level of control was suitable. The consideration of these factors as they apply to each source category is detailed in the portion of this preamble devoted to that source category.

EPA requests comments on the appropriateness of the factors it has selected for consideration. Should some factors be added or deleted? Should more emphasis be placed on some factors than others? How should the cost-effectiveness, cost-benefits, or affordability of controls be considered when establishing appropriate emission standards to provide an ample margin of safety? EPA also requests comments on whether the factors were appropriately applied to the nine source categories that were reviewed.

It is the intent of the Act that control technology or operational practices be used to control emissions. Buying land to expand the size of the site or building higher stacks to reduce exposure to nearby individuals may not be used where other emission control devices or operational procedures are reasonably available. However, there are radionuclides, principally radon, which present significant risks and for which emission controls may not always be reasonably available. As a last resort in such cases, EPA has decided to propose standards achievable through dispersion techniques.

II. Department of Energy Facilities (DOE)

A. General Description

DOE administers many facilities that emit radionuclides to air. These facilities are Government owned but are managed and operated for DOE by private contractors. Operations at these

EXHIBIT I

Epicor, Incorporated

MATERIAL SAFETY DATA SHEET 49-7163

I. MATERIAL : POWDERED CATION RESIN - AMMONIA FORM.

PRODUCT CODE : PD-2

CHEMICAL NAME : STYRENE/DVB ION EXCHANGE RESIN

II. PHYSICAL DATA:

BOILING POINT	:	NOT APPLICABLE
VAPOR PRESSURE	:	NOT APPLICABLE
VAPOR DENSITY	:	NOT APPLICABLE
SOLUBILITY IN WATER	:	INSOLUBLE
% VOLATILE BY VOLUME	:	49 - 56
APPEARANCE AND ODOR	:	TAN SOLID/ODORLESS
FREEZING POINT	:	~ 32° F

III. FIRE AND EXPLOSION HAZARD DATA:

FLASH POINT	:	NOT APPLICABLE
EXTINGUISHING MEDIA	:	DRY CHEMICAL
FLAMMABLE LIMITS	:	(STP IN AIR)
LOWER EXPLOSION LIMIT	:	NOT APPLICABLE
UPPER EXPLOSION LIMIT	:	NOT APPLICABLE

SPECIAL FIRE FIGHTING PROCEDURES:

PRODUCT IS NOT COMBUSTIBLE UNTIL MOISTURE IS REMOVED, THEN RESIN STARTS TO BURN IN FLAME AT 230° C. WEAR MESA/NIOSH APPROVED SELF CONTAINED BREATHING APPARATUS. AVOID BREATHING FUMES FROM FIRE.

10/14/82
REV. 1

IV. REACTIVITY DATA:

STABILITY : STABLE

CONDITIONS TO AVOID : EXCESSIVE HEAT

HAZARDOUS DECOMPOSITION PRODUCTS - THERMAL DECOMPOSITION MAY YIELD

NAPHTHALENE, BENZALDEHYDES, PHENOL, CARBON DIOXIDE, WATER, SULFUR OXIDES, ORGANIC SULFONATES.

INCOMPATABILITY:- AVOID CONTACT WITH NITRIC ACID OR ANY OTHER STRONG OXIDIZING AGENTS.

V. FIRST AID:

EYE - IRRIGATE EYE IMMEDIATELY FOR FIVE MINUTES - INJURY IS UNLIKELY.

SKIN - WASH OFF IN FLOWING WATER

INHALATION - NO EFFECT IS EXPECTED.

INGESTION - NO EFFECT IS EXPECTED.

Epicor. Incorporated

MATERIAL SAFETY DATA SHEET 49-7164

I. MATERIAL : POWDERED CATION RESIN - HYDROGEN FORM.

PRODUCT CODE : PD-3

CHEMICAL NAME : STYRENE/DVB ION EXCHANGE RESIN

II. PHYSICAL DATA:

BOILING POINT	:	NOT APPLICABLE
VAPOR PRESSURE	:	NOT APPLICABLE
VAPOR DENSITY	:	NOT APPLICABLE
SOLUBILITY IN WATER	:	INSOLUBLE
% VOLATILE BY VOLUME	:	49 - 56
APPEARANCE AND ODOR	:	TAN SOLID/ODORLESS
FREEZING POINT	:	~ 32° F

III. FIRE AND EXPLOSION HAZARD DATA:

FLASH POINT	:	NOT APPLICABLE
EXTINGUISHING MEDIA	:	DRY CHEMICAL
FLAMMABLE LIMITS	:	(STP IN AIR)
LOWER EXPLOSION LIMIT	:	NOT APPLICABLE
UPPER EXPLOSION LIMIT	:	NOT APPLICABLE

SPECIAL FIRE FIGHTING PROCEDURES:

PRODUCT IS NOT COMBUSTIBLE UNTIL MOISTURE IS REMOVED, THEN RESIN STARTS TO BURN IN FLAME AT 230° C. WEAR MESA/NIOSH APPROVED SELF CONTAINED BREATHING APPARATUS. AVOID BREATHING FUMES FROM FIRE.

10/14/82

Epicor, Incorporated

MATERIAL SAFETY DATA SHEET

POWDERED CATION RESIN - HYDROGEN FORM

PD-3

IV. REACTIVITY DATA:

STABILITY : STABLE

CONDITIONS TO AVOID : EXCESSIVE HEAT

HAZARDOUS DECOMPOSITION PRODUCTS - THERMAL DECOMPOSITION MAY YIELD

NAPHTHALENE, BENZALDEHYDES, PHENOL, CARBON DIOXIDE, WATER, SULFUR OXIDES, ORGANIC SULFONATES.

INCOMPATABILITY: AVOID CONTACT WITH NITRIC ACID OR ANY OTHER STRONG OXIDIZING AGENTS.

V. FIRST AID:

EYE - IRRIGATE EYE IMMEDIATELY FOR FIVE MINUTES - INJURY IS UNLIKELY.

SKIN - WASH OFF IN FLOWING WATER

INHALATION - NO EFFECT IS EXPECTED.

INGESTION - NO EFFECT IS EXPECTED.

Epicor, Incorporated

49-7165

I. MATERIAL : POWDERED ANION RESIN - HYDROXIDE FORM.

PRODUCT CODE : PD-1

CHEMICAL NAME : STYRENE/DVB ION EXCHANGE RESIN

II. PHYSICAL DATA:

BOILING POINT	:	NOT APPLICABLE
VAPOR PRESSURE	:	NOT APPLICABLE
VAPOR DENSITY	:	NOT APPLICABLE
SOLUBILITY IN WATER	:	INSOLUBLE
% VOLATILE BY VOLUME	:	61.5 (WATER)
APPEARANCE AND ODOR	:	TAN SOLID/AMINE ODOR
FREEZING POINT	:	~ 32° F

III. FIRE AND EXPLOSION HAZARD DATA:

FLASH POINT	:	NOT APPLICABLE
EXTINGUISHING MEDIA	:	DRY CHEMICAL
FLAMMABLE LIMITS	:	(STP IN AIR)
LOWER EXPLOSION LIMIT	:	NOT APPLICABLE
UPPER EXPLOSION LIMIT	:	NOT APPLICABLE

SPECIAL FIRE FIGHTING PROCEDURES:

PRODUCT IS NOT COMBUSTIBLE UNTIL MOISTURE IS REMOVED, THEN RESIN STARTS TO BURN IN FLAME AT 230° C. WEAR MESA/NIOSH APPROVED SELF CONTAINED BREATHING APPARATUS. AVOID BREATHING FUMES FROM FIRE.

10/14/82
REV. 1
JG

IV. REACTIVITY DATA:

STABILITY : STABLE

CONDITIONS TO AVOID : EXCESSIVE HEAT

HAZARDOUS DECOMPOSITION PRODUCTS - THERMAL DECOMPOSITION MAY YIELD OXIDES OF CARBON AND NITROGEN.

INCOMPATABILITY: AVOID CONTACT WITH CONCENTRATED NITRIC ACID OR ANY OTHER STRONG OXIDIZING AGENTS.

V. FIRST AID:

EYE - IRRIGATE EYE IMMEDIATELY FOR FIVE MINUTES - INJURY IS UNLIKELY.

SKIN - WASH OFF IN FLOWING WATER

INHALATION - REMOVE TO FRESH AIR IF EFFECT OCCURS. NO EFFECT IS EXPECTED.

INGESTION - NO EFFECT IS EXPECTED.

EXHIBIT J

DAVIS-BESSE NUCLEAR POWER STATION UNITS NO. 2 & 3

VOLUME 1

Application to the Ohio Power Siting Commission for a Certificate of Environmental Compatibility and Public Need

1974

TOLEDO EDISON

An additional 135-acre marsh area, acquired from private owners between December 1967 and July 1970, has been leased to the Bureau for a period of 25 years. The Bureau has also been given management of 33 more acres under an informal arrangement. These areas are indicated on Figure 1302-B-9.

An earthen dike has been constructed along the northern boundary of the site for water level control purposes. It separates the northern boundary from the adjoining privately owned marsh (Hankison Marsh).

Fifty-six acres of the site were proposed for the graded and fenced station area associated with Unit No. 1, excluding the cooling tower. The construction permit for Unit No. 1 was approved and issued on March 24, 1971. The construction schedule calls for completion and commercial operation of Unit No. 1 in 1976.

1302-B.1.d.IV Individual Structures and Installations

The locations of the proposed Davis-Besse Units No. 2 and 3 structures and installations are indicated on Figure 1302-B-5.

The shield buildings of Units No. 2 and 3 will both fall on a common UTM coordinate of 326,052 east and have a distance of 470 ft between center points. The units will be exact duplicates of Unit No. 1 but will be independent both structurally and operationally.

1302-B.1.d.V Surface Bodies of Water

Surface water bodies, including Lake Erie and the Toussaint River, are shown on Figure 1302-B-5.

1302-B.1.d.VI Groundwater Supplies

Elevation of the piezometric surface at the site (elevation 571 to elevation 572 International Great Lakes Datum 1955 [IGLD 1955]) is generally a few feet above mean water level of Lake Erie. Lake Erie mean water level for the last 10-year period is approximately elevation 570. In 1973, however, the mean water level of Lake Erie was approximately elevation 572, the highest in recorded history. Consequently, during December 1973 the piezometric surface at the site was slightly below lake elevation. Normally, the lake levels vary slightly (±2 ft) with the seasons. Fluctuations of the piezometric surface at the site generally lag behind and are of smaller amplitude than the fluctuations of the lake level.

A well inventory has been conducted within a 3-mi radius of the site. The owners of 30 wells within this area were interviewed to evaluate groundwater conditions at the site.

Water, from wells in the site locality, is used primarily for domestic sanitary purposes and for farm irrigation. In most instances, as a result of hardness, objectionable odor, and bitter taste, groundwater is not used domestically for washing or drinking. Of the 30 wells inspected, 13 are no longer being used, and the remaining 17 are used only intermittently for irrigation and sanitation purposes.

Locations of several of these wells which are within the site boundary are shown on Figure 1302-B-5.

1302-B.1.d.VII Vegetative Cover That Will Be Removed During Construction

The amount of vegetative cover to be removed during construction of Davis-Besse Units No. 2 and 3 will be limited because much of the area has already been cleared for construction of Unit No. 1. Construction of the Unit No. 3 cooling tower and a wave protection dike will be the only major additional areas of impact. Additional information is presented in Section 1302-C.1.a.II.

1302-B.2 GEOLOGY AND SEISMOLOGY

Subsurface conditions in the Unit No. 2 and 3 areas consist of approximately 12 to 22 ft of glacial soils overlying a dolomitic bedrock formation. Figure 1302-B-10 shows the regional bedrock surface contours and the three principal geologic formations, the Tymochtee, the Greenfield, and the Guelph formations. Figure 1302-B-11 presents detailed bedrock surface contours at the site. At this scale, the upper formation is the Tymochtee and it is underlain by the Greenfield, which, in turn, is underlain by the Guelph.

A regional cross-sectional map of the major geologic formations is shown in Figure 1302-B-12. Detailed cross sections for West-East and North-South transects under the proposed Units No. 2 and 3 are presented in Figures 1302-B-13 through 1302-B-16. The locations of the cross sections are shown on the site plan in Figure 1302-B-17.

A preconstruction subsurface exploration program has been essentially completed. It consists of borings, unsampled rock probes, seismic up-hole and cross-hole measurements, in-situ bedrock permeability tests and sections of test excavations. The locations of the exploration samples in the site area are shown in Figures 1302-B-11 and 1302-B-17.

1302-B.2.a Ability of the Geological Configuration to Support Heavy Structures

The site is situated on a low flatland bordering Lake Erie. Lake Erie mean water level is approximately El. 570 IGLD 1955. A narrow ridge of beach sand and man-placed riprap parallels the shoreline. The eastern portion of the site is marshland at approximately El. 570. The western portion of the site was formerly farmland, with the ground surface averaging El. 576. This portion of the site has undergone significant alterations as a result of Unit No. 1 construction activities.

Site Geology

The site is underlain by two distinct types of glacial soil deposits: a glaciolacustrine deposit, essentially consisting of silty clay, overlying a glacial till deposit essentially consisting of silty and sandy clay. The thickness of glacial deposits in Ottawa County averages 25 ft; at the site, it was found to be approximately 12 to 22 ft in the borings. A local sand ridge of approximately 10 ft thickness occurs along the lake shore and local thin organic deposits occur in the marshland. Approximately 6 ft to 9 ft of general earth fill has been placed in the Unit No. 1 area and will be placed in the Unit No. 2 and 3 areas.

In the borings made at the site, the thickness of the glaciolacustrine deposit was found to be approximately 6 to 12 ft. The glaciolacustrine deposit generally is in a stiff condition because of desiccation, which is believed to have occurred when the level of Lake Erie was lower than the present Lake Erie level. In the borings made at the site, the thickness of the underlying till deposit was found to be approximately 6 to 12 ft. The till deposit is in a hard condition. The physical properties of the soil deposits are presented in Section 1302-C.2.b.

Underlying the soil deposits at the site is the Tymochtee formation of the Bass Island group of the upper Silurian epoch. The Tymochtee formation is a flat-lying, soft to hard, thin-bedded to massive, laminated, argillaceous dolomite with occasional carbonaceous shale partings along the bedding planes. It contains varying amounts of gypsum and anhydrite.

Portions of the Tymochtee formation are prone to solution activity. This characteristic is demonstrated along the western shore of South Bass Island, approximately 15 mi east of the site, where the contact between the Tymochtee dolomite and the overlying Put-in-Bay dolomite is exposed a few feet above water level. Solution activity by lake water has caused the Tymochtee dolomite to dissolve and the overlying, more resistant Put-in-Bay dolomite to collapse. Numerous caves also exist in the Tymochtee formation along the shore of this island.

At the site, small solution fissures were observed in the borings and solution cavities were discovered and explored in the surface depression area.

Beneath the Tymochtee formation is the Greenfield formation. The lithology of the Greenfield formation is very similar to that of the Tymochtee formation, except for many carbonaceous streaks occurring as stylolites.

Beneath the Greenfield Formation, two deep borings drilled in the containment structure area for Units No. 2 and 3 encountered the Guelph formation. The Guelph formation consists of a light gray, hard, massive, thin to very-thick bedded recrystallized fossilliferous dolomite.

No tectonic faults are known to exist in the site locality. A local geologic study, including a literature study, examination of the local topography, airphoto imagery, and subsurface investigations of the site and local quarries have not disclosed any tectonic faults in Ottawa County, and from our investigation, we conclude that none exist.

Site Structured Geology

The site is located on the east flank of the flat-lying Findlay Arch, approximately 15 mi from the axis of the Arch. The dip of the bedrock at the site is very flat with a slight dip (1%) to the east.

Analysis of data obtained from the geologic mapping of the bedrock exposed during Unit No. 1 construction indicates: (1) the major primary joint set has a strike of approximately N45°E, and the secondary joint sets have strikes of N50°W and N90°W; (2) joints mapped were typically vertical; (3) approximately 10% of the joints mapped on the bedrock surface (El. 560 ±) were open and had indications of minor solution activity. This minor solution activity was confined to the upper 3 ft of bedrock [see (5) below]; (4) approximately 90% of the joints on the bedrock surface (El. 560 ±) were typically less than 0.1 ft wide, filled with till or satin spar gypsum, and had no indications of solution activity; (5) joints mapped on excavated bedrock surfaces and presplit excavation walls were typically less than 0.05 ft wide, were filled with satin spar gypsum, and had no indications of solution activity below a depth of 3 ft below the top of the bedrock surface; and, (6) there were no indications of significant continuity of joints with depth when comparing the location of joints mapped at the bedrock surface (El. 560 ±) with those mapped on excavated bedrock surfaces (El. 542 to El. 528).

Exploration Program

An exploration program has been developed to identify and evaluate subsurface features that may need some form of remedial treatment to insure their ability to bear heavy loads. The preconstruction phase subsurface investigation for Units No. 2 and 3 is being made following the logic flow chart presented in Figure 1302-B-18. The bedrock formation at the site is known to be susceptible to solution activity. A bedrock verification program consisting of borings, probes, geologic mapping, and geophysical surveys will be implemented in accordance with the above referenced logic chart during foundation construction to confirm the competence of the bedrock in the foundation areas.

The preconstruction investigation consists of 54 borings, 40 unsampled rock probes, 56 seismic up-hole and cross-hole measurements, 60 in-situ bedrock permeability tests, and three sections of a test excavation. The locations of these investigation measurements made in the station area are presented in Figures 1302-B-11 and 1302-B-17. The geotechnical investigations made for Unit No. 1, described in the FSAR for that unit, overlap the areas of the Units No. 2 and 3 investigation; consequently, significant use of the information obtained during geotechnical studies for Unit No. 1 has been made in the studies for Units No. 2 and 3.

Based on analysis of results obtained from the preconstruction investigation and the planned bedrock verification program, the bedrock beneath the foundations of Units No. 2 and 3 either will be confirmed free of significant solution activity or remedial treatment will be performed on areas of significant solution activity in order to provide competent foundation support.

Bedrock Formation

A description of the physical properties of the bedrock and the foundation criteria are described in the following paragraphs.

The bedrock formation is the Tymochtee formation which consists of argillaceous dolomite with interbedded gypsum, anhydrite, and shale strata. The argillaceous dolomite can be divided into two major units: a massive dolomite and a bedded dolomite. A description of each dolomite rock unit and representative static and dynamic properties follows.

The massive dolomite occurs in a 8 to 10-ft-thick stratum, the top of which is typically located approximately 10 ft below the bedrock surface. The massive dolomite is medium hard to hard, buff to gray, and argillaceous.

The bedded dolomite typically occurs above and below the massive dolomite unit. It is medium hard, gray to buff, and argillaceous with frequent laminae of gypsum, anhydrite, and shale.

Representative static and dynamic properties for the bedrock are listed as follows:

Property	Representative Value
Total unit weight, lb/cu ft	150
Unconfined compression strength, tons/sq ft	800
Compression modulus, E, kips/sq ft	390 to 470*
Shear modulus, G, kips/sq ft	150 to 180*
Poisson's ratio, μ	0.3
Damping ratio, λ	0.01 to 0.02**

*Values are strain dependent. Smallest value used with safe shutdown earthquake; largest value used with operating basis earthquake.
**Values are strain dependent. Largest value used with safe shutdown earthquake; smallest value used with operating basis earthquake.

Foundations for Category I Structures

Foundations for Category I station structures consist of mat or strip footings bearing on bedrock or Category I structural granular fill and pier footings socketed into bedrock.

Maximum design bearing capacity, ultimate bearing capacity, and ultimate bedrock socket-concrete bond strength for geologic materials supporting foundations for Category I structures are based on the analysis of the subsurface materials. The maximum design bearing capacity, ultimate bearing capacity, and ultimate bedrock socket-concrete bond strength for geologic materials supporting foundations for Category I structures are as follows:

Bearing Material	Maximum Design Bearing Capacity k/sq ft	Maximum Design Bedrock Socket-Concrete Bond Strength, k/sq ft
a. Bedrock free of significant solution activity or after suitable remedial treatment	100	36
b. Bedrock with significant solution activity after suitable remedial treatment	50	36
c. Structural fill constructed on till deposit	10	NA
d. In-situ till deposit	10	NA

Table 1302-B-3 shows the maximum contact stress expected beneath mat or strip footing foundations supporting Category I structures, the ultimate bearing capacity of geologic materials beneath these foundations, and the expected maximum settlement of the foundation at the maximum contact stress.

The factor of safety of mat and strip footing foundations for Category I structures against a bearing capacity failure (expressed as a ratio between the ultimate bearing capacity of material beneath the footing and the maximum contact stress beneath the footing) is greater than five. Estimated total settlement of Category I structures founded on bedrock is less than 0.125 in., and estimated total settlement of Category I structures founded on Category I structural granular fill is less than 0.25 inch. Settlement of structures will be elastic within the range of footing contact stresses anticipated. Consequently, settlements will occur upon application of footing stresses and no long-term settlement of structures is expected.

Socketed Pier Footing Foundations

A portion of the auxiliary building is supported on socketed pier footing foundations. The maximum load expected on these footings is 1700 kips. The ultimate load that can be supported by the bedrock socket is 4900 kips. Estimated total settlement of individual piers, at the 1700-kip load, is expected to be less than 0.25 inch.

Solution Activity in Bedrock

A minor portion of the bedrock formation at the site, in particular, gypsum strata which account for approximately 20% of the bedrock formation above El. 530, appears to be susceptible to solution activity. For this reason, a bedrock verification program was implemented during foundation construction of Unit No. 1 to determine the degree of solution activity, if any, in bedrock in the station area.

The results of this Bedrock Verification Program (BVP) were presented in Appendix 2C of the Final Safety Analysis Reports for Davis-Besse Nuclear Power Plant Unit No. 1, and identified no significant solution activity in the bedrock beneath the foundations of Unit No. 1. However, the principal geologic conditions necessary for solution activity in the bedrock consist of (1) groundwater with a chemical unbalance or "appetite" for solution of the bedrock and (2) a high hydraulic groundwater gradient which results in a high volume of groundwater flow through the bedrock. Based on extensive chemical analysis of the groundwater during Unit No. 1 design and construction phases, it has been concluded that the existing groundwater is chemically saturated and has no "appetite" to dissolve bedrock and, in fact, is precipitating gypsum crystals in the joints of the bedrock.

The existing hydraulic groundwater gradient is very low (approximately 2 ft/mi) and, thus, even if the groundwater did have an "appetite" to dissolve the bedrock, very little activity could occur during the life of the station.

The bedrock formation is known to be susceptible to solution activity and the upper 20 ft (approximately El. 560 to El. 540) of bedrock in the Units No. 2 and 3 area contain some significant solution activity. However, a majority of the structures for Units No. 2 and 3 is to be founded below this zone of solution activity; that is, shield building and portions of auxiliary building. For the buildings founded above or in the zone of solution activity; that is, the remainder of the auxiliary building, and turbine and office buildings, it is likely remedial treatment consisting of structural grouting and/or dental excavation will be required.

During construction of Unit No. 1, it was necessary to dewater the foundation area. This dewatering operation did create higher hydraulic groundwater gradients. However, a grout cutoff wall was used to minimize pumping quantities and monitoring of the dewatering system discharge (both quantity of water and water chemistry) indicated no siginificant solution activity occurred during the construction period. A similar grout cutoff wall is proposed for Units No. 2 and 3 and monitoring of the dewatering operations will continue until the groundwater has returned to preconstruction levels.

There are no operational aspects of Units No. 1, 2, and 3 which will affect the solution of bedrock at the site.

Upon completion of the bedrock verification program, the bedrock will be established to be free of solution activity, or if significant solution activity is found, the bedrock will be suitably treated so that surface or subsurface subsidence of bedrock in the station area caused by the collapse of solution cavities or fissures during vibratory motion associated with the safe shutdown earthquake will not occur. Figure 1302-B-18 presents the logic flow chart of the exploration programs for Units No. 2 and 3, which includes the verification program for Units No. 2 and 3.

Section 1304-G.4 presents a discussion of existing and future groundwater usage in the site region, and concludes that there is very little water withdrawal in the site locality now and little potential for significant increased withdrawal in the future.

Based on the results of the study of subsurface fluid addition or withdrawal, it is concluded that there are no significant cavities or fissures beneath the site caused by such additions or withdrawals which would result in surface or subsurface subsidence during the vibratory motions associated with the safe shutdown earthquake.

Shear Zones, Joints, Fractures, Folds, Zones of Alteration, Irregular Weathering, or Structural Weakness

Based on the results of the geologic, seismologic, and subsurface investigations, the bedrock beneath the foundations of the Davis-Besse nuclear power station will be confirmed to be free of significant zones of structural weakness upon completion of the BVP or appropriate remedial treatment will be implemented.

The joints and natural fractures observed in the station area test borings for Units No. 1, 2, and 3 and the Unit No. 1 foundation excavations were typically healed with calcite or satin spar gypsum and were no wider than 0.1 feet.

Unrelieved Residual Stresses in Bedrock

Based on results of the geologic, seismologic, subsurface investigation, and observations made during excavation for Unit No. 1, it is concluded that there are no significant unrelieved residual vertical or horizontal stresses in the bedrock in the station area. Because there are no significant unrelieved residual stresses in the bedrock at the site, there is no potential for such stresses to cause instability during the vibratory motion associated with the safe shutdown earthquake.

Anhydrite-Gypsum

The bedrock formation below El. 500 contains approximately 40% anhydrite. Under high temperature and pressure conditions, anhydrite can be transformed into gypsum with an increase in volume as a result of the addition of water of hydration. However, under the temperature, pressure, and groundwater conditions at the site, the anhydrite is considered stable. Construction and operation of Units No. 1, 2, and 3 will not affect the stability of anhydrite beneath the site.

1302-B.2.b <u>Suitability of Soil for Compaction</u>

Existing soils are not used as foundation support for any Category I structures. Where Category I structures are not placed directly upon bedrock or concrete fill, their footers were placed on compacted granular backfill. These include the borated water storage tank, electric manholes, diesel oil storage tank, and the service water piping manholes. In all cases, the factor-of-safety of ultimate bearing capacity to maximum contact stress was greater than five. These data are included in Table 1302-B-3.

Based on the gradation of the backfill material (crushed granular material or glacial till) and placement criteria, Category I backfill will not undergo differential consolidation or liquefaction under the effects of the vibratory motions of the safe shutdown earthquake. Consequently, there is no potential for these earthquake-induced phenomena to cause instability of the Category I backfill beneath the foundations of the station.

Excavation and Backfill

Plan and profiles of structural backfill are presented in Figure 1302-B-19. Structural backfill in the station area will consist of granular material obtained from off-site quarries and/or recompacted glacial till from borrow excavations.

Structural backfill is to be placed in loose lift thicknesses ranging from 12 in. in large work areas to 6 in. in small work areas. Structural backfill is to be compacted to 98% of the maximum dry density determined in accordance with ASTM Specification No. D698 Method D, latest revision, or to 80% relative density determined in accordance with ASTM Specification No. D2049.

Summary of Static and Dynamic Soil Properties

Major soil deposits at the site consist of a glaciolacustrine and a till deposit. The glaciolacustrine deposit consists of a stiff, fissured, gray and brown silty clay. Representative values for selected static properties for the glaciolacustrine deposit are listed as follows:

Property	Representative Value*
Range of thickness in station area, ft	6 to 10
Water content, %	24
Liquid limit, %	51
Plastic limit, %	23
Total unit weight, lb/cu ft	125
Unconfined compression strength, tons/sq ft	3.5
Standard penetration resistance, blows/ft	12
Permeability, cm/sec	less than 10^{-6}
Compression index, C_c	0.15
Recompression index, C_r	0.4
Coefficient of consolidation, C_v, sq cm/sec	0.5×10^{-2}
Range of maximum past effective consolidation pressure, tons/sq ft	4 to 12

*No dynamic parameters were determined for glaciolacustrine deposit because no major structures are to be founded on the deposit.

The till deposit consists of a hard, fissured, gray to brown silty sandy clay with generally less than 10% gravel. Representative values for selected static and dynamic properties for till deposit are listed as follows:

Property	Representative Value
Range of thickness in station area, ft	6 to 10
Water content, %	15

Property	Representative Value
Liquid limit, %	33
Plastic limit, %	17
Total unit weight, lb/cu ft	132
Unconfined compression strength, tons/sq ft	8
Standard penetration resistance, blows/ft	40
Permeability, cm/sec	less than 10^{-6}
Compression index C_c	0.08
Recompression index, C_r	0.02
Coefficient of consolidation, C_v, sq cm/sec	1 x 10-2
Range of maximum past effective consolidation pressure, tons/sq ft	10 to 50
Compression modulus, E, kips/sq ft	28 to 34*
Shear modulus, G, kips/sq ft	10 to 12*
Poisson's ratio, μ	0.4
Damping ratio, λ	0.04 to 0.05**

*Values are strain dependent. Smallest value used with safe shutdown (larger) earthquake; largest value used with operating basis (smaller) earthquake.

**Values are strain dependent. Largest value used with safe shutdown (larger) earthquake; smallest value used with operating basis (smaller) earthquake.

The stability of soil slopes for the existing Category I intake canal dikes was analyzed to determine their factor of safety against failure during the occurrences of a safe shutdown earthquake.

The factor of safety is defined as the ratio of the available undrained shear strength on an assumed failure surface to the undrained shear strength along the same failure surface required to provide a factor of safety of 1.0 for assumed loading conditions.

For purposes of the analyses, the water level in the intake area was assumed to be at El. 563; a horizontal force equal to 0.15 times the weight of the sliding mass was assumed to act in the direction of sliding.

Factors of safety were calculated for several assumed failure surfaces to determine the critical failure surface which would result in the lowest factor of safety. Circular arc and sliding wedges modes of failure were analyzed to determine the required undrained shear strength along the failure surface for the assumed loading conditions. The sliding wedge mode of failure resulted in the minimum factor of safety. Results of the analysis indicated a required undrained shear strength of 0.4 kips/sq ft for stability of the dike.

The undrained shear strength characteristics of the compacted glaciolacustrine and till deposits were determined in two series of strength tests. Prior to construction, a series of unconsolidated-undrained (UU) triaxial tests were made on samples of compacted glaciolacustrine and till deposits (compaction was in accordance with ASTM Specification No. D698-68T Method A).

The UU tests indicated that the undrained shear strength of the compacted gladiolacustrine deposit ranged from approximately 2.6 kips/sq ft at a water content of 20% to 1.0 kips/sq ft at a water content of 25%; and that the undrained shear strength of the compacted till deposit ranged from 5.0 kips/sq ft at a water content of 13% to 0.6 kips/sq ft at a water content of 19%. It is concluded, on the basis of test procedures used to make the UU tests and on the basis of the plasticity indices of the material tested, that the data obtained represent the lower bound of undrained shear strength of compacted glaciolacustrine and till deposits.

During construction, a series of 13 in-situ vane shear strength tests were made in the Category I fill. A discussion of these tests is presented in Section V of Appendix 2C of the Final Safety Analysis Reports for Davis-Besse Nuclear Power Plant Unit No. 1. These tests indicated that the vane shear strength of compacted glaciolacustrine deposit ranged from approximately 4.0 kips/sq ft at a water content of 20% to 2.0 kips/sq ft at a water content of 29%; and that the vane shear strength of compacted till deposit ranged from 7.0 kips/sq ft at a water content of 15% to 3.5 kips/sq ft at a water content of 19%. It is concluded, on the basis of test procedures used, that the data obtained from the vane shear strength tests represent the upper boundary of undrained shear strength of compacted glaciolacustrine and till deposits.

Water content tests were made on samples of the in-place fill obtained during inspection of placement and compaction of Category I fill. The results of 97 water content tests, made on till deposit samples, indicated the average water content of till deposit placed and compacted as Category I fill was approximately 16%. The results of 144 water content tests, made on glaciolacustrine deposit samples, indicated the average water content of glaciolacustrine deposit placed and compacted as Category I fill was approximately 25%.

If it is assumed that the material along the critical failure surface consists entirely of glaciolacustrine deposit at an average water content of 25% and it is further assumed that the glaciolacustrine deposit has undrained shear strength characteristics similar to those indicated by unconsolidated-undrained (UU) strength tests, a minimum available undrained shear strength of 1.0 kips/sq ft is obtained for material along the critical failure surface. The ratio of this minimum value of available undrained shear strength and the undrained shear strength required for a factor of safety of 1.0 (0.4 kips/sq ft) indicates a minimum factor of safety of 2.5 for the Category I dikes during application of safe shutdown earthquake forces.

Compaction Specification

Category I intake canal forebay dike fill (heareafter referred to as Category I intake fill) consists of compacted glaciolacustrine and till deposits obtained from on-site borrow areas.

Category I intake fill was placed in lifts with a maximum thickness of 12 in. and compacted with a minimum of six coverages of an approved sheep's-foot roller. Category I intake fill material was placed and compacted within a water content range of in-situ water content to optimum water content minus 5 percentage points.

1302-B.2.c Seismic Activities

Extensive geologic and seismologic investigations were made of the site area and region. Dynamic parameters for use in the design of station facilities were recommended based on results of these investigations. This site has been reviewed and granted a construction permit by the AEC for Davis-Besse Unit No. 1. The scope and results of the investigations and the recommended dynamic parameters used in the design are summarized in this section.

The regional and local lithographic, stratigraphic, and structural geologic conditions are described in Section 1302-B.2.a.

The primary tectonic structures in the region are the Findlay Arch, the Michigan basin, the Appalachian Geosyncline, and the Ohio-Indiana Platform. Secondary tectonic structures in the region, superimposed on the primary broad features, are the Waverly Arch, the Chatham Sag, the Howell-Northville Anticline, the Lucas Monocline, the Parkersburg-Lorain Syncline, and the Cambridge Arch. The major faults which have been identified in the region are the Bowling Green fault, the Electric fault, the Clearville fault, the Dawn fault, the Kinball-Colinville fault, the Willey fault, the hypothesized Howell-Northville fault, and the Peck fault. The locations of these structures are shown in Figure 1302-B-20.

The site is located on the east flank of the Findlay Arch. No other tectonic structures are known to underlie the site. The nearest fault is the Bowling Green fault, which is located 35 mi west of the site at its closest point and trends northwest-southeast.

Results of the geologic, seismologic, and subsurface investigations indicate no evidence of fault traces, offset geomorphic features,

TABLE 1302-B-3

SUMMARY OF MAXIMUM CONTACT STRESSES AND ULTIMATE BEARING CAPACITY FOR MAT AND STRIP FOOTINGS SUPPORTING SEISMIC CATEGORY I STRUCTURES

Category I Structure	Maximum Contact Stress Beneath Footing $\sigma_{u'}$ kips/sq. ft.	Bearing Material	Ultimate Bearing Capacity of Bearing Material $f_{bu'}$ kips/sq. ft.	Factor of Safety $\frac{f_{bu}}{\sigma_{u'}}$	Maximum Total Settlement of Footing at $\sigma_{u'}$ in.
Containment	15	Bedrock	600	40	Less than 1/8
Auxiliary	7	Bedrock	600	85	Less than 1/8
Intake	26	Bedrock	600	37	Less than 1/8
Valve room 4	4	Concrete fill	600	150	Less than 1/8
Valve room 5	4	Concrete fill	576	10	Less than 1/4
Borated water tank	7.5	Compacted granular backfill	50	6.7	Less than 1/4
Electric manholes 3001, 3004, and 3005	2	Compacted granular backfill	50	25	Less than 1/8
Diesel oil storage tank	7.5	Compacted granular backfill	50	6.7	Less than 1/4
Service water piping manholes	2	Compacted granular backfill	50	25	Less than 1/8

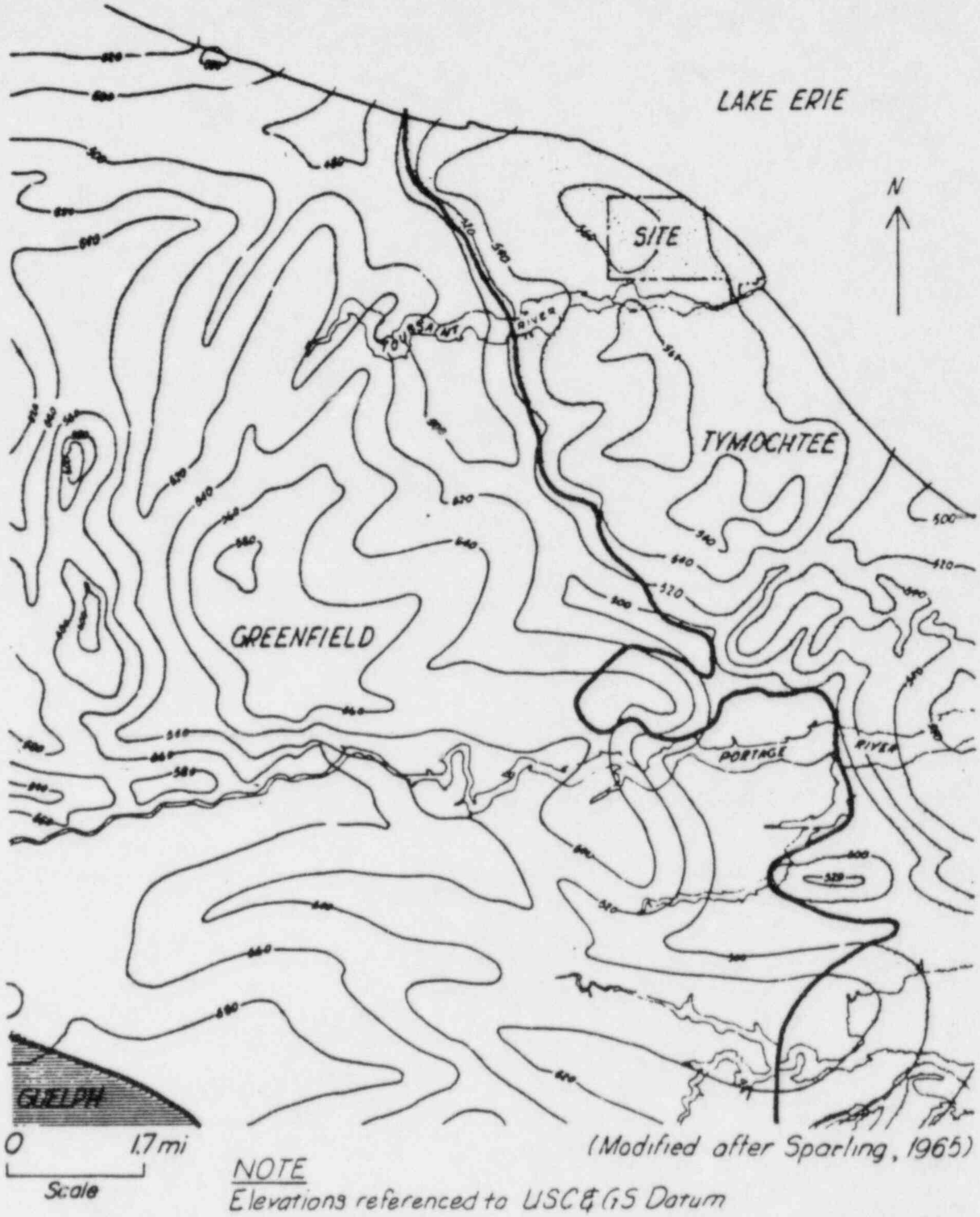


FIGURE 1302-B-10

INFERRED LOCAL BEDROCK SURFACE CONTOURS AND GEOLOGIC MAP

DAVIS BESSE STATION UNITS NO. 2 & 3
OPSC CERTIFICATE APPLICATION

TOLEDO EDISON

EXHIBIT K

United States Department of Agriculture

Soil Conservation Service

In Cooperation with Ohio Department of Natural Resources Division of Lands and Soil and Ohio Agricultural Research and Development Center

Soil Survey of Ottawa County Ohio

Published Apr. 1985

soil survey of
Ottawa County, Ohio

By D. K. Musgrave and G. D. Derringer, Ohio Department of Natural Resources
Division of Lands and Soil

Fieldwork by D. K. Musgrave, R. A. Robbins, and G. D. Derringer,
Ohio Department of Natural Resources,
Division of Lands and Soil

United States Department of Agriculture, Soil Conservation Service
In cooperation with Ohio Department of Natural Resources, Division of Lands and Soil, and Ohio Agricultural Research and Development Center

Ottawa County is in the north-central part of Ohio. It is bordered by Lake Erie on the east and northeast, by Sandusky County on the south, by Wood County on the west, and by Lucas County on the north. Ottawa County occupies approximately 172,160 acres, or 270 square miles. It has twelve townships.

The population of the county in 1970 was 37,099 (*17*). Port Clinton, the county seat and the largest city, is in the eastern part of the county. It had a population of 7,202 in 1970. Villages are Clay Center, Elmore, Genoa, Lakeside, Marblehead, Oak Harbor, Put-In-Bay (on the South Bass Island), and Rocky Ridge.

This survey updates the soil survey of Ottawa County published in 1928 (*11*). It provides additional information and larger maps that show the soils in greater detail.

general nature of the county

This section provides general information about the county. It discusses the climate; settlement; farming; physiography, relief, and drainage; and history and economic development of the area.

The most valuable natural resources are soil and water. Limestone and sand and gravel are other important natural resources.

climate

Prepared by the National Climatic Center, Asheville, North Carolina.

Ottawa County is cold in winter and warm and occasionally hot in summer. Precipitation is well distributed throughout the year with a moderate peak in summer, and it is adequate for most crops on most soils. Winter precipitation is mainly snow, which occurs sometimes as a blizzard.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Ottawa, Ohio, in the period 1972 to 1978. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is 26 degrees F, and the average daily minimum temperature is 17 degrees. The lowest temperature on record, which occurred at Ottawa on January 17, 1977, is -15 degrees. In summer the average temperature is 71 degrees,and the average daily maximum temperature is 83 degrees. The highest recorded temperature, which occurred on July 15, 1977, is 100 degrees.

Growing degree days are shown in table 1. They are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (50 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop for wetland wildlife. Pump drainage is used in some areas that are farmed. These soils are generally not suited to crops unless they are artificially drained. They are also generally not suited to woodland and as a site for buildings and septic tank absorption fields. They are well suited to habitat for wetland wildlife.

Levees, open ditches, subsurface and surface drains, and pump drainage are commonly used in areas that are farmed. Pump drainage permits the growing of grain crops and the flooding of these areas to attract and feed wetland waterfowl during migration.

5. Toledo-Nappanee association

Deep, nearly level, very poorly drained and somewhat poorly drained soils formed in clayey glacial lakebed sediments and glacial till

This association is on broad, flat lake plains that have slight rises. The soils are mainly nearly level; however, some sloping areas are along waterways.

This association covers about 50 percent of the county. It is about 55 percent Toledo soils, 20 percent Nappanee soils, and 25 percent soils of minor extent (fig. 1).

Toledo soils are on broad flats and in long, narrow depressions. Nappanee soils are on slight rises and on slope breaks along drainageways. Toledo soils are nearly level and very poorly drained. They formed in clayey lakebed sediments. Permeability of the Toledo soils is slow. These soils have a seasonal high water table near or above the surface and are ponded during periods of heavy rain. Nappanee soils are nearly level and somewhat poorly drained. They formed in silty and clayey glacial till. Permeability of the Nappanee soils is slow. A seasonal high water table is at a depth of 12 to 24 inches. Both soils have a moderate available water capacity.

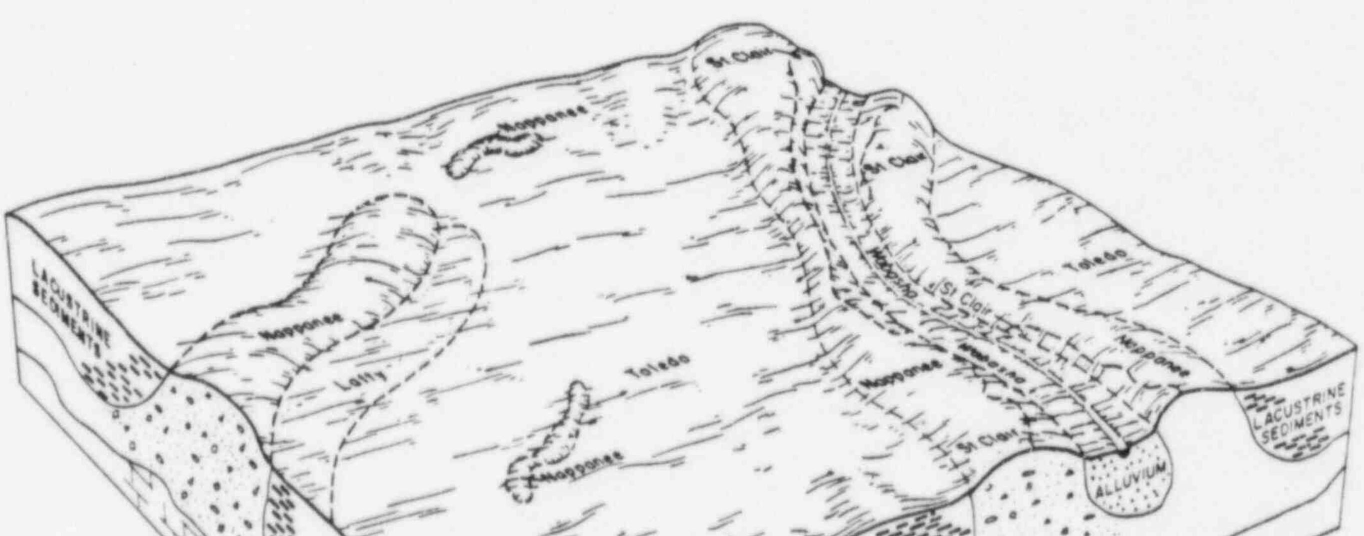


Figure 1.—Typical pattern of soils and underlying material in the Toledo-Nappanee association.

The minor soils in this association are in the Bono, Hoytville, Latty, Lenawee, Haskins, Rimer, St. Clair, Wabasha, Genesee, and Shoals series. The very poorly drained Bono, Hoytville, Latty, and Lenawee soils are on flats and in depressions; the somewhat poorly drained Haskins and Rimer soils are on slight rises; the moderately well drained St. Clair soils are on side slopes along drainageways; the very poorly drained Wabasha soils are on narrow flood plains; and the well drained Genesee and somewhat poorly drained Shoals soils are on the wider flood plains.

The soils in this association are used mainly for corn and soybeans. Some areas are used for specialty crops. Drained areas are suited to row crops, small grains, and specialty crops. These soils are moderately well suited to poorly suited as building sites. They are poorly suited to generally not suited to septic tank absorption fields.

Ponding, slow permeability, and high shrink-swell potential are major limitations to the use of these soils. Surface and subsurface drains are commonly used to improve drainage. These soils should be tilled, harvested, or grazed within a narrow range of moisture content, because they become compacted and cloddy if worked when wet. Because Nappanee soils are on slight rises and slope breaks along drainageways, they are better suited as sites for buildings than Toledo soils. Tops of foundations should be elevated above normal grade, and building sites and septic tank absorption fields should be landscaped for good surface drainage away from foundations and absorption fields.

TABLE 17.--SOIL AND WATER FEATURES

["Flooding" and "water table" and terms such as "rare," "brief," "apparent," and "perched" are explained in the text. The symbol < means less than; > means more than. Absence of an entry indicates that the feature is not a concern or that data were not estimated]

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
Ag: Algansee	B	Occasional	Long	Nov-May	1.0-2.0	Apparent	Nov-May	>60	---	Moderate	Low	Low.
Bo: Bono	B/D	None	---	---	+1-1.0	Apparent	Dec-May	>60	---	Moderate	High	Low.
ChB: Castalia	C	None	---	---	>6.0	---	---	20-40	Hard	Moderate	Low	Low.
Co: Colwood	B/D	None	---	---	+1-1.0	Apparent	Oct-May	>60	---	High	High	Low.
DeA: Del Rey	C	None	---	---	1.0-3.0	Apparent	Jan-May	>60	---	High	High	Moderate.
DuB: Dunbridge	B	None	---	---	>6.0	---	---	20-40	Hard	Moderate	Moderate	Low.
Gn: Genesee	B	Frequent	Brief	Oct-Jun	>6.0	---	---	>60	---	Moderate	Low	Low.
Go: Genesee Variant	B	Frequent	Brief	Jan-May	>6.0	---	---	20-40	Hard	Moderate	Low	Low.
Gr: Glendora	A/D	Frequent	Long	Jan-Dec	0-1.0	Apparent	Nov-Jun	>60	---	Moderate	High	Moderate.
HaA: Haskins	C	None	---	---	1.0-2.5	Perched	Jan-Apr	>60	---	High	High	Moderate.
Hy: Hoytville	D	None	---	---	+1-1.0	Perched	Jan-Apr	>60	---	High	High	Low.
KfA: Kibbie	B	None	---	---	1.0-2.0	Apparent	Nov-May	>60	---	High	Low	High.
Lc: Latty	D	None	---	---	+.5-1.0	Perched	Jan-Apr	>60	---	Moderate	High	Low.
Lf: Lenawee	B/D	None	---	---	+1-1.0	Apparent	Nov-May	>60	---	High	High	Low.
Mh: Millsdale	B/D	None	---	---	+1-1.0	Perched	Jan-Apr	20-40	Hard	High	High	Low.
MtB: Milton	C	None	---	---	>6.0	---	---	20-40	Hard	Moderate	High	Moderate.
NpA: Nappanee	D	None	---	---	1.0-2.0	Perched	Nov-May	>60	---	Moderate	High	Low.

TABLE 17.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
OaB: Oakville	A	None	---	---	>6.0	---	---	>60	---	Low	Low	Moderate.
Pt*. Pits												
RaB: Rawson	B	None	---	---	2.5-4.0	Perched	Jan-Apr	>60	---	Moderate	High	High.
RmA: Rimer	C	None	---	---	1.0-2.5	Perched	Jan-Apr	>60	---	High	High	Moderate.
SbC2: St. Clair	D	None	---	---	2.0-3.0	Perched	Mar-May	>60	---	Moderate	High	Moderate.
Sh: Shoals	C	Frequent	Brief	Oct-Jun	1.0-3.0	Apparent	Jan-Apr	>60	---	High	High	Low.
To: Toledo	D	None	---	---	+1-1.0	Perched	Jan-Apr	>60	---	High	High	Low.
Tp: Toledo	D	None	---	---	+3-1.0	Perched	Sep-May	>60	---	High	High	Low.
Ud*. Udorthents												
Wa: Wabasha	D	Frequent	Long	Jan-May	0-1.0	Apparent	Dec-Jun	>60	---	High	High	Low.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodi-bility group	Organic matter
	In	Pct	G/cm3	In/hr	In/in	pH					Pct
NpA: Nappanee	0-8	32-40	1.30-1.50	0.2-0.6	0.18-0.22	5.1-7.3	Moderate	0.43	3	7	1-3
	8-34	45-60	1.40-1.80	0.06-0.2	0.08-0.14	5.1-7.8	Moderate	0.32			
	34-60	35-50	1.60-1.85	0.06-0.2	0.06-0.12	7.4-8.4	Moderate	0.32			
OaB: Oakville	0-4	0-10	1.30-1.55	6.0-20	0.07-0.09	5.6-7.3	Low	0.15	5	1	.5-2
	4-60	0-10	1.30-1.65	6.0-20	0.06-0.10	5.6-7.3	Low	0.15			
Pt*. Pits											
RaB: Rawson	0-10	12-20	1.35-1.50	0.6-2.0	0.18-0.22	4.5-7.3	Low	0.32	4	5	1-3
	10-23	18-35	1.50-1.70	0.6-2.0	0.12-0.16	5.1-7.8	Low	0.32			
	23-60	35-55	1.60-1.85	<0.2	0.08-0.12	6.6-8.4	Moderate	0.32			
RmA: Rimer	0-14	5-15	1.40-1.60	6.0-20.0	0.10-0.14	5.1-7.3	Low	0.17	4	2	1-3
	14-26	5-18	1.40-1.60	6.0-20.0	0.08-0.14	5.1-7.3	Low	0.17			
	26-37	40-50	1.40-1.70	0.06-0.2	0.11-0.13	6.1-7.8	High	0.32			
	37-60	20-45	1.40-1.70	0.06-0.2	0.10-0.18	7.4-8.4	Moderate	0.32			
SbC2: St. Clair	0-7	27-40	1.50-1.60	0.2-2.0	0.17-0.23	5.6-7.3	Moderate	0.37	2	7	1-3
	7-23	50-60	1.35-1.70	<0.2	0.10-0.12	5.6-8.4	High	0.37			
	23-60	40-55	1.60-1.75	<0.2	0.09-0.11	7.4-8.4	High	0.37			
Sh: Shoals	0-10	18-27	1.30-1.50	0.6-2.0	0.22-0.24	6.1-7.8	Low	0.37	5	5	2-5
	10-47	18-32	1.35-1.55	0.6-2.0	0.17-0.22	6.1-7.8	Low	0.37			
	47-60	12-25	1.35-1.60	0.6-2.0	0.12-0.21	6.6-7.8	Low	0.37			
To: Toledo	0-7	40-55	1.45-1.65	0.2-0.6	0.12-0.14	6.1-7.3	High	0.28	5	4	3-6
	7-48	40-60	1.40-1.70	0.06-0.2	0.09-0.13	6.1-7.8	High	0.28			
	48-60	35-60	1.45-1.75	0.06-0.2	0.08-0.12	7.4-8.4	High	0.28			
Tp: Toledo	0-6	40-55	1.45-1.65	0.2-0.6	0.12-0.14	6.1-7.3	High	0.28	5	4	4-8
	6-41	40-60	1.40-1.70	0.06-0.2	0.10-0.13	6.1-7.8	High	0.28			
	41-60	40-60	1.45-1.75	0.06-0.2	0.08-0.12	7.4-8.4	High	0.28			
Ud*. Udorthents											
Wa: Wabasha	0-9	40-45	1.35-1.55	0.2-0.6	0.14-0.18	6.1-7.8	High	0.32	5	4	3-6
	9-50	40-55	1.35-1.65	0.06-0.2	0.12-0.16	6.1-7.8	High	0.32			
	50-60	35-55	1.50-1.65	0.06-0.2	0.12-0.17	6.1-8.4	High	0.32			

* See description of the map unit for composition and behavior characteristics of the map unit.

SOIL LEGEND

Symbols consist of letters or combinations of letters and numbers. The first two letters identify the soil or miscellaneous area, and the next letter, if used, identifies the slope class. Symbols without a slope designation are either level or nearly level or a miscellaneous area. A final number 2 indicates those soils which have been eroded.

SYMBOL	NAME
Ag	Algansee fine sand, occasionally flooded
Bo	Bono silty clay
ChB	Castalia very stony fine sandy loam, 1 to 6 percent slopes
Co	Colwood loam
DeA	Del Rey silt loam, 1 to 3 percent slopes
DuB	Dunbridge fine sandy loam, 2 to 6 percent slopes
Gn	Genesee silt loam, frequently flooded
Go	Genesee Variant loam, frequently flooded
Gr	Glendora loamy fine sand, frequently flooded
HaA	Haskins loam, 0 to 3 percent slopes
Hy	Hoytville silty clay loam
KfA	Kibbie fine sandy loam, 0 to 2 percent slopes
Lc	Latty silty clay
Lf	Lenawee silty clay loam
Mh	Millsdale silty clay loam
MtB	Milton silt loam, 2 to 6 percent slopes
NpA	Nappanee silty clay loam, 0 to 3 percent slopes
OaB	Oakville fine sand, 2 to 8 percent slopes
Pt	Pits, quarry
RaB	Rawson loam, 2 to 6 percent slopes
RmA	Rimer loamy fine sand, stratified substratum, 0 to 2 percent slopes
SbC2	St. Clair silty clay loam, 4 to 12 percent slopes, eroded
Sh	Shoals silt loam, frequently flooded
To	Toledo silty clay
Tp	Toledo silty clay, ponded
Ud	Udorthents, gently sloping
Wa	Wabasha silty clay, frequently flooded

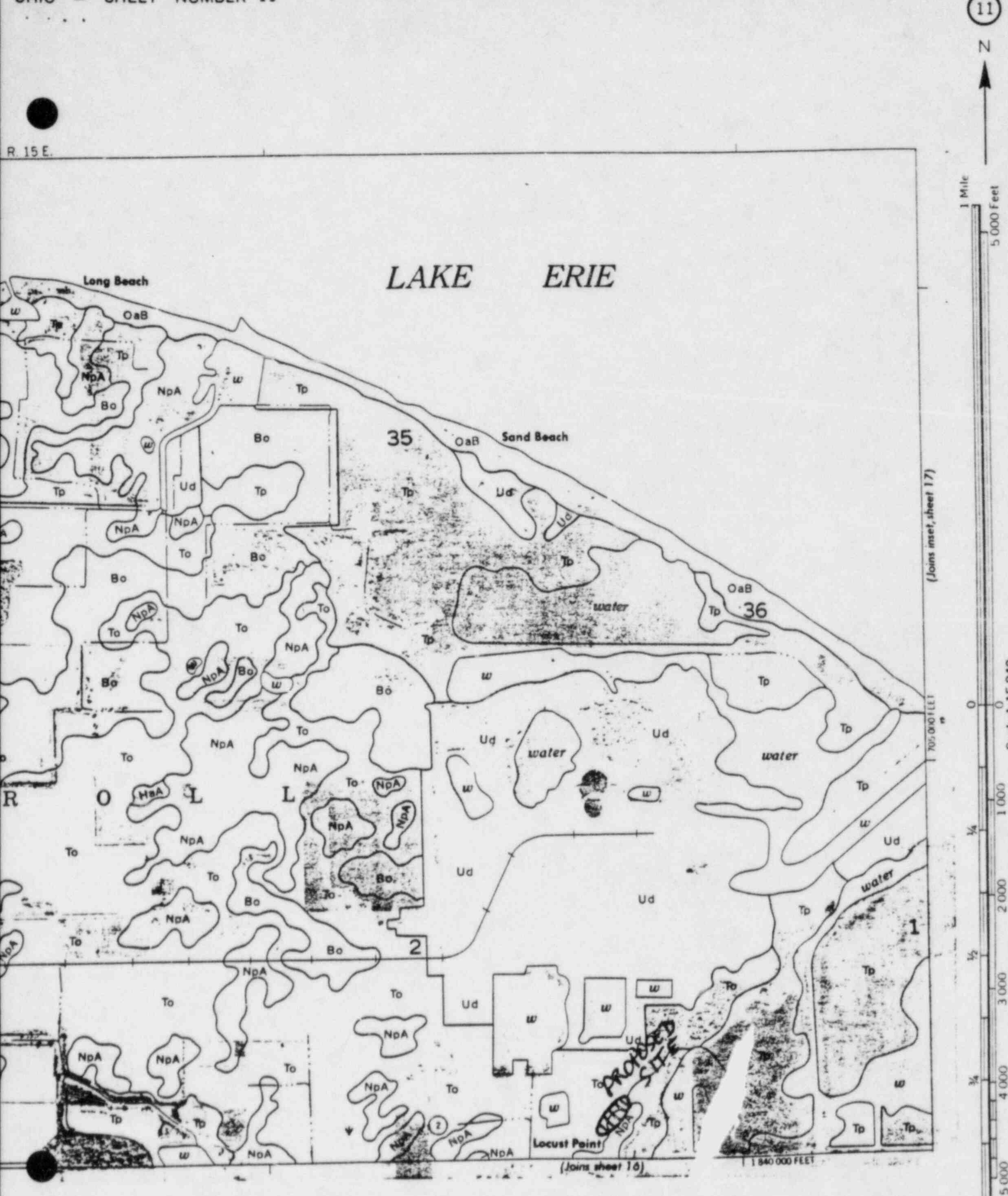

11
N
R. 15 E.
LAKE ERIE
Long Beach
Sand Beach
35
36
Locust Point
PROPOSED SITE
(Joins inset, sheet 17)
(Joins sheet 16)
705 000 FEET
1 840 000 FEET
1 Mile
5 000 Feet
Scale 1:15 840

EXHIBIT L

LOCATED DRILLERS LOGS

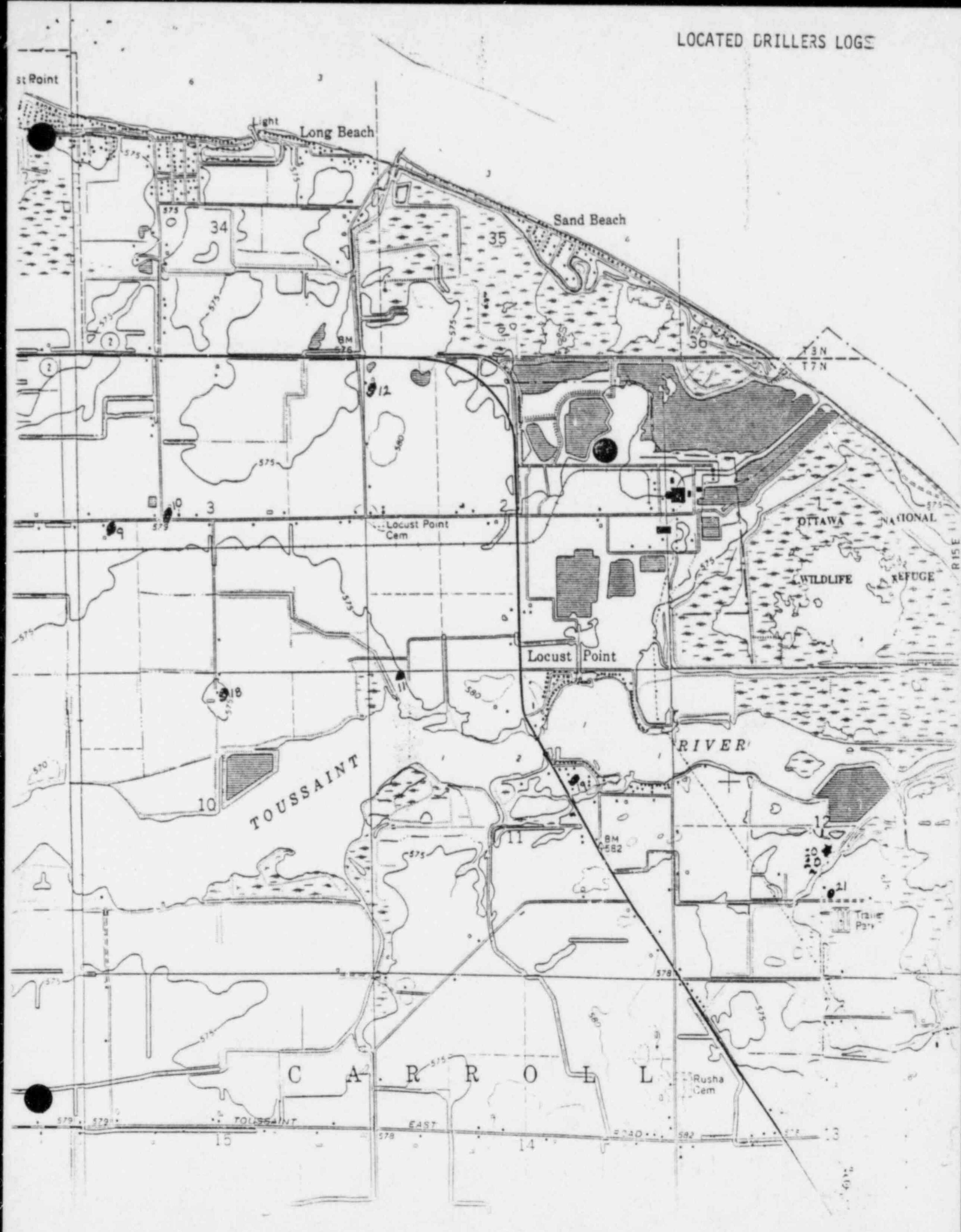


EXHIBIT M

ORIGINAL

18-2

WELL LOG AND DRILLING REPORT

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
1562 W. First Avenue
Columbus, Ohio 43212

PLEASE USE PENCIL OR TYPEWRITER

DO NOT USE INK.

№ 343889

County: OTTAWA Township: CARROLL Section of ~~Township~~: & Sec. 31

Owner: CHUCK BEWITZ Address: RFD. OAK HARBOR

Location of property: ON. DUFF WASHA-Rd in Carroll twp. - Sec. 4

CONSTRUCTION DETAILS

Casing diameter: 4½ Length of casing: 42

Type of screen: ______ Length of screen: ______

Type of pump: ______

Capacity of pump: ______

Depth of pump setting: ______

Date of completion: ______

BAILING OR PUMPING TEST

Pumping Rate: 16 G.P.M. Duration of test: ______ hrs.

Drawdown: 4 ft. Date: 12/21/69

Static level-depth to water: 10 ft.

Quality (clear, cloudy, taste, odor): Sulfur + gas

Pump installed by: ______

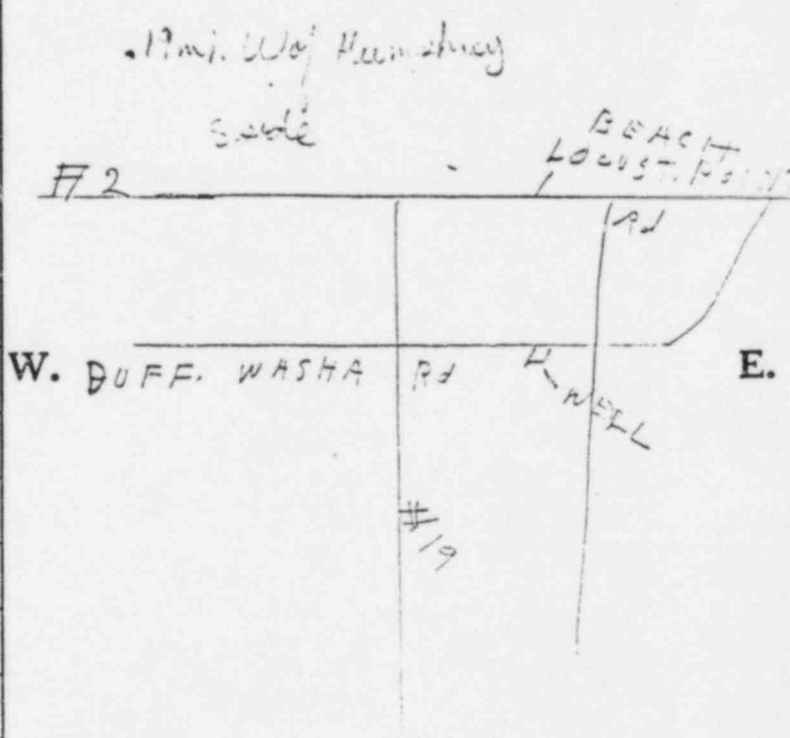
WELL LOG*

Formations Sandstone, shale, limestone, gravel and clay	From	To
Clay + Gravel	0 Feet	40 Ft.
Lime Stone	40	82

SKETCH SHOWING LOCATION

Locate in reference to numbered State Highways, St. Intersections, County roads, etc.

N.



S.

See reverse side for instructions

Drilling Firm: KIMBELL WELL DRILLING Date: 12/29/69

Address: ______ Signed: ______

*If additional space is needed to complete well log, use next consecutive numbered form.

WELL LOG AND DRILLING REPORT

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
1562 W. First Avenue
Columbus, Ohio 43212

PLEASE USE PENCIL OR TYPEWRITER
DO NOT USE INK.

Nº 343888

County OTTAWA Township CARROLL Section of ~~Township~~ 3

Owner KENNETH - FRIESMAN Address OAK HARBOR

Location of property

CONSTRUCTION DETAILS

Casing diameter 4 Length of casing 34

Type of screen Length of screen

Type of pump

Capacity of pump

Depth of pump setting

Date of completion

BAILING OR PUMPING TEST

Pumping Rate 16 G.P.M. Duration of test hrs.

Drawdown 3 ft. Date 12/12/67

Static level-depth to water 8 ft.

Quality (clear, cloudy, taste, odor)

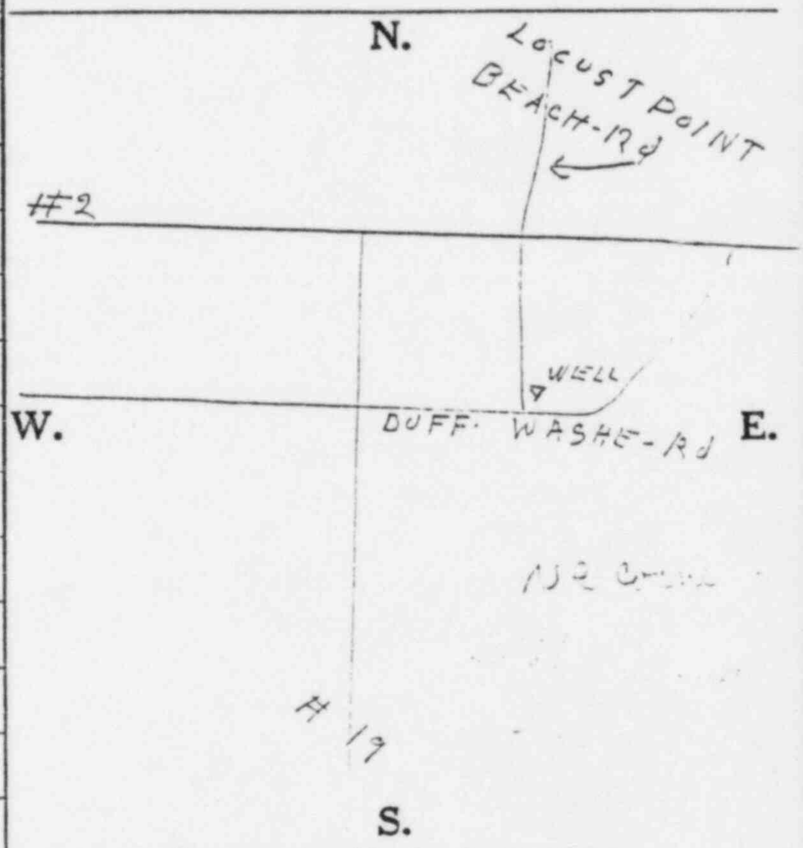
Pump installed by

WELL LOG*

Formations Sandstone, shale, limestone, gravel and clay	From	To
Clay + Gravel	0 Feet	32 Ft.
Lime Stone	32	47

SKETCH SHOWING LOCATION

Locate in reference to numbered State Highways, St. Intersections, County roads, etc.



See reverse side for instructions

Drilling Firm Date

Address Signed

*If additional space is needed to complete well log, use next consecutive numbered form.

WELL LOG AND DRILLING REPORT

ORIGINAL

NO CARBON PAPER
NECESSARY—
SELF-TRANSCRIBING

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
65 S. Front St., Rm. 815 Phone (614) 469-2646
Columbus, Ohio 43215

No. 417898

County Ottawa Township Port... Carroll Section of Township 2

Owner Bill Luckwater Address 719 Fulton St. Port Clinton O

Location of property Across from Atomic Plant

CONSTRUCTION DETAILS	
Casing diameter 5 3/8"	Length of casing 25 1/2
Type of screen —	Length of screen —
Type of pump	
Capacity of pump	
Depth of pump setting 50'	
Date of completion June 17, 1971	

BAILING OR PUMPING TEST (Specify one by circling)

Test Rate 15' G.P.M. Duration of test 1 hrs.
Drawdown 75 ft. Date June 17, 1971
Static level-depth to water 7 ft.
Quality (clear, cloudy, taste, odor) Black Sulfur

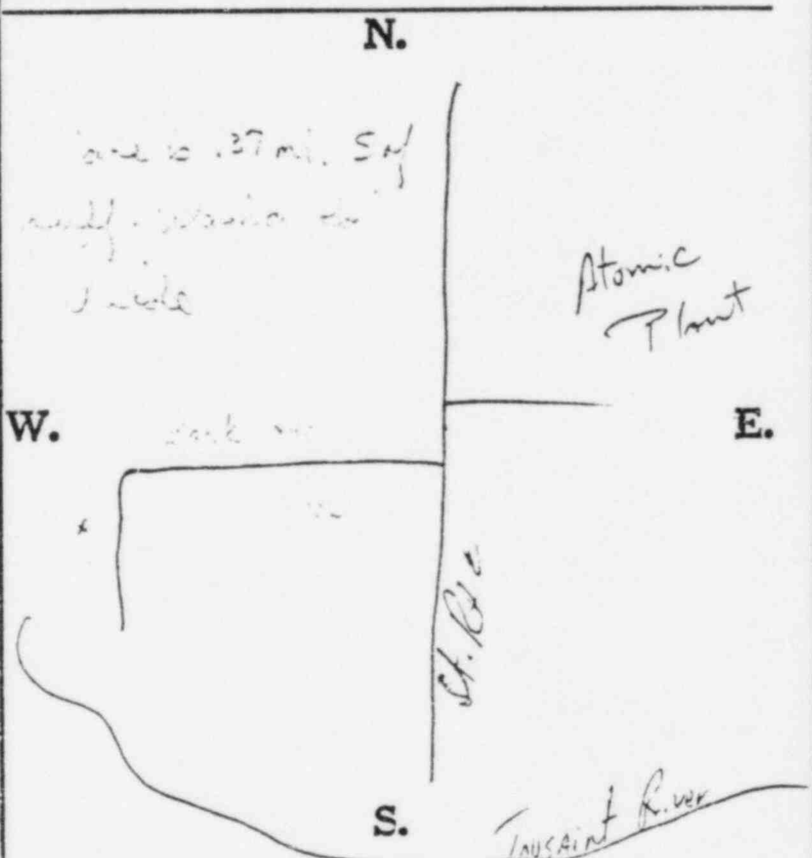
Pump installed by

WELL LOG*

Formations Sandstone, shale, limestone, gravel and clay	From	To
Yellow Clay	0 Feet	10 Ft.
Blue Clay	10	23
Limestone	23	125
Water feed @ 125		

SKETCH SHOWING LOCATION

Locate in reference to numbered State Highways, St. Intersections, County roads, etc.



Drilling Firm Tibbels Well Drilling Date June 19, 1971

Address Rt 3 Bellevue O Signed ... Tibbels

*If additional space is needed to complete well log, use next consecutive numbered form.

WELL LOG AND DRILLING REPORT

ORIGINAL

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Geological Survey
Fountain Square
Columbus, Ohio 43224 Phone (614) 466-5344

NO CARBON PAPER NECESSARY—SELF-TRANSCRIBING

472396

COUNTY Ottawa TOWNSHIP Carroll SECTION OF TOWNSHIP OR LOT NUMBER 2

OWNER Walter Cabel ADDRESS 2202 Walnut St Toledo O

LOCATION OF PROPERTY Twp Rd 128 - 1/8 mi S. of St Rt 2

CONSTRUCTION DETAILS

Casing diameter 5 5/8" Length of casing 24'

Type of screen — Length of screen —

Type of pump Shallow Well

Capacity of pump

Depth of pump setting 23'

Date of completion 7-1-74

BAILING OR PUMPING TEST
(specify one by circling)

Test rate 20 gpm Duration of test 1 hrs

Drawdown 10 ft Date 7-1-74

Static level (depth to water) 7 ft

Quality (clear, cloudy, taste, odor) Appears Good

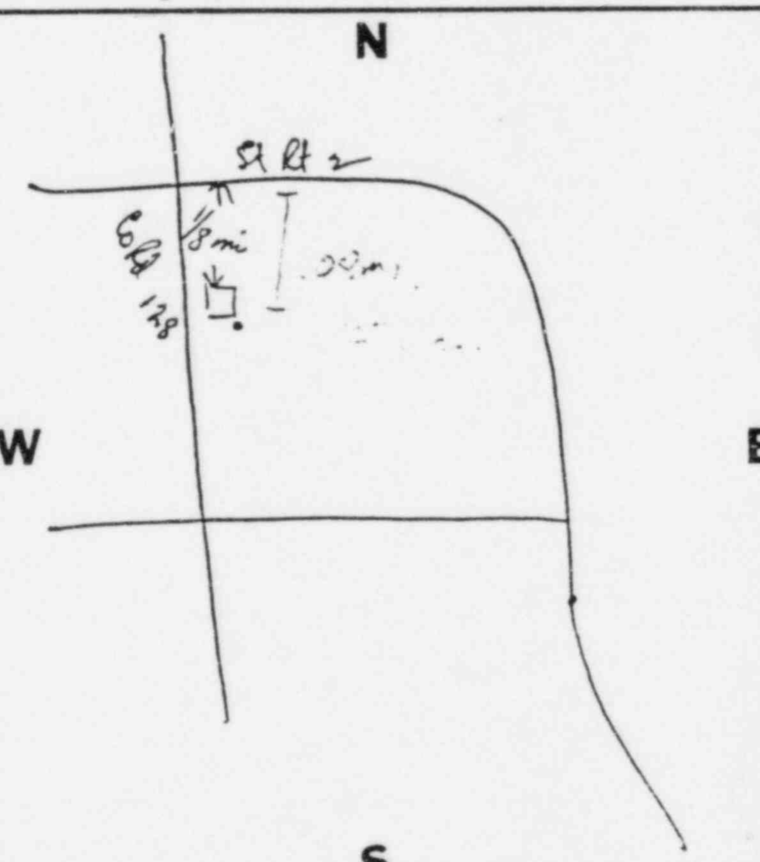
Pump installed by

WELL LOG*

Formations: sandstone, shale, limestone, gravel, clay	From	To
Yellow Clay	0 ft	10 ft
Blue Clay	10	21
Broken Limestone (water)	21	25

SKETCH SHOWING LOCATION

Locate in reference to numbered state highways, street intersections, county roads, etc.



DRILLING FIRM TIBBOLES WELL DRILLING
ADDRESS R.R.3 Bellevue, Ohio 44811

DATE 7-1-74
SIGNED Wm Tibboles

*If additional space is needed to complete well log, use next consecutive numbered form.

ORIGINAL

12 ✓

WELL LOG AND DRILLING REPORT

NO CARBON PAPER NECESSARY— SELF-TRANSCRIBING

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
65 S. Front St., Rm. 815 Phone (614) 469-2646
Columbus, Ohio 43215

433953

County Ottawa Township Carroll Section of Township 10 ✓

Owner Richard Goerden Address

Location of property 4 mi. N of Oak Harbor Ohio

CONSTRUCTION DETAILS

Casing diameter 4¼" I.D. Length of casing 52

Type of screen Length of screen

Type of pump

Capacity of pump

Depth of pump setting

Date of completion

BAILING OR PUMPING TEST
(Specify one by circling)

Test Rate 15 G.P.M. Duration of test 2 hrs

Drawdown ft. Date 4-4-72

Static level-depth to water 4 ft.

Quality (clear, cloudy, taste, odor)

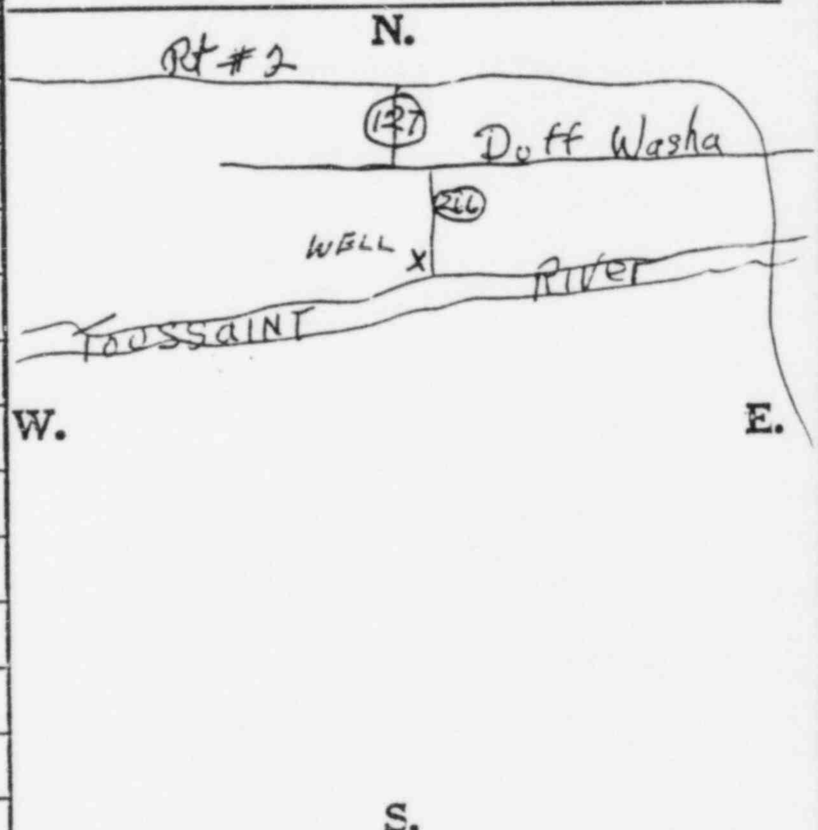
Pump installed by

WELL LOG*

Formations Sandstone, shale, limestone, gravel and clay	From	To
	0 Feet	Ft.
Clay	0	47
LOOSE LIMESTONE	47	95

SKETCH SHOWING LOCATION

Locate in reference to numbered State Highways, St. Intersections, County roads, etc.



Drilling Firm Bihn's Well Drilling Date 4-4-72

Address Walbridge, Ohio Signed Wendell Bihn

*If additional space is needed to complete well log, use next consecutive numbered form.

WELL LOG AND DRILLING REPORT — ORIGINAL

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
1500 Dublin Road
Columbus, Ohio

2/a

No. 182108

County: Ottawa — Township: Carroll — Section of Township: 11

Owner: August Hess — Address: Oak Harbor

Location of property: Old Section of State Rt 2.

CONSTRUCTION DETAILS	
Casing diameter	6 1/4
Length of casing	16'
Type of screen	None
Length of screen	
Type of pump	None
Capacity of pump	
Depth of pump setting	
Date of completion	

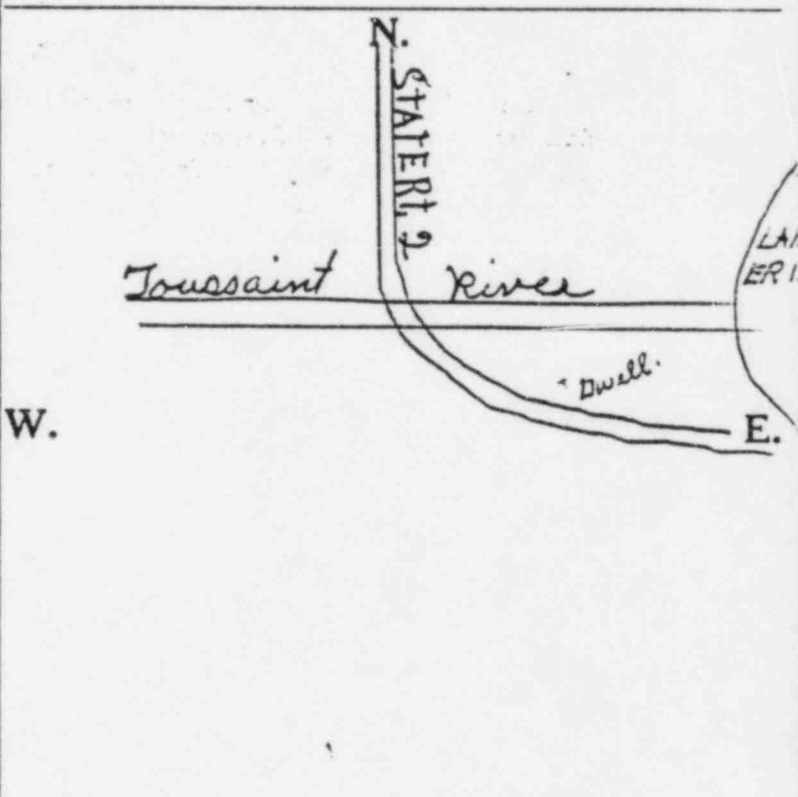
BAILING OR PUMPING TEST	
Pumping rate	460 G.P.M.
Duration of test	1 hrs.
Drawdown	None ft.
Date	7/23/56
Developed capacity	
Static level—depth to water	ft.
Pump installed by	None

WELL LOG

Formations Sandstone, shale, limestone, gravel and clay	From	To
Hard Pan Top Soil	0 Feet	17 Ft.
Water at	17'	
Sulphur Water		

SKETCH SHOWING LOCATION

Locate in reference to numbered State Highways, St. Intersections, County roads, etc.



See reverse side for instructions

Drilling Firm: Flanagan Drilling Co. — Date: 7/24/56

Address: Sycamore Ohio R.D #5 — Signed: Roy Flanagan

ORIGINAL

WELL LOG AND DRILLING REPORT

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
Fountain Square
Columbus, Ohio 43224

NO CARBON PAPER NECESSARY– SELF-TRANSCRIBING

6a

502208

COUNTY ~~[illegible]~~ Ottawa TOWNSHIP Carroll SECTION OF TOWNSHIP 12

OWNER Carlton Wilkins ADDRESS 4445 N. Rider Rd 224 Oak Harbor O 43449

LOCATION OF PROPERTY Wilkins Sub Div.

CONSTRUCTION DETAILS

Casing diameter 5 5/8" Length of casing

Type of screen — Length of screen —

Type of pump

Capacity of pump

Depth of pump setting 26'

Date of completion 5-21-76

BAILING OR PUMPING TEST
(specify one by circling)

Test rate 7 gpm Duration of test 1 hrs

Drawdown 15 ft Date 5-21-76

Static level (depth to water) 5 ft

Quality (clear, cloudy, taste, odor) Appears Good

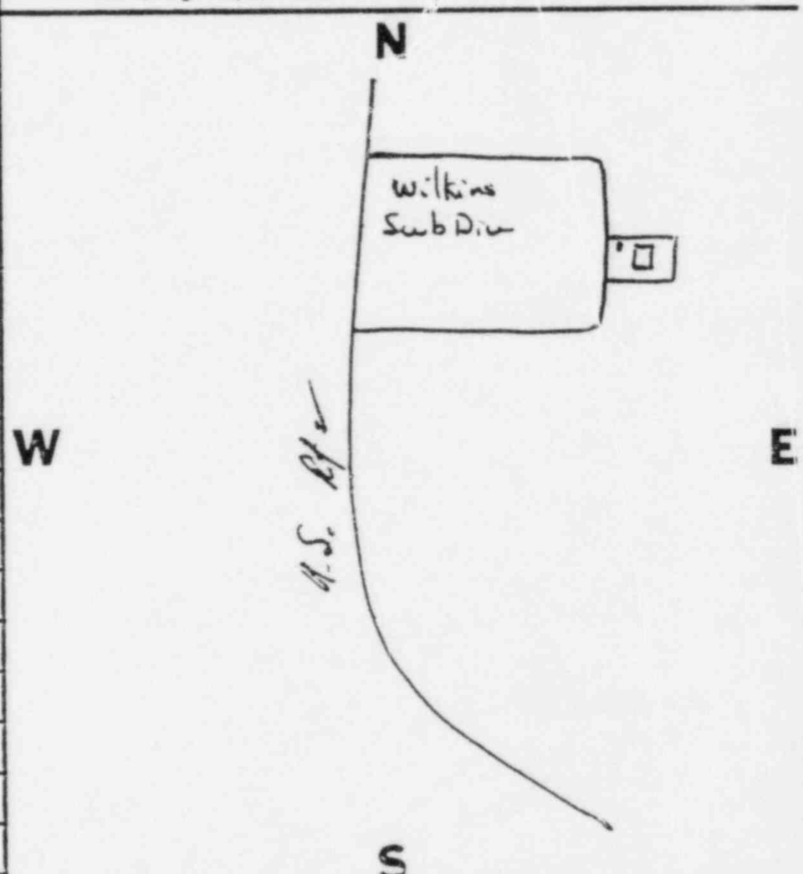
Pump installed by

WELL LOG*

Formations: sandstone, shale, limestone, gravel, clay	From	To
Yellow Clay	0 ft	10 ft
Blue Clay	10	21
Limestone - water	21	29

SKETCH SHOWING LOCATION

Locate in reference to numbered state highways, street intersections, county roads, etc.



DRILLING FIRM TIEBOLES WELL DRILLING, INC. [illegible] DATE 5-21-76

ADDRESS [illegible] SIGNED [signature]

*If additional space is needed to complete well log, use next consecutive numbered form.

ORIGINAL

WELL LOG AND DRILLING REPORT

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Geological Survey
Fountain Square
Columbus, Ohio 43224 Phone (614) 466-5344

NO CARBON PAPER NECESSARY— SELF-TRANSCRIBING

472390

COUNTY: Ottawa TOWNSHIP: Portage / Carroll SECTION OF TOWNSHIP OR LOT NUMBER: 12

OWNER: Carlton Wilkins ADDRESS: 4445 N. Rider Rd Oak Harbor, O

LOCATION OF PROPERTY: St Rt 2 - 1 mi S. of Davis Bessie

CONSTRUCTION DETAILS

Casing diameter: 5 5/8" Length of casing: 19'

Type of screen: — Length of screen: —

Type of pump: Shallow well

Capacity of pump:

Depth of pump setting: 24

Date of completion: 6-26-74

BAILING OR PUMPING TEST
(specify one by circling)

Test rate: 10 gpm Duration of test: 1 hrs

Drawdown: 10 ft Date: 6-26-74

Static level (depth to water): 3 ft

Quality (clear, cloudy, taste, odor): Appears Good

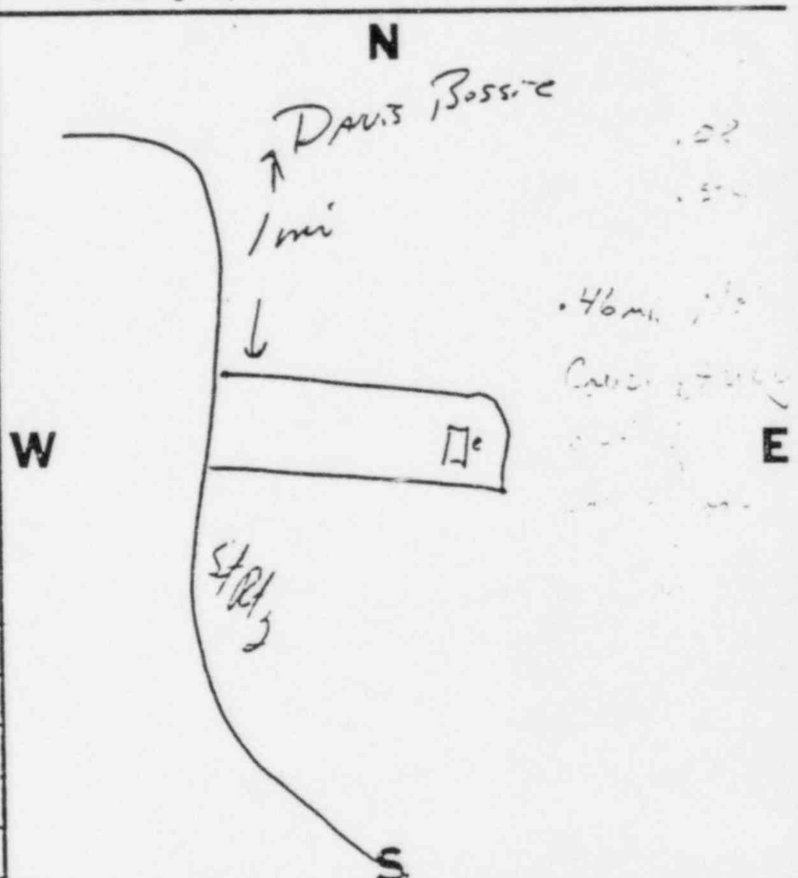
Pump installed by:

WELL LOG*

Formations: sandstone, shale, limestone, gravel, clay	From	To
Topsoil	0 ft	3 ft
Yellow Clay	3	10
Blue Clay	10	18
Limestone	18	26

SKETCH SHOWING LOCATION

Locate in reference to numbered state highways, street intersections, county roads, etc.



DRILLING FIRM: HIBBELES WELL [illegible]

ADDRESS: R R 3 [illegible], Ohio

DATE: 6-26-74

SIGNED: [signature]

*If additional space is needed to complete well log, use next consecutive numbered form.

ORIGINAL 6

WELL LOG AND DRILLING REPORT

NO CARBON PAPER NECESSARY— SELF-TRANSCRIBING

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
65 S. Front St., Rm. 815 Phone (614) 469-2646
Columbus, Ohio 43215

No. 394181

County Ottawa Township Carrol Section of Township 12

Owner Robert Stephens Address 649 Laurel Ave Port Clinton O

Location of property ~~[illegible]~~ Rider Rd.

CONSTRUCTION DETAILS

Casing diameter 5 5/8" Length of casing 25'

Type of screen — Length of screen —

Type of pump Submersible

Capacity of pump

Depth of pump setting 18'

Date of completion June 1, 1969

BAILING OR PUMPING TEST
(Specify one by circling)

Test Rate 30 G.P.M. Duration of test 1 hrs.

Drawdown 3 ft. Date June 1, 1969

Static level-depth to water 3 ft.

Quality (clear, cloudy, taste, odor) Appears Good

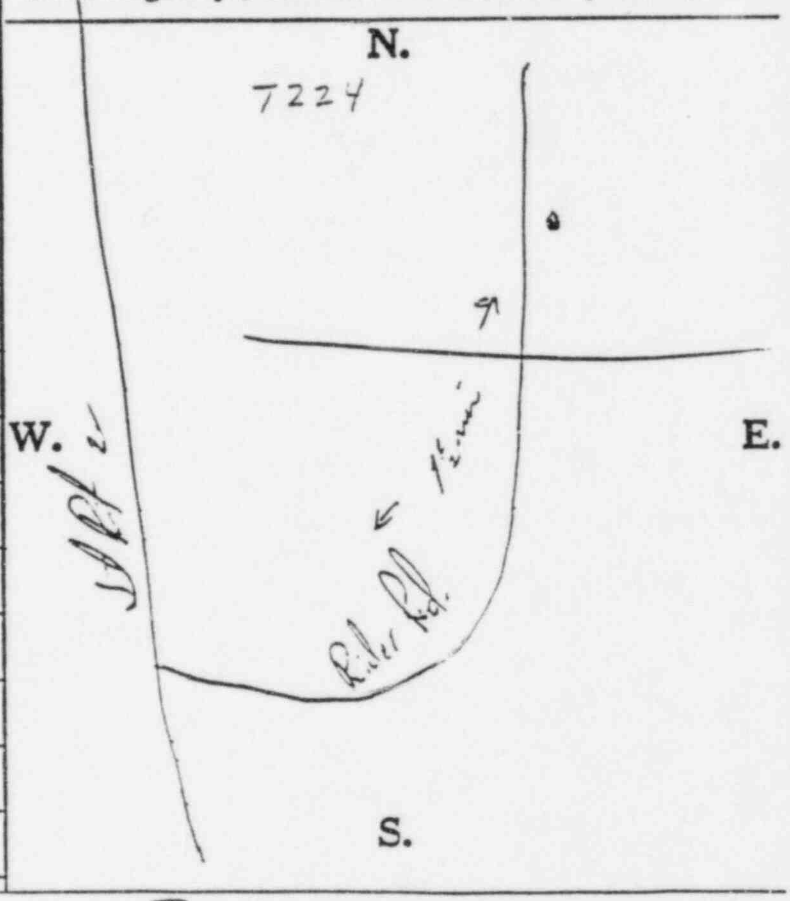
Pump installed by

WELL LOG*

Formations Sandstone, shale, limestone, gravel and clay	From	To
Yellow Clay	0 Feet	9 Ft.
Limestone	9	35
Water found in limestone		

SKETCH SHOWING LOCATION

Locate in reference to numbered State Highways, St. Intersections, County roads, etc.

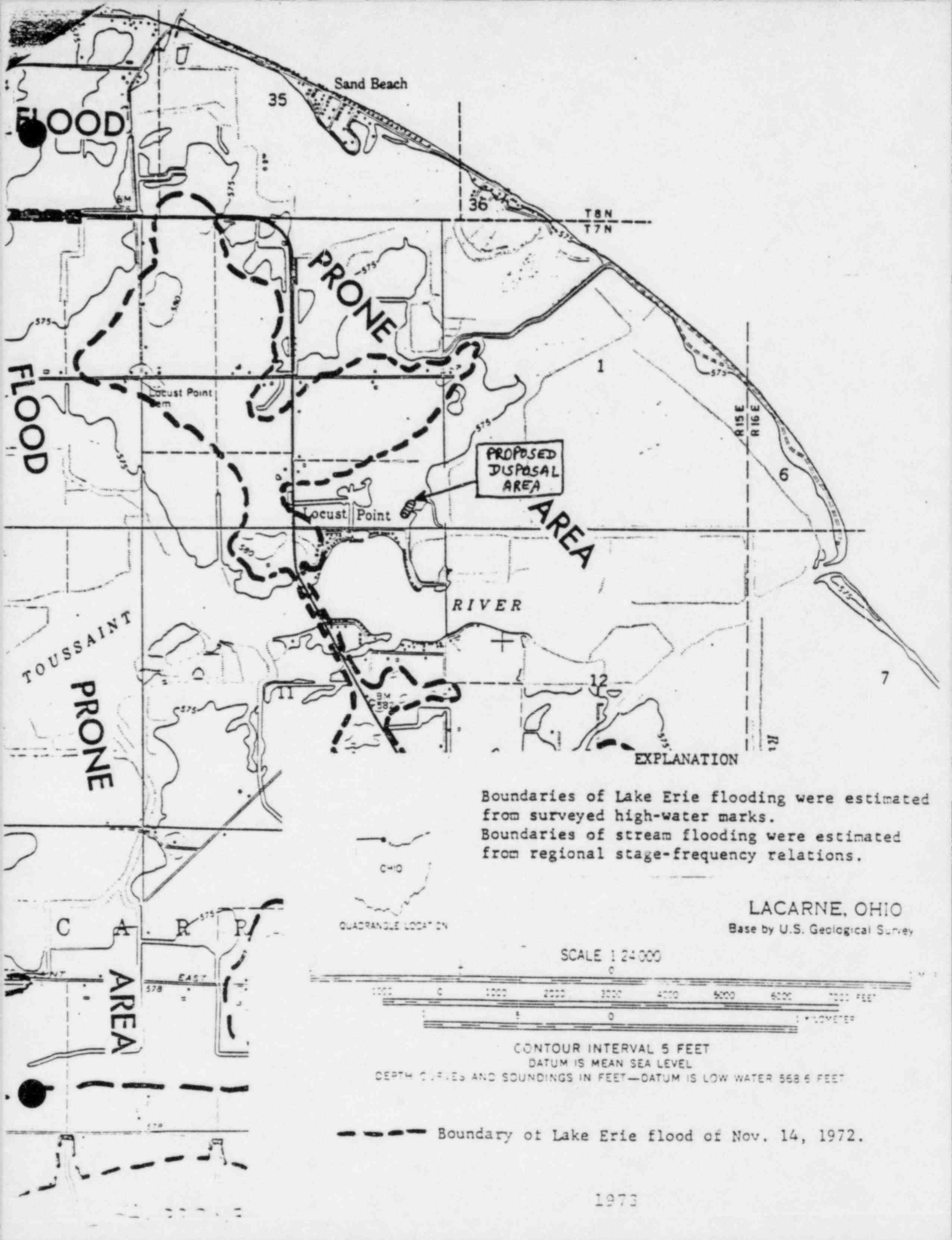


Drilling Firm Tibbles Well Drilling Date June 1 1969

Address Rt 3 Bellevue O Signed [illegible] Tibbles

*If additional space is needed to complete well log, use next consecutive numbered form.

EXHIBIT N



EXPLANATION

Boundaries of Lake Erie flooding were estimated from surveyed high-water marks.
Boundaries of stream flooding were estimated from regional stage-frequency relations.

LACARNE, OHIO
Base by U.S. Geological Survey

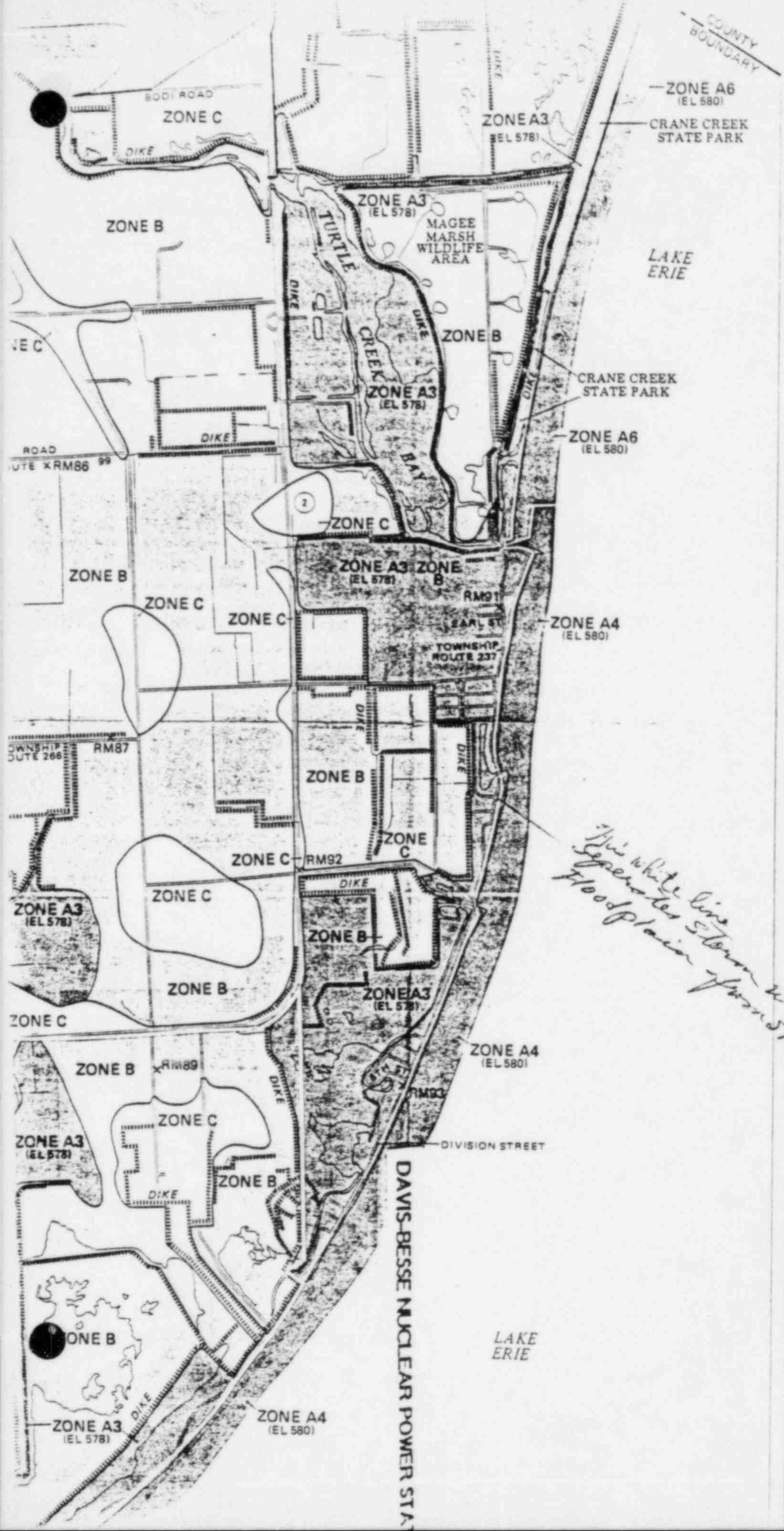
SCALE 1:24000

CONTOUR INTERVAL 5 FEET
DATUM IS MEAN SEA LEVEL
DEPTH CURVES AND SOUNDINGS IN FEET—DATUM IS LOW WATER 568.6 FEET

Boundary of Lake Erie flood of Nov. 14, 1972.

1973

EXHIBIT O



CONVERSION TO REGULAR PROGRAM
OCTOBER 17, 1978

Refer to the CONVERSION TO REGULAR PROGRAM date shown on this map to determine when actuarial rates apply to structures in the zones where elevations or depths have been established.

To determine if flood insurance is available in this community, contact your insurance agent, or call the National Flood Insurance Program, at (800) 638-6620, or (800) 424-8872.

APPROXIMATE SCALE

2000 0 2000 FEET

NATIONAL FLOOD INSURANCE PROGRAM

FLOOD INSURANCE RATE MAP

OTTAWA COUNTY, OHIO
(UNINCORPORATED AREAS)

COMMUNITY-PANEL NUMBER
390432 0050 A

PAGE 50 OF 250
(SEE MAP INDEX FOR PAGES NOT PRINTED)

EFFECTIVE
OCTOBER 17, 1978

With Elevation in Feet**

Base Flood Elevation in Feet Where Uniform Within Zone** (EL 987)

Elevation Reference Mark RM7×

River Mile • M1.5

**Referenced to the National Geodetic Vertical Datum of 1929

*EXPLANATION OF ZONE DESIGNATIONS

ZONE	EXPLANATION
A	Areas of 100-year flood; base flood elevations and flood hazard factors not determined.
A0	Areas of 100-year shallow flooding where depths are between one (1) and three (3) feet; average depths of inundation are shown, but no flood hazard factors are determined.
AH	Areas of 100-year shallow flooding where depths are between one (1) and three (3) feet; base flood elevations are shown, but no flood hazard factors are determined.
A1-A30	Areas of 100-year flood; base flood elevations and flood hazard factors determined.
A99	Areas of 100-year flood to be protected by flood protection system under construction; base flood elevations and flood hazard factors not determined.
B	Areas between limits of the 100-year flood and 500-year flood; or certain areas subject to 100-year flooding with average depths less than one (1) foot or where the contributing drainage area is less than one square mile; or areas protected by levees from the base flood. (Medium shading)
C	Areas of minimal flooding. (No shading)
D	Areas of undetermined, but possible, flood hazards.
V	Areas of 100-year coastal flood with velocity (wave action); base flood elevations and flood hazard factors not determined.
V1-V30	Areas of 100-year coastal flood with velocity (wave action); base flood elevations and flood hazard factors determined.

NOTES TO USER

Certain areas not in the special flood hazard areas (zones A and V) may be protected by flood control structures.

This map is for flood insurance purposes only; it does not necessarily show all areas subject to flooding in the community or all planimetric features outside special flood hazard areas.

For adjoining map panels, see separately printed Index To Map Panels.

Description of Elevation Reference Marks on Panel 390432 0225

INITIAL IDENTIFICATION
OCTOBER 17, 1978

CONVERSION TO REGULAR PROGRAM
OCTOBER 17, 1978

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EXHIBIT P

STATE OF OHIO
John J. Gilligan, Governor
DEPARTMENT OF NATURAL RESOURCES
William B. Nye, Director
DIVISION OF GEOLOGICAL SURVEY
Horace R. Collins, Chief

Information Circular No. 39

THE NOVEMBER 1972 STORM ON LAKE ERIE

by

Charles H. Carter

Columbus
1973

Ohio DEPARTMENT OF NATURAL RESOURCES

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Jean J. Miller, *Photocopy Composer*

STATE OF OHIO
John J. Gilligan, Governor
DEPARTMENT OF NATURAL RESOURCES
William B. Nye, Director
DIVISION OF GEOLOGICAL SURVEY
Horace R. Collins, Chief

Information Circular No. 39

THE NOVEMBER 1972 STORM ON LAKE ERIE

by

Charles H. Carter

Columbus
1973

GEOLOGY SERVES OHIO

CONTENTS

FIGURES

TABLE

THE NOVEMBER 1972 STORM ON LAKE ERIE

by

Charles H. Carter

ABSTRACT

The Lake Erie area was hit by a severe storm on the 13th and 14th of November, 1972. A north-northeast wind, which reached a speed of 60 knots, blew for two days directly down the long axis of the lake. This wind generated high (12-foot) waves and at the west end of the lake piled up water more than 6 feet above the lake's average November level (or about 4 feet above the record high lake level set in November 1972). The waves and high water caused damage estimated at 22 million dollars to the Ohio shore. Northern Ohio was declared a major disaster area by the President, and the U.S. Small Business Administration declared Lucas, Ottawa, Sandusky, Erie, Lorain, Cuyahoga, and Lake Counties disaster areas.

INTRODUCTION

The Lake Erie storm of the 13th and 14th of November, 1972, was one of the worst natural disasters to take place along the Ohio shore in historic time. The storm, which took place when the lake was about 2 feet above its long-term November average, forced hundreds of people to evacuate their homes and caused extensive wave and flood damage to residential, agricultural, and recreational interests in the low-lying areas adjacent to the lake (fig. 1). The Ohio damage was estimated at 22 million dollars (Environmental Data Service, 1972). Northern Ohio was declared a major disaster area by the President, and seven Ohio counties, Lucas, Ottawa, Sandusky, Erie, Lorain, Cuyahoga, and Lake, were declared disaster areas by the U.S. Small Business Administration.

This report was prepared because of the tremendous effect that the storm has had on man and his environment in the Lake Erie region. The report has a fourfold purpose: (1) documentation of the storm and storm effects, (2) a historical review of some other Lake Erie storms to show the relationship between lake level and storm damage, (3) a review of natural and man-related factors affecting the water level of Lake Erie, and (4) a Lake Erie forecast considering what measures the people of Ohio can take to reduce damage to the Lake Erie shore.

The following U.S. Coast Guard stations provided wind and sea information for the November 1972 storm: Toledo, Marblehead, Lorain, and Cleveland. The Corps of Engineers gave water-level readings from Toledo (Detroit district) and Buffalo (Buffalo district).

STORM DYNAMICS

Weather front

A low pressure system (cyclone-occluded front) that moved through central Ohio on the 13th and 14th of November, 1972, generated the wind that buffeted Lake Erie.

Wind, water level, and waves

The wind began blowing from the northeast early in the morning of November 13th and continued blowing from this direction until late on November 15th, when it gradually shifted to the northwest. Wind speeds at Lorain and Marblehead were greater than 20 knots for a continuous 28-hour period, and at Toledo wind speeds were greater than 20 knots for a continuous 40-hour period. Maximum wind speed ranged from 35 knots at Cleveland and Lorain to 60 knots at Toledo.

As soon as the wind began to blow it started pushing water from the eastern toward the western end of Lake Erie. The water began to pile up against the southwest shore and at about 0600 hours on the 14th the lake level at Toledo reached its maximum storm height (fig. 2). This height was about 6 feet above the long-term November average of 570.0 feet (Lake Survey Center, 1972). The lake stayed at this level until the wind speed decreased (at 0800 hours on the 14th the wind speed at Toledo was 60 knots and at 1200 hours it was 30 knots). When the force of the wind was unable to hold back the water that had piled up, an inertial surge of water (seiche) from the western to

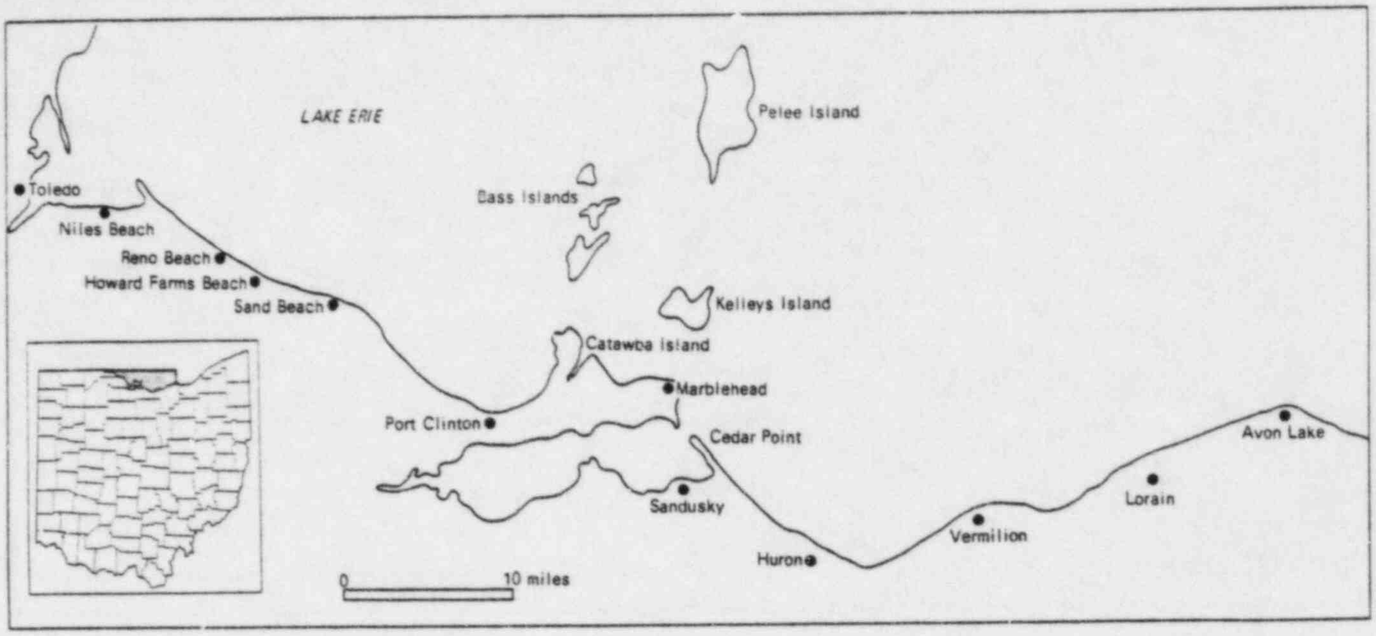

FIGURE 1.—Portion of the south shore of Lake Erie severely damaged by November 1972 storm.

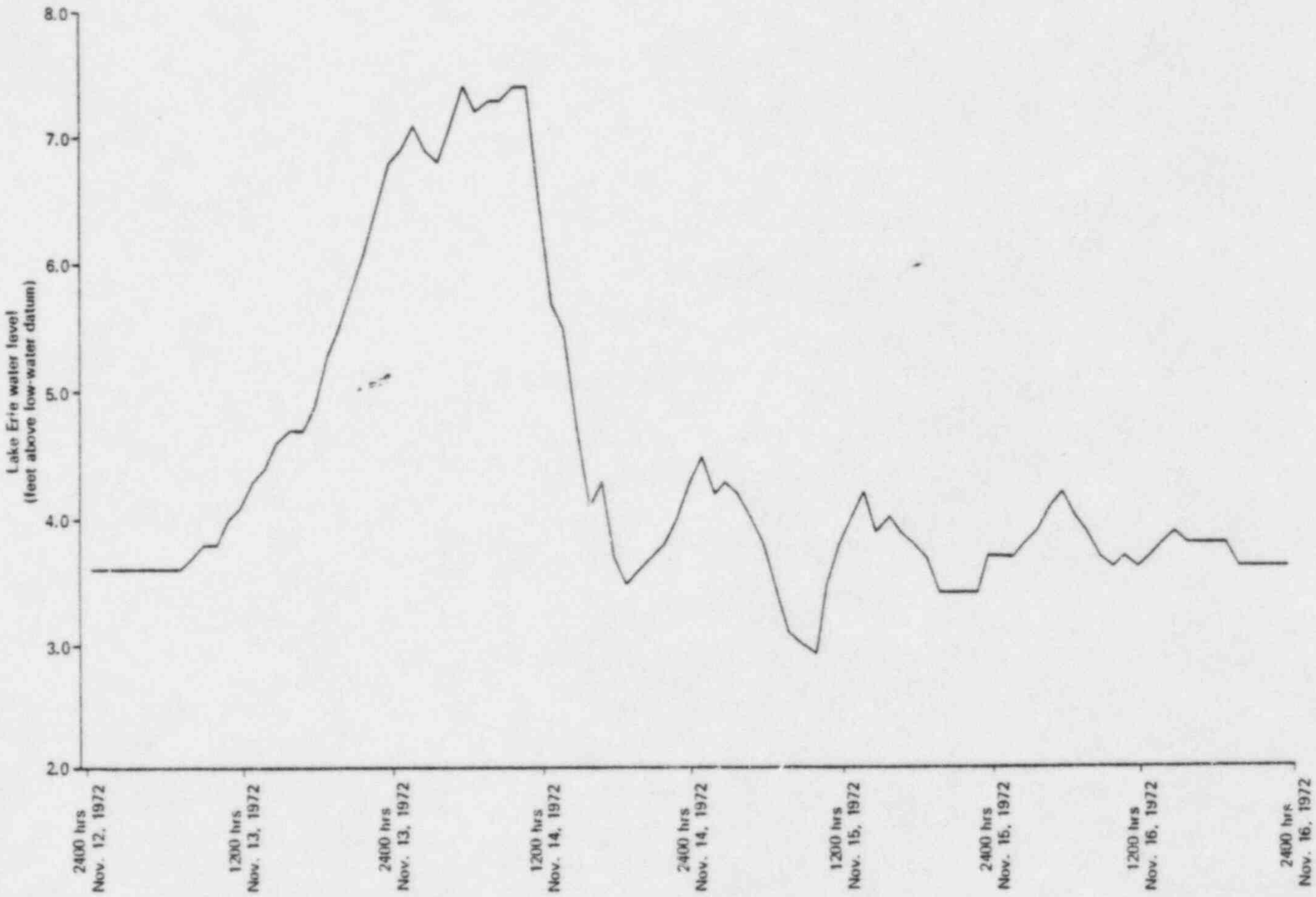

FIGURE 2.—Water-level record during storm at Toledo.

the eastern end of the lake took place. This rapid drop in lake level marked the end of the storm for Lake Erie.

Waves began building on the lake shortly after the wind began to blow. Observations at the Marblehead Coast Guard station show that waves increased in height from 1 foot on the morning of the 13th to 12 feet on the morning of the 14th. Furthermore, wave heights of 4 feet or greater were observed at Marblehead throughout a 34-hour period. Wave direction, in the main, paralleled wind direction. Three principal factors contributed to the high waves: (1) the long fetch (in places over 100 miles), (2) wind duration (more than 2 days), and most importantly (3) wind speed (60 knots).

STORM EFFECTS

The waves and high water forced hundreds of people at the western end of the lake to evacuate their homes. Many of the homes which were built directly on the lake suffered severe structural damage from the waves; in places such as Reno Beach and Howard Farms Beach a few homes were completely demolished.

Other manmade works were badly damaged also or were made unusable by the wave activity. For example, cement blocks, some weighing as much as two hundred pounds, were moved several feet from a protective riprap seawall at Niles Beach. Roads at Cedar Point, Marblehead, and Port Clinton were undermined in places when waves eroded the protective beaches, and at Cedar Point and Sand Beach waves carried so much sand over protective dikes, dunes, and seawalls that the roads were covered by up to 3 feet of sand. At East Harbor State Park, Catawba Island, waves overtopped the cement seawall and eroded sand from behind and under the structure, causing sections of it to collapse. Shore erosion was greatly accelerated owing to wave action. In areas such as Sand Beach and Cedar Point the waves cut into sand and clay banks for as much as 10 feet, partially destroying the natural barriers and eroding much valuable land.

Widespread flooding took place where waves and high water breached dikes and structures protecting low-lying areas. State Route 2, near the entrance to Sand Beach, was barely passable more than a day after the storm. The elevation there is about 575 feet. Because most of the land bordering the lake at the western end is clay, the water was unable to percolate downward; in areas like Reno Beach and Howard Farms Beach the ground was covered by water to a depth of several feet for many days.

LAKE LEVEL AND STORM DAMAGE

There have been a number of damaging northeast storms on Lake Erie. The more recent ones took place in July 1943, May 1946, March 1952, April 1966, and July 1969. However, some of the most damaging storms took place in the middle 1800's. E. L. Moseley (1906), for example, wrote that:

> The greatest storms of the past century or those which were most effective because occurring at time of highest water were those of 1857-1862.

He then described the August 1861 storm at Sandusky:

> Northeast gales may have been more violent at other times, but this one coming when the water was already high and lasting several days was probably in its effect the greatest storm of the century. East of where the water works are now located it lifted the railroad track from its bed and pushed it in places 20 feet away. At the foot of Columbus Avenue the dock was about a foot lower than now and did not extend so far north. A track ran onto the dock from a turn table south of it. In this storm water covered the dock and a great sea struck two empty cars that had been standing there with such force as to move them along the track and cause them to fall into the turn pit.

Other storms in September 1878, July and August 1879, April 1882, and May 1903, caused extensive shoreline damage. One storm, on January 31, 1881, did not cause extensive damage. Moseley wrote:

> January 31, 1881, a gale from the northeast began at 7:30 a.m., reaching its height, 64 miles northeast, at 9:35 a.m., February 1, and ending at 5:30 p.m., "The storm was one of the most severe known in these parts, the wind averaging 42 miles per hour for 18 hours: no extensive damage done." The water that winter was too low to be raised to an extraordinary height even by such a gale.

Moseley felt that storm damage is directly related to the lake level. To test this hypothesis average monthly lake levels were plotted for the storms just mentioned (fig. 3). Eleven of the 13 damaging storms occurred when lake level was above its long-term average of 570.4 feet (U.S. Army Engineer Division, 1965, pl. 2). The two most damaging storms of recent vintage (the March 1952 storm and the November 1972 storm) took place when the lake level was 2 to 3 feet above its long-term average, whereas the 1881 storm occurred when the lake was below its long-term average level.

In summary, the most damaging northeast storms on Lake Erie appear to take place during high lake levels. Furthermore, there is a sound physical basis for this: not only is the lake closer to flood stage, but the deeper water allows waves to build to greater heights and to break nearer the shore.

LAKE-LEVEL CHANGES

Man has been fortunate that most of the severe storms on the lake take place during seasonal periods of low water, roughly October to April; however, when lake levels are high during these months, as they were

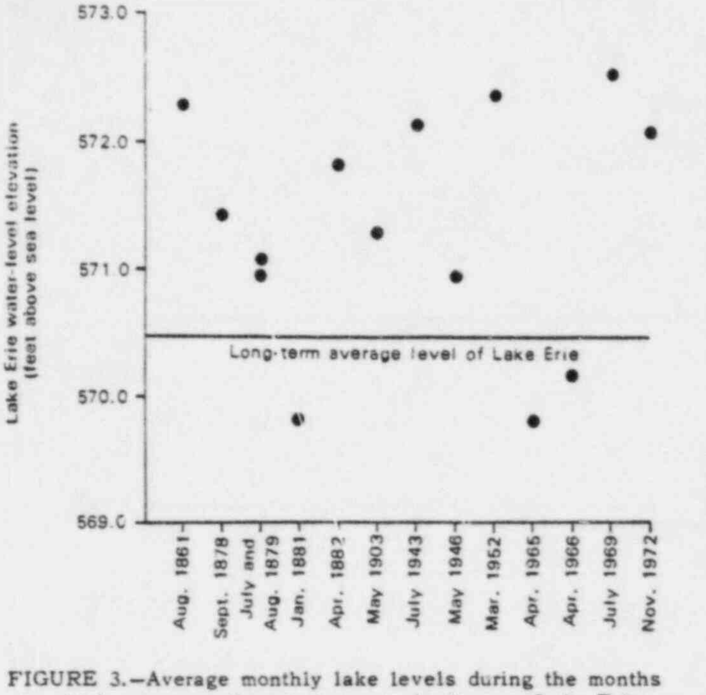

FIGURE 3.—Average monthly lake levels during the months in which severe northeast storms took place on Lake Erie.

this past November, the storms can cause extensive damage. In this section I am going to consider briefly some of the natural and man-related factors that could have an influence on the level of the lake for prolonged periods of time (several years).

Natural causes

Precipitation (and associated climatic conditions), in both the Lake Erie drainage basin and the upper lakes (Superior, Michigan, Huron) drainage basin, appears to be the principal cause of natural water-level fluctuations in Lake Erie. Processes contributing to a rise in lake level include direct precipitation on the lake surface, runoff from adjacent land surfaces and tributaries, and inflow from the Detroit River; processes contributing to a lowering of lake level include evaporation and outflow through the Niagara River. The influence of ground water on the lake level is not well documented. However, the direct relationship between precipitation and ground-water level (Gilluly and others, 1958, p. 254) suggests that the influence of ground water on the lake level is related directly to precipitation.

The relationship between lake level and precipitation during the period 1959 through 1972 can be seen by comparing table 1 and figure 4; the data were supplied by the Lake Survey Center, NOAA, U.S. Department of Commerce. Note that even though the differences in rainfall are only on the order of a few inches the two periods of rising lake level coincide with above-average precipitation, and the period of falling lake level coincides with below-average precipitation.

Another natural cause, although an irreversible one, contributing to a change in the level of Lake Erie is crustal movement. In certain parts of North America, such as the Great Lakes region, the earth is still rebounding from the tremendous pressure exerted by the glaciers. This movement, which has raised the north side of Lake Erie relative to its south side, has caused the lake level on the south side to rise an estimated 0.37 foot/century (U.S. Army Engineer Division, 1965, Appendix A, p. A-19).

Man-related causes

There are several manmade projects that have modified the inflow and outflow of the Great Lakes. The most significant include the following (U.S. Army Engineer Division, 1965, Appendix A, p. A-23):

(1) Long Lake and Ogoki diversions into Lake Superior, in Canada.
(2) Regulatory works in the St. Marys River.
(3) Diversion out of the [illegible] Michigan Basin at Chicago.
(4) Channel changes in [illegible] Clair-Detroit River system.
(5) Diversion via the Wella[illegible]nal, bypassing the Niagara River.
(6) The Gut Dam and Channel changes in the St. Lawrence River.
(7) Regulatory works in the St. Lawrence River.

Projects 1 to 5 could affect the level of Lake Erie; whereas projects 6 and 7 cannot. Effects of projects 1, 3, and 5 on Lake Michigan-Huron and Lake Erie were evaluated by the Lake Survey (U.S. Army Engineer District, Lake Survey, 1964):

Lake	Rise(+) or fall(−) effect (inches)		
	Long Lake-Ogoki diversion	Chicago diversion	Welland Canal diversion
Michigan-Huron	+4½	−2¾	−1¼
Erie	+2¾	−1⅝	−3⅞

These calculations suggest that Lake Erie could be lowered 2¾ inches by the combined effects of the diversions (projects 1, 3, and 5).

There have been several channel changes in the St. Clair-Detroit River system (project 4). The Michigan-Huron lake level was lowered about 0.6 foot by channel changes prior to 1927 (U.S. Army Engineer Division, 1965, Appendix A, p. A-24). Subsequent dredging for 25- and 27-foot navigation projects has lowered the level of Lake Michigan-Huron farther yet:

Recent studies indicate that by the end of 1968, Lake Michigan-Huron had nearly reached equilibrium and the net effect of the 25 and 27-foot projects was that the level of Lake Michigan-Huron was lowered by 0.59 foot. To date this value has not been coordinated with the responsible Federal Canadian agency and may be subject to revision (Ernest Graves, March 1973, written communication).

TABLE 1.—*Average annual precipitation in inches*

Basin	1900-1971	1959-1961	1962-1964	1965-1972
Great Lakes	31.50	33.13	28.60	33.62
Lake Erie	33.75	34.38	28.61	35.07

Therefore Lake Michigan-Huron has been lowered an estimated 1.19 feet by the St. Clair-Detroit River channel changes; this increased discharge from the St. Clair-Detroit River system has probably caused the level of Lake Erie to rise at least several inches. Even excluding a discussion of the regulatory works in the St. Marys River (project 2), it is obvious that manmade projects have affected the level of Lake Erie.

LAKE ERIE FORECAST

Storms, especially during periods of high lake level, will continue to damage the Ohio shore. Even between storms, the lake shore is undergoing continuous erosion; valuable irreplaceable land is being lost to the lake. And this is not a new problem: as early as 1838, from 165 to 330 feet of land had been lost to the lake east of Cleveland within a 32-year period (Whittlesey, 1838, p. 53). Shore erosion of this magnitude is common today (Ohio Division of Shore Erosion, 1961).

What can be done to help correct the present situation? There are at least three possible courses of action: (1) lake-level regulation, (2) shore erosion and flood-control measures, and (3) shore zoning.

Lake-level regulation

Since the November storm lake-level regulation has been the most publicized solution for Lake Erie's problems. This idea was also in vogue following the storms in the spring of 1952 and was one of the primary purposes of a comprehensive report published by the U.S. Army Engineer Division (1965). Because regulation of the level of Lake Erie would reduce storm damage and reduce the rate of erosion (and the rate of lake sedimentation), why hasn't it been attempted? There are at least two reasons. First, regulation of Lake Erie would be costly. For example, a preliminary cost estimate for regulatory works in the upper Niagara River was over 100 million dollars (U.S. Army Engineer Division, 1965, Appendix F, p. F-24). Second, lake regulation is a complex engineering problem. Planning and design, for example, are complicated by the variability of Great Lakes weather and the intimate hydraulic relationships among Lakes Michigan-Huron, Erie, and Ontario. Moreover, many political and economic concerns have an interest in the water levels of the Great Lakes.

Shore erosion and flood-control measures

The best protection against shore erosion caused by storm waves is a broad beach and/or a rocky shore. A beach causes the waves to break lakeward of the shoreline, whereas a rocky shore, like that at Marblehead Peninsula or the point at Avon Lake, is resistant to erosion caused by storm waves. Along other shores severe wave erosion will take place during storms unless preventive measures are taken. Two basic types of structures for preventing and/or limiting shore erosion caused by storm waves are: (1) structures such as seawalls and breakwaters that protect the shore by blocking the waves, and (2) structures such as groins and jetties that protect the shore by trapping sand on the updrift side of the structure, causing the buildup of a beach. These structures are expensive to con-

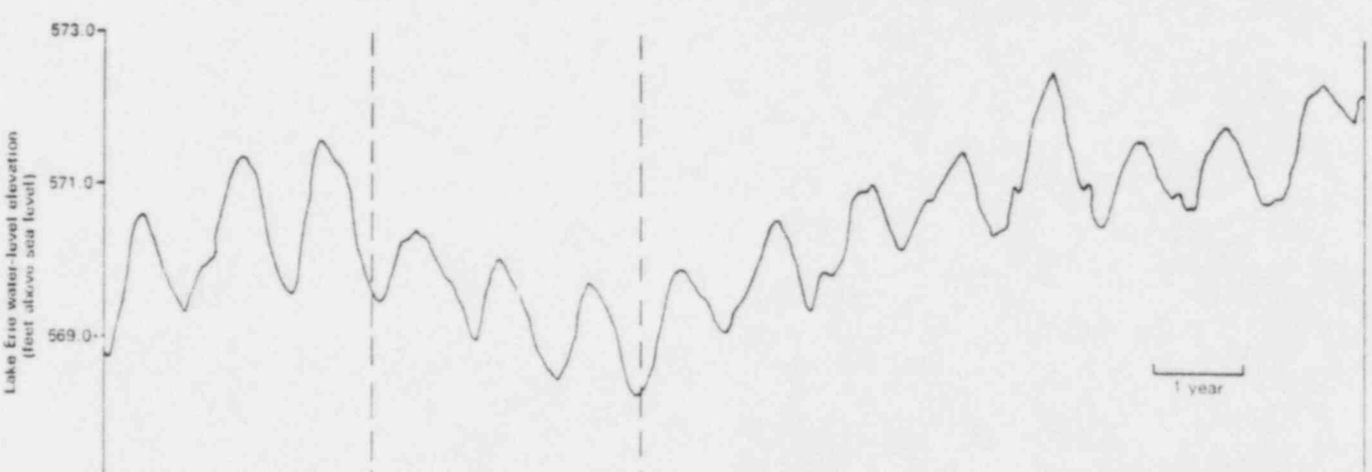

FIGURE 4.—Plot of Lake Erie water-level elevation vs. time for the period 1959 through 1972.

struct and maintain, and their effects on the adjacent shore are not well known. The jetties, for example, trap sand that would normally be transported farther along the shore, thereby depriving other areas of sand and in places causing accelerated erosion (Hartley, 1964). Seawalls and breakwaters, on the other hand, commonly cause changes in the offshore profile; moreover, seawalls, in preventing erosion, keep sediment from entering the littoral drift system.

Dikes such as those in the Reno Beach-Howard Farms Beach area have been relatively successful in preventing the flooding of low-lying areas. However, dikes built directly on the shoreline must be sturdy enough to withstand the impact of storm waves. For example, the substantial outer dike at the Reno Beach-Howard Farms Beach area was breached during the November storm; this dike has subsequently been repaired and strengthened by the U.S. Army Corps of Engineers, Detroit.

Shore zoning

New zoning regulations to restrict or prohibit construction along the Ohio shore of Lake Erie would greatly reduce the amount of storm damage to property and roads. The shore, however, would still be subject to erosion, especially during high-water periods.

Discussion

In conclusion, all of the listed corrective measures have some merit. What is needed now is a comprehensive and coordinated plan of action so that we can begin to remedy the shore erosion and flooding problems along the Ohio shore of Lake Erie.

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APPENDIX A - WEATHER

U.S. Coast Guard Station
Cleveland Harbor

Date and time (hrs)	Wind direction	Wind speed (knots)	Barometric pressure (in)	Wave height (ft)
11/12/72				
0100	WSW	06		
0300	SSW	04		
0500	SSW	05		
0700	SSW	06		
0900	S	06		
1100	S	03		
1300	SSW	03		
1500	N	05		
1700	NW	04		
1900	NNW	07		
2100	NNE	07		
2300	NNE	08		
11/13/72				
0100	S	05		
0300	SE	06		
0500	S	05		
0700	N	04		
0900	ENE	07		
1100	ENE	10		
1300	NE	10		
1500	E	10		
1700	NE	08		
1900	ENE	12		
2100	ENE	09		
2300	ENE	11		
11/14/72				
0100	ENE	20		
0300	ENE	15		
0500	ENE	25		
0700	E	15		
0900	ENE	10		
1100	ENE	18		
1300	ENE	20		
1500	NE	30		
1700	NNE	25-35		
1900	ENE	25		
2100	NNE	26		
2300	NNE	25		
11/15/72				
0100	NNE	20		
0300	N	18		
0500	N	17		
0700	N	20		
0900	NNE	20		
1100	N	20		
1300	N	16		
1500	N	11		
1700	NNE	09		
1900	NNE	08		
2100	NNE	07		
2300	NNE	05		

U.S. Coast Guard Station
Lorain

Date and time (hrs)	Wind direction[1]	Wind speed[1] (knots)	Barometric pressure (in)	Wave height (ft)
11/12/72				
0100	SSW	7	30.19	
0300	SSW	5	30.20	
0500	S	6	30.19	
0700	SSW	5	30.20	
0900	S	7	30.22	
1100	S	7	30.52	
1300	W	8	30.20	
1500	NNW	9	30.19	
1700	NW	5	30.20	
1900	NNW	8	30.20	
2100	NNW	7	30.20	
2300	NNE	7	30.20	
11/13/72				
0100	ESE	4	30.20	
0300	ESE	2	30.20	
0500	S	5	30.20	
0700	N	4	30.17	
0900	ENE	10	30.19	
1100	NE	14	30.19	
1300	NE	14	30.13	
1500	ENE	17	30.09	
1700	ENE	16	30.06	
1900	ENE	19	29.99	
2100	ENE	17	29.98	
2300	ENE	25	29.86	
11/14/72				
0100	ENE	30	29.29	
0300	NE	28	29.72	
0500	NE	28	29.70	
0700	NE	35	29.64	
0900	NE	24	29.64	
1100	NE	26	29.65	
1300	NNE	24	29.63	
1500	N	30	29.68	
1700	NNW	26	29.79	
1900	N	29	29.82	
2100	N	25	29.89	
2300	N	21	29.93	
11/15/72				
0100	Variable	23	29.96	
0300	Variable	19	30.01	
0500	Variable	21	30.04	
0700	Variable	19	30.05	
0900	N	12	30.01	
1100	NW	16	30.19	
1300	N	12	30.16	
1500	NNE	9	30.18	
1700	N	9	30.18	
1900	N	10	30.20	
2100	NW	8	30.20	
2300	NE	8	30.21	
11/16/72				
0100	NE	7	30.20	
0300	NNW	7	30.24	
0500	SSE	6	30.20	
0700	E	3	30.20	
0900	SE	7	30.20	
1100	SE	9	30.19	
1300	ESE	9	30.14	
1500	NE	7	30.11	
1700	ENE	10	30.06	
1900	ENE	6	30.06	
2100	SE	9	30.04	
2300	ENE	7	30.02	

[1]Measurements obtained from the Lorain sewage and treatment plant anemometer.

U.S. Coast Guard Station
Marblehead

Date and time (hrs)	Wind direction	Wind speed (knots)	Barometric pressure (in)	Wave height (ft)
11/12/72				
0100	SW	5	30.22	Calm
0300	SW	5	30.24	Calm
0500	SW	4	30.24	Calm
0700	SSW	6	30.24	Calm
0900	SW	7	30.24	Calm
1100	SW	8	30.26	Calm
1300	SW	6	30.26	Calm
1500	WNW	6	30.24	Calm
1700	NW	8	30.24	Calm
1900	NW	4	30.24	Calm
2100	N	4	30.23	Calm
2300	NNE	5	30.23	Calm
11/13/72				
0100	NNW	3	30.22	Calm
0300	NNE	7	30.21	Calm
0500	N	6	30.26	Calm
0700	NNE	10	30.22	Calm
0900	NE	12	30.23	1
1100	NE	16	30.23	2
1300	NE	17	30.17	2
1500	ENE	17	30.13	3
1700	NE	15	30.11	3
1900	NE	25	30.07	3
2100	NE	28	30.00	4
2300	ENE	30	29.86	8
11/14/72				
0100	ENE	30	29.80	8
0300	ENE	30	29.80	9
0500	NE	38	29.76	9
0700	NE	35	29.72	9
0900	NE	30	29.72	9
1100	NNE	30	29.66	12NE
1300	NNE	27	29.66	8
1500	N	27	29.78	4-6
1700	N	27	29.80	4-6
1900	N	27	29.80	4-6
2100	NNE	25	29.90	6
2300	NNE	20	29.90	5
11/15/72				
0100	N	18	29.90	5NNE
0300	N	20	29.90	5NNE
0500	N	20	29.90	5NNE
0700	NNW	25	30.10	5N
0900	N	15	30.10	1-2
1100	N	12	30.10	1-2
1300	N	12	30.10	2
1500	N	8	30.10	1-2
1700	N	9	30.22	1
1900	NW	8	30.24	1
2100	NW	8	30.25	Calm
2300	N	5	30.24	Calm
11/16/72				
0100	NE	5	30.23	Calm
0300	W	5	30.23	Calm
0500	SW	5	30.23	Calm
0700	SW	3	30.22	Calm
0900	SW	3	30.22	Calm
1100	SSE	10	30.19	Calm
1300	E	7	30.16	Calm
1500	E	7	30.12	Calm
1700	E	8	30.10	Calm
1900	E	8	30.08	Calm
2100	E	6	30.08	Calm
2300	E	6	30.06	Calm

U.S. Coast Guard Station
Toledo

Date and time (hrs)	Wind direction	Wind speed (knots)	Barometric pressure (in)	Wave height (ft)
11/12/72				
0000	SSW	8	29.4	
0400	SW	8	29.4	
0800	SW	8	29.4	
1200	SSW	3	29.4	
1600	SSW	4	29.3	
2000	SSW	2	29.3	
11/13/72				
0000	Calm	Calm	29.4	
0400	N	8	29.4	
0800	NNE	13	29.4	
1200	NE	23	29.3	
1600	NE	23	29.4	
2000	NE	40	29.3	
11/14/72				
0000	NE	30	29.0	
0400	NE	25	28.9	
0800	N	60	29.9	
1200	NNW	30	29.0	
1600	N	23	29.1	
2000	N	25	29.2	
11/15/72				
0000	NNE	22	29.1	
0400	NNE	20	29.6	
0800	N	13	29.4	
1200	NE	6	29.5	
1600	W	5	29.5	
2000	WNW	5	29.4	
11/16/72				
0000	NW	5	29.4	
0400	S	5	29.4	
0800	NNW	4	29.4	
1200	SE	5	29.3	
1600	N	6	29.3	
2000	NE	7	29.3	

APPENDIX B - LAKE ERIE WATER-LEVEL RECORDS

Corps of Engineers Gage
Buffalo Harbor, Buffalo, N.Y.

Time (hrs)	Water level (ft above low-water datum of 568.6 ft)				
	11/12/72	11/13/72	11/14/72	11/15/72	11/16/72
0100	3.48	3.30	1.67	2.60	3.42
0200	3.45	3.30	1.34	2.87	3.45
0300	3.43	3.40	0.80	2.86	3.33
0400	3.29	3.41	0.78	3.10	3.28
0500	3.31	3.36	0.28	3.51	3.22
0600	3.29	3.37	0.08	3.25	3.31
0700	3.26	3.40	0.10	3.43	3.38
0800	3.32	3.30	0.21	3.57	3.43
0900	3.35	3.25	0.00	3.79	3.45
1000	3.30	3.27	-0.91	3.53	3.46
1100	3.32	3.22	0.42	3.50	3.51
1200	3.32	3.10	0.17	3.48	3.48
1300	3.37	3.10	0.61	3.40	3.50
1400	3.26	2.98	0.58	3.32	3.46
1500	3.40	2.86	1.52	3.28	3.50
1600	3.31	2.88	1.84	3.37	3.31
1700	3.32	3.04	2.03	3.37	3.26
1800	3.40	2.80	2.28	3.32	3.17
1900	3.40	2.42	2.90	3.43	3.14
2000	3.49	2.40	2.69	3.68	3.20
2100	3.32	2.43	3.01	3.80	3.21
2200	3.35	2.48	2.98	3.72	3.20
2300	3.28	2.27	2.70	3.76	3.15
2400	3.33	1.93	2.40	3.56	3.23

Corps of Engineers Gage
Bayview Station, Toledo

Time (hrs)	Water level (ft above low-water datum of 568.6 ft)				
	11/12/72	11/13/72	11/14/72	11/15/72	11/16/72
0100	3.4	3.6	6.9	4.5	3.7
0200	3.4	3.6	7.1	4.2	3.7
0300	3.5	3.6	6.9	4.3	3.8
0400	3.5	3.5	6.8	4.2	3.9
0500	3.5	3.6	7.1	4.0	4.1
0600	3.5	3.6	7.4	3.8	4.2
0700	3.5	3.6	7.2	3.4	4.0
0800	3.5	3.7	7.3	3.1	3.9
0900	3.5	3.8	7.3	3.0	3.7
1000	3.5	3.8	7.4	2.9	3.6
1100	3.5	3.9	7.4	3.5	3.7
1200	3.6	4.1	6.6	3.8	3.6
1300	3.6	4.3	5.7	4.0	3.7
1400	3.5	4.4	5.5	4.2	3.8
1500	3.5	4.6	4.7	3.9	3.9
1600	3.5	4.7	4.1	4.0	3.8
1700	3.5	4.7	4.3	3.9	3.8
1800	3.5	4.9	3.7	3.8	3.8
1900	3.5	5.3	3.5	3.7	3.8
2000	3.5	5.5	3.6	3.4	3.6
2100	3.5	5.8	3.7	3.4	3.6
2200	3.6	6.1	3.8	3.4	3.6
2300	3.6	6.5	4.0	3.4	3.6
2400	3.6	6.8	4.3	3.7	3.6

Ohio Division of Geological Survey Gage
Lorain

Time (hrs)	Water level (ft above low-water datum of 568.6 ft)				
	11/12/72	11/13/72	11/14/72	11/15/72	11/16/72
0000	3.41	3.46	4.22	4.00	3.47
0100	3.41	3.48	4.38	4.06	3.42
0200	3.42	3.47	4.58	4.07	3.54
0300	3.46	3.49	4.80	4.13	3.62
0400	3.47	3.49	NR[1]	4.10	3.73
0500	3.44	3.47	NR	4.05	3.77
0600	3.44	3.46	NR	3.92	3.72
0700	3.45	3.47	NR	3.70	3.65
0800	3.46	3.48	NR	3.68	3.75
0900	3.47	3.51	NR	3.69	3.72
1000	3.45	3.52	NR	3.68	3.66
1100	3.44	3.58	NR	3.74	3.62
1200	3.43	3.59	NR	3.65	3.54
1300	3.44	3.63	NR	3.56	3.53
1400	3.46	3.65	NR	3.68	3.59
1500	3.47	3.64	NR	3.75	3.63
1600	3.47	3.71	4.77	3.86	3.62
1700	3.46	3.77	4.65	3.89	3.77
1800	3.44	3.76	4.28	3.76	3.69
1900	3.45	3.86	4.31	3.72	3.78
2000	3.44	3.89	3.98	3.65	3.82
2100	3.43	3.86	3.87	3.62	3.83
2200	3.46	3.91	3.93	3.57	3.77
2300	3.46	4.02	4.12	3.54	3.79
2400	3.46	4.22	4.00	3.47	3.71

[1]No record.

Ohio Division of Geological Survey Gage
Port Clinton

Time (hrs)	Water level (ft above low-water datum of 568.6 ft)			
	11/13/72	11/14/72	11/15/72	11/16/72
0000	NR[1]	5.74	4.86	3.91
0100	NR	5.97	5.02	3.99
0200	NR	6.02	4.98	4.04
0300	NR	6.17	4.92	4.16
0400	NR	6.14	4.86	4.24
0500	NR	6.14	4.66	4.22
0600	NR	6.24	4.60	4.27
0700	NR	6.38	4.36	4.29
0800	3.72	6.45	4.09	4.10
0900	3.87	6.45	3.99	4.09
1000	3.92	6.45	4.00	3.98
1100	3.97	6.48[2]	3.97	3.88
1200	4.06	6.48	4.20	3.96
1300	4.11	6.40	4.29	3.94
1400	4.25	6.08	4.28	4.00
1500	4.38	5.75	4.44	4.12
1600	4.39	5.24	4.36	4.18
1700	4.50	5.21	4.28	4.23
1800	4.51	5.07	4.23	4.28
1900	4.54	4.95	4.10	4.24
2000	4.57	4.80	4.00	4.23
2100	4.72	4.75	3.92	4.22
2200	5.03	4.81	3.88	4.19
2300	5.28	4.92	3.93	4.16
2400	5.74	4.86	3.91	4.14

[1]No record.
[2]Upper recording limit.

Ohio Division of Geological Survey Gage
Put-in-Bay, South Bass Island

Time (hrs)	Water level (ft above low-water datum of 568.6 ft)		
	11/12/72	11/13/72	11/14/72
0000	3.47	3.54	5.90
0100	3.48	3.55	5.95
0200	3.52	3.54	6.03[1]
0300	3.51	3.55	5.95
0400	3.52	3.55	5.77
0500	3.52	3.54	5.95
0600	3.48	3.56	NR[2]
0700	3.48	3.55	NR
0800	3.51	3.63	NR
0900	3.52	3.70	NR
1000	3.53	3.73	NR
1100	3.54	3.83	NR
1200	3.52	3.87	NR
1300	3.50	3.98	NR
1400	3.47	4.13	NR
1500	3.44	4.12	NR
1600	3.45	4.13	NR
1700	3.46	4.21	NR
1800	3.47	4.22	NR
1900	3.50	4.35	NR
2000	3.52	4.45	NR
2100	3.53	4.80	NR
2200	3.55	5.04	NR
2300	3.54	5.42	NR
2400	3.54	5.90	NR

[1]Upper recording limit.
[2]No record.

Ohio Division of Geological Survey Gage
Rossford

Time (hrs)	Water level (ft above low-water datum of 568.6 ft)				
	11/12/72	11/13/72	11/14/72	11/15/72	11/16/72
0000	3.40	3.67	6.50	4.22	3.87
0100	3.45	3.65	7.07	4.42	3.92
0200	3.54	3.64	7.36	4.92	4.06
0300	3.58	3.64	7.58	4.84	4.12
0400	3.57	3.63	7.33	4.57	4.16
0500	3.57	3.65	7.11	4.58	4.25
0600	3.62	3.69	7.12	4.54	4.44
0700	3.64	3.72	7.70	4.31	4.58
0800	3.62	3.73	7.75	4.12	4.57
0900	3.56	3.75	7.67	3.67	4.49
1000	3.55	3.85	7.66	3.54	4.33
1100	3.57	3.95	7.68	3.38	4.13
1200	3.65	4.03	7.67	3.47	4.12
1300	3.69	4.17	7.30	3.85	4.14
1400	3.68	4.47	6.44	4.15	4.11
1500	3.58	4.99	5.69	4.37	4.15
1600	3.52	4.90	5.22	4.03	4.24
1700	3.50	4.83	4.78	4.43	4.38
1800	3.50	4.90	4.44	4.40	4.57
1900	3.56	5.17	4.35	4.38	4.64
2000	3.60	5.59	4.06	4.26	4.63
2100	3.61	5.88	3.78	4.09	4.63
2200	3.62	5.95	3.97	3.90	4.53
2300	3.66	6.10	4.08	3.86	4.46
2400	3.67	6.50	4.22	3.87	4.48

Ohio Division of Geological Survey Gage
Sandusky

Time (hrs)	Water level (ft above low-water datum of 568.6 ft)				
	11/12/72	11/13/72	11/14/72	11/15/72	11/16/72
0000	3.49	3.62	5.38	4.46	3.62
0100	3.51	3.65	5.54	4.56	3.65
0200	3.60	3.63	5.63	4.51	3.80
0300	3.60	3.65	5.75	4.55	3.92
0400	3.56	3.64	5.77	4.36	3.93
0500	3.58	3.59	5.78	4.17	3.93
0600	3.58	3.68	5.79	4.08	3.93
0700	3.58	3.70	5.80	3.89	3.96
0800	3.58	3.68	NR[1]	3.83	3.92
0900	3.59	3.72	NR	3.82	3.84
1000	3.56	3.79	NR	3.80	3.78
1100	3.57	3.85	NR	3.76	3.69
1200	3.57	3.87	NR	3.79	3.66
1300	3.57	3.97	NR	3.87	3.77
1400	3.59	4.05	5.76	4.01	3.79
1500	3.57	4.13	[illegible]	4.03	3.84
1600	3.57	4.16	5.05	4.13	3.94
1700	3.57	4.14	4.90	3.97	3.97
1800	3.56	4.20	4.80	3.88	4.02
1900	3.57	4.35	4.78	3.87	4.07
2000	3.57	4.40	4.61	3.78	4.05
2100	3.57	4.40	4.56	3.69	4.04
2200	3.63	4.82	4.72	3.67	4.00
2300	3.62	5.13	4.55	3.60	3.93
2400	3.62	5.38	4.46	3.62	3.87

[1]No record. The water level peaked between 0900 and 1100 hrs at 6.75 ft above low-water datum.

EXHIBIT Q

ATTACHMENT I

Request Item 1:

Any documents generated by or directed to NRC concerning this matter.

Response:

These documents were provided to participants at the April 2, 1986 meeting.

Request Item 2:

Any analyses, tests or studies, etc. done of the proposed disposal site.

Response:

A report on the radiological analysis of the proposed disposal of the resins was enclosed with Toledo Edison's letter to the NRC (Serial No. 972), dated July 14, 1983. This report and responses to specific NRC questions were provided to the meeting participants in response to Request Item 1. Additional reports of analyses and studies are addressed below in the responses to Request Items 4 and 6. Toledo Edison is reviewing its records for any additional analyses, tests or studies and plans to provide a final response to this request by April 30, 1986.

Request Item 3:

Any tests, monitoring results or analyses done of the settling ponds.

Response:

A report on the radiological analyses performed of the settling basins was enclosed with Toledo Edison's letter to the NRC (Serial No. 972), dated July 14, 1983. This report and responses to specific NRC questions were provided to the meeting participants in response to Request Item 1. Toledo Edison is reviewing its records for any additional analyses, tests or studies and will provide a final response to this request by April 30, 1986.

Request Item 4:

Any ecological reports or studies done of the area surrounding the proposed disposal site.

Response:

No ecological reports or studies have been performed on this proposed site for the specific disposal of this waste. However, environmental studies of the Davis-Besse site area have been performed. Enclosed are the copies of the following documents:

a. Final Environmental Statement Related to Construction of Davis-Besse Nuclear Power Station, March 1973.

b. Final Environmental Statement Related to Operation of Davis-Besse Nuclear Power Station Unit No. 1, NUREG-75/097, October 1975.

c. Final Environmental Statement Related to Construction of Davis-Besse Nuclear Power Station Units 2 and 3, NUREG-75/083, September 1975.

d. Davis-Besse Nuclear Power Station Units 2 and 3, Environmental Report, Section 2.7 and Appendix 2E, July 1974.

Request Item 5:

Any geological data concerning the area surrounding the proposed disposal site.

Response:

No geological data has been specifically obtained at the proposed disposal site. However, geological data has been obtained for the Davis-Besse Nuclear Power Station site. Enclosed is a copy of Appendix 2C, Section 2C.2.0, Geology, of the Updated Safety Analysis Report for Unit No. 1.

Request Item 6:

A list of the vegetation and wildlife that are found in the area of the proposed disposal site, including any studies done of the possible environmental impacts upon this vegetation and wildlife due to the disposal of this waste.

Response:

See Toledo Edison's response to Request Item 4.

Request Item 7:

Any soils analyses of the proposed disposal site.

Response:

No soils analyses have been performed specifically at the proposed disposal site. However, a number of test borings were made as part of the site investigation for construction of Unit No. 1 and later Units No. 2 and 3 of the Davis-Besse Nuclear Power Station. The nearest proposed structures to the proposed disposal area were the Unit No. 3 cooling tower and the Units No. 2 and 3 ultimate heat sink pumphouse. The general locations of these proposed structures are shown on the enclosed Figure 7-2.

Copies of the soil portion of boring logs B-124 (ultimate heat sink pumphouse), B-125 (center of Unit 3 cooling tower) and B-130 (south side of Unit 3 cooling tower) are provided to show the type of soil anticipated to be encountered at the proposed disposal site when site-specific boring are completed. The location of borings B-124, B-125 and B-130 and the proposed disposal site are indicated on enclosed Drawing 7749-C-1.

A detailed soils investigation will be performed of the proposed disposal site.

Request Item 8:

Disposal area's borrow pit soils data.

Response:

Toledo Edison is investigating this item and will provide a response by April 30, 1986.

Request Item 9:

Disposal area elevation maps.

Response:

Toledo Edison is investigating this item and will provide a response by April 30, 1986.

Request Item 10:

Dates dikes were constructed.

Response:

Toledo Edison is investigating this item and will provide a response by April 30, 1986.

Request Item 11:

Information about soils in site (mottling, color).

Response:

See Toledo Edison's response to Request Item 7.

Request Item 12:

Is the disposal area wetland? Confirmation of depth to water table.

Response:

None of the proposed disposal area is believed to be wetland, however, this item will be verified by a detailed soils investigation.

With regards to the depth to the water table, the following information is provided to clarify the discussion on April 2, 1986 held at the Davis-Besse site. Groundwater flow at the Davis-Besse site is confined to the bedrock, under pressure, due to the impervious nature of the soils (i.e., normally the groundwater level corresponds to the top of the bedrock). At the proposed disposal site, ground elevation is about 573 to 575 feet and the anticipated bedrock elevation is 560 to 562 feet. Thus, under undisturbed conditions the groundwater level would be about 10 to 15 feet below grade. However, if an excavation were made to the top of bedrock or to a point where the pressure of the groundwater were sufficient to force it into the excavation the evacuation would fill up with water to the approximate average monthly lake level. This can be illustrated by reviewing the logs of borings B-124 and B-125 submitted in response to Item 7.

	B-124	B-125
Ground Elevation	572.6	590.3
Bedrock Elevation	560.6	561.3
Water First Encountered	563.6	562.3
Water After 24 Hours	571.2	571.5

Request Item 13:

Elevation characteristics; vegetative survey; flood plain information.

Response:

Information on the vegetation in the area is addressed by the response to Request Item 4. Toledo Edison is researching the elevation and flood plain information and will provide a response by April 30, 1986.

Request Item 14:

Describe the chemical and physical characteristics of the resin(s) used by the demineralizer process.

Response:

Three types of powdered resins (all manufactured by Epicor, Incorporated) are utilized by the demineralizer process:

- Powdered cation resin (hydrogen form).
- Powdered cation resin (ammonia form).
- Powdered anion resin (hydroxide form).

The Material Safety Data Sheets for these three resins are enclosed.

EXHIBIT R

OFFICE OF EMERGENCY PREPAREDNESS
EXECUTIVE OFFICE OF THE PRESIDENT

DAMAGE SURVEY REPORT

(Under Public Law 606, 91st Congress)

1. APPLICANT (State Agency, County, City, Irrigation District, etc.): STATE OF OHIO DEPT NATURAL RESOURCES

2. DISASTER DECLARATION DATE: 24 NOV 1972

3. STATE: OHIO

4. COUNTY: OTTAWA

5. INSPECTION DATE: 21 DEC 1972

6. WORK CATEGORY (SEE DEFINITIONS)

a. EMERGENCY ☐ A ☐ B ☐ C-1 ☐ D-1 ☐ E-1 ☐ F-1

b. PERMANENT ☐ C-2 ☒ D-2 ☐ E-2 ☐ F-2 ☐ G

7. MAP OR PHOTO REFERENCE NO.: NONE

8. ITEM NO.: 1

9. WORK TO BE ACCOMPLISHED BY: ☐ a. Contract ☒ b. Force Account

10. PERCENTAGE OF WORK COMPLETED TO DATE: 0%

11. LOCATION AND DESCRIPTION OF DAMAGED FACILITIES: TOUSSAINT WILD LIFE AREA DIKE

11. DESCRIPTION OF DAMAGE: 300' SECTION OF EARTH DIKE DESTROYED

12. PROPOSED WORK: REBUILD 300' SECTION OF DIKE

13. SUMMARY OF ESTIMATE

QUANTITY a.	UNIT b.	MATERIAL AND/OR DESCRIPTION c.	UNIT PRICE d.	COST e.
1470	Cu yds	EARTH FILL HAULED AND PLACED	3.00 p/yd	4410.00
		TOTAL ESTIMATED COST		$4410.00

14. INSURANCE COVERAGE ☐ YES ☒ NO AMOUNT, ______

15. RECOMMENDATION

a. ELIGIBLE ☐ b. INELIGIBLE (Explain Separately)

c. FEDERAL INSPECTION (Signature & Agency Name): [signature], Corps of Engineers

d. DATE: 12/21/72

16. CONCURRENCES

a. YES ☐ b. NO

c. STATE INSPECTOR (Signature): [signature]

d. AGENCY OR OFFICE: Ohio Dept. Natural Resources

e. DATE: 12/21/72

a. YES ☐ b. NO

c. REPRESENTATIVE OF APPLICANT (Signature): [signature] Ohio Dept. Natural Resources

d. DATE: 12/21/72

OEP-FORM 104
August 1971

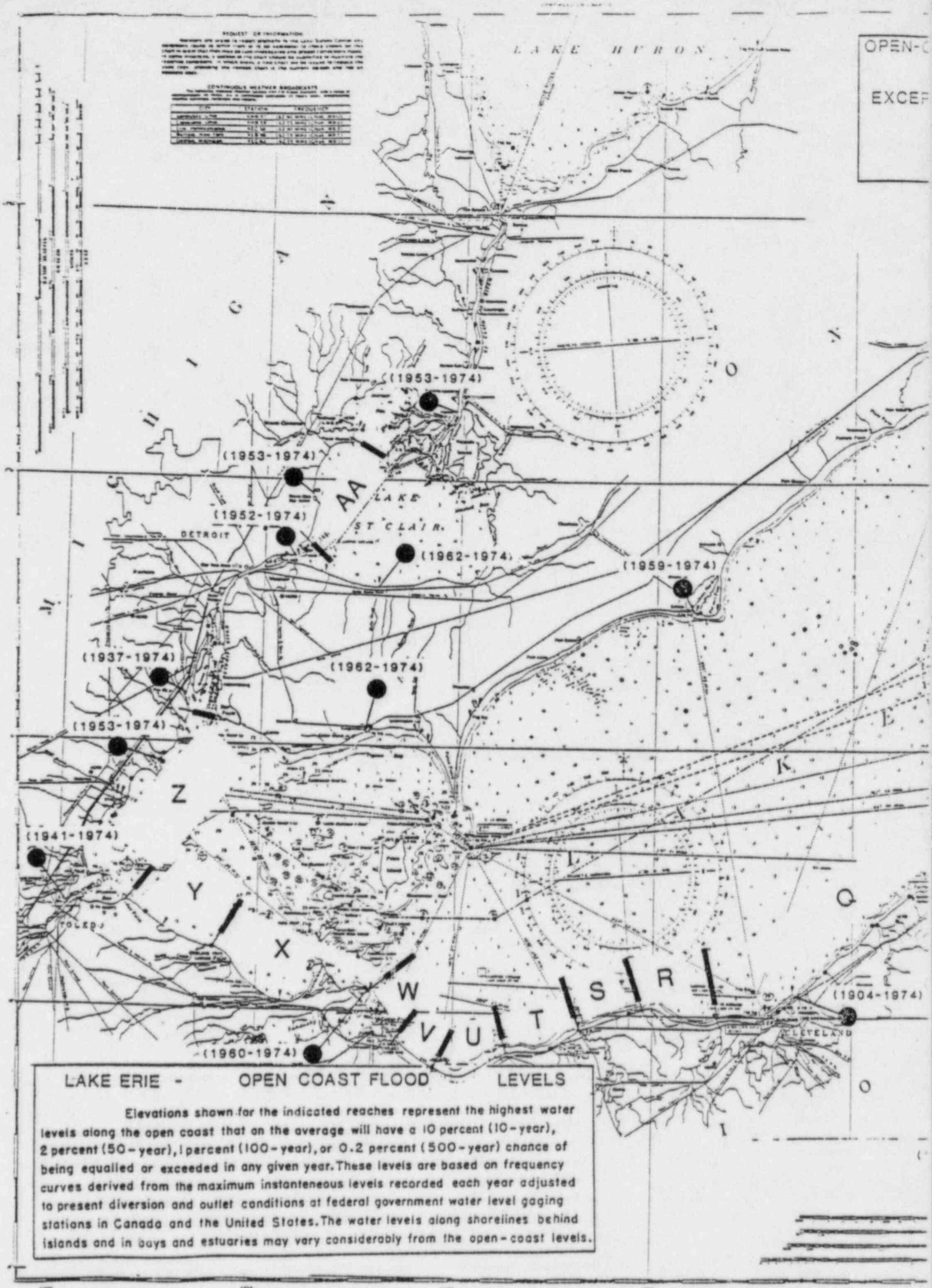
INSTRUCTIONS FOR COMPLETING THIS FORM ARE CONTAINED IN MANUAL

FOR FEDERAL OFFICIALS SEE CIRCULAR

FIELD COPY

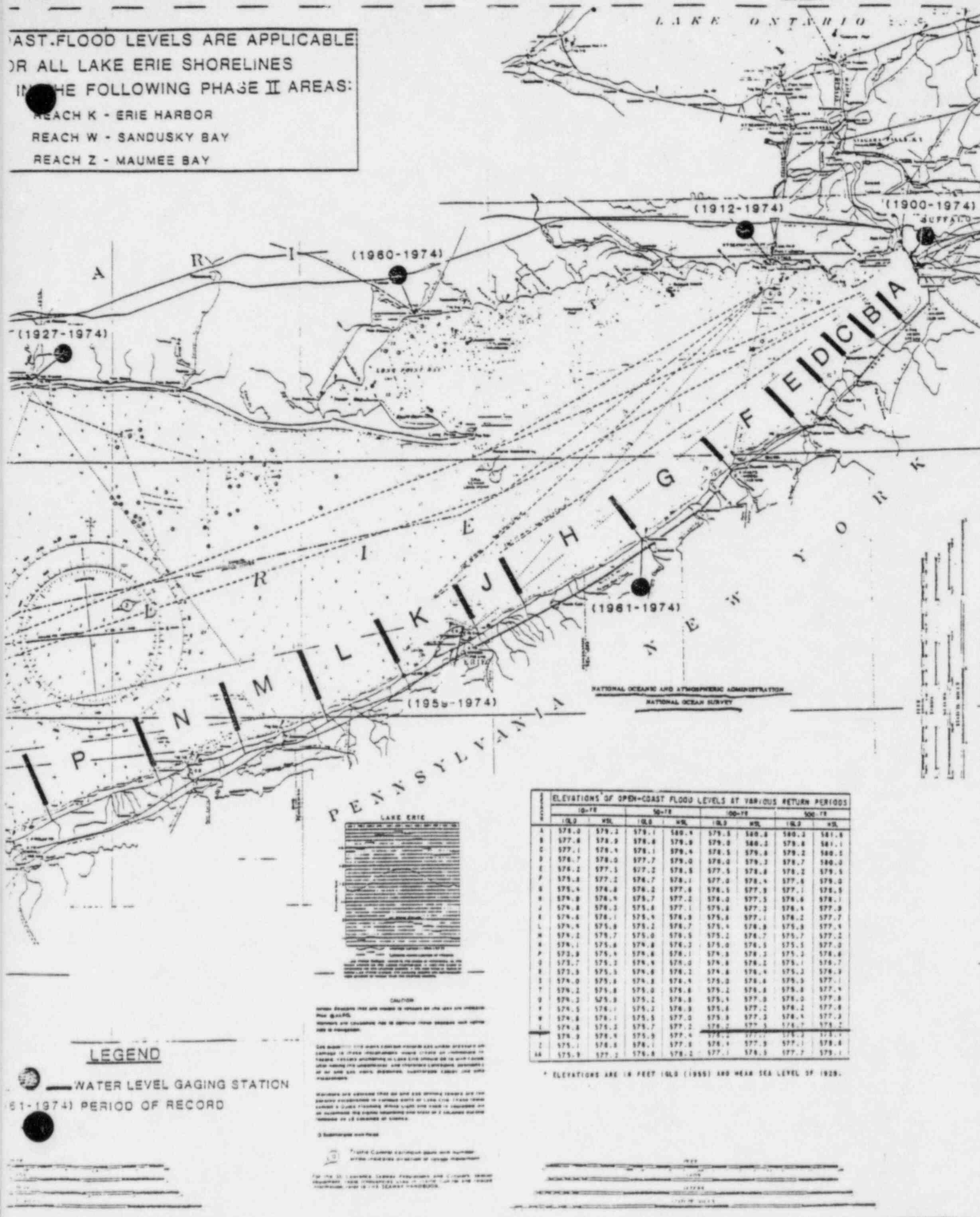
EXHIBIT S

This is a copy from, "Report on Great Lakes Open-Coast Flood Levels", prepared by U. S. Army Corps of Engineers for Federal Insurance Administration, Department of Housing and Urban Development. Detroit, Michigan-February 1977



LAKE ERIE - OPEN COAST FLOOD LEVELS

Elevations shown for the indicated reaches represent the highest water levels along the open coast that on the average will have a 10 percent (10-year), 2 percent (50-year), 1 percent (100-year), or 0.2 percent (500-year) chance of being equalled or exceeded in any given year. These levels are based on frequency curves derived from the maximum instantaneous levels recorded each year adjusted to present diversion and outlet conditions at federal government water level gaging stations in Canada and the United States. The water levels along shorelines behind islands and in bays and estuaries may vary considerably from the open-coast levels.



REACH	ELEVATIONS* OF OPEN-COAST FLOOD LEVELS AT VARIOUS RETURN PERIODS							
	10-YR		50-YR		100-YR		500-YR	
	IGLD	MSL	IGLD	MSL	IGLD	MSL	IGLD	MSL
A	578.0	579.2	579.1	580.4	579.5	580.8	580.3	581.6
B	577.6	578.9	578.6	579.9	579.0	580.3	579.8	581.1
C	577.1	578.4	578.1	579.4	578.5	579.8	579.2	580.5
D	576.7	578.0	577.7	579.0	578.0	579.3	578.7	580.0
E	576.2	577.5	577.2	578.5	577.5	578.8	578.2	579.5
F	575.8	577.2	576.7	578.1	577.0	578.4	577.6	579.0
G	575.4	576.8	576.2	577.6	576.5	577.9	577.1	578.5
H	574.9	576.4	575.7	577.2	576.0	577.5	576.6	578.1
J	574.8	576.3	575.6	577.1	575.8	577.3	576.4	577.9
K	574.6	576.1	575.4	576.9	575.6	577.1	576.2	577.7
L	574.4	575.9	575.2	576.7	575.4	576.9	575.9	577.4
M	574.2	575.7	575.0	576.5	575.2	576.7	575.7	577.2
N	574.1	575.6	574.8	576.3	575.0	576.5	575.5	577.0
P	573.9	575.4	574.6	576.1	574.8	576.3	575.3	576.8
Q	573.7	575.2	574.4	575.9	574.6	576.2	575.1	576.7
R	573.8	575.3	574.6	576.2	574.8	576.4	575.3	576.9
S	574.0	575.6	574.8	576.4	575.0	576.6	575.5	577.1
T	574.2	575.8	575.0	576.6	575.2	576.8	575.8	577.4
U	574.3	575.9	575.2	576.8	575.4	577.0	576.0	577.6
V	574.5	576.1	575.3	576.9	575.6	577.2	576.2	577.8
W	574.6	576.1	575.5	577.0	575.8	577.3	576.4	577.9
X	574.8	576.3	575.7	577.2	576.2	577.5	576.7	578.2
Y	574.9	576.4	575.9	577.4	[illegible]	[illegible]	[illegible]	[illegible]
Z	575.1	576.6	576.1	577.6	576.4	577.9	577.1	578.6
AA	575.9	577.2	576.8	578.2	577.1	578.5	577.7	579.1

* ELEVATIONS ARE IN FEET IGLD (1955) AND MEAN SEA LEVEL OF 1929.

PLATE 4

EXHIBIT T

US Army Corps of Engineers
North Central Division

GREAT LAKES LEVELS
UPDATE, NO. 8
3 March 1986

All of the Great Lakes continue to be dangerously high. Lakes Superior, Michigan-Huron, St. Clair and Erie have again all set new monthly record high levels in February. For Lakes Superior and St. Clair, this is the sixth straight month that record highs have been set; for Lakes Michigan-Huron, it is the fifth; and for Lake Erie, it is the fourth. The Lake Ontario level is well above normal and Criterion (k), which requires that Lake Ontario be regulated so as to provide all possible relief to riparians upstream and downstream of the St. Lawrence River control structures, is still in effect. As a result, the International Joint Commission's St. Lawrence River Board is maximizing the Lake Ontario outflows while maintaining a stable ice cover on the river.

The attached bulletin shows our projected levels for the period March 1, 1986, through August 31, 1986. All the upper Great Lakes are predicted to remain extremely high for the next six months. The Lake Superior February monthly mean level was 601.24 feet, which is 3/4 inch above the previous February record of 601.18 feet, set in 1975. Lakes Michigan-Huron's February level was 580.37 feet, 5-1/2 inches above the previous record of 579.91 feet that was set in 1952. Lake St. Clair's level was 9-1/4 inches above its previous record of 575.39 feet, set in 1974. The Lake Erie level was 3 inches above its previous record February high level of 572.53 feet that was set in 1973. Continued high inflows from upstream and some local basin runoff in February caused the Lake Ontario level to rise to 245.48 feet, or about 16 inches above normal.

With Lake Superior at its maximum winter outflow setting and Lake Ontario being regulated under Criterion (k), the two Great Lakes that can be regulated are discharging the maximum flows possible while maintaining the integrity of the river ice covers. Lakes Michigan-Huron and Erie have no control structures on their outflow rivers. Ice jamming, and resultant flooding, in the lower St. Clair River occasionally occurs because of the high water levels and climatic conditions such as winds and temperature changes.

The outlook is for all the lakes except Lake Ontario to remain near or above record high levels at least through August 1986. As spring weather approaches and the ice cover dissipates, there is concern that severe storms acting on the record high levels can cause serious damage to shoreline properties. Riparian property owners should be aler to take necessary precautions.

The Corps of Engineers has authority under Public Law 84-99 to carry out preventive work prior to a flood threat to life and improved property. This program, known as Advance Measures, was initiated on the Great Lakes early in 1985 at the request of the Governors of Michigan and Ohio to counter the threat presented by the high Great Lakes water levels. The program is underway at a number of sites in these states.

In Michigan, five projects have been approved and are under construction at Luna Pier, Estral Beach, Detroit Beach in Frenchtown Township, and Labo Island and Milleman in Brownstown Township. Five other projects are under consideration. In Ohio, three projects have been approved; Reno Beach/Howard Farms, Whites Landing and Bayview. Only the Bayview project is under construction. A project at Eastlake, Ohio, appears to be viable, but has yet to be authorized. Projects at all other potential locations in both states either are ineligible or have been declined by the Communities.

The Corps is also authorized to assist local communities in responding to actual flooding situations. This includes providing technical assistance, supplies and equipment and contracting, as necessary, to supplement maximum state and local efforts. Requests for assistance should be directed through the local and state disaster assistance agencies.

For Great Lakes basin technical assistance or information, please contact one of the following Corps of Engineers District Offices:

(1) States of New York, Pennsylvania, and Ohio
Colonel Daniel R. Clark
Commander, Buffalo District
1776 Niagara Street
Buffalo, New York 14207-3199
(716) 876-5454 - Ext. 2201

(2) States of Michigan, Minnesota, and Wisconsin
Colonel Robert F. Harris
Commander, Detroit District
Post Office Box 1027
Detroit, Michigan 48231-1027
(313) 226-6440 or 226-6441

(3) States of Illinois and Indiana
Lieutenant Colonel Frank R. Finch
Commander, Chicago District
219 South Dearborn (6th Floor)
Chicago, Illinois 60604-1797
(312) 353-6400

The "Help Yourself" brochure which contains information on shoreland damage causes and some protective measures is available from the District Offices listed above or from this office:

North Central Division
536 S. Clark Street
Chicago, Illinois 60605-1592
(312) 353-6364

I will continue to issue these updates in an effort to keep you informed of the lake levels and the actions being taken to help alleviate the situation. These updates will accompany the monthly bulletin until the lakes return to safe levels.

JOSEPH PRATT
Brigadier General, USA
Commanding

EXHIBIT U

anybody would like to talk to me afterwards. I will not take the time here to do it.

I would like to mention to Miss Jensen, she mentioned the level of Lake Erie and whether we would raise the level of Lake Erie to get the barge canal in. If I knew -- was capable of determining how to control the levels of Lake Erie, I don't think I would be working for the Toledo Edison Company, because I could probably have a much better job as a consultant, because we can't control in any manner the levels of Lake Erie: that we accept the levels as they come, the same as Mrs. Jensen must.

And we are not burying nuclear waste around the Davis-Besse facility. We've had mentions about -- from the P.O.W.W.E.R. group, that 33 percent of the residents of the State of Ohio, over a million people, spoke out on Issue 6.

I would like to say that 66 percent,