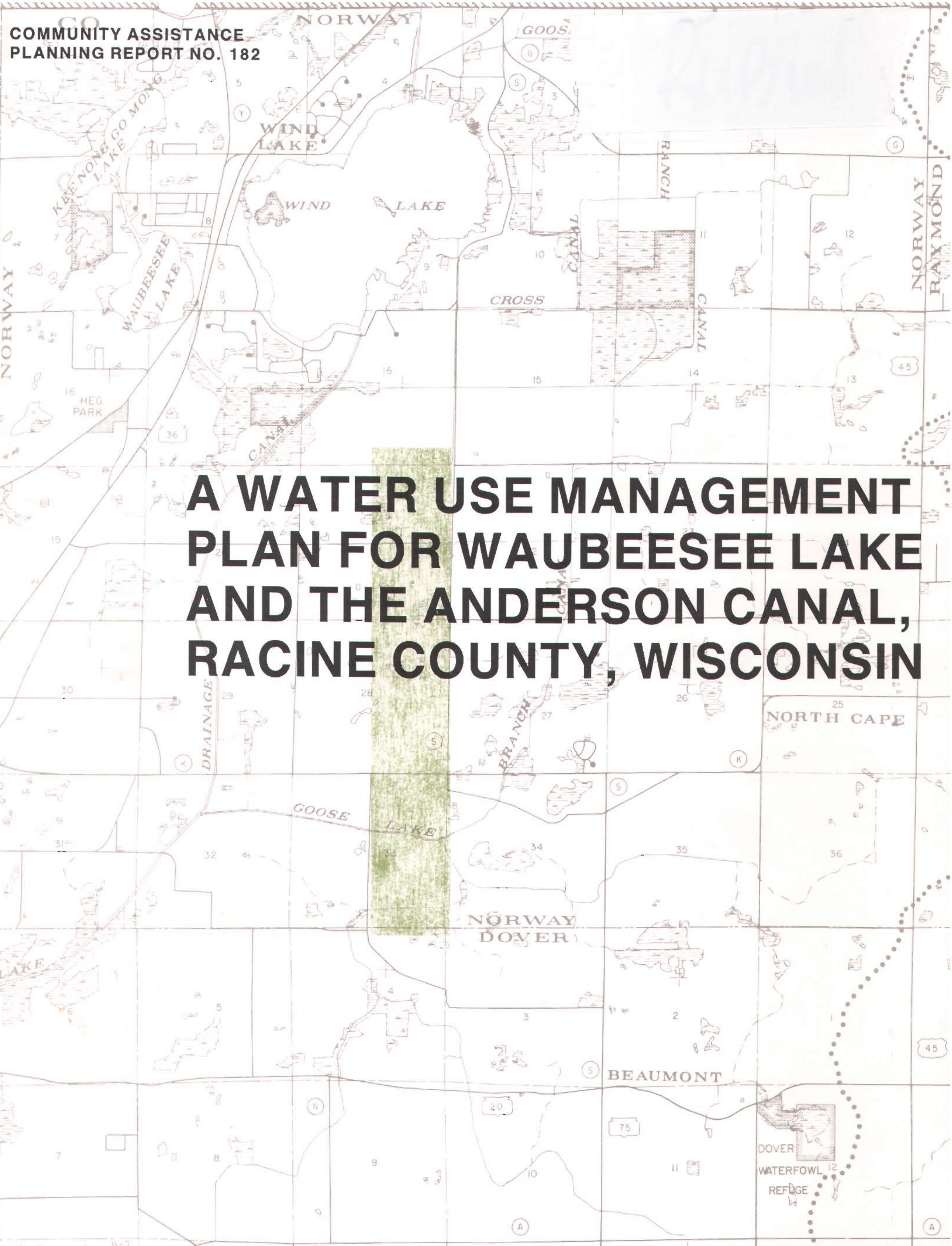
COMMUNITY ASSISTANCE
PLANNING REPORT NO. 182



A WATER USE MANAGEMENT PLAN FOR WAUBEESEE LAKE AND THE ANDERSON CANAL, RACINE COUNTY, WISCONSIN

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

Special acknowledgement is due Ms. Nancy Zolidas, SEWRPC Principal Specialist, Mr. David Kendziorski, former SEWRPC Principal Planner, and Ms. Tami Dake and Ms. Mary Jo Schabel, SEWRPC Planning Analysts, for their contribution to the conduct of ths study and the preparation of ths report.

COMMUNITY ASSISTANCE PLANNING REPORT
NUMBER 182

A WATER USE MANAGEMENT PLAN FOR WAUBEESEE LAKE AND THE ANDERSON CANAL, RACINE COUNTY, WISCONSIN

Prepared by the

Southeastern Wisconsin Regional Planning Commission
for
The Town of Norway
and
Tri-Lakes Conservation, Inc.

December 1990

Inside Region	$2.50
Outside Region	$5.00

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SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

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December 31, 1990

TO: All Units and Agencies of Government and Citizen Groups
Involved in Water Use Management for Waubeesee Lake

In 1989, the Regional Planning Commission, at the request of the Town of Norway and of Tri-Lakes Conservation, Inc., a citizens' group concerned with environmental protection in the area, undertook a study of existing and anticipated water use problems in the Anderson Canal and Waubeesee Lake. The purpose of the study was to identify means to improve the usability of the Anderson Canal and to prevent deterioration of the condition and recreational potential of Waubeesee Lake. The findings and recommendations of that study are presented in this report.

The report as it pertains to the Anderson Canal includes a brief history of the Canal; a description of the existing biological, bottom sediment, and shoreline conditions; an evaluation of alternative measures to abate aquatic plant growth and sedimentation problems in the Canal; and a recommended management plan. The report as it pertains to Waubeesee Lake includes a description of the physical and biological characteristics of the Lake and its watershed; a description of existing recreational uses; an estimation of pollutant loadings; an examination of shoreline conditions; a presentation of lake use problems and concerns; and a recommended management plan.

A preliminary draft of this report was reviewed and commented on by the Town of Norway and Tri-Lakes Conservation, Inc. This final draft reflects the comments and suggestions made as a result of this review.

The plan presented in this report should provide a sound guide to the making of decisions concerning the wise management of the Anderson Canal and of Waubeesee Lake as important aesthetic and recreational assets. Accordingly, adoption of the plan presented herein by all of the concerned water use management agencies is urged. The Regional Planning Commission stands ready to assist the various units and agencies of government concerned in carrying out the plan recommendations.

Respectfully submitted,

Kurt W. Bauer

Kurt W. Bauer
Executive Director

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF MAPS

A WATER USE MANAGEMENT PLAN FOR WAUBEESEE LAKE AND THE ANDERSON CANAL, RACINE COUNTY, WISCONSIN

INTRODUCTION

Waubeesee Lake and the Anderson Canal, which flows into the Lake, are valuable ecological resources offering an attractive variety of recreational opportunities. However, recreational use of the Anderson Canal has been hindered by excessive sedimentation and aquatic plant growths. The water quality of Waubeesee Lake is potentially threatened by increased pollutant loadings from urbanization, while there is an increasing demand for such high quality recreational uses of the Lake as boating, fishing, and waterskiing.

Seeking to improve the usability of the Anderson Canal and to prevent deterioration of the natural assets and recreational potential of Waubeesee Lake, Tri-Lakes Conservation, Inc., and the Town Board of the Town of Norway, in October 1988, requested that the Regional Planning Commission prepare a plan for abating siltation and aquatic plant growth in the Anderson Canal and for managing water uses of Waubeesee Lake. The study was initiated in July 1989 and completed in March 1990.

The management plan for the Anderson Canal includes a brief history of the Canal; a description of the existing biological, bottom sediment, and shoreline and related watershed conditions; an evaluation of alternative measures to abate aquatic plant growth and sedimentation problems in the Canal; and a presentation of a recommended management plan. The management plan for Waubeesee Lake includes a description of the physical and biological characteristics of the Lake and its watershed; a description of existing recreational uses; an estimation of pollutant loadings; an examination of shoreline conditions; a presentation of lake use problems and concerns; and a presentation of a recommended lake use management plan. The plans utilize information contained in the files of the Wisconsin Department of Natural Resources and of the Regional Planning Commission, information obtained from personal interviews of lake residents, and data collected in field surveys conducted by the Commission staff during the summer of 1989.

ANDERSON CANAL USE MANAGEMENT PLAN

Introduction

The Anderson Canal is a 3,900-foot-long channel, with a mean width of 70 feet and a total water surface area of 6.4 acres, which connects Kee Nong Go Mong Lake (Long Lake) to Waubeesee Lake (Swan Lake) in the Town of Norway, Racine County. About 780 feet of the channel, or 20 percent, lie upstream of Long Lake Road, while the remaining 3,120 feet of the channel, or 80 percent, lie downstream of the Road. The shallow channel supports heavy rooted aquatic plant and algal growths which restrict navigation through the channel and impair the aesthetic and ecological qualities of the channel.

History

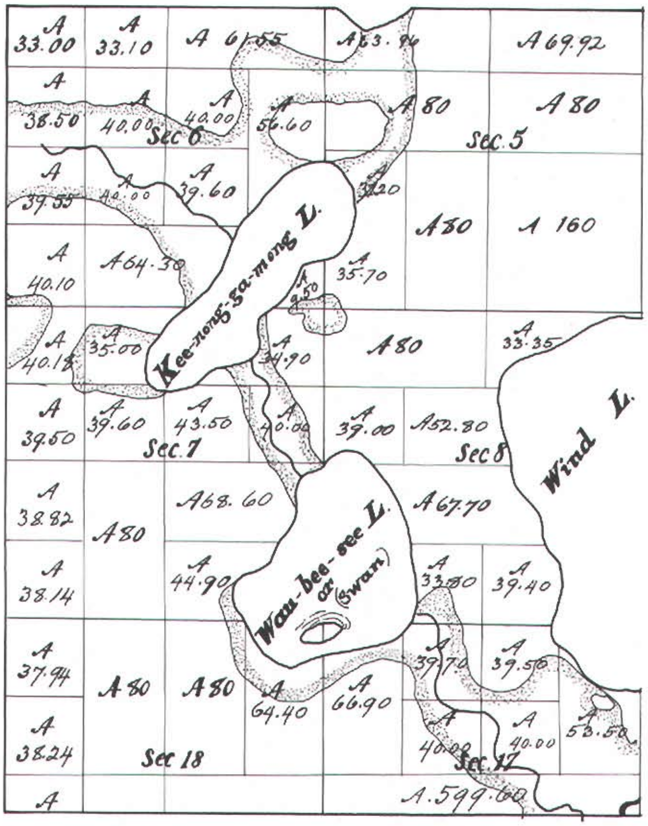
Both Waubeesee and Kee Nong Go Mong Lakes are of glacial origin, their irregular basins formed by the melting of several ice blocks. Prior to 1945, drainage from Kee Nong Go Mong Lake flowed in a small stream through a wetland into Waubeesee Lake. This small stream was shown on the original 1836 U. S. Public Land Survey plat, as well as plats dating from 1908 through 1944, and on a soil survey map prepared by the Wisconsin Geological and Natural History Survey in 1923. The original 1836 Government Survey Plat, shown on Map 1, indicates that the land within 200 to 700 feet of the stream was wetland.

To improve access and navigation, the channel between Waubeesee and Kee Nong Go Mong Lakes was first dredged in 1944 and 1945 by Mr. Orville Anderson, who owned the land adjacent to the channel. Dragline-type equipment was apparently used for the dredging. Some of the dredge spoil was placed on a site near the existing intersection of Racine Avenue and Loomis Road, and some on the land immediately adjacent to the channel. The extent and depth of this initial dredging, and the amount of spoil removed, are not known.

Since that time the Anderson Canal has been dredged several times, but, again, the extent,

Map 1

U. S. PUBLIC LAND SURVEY MAP OF THE WAUBEESEE LAKE AREA: 1838



Source: U. S. Public Land Survey and SEWRPC.

depth, and volume of dredging have seldom been recorded. Figure 1 shows how the channel configuration has changed from 1950 through 1985. The most recent channel dredging occurred on October 30, 1988, when about five cubic yards of material were removed with a backhoe from a 145-square-foot area of the channel. The spoil was placed on the adjacent property owner's lot.

Sand was periodically placed in portions of the channel to provide a firm bottom for swimming. Such placement of sand, however, was apparently discontinued in the early 1980s.

Existing Conditions

A series of inventories was conducted in the summer of 1989 to determine the water depths, sediment depths and characteristics, and aquatic vegetation of the Anderson Canal and to identify and delineate adjacent land uses.

Water Depths: The water depths in the Anderson Canal are influenced by local climatic conditions, by the elevation of the groundwater table, and by the lake inlet and outlet structure elevations concerned. Field surveys were conducted in July of 1989. About 34.56 inches of precipitation fell during the 12 months prior to the survey period, as measured at General Mitchell International Airport in Milwaukee, about 7 percent higher than the average. Observations over the study period indicate that the water level in the channel at the time of the survey was somewhat above normal. Maximum water levels in the Canal are controlled in part by the Waubeesee Lake outlet dam, which has an elevation for the top of the concrete spillway of about 777.60 feet above National Geodetic Vertical Datum (NGVD) and an elevation for the bottom of the notch of about 776.57 feet above NGVD. This outlet dam normally is dry, active as a lake outlet only during wet weather, high-flow periods. The Kee Nong Go Mong Lake outlet dam, located on the Anderson Canal about 75 feet upstream of Long Lake Road, has an elevation at the top of the concrete spillway of about 777.50 feet above NGVD and an elevation for the bottom of the notch in the spillway of about 776.50 feet above NGVD.

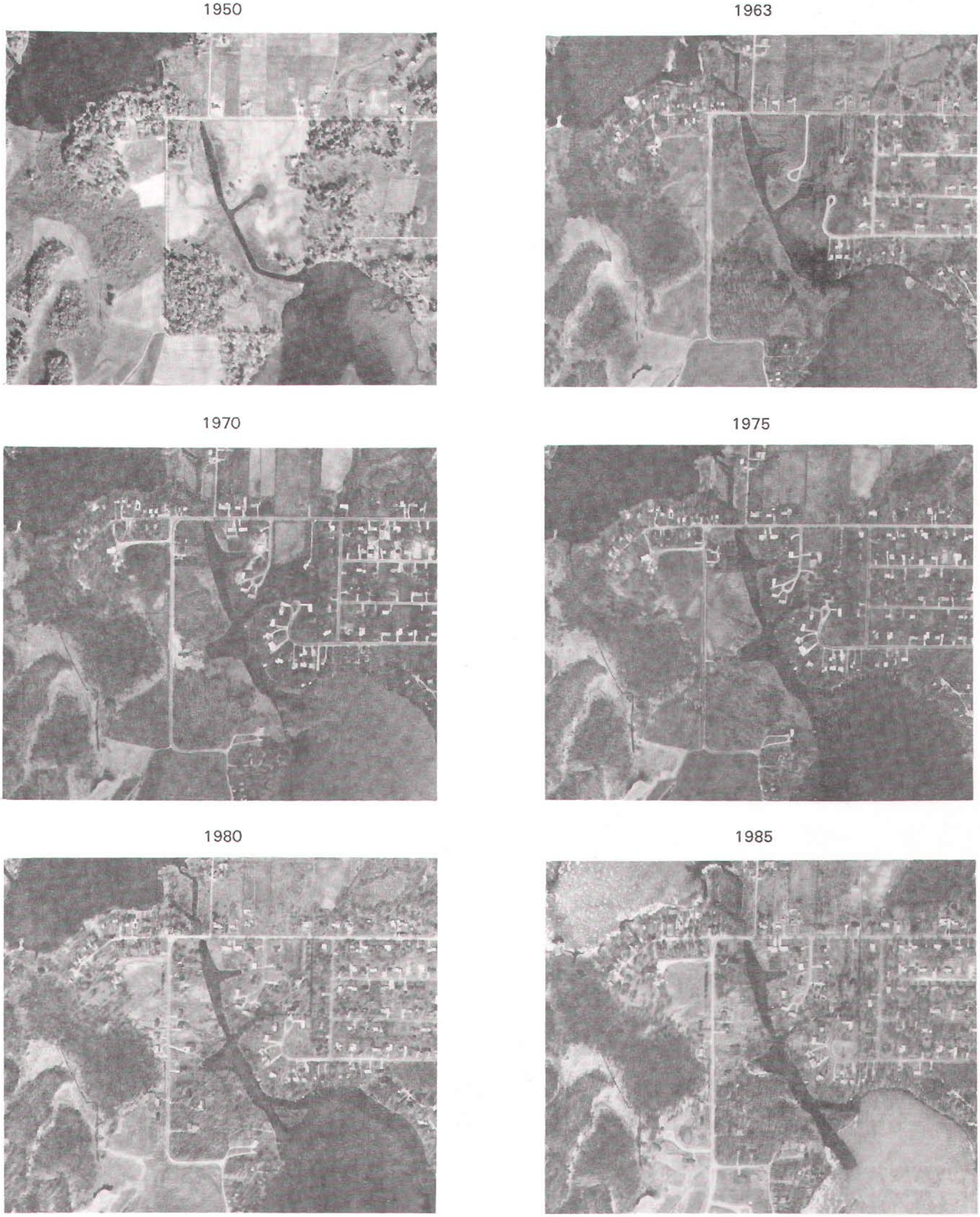
Map 2 shows the water depths in the Anderson Canal in July 1989. The water in the channel was generally shallower north of Long Lake Road than south of the Road. North of Long Lake Road, the water depths ranged from 1.0 to 2.4 feet, with a mean depth of 1.6 feet. South of Long Lake Road, the water depths ranged from 1.1 to 5.9 feet, with a mean depth of 3.1 feet.

Bottom Sediments: The thickness of the soft sediments covering the channel bottom was measured along a series of 59 transects, shown on Map 3, located at intervals ranging from about 20 feet to 130 feet. The thickness of the soft sediments was measured by inserting to refusal a graduated rod into the sediments.

The survey indicated that throughout nearly all of the Anderson Canal a layer of soft sediments was present above a firmer substrate. As shown on Map 4, these soft sediments ranged in depth from 0.5 to 8.3 feet. Figure 2 shows a representative cross-section of the Canal. The deepest soft sediment deposits were located north of Long Lake Road and about 250 feet north of the island at the mouth of the Anderson Canal in

Figure 1

AERIAL PHOTOGRAPHS OF ANDERSON CANAL: 1950-1985



Source: U. S. Soil Conservation Service and SEWRPC.

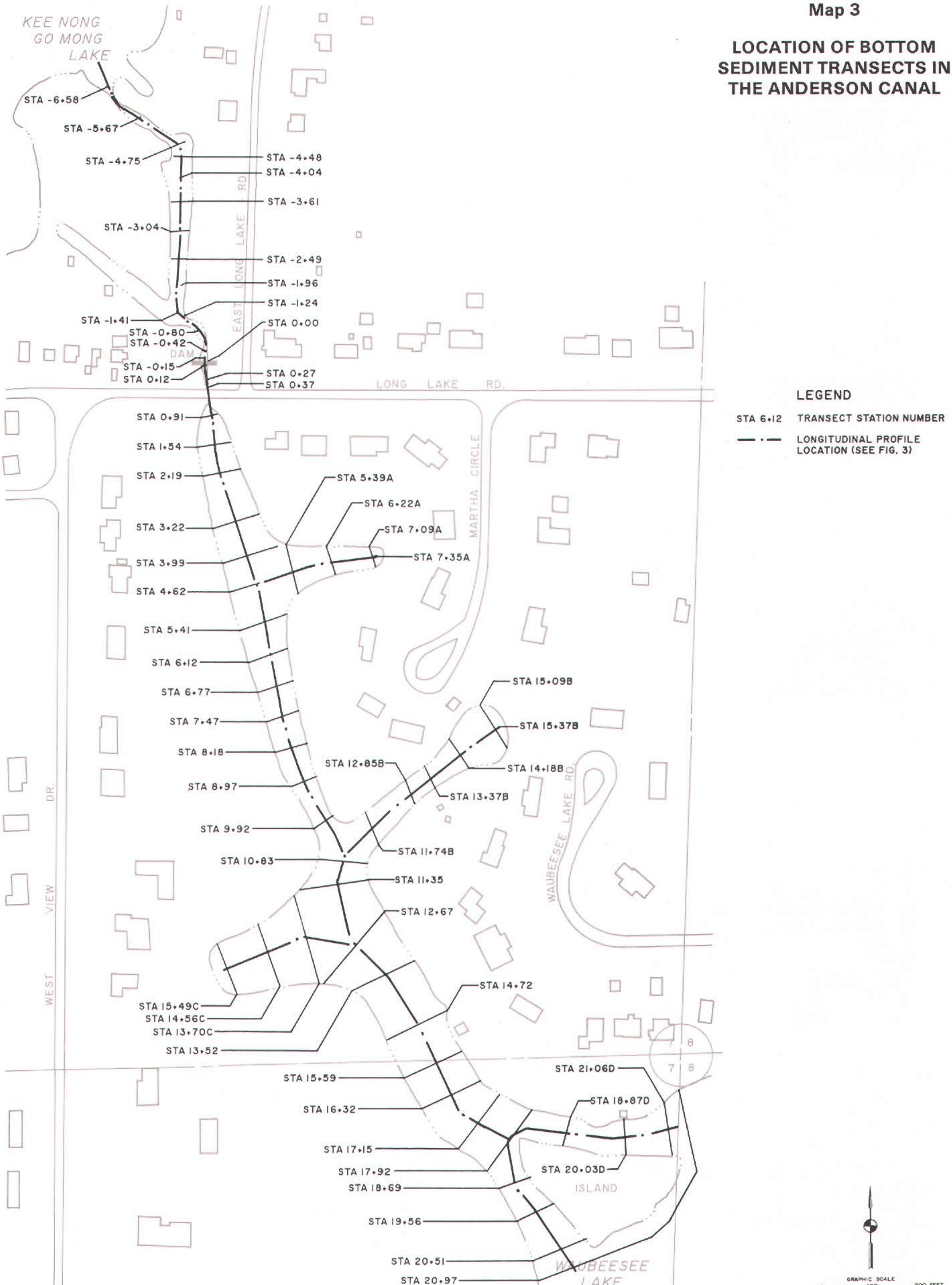
Map 2

WATER DEPTH IN THE ANDERSON CANAL JULY 1989

Source: SEWRPC.

Map 3

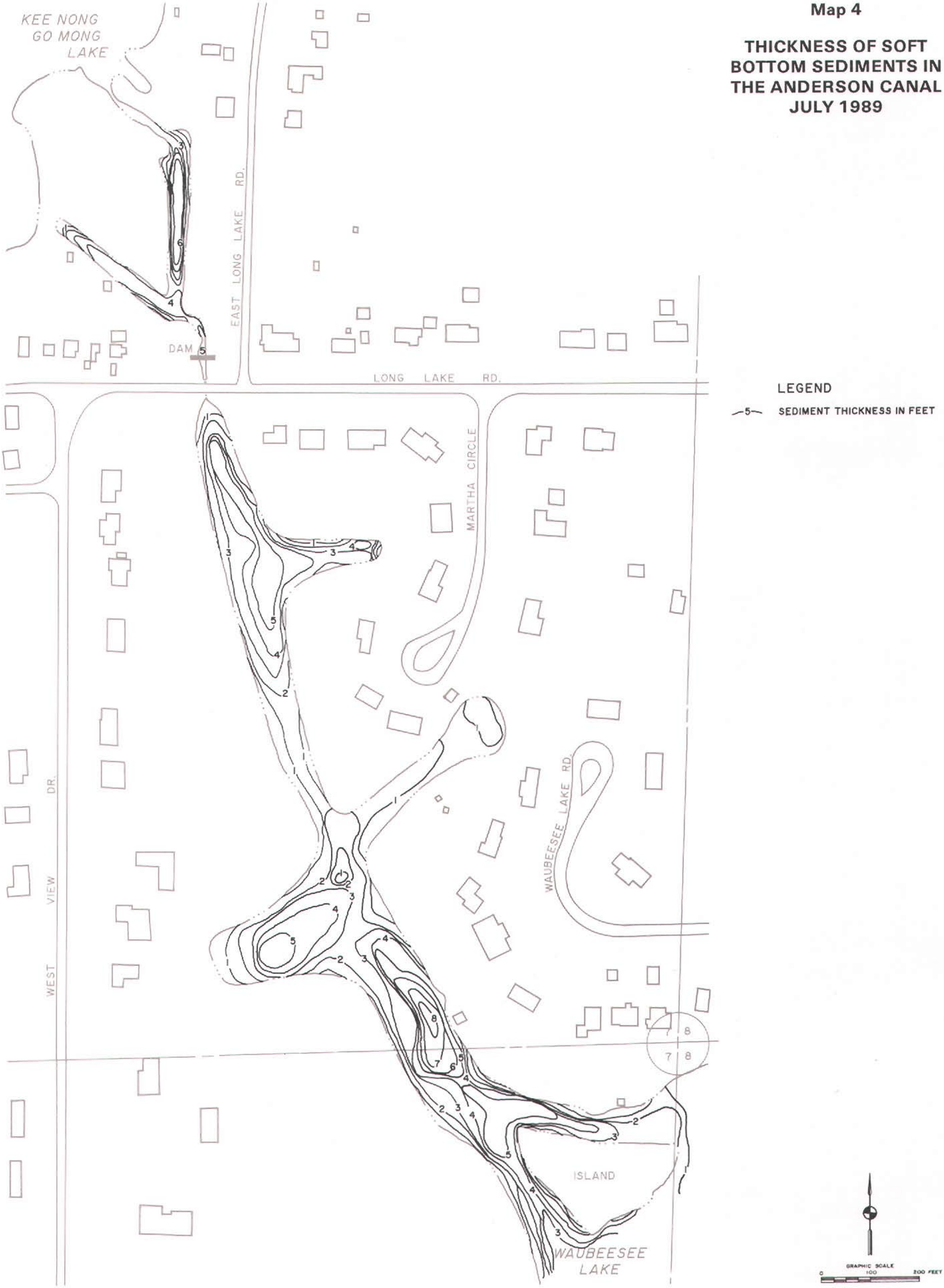
LOCATION OF BOTTOM SEDIMENT TRANSECTS IN THE ANDERSON CANAL



Source: SEWRPC.

Map 4

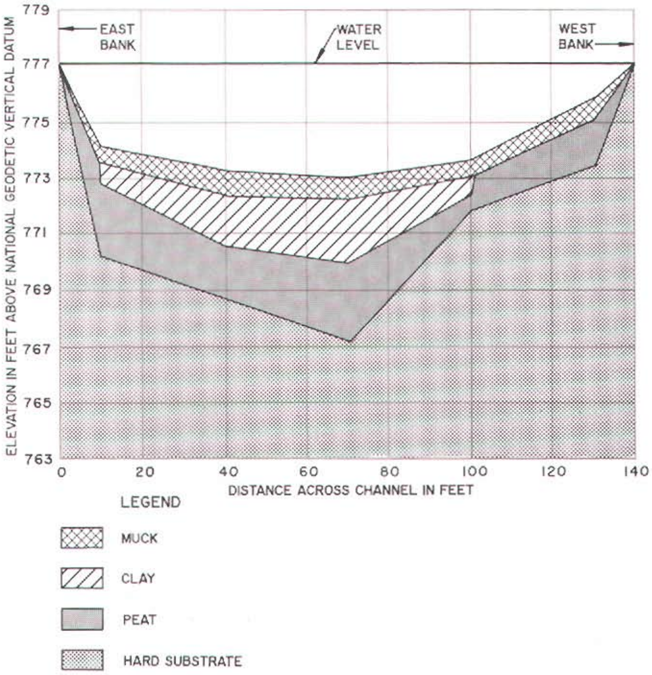
THICKNESS OF SOFT BOTTOM SEDIMENTS IN THE ANDERSON CANAL JULY 1989



Source: SEWRPC.

Figure 2

CROSS-SECTION OF THE ANDERSON CANAL AT TRANSECT STATION 13+52: JULY 1989



Source: SEWRPC.

Waubeesee Lake. A total of nearly 30,000 cubic yards of soft sediments are deposited on the bottom of the Canal.

The soft bottom sediments are primarily peat, muck, marl, loam, or clay. Peat is an organic soil containing partially decomposed plant remains still containing recognizable plant material. Muck is an organic soil in which the organic matter is well decomposed. Marl is a grayish-white substance formed of calcium carbonate precipitated by microscopic plants and animals. Loam is a medium-textured soil, consisting of clay, silt, and sand, which retains water well. Clay is a mineral soil comprised of extremely small particles with a mean diameter of about two microns (about 1/13,000 of an inch) or less. Map 5 shows the distribution of sediment types present at the surface of the substrate. Figure 3 shows a longitudinal profile of the bottom sediments along the thread of the channel. The soft sediments overlie a glacial till comprised primarily of silty clay loam, referred to herein as "hard substrate."

Aquatic Vegetation: During the July 1989 field surveys, heavy rooted aquatic plant and algal growths were present in the Canal. The rooted plants slow the flow of water and trap sediments. As the rooted plants and algae die and decompose, their remains contribute to the peat and muck deposits in the channel. The western portion of the Canal, the shoreline around the island located at the mouth of the Canal, and the Waubeesee Lake shoreline adjacent to the Canal mouth, as shown on Map 6, contain diverse aquatic plant communities and fish spawning sites, and therefore were identified as environmentally sensitive areas. A macrophyte survey conducted by the Wisconsin Department of Natural Resources in July 1987 indicated that submergent macrophyte growth in the Canal was dominated by Eurasian water milfoil and bladderwort and lesser amounts of coontail. Attached floating-leaf macrophytes included white and yellow water lilies. Emergent macrophytes included purple and swamp loosestrife. Blue-green algae were in nuisance abundance.

Terrestrial vegetation adjacent to the Anderson Canal included water-tolerant trees and shrubs. The root systems of many of these trees and shrubs extended into the channel, helping to stabilize the channel banks but also trapping sediments.

Land Use: The Anderson Canal receives drainage from Kee Nong Go Mong Lake and from a direct tributary drainage area of about 97 acres. As of 1985, as shown on Map 7 and presented in Table 1, urban land uses occupied about 62 percent of the direct drainage area. Most of these residential uses were developed in the 1960s and 1970s. Primary environmental corridor lands covered 26 percent of the area and other open land uses occupied about 4 percent of the direct drainage area. Surface water covered the remaining 8 percent of the direct drainage area to the Canal.

The Commission's year 2010 planned land use conditions for the direct drainage area to the Anderson Canal are also shown on Map 7. Under that plan, urban land use would increase by about 7 percent, to occupy a total of about 66 percent of the drainage area. Primary environmental corridor lands and surface water areas would be preserved in essentially natural open uses.

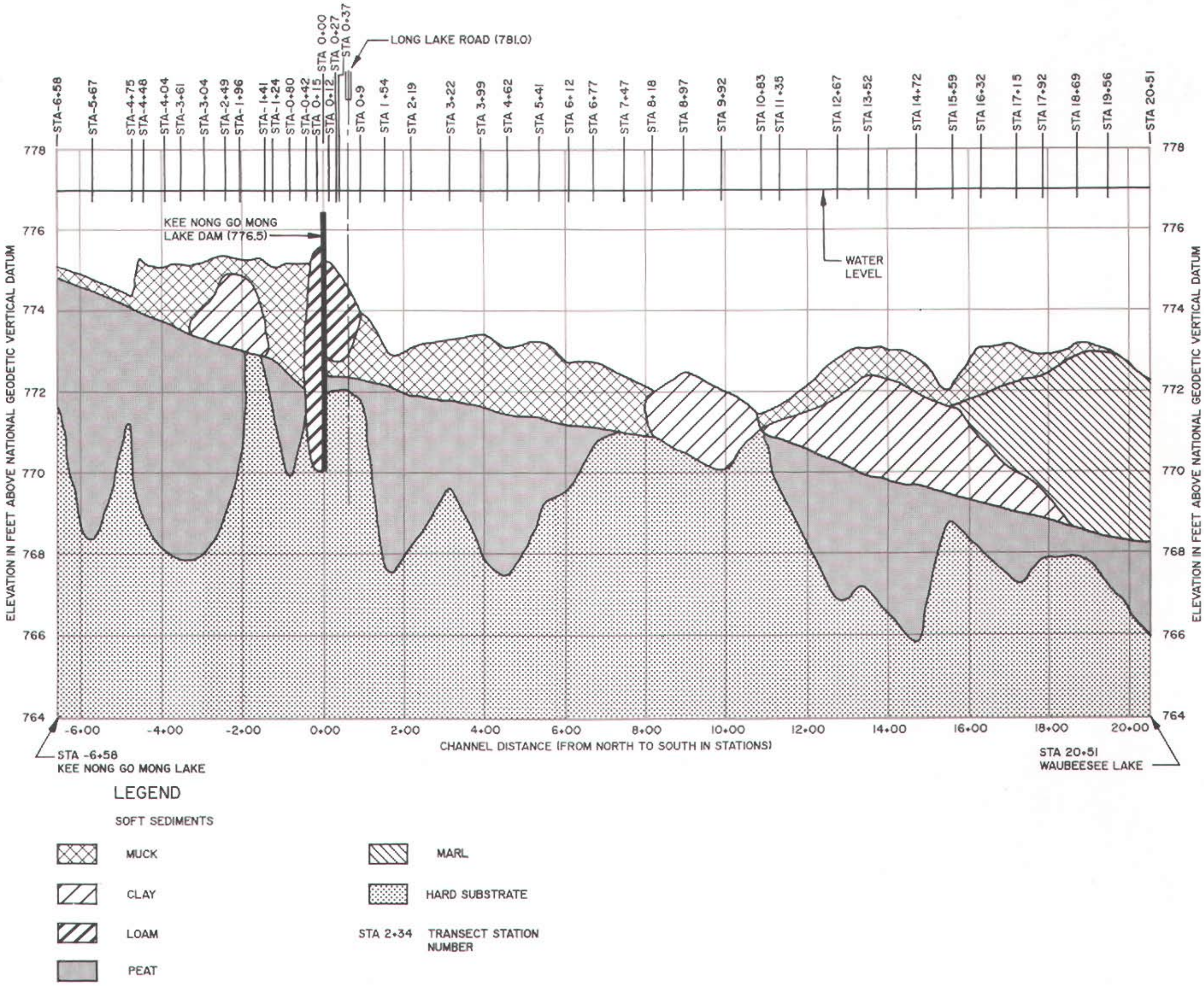
Map 5

BOTTOM SEDIMENTS IN THE ANDERSON CANAL JULY 1989

Source: SEWRPC.

Figure 3

LONGITUDINAL PROFILES OF THE ANDERSON CANAL



Source: SEWRPC.

Sediment Loadings and Sources: The bottom sediments in the Anderson Canal were formed by sediment particles washed into the channel from Kee Nong Go Mong Lake and from the direct drainage area; by the decomposed remains of aquatic plants growing in the channel; and, to a lesser extent, by channel bank sluff. Because the depths of the various dredging activities were not, except in minor cases, documented, it is impossible to determine the rate of channel filling on the basis of channel survey records.

The sources of the bottom sediments may be roughly identified by estimating sediment loading rates and aquatic plant die-off and accumulation rates. With respect to sediment loadings, under existing conditions, an estimated 56,000

Map 6

ENVIRONMENTALLY SENSITIVE AREAS IN THE ANDERSON CANAL JULY 1989

Source: SEWRPC.

Table 1

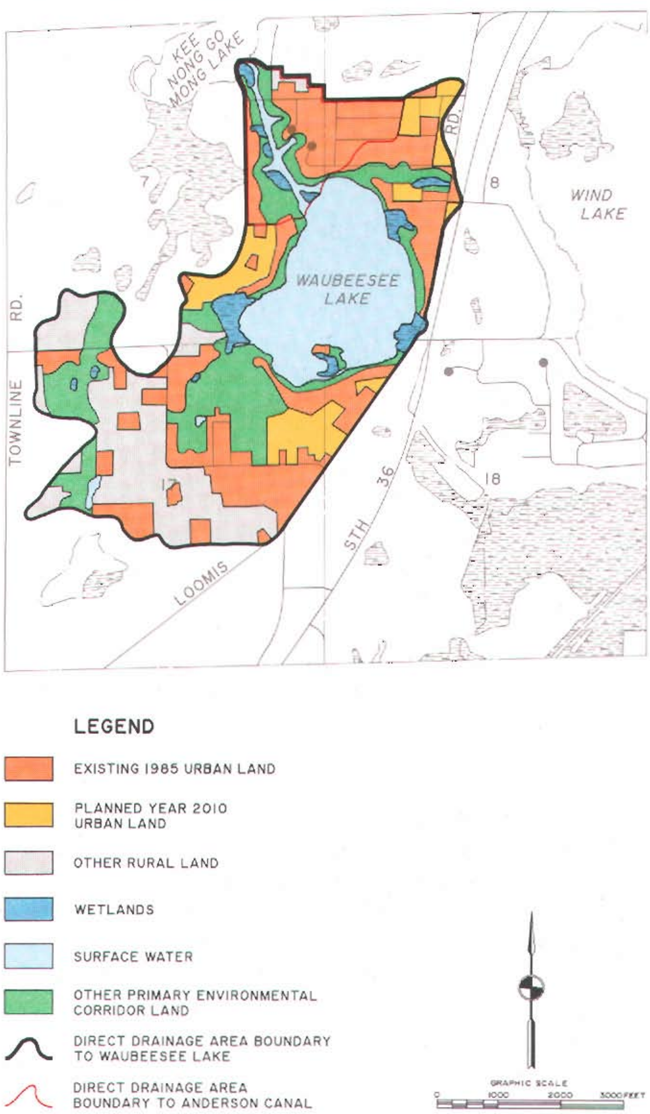
EXISTING 1985 AND PLANNED YEAR 2010 GENERALIZED LAND USE IN THE DIRECT DRAINAGE AREA TO THE ANDERSON CANAL

Land Use	1985 Acres	1985 Percent of Total	1985-2010 Change (acres)	2010 Acres	2010 Percent of Total
Urban	60	61.9	4	64	66.0
Primary Environmental Corridor	25	25.8	- -	25	25.8
Surface Water	8	8.2	- -	8	8.2
Other Open Lands	4	4.1	-4	- -	- -
Total	97	100.0	- -	97	100.0

Source: SEWRPC.

Map 7

EXISTING AND PLANNED YEAR 2010 LAND USE IN THE DIRECT DRAINAGE AREA TO WAUBEESEE LAKE



Source: SEWRPC.

pounds of sediment are contributed to the Anderson Canal by Kee Nong Go Mong Lake each year. An additional 10,000 pounds of sediment are contributed by the direct drainage area.[1] Only a portion of this total sediment load is deposited in the channel; the remainder is transported into Waubeesee Lake. If 25 percent of this sediment load of 66,000 pounds per year was evenly deposited in the channel, it would form a layer about 0.05-inch deep on the channel bottom each year. During construction of the residential land uses in the 1960s and 1970s, sediment loadings may have increased to a total of about 130,000 pounds per year. If 25 percent of this sediment load was deposited in the channel, it would form a layer about 0.10-inch deep each year. Thus, sediment loadings to the channel could account for accumulation rates of up to about 0.10 inch per year.

The other contributor to the formation of bottom sediments is decomposed aquatic plant life. The Wisconsin Department of Natural Resources

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[1] *The sediment load from Kee Nong Go Mong Lake was estimated by multiplying the phosphorus load from Kee Nong Go Mong Lake set forth in Volume Two of SEWRPC Planning Report No. 30, A Regional Water Quality Management Plan for Southeastern Wisconsin: 2000, 1979, by the ratio of sediment to phosphorus considered typical for lake outlets. The sediment load from the direct drainage area to the Anderson Canal was estimated by applying typical unit-area sediment loading rates to the existing land use areas shown on Map 7.*

found that in Lilly Lake, Kenosha County, decaying plant remains from dense rooted aquatic macrophytes in water five feet deep accumulated on the lake bottom at a rate of about 0.20 inch per year, or about two to four times the probable infilling rate of the Anderson Canal from sediment sources as estimated above. It therefore appears that most, up to 80 percent, of the accumulating bottom sediments in Anderson Canal are formed by macrophyte decomposition.

This conclusion is further supported by the observed characteristics of the bottom sediments. Most of the sediments were classified as peat or muck, rather than mineral soil. This finding indicates that future deposition of material in the Anderson Canal can be most effectively reduced by controlling the amount of plant growth in the channel.

Shoreline Conditions: A survey of Canal shoreline protection structures was conducted in July 1989 to identify their type and condition. A total of 16 structures were found to be in place to protect portions of the channel shoreline, as shown on Map 8. These structures were apparently constructed to stabilize the banks of the channel, to prevent sluffing of the banks into the channel, and to provide a more usable shoreline.

Of the 16 structures, 10 structures were revetments, five were bulkheads, and one was a sandy beach. The structures covered a total of 995 lineal feet of channel shoreline, or about 15 percent of the total channel shoreline length. Most of the structures had partially collapsed; only two structures, one revetment and one bulkhead, as shown on the map, showed no signs of failure or need of repair.

Although structures protected a portion of the channel shoreline, there was little indication of erosion along the remaining shoreline segments. The channel shoreline appeared to be stable and well vegetated, with little evidence of sluffing. The channel, however, has on previous occasions experienced shoreline erosion problems. Channel residents reported that up to two to four feet of bank erosion has occurred in portions of the channel over the past few decades. Thus, historically, channel bank sluffing may have been a major contributor to the accumulated bottom sediments in the channel.

Management Alternatives for the Anderson Canal

The Anderson Canal provides a unique, highly productive aquatic environment contiguous to Waubeesee Lake and a means of access to the Lake for channel shoreline property owners. However, full recreational enjoyment of the channel is limited because of shallow water conditions, excessive aquatic plant growths, and, to a minor extent, a shoreline which could be easily damaged by excessive use or by such disturbances as motorboating.

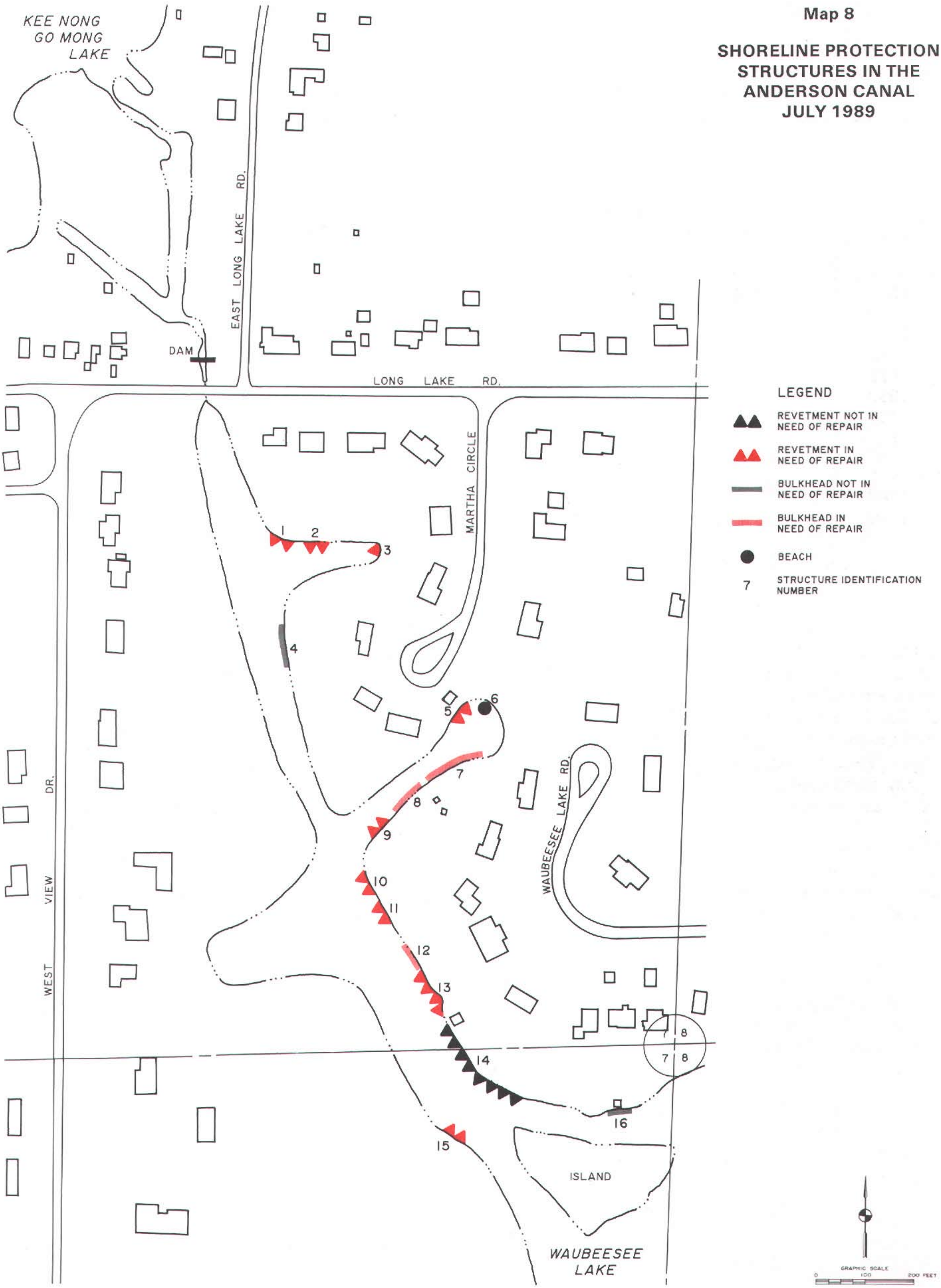
Alternatives considered to enhance the usefulness of the Anderson Canal include application of aquatic plant herbicides, macrophyte harvesting, channel bottom covering, dredging, and increasing protection of the shoreline. All of the alternatives except shoreline protection would substantially reduce aquatic macrophyte growth in the channel. Under any of these alternatives, reduced macrophyte growth may result in increased growth of planktonic algae because of greater light availability and a reduced competition for nutrients. Each of these alternatives is discussed below.

Aquatic Plant Herbicides: Aquatic plant herbicides are liquids, powders, soluble materials, or granules which are applied to surface waters to destroy algae and rooted aquatic plants. Chemical control of aquatic plants began in Wisconsin in the 1920s with the use of copper sulfate to control algal growths. Sodium arsenite was used in many lakes from 1926 through the 1960s to control rooted plants. Sodium arsenite, prohibited since 1969 because of concerns about arsenic toxicity, was not applied to either Waubeesee Lake or to the Anderson Canal, although a small amount, recorded as 225 pounds, was applied to Kee Nong Go Mong Lake in 1954. It is therefore unlikely that a significant amount of arsenic has been deposited in the bottom sediments of the Anderson Canal.

All aquatic herbicides presently used must be approved by, and registered with, the U. S. Environmental Protection Agency. Use of aquatic herbicides is regulated under NR 107 of the Wisconsin Administrative Code and a permit from the Wisconsin Department of Natural Resources is required prior to any application. Commonly used aquatic herbicides in Wisconsin include Endothall, Diquat, 2,4-D compounds, and copper sulfate. Waubeesee Lake has been

Map 8

SHORELINE PROTECTION STRUCTURES IN THE ANDERSON CANAL JULY 1989



Source: SEWRPC.

Table 2

HISTORY OF AQUATIC PLANT CONTROL IN WAUBEESEE LAKE: 1974-1988

Year	Algae		Submergent Macrophytes		
	CuSO4 (Cutrine Plus)				
	(pounds)	(gallons)	2,4-D (gallons)	Endothall (Aquathol=K) (gallons)	Diquat (gallons)
1974	138.0	- -	- -	43.0	- -
1976	133.5	42.00	- -	49.0	- -
1977	- -	27.5	- -	24.0	- -
1978	- -	29.25	0.75	22.0	- -
1979	- -	18.0	- -	23.0	- -
1980	- -	26.0	1.0	27.0	- -
1981	- -	22.85	- -	23.0	0.2
1982	- -	10.5	- -	16.0	- -
1985	- -	9.0	4.5	18.0	- -
1986	- -	10.0	5.0	10.0	- -
1987	- -	16.0	- -	15.5	- -
1988	- -	8.8	- -	17.0	- -

Source: Wisconsin Department of Natural Resources.

repeatedly treated with copper sulfate for control of algae and with Endothall for control of submergent macrophytes, as shown in Table 2. A detailed discussion of the use of aquatic herbicides is set forth in Environmental Assessment, Aquatic Nuisance Control (NR107) Program, published by the Wisconsin Department of Natural Resources in May 1988.

The advantages of using aquatic herbicides include ease of use, rapid effectiveness, control of a wide variety of aquatic plants for an entire growing season, suitability for use in shallow water and around obstructions, and relatively low cost. Certain aquatic herbicides can effectively control specific plants, leaving other plants unharmed. Herbicides are less likely than harvesting to result in viable plant fragments drifting off to colonize new growth beds.

The disadvantages of using aquatic herbicides include potential fish kills, depletion of dissolved oxygen levels in the water as large numbers of plants rapidly die and decompose, and largely unknown long-term impacts on fish and other aquatic life. Some aquatic herbicides metabolize to form trace quantities of toxic or carcinogenic substances such as dioxin and ethylene dibromide (EDB). While Diquat and Endothol are broad spectrum herbicides capable of destroying a wide spectrum of plants, 2,4-D compounds are more selective. Some species, such as Vallisneria americana (wild celery) and Chara species are relatively resistant to herbicides and may actually increase after the use of the herbicides because of a loss of competition from more sensitive species. Use of aquatic herbicides can thus change the ecological character and diversity of a plant community. The decomposition of dead plant remains may also release nutrients to the overlying water column, with such release accelerated under low dissolved oxygen levels.

Aquatic herbicides are typically applied by a private firm on a contract basis. Although costs vary widely, treatment of the Anderson Canal may be expected to entail a cost of about $300 to $400 per acre per year.[2] More than one treatment per year may be required. Of the total cost, about 50 percent would be for chemicals;

[2] *James Schmidt, Surface Water Product Manager, Marine Biochemists, Inc., Personal Communication, February 21, 1990.*

about 25 percent for labor, equipment, and profit; and about 25 percent for permit fees and other regulation-related costs.

Assuming a typical annual cost of $350 per acre, treatment of the entire Anderson Canal would entail a total annual cost of about $2,200. Over a 20-year planning period, the total cost would be $44,000, with a present worth value of about $25,200.

Macrophyte Harvesting: Mechanical harvesters can be used to cut and remove macrophytes from a body of water. Two general types of harvesting systems are commercially available. The first system, referred to as a single-stage system, has the cutting, collection, and removal equipment on one machine. The second system is a two-stage system, which employs one machine to cut the plants, with collection and removal of cut plants performed manually or by a second machine.

Collected plants are typically transported by truck to a landfill or applied to agricultural land. Aquatic plants have a high air and water content, typically consisting of only 10 percent solids by weight, and only 2 percent solids by volume. One ton of collected plant material may be expected to contain nearly 20 pounds of nitrogen and two pounds of phosphorus.

Commercial harvesters typically cut a swath of four to 12 feet and have maximum cutting depths ranging from four to eight feet. Maximum cutting speeds are typically about two miles per hour. A small harvester may be expected to harvest about 0.5 acre per hour, while a large harvester may harvest about one acre per hour, removing anywhere from one to over 10 tons of plants per acre.

Macrophyte harvesting is not regulated by the State of Wisconsin and no permits are required. However, the Wisconsin Department of Natural Resources does require that all cut plants be removed from the water body.

The advantages of macrophyte harvesting are that it provides immediate benefits to channel users; water uses are not restricted; nutrients like nitrogen and phosphorus are removed from the water body; the removal of the plants decreases the potential for low dissolved oxygen levels caused by decomposing plants; there are reduced accumulations of organic matter; and there are no long-term toxic impacts. The cost of harvesting can be lower than herbicide use if the water depths are between three and six feet and if the treatment area exceeds 10 to 20 acres. Harvesting may remove a large portion of the plant biomass. One study found that one harvest per year reduced total plant growth by 50 percent, two harvests reduced plant growth by 75 percent, and three harvests virtually eliminated plant material from the harvest area. Harvesting can provide some long-term benefits; effective harvesting during a growing season has been found to reduce aquatic plant growth the following year as well.

The disadvantages of macrophyte harvesting include the potential drifting and regrowth of plant fragments; the need for several harvests, at some sites, during the growing season; the potential destruction of desired valuable plants since harvesting is not selective; difficulty in harvesting in very shallow water or around obstructions; a potential shift in species composition by favoring plants which have rapid regrowth; the need to find suitable sites for the disposal of the harvested plant materials; and aesthetic problems related to the harvester noise and to odors and flies associated with the harvested plants. When large, extensive areas are harvested, as opposed to selected cutting, fish and invertebrate organisms and habitats may be destroyed.

A new harvester cutting, collection, and transport system may be expected to entail a capital cost of from $30,000 to $80,000 or more. Operation, maintenance, and disposal costs may be expected to approximate $200 per acre harvested. One alternative for the Anderson Canal would be to purchase a small harvester for about $40,000, and to hire a crew to operate the harvester and dispose of the collected plant material. Assuming a truck would be available to transport the collected macrophytes, the entire Anderson Canal could be harvested twice per year at a total annual operation, maintenance, and disposal cost of about $2,600. The total cost of this alternative over a 20-year period is about $92,000, with a present worth value of about $69,400.

Because a harvester could treat the Anderson Canal within a few days, the harvester could be jointly purchased, and shared, with other lake organizations. If the harvester was jointly purchased to be used on three lakes, the resultant capital cost allocated for the Anderson

Canal would be reduced to about $13,300, for a total cost of about $65,300, and a present worth value of about $42,700.

Harvesting could also be conducted by a private firm under contract. The contractor would supply the equipment and crew, provide insurance, haul away the vegetation, and maintain the equipment. Harvesting the Anderson Canal on a contract basis may be expected to entail an annual cost of about $500 to $600 per acre harvested. The entire Anderson Canal could be harvested twice per year on a contract basis for a total cost of about $7,000 per year. The total cost of this alternative over a 20-year planning period is about $140,000, with a present worth value of about $80,700.

Channel Bottom Covering: Channel bottom covering involves the placement of natural or artificial materials on the channel bottom to reduce growth by rooted aquatic plants. Cover materials may include sand and gravel, or plastic, rubber, or fiberglass blankets, sheets, or screens. Sand and gravel provide few benefits because nutrients quickly diffuse up through the cover and plants readily recolonize the area. Plastic or rubber blankets or sheets may be difficult to place and secure over soft sediments.

Fiberglass screens may provide effective control of rooted aquatic plants. The screens may be custom fitted close to the shore and around obstructions. The screens may be relocated during the growing season as needed. The screens are flexible and typically placed on the bottom in spring or draped over plants in summer. The screens reduce sunlight, which kills and helps decompose the plant material, which sinks to the bottom. The screens also sink readily but must be staked down or anchored. The screens can be removed each fall for cleaning and reinstalled the next spring. A permit from the Wisconsin Department of Natural Resources is required for the placement of sediment covering in a navigable waterway.

The advantages of fiberglass screens are that they provide very effective localized control; they are aesthetically unobtrusive; bottom sediments are not stirred; they can be installed by lake residents; and, once purchased, the screens can be reused in subsequent years.

The screens are difficult to apply on steep side slopes or over stumps or boulders. The screens destroy most bottom dwelling organisms and do not provide a suitable substrate for fish feeding or spawning. Screens should not be used in areas of heavy bottom angling or in shallow waters where motorboating occurs. If the screens are not removed each fall, they become covered with new sediment and plants rapidly recolonize the covered areas.

Material costs for effective light screens are prohibitive for large areas. Relatively ineffective materials such as burlap and polyethylene may be purchased for $1,500 to $2,000 per acre. A fiberglass screen consisting of a polyvinyl-coated noncorrosive mesh would cost about $9,500 per acre. If screens were placed on one-half of the Anderson Canal at any one time, this alternative could entail a total capital cost of about $30,400. Annual maintenance costs may be estimated at $1,500. The 20-year total cost of this alternative, assuming that the screens would be replaced after 10 years, would be about $90,800, with a present worth value of about $64,600.

Dredging: Dredging would involve the removal of bottom sediments from the Anderson Canal and their disposal at an upland site. Dredging would deepen the channel, improve navigation, reduce macrophyte growth because less light would reach the bottom, and remove nutrient-rich muck deposits.

Dredging might have serious, though generally short-term, adverse effects on the Anderson Canal and on adjacent areas of Waubeesee and Kee Nong Go Mong Lakes. These adverse effects include increased turbidity caused by sediment resuspension, oxygen depletion as the organic sediments mix with the overlying water, water temperature alterations, and destruction of benthic habitats. There may also be impacts at the upland disposal site, such as odor problems, restricted use of the site, and trucking disturbances.

Dredging requires a permit under Section 30.20 of the Wisconsin Statutes, and must comply with standards set forth in Chapter NR 347 of the Wisconsin Administrative Code. Chapter NR 347 also includes guidelines for sampling and analysis of dredge spoil.

Dredging Method: The selection of dredging equipment and methods depends on the amount and characteristics of the sediments to be removed, the dredging depth, site and access restrictions, disposal site conditions, and cost.

There are two primary methods of dredging: hydraulic and mechanical. Hydraulic dredges employ a rotating cutterhead to loosen the sediment, which is then excavated with a high-capacity pump. The removed dredge spoil slurry is pumped directly to a disposal area through a moveable, large-diameter pipe. The dredge spoil solids are allowed to settle at the disposal site, and the resultant "clean" water may be discharged back to the water body or allowed to evaporate.

A small portable hydraulic dredge, such as a "Mudcat," may be suitable for use in the Anderson Canal. The "Mudcat" hydraulic dredge, is typically about nine feet wide and 39 feet long, and can operate in water as shallow as two feet. It can dredge to a maximum depth of 15 feet at a rate of up to 120 cubic yards of sediment per hour. The dredge spoil slurry normally has a solids content of from 10 to 20 percent.

The advantages of hydraulic dredging, compared to mechanical dredging, is that less turbidity and sediment resuspension occurs; the dredging can be completed in less time; there is less disruption of channel uses; and there is less disturbance of the shoreline area. The disadvantages of a hydraulic dredge include the need for a larger disposal site because the water content of the slurry is higher than that of mechanical dredge spoil, and the need to locate a disposal site within about one-half mile of the channel in order to be economically feasible.

Hydraulic dredging may be more economical than mechanical dredging when a large volume of sediments is to be removed, where the disposal site is located close to the dredge site, and where a mechanical dredge would have to be barge-mounted. However, for the Anderson Canal, hydraulic dredging conducted by a private firm on a contract basis may be expected to be more costly than mechanical dredging, entailing a unit dredging cost of about $4.00 to $6.00 per cubic yard of sediments measured in situ.

Mechanical dredging utilizes dragline or clamshell equipment to remove the sediment. The dragline or clamshell equipment would be situated onshore. The sediment dredged from the channel would be either stockpiled onshore or placed directly onto trucks which would transport the sediment, at approximately its in-place solids content, to the disposal site.

The advantages of mechanically dredging the Anderson Canal include a lower cost than hydraulic dredging, the need for a smaller disposal site because the solids content of the dredge spoil would be higher, and the ability to use disposal sites located relatively far from the dredge site. The disadvantages of mechanical dredging include the production of high turbidity, the disruption of channel uses, disturbance of the shoreline area, increased truck traffic and related disturbances, and a longer time required to conduct operation. Mechanical dredging conducted by a private firm on a contract basis may be expected to entail a unit dredging cost of about $3.00 to $3.50 per cubic yard of sediments, measured in situ.

Dredging Alternatives: Two alternative mean channel depths were considered for the dredging analysis: five feet and 10 feet. Either depth could be achieved using either the hydraulic or the mechanical dredging. Channel side slopes would be dredged to an angle of one vertical on three horizontal. The unit dredge costs reported above assume that an adequate disposal site could be obtained within about one-half mile of the channel if a hydraulic dredging method was used, and within about three miles of the channel if a mechanical dredging method was used. To estimate a total cost, the dredging costs were increased by 25 percent to account for engineering, legal, administrative fees, and contingencies.

The dredging alternatives evaluated for the Anderson Canal are compared in Table 3. To achieve a mean channel depth of five feet for the entire channel, about 20,800 cubic yards of sediment would need to be removed. Dredging the entire channel to a mean depth of 10 feet would require the removal of about 55,350 cubic yards of sediment. The estimated total costs for dredging and disposal may be expected to range from $85,000 to dredge to a five-foot mean depth mechanically; to $346,000 to dredge to a 10-foot depth hydraulically. The cost estimates do not include land acquisition costs for the dredge spoil disposal sites, which may be expected to approximate $2,100 per acre. Under any of the alternatives, the entire dredging project could be completed within a one-year period, although if the channel was dredged mechanically to a mean depth of 10 feet, the dredging would have to be conducted for an entire ice-free season on a full-time basis.

Table 3

DREDGING ALTERNATIVES FOR THE ANDERSON CANAL

Alternative Number	Dredge Method	Mean Depth of Dredged Channel (feet)	Volume of Sediments Removed (cubic yards)	Disposal Site Volume Required[a] (cubic yards)	Weeks of Active Dredging Required[b]	Dredging and Disposal Cost	Total Cost[c]
1	Mechanical	5	20,800	20,800	13.0	$ 68,000	$ 85,000
2	Hydraulic	5	20,800	41,600	4.3	104,000	130,000
3	Mechanical	10	55,350	55,350	34.5	180,000	225,000
4	Hydraulic	10	55,350	110,700	11.5	277,000	346,000

[a]To calculate the needed volume of a disposal site, it was assumed that the solids content of mechanical dredge spoils would be the same as the in-place sediments, about 30 percent solids. Thus, the disposal site volume would be the same as the volume of sediments removed. The solids content of hydraulic dredge spoils was estimated to be 15 percent. Thus, the disposal site volume for hydraulic dredging alternatives would be twice the volume of the sediments removed.

[b]Based upon a hydraulic dredging rate of 120 cubic yards of in-place sediments per hour and 40 hours per week. It was assumed that the productivity of mechanical dredging with a single dragline or clamshell would be only one-third that of hydraulic dredging.

[c]Includes the dredging and disposal cost plus 25 percent for engineering, legal, and administrative fees and contingencies. For dredging alternatives, the total cost is equal to the 20-year present worth. The costs do not include the land acquisition costs for the dredge spoils disposal sites, which may be expected to cost about $2,100 per acre.

Source: SEWRPC.

If the dredging were conducted to a mean depth of five feet, aquatic plant growth in the channel would be only slightly reduced, since water clarity would be sufficient to allow light penetration down to at least the five-foot depth. Furthermore, in the center portion of the Canal, the newly exposed sediments would still be organic and so provide a readily available nutrient supply for heavy plant growth. Thus, if the Anderson Canal was dredged to a mean depth of five feet, aquatic plant control would still be required to improve the navigability and use of the channel. The channel would begin to refill with material at a rate of at least one inch every five to 10 years.

If the dredging were conducted to a mean depth of 10 feet, aquatic plant growth would be greatly reduced. Reduced availability of light would limit plant growth, and the newly exposed sediments would be primarily native mineral soil material with a lower content of organic matter and nutrients than peat or muck. Because smaller amounts of plant material would be deposited in the Canal, the Canal would refill with sediments at a slower rate, probably at an average rate of less than one inch every 10 years.

The water level of Waubeesee Lake could be drawn down over the winter to facilitate the dredging of the Anderson Canal. Drawing down Waubeesee Lake would require pumping of lake water because the elevation of the bottom of the notch in the Waubeesee Lake dam is at about 776.6 feet above NGVD, while most of the bottom elevation of the Anderson Canal is between 772.0 and 773.0 feet above NGVD. Assessment of the practicality of drawdown would require a hydrologic investigation of the Lake to estimate groundwater and surface water contributions during the drawdown period, and to estimate the refill rates following the drawdown. If surface water and groundwater inflow are found to be minimal during the drawdown period, approximately 595 acre-feet of water would need to be pumped from the Lake to lower its level by about five feet, which would expose the existing bed of the Anderson Canal. This pumping would entail a total cost of about $61,000.

Drawdown would consolidate the sediments and improve the access for, and efficiency of, mechanical dredging equipment. A winter dredging project may be expected to have fewer adverse impacts on the ecology of the Lake than would a spring, summer, or fall dredging project. There are several potential risks, however, associated with drawing down Waubeesee Lake. During the drawdown and refilling period, nuisance submergent aquatic plant species such as water milfoil, which invades disturbed areas, may increase in abundance along the shoreline. Some areas may also become infested with dense stands of emergent species such as cattails, which may reduce the use of the shoreline and impede access to the Lake. The diversity and quality of the aquatic plant communities within the environmentally sensitive areas shown on Map 6 may also be adversely affected. Based on this risk of environmental damage to Waubeesee Lake, it was concluded that drawdown of the Lake should not be recommended.

Disposal Alternatives: Locating a dredge spoil disposal site frequently constitutes a serious constraint on the feasibility of a dredging project. Proposals for disposing of dredge spoil on a particular site may generate strong local opposition and may be precluded by local zoning ordinances.

The ultimate selection of a specific site for the disposal of dredge spoil must be based on detailed, site-specific studies carefully evaluating economic, social, environmental, and technological considerations. The conduct of these site-specific studies is costly and time consuming. However, a generalized site selection study can provide useful information on the availability of suitable sites. The findings of such a generalized study as set forth in this report provide an indication of where the most feasible dredge spoil disposal sites may be located and aid in the preparation of preliminary cost estimates.

The identification of potential disposal sites requires the establishment and application of site evaluation criteria. The criteria used should be based on State of Wisconsin regulatory requirements and on sound environmental protection guidelines. For the purpose of the analyses conducted under this study, it was assumed that the dredge spoil would be landfilled at an open disposal site. Dredge spoil could also be used as a soil conditioner or applied to agricultural lands.

Criteria used in the selection of suitable disposal sites included existing and proposed land use, the existence of flood hazard, the existence of primary environmental corridors, soil and slope limitations, areal extent, distance from the dredging site, and distance from a watercourse. The specific criteria used to evaluate potential disposal sites are listed in Table 4. These criteria were applied to the area within about three miles of the Anderson Canal, and based on that application, eight potential dredge spoil disposal sites were identified. All of the sites are located north of the Canal.

The eight potential disposal sites are listed in Table 5. Map 9 shows the location of the sites, including the needed buffer areas. All of the sites except Site 1 would likely make hydraulic dredging economically infeasible because of the relatively long distance the slurry would have to be pumped. All the sites provide ample capacity for the anticipated volume of dredge spoil, except that Sites 1 and 2 would need to be excavated to contain the full amount of dredge spoil expected if the Anderson Canal was dredged to a mean depth of 10 feet.

The analysis indicates that there are several suitable sites available for the placement of dredge spoil removed by mechanical dredging. Further investigations would be needed to evaluate the available sites, as well as the potential economic, social, and environmental impacts related to the use of each site for dredge spoil disposal.

Shoreline Protection: As noted above, about 15 percent of the 6,600-foot-long Anderson Canal shoreline was protected by shore protection structures in 1989, although most of these structures had at least partially failed. In addition, few unprotected shoreline areas in the channel appeared to be unstable. Thus it appears that, under existing conditions there is little need for additional structural protection of the Anderson Canal shoreline, other than continuing to maintain a good vegetative cover at the shore.

Additional shoreline protection may be expected to be required, however, if the channel is dredged or if motorboating activities increase. Dredging activities would steepen and disturb the shoreline slope, create deeper water which would allow larger waves to reach the shore, and reduce dense macrophyte growth which cur-

Table 4

CRITERIA USED TO EVALUATE POTENTIAL DREDGING SPOIL DISPOSAL SITES

Site Conditions	Basis for Elimination of Potential Disposal Sites
Land Use	Residential, commercial, industrial, transportation, communication, utilities, governmental and institutional, recreational, wetland, and surface water
Primary Environmental Corridor	Primary environmental corridors which contain high value woodlands, wetlands, wildlife habitats, and shorelands
Flood Hazard	Land within the 100-year floodplain
Soil Conditions	Soils unsuitable for area-type landfills based on flooding hazard, permeability, depth to water table, depth to bedrock, and slope
Slope Conditions	Slopes greater than 6 percent
Areal Extent	Sites less than one acre
Distance from Dredge Site	Areas greater than a three-mile one-way transportation distance if a mechanical dredging method is used; and greater than one-half mile one-way distance if a hydraulic dredging method is used
Proximity to Wetlands, Watercourses, or Residential Land Uses	Land within 300 feet of a wetland, watercourse, or residential land use

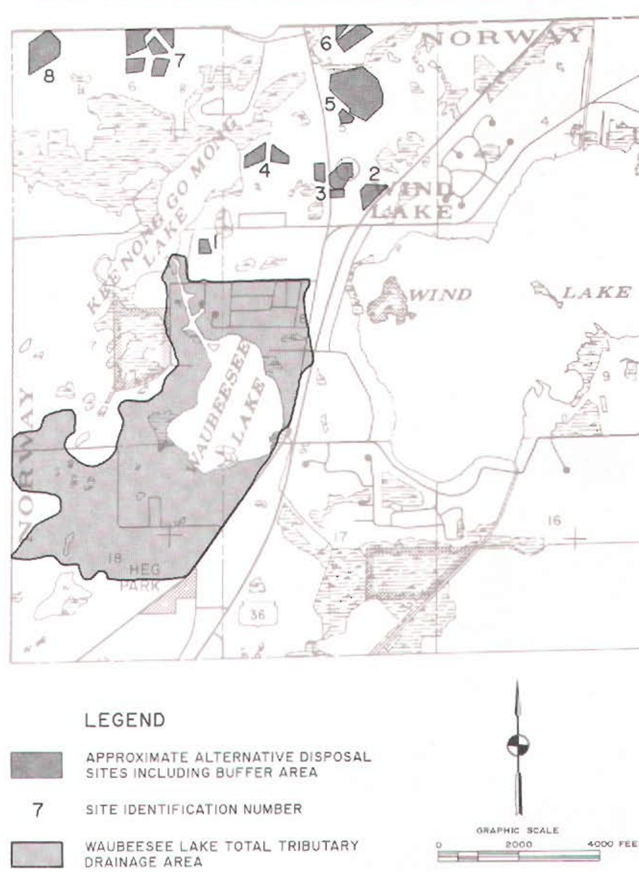
Source: SEWRPC.

rently helps dampen wave action on the shore. Perhaps most important, the operation of mechanical dredging equipment, based on the shore, would destroy the shoreline vegetation and increase the potential for the erosion of the adjacent soils. Motorboating, which may generate larger waves on the Canal than those produced by wind, may increase if improved public access to Waubeesee Lake is provided, especially if such access is located on the Anderson Canal or if the Canal is deepened to allow greater use of the channel by both Lake and Canal residents and by other boaters.

The most appropriate shoreline protection measures for the Anderson Canal would be revetments and bulkheads. Revetments could be constructed of quarry stone, grout-filled vinyl bags, gabions (rock-filled wire baskets), or interlocking concrete blocks. Bulkheads could be constructed of timber, steel sheet pile, or concrete. The establishment of a sand or gravel beach on the Anderson Canal would not be recommended because of the shallow water conditions and the muck and peat bottom substrate. Table 6 summarizes the capital costs of shore protection structures for an inland lake. Annual maintenance costs may be expected to range from 2 to 3 percent of the capital cost.

Map 9

ALTERNATIVE DREDGED MATERIAL DISPOSAL SITES FOR THE ANDERSON CANAL



Source: SEWRPC.

Table 5

POTENTIAL DREDGING SPOIL DISPOSAL SITES

Site Number	Location	Areal Extent of Site (acres)		One-Way Travel Distance (miles)	Existing Land Use	Street Access	Final Dewatered Dredge Spoils Depth (feet)[c]	
		Without Buffer Area[a]	With Buffer Area[b]				5-Foot Channel Depth	10-Foot Channel Depth
1	450 feet north of Long Lake Road, 400 feet east of E. Long Lake Road	1.7	1.9	0.25	Cropland	Long Lake Road	3.3	8.6[d]
2	Adjacent to STH 36, 800 feet north of intersection with Loomis Road	2.2	3.7	1.2	Cropland	STH 36	2.5	6.7[d]
3	Three parcels adjacent to Racine Avenue	13.0	13.2	1.1	Cropland	Racine Avenue	0.4	1.1
4	Two parcels 800 feet west of Racine Avenue, 950 feet north of Lakeview Drive	5.6	11.0	1.6	Cropland	Racine Avenue	0.9	2.6
5	Two parcels 550 feet east of Racine Avenue, 1,000 feet northwest of STH 36	27.0	33.1	1.7	Cropland, open land, pasture	Racine Avenue	0.2	0.5
6	Two parcels 750 feet east of Racine Avenue just south of Muskego Dam Road	7.1	11.0	2.1	Cropland, pasture	Muskego Dam Road	0.8	2.1
7	Five parcels adjacent to Denoon Road, 3,500 feet west of Racine Avenue	20.0	20.4	2.7	Open land	Denoon Road	0.3	0.7
8	Adjacent to Denoon Road, 6,700 feet west of Racine Avenue	18.6	18.8	3.0	Cropland	Denoon Road	0.3	0.8

[a] *Includes only that area which could be used for dredging spoil disposal.*

[b] *Includes that area which could be used for dredging spoil disposal, plus an assumed 300-foot buffer adjacent to residential land, wetland, or a watercourse.*

[c] *Assumes the dredging spoil, once drained, will have a solids content of 70 percent, and that all of the dredge spoils would be placed equally over the entire site, excluding the buffer area.*

[d] *To accommodate spoil depths greater than four feet, additional site excavation would probably be required, thereby increasing the costs of using these disposal sites.*

Source: SEWRPC.

It would appear that the most cost-effective shoreline protection in the Anderson Canal could be provided by quarry stone revetments and by timber bulkheads. These measures have a relatively low cost, can be readily repaired, and do not require heavy equipment for construction. Because the shoreline is low and the wave action modest, the estimated costs may be expected to be $30 per lineal foot for a quarry stone revetment and $40 per lineal foot for a timber bulkhead, as set forth in Table 6.

Shoreline protection measures should not be installed until shoreline erosion problems begin to occur, or until a dredging project is completed. Thus, it is difficult to determine what portion of the Anderson Canal shoreline will actually eventually need protection. However, if it is assumed that all of the existing structures needing repair would be repaired at a unit cost of $15 per lineal foot, and that an additional 1,000 feet of shoreline would be protected by a new quarry stone revetment at a unit cost of $30

Table 6

APPROXIMATE CAPITAL COSTS OF SHORE PROTECTION STRUCTURES FOR INLAND LAKES

STRUCTURE COSTS

Structure	Material	Capital Cost per Foot Installed
Revetment	6 to 9 inch quarry stone 12 to 24 inch quarry stone Grout-filled bags (two bags high) Gabions (rock-filled wire baskets) Flex slab concrete blocks	$ 20-30 30-50 50-70 70-120 30-50
Bulkhead	Timber Steel sheet pile Concrete	$ 40-70 100-150 100-150
Beach System	Sand or gravel blanket (6-inches thick, 10-feet wide)	$ 2-5

UNIT COSTS

	Material	Capital Cost per Unit Installed
Armor Stone	More than 300 pounds (18 inches) 15-300 pounds (6 to 18 inches) Shot rock (blasted-fines to 18 inches)	$15/ton 10/ton 7/ton
Grout-Filled Bags	(20 feet by 6 feet by 2.5 feet)	$75/bag plus $80/ cubic yards of concrete
Gabions	Wire basket, 9 feet by 3 feet by 1 foot 9 feet by 3 feet by 3 feet Rock fill (placed) 125 pounds/cubic foot	$150 each 275 each 25/ton
Flex Slab Concrete Blocks	(2.8 square feet each)	$ 7 each
Bulkhead	Timber Steel Sheet Pile Concrete	$ 7/square foot 15/square foot 200-300/cubic yard
Pea Gravel/Sand	- -	$ 10/ton
Filter Fabric	- -	$1/square foot

NOTE: The above costs are approximate ranges for structures with a life of about 25 years. The actual cost of an individual structure depends on the specific characteristics of the site. All costs are in 1988 dollars.

Source: SEWRPC.

per lineal foot, thereby doubling the total existing shoreline area protected, the estimated capital cost would be $40,600, with an estimated annual maintenance cost of $800. The total cost of this alternative over a 20-year period is about $56,600, with a present worth value of about $49,800.

Recommended Canal Use Management Plan

The recommended plan for the Anderson Canal provides a strategy to abate the sedimentation and nuisance aquatic plant growth problems in the channel, to improve the usability of the channel, and protect valuable ecological resources. The plan includes dredging, macrophyte harvesting, and channel shoreline protection. The recommended plan is shown in graphic summary form on Map 10.

1. Dredging: It is recommended that the entire channel, except for 2.3 acres of environmentally sensitive areas which contain valuable aquatic plant communities and fish spawning habitat, be mechanically dredged to a mean depth of five feet. A total of 4.1 acres of channel would be dredged, or 64 percent of the total channel area.

   A total of 15,800 cubic yards of dredge spoil would be removed from the channel. The project would probably require a minimum of 10 weeks to complete and would probably entail an estimated total capital cost of $64,200.

   As already noted, a number of sites exist in the area that may be expected to be suitable for the disposal of the dredge spoil. Site 1 is located closest to the Canal and would appear to be the most cost-effective disposal site. However, all of the other sites listed in Table 5 should also provide for adequate and environmentally sound disposal of the dredge spoil. The dredge spoil could also be landfilled or applied as a soil conditioner.

   It is further recommended that, within the dredged portion of the channel, pier lengths be restricted to a maximum length of 25 feet in order to prevent the obstruction of navigation through the channel. Pier length limitations would also provide for easy access to the channel for macrophyte harvesting.

2. Macrophyte Harvesting: Macrophyte harvesting is recommended to be conducted on about 2.4 acres, or 36 percent of the total channel area, to improve boat access and to limit the accumulation of dead plant material on the channel bed. It is probable that the harvesting would need to be conducted twice per year. Those areas not harvested would provide suitable habitat for fish and other aquatic life. Use of aquatic herbicides is not preferred, although such chemicals may be used as needed on a limited basis around piers and other heavily used areas where harvesting may not be practical. Harvesting and aquatic herbicide application should be conducted only when absolutely necessary in water depths shallower than about three feet. This shallow nearshore zone should be preserved as valuable habitat for shoreline organisms. Harvesting conducted on a contract basis would entail an annual cost of about $2,500.

3. Shoreline Protection: All existing shoreline protection structures should continue to be maintained, repaired, or reconstructed. In addition, it is recommended that approximately 1,000 lineal feet of new shore protection structures, either quarry stone revetments or timber bulkheads, be installed in order to provide structural protection for a total of about 30 percent of the total channel shoreline, or double the existing protected shoreline length. Shoreline protection, including repair of existing and construction of new structures, would entail a total capital cost of about $40,600, with an estimated annual maintenance cost of $800.

4. Environmentally Sensitive Lands Protection: As discussed in the next section of this report, it is recommended that primary environmental corridor lands in the Waubeesee Lake watershed be preserved in essentially natural open space. This includes some lands in the Anderson Canal direct drainage area, shown on Map 7.

The recommended plan for the Anderson Canal is intended to provide a usable, well-protected and well-managed channel, and to preserve the existing valuable ecological resources present in the channel. The estimated cost of the recommended plan is summarized in Table 7. The plan would entail a total capital cost of approximately $104,800 and an annual operation and maintenance cost of about $3,300.

The dredging and shoreline protection elements of the recommended plan could be implemented as a single major project, or the plan could be implemented over a five-to-ten-year period. Macrophyte harvesting should be conducted as needed. Implementation of this plan would enhance the overall quality of the Anderson

Map 10

RECOMMENDED PLAN FOR THE ANDERSON CANAL

Source: SEWRPC.

Table 7

RECOMMENDED MANAGEMENT PLAN COSTS FOR THE ANDERSON CANAL

Plan Element	Upstream				Downstream			
	Capital		Annual Operation and Maintenance		Capital		Annual Operation and Maintenance	
	Cost	Percent of Total	Cost	Percent of Total	Cost	Percent of Total	Cost	Percent of Total
1. Mechanical Dredging and Disposal of Dredge Spoils	$12,840	61.3	$ - -	- -	$51,360	61.3	$ - -	- -
2. Macrophyte Harvesting	- -	- -	500	75.8	- -	- -	2,000	75.8
3. Shoreline Protection	8,120	38.7	160	24.2	32,480	38.7	640	24.2
Total	$20,960	100.0	$660	100.0	$83,840	100.0	$2,640	100.0

Source: SEWRPC.

Canal and provide easy boat access for local property owners to Waubeesee Lake or Kee Nong Go Mong Lake.

WAUBEESEE LAKE USE PLAN

Introduction

Waubeesee Lake is a relatively clean, deep, flow-through lake which offers excellent recreational opportunities and has comparatively few environmental or ecological problems. The Lake has a surface area of about 129 acres. However, because of increased urban development in the Lake's watershed and because of an increasing demand for access to high-quality, water-based recreational opportunities in southeastern Wisconsin, there are stresses on the Lake's still essentially healthy ecosystem, the Lake's water quality is being threatened, and lake use conflicts may occur.

It is important to note that this report does not represent a comprehensive water quality management plan for Waubeesee Lake. Such a comprehensive plan, an example of which is set forth in SEWRPC Community Assistance Planning Report No. 58, A Water Quality Management Plan for Pewaukee Lake, Waukesha County, Wisconsin, 1984, requires a great deal of water quality and biological data collection and analysis as well as a detailed assessment of the lake's watershed characteristics. Only after such a complete inventory and analysis can a management plan be prepared which specifies the land use, pollution control, and in-lake management techniques needed to protect or enhance a lake's water quality. Instead, the scope of this report is limited to consideration of those management measures which can be identified based on the currently available data, which can be readily undertaken by local governmental officials or by lakeshore property owners, and which directly affect the use of Waubeesee Lake.

Existing Conditions

Information available in the files of the Wisconsin Department of Natural Resources and of the Regional Planning Commission was supplemented by some special field surveys to help assess the existing condition of Waubeesee Lake. Field surveys of shore bottom sediments, aquatic vegetation, environmentally sensitive areas, and existing shoreline protection measures were conducted by the Commission staff in the summer of 1989.

Physical Characteristics: Waubeesee Lake, 129.4 acres in area, has a mean water depth of 18.9 feet and a maximum water depth of 73 feet.

About 37 percent of its area has a depth greater than 20 feet. The hydrographic characteristics of the Lake are shown on Map 11.

Much of the Waubeesee Lake nearshore shallow areas are underlain by sand or gravel, especially on the eastern and western shores. Marl dominates the bottom beneath most areas with a water depth of between three and 10 feet. Areas of deeper water, greater than 10 feet, are underlain primarily by muck. The shallow-water bottom sediment types are suitable for spawning by a variety of desirable fish species; they help limit the amount of aquatic plant growth in the Lake; and they are nearly ideal for a wide range of recreational activities, like swimming, wading, waterskiing, and fishing. Thus, the bottom sediments strongly influence the overall character and quality of the Lake.

Aquatic Vegetation: As shown on Map 12, diverse communities of emergent, submergent, attached-floating, and free-floating vegetation form a moderate or dense cover a relatively small portion of Waubeesee Lake, about 14.8 acres, or about 11 percent of the Lake's total area. About 14.1 acres of adjacent wetlands also provide valuable habitat for fish and wildlife. The aquatic plant growth is apparently limited by the abundance of nutrient-poor sand, gravel, and marl deposits and by the low-to-moderate nutrient concentrations in the water. Water clarity is not a limiting factor, with Secchi disk readings approximating 13 feet. Chara species, an attached alga, covers much of the Lake's bottom in water depths less than about nine feet, but forms a mat which does not extend far off the bottom. Chara thus does not interfere with most lake uses. The predominance of Chara may be attributed to its ability to obtain nutrients primarily from the water, rather than from the bottom sediments.

Aquatic macrophyte species identified by the Wisconsin Department of Natural Resources in 1987, and by the Regional Planning Commission in 1989, are listed in Table 8. A good variety of vegetation was identified, including 15 emergent, 14 submergent, two attached-floating, and three free-floating plant species.

Myriophyllum spicatum, or spiked water milfoil, also referred to as Eurasian water milfoil, was common but not dominant in most areas. Spiked water milfoil is becoming dominant in many lakes in southeastern Wisconsin, especially in lakes which are nutrient enriched and lakes in which the aquatic plant beds have been disturbed. The increased dominance of the water milfoil is due to the efficient dispersal and reproductive capabilities of this species. These perennial plants overwinter as green shoots, enabling them to grow rapidly in spring. Milfoil branches extensively and creates thick growth which obstructs navigation and shades out other plants. This plant can draw nutrients from either the water column or bottom sediments and can endure reduced light intensities beneath an ice cover or an algal bloom. Milfoil also has a long growing season, extending from April into September. Growth from shoot fragments ensures rapid recovery following treatment with aquatic herbicides or harvesting.

Fishery Resources: Fishing is one of the most popular uses of Waubeesee Lake. The Wisconsin Department of Natural Resources reports that the Lake receives moderately heavy fishing pressure, and that as many as 16 fishing boats have been observed on the Lake at one time. From the 1930s through the 1950s, several fish species, including largemouth bass, walleye, and brown trout, were stocked in Waubeesee Lake. No more recent stocking has been reported. In 1987, the Department surveyed the fish populations in Waubeesee Lake using fyke nets, seine nets, and electric shocking equipment. A total of 20 species of fish were identified in Waubeesee Lake, as listed in Table 9. The Department surveys indicated that the fish community was diverse and healthy. The panfish population, dominated by bluegill, contained some fish longer than nine inches. The populations of the dominant predators, largemouth bass and northern pike, were excellent, with several fish caught exceeding four pounds in weight. Map 13 shows generalized prime spawning areas suitable for use by largemouth bass and northern pike in Waubeesee Lake. Although rough fish, such as carp, were present, there were no indications of rough fish problems.

According to lake residents, largemouth bass is the predator species most popular among anglers. Bass spawn between late April and early July on a sand or gravel substrate. Such a substrate covers about 9.9 acres, or about 8 percent of the bottom of Waubeesee Lake. Fingerling bass feed primarily on microcrustaceans, copepods, cladocerans, and ostracods.

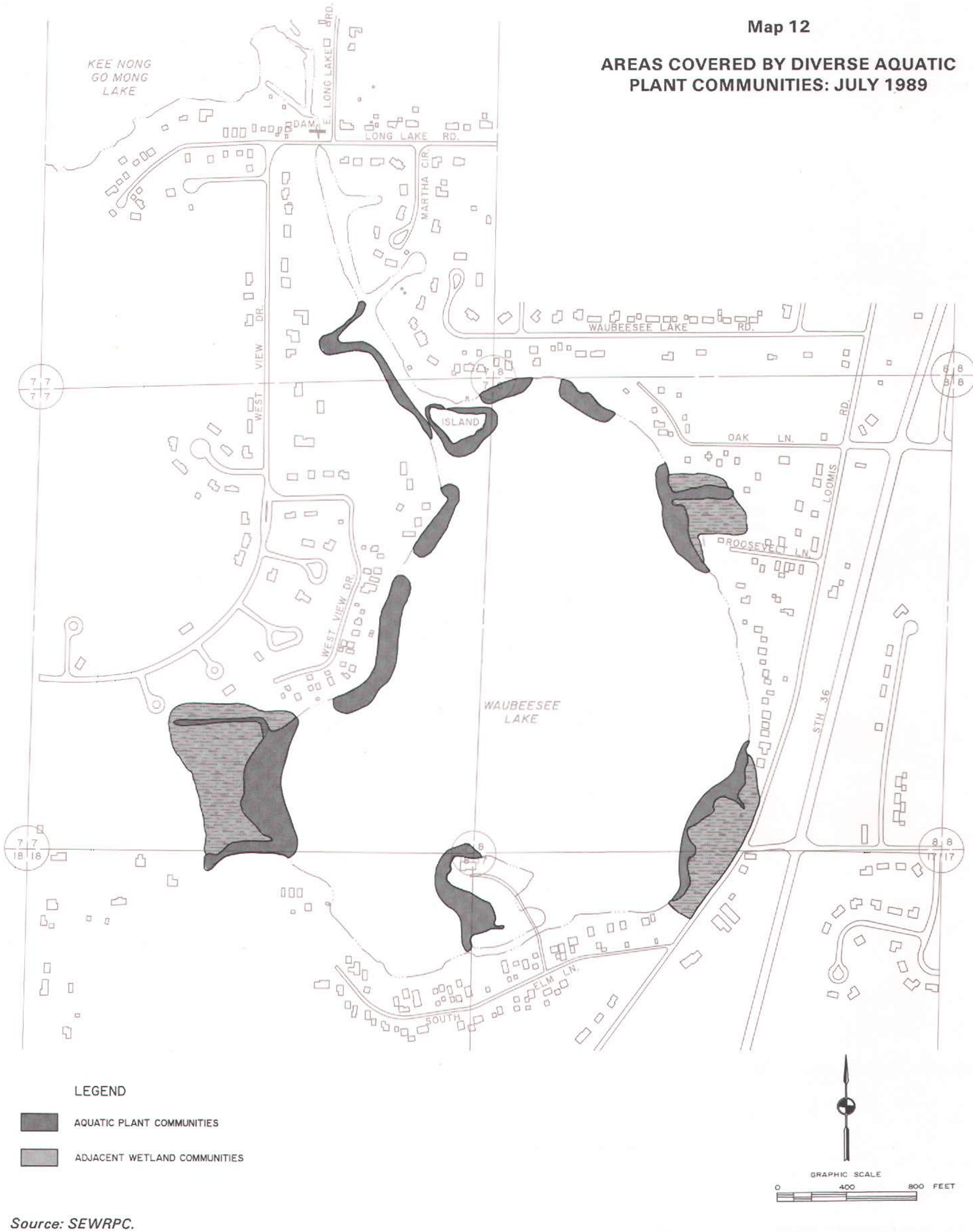
Map 11

HYDROGRAPHIC MAP OF WAUBEESEE LAKE, RACINE COUNTY, WISCONSIN

Source: Wisconsin Department of Natural Resources.

Map 12

AREAS COVERED BY DIVERSE AQUATIC PLANT COMMUNITIES: JULY 1989



Source: SEWRPC.

Table 8

AQUATIC MACROPHYTES IDENTIFIED IN WAUBEESEE LAKE: 1987 AND 1989

Scientific Name	Common Name	DNR July 23, 1987	SEWRPC July 27, 1989
Emergent Vegetation			
Typha latifolia	Broad-leaved cattail	- -	X
Typha angustifolia	Narrow-leaved cattail	X	- -
Sparganium eurycarpum	Common bur reed	X	X
Alisma plantago-aquatica	Water plantain	- -	X
Sagittaria latifolia	Common arrowhead	X	X
Eleocharis sp.	Spike rush	- -	X
Carex aquatilis	Aquatic sedge	- -	X
Scirpus americanus	Chairmakers rush	X	X
Scirpus validus	Soft-stemmed bulrush	X	X
Pontederia cordata	Pickerelweed	X	- -
Decodon verticilliatus	Water willow	- -	X
Iris versicolor	Blue flag iris	X	- -
Polygonom sp.	Water knotweed	X	- -
Lythrum salicaria	Purple loosestrife	X	X
Lysimachia terrestris	Swamp candles	X	- -
Floating Leaf-Attached Vegetation			
Nuphar variegatum	Yellow water lily	X	X
Nymphaea odorata	White water lily	X	X
Free-Floating Vegetation			
Lemna trisulca	Forked duckweed	X	- -
Lemna minor	Lesser duckweed	X	X
Wolfia sp.	Watermeal	X	X
Submergent Vegetation			
Potamogeton richardsonii	Richardson's pondweed	X	X
Potamogeton crispus	Curly pondweed	- -	X
Potamogeton zosteriformis	Flat-stemmed pondweed	X	- -
Potamogeton pectinatus	Sago pondweed	X	X
Potamogeton americana	American pondweed	X	X
Potamogeton nodosus	Long-leaved pondweed	X	- -
Potamogeton sp.	Pondweed	- -	X
Naias minor	Brittle pondweed	X	- -
Naias quadalupensis	Southern naiad	X	- -
Naias sp.	Naiad	- -	X
Vallisneria americana	Wild celery	X	X
Elodea canadensis	Elodea	X	- -
Ceratophyllum demersum	Coontail	X	X
Myriophyllum spicatum	Spiked water milfoil	X	X

Source: Wisconsin Department of Natural Resources and SEWRPC.

Larger bass feed on insects, other fish, crayfish, and frogs. Although bluegills often become overpopulated and stunted where bass are the primary predator species in a lake, this condition has apparently not occurred in Waubeesee Lake.

Northern pike spawn between late March and early April, as soon as ice breakup occurs. Spawning sites are located in shallow, flooded wetlands adjacent to lakes or in inlet streams to the lakes. Such potential northern pike spawning areas cover about 6.6 acres of the Lake itself, or about 5 percent of the Lake's total area, plus about 4.6 acres of adjacent wetlands. Young pike feed primarily on zooplankton and insects. Although adult northern pike are normally present in natural environments in low densities, they have voracious appetites. The greatest management concern with regard to northern pike is that pike spawning grounds be destroyed by dredging, filling, shoreline development, and motorboating activities.

Recreational Uses: Waubeesee Lake is well suited for a variety of water-based recreational activities. During the summer, the Lake is used for swimming and wading; boating with sailboats, motorboats, pontoon boats, and other pleasure craft; waterskiing; fishing; and nature study and enjoyment. Although fishing occurs throughout the Lake, the most heavily fished areas are those near or within macrophyte beds or other shallow areas. Prime swimming areas are those with few macrophytes and a firm sand bottom. Because Waubeesee Lake contains relatively few dense macrophyte beds or very shallow areas, nearly 60 percent of the Lake's area is suitable for all types of boating activity, including fast motorboating and waterskiing. During the winter, Waubeesee Lake is used for ice fishing, ice skating, cross-country skiing, and snowmobiling. During the fall, limited hunting, primarily for ducks, occurs near some of the adjacent wetlands.

In part because there is no improved public access to Waubeesee Lake, the vast majority of users are lakeshore residents. Nearly all the Lake's residents are year-round residents, few of the homes are only seasonally used. Because access to the Lake is limited, overcrowding or excessive use is not common.

Two types of surveys were conducted to investigate the present recreational use of Waubeesee Lake. A boat count detailing activities people were participating in at any one time was taken on Sunday, July 29, 1990, by Tri-Lakes Conservation, Inc. In addition, the type and number of boats and watercraft moored on the Lake and docked onshore were noted. The survey indicated that pleasure boating and swimming were the most popular activities, making up 61 percent of the activities counted, as shown in Figure 4.

A total of 280 boats and watercraft were docked or moored on Waubeesee Lake in the summer of 1990. Most boats, about 44 percent, were rowboats, as shown in Figure 5. Powerboats constituted about 24 percent of the total.

Land Use: As of 1985, and as shown on Map 7 and presented in Table 10, urban land uses occupied about 30 percent of the 708-acre direct drainage area to Waubeesee Lake, which includes the drainage area to the Anderson Canal. Primary environmental corridor lands covered 22 percent of the area, and other open land uses occupied about 27 percent of the direct drainage area. About 2 percent of the drainage area is an isolated natural area which contains particularly valuable natural resources not

Table 9

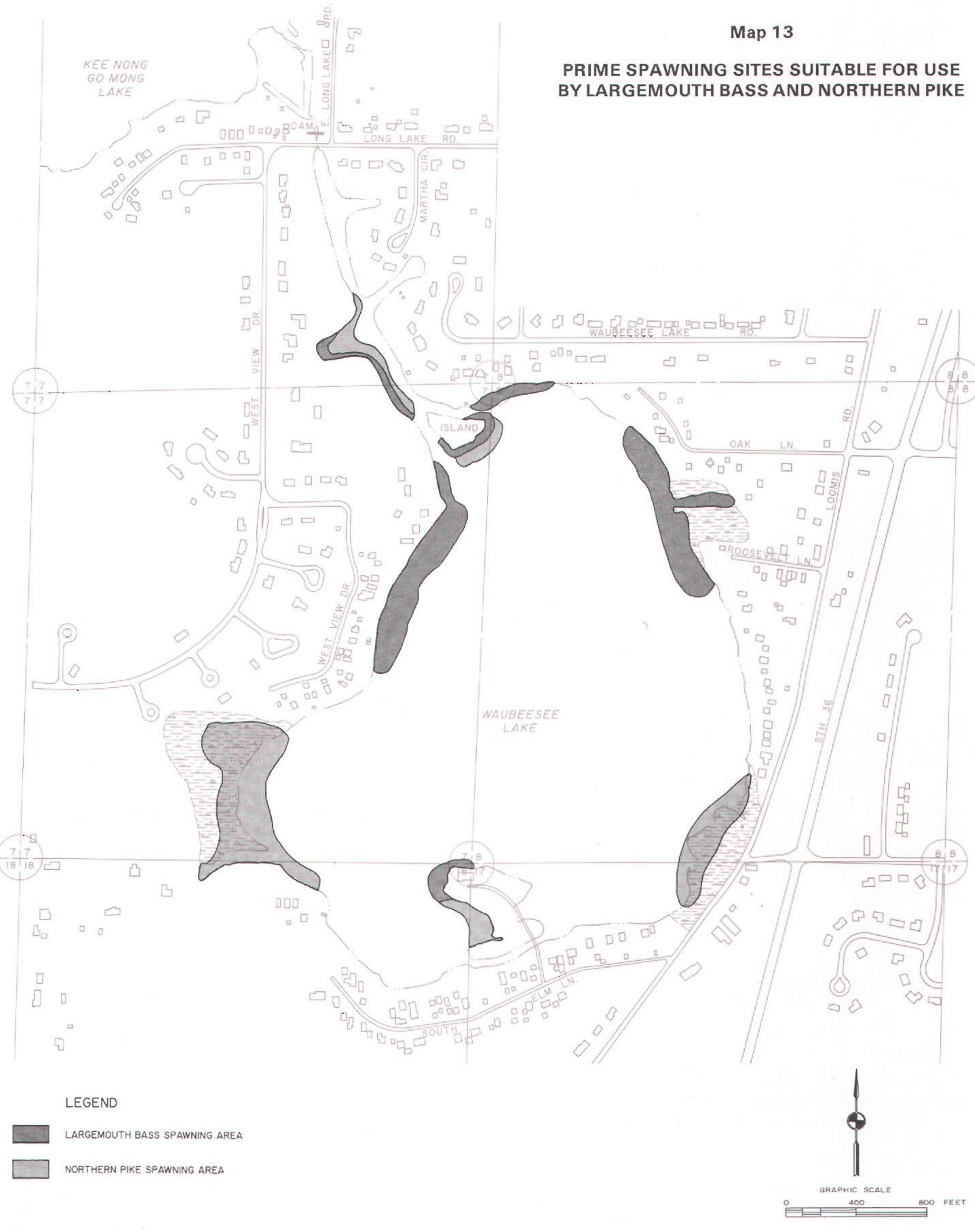
FISH SPECIES IDENTIFIED IN WAUBEESEE LAKE: 1987

Scientific Name	Common Name
1. Ambloplites rupestris	Rock bass
2. Amia calva	Bowfin
3. Carpiodes cyprinus	Quillback carpsucker
4. Cyprinus carpio	Carp
5. Erimyzon sucetta	Lake chubsucker
6. Esox americanus vermiculatus	Grass pickerel
7. Esox lucius	Northern pike
8. Ictalurus melas	Black bullhead
9. Ictalurus natalis	Yellow bullhead
10. Labidesthes sicculus	Brook silverside
11. Lepisosteus osseus	Longnose gar
12. Lepomis cyanellus	Green sunfish
13. Lepomis gibbosus	Pumpkinseed
14. Lepomis gulosus	Warmouth sunfish
15. Lepomis macrochirus	Bluegill
16. Micropterus salmoides	Largemouth bass
17. Notemigonus crysoleucas	Golden shiner
18. Perca flavescens	Yellow perch
19. Pomoxis nigro-maculatus	Black crappie
20. Umbra limi	Mudminnow

Source: Wisconsin Department of Natural Resources.

Map 13

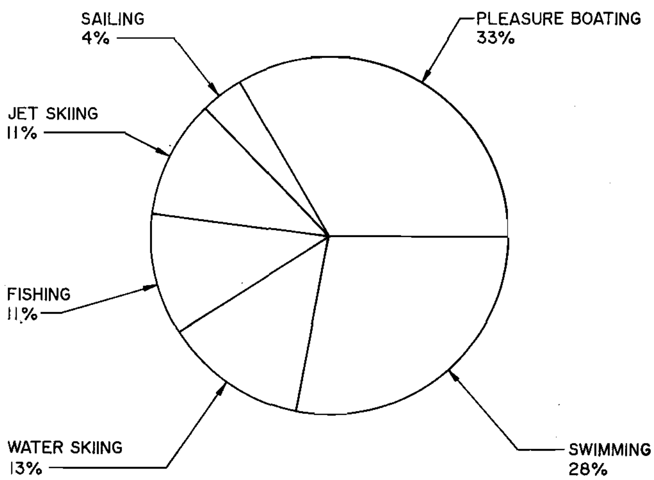
PRIME SPAWNING SITES SUITABLE FOR USE BY LARGEMOUTH BASS AND NORTHERN PIKE



Source: SEWRPC.

Figure 4

WAUBEESEE LAKE BOATING USE SURVEY: 1990

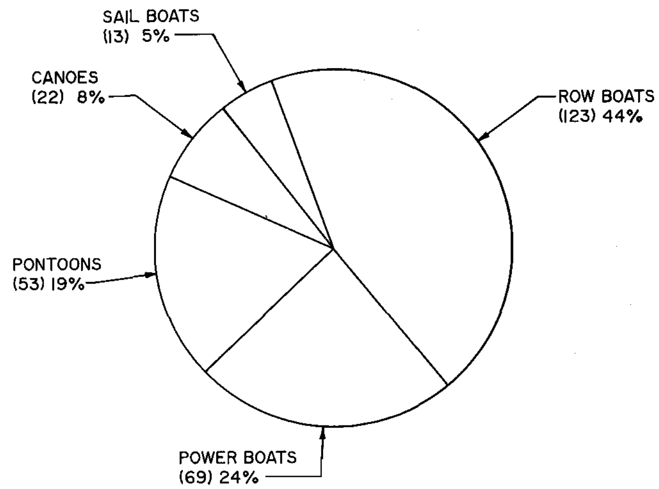


AVERAGE NUMBER OF WATER CRAFT ON LAKE AT ONE TIME: 12

Source: Tri-Lakes Conservation, Inc.

Figure 5

RESIDENT BOATS AND WATERCRAFT DOCKED OR MOORED ON WAUBEESEE LAKE: 1990



TOTAL NUMBER OF RESIDENT BOATS AND WATER CRAFT: 280

Source: Tri-Lakes Conservation, Inc.

located within the environmental corridor. Surface water covered the remaining 19 percent of the direct drainage area to the Lake.

The Commission's year 2010 planned land use conditions for the direct drainage area to Waubeesee Lake are also shown on Map 7. Under that plan, urban land use would increase by about 30 percent, to occupy a total of about 38 percent of the drainage area. Primary corridor lands, surface water areas, and the isolated natural area would be preserved in essentially natural open uses, although about 33 percent of the other open lands would be converted to urban use.

Pollution Loadings and Sources: Pollutant loadings are contributed to Waubeesee Lake from the Kee Nong Go Mong Lake outlet and from a 708-acre direct tributary drainage area. Waubeesee Lake discharges to the Wind Lake Drainage Canal. The two pollutants of greatest concern with respect to the water quality of Waubeesee Lake are sediment and phosphorus.

A water quality analysis previously conducted by the Regional Planning Commission for the Town of Norway concluded that uncontrolled erosion from construction of a major subdivision may constitute a major pollution source, accounting for up to 25 percent of the total phosphorus load and over 65 percent of the total sediment load contributed to the Lake during the construction period.[3] Of particular concern was potential damage to a valuable seven-acre wetland located in the southwest portion of the Lake. Sediment deposition can cover and smother benthic organisms, eggs and larvae, and food supplies for fish. That analysis stressed the importance of controlling erosion from construction sites.

In the past, construction site erosion has been a major source of pollution to the Lake; the impacts are greatest when a major subdivision is under construction near the Lake. The Town of Norway has adopted a construction erosion control ordinance to attempt to reduce pollutant loadings from these sites. Table 11 presents estimates of existing phosphorus and sediment loadings to Waubeesee Lake. The area of urban

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[3]*Letter from Mr. Kurt W. Bauer, Executive Director, Southeastern Wisconsin Regional Planning Commission, to Mr. John L. Malchine, Chairman, Town of Norway, September 7, 1988.*

Table 10

EXISTING 1985 AND PLANNED YEAR 2010 GENERALIZED LAND USE IN THE DIRECT DRAINAGE AREA TO WAUBEESEE LAKE

Land Use	1985		1985-2010 Change (acres)	2010	
	Acres	Percent of Total		Acres	Percent of Total
Urban	209	29.5	63	272	38.4
Primary Environmental Corridor	158	22.3	- -	158	22.3
Surface Water	137	19.4	- -	137	19.4
Isolated Natural Area[a]	12	1.7	- -	12	1.7
Other Open Lands	192	27.1	-63	129	18.2
Total	708	100.0	- -	708	100.0

[a] *Includes woodlands, wetlands, or other valuable natural resources not located within an environmental corridor.*

Source: SEWRPC

land expected to be under development in an average year, about three acres, is based on the Commission's year 2010 optimistic population and employment growth, centralized land use development scenario. Over the planning period, construction site erosion may be expected to contribute about one-fourth of the total sediment load to the Lake if erosion control measures are not implemented. The major sources of pollution to Waubeesee Lake, in addition to construction site erosion, include outflow from Kee Nong Go Mong Lake and runoff from agricultural land.

Shoreline Erosion: Erosion of the Waubeesee Lake shoreline results in the loss of land, in damage to lakeside buildings and facilities, and in interference with access to, and use of, the shoreline. Such erosion is primarily caused by wind-generated waves, by motorboating activities, and by ice action. To protect the shoreline, most property owners have constructed revetments or bulkheads, or created sand or gravel beaches at the shoreline.

A total of 97 shore protection structures were surveyed on Waubeesee Lake by the Commission staff in July of 1989. These 97 structures, consisting of 57 revetments, 31 bulkheads, and nine beaches, covered about 5,650 lineal feet, or 35 percent of the total shoreline of Waubeesee Lake. Of the 97 structures surveyed, 44 structures, or 45 percent, required some type of repair or reconstruction. Most of the structures needing repair were either partially collapsed, or constructed of improper material. Map 14 shows the location of shore protection structures in Waubeesee Lake in 1989 and identifies those structures in need of repair.

Lake Use Problems and Concerns

Although Waubeesee Lake is in good condition and is capable of supporting a wide variety of water uses, there are a number of existing and potential future problems which warrant concern. These problems or issues of concern include the protection of environmentally sensitive areas, construction site erosion control, boating and fishing demands, improved public access to the Lake, and continued protection of the shoreline.

Environmentally Sensitive Areas: Environmentally sensitive areas that have been identified in this report include portions of Waubeesee Lake or the Anderson Canal which support important biota or contain valuable habitat, wetlands which lie adjacent to the Lake, and primary environmental corridors within the Lake's drainage area. Critical sites within Waubeesee

Table 11

ESTIMATED EXISTING ANNUAL TOTAL PHOSPHORUS AND SEDIMENT LOADS TO WAUBEESEE LAKE: 1985

Source	Extent	Phosphorus		Sediment	
		Pounds per Year	Percent of Total	Pounds per Year	Percent of Total
Direct Tributary Loadings					
Urban Land (acres)	209	50	6.9	12,500	5.4
Urban Land Under Development[a] (acres)	3.0	39	5.4	60,000	25.8
Agricultural Land (acres)	155	133	18.3	70,700	30.4
Woodlands, Wetlands, and Other Natural Areas (acres)	204	8	1.1	5,100	2.2
Septic Systems[b] (number)	103	30	4.1	2,200	0.9
Atmospheric Contribution (acres of surface water)	137	18	2.5	25,800	11.1
Subtotal	- -	278	38.3	176,300	75.8
Upstream Loadings					
Kee Nong Go Mong Lake Outlet	- -	450	61.7	56,400	24.2
Total	- -	728	100.0	232,700	100.0

[a]*Average land area under development based on the Commission year 2010 optimistic population and employment growth, centralized land use development scenario. Assumes no significant control of construction site erosion.*

[b]*Includes only those systems located on soils identified in the regional soil survey as having severe or very severe limitations for disposal of septic tank effluent.*

Source: SEWRPC.

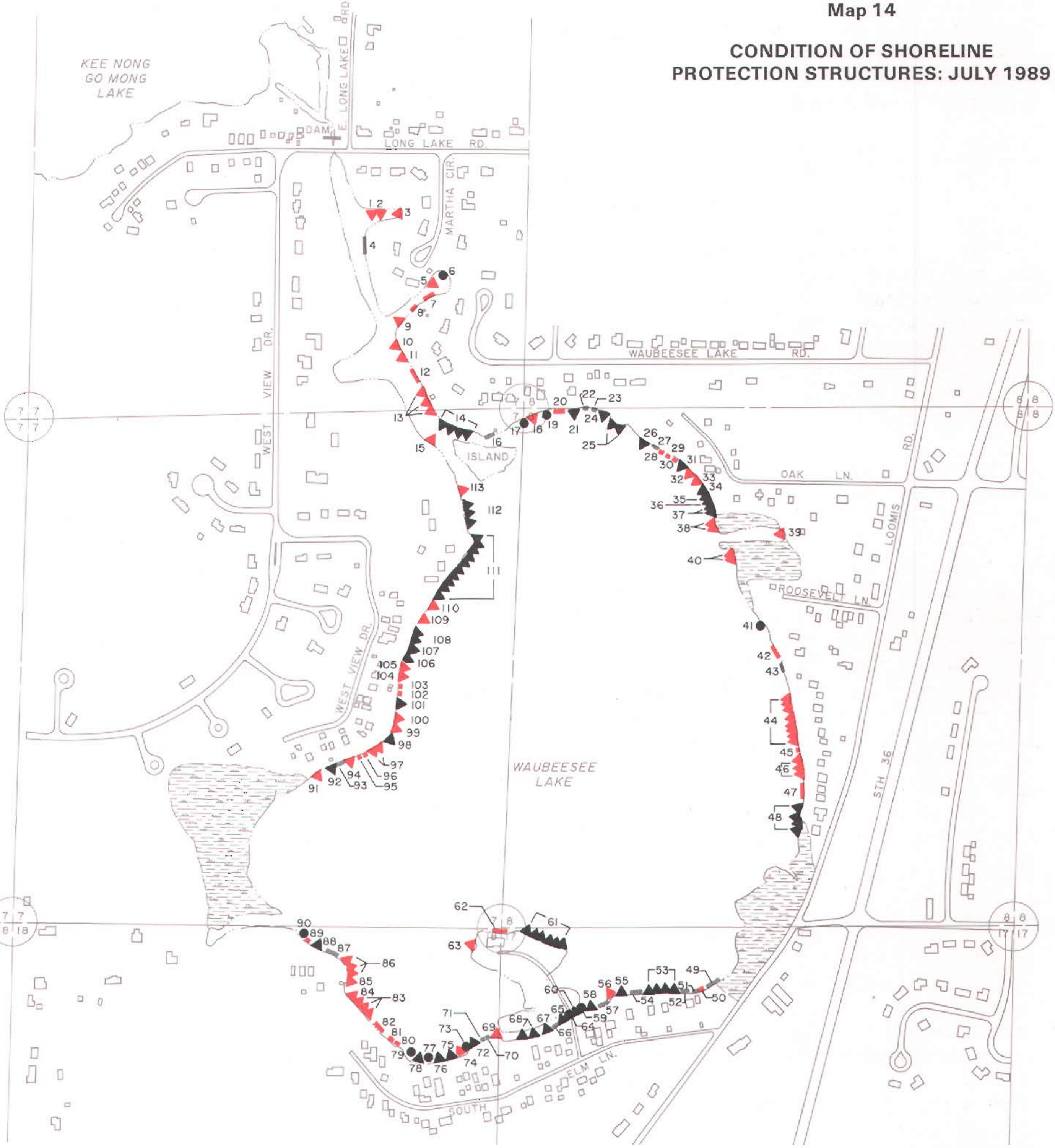
Lake include prime fish spawning habitats, macrophyte beds, and the shoreline bays and channels which support productive aquatic life.

Three wetlands adjacent to Waubeesee Lake were also identified as important environmental assets. These wetlands are used for fish spawning purposes, especially during spring high-water periods; to provide wildlife habitat; to create a natural shoreline appearance; and to filter pollutants entering the Lake. The environmentally sensitive areas within Waubeesee Lake and the adjacent wetlands should be protected from disturbance, increased pollution, and improper use.

The primary environmental corridors in the direct drainage area to Waubeesee Lake contain almost all the best remaining woodlands, wetlands, and wildlife habitat areas in the watershed of the Lake. The protection of the primary environmental corridors from additional intrusion by incompatible land uses, and thereby from degradation and destruction, and the

Map 14

CONDITION OF SHORELINE PROTECTION STRUCTURES: JULY 1989



LEGEND

- ▲ REVETMENT NOT IN NEED OF REPAIR
- ▲ REVETMENT IN NEED OF REPAIR
- BULKHEAD NOT IN NEED OF REPAIR
- BULKHEAD IN NEED OF REPAIR
- ● BEACH
- 7 STRUCTURE IDENTIFICATION NUMBER

Source: SEWRPC.

preservation of these corridors in an essentially open, natural state, is essential to the maintenance of a high level of environmental quality, to the protection of the remaining natural beauty, and to provide valuable recreational opportunities in the watershed.

Construction Site Erosion: Erosion from new urban construction in its direct tributary drainage area to Waubeesee Lake appears to represent a significant threat to the Lake's water quality conditions. Analyses conducted by the Commission staff indicate that substantial new urban development may be expected to occur in the watershed of the Lake. In the past, adequate erosion control measures were not voluntarily implemented by subdivision developers. Pollutant loadings from these construction sites had a substantial impact on the Lake's environment.

As noted above, the Town of Norway has adopted a new construction site erosion control ordinance. Proper enforcement of this ordinance is needed to ensure that appropriate measures are taken to reduce sediment and nutrient contributions to the Lake from construction sites. The Wisconsin Department of Natural Resources report, Wisconsin Construction Site Best Management Practice Handbook, 1989, describes methods of controlling construction site erosion and presents a model ordinance prepared by the Department in cooperation with the League of Wisconsin Municipalities. Department staff have estimated that conformance with the model ordinance may be expected to reduce sediment loadings from construction sites by up to 75 percent.

Boating and Fishing Demands: While boating and fishing demands have apparently not exceeded the capacity of Waubeesee Lake at this time, overcrowding and excessive use have plagued other lakes in the area. Indeed, recreational demands on a lake offering high quality recreational opportunities and located within about a one-hour drive from Milwaukee and about a two-hour drive from Chicago may be expected to increase substantially in the foreseeable future.

If the pressure from anglers increases to the point that the demand exceeds the sustaining capacity of the fishery resource, the predator base could be depleted, a stunted panfish problem could develop, and rough fish could increase in abundance. Such impacts would have long-term, and perhaps irreversible, effects on the existing balanced fishery. Excessive boating levels, especially involving fast motorboats, could intensify the risk of boating accidents, increase wave action with a resulting increase in shoreline erosion, interfere with other desired lake uses, damage valuable environmentally sensitive areas, and reduce the overall enjoyment of the Lake by the present users of the Lake. To accommodate the potential increase in fishing and boating, efforts should be undertaken to define the levels of fishing and boating use which the Lake may tolerate, to limit the increases to within acceptable levels, and to minimize any adverse impacts which do occur by carefully coordinating water access arrangements, boating regulations, and fish management activities.

Public Access: There currently are no improved public sites which allow access to Waubeesee Lake. The only publicly owned shoreline is a 0.93-acre parcel purchased by the Wisconsin Department of Natural Resources in July 1977. This parcel, shown on Map 15, is located on the Anderson Canal, just south of Long Lake Road.

Chapter NR 1 of the Wisconsin Administrative Code provides guidelines for determining the adequacy of public access to waterways. The adequacy of public access is considered by the Wisconsin Department of Natural Resources in awarding development grants, in developing facilities adjacent to a water body, and in providing management services such as fish management activities. Guidelines set forth in NR 1 state that the public should be able to park within reasonable walking distances, in no case more than one-quarter mile, from the lake; that adequate automobile and boat trailer parking be provided where boating is involved; that the parking capacity of an access site should be properly related to the size of the lake, following the general guideline of not more than one parking unit for each 10 acres of water surface; and that a minimum access width of 60 feet should be provided.

In 1988, the Wisconsin Department of Natural Resources established a procedure to prioritize public access needs and access development projects.[4] In 1989, this procedure was applied to

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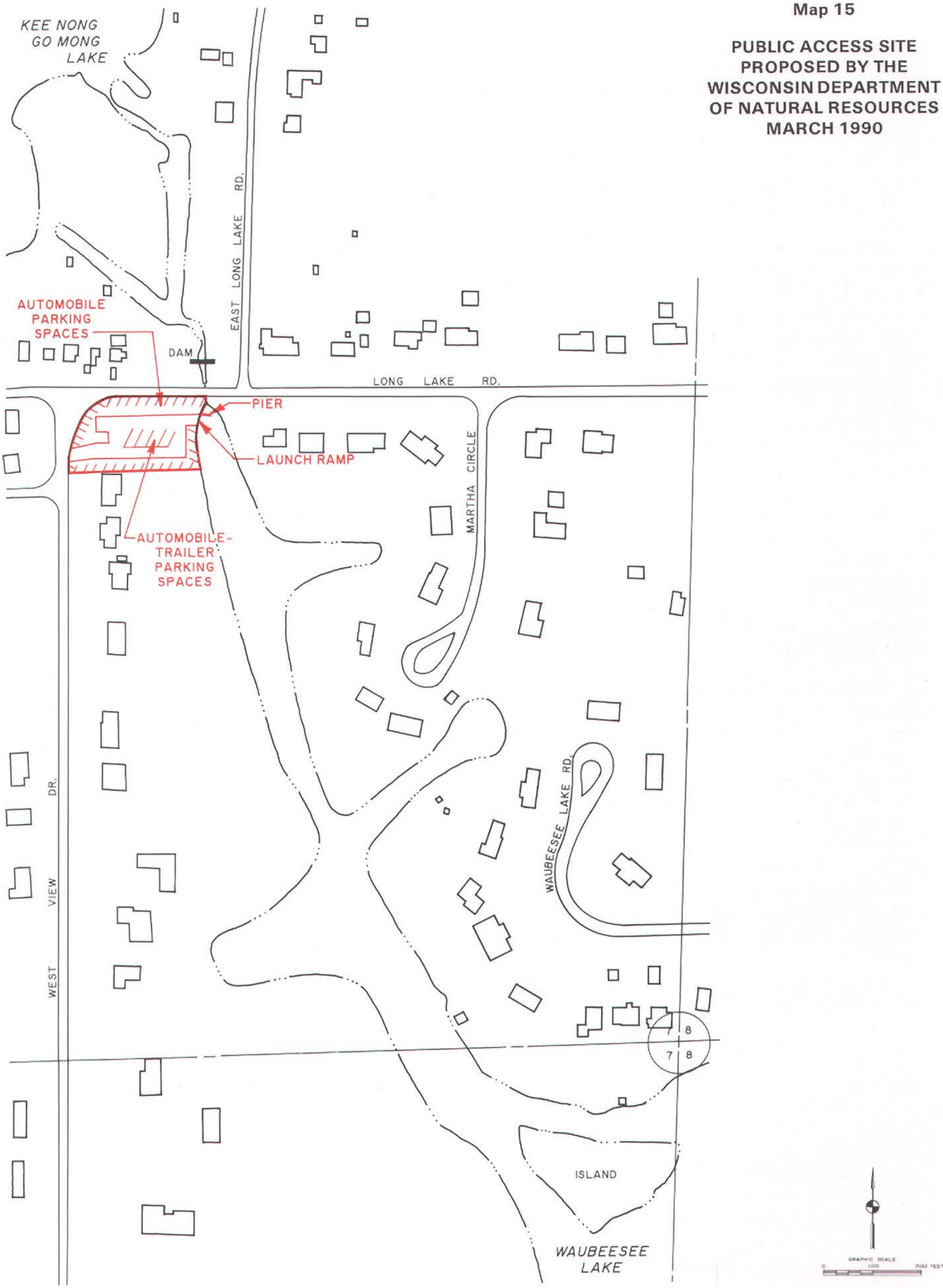
[4] *Wisconsin Department of Natural Resources, Wisconsin Access Policy for Navigable Bodies of Water, Draft, December 1988.*

Map 15

PUBLIC ACCESS SITE
PROPOSED BY THE
WISCONSIN DEPARTMENT
OF NATURAL RESOURCES
MARCH 1990



Source: Wisconsin Department of Natural Resources.

the lakes in the State and high, medium, and low priorities for access development were established.[5] The Department's evaluation of Waubeesee Lake indicated that although the total surface area of the Lake is 129 acres, there are only 74 acres of water usable for sailboating, fast motorboating, and waterskiing. The Department concluded that there were 10 existing public parking spaces within one-quarter mile walking distance of the Lake for automobiles alone, but no spaces for automobiles with boat trailers. The Lake was found to have an inadequate existing public access but a high recreational use potential. Overall, Waubeesee Lake was assigned a high priority for development of an improved public access.

Over the past decade, the Wisconsin Department of Natural Resources has made several proposals to develop an improved means of public access to Waubeesee Lake. Some of these proposals included walk-in access only, while others included parking for automobiles with boat trailers and an improved boat launch. According to Department staff, all of these proposals for improved access to Waubeesee Lake have been opposed by lake residents and by Town of Norway officials.

The Department is currently preparing plans to provide an improved means of access on Department property on the Anderson Canal. The preliminary plan is shown on Map 15. The access, as proposed by the Department in March 1990, would consist of six parking units, four for automobiles with boat trailers and two for automobiles alone, plus a boat launch ramp and pier. The public access site would not contain a swimming beach. Thus, under the Department's proposal, up to six additional motorboats or sailboats could use Waubeesee Lake at any one time.

There are two primary concerns about the provision of a means of public access as proposed by the Department of Natural Resources. The first concern relates to the location of the access. An increase in motorboat traffic in the Anderson Canal may be expected to resuspend the soft, flocculent bottom sediments in the Canal, which would possibly contribute to the covering of desirable benthic environments, the release of nutrients from the sediments, and an increase in oxygen consumption. About five acres of environmentally sensitive habitat located either in the Canal or in Waubeesee Lake near the mouth of the Canal may be expected to be frequently disturbed or damaged by the effects of boats launched at the access site. These boating effects include increased wave action, the cutting of aquatic plants by propellers, disturbance of the bottom sediments, and possible leakage of gasoline and lubrication oil. The depth of mixing or disturbance caused by motorboats varies with the size of the engine, ranging from less than five feet for small engines to 15 feet for 50 horsepower engines.[6] In shallow shore areas with a water depth less than five feet, as exists in the Anderson Canal and nearshore Waubeesee Lake, increased turbidity and floating matter have been observed to persist for about one hour after the cessation of boating activity.

The increased boat traffic could also result in more frequent disturbance of some of the most important fish spawning sites in Waubeesee Lake. Northern pike and, to a lesser extent, largemouth bass and sunfish, spawn in the Anderson Canal. The vegetated shoreline of Waubeesee Lake near the mouth of the Anderson Canal contains a sand and gravel bottom used for spawning and feeding by largemouth bass and by certain panfish.

Finally, increased boating traffic may be expected to increase wave action, resulting in possible additional shoreline erosion. If the Canal is dredged as recommended above, there would be less likelihood of bottom sediment resuspension. Furthermore, the concerns about sediment resuspension, fish spawning habitat disturbance, and shoreline erosion could be mitigated, in part, by restrictions on boat types, speeds, and navigation areas.

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[5] *Wisconsin Department of Natural Resources, Wisconsin Access Policy, Preliminary Waterbody Rankings into High, Medium, and Low Priorities, July 1989.*

[6] *U. S. Environmental Protection Agency, Assessing Effects on Water Quality by Boating, EPA-670/2-74-072, October 1974.*

It should be noted that dredging of the Anderson Canal, as recommended in this report, would also cause serious disturbances of the channel, especially during the actual dredging operation. While turbidity levels would be high during the dredging, and while largemouth bass and certain panfish, which currently spawn and feed in the Anderson Canal on a limited basis, would likely no longer use the channel to the same extent, northern pike would continue to spawn in the shallower areas of the channel, and some channel areas could actually show an increase in spawning activity. The removal of muck and the exposure of a firm bottom substrate in limited areas could enhance spawning activity by some species of fish. To preserve the most valuable aquatic vegetation and fish spawning areas in the channel, dredging is not recommended for much of the western portion of the channel.

The second major concern about the Department of Natural Resources proposed access relates to the ability of Waubeesee Lake to support the increased boating traffic. The Department's proposal would provide the potential for up to one new boat per 12 acres of usable surface water area. However, two of these boats would be small, suitable for cartop transport, and presumably not used for fast boating. Thus, there is the potential for up to one new fast boat per 19 acres of usable surface water area. Regional Planning Commission standards, set forth in SEWRPC Planning Report No. 27, A Regional Park and Open Space Plan for Southeastern Wisconsin: 2000, 1977, call for the provision of 16 acres of usable surface water for each motorboat, including boats used by lake residents. A conservative assumption would be that during a typical summer weekend day, about 10 percent of the 69 moored or docked powerboats would be out on the Lake at a given time. Thus, lake residents may be expected to have about seven boats out on the Lake, or one boat per 11 usable acres, which already exceeds the boating capacity of the Lake. In addition, nearby residents which do not own lake frontage also use Waubeesee Lake for boating activities. Allowing four additional fast boats on the Lake from a public access site, along with two smaller boats, could increase the risk of boating accidents, make boating less pleasant for all boaters, and interfere with other lake uses, such as fishing and swimming.

One additional concern would be the possibility of over-harvesting of the predator fish population, comprised primarily of largemouth bass and northern pike, by larger numbers of anglers. Presumably once an adequate public access site is provided, however, the Department of Natural Resources would provide fish management services. The Department would conduct periodic fishery surveys to monitor the populations, and take whatever action is needed, such as stocking of additional fish, to prevent over-harvesting.

Shoreline Erosion: Although shoreline erosion is not a major problem on Waubeesee Lake, it is noteworthy that 97 structures had been built to protect the Lake's shoreline, and that about 45 percent of these structures were in need of repair or reconstruction in 1989. Shoreline erosion problems could become more severe if motorboating activity increases substantially in Waubeesee Lake.

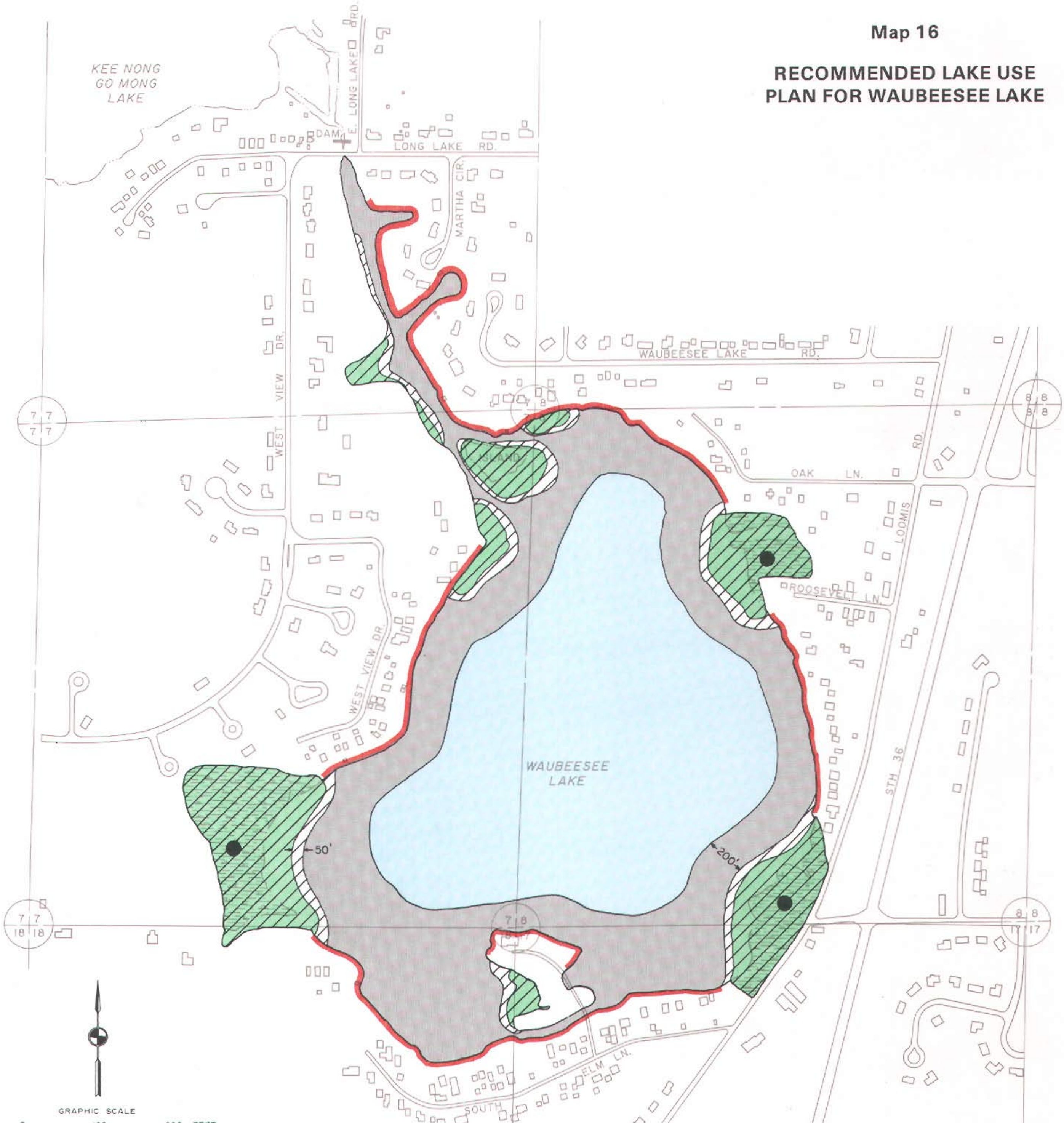
Shoreline protection could be enhanced by providing lakeshore property owners with information on the methods of proper construction and maintenance of a shore protection structure, on the problems commonly associated with such structures, and on the costs of alternative structures. Some of this information is contained in this report; other sources of information include private contractors, the Wisconsin Department of Natural Resources, the University of Wisconsin's Extension Service, and the U. S. Army Corps of Engineers.

Recommended Lake Use Management Plan

The recommended lake use management plan for Waubeesee Lake provides an overall strategy for accommodating increased demands for new urban development, additional recreational activities, and more public access without damaging the Lake's most valuable and limited high quality resources. The plan contains recommendations to protect environmentally sensitive areas, to abate excessive sediment loadings from new urban construction, to restrict boating to safe and environmentally sound levels, to provide adequate public access, and to prevent increased erosion of the shoreline. The recommended plan is summarized in graphic form on Map 16. The recommendations for Waubeesee Lake also apply to the Anderson Canal because of the direct hydrologic and ecologic relationship between the two water bodies. It is recommended that the Town of Norway and Tri-Lakes Conser-

Map 16

RECOMMENDED LAKE USE PLAN FOR WAUBEESEE LAKE



LEGEND

PROTECT ENVIRONMENTALLY SENSITIVE AREAS

- NO MOTORBOATING, WEED HARVESTING, OR HERBICIDE USE
- NO DREDGING OR PLACEMENT OF MATERIAL ON LAKEBED
- LIMIT SWIMMING TO MINIMUM AREAS
- PROTECT AND PRESERVE PRIMARY ENVIRONMENTAL CORRIDORS IN THE LAKE WATERSHED (NOT SHOWN)

CONSIDER PUBLIC AQUISITION OF ADJACENT WETLANDS

SHORELINE PROTECTION

CONSTRUCT AND MAINTAIN ADEQUATE PROTECTION

MOTORBOATING RESTRICTIONS

NO MOTORBOATING

"NO WAKE" MOTORBOATING ONLY

FAST (25 MPH) BOATING AND WATERSKIING ALLOWED (10:00 AM-6:00 PM) AT OTHER TIMES, BOAT SPEEDS LIMITED TO LESS THAN 25 MPH; WATERSKIING PROHIBITED

OTHER RECOMMENDATIONS

PUBLIC ACCESS

- PROVIDE ONE SLOW BOATING ACCESS WITH SIX PARKING UNITS ON WAUBEESEE LAKE

CONSTRUCTION SITE EROSION CONTROL

- STRICTLY ENFORCE ADOPTED CONSTRUCTION SITE EROSION CONTROL ORDINANCE IN THE LAKE WATERSHED

Source: SEWRPC.

vation, Inc., a voluntary lake property owners association serving Waubeesee Lake, Kee Nong Go Mong Lake, and Wind Lake, take the lead in implementing the plan.

1. Protect Environmentally Sensitive Areas: It is recommended that measures be taken to preserve and protect environmentally sensitive areas, which include extensive aquatic macrophyte beds and fish spawning sites in Waubeesee Lake and the Anderson Canal, adjacent wetlands, and primary environmental corridors in the Lake's watershed. The environmentally sensitive areas in Waubeesee Lake and the Anderson Canal and the adjacent wetlands, shown on Map 16, cover a total of 25 acres. In order to prevent disturbance of these important ecological sites, the following restrictions are recommended:

   a. That the Town of Norway prohibit motorboating within the environmentally sensitive areas, as discussed in more detail below;

   b. That the Town of Norway and Tri-Lakes Conservation, Inc., through a joint education and information program, discourage macrophyte harvesting or herbicide use within the environmentally sensitive areas except where absolutely necessary to provide a minimum access-way for a riparian property owner, and limit swimming in the environmentally sensitive areas;

   c. That the Wisconsin Department of Natural Resources prohibit dredging or placement of material in environmentally sensitive areas; and

   d. That the environmentally sensitive water areas be marked by the Town of Norway with buoys and signs, in order to help enforce the recommended restrictions.

   In order to assure the protection and preservation of the three wetlands located adjacent to Waubeesee Lake, which contain valuable aquatic plant communities and important fish and wildlife habitat, as shown on Map 16, it is recommended that the Town of Norway consider public acquisition of these wetlands. In this regard, it is important to note that while the usual manner of acquisition is the purchase of fee simple interest, there are alternative methods of acquiring less than fee simple interest in the land in order to protect and preserve natural resources, including the purchase and resale on condition, purchase and "lease-back" arrangements, acquisition subject to life estate, acquisition of tax-delinquent lands, conservancy easements, scenic easements, acquisition of development rights, acquisition through gift or donation, and acquisition through land dedication requirements.

   It is recommended that all other primary environmental corridor lands in the Waubeesee Lake watershed be preserved in essentially natural open space uses, primarily through public land use controls. Such preservation should be promoted through the placement of such resources in appropriate conservancy zoning districts and through the enforcement of existing regulations intended to protect such natural resources. While only the wetlands located adjacent to Waubeesee Lake are specifically recommended for public acquisition, appropriate public agencies should consider the acquisition of other primary corridor lands should such lands become available. Furthermore, should urban development not proposed or envisioned under the land use plan shown on Map 7 threaten to destroy or degrade natural resources located within the primary environmental corridors, an appropriate public agency should consider the acquisition of such lands for resource and open space preservation purposes.

2. Restrict Motorboating: It is recommended that the Town of Norway amend its Recreation, Boating, and Swimming Ordinance to restrict boating activities within the designated areas shown on Map 16. The Town should also consider establishing a maximum limit on boat speeds because of the Lake's relatively small area. These boating regulations would help reduce environmental damages, safety hazards, and recreational use conflicts associated with motorboating activities.

3. Abate Construction Site Erosion: The Town of Norway has adopted a construction erosion control ordinance. It is recom-

mended that this ordinance be strictly enforced to sufficiently reduce sediment loadings from construction sites, especially when the sites are tributary to a lake.

4. Prevent Shoreline Erosion: It is recommended that Tri-Lakes Conservation, Inc., compile and provide to the lakeshore property owners information on proper methods to protect the shoreline, estimated costs, design criteria, and problems commonly encountered. The simplest, least costly, and most natural method of attempting shoreline erosion control is the provision of a vegetative buffer strip immediately adjacent to the Lake. This technique is accomplished by encouraging natural vegetation rather than maintained lawns within about five feet of the lakeshore or by encouraging establishment of emergent aquatic vegetation two to six feet lakeward of the eroding shoreline. The Regional Planning Commission would, on request, assist the Association in preparing this information at no cost to the Association.

5. Provide Public Access: It is recommended that the Town of Norway, Tri-Lakes Conservation, Inc., and the Wisconsin Department of Natural Resources cooperatively consider the potential development of a public access site for the Lake, including consideration of potential sites on the main body of Waubeesee Lake itself, rather than on the Anderson Canal.

   It is also recommended that the developed public access site be designed to provide only slow-boating opportunities, such as fishing and canoeing. The site should contain six automobile parking units designed primarily to allow for boats transported on cartop. In order to allow access for slow boating for elderly and handicapped persons, consideration should be given to designing one or two of the parking units for automobile-trailer parking, perhaps providing a boat launch ramp for trailered boat use.

SUMMARY

This report, which documents the findings and recommendations of a study requested by the Town Board of the Town of Norway and Tri-Lakes Conservation, Inc., examines existing and anticipated water use problems encountered by users of the Anderson Canal and Waubeesee Lake and presents a recommended plan for the resolution of these problems. The Anderson Canal was found to be a shallow channel with deep organic sediments supporting excessive aquatic plant growths which interfere with the continued use of the channel, particularly for navigation and access to the Lake. Surveys indicated that portions of the channel contain a diverse community of aquatic plants as well as fish spawning habitat. Waubeesee Lake supports excellent aquatic resources, including a variety of healthy plant and animal communities, and provides high quality recreational uses.

The Anderson Canal use management plan recommends that 4.1 acres of the channel be mechanically dredged to a mean depth of five feet, that macrophyte harvesting be conducted on about 2.3 acres of the channel, and that shoreline protection be provided for an additional 1,000 feet of the channel shoreline. The Anderson Canal plan would entail a capital cost of approximately \$104,800 and an annual operation and maintenance cost of about \$3,300.

The recommended dredging of the Anderson Canal would also provide benefits for residents of Waubeesee Lake. Deepening the channel would enhance the enjoyment of boating within the Canal for residents of both Lake and Canal. The reduction of excessive aquatic plant growths would improve the aesthetic quality of the overall lake environment. The removal of nutrient-rich organic sediments would reduce the likelihood of those sediments flushing into Waubeesee Lake. Inflowing sediments would be more likely to settle in a deeper channel than in the existing channel.

The Waubeesee Lake use management plan recommends protection of about 25 environmentally sensitive acres in or immediately adjacent to Waubeesee Lake and the Anderson Canal. This includes consideration of public acquisition of wetlands located adjacent to the Lake, the preservation of primary environmental corridors within the Lake's watershed, the development of motorboating regulations as needed to prevent ecological damage and interference with other lake uses, the enforcement of a construction erosion control ordinance, the provision of technical information and assistance to help property owners protect their shoreline, and the provision of a public access site for slow-boating opportunities. Costs for the Waubeesee Lake use management plan were not estimated; such costs are primarily administrative costs, borne by the local lake property owners association and by units of government.