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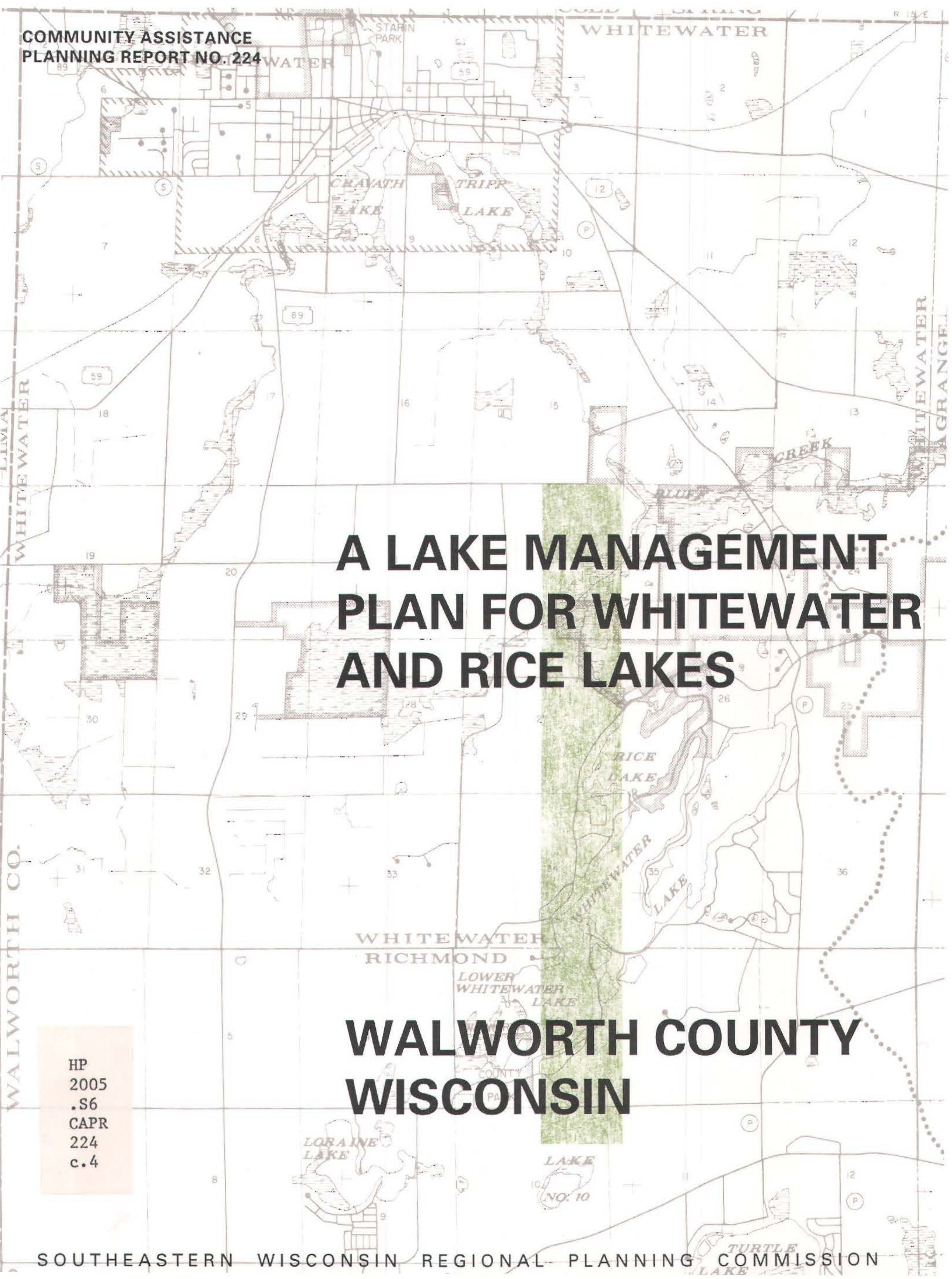

A LAKE MANAGEMENT PLAN FOR WHITEWATER AND RICE LAKES

WALWORTH COUNTY WISCONSIN

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A LAKE MANAGEMENT PLAN FOR WHITEWATER AND RICE LAKES
WALWORTH COUNTY, WISCONSIN

Prepared by the

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February 28, 1997

TO: All Units and Agencies of Government and Citizen Groups Involved in Water Quality and Water Use Management of Whitewater and Rice Lakes

Over the past approximately seven years, the U.S. Geological Survey and the Southeastern Wisconsin Regional Planning Commission, at the request of the Whitewater-Rice Lakes Management District, have been conducting lake management-related data collection and analysis efforts. These efforts have now been integrated into a lake management plan for Whitewater and Rice Lakes, which plan addresses the water quality, recreational use, and natural resource problems of the Lakes. The preparation of the plan was a cooperative effort by the Whitewater-Rice Lakes Management District, the U.S. Geological Survey, the Wisconsin Department of Natural Resources, and the Southeastern Wisconsin Regional Planning Commission.

This report documents the recommended lake management plan. The report describes the physical and biological characteristics of Whitewater and Rice Lakes and their watershed; the quality of the Lake waters and the factors affecting that quality, including land use and management practices; the recreational use of the Lakes; the shoreline conditions around the Lakes; and sets forth recommended management measures.

The plan presented in this report is intended to provide a guide to the making of development decisions concerning the wise use and management of Whitewater and Rice Lakes as an aesthetic and recreational asset of immeasurable value. Accordingly, adoption of the plan presented herein by all concerned water use management agencies is urged. The Regional Planning Commission stands ready to assist the various units and agencies of government concerned in adopting and carrying out over time the plan recommendations.

Respectfully submitted,

Philip C. Evenson

Philip C. Evenson
Executive Director

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Chapter I

INTRODUCTION

Whitewater Lake is an impounded 697-acre drainage lake located in the Towns of Whitewater and Richmond in Walworth County. The lake adjoining Whitewater Lake, Rice Lake, is a 162-acre drainage lake. These Lakes offer a variety of water-based recreational opportunities and are the focus of the lake-oriented community surrounding the Lakes. However, during recent years, both Lakes have experienced various management problems including excessive plant growth and lack of species diversity, and recreation user conflicts and limitations. In addition, concerns have been raised regarding variable water quality and the need to protect environmentally sensitive areas in the lake basin.

Seeking to improve the usability of Whitewater and Rice Lakes, and to prevent deterioration of the natural assets and recreational potential of the Lakes, the residents of the watershed formed the Whitewater-Rice Lakes Management District during 1986. Since that time, the lake residents have enrolled in the Wisconsin Department of Natural Resources Self-Help Monitoring Program, and sought assistance from the Wisconsin Department of Natural Resources and the U.S. Geological Survey, with Phase I and Phase II funding provided in part through the lake management planning grant program provided for under Chapter NR 119 (currently Chapter NR 190) of the Wisconsin Administrative Code. These actions, in conjunction with a number of other water quality-related studies conducted by the Ecology Committee of Whitewater Lake,[1] and the Wisconsin Department of Natural Resources under their Long-Term Trend Monitoring Program have contributed to the development of a data base which can provide the residents of the Whitewater and Rice Lakes with a better understanding of their Lake and their Lakes' watershed.

This lake management plan represents part of the ongoing commitment of the Whitewater-Rice Lakes Management District to sound environmental planning with respect to the Lakes. This plan was prepared during 1995 by the Regional Planning Commission in cooperation with the District and represents one of several related actions taken by the District to manage the Whitewater and Rice Lakes resources.

This report summarizes the results of the sampling programs and other related inventories and provides an evaluation and interpretation of the data collected and collated. Such programs include the hydrologic and water quality monitoring program conducted by the U.S. Geological Survey[2]; data collected by the Wisconsin Department of Natural Resources under its Long-Term Trend Monitoring Program and other programs[3]; several reports prepared by the Ecology Committee on Whitewater Lake and the Whitewater-Rice Lakes Management District[4]; and data set forth in the regional water quality management plan.[5] As part of this planning

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[1] *An informal group headed by the late limnologist Dr. Willard L. Gross, a lake resident and professor at the University of Wisconsin-Whitewater.*

[2] *U.S. Geological Survey, Water Resources Investigation Report 44-410, "Hydrology and Water Quality of Whitewater and Rice Lakes in Southeastern Wisconsin, 1990-1991," 1994.*

[3] *Wisconsin Department of Natural Resources, "Ambient Lakes Monitoring Program—Macrophyte Survey: Whitewater Lake," June 1990; Wisconsin Department of Natural Resources, "Whitewater Lake, Walworth County: Long-Term Trend Lake—1986," June 1990; and Wisconsin Department of Natural Resources, "Whitewater Lake, Walworth County: Long-Term Trend Lake—1987," June 1990.*

[4] *W.L. Gross, "Progress Report on Feasibility Study of Whitewater Lake," November 1971 and "Whitewater Lake Water Quality Study," April 1972; K. Lundin, "Whitewater Lake History," s.d.; and Whitewater-Rice Lakes Management District, "Newsletter," various dates.*

effort an updated aquatic plant survey, a lake resident opinion and information survey, and recreational-use surveys were conducted. The report presents feasible alternative in-lake measures for enhancing the water quality conditions and for providing opportunities for safe and enjoyable use of the Lakes. More specifically, this report describes the physical, chemical, and biological characteristics of the Lakes and pertinent related characteristics of the tributary watershed, as well as the feasibility of various watershed and in-lake management measures which may be applied to enhance the water quality conditions, biological communities, and recreational opportunities of the Lakes.

The primary management objectives for Whitewater and Rice Lakes include: 1) to contribute to the overall conservation and wise use of the Whitewater and Rice Lakes through the environmentally sound management of vegetation, fishes, and wildlife populations in and around the Lakes; 2) to provide the potential for high-quality, water-based recreational experiences by residents and visitors to Whitewater and Rice Lakes; and 3) to effectively control the quantity and density of aquatic plant growth in portions of the Whitewater and Rice Lakes basin to better facilitate the conduct of water-related recreation, to improve the aesthetic value of the resource to the communities, and to enhance the resource value of the waterbody. This plan should serve as a practical guide to achieving these objectives over time in a technically sound manner.

[5] *SEWRPC Planning Report No. 30, A Regional Water Quality Management Plan for Southeastern Wisconsin: 2000, Volume Two, Alternative Plans, February 1979.*

Chapter II

PHYSICAL DESCRIPTION

INTRODUCTION

The physical characteristics of a lake and its watershed are an important factor in any evaluation of existing and probable future water quality conditions, or of recreational uses and needs. Characteristics such as watershed topography, lake morphometry, and local hydrology ultimately influence water quality conditions and the composition of plant and fish communities within the lake, and, therefore, these characteristics must be considered in any sound lake management planning process. Accordingly, this chapter provides pertinent information on the physical characteristics of Whitewater and Rice Lakes, their watershed, and on the climate and hydrology of the Lakes. Subsequent chapters deal with the land use conditions and the chemical and biological environments of the Lakes.

WATERBODY CHARACTERISTICS

Whitewater and Rice Lakes are located southwest of the City of Whitewater adjacent to the southern most portion of the Kettle Moraine State Forest in Walworth County, as shown in Map 1. Both Lakes are man-made drainage lakes; Whitewater Lake was created in 1947 by the damming of a chain of three smaller lakes. Rice Lake was created in 1954 by constructing a dam across Whitewater Creek. Discharge over the outlet dam of Whitewater Lake occurs infrequently, with no outflows being observed during the period of November 15, 1990 through November 14, 1991—the study period for the hydrologic and water quality study conducted on the Lakes by the U.S. Geologic Survey. Since 1991, periodic overflows of the Whitewater Lake outlet dam have been observed. Rice Lake is connected to Whitewater Lake by a 300-foot intermittent stream.

Whitewater Lake has a surface area of 697 acres, with a maximum depth of about 40 feet. Twenty-four percent of the total Lake area, and 13 percent of the total volume is five or less feet in depth and 88 percent of the Lake area, and 97 percent of the lake volume is 10 or less feet in depth. The shoreline of the Lake is irregular in shape forming three basins. Whitewater Lake is about 2.6 miles long and 0.6 mile wide. The deepest area of the Lake—approximately 40 feet—is located in the main, or central, basin while the northern basin has a maximum depth of about 13 feet, and the southern basin has a maximum depth of about seven feet.

Rice Lake, downstream of Whitewater Lake, has a surface area of about 162 acres, with a maximum depth of about 11 feet. The Lake is roughly oval in shape with the deepest area being near the center of the Lake. The hydrological characteristics of both Lakes are summarized in Table 1 and the bathymetry of the Lakes is shown on Map 2. No outflows over the Rice Lake outlet dam were observed during the period November 15, 1990 through November 14, 1991—the study period for the hydrologic and water quality study conducted on the Lakes by the U.S. Geologic Survey.

The shoreline of Whitewater Lake is almost entirely developed for residential uses, with the exception of the reaches of the western and southern shores of the south bay and the western shore of the northwest lobe of the Lake which are in park and open space use. The western shore of Rice Lake is also largely developed for residential uses, while the remainder of the shoreline is largely in park and open space uses being part of the Kettle Moraine State Forest.

Erosion of shorelines results in the loss of riparian land, damage to shoreland infrastructure, and interference with access and lake use. Such erosion is usually caused by wind-wave erosion, ice movement and motorized boat traffic. A survey of the Whitewater and Rice Lakes shorelines, conducted by Regional Planning Commission staff during the summer of 1995, identified existing shoreline protection conditions around these lakes. About three miles, or about 30 percent of the shoreline

Map 1

LOCATION MAP OF WHITEWATER AND RICE LAKES

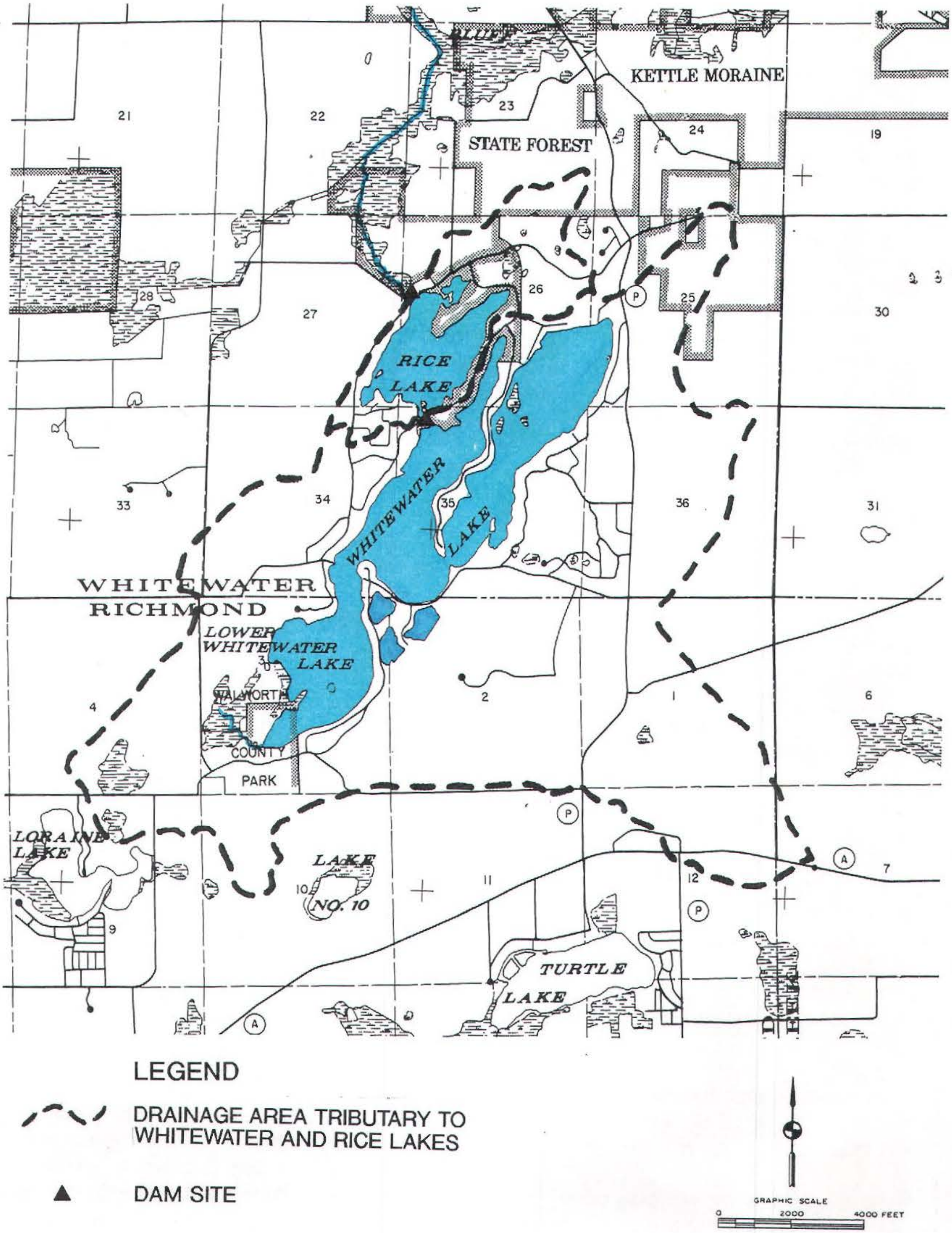


Table 1

SIGNIFICANT HYDROLOGIC AND HYDROGRAPHIC CHARACTERISTICS OF WHITEWATER AND RICE LAKES

Parameter	Whitewater Lake	Rice Lake
Surface Area (acres)	697	162
Volume (acre-feet)	5,806	930
Maximum Depth (feet)	40	11
Mean Depth (feet)	8.3	5.8
Tributary Watershed Area (acres)	4,659	5,007
Length of Shoreline (miles)	10.0	3.3

Source: SEWRPC.

of Whitewater Lake, were in a natural condition; including reaches of sand beach while the remaining seven miles were protected by some type of shore protection structure, including bulkheads—vertical walls; revetments—sloping stone walls; and areas where riprap had been used to stabilize the shoreline, as shown on Map 3.

On Rice Lake only a few areas were noted to have riprap shoreline protection or beaches, as shown on Map 4. Most bulkheads were of concrete or wooden construction, although some appeared to have been grouted revetments given the size of the stone used.

WATERSHED CHARACTERISTICS

The tributary drainage areas of Whitewater and Rice Lakes are 7.2 and 7.8 square miles in size, respectively, as shown on Map 1. As previously noted, there is normally no flow over the dam at the outlet of Whitewater Lake with no observation of such discharge during water years 1990 and 1991 and limited discharges subsequent to that. Thus, the tributary area to Rice Lake is normally effectively limited to the 350-acre drainage area located downstream of Whitewater Lake. The U.S. Geological Survey study[1] of lake hydrology and water quality conducted over the period from November 1990, through November 1991, indicates that due to the rough topography and soils in the tributary area, there are normally only about 1.4 square miles and 0.3 square mile of land surface which actually contribute drainage to Whitewater and Rice Lakes, respectively. These areas are shown on Map 5.

Soil Types and Conditions

Soil type, land slope, and land use and management practices are among the more important factors determining lake water quality conditions. Soil type, land slope, and vegetative cover are also important factors affecting the rate, amount, and quality of stormwater runoff. The soil texture and soil particle structure influence the permeability, infiltration rate, and erodibility of soils. Land slopes are also important determinants of stormwater runoff rates and of susceptibility to erosion.

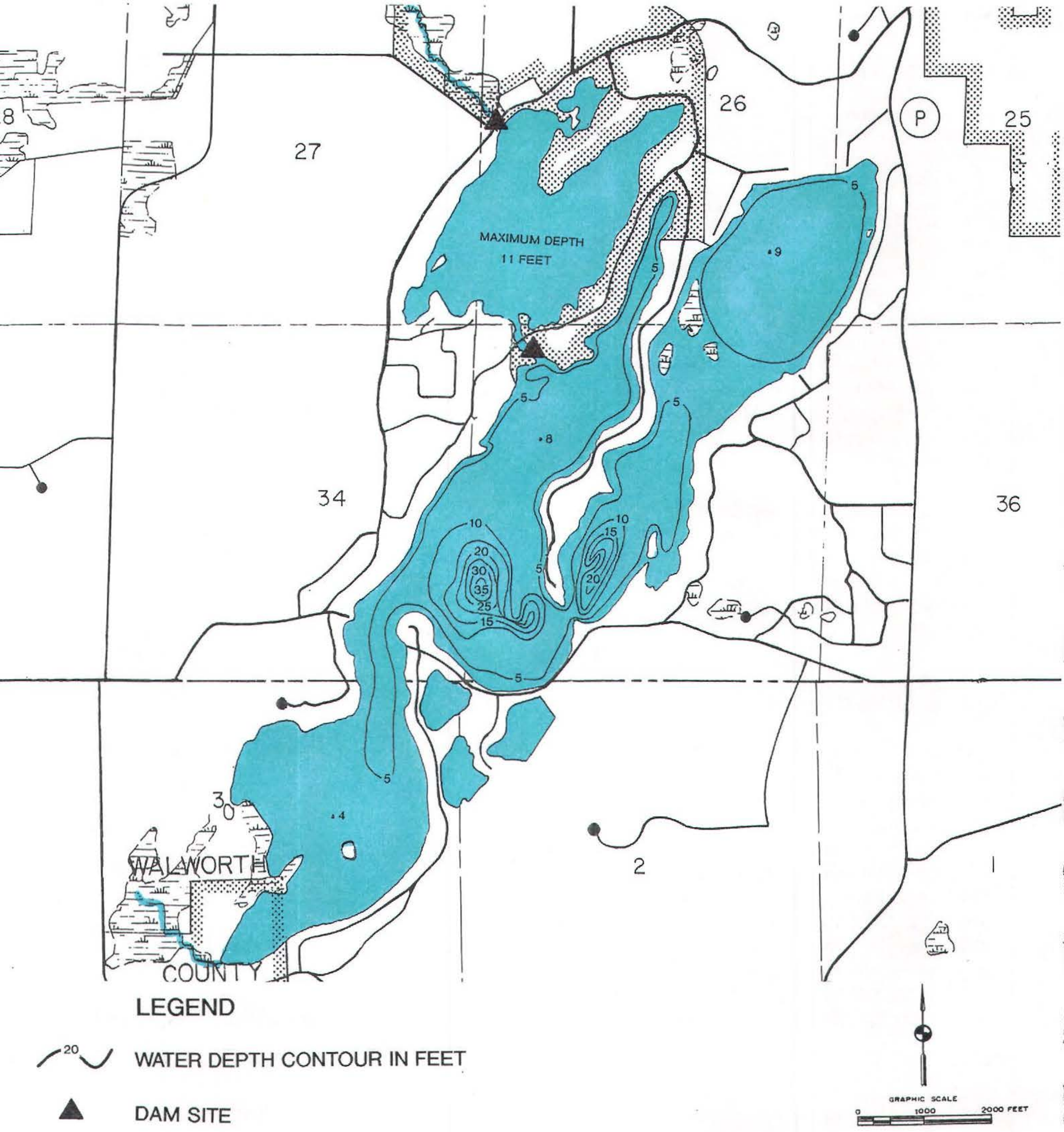
The U.S. Soil Conservation Service, under contract to the Southeastern Wisconsin Regional Planning Commission, completed a detailed soil survey of the Whitewater and Rice Lakes area in 1966.[2] The soil survey contained interpretations for planning and engineering applications as well as for agricultural application. Using the regional soil survey, an assessment was made of hydrologic characteristics of the soils in the drainage area of Whitewater and Rice Lakes. The suitability of the soils for

[1] *U.S. Geological Survey, Water Resources Investigation Report 44-410, "Hydrology and Water Quality of Whitewater and Rice Lakes in Southeastern Wisconsin, 1990-1991," 1994.*

[2] *See: SEWRPC Planning Report No. 8, The Soils of Southeastern Wisconsin, June 1966.*

Map 2

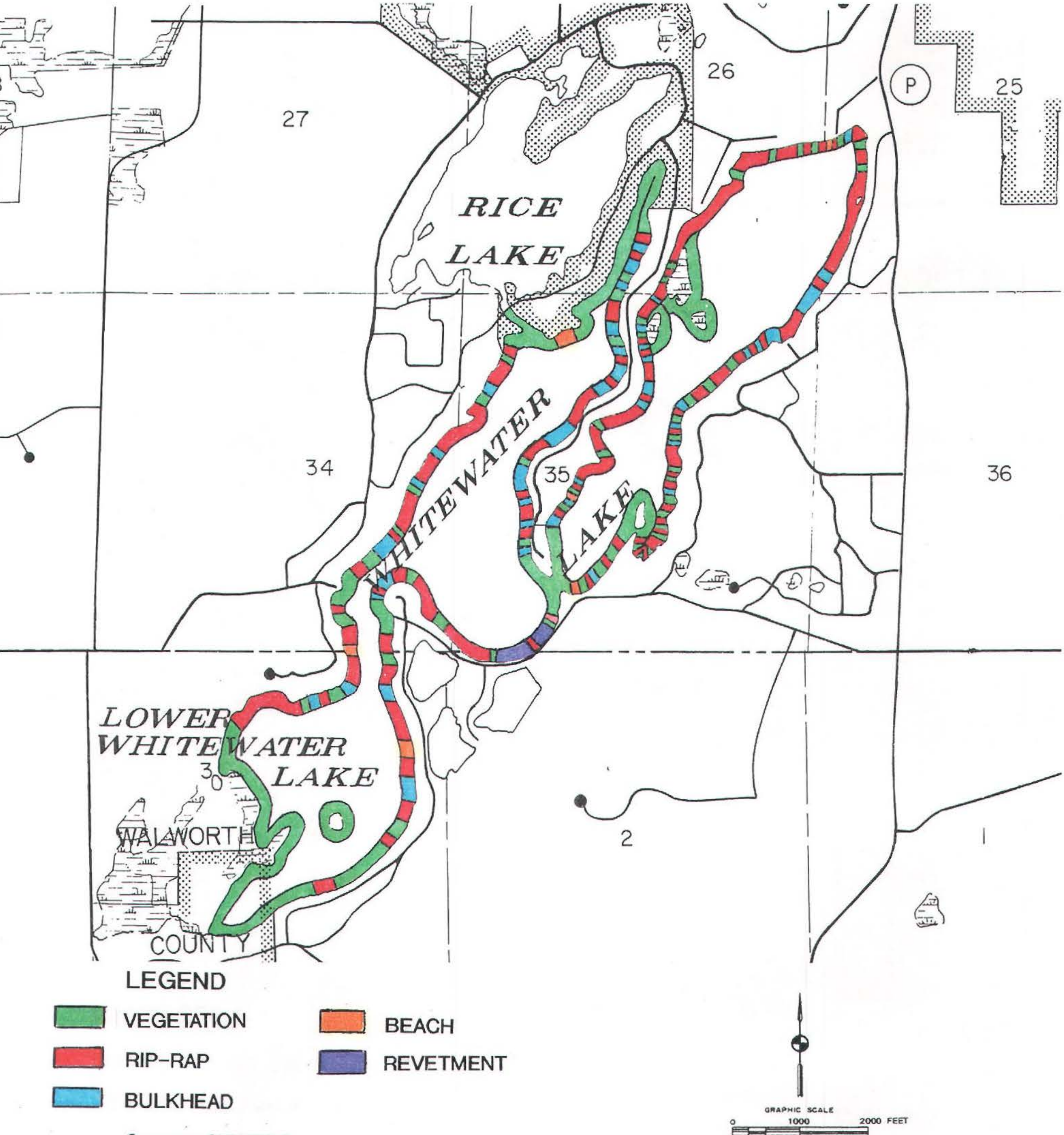
BATHYMETRIC MAP OF WHITEWATER AND RICE LAKES



Source: SEWRPC.

Map 3

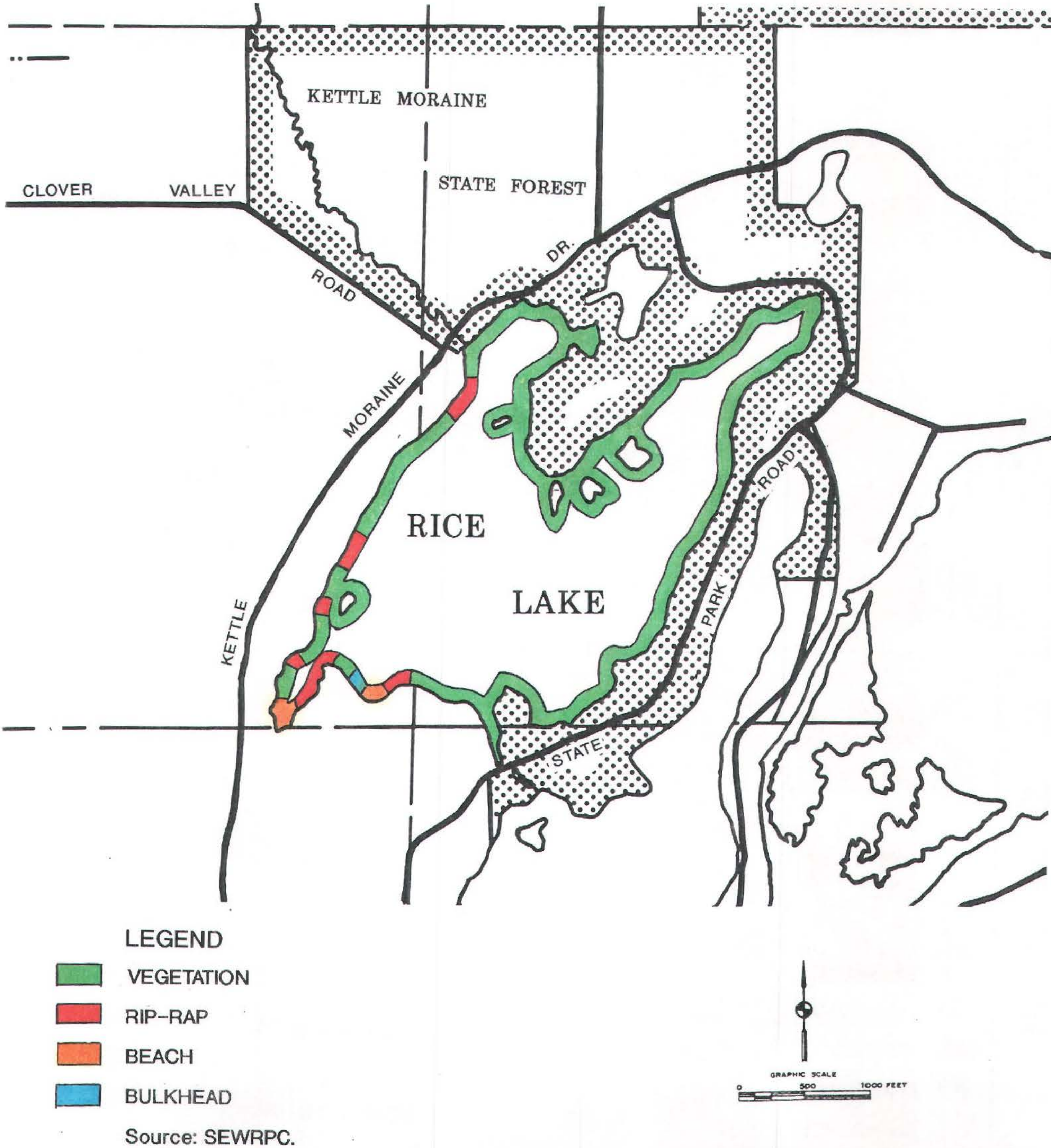
SHORELINE PROTECTION CONDITIONS ON WHITEWATER LAKE: 1995



Source: SEWRPC.

Map 4

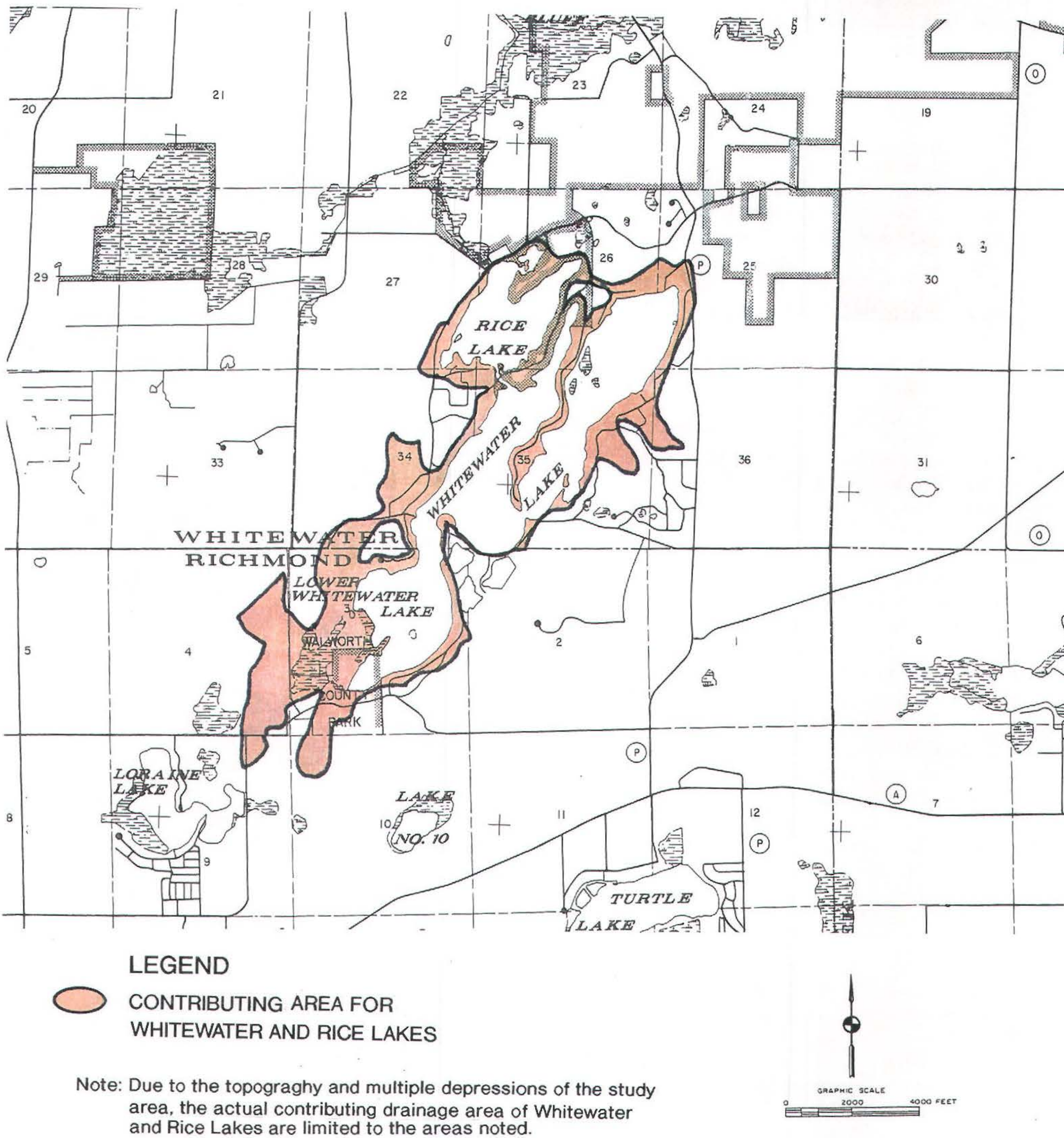
SHORELINE PROTECTION CONDITIONS ON RICE LAKE: 1995



Source: SEWRPC.

Map 5

DRAINAGE AREAS CONTRIBUTING RUNOFF TO WHITEWATER AND RICE LAKES



LEGEND

CONTRIBUTING AREA FOR WHITEWATER AND RICE LAKES

Note: Due to the topograghy and multiple depressions of the study area, the actual contributing drainage area of Whitewater and Rice Lakes are limited to the areas noted.

Source: U.S. GEOLOGICAL SURVEY AND SEWRPC.

urban residential development was assessed using three common development scenarios: development with conventional onsite sewage disposal systems; developed with alternative onsite sewage disposal systems; and developed with public sanitary sewers.

Soils within the tributary area to Whitewater and Rice Lakes were categorized into four main hydrologic soil groups, as well as an "other" category, as indicated in Table 2. The areal extent of these soils and their locations within the watershed are shown on Map 6. About 98 percent of the Whitewater and Rice Lakes tributary drainage area is covered by the moderately well-drained soils with about 1 percent of area being covered by well-drained soils. About 89 percent of the lands which have been determined by the U.S. Geological Survey to normally contribute surface water drainage to Whitewater and Rice Lakes are covered by soil classified as moderately well-drained with about 5 percent of the area being covered by well-drained soils and the remainder by very poorly drained soils.

As noted above, the soils within the tributary drainage area of Whitewater and Rice Lakes were classified with respect to suitability for various types of urban and rural development under the Regional soil survey. The suitability for use of onsite sewage disposal systems was updated by the Regional Planning Commission, based upon the soil characteristics provided by the detailed soil surveys and the field experience of County and State technicians responsible for overseeing the location and design of such systems. The classifications reflect the current soil and site specifications set forth in ILHR 83 of the Wisconsin Administrative Code.

With respect to residential development utilizing conventional onsite sewage disposal systems, as shown on Map 7, about 45 percent of the Whitewater and Rice Lakes drainage area is covered by soils suitable for urban development utilizing onsite sewage disposal systems, and about 10 percent by soils unsuitable for such development. The soil suitability could not be determined without further field surveys for 35 percent of the land in the drainage area.

Using alternative onsite sewage disposal systems, such as mound systems, as shown on Map 8, yields additional land which may be suitable for urban residential development utilizing onsite sewage disposal systems; with about 52 percent of the Whitewater and Rice Lakes drainage areas being covered by soils suitable for such development.

The urban development surrounding Whitewater Lake is, in part, located on areas which have soils considered to be unsuitable for onsite systems. Chapter IV includes a further discussion of the impact of onsite sewage disposal systems on lake water quality.

Soil limitations for residential development utilizing sanitary sewer service are shown on Map 9. About 61 percent of the Whitewater and Rice Lakes drainage areas is covered by soils suitable for such development, and about 37 percent by soils unsuitable for such development. In 1996, the urban development within the Whitewater and Rice Lakes drainage areas is served exclusively by onsite sewage disposal systems. The regional water quality management plan[3] does not include the drainage area concerned in the planned year 2010 public sanitary sewer service area for the City of Whitewater.

LAKE HYDROLOGY

Data on the hydrology of Whitewater and Rice Lakes are needed to assess the water quality and biological resource relationships and in developing strategies for resolving lake use problems. Data on the hydrology were developed by the U.S. Geological Survey in a study undertaken from November 1990 and November 1991 study.[4]

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[3]*SEWRPC Community Assistance Planning Report No. 94, Sanitary Sewer Service Area for the City of Whitewater, Walworth County, Wisconsin, September 1987.*

[4]*U.S. Geological Survey, Water Resources Investigation Report 44-410, "Hydrology and Water Quality of Whitewater and Rice Lakes in Southeastern Wisconsin, 1990-1991," 1994.*

Table 2

GENERAL HYDROLOGIC SOIL TYPES IN THE TRIBUTARY AREA TO WHITEWATER AND RICE LAKES

Group	Soil Characteristics	Tributary Drainage Area Extent (acres)	Percent of Total
A	Well drained; very rapid to rapid permeability; low shrink-swell potential	38	1
B	Moderately well drained; texture intermediate between coarse and fine; moderately rapid to moderate permeability; low to moderate shrink-swell potential	4,007	98
C	Poorly drained; high water table for part or most of year; mottling, suggesting poor aeration and lack of drainage, generally present in A to C horizons	- -	- -
D	Very poorly drained; high water table for most of year; organic or clay soils; clay soils having high shrink-swell potential	39	1
- -	Hydrologic soil group not determined	9	<1
- -	Total	4,093	100

Source: SEWRPC.

Precipitation and Evaporation

Precipitation data were collected from four monitoring sites during a study[5] conducted by the U.S. Geological Survey during the period of November 1990 through November 1991, as shown on Map 10. One of the monitoring sites also included evaporation data collection equipment.

Precipitation at the four rain gages located around Whitewater and Rice Lakes averaged 32.88 inches from November 15, 1990 through November 14, 1991. Precipitation at the National Weather Service Station at Whitewater was 32.91 inches for the same period. The long-term, average annual precipitation at this station is 31.71 inches. Evaporation from the surfaces of Whitewater and Rice Lakes was estimated as 22.85 inches. Monthly precipitation and evaporation totals are listed in Table 3.

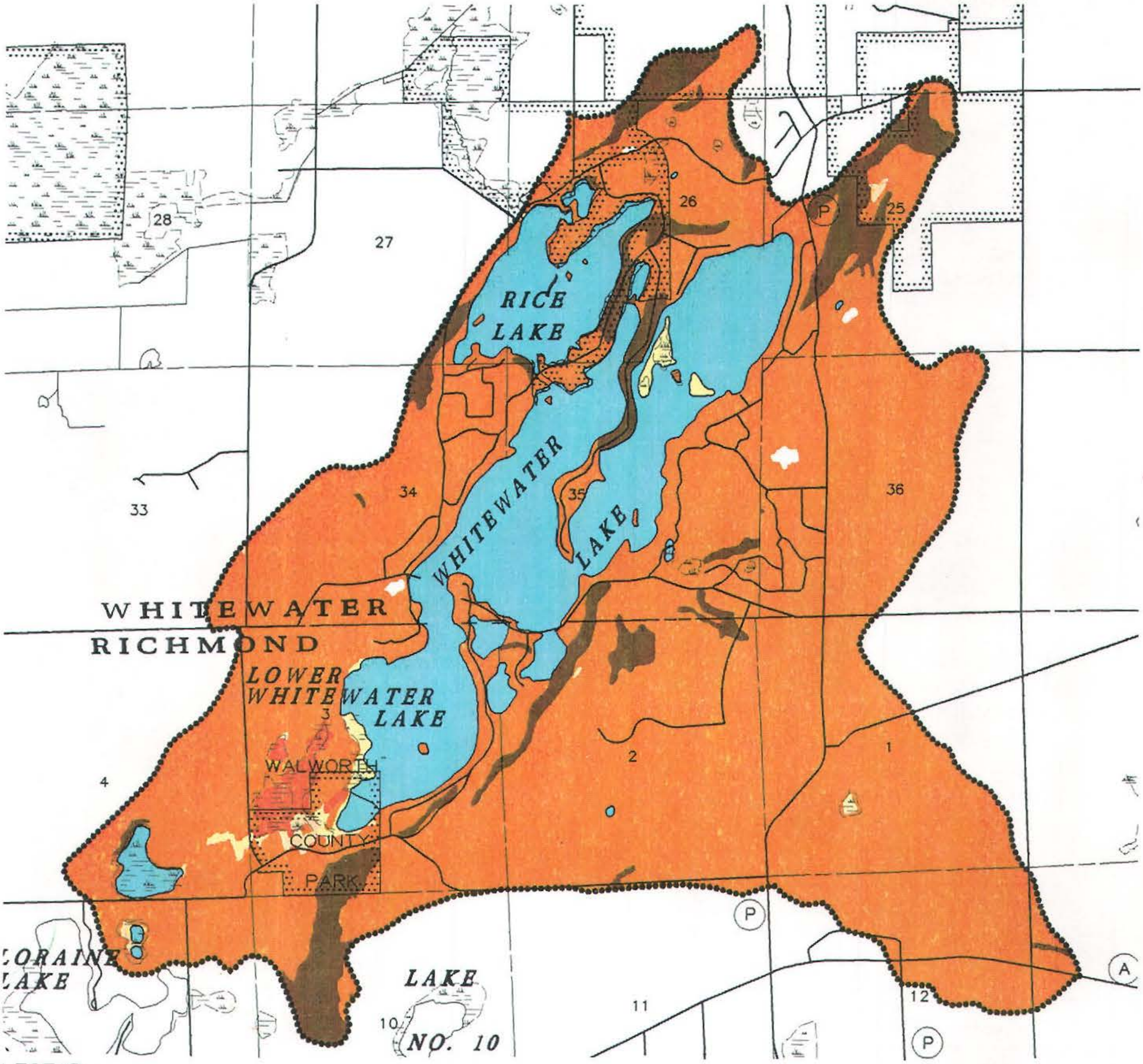
[5]*U.S. Geological Survey, Water Resources Investigation Report 44-410, "Hydrology and Water Quality of Whitewater and Rice Lakes in Southeastern Wisconsin, 1990-1991," 1994.*

Lake Stage

Lake stage data were also collected for the period October 1, 1990 through September 31, 1991 at gages located near the outlet of both Whitewater and Rice Lakes. The data are graphically provided in Figure 1. The maximum lake stage for Whitewater Lake of 891.2 feet above National Geodetic Vertical Datum of 1929 (NGVD-29) was recorded on April 16, 1991; and the minimum lake stage of 889.8 feet NGVD-29 was recorded on September 30, 1991. The maximum lake stage for Rice Lake of 882.9 feet NGVD-29 was recorded on April 15, 16, and 30, 1991; and the minimum lake stage of 881.7 feet NGVD-29 was recorded on September 30, 1991. The maximum lake stages did not reach the spillway crest elevations in either Lake. However, discharge over the Whitewater Lake dam have been observed in earlier and subsequent years. Changes in the Rice Lake stage closely follows the changes in stage of Whitewater Lake, and outflow from Rice Lake may have occurred in the same years as was observed in previous years for Whitewater Lake. Lake stages below the dam crest of Whitewater Lake appear to be correlated with groundwater levels, as discussed below.

Map 6

HYDROLOGIC SOIL GROUPS WITHIN THE DRAINAGE AREA TRIBUTARY TO WHITEWATER AND RICE LAKES



LEGEND

- GROUP A: Well-drained soils
- GROUP A/D: Well-drained soils/Very poorly-drained soils 1
- GROUP B: Moderately-drained soils
- GROUP B/D: Moderately-drained soils/Very poorly-drained soils 2
- GROUP C/D: Poorly-drained soils/Very poorly-drained soils 3
- GROUP D: Very poorly-drained soils
- Hydrologic soil group not determined
- SURFACE WATER

1 Well-drained if water table is lowered through provision of a drainage system. Very poorly-drained if water table is not lowered.

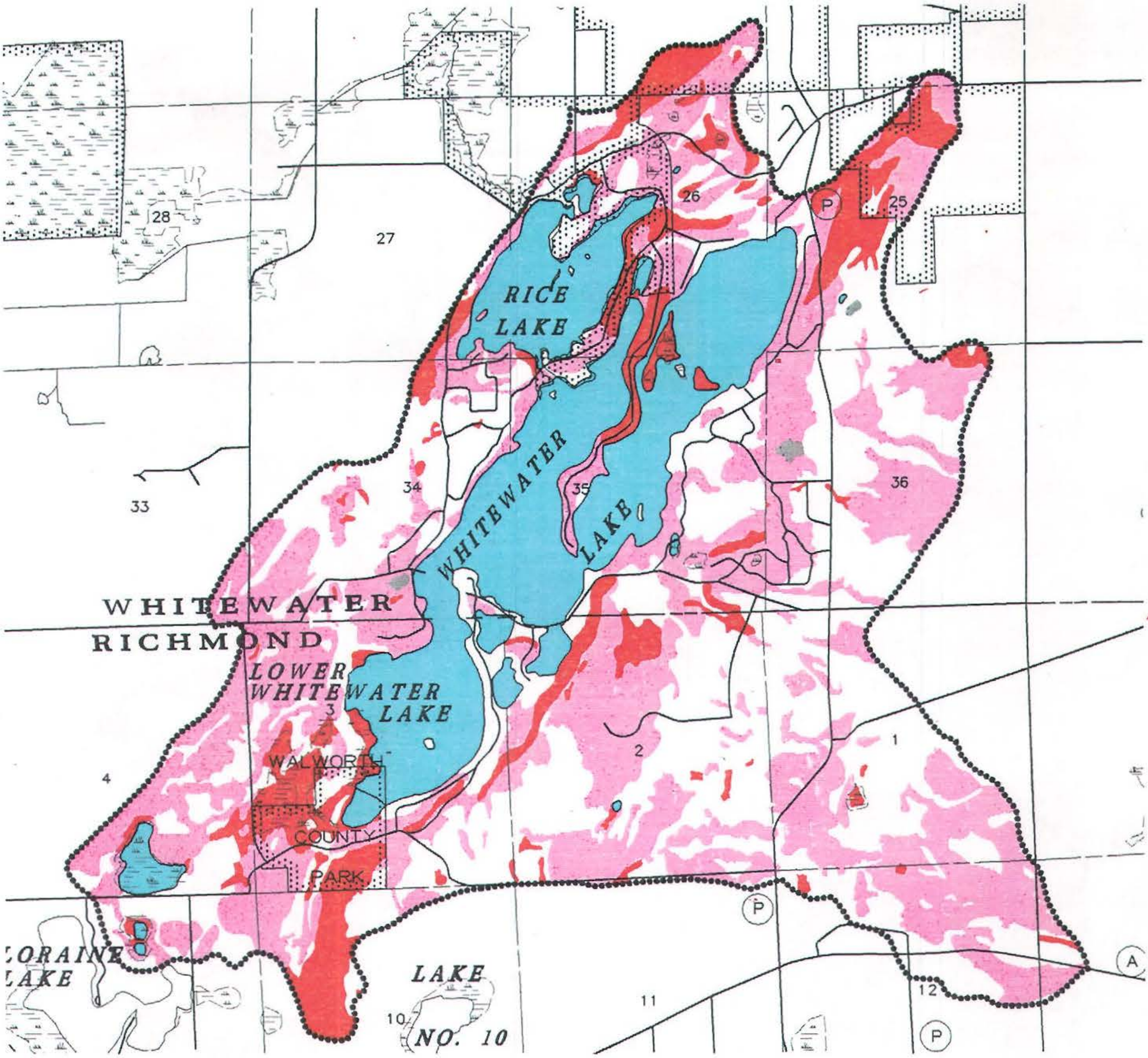
2 Moderately-drained if water table is lowered through provision of a drainage system. Very poorly-drained if water table is not lowered.

3 Poorly-drained if water table is lowered through provision of a drainage system. Very poorly-drained if water table is not lowered.

0 1500 3000
GRAPHIC SCALE IN FEET

Source: SEWRPC.

SUITABILITY OF SOILS WITHIN THE DRAINAGE AREA TRIBUTARY TO WHITEWATER AND RICE LAKES FOR CONVENTIONAL ONSITE SEWAGE DISPOSAL SYSTEMS UNDER CURRENT ADMINISTRATIVE RULES: FEBRUARY 1991



LEGEND

UNSUITABLE: Areas covered by soils which have a high probability of not meeting the criteria of Chapter ILHR 83 of the Wisconsin Administrative Code governing conventional onsite sewage disposal systems.

UNDETERMINED: Areas covered by soils having a range of characteristics and/or slopes which span the criteria of Chapter ILHR 83 of Wisconsin Administrative Code governing conventional onsite sewage disposal systems so that no classification can be assigned.

SUITABLE: Areas covered by soils having a high probability of meeting the criteria of Chapter ILHR 83 of the Wisconsin Administrative Code governing conventional onsite sewage disposal systems.

OTHER: Areas consisting for the most part of disturbed land for which no interpretive data are available.

SURFACE WATER

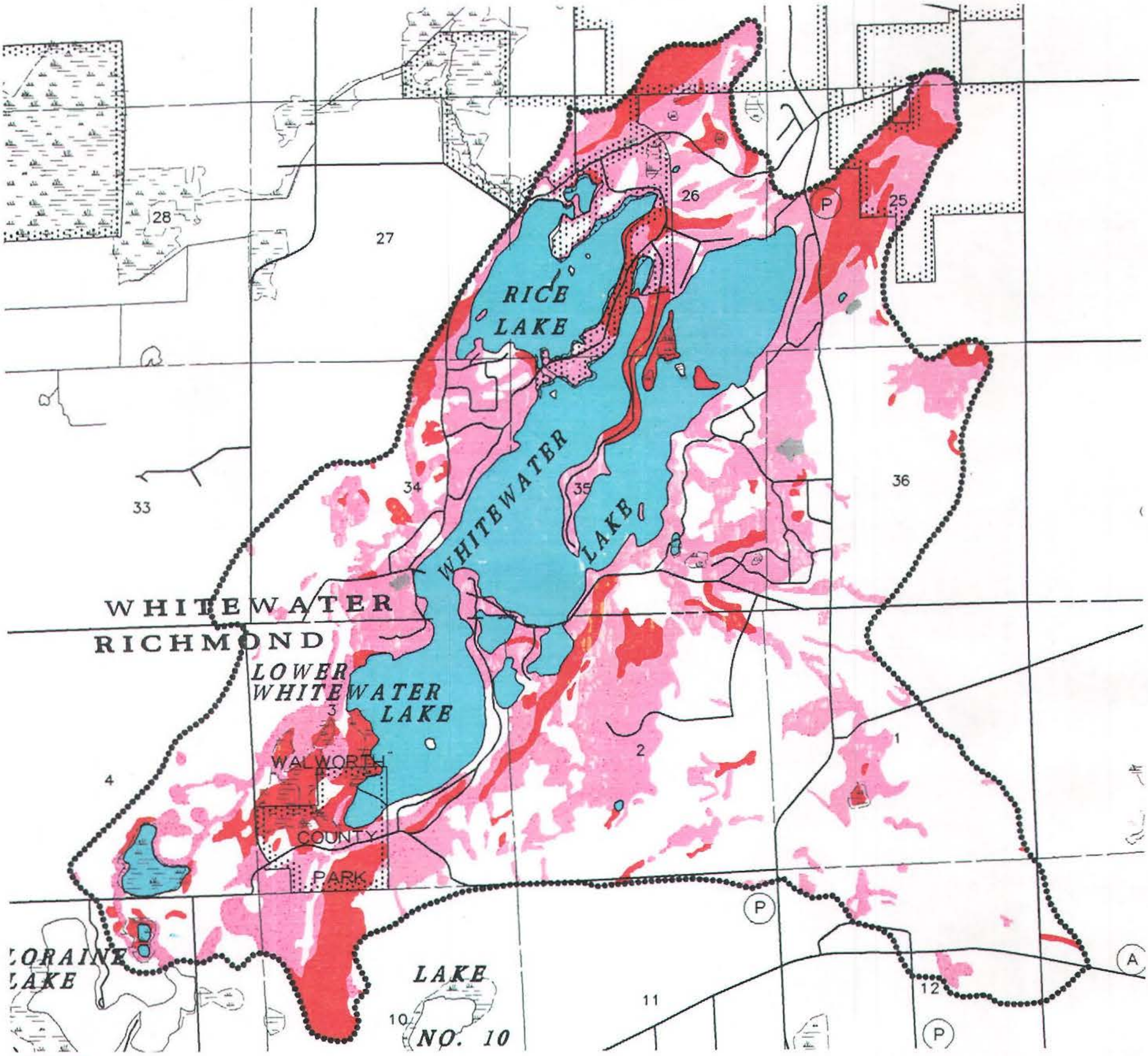
0 1500 3000

GRAPHIC SCALE IN FEET

Source: SEWRPC.

Map 8

SUITABILITY OF SOILS WITHIN THE DRAINAGE AREA TRIBUTARY TO WHITEWATER AND RICE LAKES FOR MOUND SEWAGE DISPOSAL SYSTEMS UNDER CURRENT ADMINISTRATIVE RULES: FEBRUARY 1991



LEGEND

UNSUITABLE: Areas covered by soils which have a high probability of not meeting the criteria of Chapter ILHR 83 of the Wisconsin Administrative Code governing mound sewage disposal systems.

UNDETERMINED: Areas covered by soils having a range of characteristics and/or slopes which span the criteria of Chapter ILHR 83 of the Wisconsin Administrative Code governing mound sewage disposal systems so that no classification can be assigned.

SUITABLE: Areas covered by soils having a high probability of meeting the criteria of Chapter ILHR 83 of the Wisconsin Administrative Code governing mound sewage disposal systems.

OTHER: Areas consisting for the most part of disturbed land for which no interpretive data are available.

SURFACE WATER

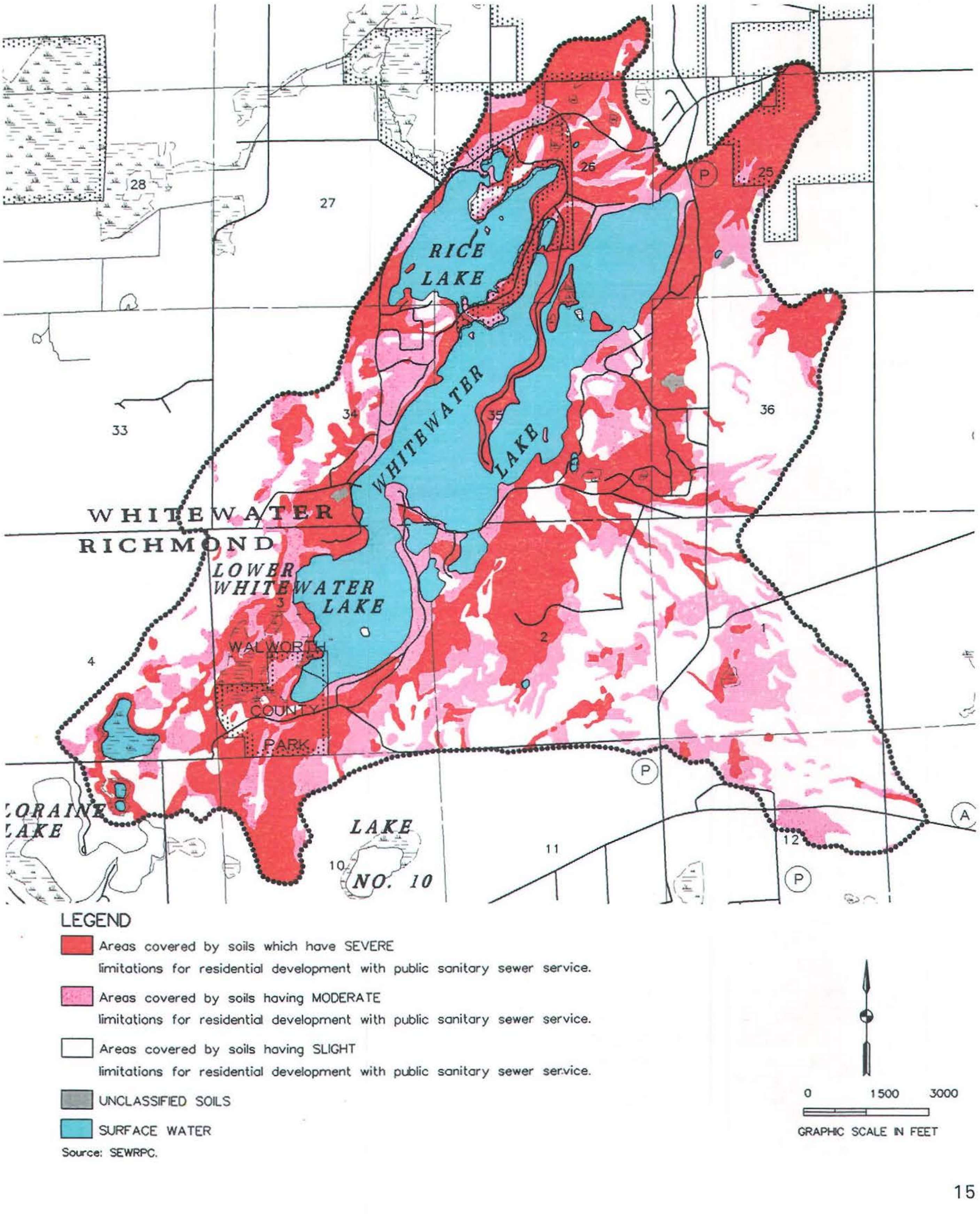
0 1500 3000

GRAPHIC SCALE IN FEET

Source: SEWRPC.

Map 9

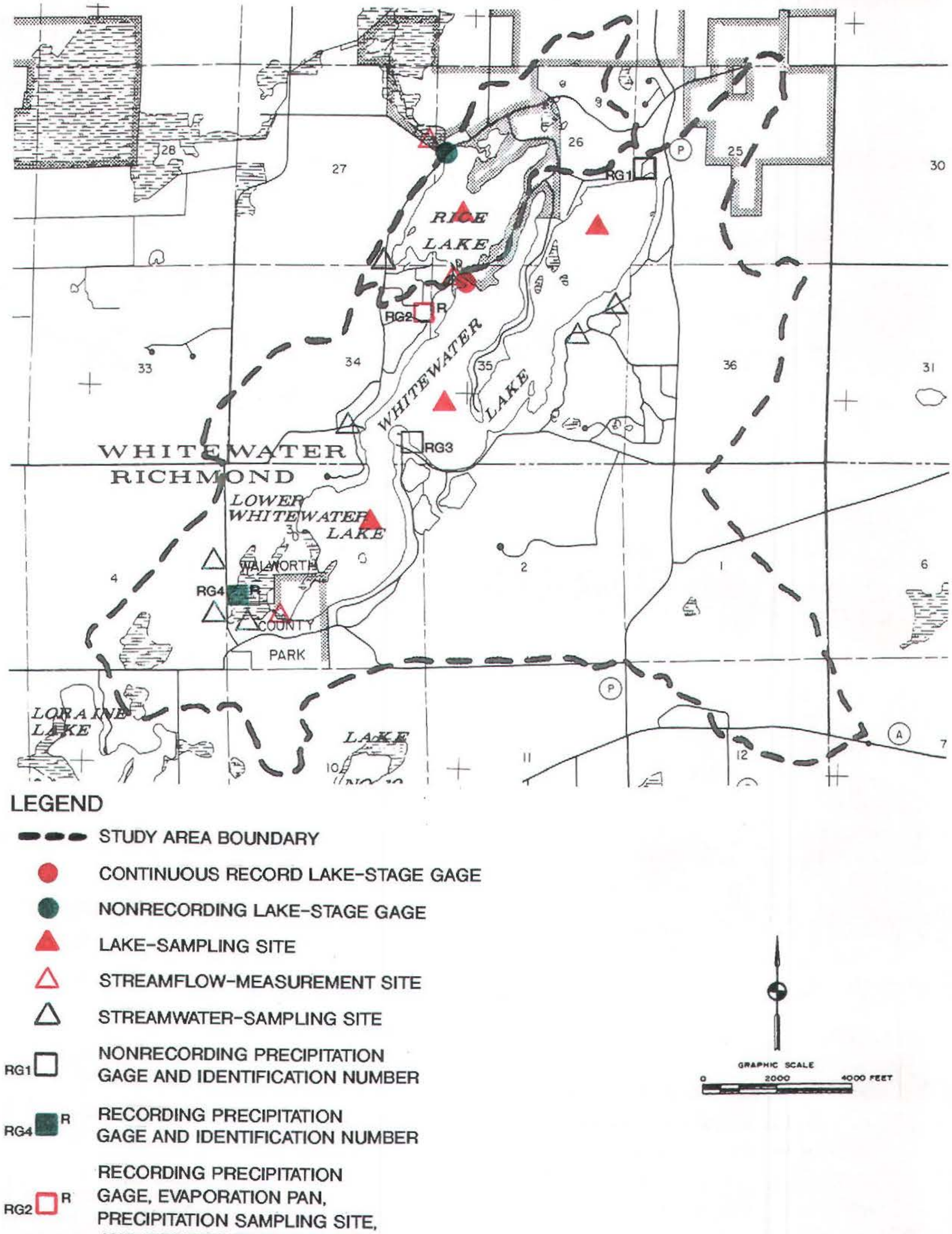
SUITABILITY OF SOILS WITHIN THE DRAINAGE AREA TRIBUTARY TO WHITEWATER AND RICE LAKES FOR RESIDENTIAL DEVELOPMENT WITH PUBLIC SANITARY SEWER



Source: SEWRPC.

Map 10

LOCATION OF MONITORING STATIONS WITHIN THE DRAINAGE AREA TRIBUTARY TO WHITEWATER AND RICE LAKES: 1991-1992



Source: U.S. GEOLOGICAL SURVEY.

Table 3

PRECIPITATION AND EVAPORATION DATA FOR WHITEWATER AND RICE LAKES: NOVEMBER 15, 1990 THROUGH NOVEMBER 14, 1991

Period	Precipitation (inches)					Evaporation Pan Data (inches)
	Station[a]					
	RG 1	RG 2	RG 3	RG 4	Whitewater	
November 15-30, 1990	1.10	1.19[b]	1.27	1.19[b]	1.19	0.60[c]
December	2.47[d]	2.47[d]	2.47[d]	2.47[d]	2.47[d]	0.28[c]
January 1991	1.21[b]	1.21[b]	1.21[b]	1.21[b]	1.21	0.00[c]
February	0.17[b]	0.17[b]	0.17[b]	0.17[b]	0.17	0.00[c]
March	3.76[b]	3.76[b]	3.76[b]	3.76[b]	3.76	0.14[c]
April	4.05	4.16	3.56	3.85	3.34	2.64[c]
May	2.18[c]	2.47	2.25	2.61	2.48	4.04
June	1.85	1.60	1.76	1.85	1.97	6.15
July	2.90	3.20	3.16	2.77	4.54	5.77
August	1.85	1.92	1.99	2.04	2.34	5.19
September	3.45	3.34	3.11[c]	3.63	3.74	2.93
October	6.30	7.20	6.48	7.76	4.94	1.44
November 1-14, 1991	0.79[c]	0.79	0.79[c]	0.67[c]	0.76	0.49[c]
Total	32.08	33.48	31.98	33.98	32.91	29.67
Pan Coefficient	- -	- -	- -	- -	- -	X 0.77
Evaporation	- -	- -	- -	- -	- -	22.85

[a]See Map 10 for location.

[b]Daily precipitation record from National Weather Service station at Whitewater, Wisconsin.

[c]Estimated.

[d]Daily precipitation record from National Weather Service station at Lake Geneva, Wisconsin.

Source: U.S. Geological Survey.

Streamflow and Runoff

Streamflow in the Whitewater Lake inlet consists mainly of flow from several springs located at the south end of the Lake. Monthly discharge measurements made near the mouth of the inlet during the period of November 1, 1990 through November 30, 1991, ranged from 1.2 to 1.8 cubic feet per second (cfs) and averaged 1.5 cfs. Streamflow was greatest in spring and early summer and declined through the summer. Annual baseflow runoff for the inlet during November 15, 1990 through November 14, 1991, was estimated to be 1,050 acre-feet.

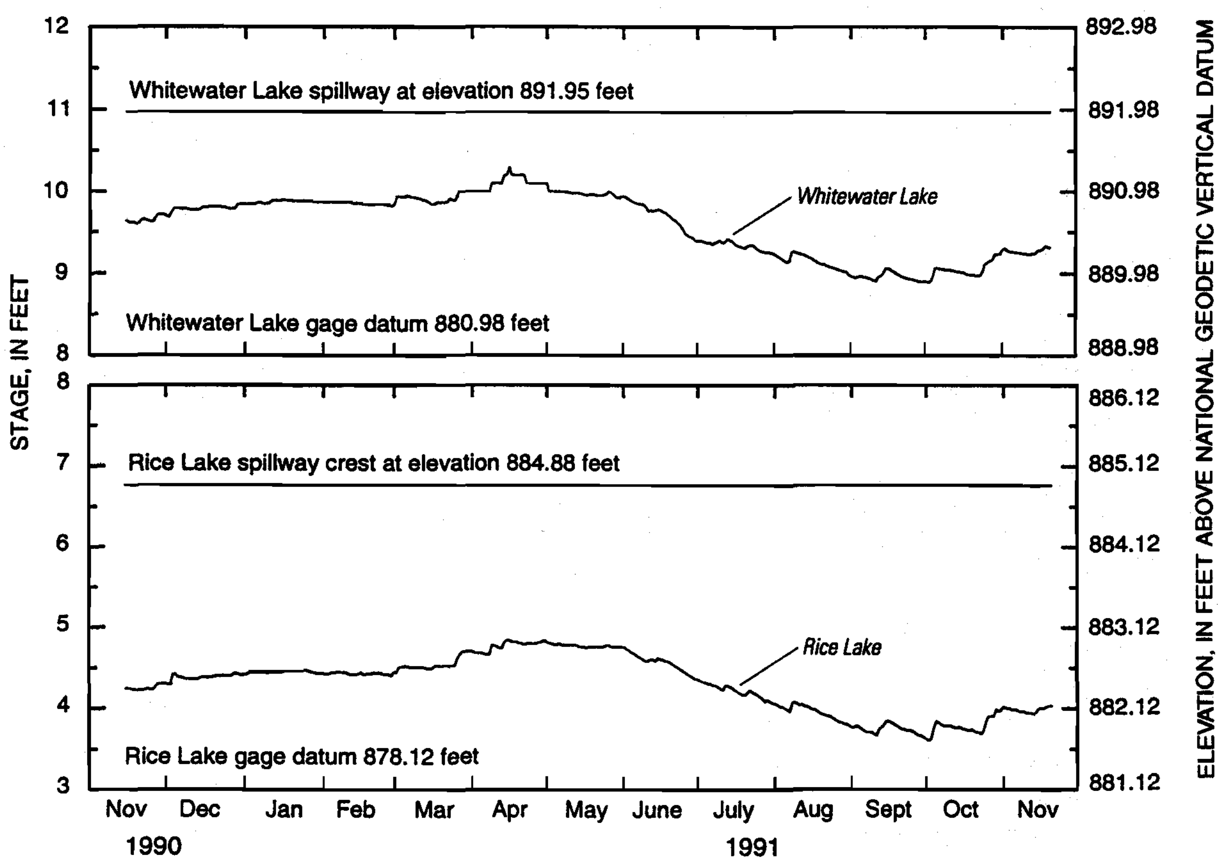
Stormwater runoff from the drainage area contributing to Whitewater Lake, not including the Whitewater Lake inlet, was estimated to be 141 acre-feet during the period of November 15, 1990 through November 14, 1991. Runoff from the drainage area contributing to Rice Lake was estimated to be 22 acre-feet. Runoff was greatest during winter and spring in response to snowmelt or rain on frozen ground.

Groundwater Flow

Twelve small-diameter wells installed along the shoreline of Whitewater Lake and four such observation wells installed along the shoreline of Rice Lake, as shown on Map 11, were used to determine the direction, and estimate the rate, of local groundwater flow, during the study period of November 15, 1990 through November 14, 1991.

Figure 1

STAGES OF WHITEWATER AND RICE LAKES: NOVEMBER 1990 AND NOVEMBER 1991



Source: U.S. Geological Survey and SEWRPC.

Groundwater levels were higher than the surfaces of Whitewater and Rice Lakes at the observation wells in the Southern Bay area (Little Whitewater Lake) and on the eastern shore of Rice Lake, an indication of groundwater flow to the Lakes at these locations. Groundwater levels were lower than the surfaces of the Lakes at all other after observation wells, which indicates groundwater flow away from the Lakes at those well locations.

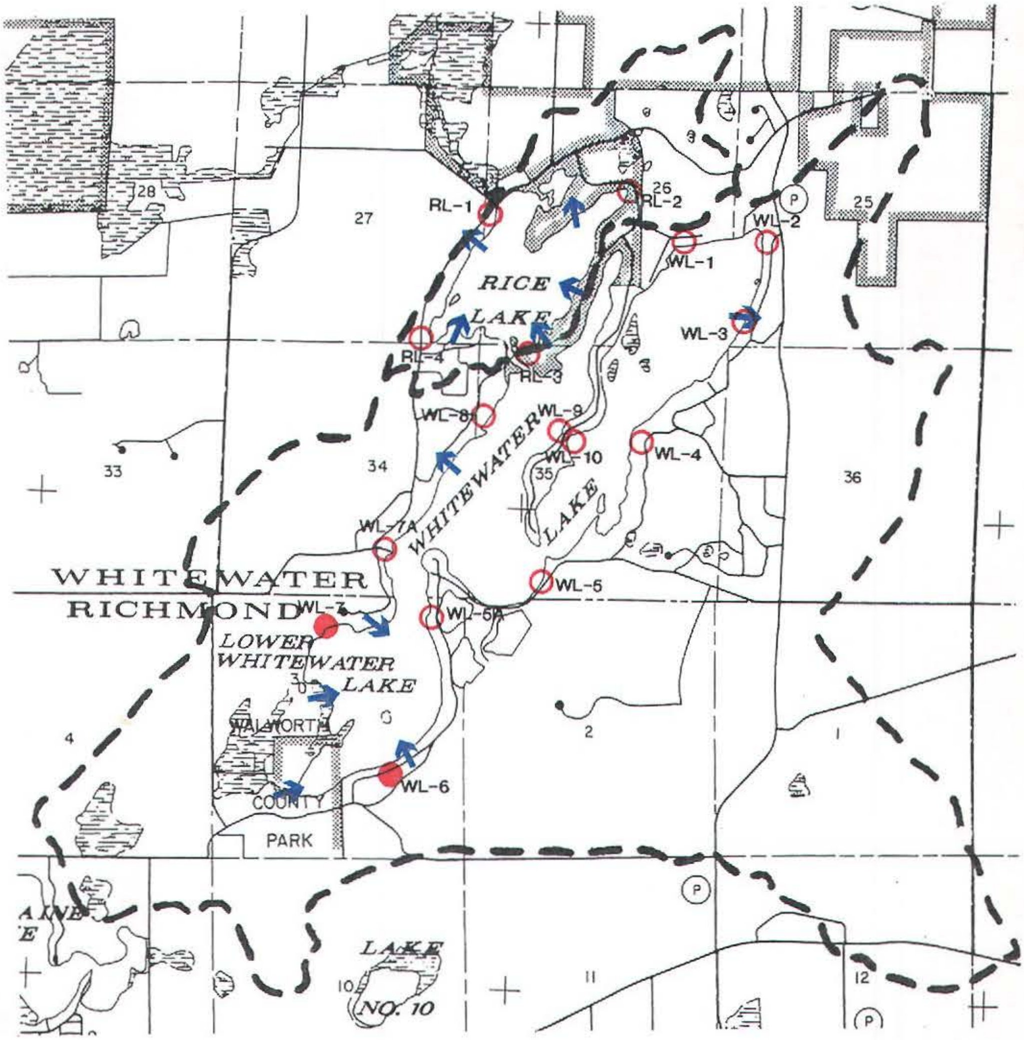
Water Budget

Based on the available data, an annual water budget for Whitewater and Rice Lakes was estimated by the U.S. Geological Survey, as set forth in Figure 2.[6] During the period from November 15, 1990 through November 14, 1991, an estimated 7,051 acre-feet, and 499 acre-feet, of water entered Whitewater Lake and Rices Lake, respectively. Estimated stream inflow volumes ranged from approximately 1,050 acre-feet for Whitewater Lake

[6]*U.S. Geological Survey, Water Resources Investigation Report 44-410, "Hydrology and Water Quality of Whitewater and Rice Lakes in Southeastern Wisconsin, 1990-1991," 1994.*

Map 11

LOCATION OF MONITORING WELLS WITHIN THE DRAINAGE AREA TRIBUTARY TO WHITEWATER AND RICE LAKES: 1991-1992



LEGEND

STUDY AREA BOUNDARY

DIRECTION OF GROUND-WATER FLOW

RL-2 OBSERVATION WELL AND IDENTIFICATION NUMBER

WL-5 OBSERVATION WELL AND WATER QUALITY SAMPLING SITE

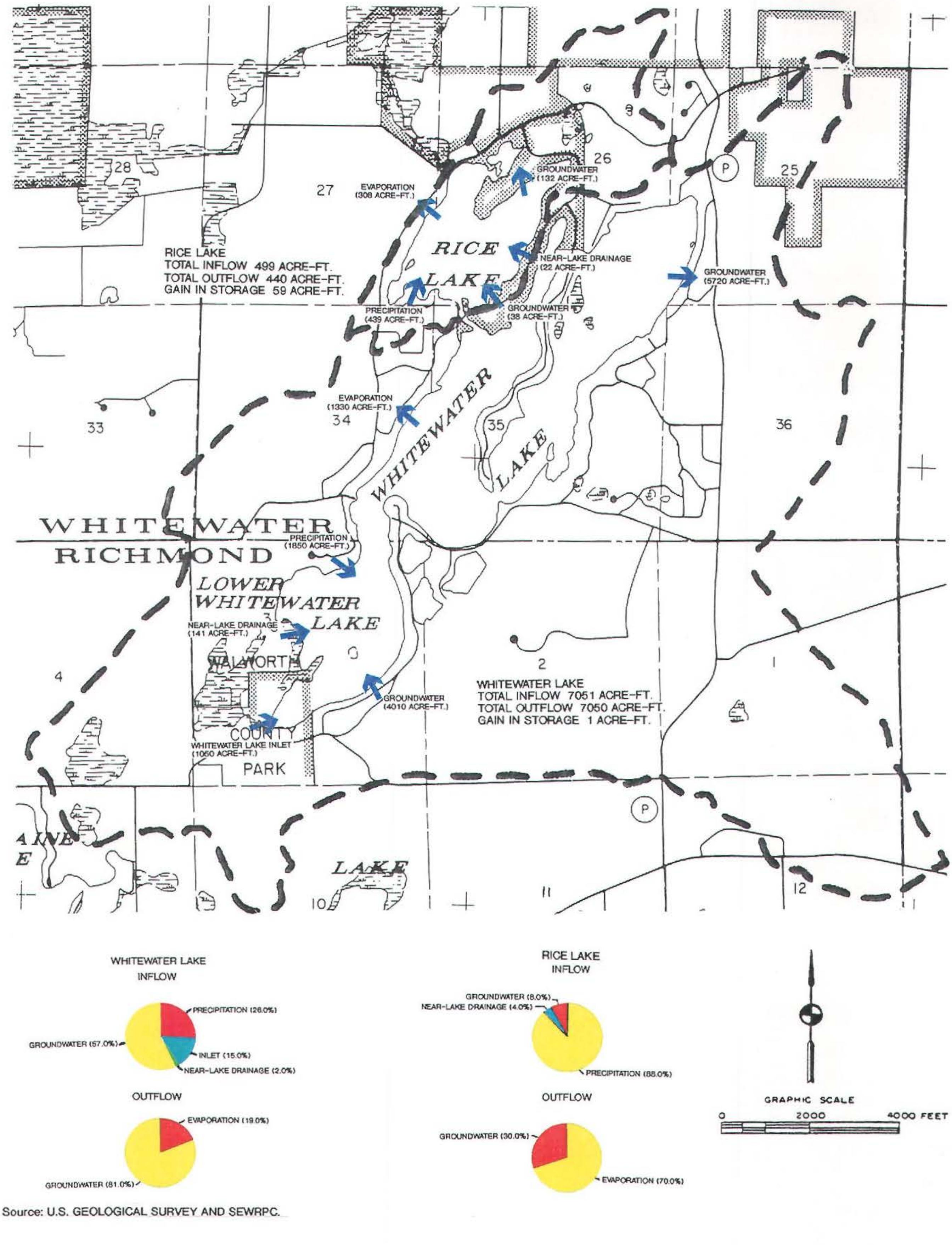
Source: SEWRPC.

to no inflow for Rice Lake. The remainder of the known inflow came from surface runoff draining directly to the Lakes, direct precipitation on the Lakes, and groundwater. Groundwater dominates the inflow and outflow of the hydrologic budget for Whitewater Lake, while precipitation and evaporation are most significant for Rice Lake. An estimated 7,050 acre-feet, and 440 acre-feet, of water per year were lost from the Whitewater and Rice Lakes, respectively, via groundwater flows and evaporation from the Lakes surfaces during the study period. After accounting for additional, unspecified losses, the net loss of water resulted in an average decrease in the lake levels of about 0.74 feet, and 0.59 feet, for Whitewater and Rice Lakes, respectively, during this period.

The hydraulic residence time, or the time required for a volume equivalent to the full volume of the lake to enter the lake basin, was approximately 0.82 years for Whitewater Lake, and 1.86 years for Rice Lake during the study period. The longer residence time for Rice Lake implies that the water quality of the Lake will less directly reflect influent quality and will develop more of a lacustrine character.

Figure 2

HYDROLOGIC BUDGET FOR THE DRAINAGE AREA TRIBUTARY TO WHITEWATER AND RICE LAKES: 1990-1991



Source: U.S. GEOLOGICAL SURVEY AND SEWRPC.

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Chapter III

HISTORICAL, EXISTING, AND PLANNED LAND USE AND POPULATION

INTRODUCTION

Water pollution problems, recreational use conflicts, and the risk of damage to the environment, and the ultimate means for abatement of these problems, are primarily a function of the human activities within the drainage area of a waterbody and of the ability of the underlying natural resource base to sustain those activities. This is especially true in an area directly tributary to a lake because lakes are highly susceptible to water quality degradation attendant to human activities in their immediate drainage area, there being no intermediate stream segments to attenuate pollutant loads. Accordingly, the population and attendant land uses in the drainage area of a lake are important considerations in any lake water quality management planning effort.

CIVIL DIVISIONS

The geographic extent and the functional responsibilities of civil divisions and special purpose units of government are important factors which must be considered in any lake management planning effort, since these local units of government provide the basic structure of the decision-making framework within which problems must be addressed. Superimposed on the Whitewater and Rice Lakes drainage area are the local civil division boundaries, as shown on Map 12. The drainage area of Whitewater and Rice Lakes includes portions of the Towns of Whitewater, Sugar Creek and Richmond. The area and proportion of the drainage area lying within each jurisdiction concerned, as of 1990, is set forth in Table 4.

POPULATION

As indicated in Table 5, the resident population of the Whitewater and Rice Lakes tributary drainage area has increased steadily between 1963 and 1980 and then remained relatively stable through 1990. The 1990 resident population of the drainage area tributary to Whitewater and Rice Lakes was estimated at approximately 950 persons, about the same as the 1980 level. Population forecasts prepared by the Regional Planning Commission, as a basis for the adopted regional land use plan,[1] indicate, as shown in Table 5, that the resident population of the drainage area tributary to Whitewater and Rice Lakes may be expected to remain relatively stable with only a small increase of about 5 percent to about 1,000 persons by the year 2010.

As indicated in Table 5, the number of resident households in the drainage area tributary to Whitewater and Rice Lakes also increased steadily between 1963 and 1980 and has since remained stable, with only a small increase since 1980. The regional plan envisions that the number of resident households in the area will increase by about 12 percent, from about 370 in 1990 to about 415 in the year 2010.

In addition to the resident population, there were, as of 1990, about 300 seasonal housing units and about 680 seasonal residents residing within the drainage area tributary to Whitewater and Rice Lakes.

Land Use

The type, intensity, and spatial distribution of the various land uses within the drainage area tributary to Whitewater and Rice Lakes are important determinants of lake water quality, and recreation use demands. In this regard, the current and planned future land use patterns, placed in the context of the historical development of the area are important considerations in lake management planning for Whitewater and Rice Lakes. The movement of European settlers into the Southeastern Wisconsin Region began about 1830. Completion within

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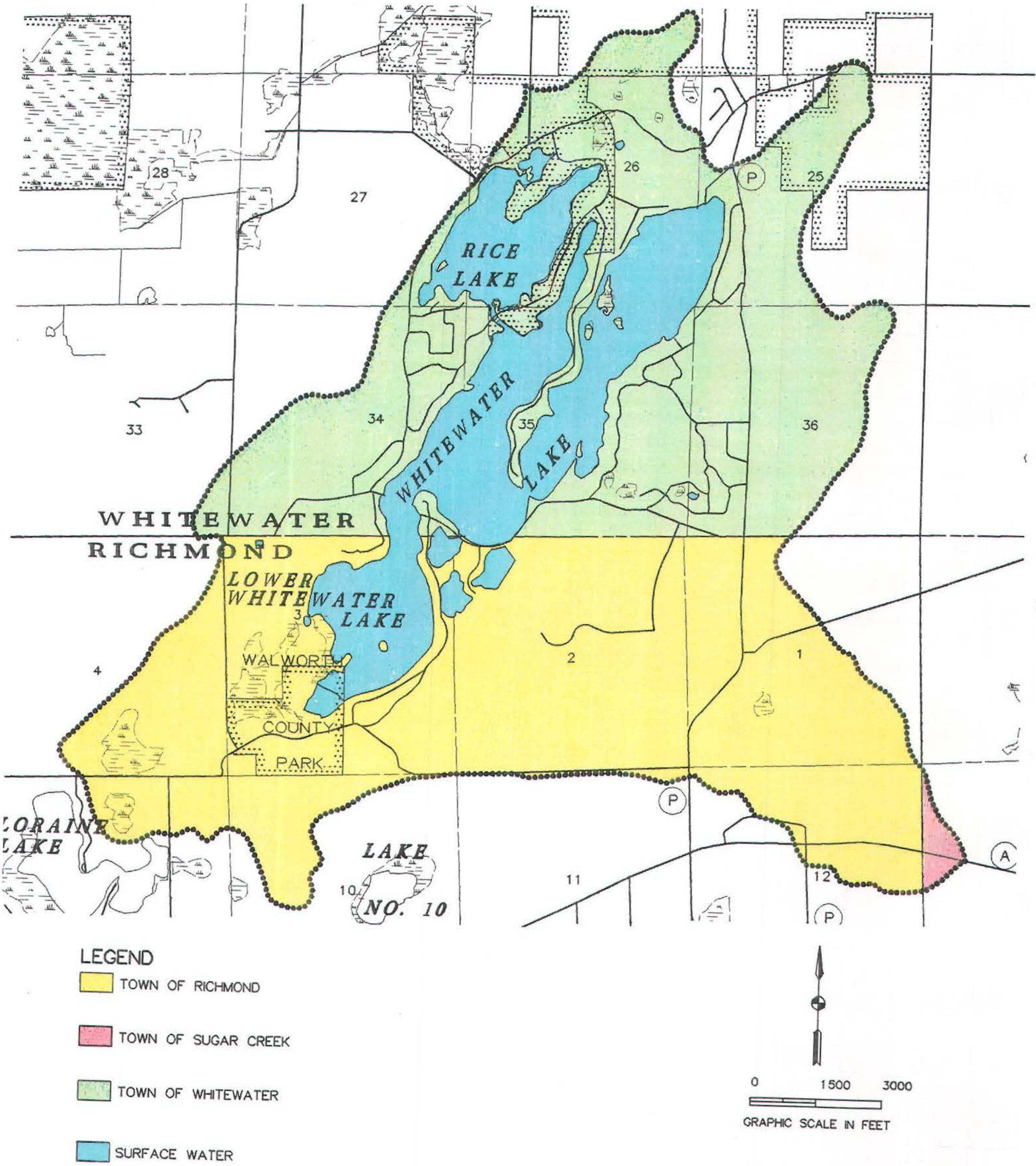
[1] *SEWRPC Planning Report No. 40, A Regional Land Use Plan for Southeastern Wisconsin—2010, January 1992.*

Map 12

CIVIL DIVISION BOUNDARIES IN THE DRAINAGE AREA TRIBUTARY TO WHITEWATER AND RICE LAKES



Source: SEWRPC.

Table 4

AREAL EXTENT OF CIVIL DIVISIONS IN THE DRAINAGE AREA TRIBUTARY TO WHITEWATER AND RICE LAKES: 1990

Civil Division	Civil Division Area within Tributary Drainage Area (acres)	Percent of Tributary Drainage Area within Civil Division	Percent of Civil Division within Tributary Drainage Area
Town of Richmond	2,231	54	10
Town of Whitewater	1,831	45	9
Town of Sugar Creek	31	1	<1
Total	4,093	100	- -

Source: SEWRPC.

Table 5

HISTORIC AND FORECAST HOUSEHOLD AND RESIDENT POPULATION LEVELS IN THE DRAINAGE AREA TRIBUTARY TO WHITEWATER AND RICE LAKES: 1963-2010[a]

Year	Number of Households	Number of Residents
1963	102	340
1970	235	910
1980	340	950
1985	357	950
1990	368[b]	950[b]
2010[c]	415	1,000

[a]*Study area approximated using whole U.S. Public Land Survey one-quarter sections.*

[b]*In addition to the households and resident population noted, as of 1990, there were about 300 seasonal housing units and a seasonal or part-time population of about 680 persons.*

[c]*Year 2010 data are presented for recommended land use plan as set forth in the year 2010 regional land use plan.*

Source: SEWRPC.

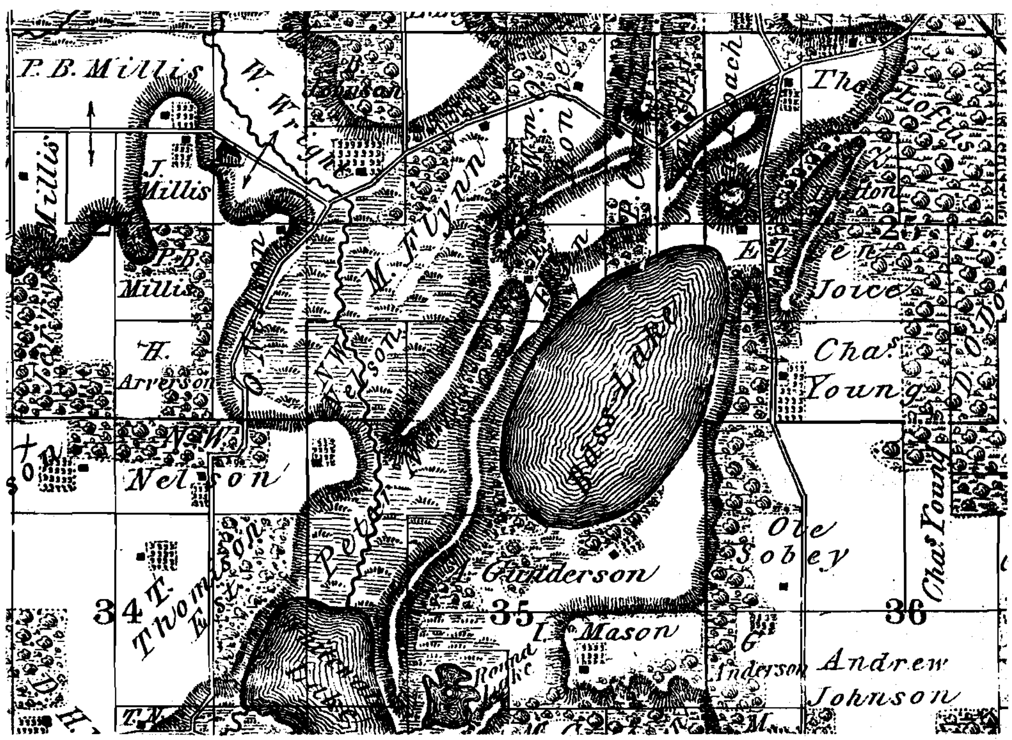
Southeastern Wisconsin of the U.S. Public Land Survey in 1836 and the subsequent sale of public lands in Wisconsin brought a rapid influx of settlers into the area. Map 13 represents a plat map of what the Whitewater and Rice Lakes area looked like in 1873.

As previously noted, Whitewater and Rice Lakes were not formed until 1947 and 1954, respectively, by the construction of dams on Whitewater Creek. Thus, no significant development around these Lakes occurred until the 1950s. Map 14 and Table 6 indicate the historic urban growth pattern in the drainage area tributary to Whitewater and Rice Lakes since 1963. The most rapid increase in urban land use development occurred between 1963 and 1980. The rate of urban development in the drainage area tributary to Whitewater and Rice Lakes after 1980 has decreased in comparison to previous years, and few changes have occurred in the last decade.

The existing land use patterns in the drainage area tributary to Whitewater and Rice Lakes, as of

Map 13

HISTORIC PLAT MAP FOR WHITEWATER AND RICE LAKES AREA: 1873



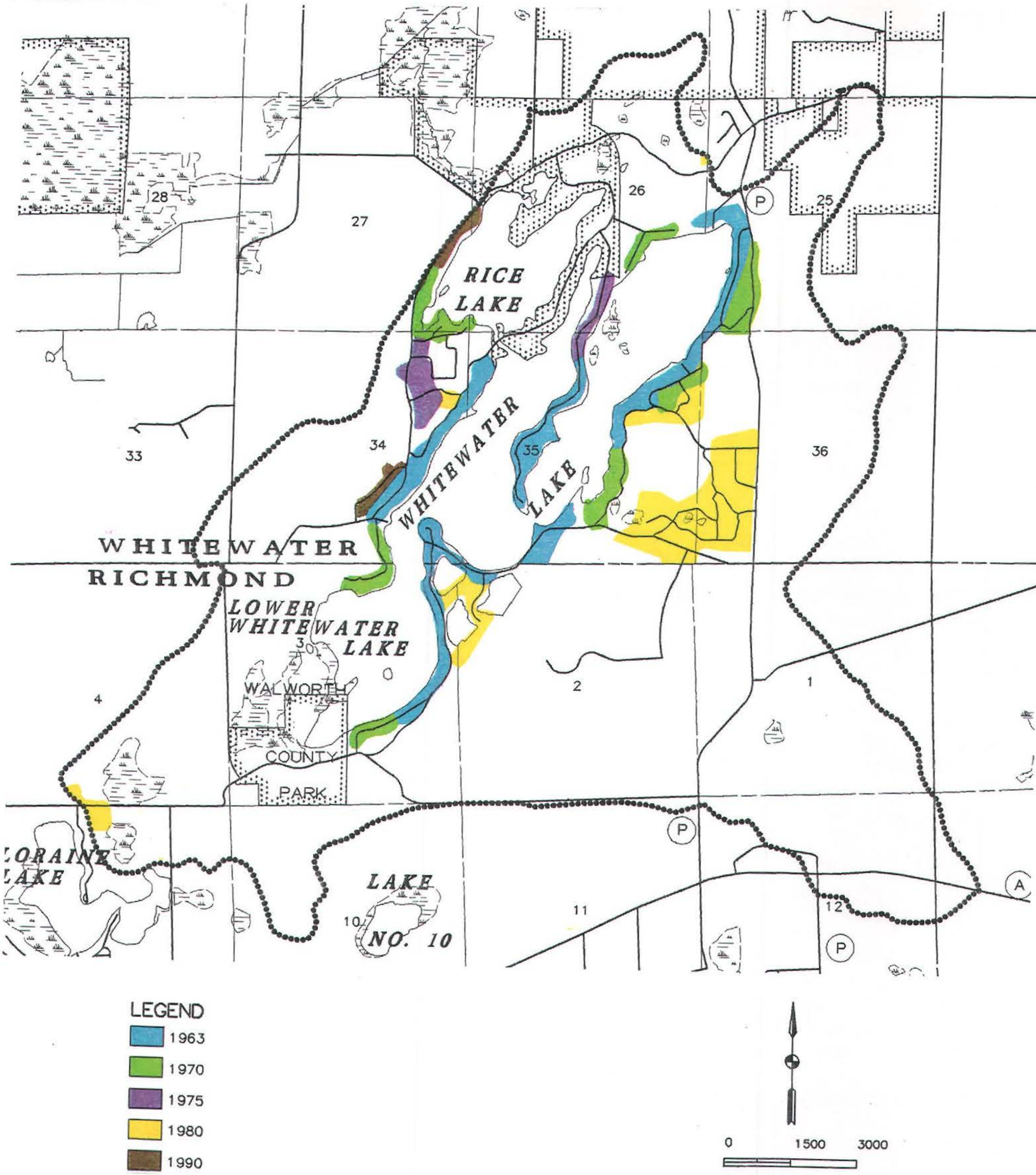
Source: F. Krause, C.E., Ann Arbor, Michigan.

1990, are shown on Map 15 and quantified in Table 7. As indicated in Table 7, by 1990, about 764 acres, or about 14 percent of the tributary drainage area, were in urban land uses, with the dominant urban land use being residential, encompassing 416 acres, or about 54 percent of the area in urban use. As of 1990, about 4,694 acres, or about 86 percent of the drainage area tributary to Whitewater and Rice Lakes, were still in rural land use. About 1,915 acres, or about 41 percent of the rural area, were in agricultural land uses. Woodlands, wetlands, and surface water, including the surface areas of Whitewater and Rice Lakes, accounted for approximately 2,505 acres, or about 53 percent of the area in rural use. Extractive operations comprised the remaining 6 percent of the area under rural land use. Most of these lands which encompass the immediate shorelands of Whitewater and Rice Lakes and substantial other park and open space lands in the drainage area tributary to Whitewater and Rice Lakes have been designated in the adopted regional land use plan as primary environmental corridor as discussed in Chapter V, and are recommended to be kept essentially natural, open uses.

As of 1990, the shoreland of Whitewater Lake is almost entirely developed for residential uses, with the exception of the western and southern shore of the south bay and the western shore of the northwest lobe, which remains in park and open space use. As of 1990, the shoreland of Rice Lake is primarily in park and open space use, with some residential development being located along the western shoreline. As noted in Chapter II, the results of a hydrologic study conducted in 1990 and 1991, indicate that, due to the character of the topography and soils in the area, there are normally only about 900 acres and about 1.4 square miles

Map 14

HISTORIC URBAN GROWTH IN THE DRAINAGE AREA TRIBUTARY TO WHITEWATER AND RICE LAKES



Source: SEWRPC.

Table 6

EXTENT OF HISTORIC URBAN GROWTH IN THE DRAINAGE AREA TRIBUTARY TO WHITEWATER AND RICE LAKES: 1963-1990

Year	New Urban Development[a] Occurring Since Previous Year	Cumulative Extent of Urban Development[a] (acres)
1963	182	182
1970	111	293
1975	39	332
1980	175	507
1990	19	526

[a]Urban development, as defined for the purposes of this discussion, includes those areas within which houses or other buildings have been constructed in relatively compact groups, thereby indicating a concentration of urban land uses. Scattered residential development were not considered in this analysis.

Source: U.S. Bureau of Census and SEWRPC.

of land surface which actually contribute drainage to Whitewater and Rice Lakes, respectively under all but extremely high periods of rainfall. These areas are shown on Map 5. These areas include all of the shoreline development and other lands located nearest to the Lakes. In total, about 260 acres, or about 22 percent of the approximately 1,100 acre area, which normally contributes runoff to the lakes were, in 1990, devoted to urban uses. These urban areas consist almost entirely of lakeshore residential land uses with some scattered commercial development.

Under year 2010 conditions, no significant changes in land use conditions within the drainage area tributary to Whitewater and Rice Lakes are envisioned in the regional land use plan, although some infilling of existing platted lots and some backlot development may be expected to occur. In addition, the redevelopment of properties and the reconstruction of existing single-family homes may be expected on lakeshore properties.

EXISTING ZONING REGULATIONS

The comprehensive zoning ordinance represents one of the most important and significant tools available to local units of government in directing the proper use of lands within their area of jurisdiction. The drainage area tributary to Whitewater and Rice Lakes includes portions of the Towns of Whitewater, Richmond, and Sugar Creek.

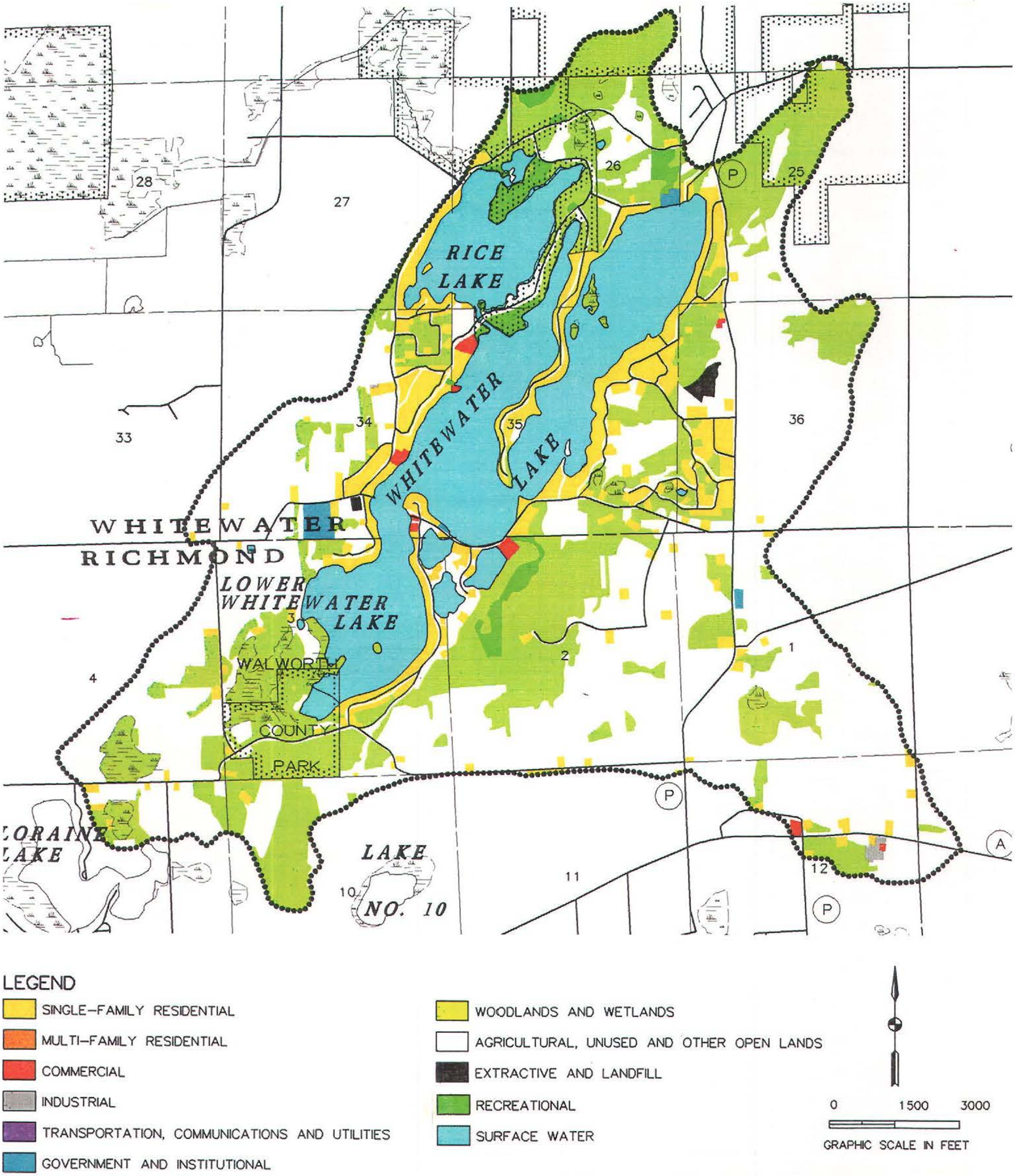
In 1990, zoning in the drainage area tributary to Whitewater and Rice Lakes was governed by county-town zoning ordinances. The zoning regulations are based on a general zoning ordinance entitled, "Zoning Ordinance, Walworth County, Wisconsin," and a shoreland ordinance entitled, "Shoreland Zoning Ordinance, Walworth County, Wisconsin." The current general zoning districts applicable to the drainage area tributary to Whitewater and Rice Lakes, as provided for under the current zoning regulations are shown on Map 16.

As shown on Map 16, the majority of currently undeveloped lands within the drainage area tributary to Whitewater and Rice Lakes were, in 1990, zoned for agricultural, park or other open space use. As noted earlier, no significant new urban development is recommended for the area. Thus, the current general zoning is generally consistent with the land use recommendations in this regard.

Section 59.971 of the Wisconsin Statutes requires counties in Wisconsin to enact ordinances to regulate the use of shoreland areas within the unincorporated areas of the counties. The regulations apply to lands within the following distances from the ordinary high water mark of navigable waters: 1,000 feet from a lake, pond, or flowage, and 300 feet from a river or stream, or to the landward side of a floodplain, whichever distance is greater. The standards and criteria for the ordinances are set forth in Chapter NR 115 of the Wisconsin Administrative Code. They include sanitary regulations, and restrictions on lot sizes, on building setbacks, and on filling, grading, and dredging. Moreover, under Chapter NR 115, all counties in the State must place wetlands five acres or more in size within the statutory shoreland

Map 15

EXISTING LAND USES WITHIN THE DRAINAGE AREA TRIBUTARY TO WHITEWATER AND RICE LAKES: 1990



Source: SEWRPC.

Table 7

EXISTING 1990 AND FORECAST 2010 LAND USE IN THE WHITEWATER AND RICE LAKES STUDY AREA[a]

Land Use	1990		2010		Percent Change
	Acres	Percent	Acres	Percent	
Urban					
Residential	416	8	424	8	- -
Commercial	15	< 1	14	< 1	- -
Industrial	8	< 1	9	< 1	- -
Transportation/Utilities	219	4	220	4	- -
Governmental/Institutional	19	< 1	19	< 1	- -
Recreational	85	1	111	2	1
Unused Urban	2	< 1	2	< 1	- -
Subtotal	764	14	800	15	1
Rural					
Agricultural	1,915	35	1,935	35	- -
Woodland	1,472	27	1,454	27	- -
Wetland	125	2	125	2	- -
Water	908	17	908	17	- -
Other	274	5	233	4	-1
Subtotal	4,694	86	4,658	85	-1
Total	5,458	100	5,458	100	0

[a]*Based on data files organized by whole U.S. Public Land Survey section.*

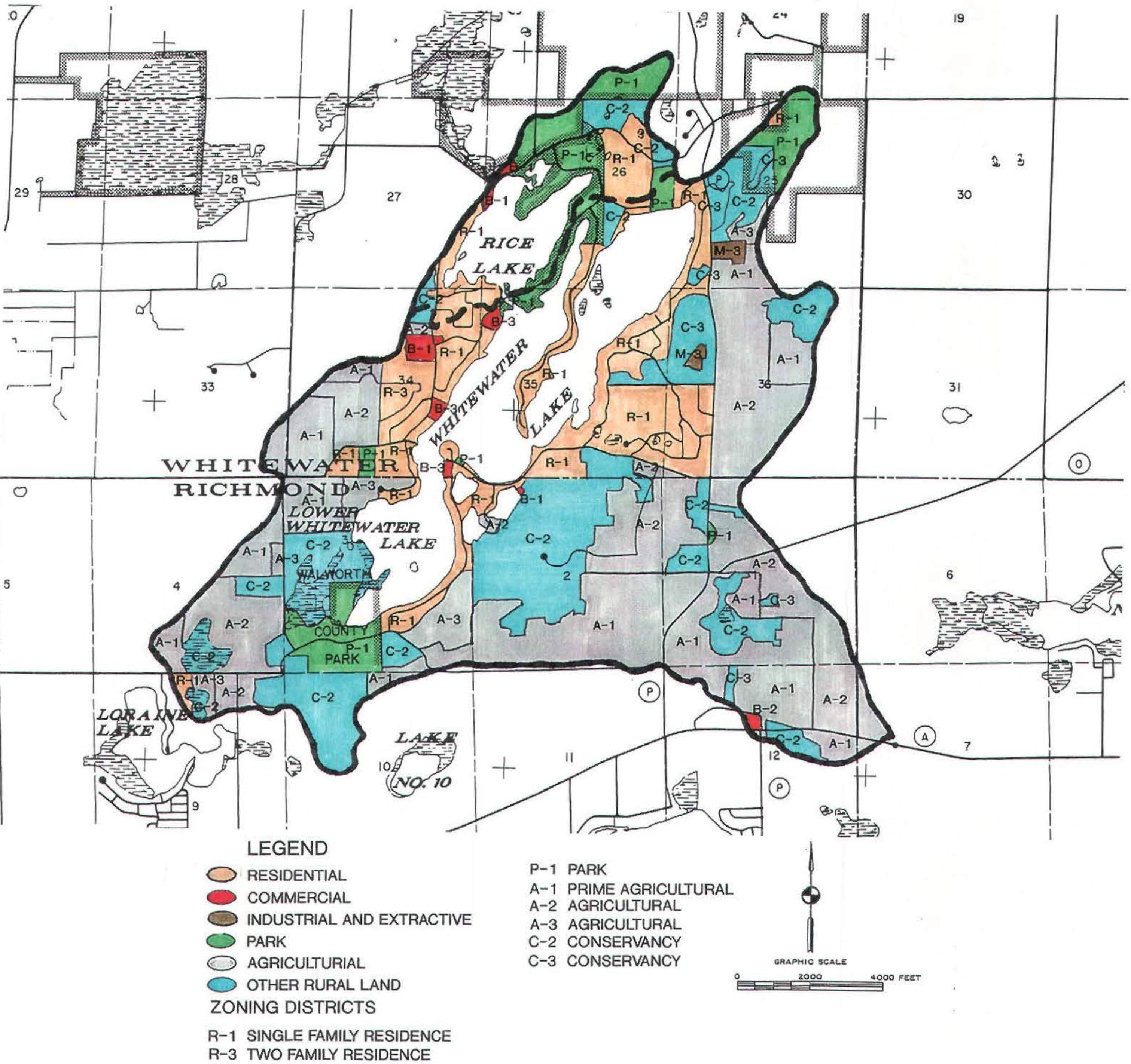
Source: SEWRPC.

zoning jurisdiction area in a shoreland-wetland zoning district to ensure their preservation.

In accordance with Chapter NR 115 of the Wisconsin Administrative Code, Walworth County has adopted ordinances which regulate the use of wetlands five acres or larger and certain other wetlands within the aforementioned jurisdictional shoreland areas. These regulations will help prevent the loss of major wetlands within the shoreland areas.

Map 16

EXISTING ZONING DISTRICTS WITHIN THE DRAINAGE AREA TRIBUTARY TO WHITEWATER AND RICE LAKES: 1990



LEGEND

- RESIDENTIAL
- COMMERCIAL
- INDUSTRIAL AND EXTRACTIVE
- PARK
- AGRICULTURIAL
- OTHER RURAL LAND

ZONING DISTRICTS

R-1 SINGLE FAMILY RESIDENCE
R-3 TWO FAMILY RESIDENCE
B-1 LOCAL BUSINESS
B-2 GENERAL BUSINESS
B-3 WATERFRONT BUSINESS
M-3 MINERAL EXTRACTION
P-1 PARK
A-1 PRIME AGRICULTURAL
A-2 AGRICULTURAL
A-3 AGRICULTURAL
C-2 CONSERVANCY
C-3 CONSERVANCY

GRAPHIC SCALE
0 2000 4000 FEET

Source: SEWRPC.

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Chapter IV

WATER QUALITY

INTRODUCTION

The earliest definitive data on water quality conditions in Whitewater Lake were collected by Professor Willard L. Gross of the University of Wisconsin-Whitewater in the early 1970s.[1] Other sources of information on the historical water quality conditions in Whitewater Lake include: the results of the measurements made by the Wisconsin Department of Natural Resources during the National Eutrophication Survey of 1973-75; and the results of the ongoing Long-Term Trends monitoring study conducted by the Wisconsin Department of Natural Resources since 1987. In addition, water clarity data were collected from both Whitewater and Rice Lakes by various resident volunteers under the Wisconsin Department of Natural Resources Self-Help Monitoring program since 1986. These data all indicate that Whitewater and Rice Lakes have relatively poor water quality at the times of those studies and that there was evidence of enrichment and excessive fertilization.

More recently, residents of Whitewater and Rice Lakes have expressed concerns about deteriorating water quality conditions—the Lake being described as eutrophic or nutrient enriched—and, in 1986, the Whitewater and Rice Lakes Management District began to take action to define the extent of perceived water quality degradation taking place in the Lakes. In response to citizen concerns, a comprehensive water quality monitoring program was developed by the District in cooperation with the U.S. Geological Survey. The U.S. Geological Survey, with local assistance provided by the Whitewater and Rice Lakes Management District, then conducted that water quality monitoring program for Whitewater and Rice Lakes from November 1990 through November 1991. This program involved the determination of physical, chemical, and biological characteristics of the Lakes' waters, including dissolved oxygen concentration and water temperature profiles, pH, specific conductance, water clarity, total and dissolved phosphorus concentrations, and chlorophyll-a concentrations. In addition to these data, the U.S. Geological Survey collected information on lake level and the basic hydrology of the Lake.[2]

The in-lake water quality monitoring investigations were funded by the State and Lake Management District under the Lake Management Planning Grant Program provided for under Chapter NR 119 of the Wisconsin Administrative Code. The data obtained through that program and the earlier investigation were used in the development of this lake protection plan, which has also been funded in part through the State Lake Management Planning Grant Program.

EXISTING WATER QUALITY CONDITIONS

The data collected during the period of 1987 through 1994 by the Wisconsin Department of Natural Resources and during 1990 and 1991 by the U.S. Geological Survey were used to determine water quality conditions in Whitewater and Rice Lakes and to characterize the suitability of the Lakes for recreational use and the support of fish and aquatic life. These data are summarized in Tables 8 through 14.

The most intensive water quality monitoring was conducted during the 1991-1992 U.S. Geological

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[1] *Ecology Committee of Whitewater Lake (W.L. Gross), Progress Report on Feasibility Study of Whitewater Lake, November 1971; W.L. Gross, Whitewater Lake Water Quality Study, April 1972.*

[2] *These data are set forth in U.S. Geological Survey Water-Resources Investigations Report No. 94-4101, Hydrology and Water Quality of Whitewater and Rice Lakes in Southeastern Wisconsin, 1990-91, 1994.*

Table 8

SEASONAL WATER QUALITY DATA FOR WHITEWATER LAKE: 1987-1994

Parameter	Fall		Spring		Summer	
	Shallow	Deep	Shallow	Deep	Shallow	Deep
Water Temperature (°F)						
Range	33.8-40.0	38.4-41.0	43.5-75.2	43.5-50.6	71.6-80.6	46.8-60.8
Mean	38.5 (5)	39.4 (5)	58.3 (8)	47.8 (8)	76.4 (15)	52.0 (15)
Conductivity (μmhos/cm)						
Range	207-280	232-321	260-365	260-370	245-416	304-470
Mean	230 (4)	277 (5)	307 (7)	315 (7)	305 (15)	385 (15)
pH (standard units)						
Range	7.1-8.8	7.5-8.6	7.2-8.8	7.2-8.6	7.7-9.8	7.1-8.4
Mean	8.2 (6)	8.0 (6)	8.1 (8)	9.1 (8)	9 (14)	7.8 (14)
Dissolved oxygen (mg/l)						
Range	4.0-16.6	0.5-6.2	8.8-12.6	0.1-12.0	7.8-12.1	0-1
Mean	10 (5)	2.7 (5)	10.3 (8)	6.2 (8)	9.5 (15)	0.27 (15)
Total Phosphorus (mg/l)						
Range	0.014-0.059	0.021-0.136	0.019-0.036	0.021-0.129	0.021-0.129	0.021-0.430
Mean	0.024 (6)	0.070 (6)	0.03 (10)	0.04 (10)	0.04 (10)	0.16 (17)
Chlorophyll-a (μg/l)						
Range	1.71-3.83	- -	3.28-22	- -	4-56	- -
Mean	5.54 (2)		10.4 (10)		22 (16)	
Secchi (m)						
Range	1.8-6.2	- -	1-2.8	- -	0.9-2.3	- -
Mean	2.8 (8)		1.7 (8)		1.3 (16)	

Source: Wisconsin Department of Natural Resources, U.S. Geological Survey, and SEWRPC.

Survey study. During that study, water quality samples were taken from the main basins of the Lakes once per month in April, October and November, and twice per month in May through September, during the study period of November 15, 1990 through November 14, 1991. The primary sampling stations were located at the deepest points in the Lakes—the U.S. Geological Survey Heart Prairie station in Whitewater Lake and deep hole station in Rice Lake, and at two additional locations in Whitewater Lake—the U.S. Geological Survey North Bay and South Bay stations, as shown on Map 10. The data collected from both Lakes indicate that the water quality conditions of Whitewater Lake were similar to those of Rice Lake.

Thermal Stratification

Thermal and dissolved oxygen profiles for Whitewater and Rice Lakes are shown in Figures 3 through 6. Water temperature ranged from 42.2°F during the winter to 82.5°F during the summer at the three stations in Whitewater Lake, and from 44.2°F during the winter to 80.8°F during the summer at the Rice Lake station. Complete mixing of the Lakes was restricted by thermal stratification in the summer and by ice cover in the winter.

Thermal stratification is the result of differential heating of lake water and the resulting water temperature-density relationships. Water is unique among liquids because it reaches its maximum density—or weight per unit of volume—at about 39.2°F. The development of thermal stratification begins in early summer, reaches its maximum in late summer, and disappears in the fall, as illustrated diagrammatically in Figure 7. Stratification may also occur in winter under ice-cover. This process is described below.

Table 9

WHITEWATER LAKE SPRING OVERTURN WATER QUALITY DATA: 1987-1992 AND 1994

Parameter	April, 1987		April 14, 1988		April 27, 1989		April 10, 1990		April 25, 1991		April 16, 1992		April 21, 1994	
	Shallow	Deep	Shallow	Deep	Shallow	Deep	Shallow	Deep	Shallow	Deep	Shallow	Deep	Shallow	Deep
Depth of Sample	0	35	0	30	0	38	0	35	0	30	0	35	0	35
Water Temperature (°F)	45.5	44.9	51.9	51.6	57.5	48.2	43.5	43.5	52.5	48.5	39.8	38.4	54.0	49.0
Turbidity	3.6	- -	3.3	3.8	1.2	2.8	1.6	- -	2.2	4.7	1.9	2.0	1.9	2.0
Clarity (Secchi)	4.3	4.3	3.3	3.3	9.2	9.2	6.6	6.6	5.0	5.0	6.6	6.6	5.6	5.6
Conductivity	295	293	320	320	268	285	260	260	292	310	280	281	- -	- -
Dissolved Oxygen	12	11.5	12.6	10.3	10.3	4.7	12	12	10.8	7.4	12.6	11.8	10.6	6.7
pH	8.5	8.4	8.5	8.5	8.8	8.6	7.5	7.9	7.8	7.8	8.3	8.3	8.3	8.3
Total Alkalinity	194	- -	196	190	161	164	182	- -	194	193	177	178	192	192
Total Kjedahl Nitrogen	- -	- -	1.0	0.9	0.8	1.1	- -	- -	0.7	0.8	0.5	.06	0.6	1.0
Total Dissolved Solids	- -	- -	252	252	224	228	- -	- -	260	270	236	234	246	250
Dissolved Ammonia Nitrogen	0.02	0.02	0.02	0.02	0.02	0.17	0.02	0.02	0.022	0.019	0.008	0.023	0.005	0.308
Unionized Ammonia Nitrogen	<0.001	<0.001	0.001	0.001	0.002	0.009	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.008
Nitrate+Nitrite Nitrogen	0.3	0.3	0.3	0.3	0.02	0.04	0.02	0.02	0.02	0.02	0.007	0.007	0.09	0.2
Total Phosphorus	0.026	0.021	0.036	0.042	0.023	0.033	0.025	0.029	0.025	0.034	0.022	0.020	0.027	0.033
Calcium	40	40	36	37	24	25	29	30	36	37	33	33	32	30
Magnesium	32	30	28	28	31	31	33	33	33	32	32	31	25	23
Sodium	3	3	3	3	3	3	4	4	3	4	4	4	4	3
Potassium	1	1	1.2	1.3	0.55	0.59	0.47	0.48	0.87	0.89	0.73	0.72	1.08	0.87
Chloride	- -	- -	6	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Sulfate	17	17	18	18	19	19	- -	- -	16	16	18	19	14	14
Chlorophyll-a	19	- -	22	- -	5	- -	9	- -	12	12	18	- -	- -	- -
Iron	- -	- -	0.10	0.05	0.05	0.05	0.05	0.05	0.05	0.08	0.05	0.05	0.05	0.09
Hardness (Ca)	232	223	205	208	188	75	208	211	226	224	214	210	183	170
Ortho-phosphorus	0.006	0.004	0.002	0.007	0.007	0.006	0.005	0.005	0.005	0.005	0.002	0.002	- -	- -

Source: Wisconsin Department of Natural Resources, U.S. Geological Survey, and SEWRPC.

Table 10

WHITEWATER AND RICE LAKES SPRING OVERTURN WATER QUALITY DATA: 1990 AND 1991

Parameter	Whitewater Lake South Bay		Whitewater Lake Heart Prairie		Whitewater Lake North Bay		Rice Lake Deep Hole	
	April 3, 1991		April 3, 1991		April 3, 1991		April 3, 1991	
	Shallow	Deep	Shallow	Deep	Shallow	Deep	Shallow	Deep
Depth of Sample	1.5	5.5	1.5	36.5	1.5	11	1.5	8.5
Specific Conductance (μs/cm)	419	420	394	407	358	365	359	362
pH	8.4	8.4	8.2	8.2	8.3	8.3	8.1	8.2
Water Temperature (°F)	47.6	47.3	46.8	46.0	47.8	47.5	46.5	46.8
Secchi, Depth (feet)	4.0	- -	5.0	- -	5.0	- -	5.6	- -
Dissolved Oxygen	12.3	12.1	10.9	9.7	11	10	11	10.7
Phosphorus, Total (as P)	0.023	0.029	0.025	0.026	0.014	0.016	0.022	0.022
Phosphorus, Ortho Dissolved (as P)	0.004	0.003	0.004	0.006	0.005	0.004	0.003	0.003
Chlorophyll-a, Phytoplankton (μg/l)	9	- -	6	- -	6	- -	6	- -

Source: U.S. Geological Survey.

Table 11

SEASONAL WATER QUALITY DATA FOR THE NORTH BAY MONITORING SITE ON WHITEWATER LAKE: 1990 AND 1991

Parameter	Spring		Summer		Fall	
	Shallow	Deep	Shallow	Deep	Shallow	Deep
Conductivity (µS/cm)						
Range	295-379	306-390	275-290	277-293	297-317	298-318
Mean	346 (4)	361 (4)	281 (6)	286 (6)	309 (3)	310 (3)
pH (standard units)						
Range	8.3-9.3	8.1-9.1	9.4-10.1	9.0-10.0	9.0-9.5	9.0-9.5
Mean	8.7 (4)	8.5 (4)	9.7 (6)	9.5 (6)	9.3 (3)	9.3 (3)
Water Temperature (°F)						
Range	47.8-75.3	47.5-74.5	73.4-78.6	71.8-78.9	42.0-59.3	41.8-59.3
Mean	61.6 (4)	58.8 (4)	77.3 (6)	75.4 (6)	52.3 (3)	52.0 (3)
Secchi Reading (feet)						
Range	4.4-9.9	- -	1.9-9.9	- -	3.9-5.9	- -
Mean	6.3 (4)		4.9 (6)		4.8 (3)	
Dissolved Oxygen (mg/l)						
Range	9.7-12.0	6.0-10.0	7.2-13.7	0.1-9.0	8.8-12.6	8.8-12.6
Mean	10.7 (4)	7.4 (4)	10.2 (6)	4.4 (6)	10.6 (3)	10.6 (3)
Total Phosphorus (mg/l)						
Range	0.014-0.023	0.016-0.089	0.014-0.040	0.031-0.095	0.023-0.044	0.023-0.038
Mean	0.018 (4)	0.041 (4)	0.04 (6)	0.056 (6)	0.034 (3)	0.031 (3)
Ortho-Phosphorus (mg/l)						
Range	0.004-0.006	0.004-0.006	0.005-0.016	0.006-0.015	0.004-0.012	0.004-0.011
Mean	0.005 (4)	0.005 (4)	0.010 (6)	0.011 (6)	0.007 (3)	0.007 (3)
Chlorophyll-a (µg/l)						
Range	2.0-10.0	- -	2.0-46.0	- -	7.0-23.0	- -
Mean	5.8 (4)		26.2 (6)		15.3 (3)	

Source: U.S. Geological Survey.

As summer begins, the lake waters absorb solar energy at the surface. Wind action, and, to some extent, internal heat-transfer mechanisms, transmit this energy to the underlying portions of the water bodies. As the upper layers of water are heated by solar energy, a physical, density barrier begins to form between the warmer surface waters and the lower, heavier, colder waters, as illustrated by the June, July and August profiles in Figures 3 through 6. These "barriers" are marked by sharp temperature gradients known as the thermocline and are characterized by an approximately 1° to 2°F drop in temperature per three feet of depth that separates the warmer, lighter, upper layers of water—called the epilimnion—from the lower layers—called the hypolimnion. Although these barrier are readily crossed by fish, provided sufficient oxygen exists, they essentially prohibit the exchange of water between the two layers. This condition, illustrated diagrammatically in Figures 7 and 8, has a great impact on both the chemistry and biology of the lakes, which are also commonly stratified as a result.

The autumnal mixing period occurs when air temperatures cool the surface waters and wind action results in the erosion of the thermoclines: as the surface waters cool, they become heavier, sinking and displacing the now relatively warmer waters below. The colder waters sink and mix under wind action until the entire columns of water are of uniform temperature. This process is known as "fall turnover."

When the water temperatures drop to the point of maximum water density, 39.2°F, the waters at the lake surface become more dense than the now warmer, less dense bottom waters of the lakes,

Table 12

SEASONAL WATER QUALITY DATA FOR THE HEART PRAIRIE MONITORING SITE ON WHITEWATER LAKE: 1990 AND 1991

	Spring		Summer		Fall	
Parameter	Shallow	Deep	Shallow	Deep	Shallow	Deep
Conductivity (μS/cm)						
Range	334-396	407-426	295-316	427-483	325-345	336-477
Mean	375 (4)	415 (4)	306 (6)	457 (6)	335 (3)	389 (3)
pH (standard units)						
Range	8.2-9.0	7.6-8.2	9.0-9.6	7.4-7.6	8.6-8.9	7.3-8.8
Mean	8.6 (4)	7.9 (4)	9.3 (6)	7.5 (6)	8.8 (3)	8.2 (3)
Water Temperature (°F)						
Range	46.8-74.8	46.0-53.0	72.4-81.0	52.4-52.6	41.2-59.5	39.9-53.0
Mean	61.6 (4)	51.0 (4)	77.3 (4)	52.5 (4)	51.9 (3)	48.3 (3)
Secchi Reading (feet)						
Range	3.6-9.2	- -	1.6-8.3	- -	4.4-7.9	- -
Mean	6.7 (4)		3.8 (6)		5.4 (3)	
Dissolved Oxygen (mg/l)						
Range	9.0-11.0	0.1-9.7	7.2-12.9	0.1-0.1	6.5-12.2	0.1-12.0
Mean	10.3 (4)	3.9 (4)	9.6 (6)	0.1 (6)	9.6 (3)	6.9 (3)
Total Phosphorus (mg/l)						
Range	0.004-0.029	0.026-0.360	0.019-0.052	0.360-0.680	0.029-0.041	0.034-0.6
Mean	0.025 (4)	0.163 (4)	0.035 (6)	0.523 (6)	0.035 (3)	0.234 (4)
Ortho-Phosphorus (mg/l)						
Range	0.004-0.005	0.006-0.300	0.005-0.011	0.276-0.580	0.005-0.006	0.007-0.05
Mean	0.004 (4)	0.137 (4)	0.008 (6)	0.469 (4)	0.006 (3)	0.175 (3)
Chlorophyll-a (μg/l)						
Range	4.0-12.0	- -	3.0-62.0	- -	5.0-25.0	- -
Mean	6.5 (4)		36.0		15.0 (3)	

Source: U.S. Geological Survey.

and "sink" to the bottom. Eventually, the water columns are cooled to the point where the surface waters, cooled to about 32°F and now lighter than the bottom waters which remain close to 39°F, become ice, covering the surfaces of the lakes and isolating them from the atmosphere for a period of up to four months, as illustrated by the November profiles in Figures 3 through 6. Winter stratification occurs as the colder, lighter waters and ice remain at the lake surfaces, now separated from the relatively warmer, heavier waters near the bottoms of the lakes.

Spring brings a reversal of this process. As the ice thaws and the upper layers of water warm, they again become more dense and begin to approach the temperature of the warmer, deeper waters until the entire water columns reach the same temperatures from surface to bottom. This is referred to as "spring turnover" and usually occurs within weeks after the ice goes out, as illustrated by the April profiles in Figures 3 through 6. After spring turnover, the waters at the surface again warm and become lighter, causing them to float above the colder, deeper water. Wind and resulting waves carry some of the energy of the warmer, lighter waters to lower depths, but only to a limited extent. Thus begins the formation of the thermoclines and another period of summer thermal stratification.

Dissolved Oxygen

Dissolved oxygen levels are one of the most critical factors affecting the living organisms of a lake ecosystem. As shown in Figures 3 and 6, dissolved

Table 13

SEASONAL WATER QUALITY DATA FOR THE SOUTH BAY MONITORING SITE ON WHITEWATER LAKE: 1990 AND 1991

Parameter	Spring		Summer		Fall	
	Shallow	Deep	Shallow	Deep	Shallow	Deep
Conductivity (μS/cm)						
Range	292-419	294-420	289-333	295-336	332-356	333-358
Mean	359 (4)	368 (4)	316 (6)	320 (6)	346 (3)	347 (3)
pH (standard units)						
Range	8.4-9.5	8.4-9.3	9.2-9.6	9.2-9.5	9.3-9.6	9.3-9.6
Mean	9.0 (4)	8.8 (4)	9.4 (6)	9.3 (6)	9.5 (3)	9.5 (3)
Water Temperature (°F)						
Range	47.0-76.2	46.8-74.2	73.0-82.4	72.4-78.5	44-58.2	44.4-57.6
Mean	62.9 (4)	59.2 (4)	78.8 (6)	76.8 (6)	52.6 (3)	52.6 (3)
Secchi Reading (feet)						
Range	0.9-1.2	- -	1.3-6.6	- -	2.6-4.6	- -
Mean	1.1 (4)		3.1 (6)		3.7 (3)	
Dissolved Oxygen (mg/l)						
Range	10.8-15.6	6.7-12.1	6.4-15.6	5.7-11.7	9.4-13.7	9.4-13.7
Mean	13.0 (4)	9.1 (4)	11.3 (6)	8.5 (6)	11.0 (3)	10.9 (3)
Total Phosphorus (mg/l)						
Range	0.023-0.048	0.029-0.065	0.036-0.067	0.034-0.118	0.023-0.119	0.031-0.110
Mean	0.040 (4)	0.050 (4)	0.054 (6)	0.070 (6)	0.060 (3)	0.062 (3)
Ortho-Phosphorus (mg/l)						
Range	0.004-0.014	0.003-0.014	0.006-0.012	0.007-0.014	0.004-0.006	0.004-0.007
Mean	0.007 (4)	0.009 (4)	0.01 (6)	0.01 (6)	0.005 (3)	0.006 (3)
Chlorophyll-a (μg/l)						
Range	3-23	- -	7-40	- -	6-22	- -
Mean	10 (4)		25 (6)		12 (3)	

Source: U.S. Geological Survey.

oxygen levels were generally higher at the surfaces of Whitewater and Rice Lakes, where there was an interchange between the waters and the atmosphere, stirring by wind action, and production of oxygen by plant photosynthesis. Dissolved oxygen levels were lowest on the bottoms of the Lakes, where decomposer organisms and chemical oxidation processes—collectively known as biochemical oxygen demand—utilized oxygen in the decay process.

When any lake becomes thermally stratified, as described above, the surface supply of dissolved oxygen to the hypolimnion is cut off. Gradually, if there is not enough dissolved oxygen to meet the total demands from the bottom-dwelling aquatic life and decaying material, the dissolved oxygen levels in the bottom waters may be reduced, even to zero—a condition known as anoxia or anaerobiasis.

The hypolimnia of Whitewater and Rice Lakes become anoxic during summer stratification. During the 1990-1991 study period, dissolved oxygen concentrations at the bottom of Whitewater Lake fell to zero at the central, deep-water station by late May, as shown in Figure 3. Dissolved oxygen concentrations dropped to below 5 milligrams per liter (mg/l), or the minimum level necessary to support many species of fish, at a depth of approximately 12 feet, with concentrations decreasing to zero at about 30 feet. In Rice Lake, because of its more shallow depth profile, dissolved oxygen concentrations demonstrated a greater variability indicative

Table 14

SEASONAL WATER QUALITY DATA FOR THE DEEP HOLE MONITORING SITE ON RICE LAKE: 1990 AND 1991

	Spring		Summer		Fall	
Parameter	Shallow	Deep	Shallow	Deep	Shallow	Deep
Conductivity (μS/cm)						
Range	316-359	320-362	278-315	279-332	322-352	324-353
Mean	336 (4)	341 (4)	294 (6)	308 (6)	337 (3)	338 (3)
pH (standard units)						
Range	8.1-8.6	8.2-8.5	8.9-9.4	8.2-9.2	8.2-8.7	8.2-8.7
Mean	8.4 (4)	8.4 (4)	9.1 (6)	8.7 (6)	8.4 (3)	8.4 (3)
Water Temperature (°F)						
Range	46.8-75.5	46.6-75.5	73.7-80.8	71.8-78.4	43.5-58.7	43.5-58.6
Mean	61.5 (4)	59.3 (4)	77.3 (6)	76.3 (6)	52.5 (3)	52.6 (3)
Secchi Reading (feet)						
Range	4-8.3	--	0.7-1.7	--	1.7-8.6	--
Mean	6.2 (4)		1.4 (6)		5.1 (3)	
Dissolved Oxygen (mg/l)						
Range	7.1-11.0	6.6-10.9	6.9-13.4	0.1-8.3	8.2-10.7	8.2-10.7
Mean	9.5 (4)	8.6 (4)	10.7 (6)	3.8 (6)	9.2 (3)	9.2 (3)
Total Phosphorus (mg/l)						
Range	0.022-0.032	0.022-0.028	0.05-0.138	0.063-0.125	0.036-0.116	0.032-0.120
Mean	0.026 (4)	0.024 (4)	0.111 (6)	0.107 (6)	0.07 (3)	0.068 (3)
Ortho-Phosphorus (mg/l)						
Range	0.002-0.006	0.002-0.005	0.002-0.009	<0.002-0.007	<0.002-0.004	<0.002-0.005
Mean	0.004 (4)	0.004 (4)	0.006 (6)	0.004 (6)	0.003 (3)	0.003 (3)
Chlorophyll-a (μg/l)						
Range	4-9	--	33-147	--	3-62	--
Mean	6 (4)		65 (6)		24 (3)	

Source: U.S. Geological Survey.

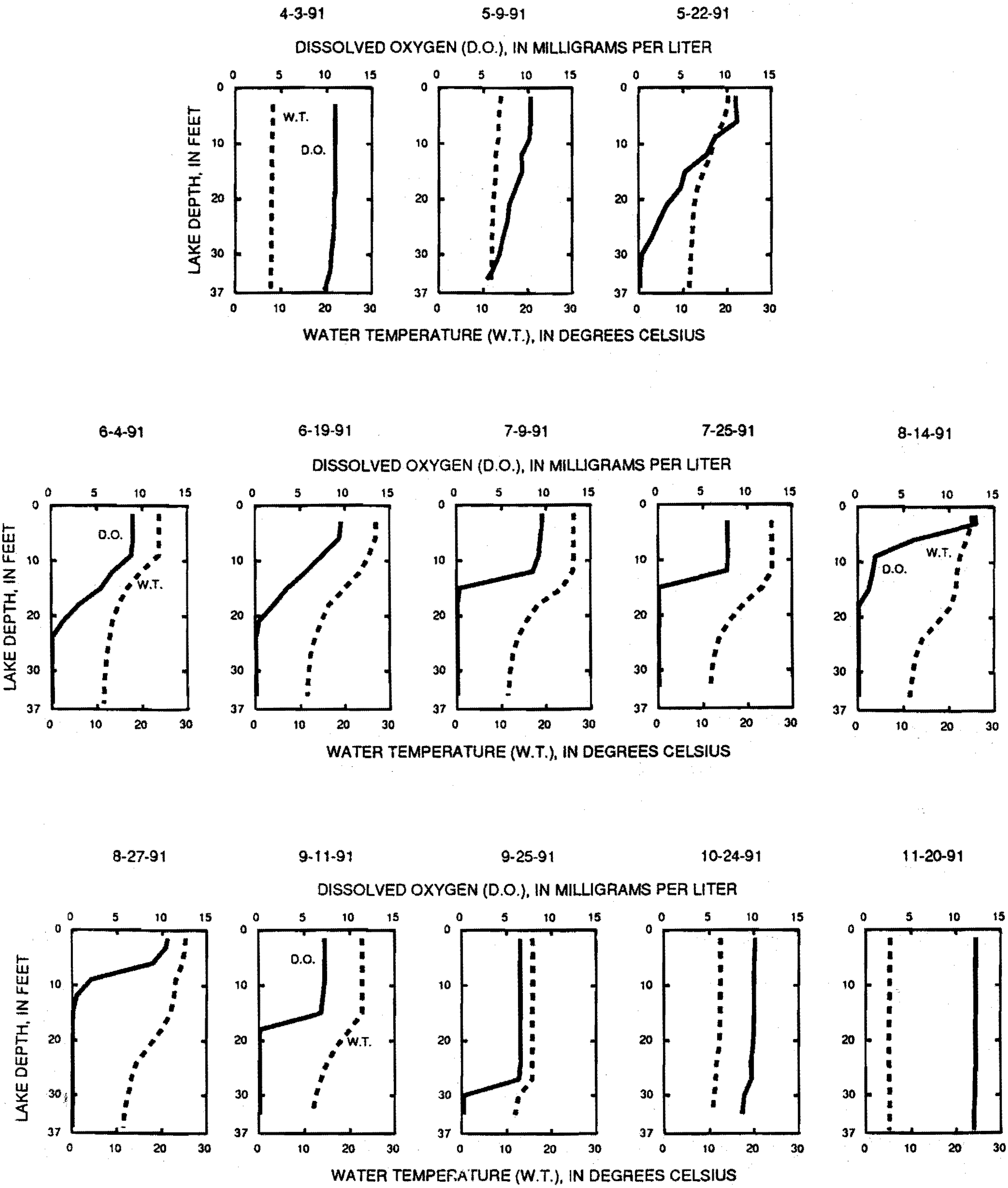
of multiple mixing or turnover events during the summer of 1991—lakes exhibiting these characteristics are known as polymictic lakes. Oxygen stratification occurred, as in Whitewater Lake, by late May as shown in Figure 6. The depth at which the dissolved oxygen concentration reached 5 mg/l was about eight feet. During July, the Lake again became well mixed from top to bottom. However, by mid-August, stratification was reestablished in Rice Lake and the dissolved oxygen concentration was generally zero at about five to 7.5 feet below to the surface of the Lake.

Fall turnover—between September and October in most years—naturally restores the supply of oxygen to the bottom waters, although hypolimnetic anoxia can be reestablished during the period of winter thermal stratification. Winter anoxia is more common during years of heavy snow fall, when snow covers the ice, reducing the degree of light penetration and reducing algal photosynthesis that takes place under the ice. In Whitewater and Rice Lakes, however, dissolved oxygen levels were found to be adequate for the support of fish throughout the winter. At the end of winter, dissolved oxygen concentrations in the bottom waters of the Lakes were restored during the period of spring turnover, which generally occurs between March and May in most years.

Hypolimnetic anoxia is common in many of the lakes in Southeastern Wisconsin during summer stratification. The depleted oxygen levels in the hypolimnion cause fish to move upward, nearer to

Figure 3

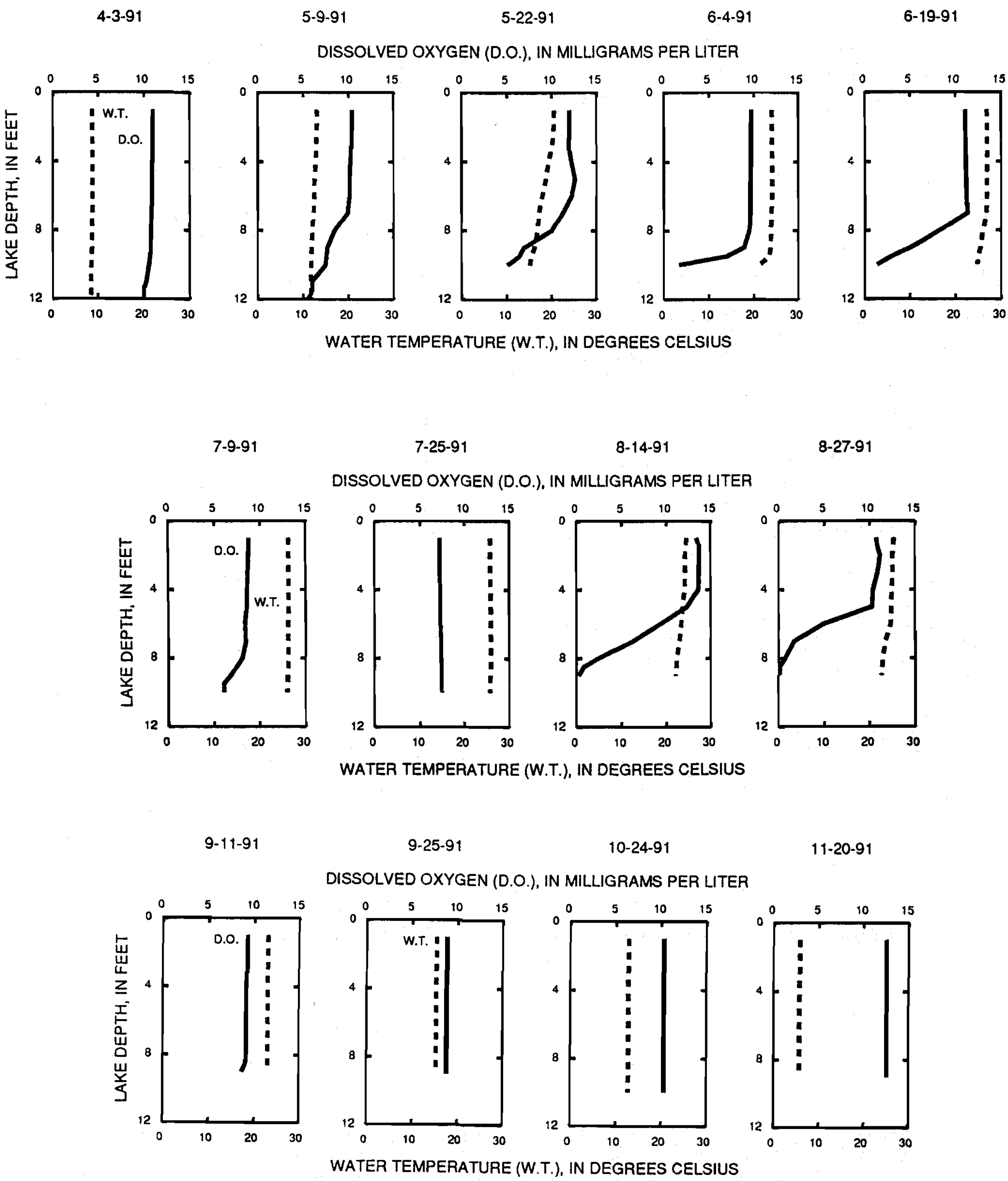
TEMPERATURE AND DISSOLVED OXYGEN PROFILES FOR HEART PRAIRIE MONITORING SITE ON WHITEWATER LAKE: 1991



Source: U.S. Geological Survey

Figure 4

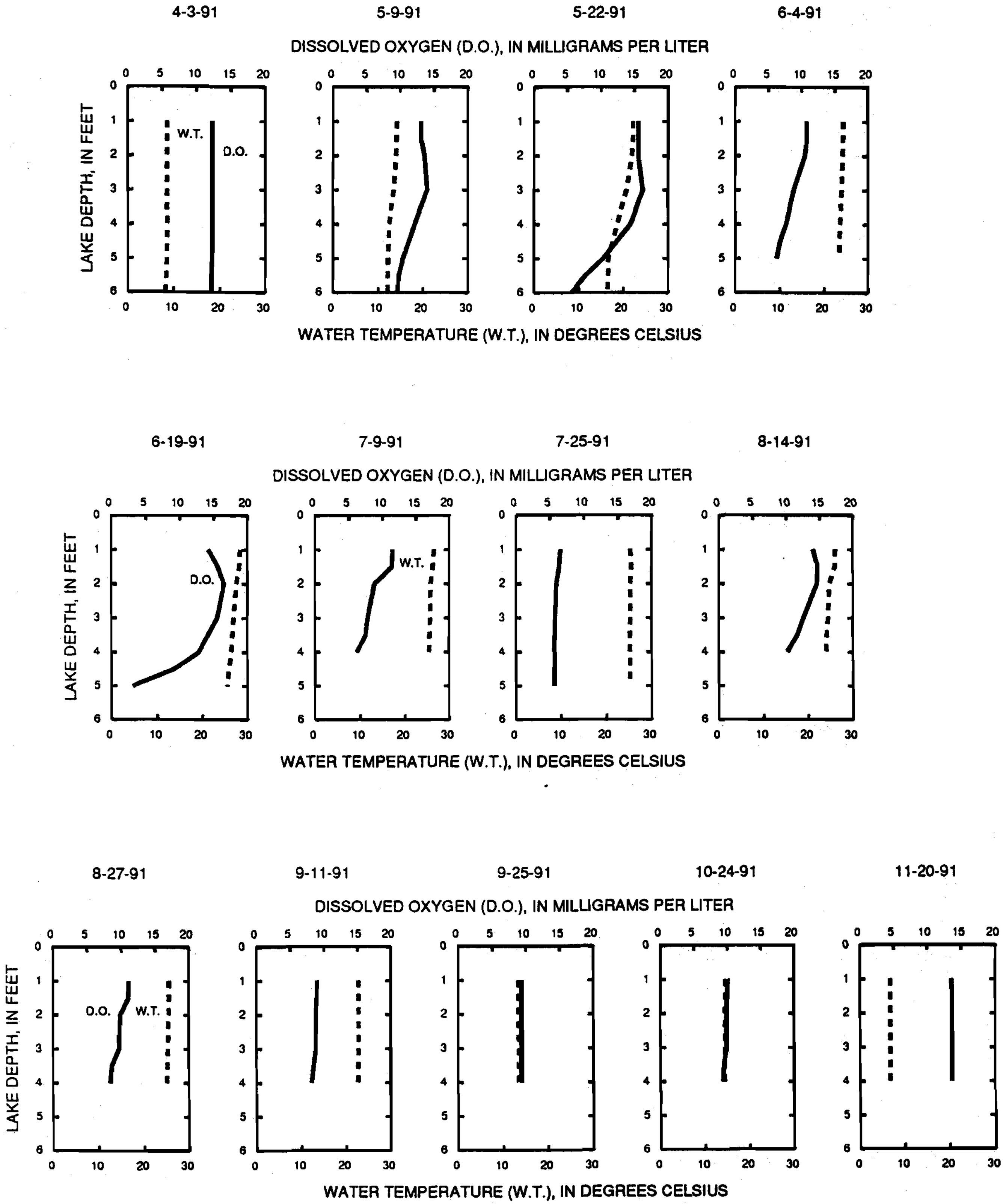
TEMPERATURE AND DISSOLVED OXYGEN PROFILES FOR NORTH BAY MONITORING SITE ON WHITEWATER LAKE: 1991



Source: U.S. Geological Survey

Figure 5

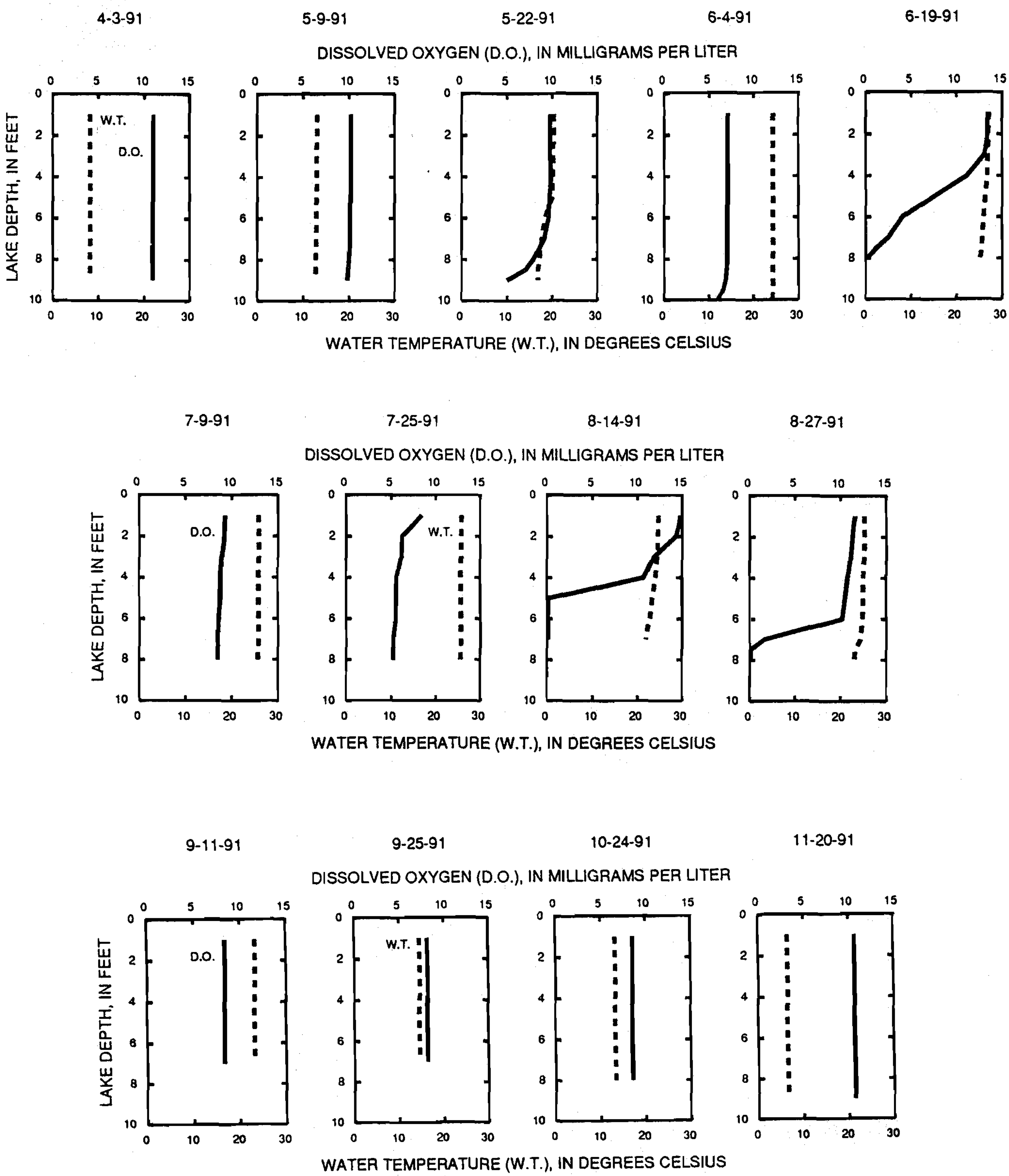
TEMPERATURE AND DISSOLVED OXYGEN PROFILES FOR SOUTH BAY MONITORING SITE ON WHITEWATER LAKE: 1991



Source: U.S. Geological Survey

Figure 6

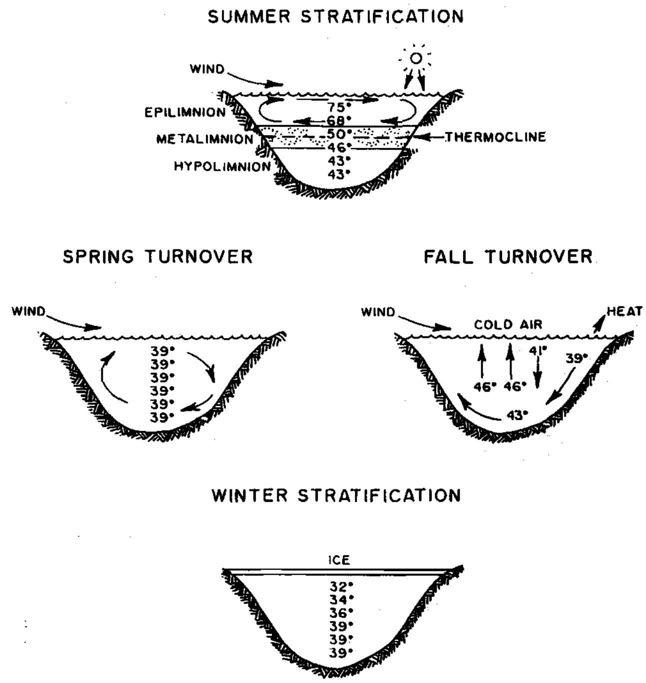
TEMPERATURE AND DISSOLVED OXYGEN PROFILES FOR RICE LAKE: 1991



Source: U.S. Geological Survey

Figure 7

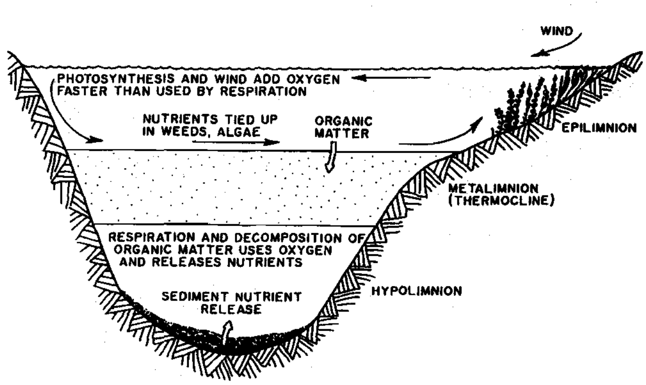
THERMAL STRATIFICATION OF LAKES



Source: University of Wisconsin Extension and SEWRPC.

Figure 8

LAKE PROCESSING DURING SUMMER STRATIFICATION



Source: University of Wisconsin Extension and SEWRPC.

the surface of the lakes, where higher dissolved oxygen concentrations exist. This migration, when combined with temperature, can select against some fish species which prefer the cooler water temperatures that generally prevail in the lower portions of lakes. When there is insufficient oxygen at these depths, these fishes are susceptible to summer-kills, or, alternatively, are driven into the warmer water portions of the lakes where their condition and competitive success may be severely impaired.

In other lakes in the Region, hypolimnetic anoxia can also occur during winter stratification. Under these conditions, anoxia contributes to winter-kill of fishes.

In addition to these biological consequences of anaerobiasis, the lack of dissolved oxygen at depth can enhance development of chemoclines, or chemical gradients, with an inverse relationship to the dissolved oxygen concentration. For example, the sediment-water exchange of elements such as phosphorus, iron and manganese is increased under anaerobic conditions, resulting in higher hypolimnetic concentrations of these elements, as shown in Figure 8. Under anaerobic conditions, iron and manganese change oxidation state enabling the release of phosphorus from the iron and manganese complexes to which they were bound under aerobic conditions. This phenomenon is apparent in the pH and specific conductance profiles for Whitewater Lake set forth in Figure 9, and in the pH profiles for Rice Lake set forth in Figure 12—see below. This "internal loading" can affect water quality significantly if these nutrients and salts are mixed into the epilimnion, especially during early summer, when these nutrients can become available for algal or plant growth.

Specific Conductance

Specific conductance is an indicator of the concentration of dissolved solids in the water; as the amount of dissolved solids increases, the specific conductance increases. Conductivity and pH profiles, and Secchi-disk transparencies, for Whitewater and Rice Lakes are shown in Figures 9 through 12. During winter and summer thermal stratification, specific conductance increases at the lake bottoms due to an accumulation of dissolved materials in the hypolimnia, referred to above as "internal loading." This phenomenon was more noticeable in Whitewater Lake during summer stratification, and most pronounced between early June and late September than at other times, as shown in Figure 9 through 11. In Rice Lake, this stratification is less pronounced and exhibits the polymictic characteristics mentioned in relation to dissolved oxygen concentrations above, as shown in Figure 12. As shown in Tables 11 through 14, the specific conductance of Whitewater and Rice Lakes during 1990-1991 ranged from 295 to 483 microSiemens per centimeter (μS/cm) at 25°C, and from 316 to 362 μS/cm, respectively, which is within the normal range for lakes in Southeastern Wisconsin.[3]

Chloride

Chloride concentrations in Whitewater Lake were 11 mg/l during the 1991 spring turnover. Chloride concentrations were not measured in Rice Lake. The most important anthropogenic source of chlorides is believed to be street deicing salts. The concentration measured in Whitewater Lake is within the normal range for lakes in Southeastern Wisconsin.[4]

Alkalinity and Hardness

Alkalinity is an index of the buffering capacity of a lake, or the capacity of a lake to absorb and neutralize acids. The alkalinity of a lake depends on the levels of bicarbonate, carbonate, and hydroxide ions present in the water. Lakes in Southeastern Wisconsin typically have a high alkalinity because of the types of soil covering, and the bedrock underlying, the watersheds. In contrast, water hardness is a measure of the multivalent metallic ions, such as calcium and magnesium, present in the lakes. Hardness is usually reported as an equivalent concentration of calcium carbonate ($CaCO_3$). Applying these measures to the study lakes, Whitewater Lake, and probably Rice Lake, are hard-water alkaline lakes. Hardness and

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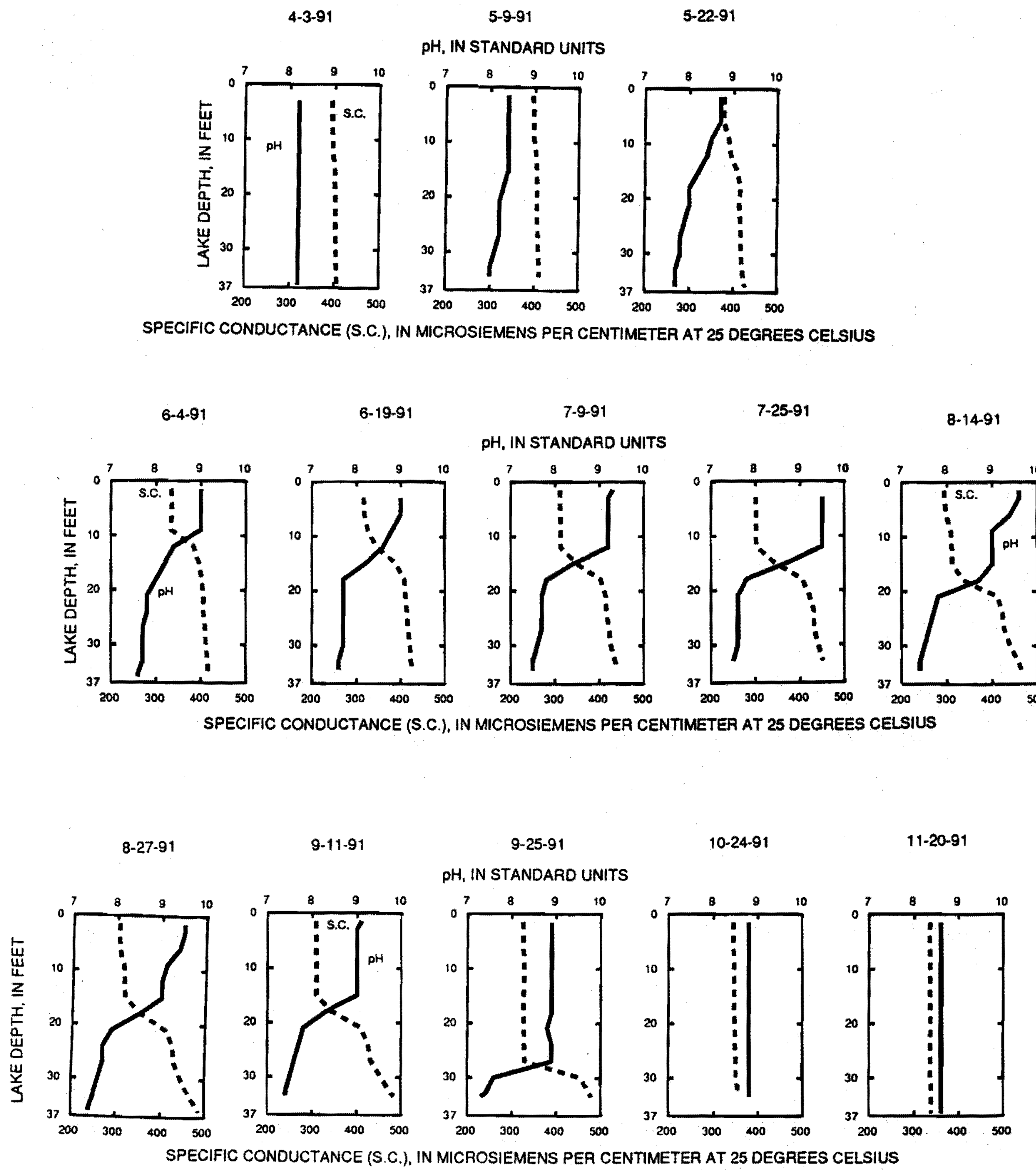
[3]*R.A. Lillie and J.W. Mason, Limnological Characteristics of Wisconsin Lakes, Technical Bulletin No. 138, Wisconsin Department of Natural Resources, 1983.*

[4]*Ibid.*

Figure 9

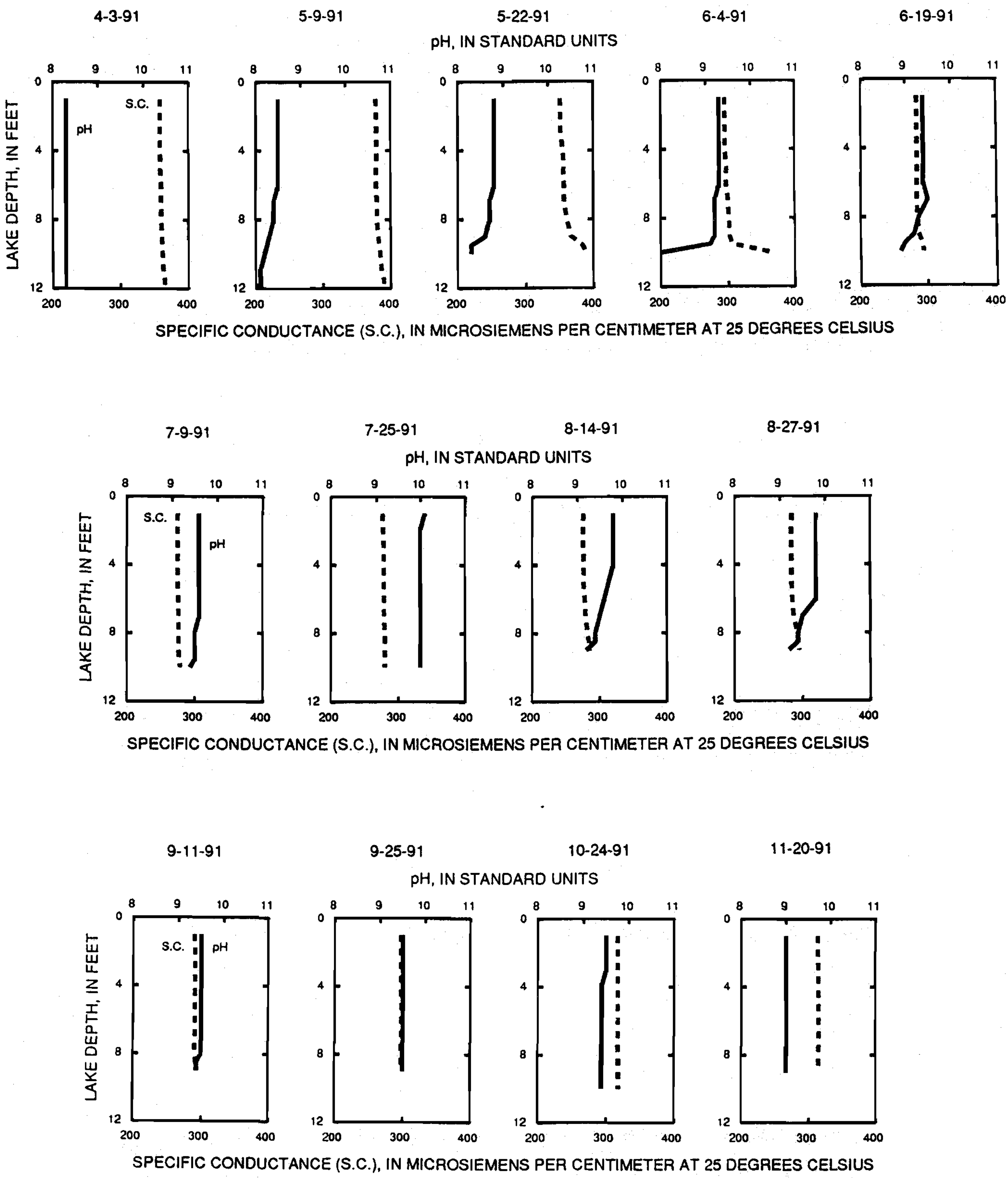
SPECIFIC CONDUCTANCE AND pH PROFILES FOR HEART PRAIRIE MONITORING SITE ON WHITEWATER LAKE: 1991



Source: U.S. Geological Survey

Figure 10

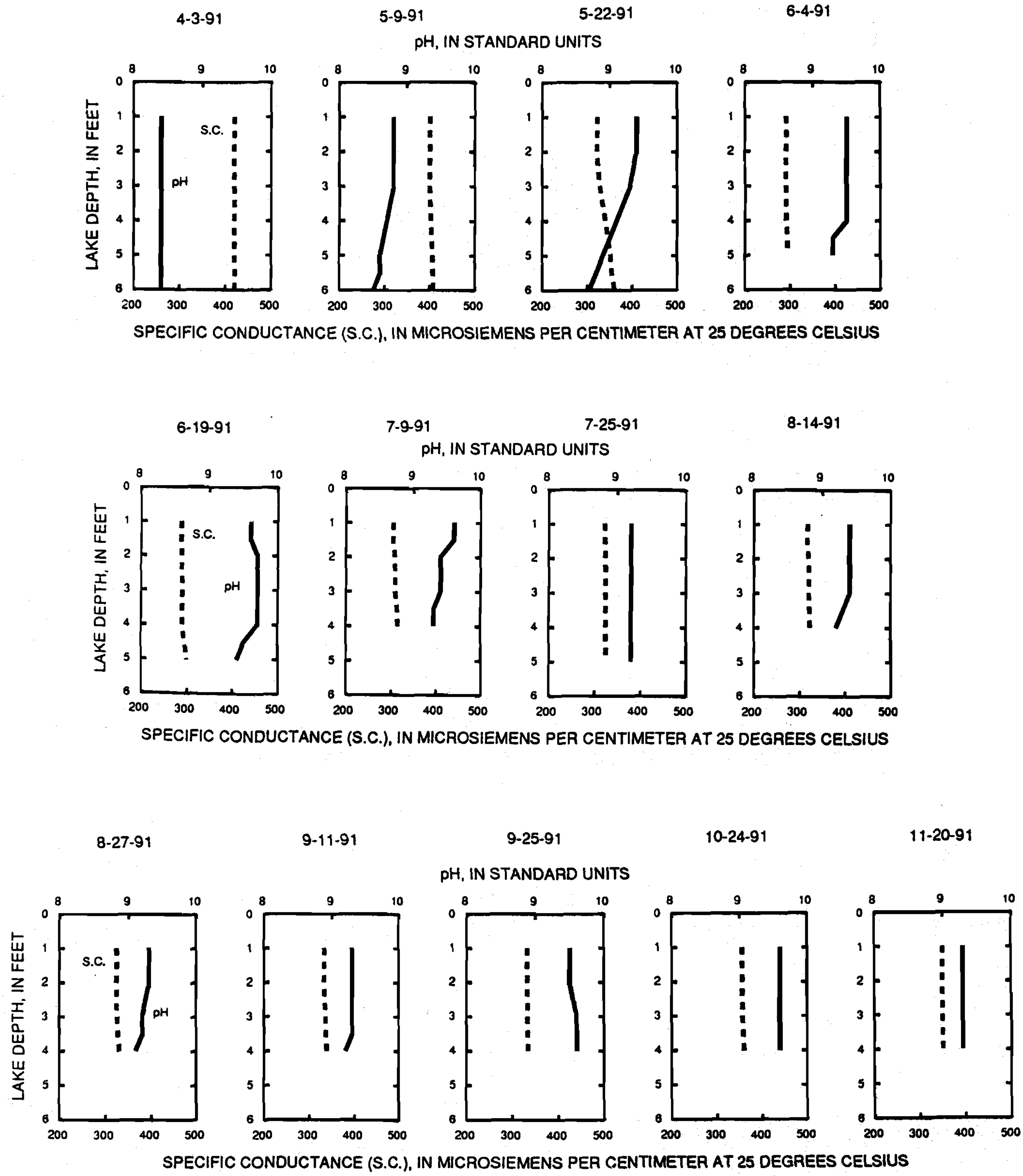
SPECIFIC CONDUCTANCE AND pH PROFILES FOR NORTH BAY MONITORING SITE ON WHITEWATER LAKE: 1991



Source: U.S. Geological Survey

Figure 11

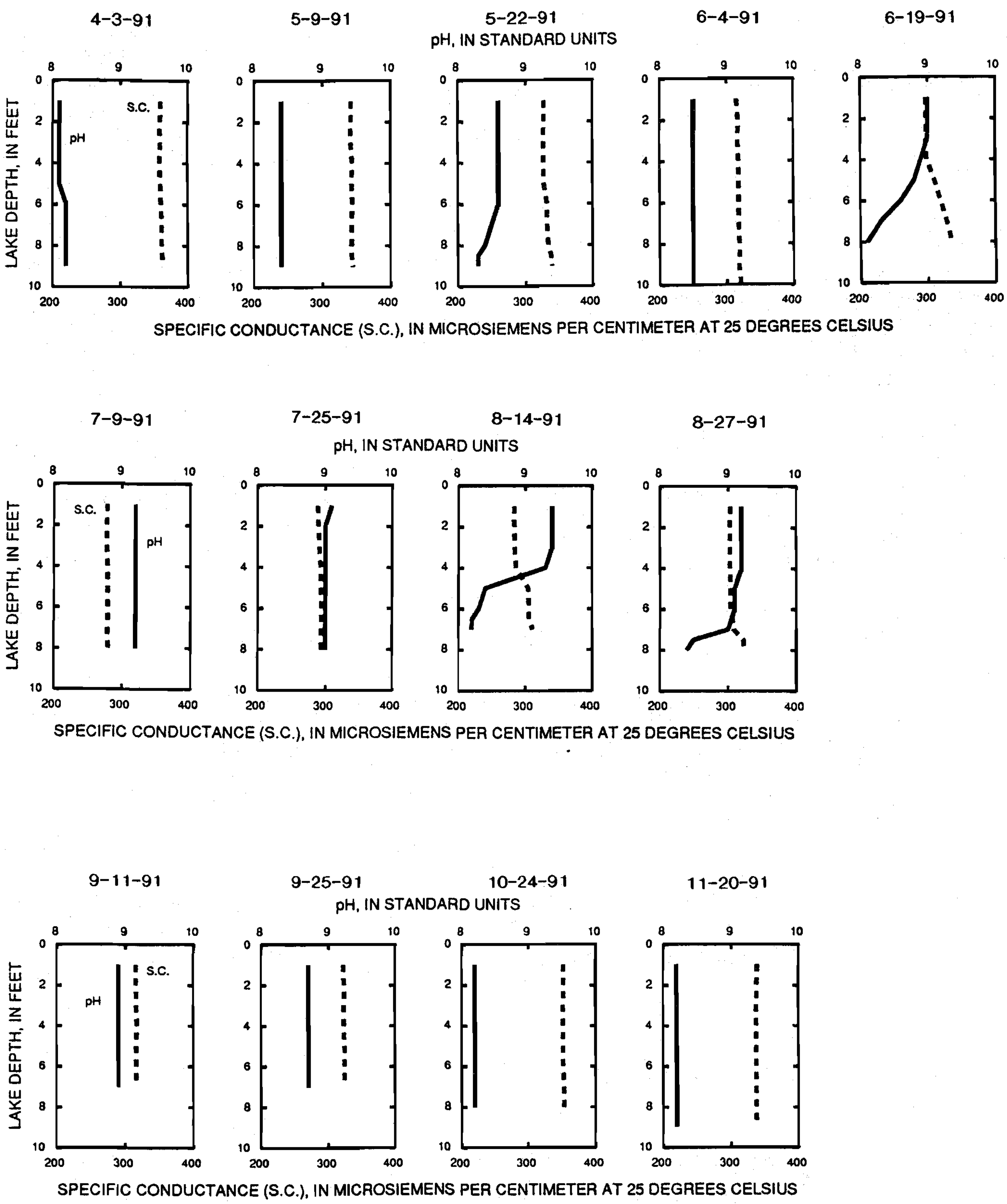
SPECIFIC CONDUCTANCE AND pH PROFILES FOR SOUTH BAY MONITORING SITE ON WHITEWATER LAKE: 1991



Source: U.S. Geological Survey

Figure 12

SPECIFIC CONDUCTANCE AND pH PROFILES FOR RICE LAKE: 1991



Source: U.S. Geological Survey

alkalinity were measured by the U.S. Geological Survey during the 1990-1991 study period only in Whitewater Lake.

During the spring turnover of 1991, alkalinity was 193 mg/l, while hardness averaged 205 mg/l, as listed in Table 9. These values are within the normal range of lakes in Southeastern Wisconsin.[5]

Hydrogen Ion Concentration (pH)

The pH is a logarithmic measure of hydrogen ion concentration on a scale of 0 to 14 standard units, with 7 indicating neutrality. A pH above 7 indicates basic (or alkaline) water, while a pH below 7 indicates acidic water. In Whitewater Lake, the pH was found to range between 7.3 and 10.1 standard units, as shown in Tables 11 through 13, while in Rice Lake the pH ranged between 8.1 and 9.5 standard units, as shown in Table 14. Since Whitewater Lake has a high alkalinity, or buffering capacity, the pH in both Lakes does not fluctuate below 7, the Lakes are probably not susceptible to the harmful effects of acidic precipitation. In general, pH declined with depth, exhibiting an inverse relationship to conductivity as shown in Figures 9 and 12. As noted in terms of electrical conductance, the pH gradient became more pronounced during the summer months, and, again, the polymictic nature of Rice Lake was apparent in the breakdown of the pH gradient during July 1991.

Water Clarity

Water clarity, or transparency, gives an indication of overall water quality; clarity may decrease because of high concentrations of suspended materials, such as algae and zooplankton, and of turbidity, or due to high concentrations of dissolved organic substance such as water color. Water clarity is measured with a Secchi-disk, a black-and-white, eight-inch-diameter disk, which is lowered into the water until a depth is reached at which the disk is no longer visible. This depth is known as the "Secchi-disk reading." These readings form an integral part of the Wisconsin Department of Natural Resources Self-Help Monitoring Program in which a citizen volunteer monitor is enrolled as part of the District's water quality monitoring effort as discussed in Chapter VIII.

Water clarity generally varies throughout the year as algal populations increase and decrease, and as the amount of inorganic suspended materials and humic coloration varies, in response to changes in weather conditions and nutrient loadings. These same factors make Secchi-disk readings vary from year to year as well. Secchi-disk readings for Whitewater and Rice Lakes were almost always greater than one foot; during much of the study period they were greater than three feet. Greatest water clarity was observed during winter, and least clarity during summer. Clarity appears to have been variable over the period of record, 1987-1994, with summer transparencies during the period from 1989 to 1990 averaging 7.9 feet in contrast to average transparencies of 4.3 feet recorded prior and subsequent to those years. These values are indicative of an average water quality compared to other lakes in Southeastern Wisconsin.[6]

Chlorophyll-a

Chlorophyll-a is the major photosynthetic ("green") pigment in algae. The amount of chlorophyll-a present in the water is an indication of biomass or amount of algae in the water. Chlorophyll-a concentrations at the central lake station in Whitewater Lake ranged from a low of 3 micrograms per liter (μg/l) in June to a high of 62 μg/l in August, 1991; a chlorophyll-a concentration of 2 μg/l was recorded in the North Bay of Whitewater Lake during June, 1991. Chlorophyll-a concentrations in Rice Lake ranged from a low of 3 μg/l in November to a high of 147 μg/l during July, 1991. These values, although within the range of chlorophyll-a concentrations recorded in other lakes in the Region,[7] are high and indicate poor water quality.

[5]*R.A. Lillie and J.W. Mason, Limnological Characteristics of Wisconsin Lakes, Technical Bulletin No. 138, Wisconsin Department of Natural Resources, 1983.*

[6]*Ibid.*

[7]*Ibid.*

Nutrient Characteristics

Aquatic plants and algae require such nutrients as phosphorus, nitrogen, carbon, calcium, chloride, iron, magnesium, sulfur, and silica for growth. In hard-water alkaline lakes, most of these nutrients are generally found in concentrations which exceed the needs of growing plants. However, in lakes where the supply of one or more of these nutrients is limited, plant growth is limited by the amount of that nutrient available. Two of the most important nutrients, in this respect, are phosphorus and nitrogen.

The ratio of total nitrogen to total phosphorus in lake water, or the N:P ratio, can indicate which nutrient is likely to be limiting plant growth. Where the nitrogen-to-phosphorus ratio is greater than 14 to 1, a lake is probably phosphorus-limited, while a ratio of less than 10 to 1 indicates that nitrogen is probably the limiting nutrient.[8] As shown in Table 15, the nitrogen-to-phosphorus ratios in spring turnover samples collected from Whitewater Lake during the period of record were generally greater than 25. This indicates that plant production was most likely consistently limited by phosphorus. Other factors, such as light, turbulence, and through flow, may also limit plant growth; these are further discussed below.

Both total phosphorus and soluble phosphorus concentrations were measured for Whitewater and Rice Lakes. Soluble phosphorus, being dissolved in the water column, is readily available for plant growth. However, its concentration can vary widely over short periods of time as plants take up and release this nutrient. Therefore, total phosphorus is usually considered a better indicator of nutrient status. Total phosphorus includes the phosphorus contained in plant and animal fragments suspended in the lake water, phosphorus bound to sediment particles, and phosphorus dissolved in the water column.

The Southeastern Wisconsin Regional Planning Commission (SEWRPC) recommends that total phosphorus concentrations in lakes not exceed 0.020 mg/l during spring turnover in order to prevent nuisance algal and aquatic plant growths. The total phosphorus concentrations at spring turnover in Whitewater Lake were generally greater than 0.020 mg/l, as shown in Table 9. During the 1990-1991 U.S. Geological Survey study, total phosphorus concentrations in both Lakes exceeded 0.020 mg/l in April 1991. Throughout the study period, total phosphorus in the surface waters of Whitewater and Rice Lakes averaged 0.037 mg/l and 0.075 mg/l, respectively. In the hypolimnia, or bottom waters, of Whitewater and Rice Lakes, total phosphorus concentrations were approximately equal to or higher than the surface water concentrations, ranging from 0.014 to 0.680 mg/l, and from 0.022 to 0.125 mg/l, respectively, as shown in Tables 11 and 14. The average bottom-water total phosphorus concentrations during the study period were 0.150 mg/l in Whitewater Lake and 0.072 mg/l in Rice Lake. The similarity of surface and bottom water phosphorus concentrations in Rice Lake is common in well-mixed or frequently-mixed shallow waterbodies.

When aquatic organisms die, they usually sink to the bottom of the lakes, where they are decomposed. Phosphorus from these organisms is stored in the bottom sediments. Because phosphorus is not highly soluble in water, it readily forms insoluble precipitates with calcium, iron, and aluminum under aerobic conditions and accumulates predominantly in the lake sediments, although some may be rereleased into the water column. However, when the bottom waters become depleted of oxygen during stratification, certain chemical changes occur, especially the change in the oxidation state of iron from the insoluble Fe^{3+} state to the more soluble Fe^{2+} state. The effect of these chemical changes is that phosphorus becomes soluble and is more readily released from the sediments. This process also occurs under aerobic conditions, but generally at a slower rate. As the waters begin to mix, during spring and fall turnovers, this phosphorus can be mixed throughout the lakes and may be available for algal growth. If the turnover event is slow, over several weeks, the hypolimnetic phosphorus may be readsorbed by the iron and precipitate back to the sediment. If the process is more rapid, a few days or less, some of this phosphorus is circulated into the upper waters of the lakes, generally in a bio-

[8] *M.O. Alum, R.E. Gessner, and J.H. Gokstatter, An Evaluation of the National Eutrophication Data, U.S. Environmental Protection Agency Working Paper No. 900, 1977.*

Table 15

NITROGEN-PHOSPHORUS RATIOS FOR WHITEWATER LAKE

Date	Nutrient Levels		
	Nitrogen (mg/l)	Phosphorus (mg/l)	N:P Ratio (mg/l)
April 7, 1987	--	0.026	--
April 14, 1988	1.30	0.036	36.1
April 27, 1989	0.82	0.023	35.7
April 10, 1990	--	0.025	--
April 25, 1991	0.72	0.025	28.8
April 16, 1992	0.51	0.020	25.5
April 21, 1994	0.69	0.022	31.4

Source: U.S. Geological Survey and SEWRPC.

available form, where it can be taken up very rapidly by algae.

The 1991 data indicated that there was the potential for considerable internal loading of phosphorus from the bottom sediments of Whitewater and Rice Lakes. This is especially true in Rice Lake, where the thermal and dissolved oxygen concentration profiles were indicative of multiple mixing events during the summer season, as previously mentioned. Such releases tended to occur primarily during the anaerobic periods of summer and winter stratification. For example, there was an increase in the surface water total phosphorus concentration of Rice Lake from 0.050 mg/l measured on June 19, 1991 to over 0.100 mg/l observed on July 9, 1991 which is strongly suggestive of internal loading. This injection of biologically-available phosphorus into the surface waters of Rice Lake was paralleled by an increase in algal biomass from 33 mg/l chlorophyll-a in late June to almost 150 mg/l chlorophyll-a in early July. No similar events were recorded in Whitewater Lake which appeared to be more stable in terms of its summer stratification regime. Stratification with respect to phosphorus concentrations was greatest in the central lake basin, which, due to its position within the Lake and its morphology, is likely to be less susceptible to wind-induced mixing than the less deep Rice Lake basin. Nevertheless, the U.S. Geological Survey note that internal recycling of phosphorus seems to be the driving force in increasing phosphorus concentrations in both Lakes during the summer.[9]

No quantitative assessment of lake bottom sediments has been carried out on either Whitewater Lake or Rice Lake. However, SEWRPC staff described the bottom as largely comprised of "muck," the characteristics of which are typically associated with organic-rich sediments during the 1995 aquatic plant survey. Such substrates are commonly associated with the high rates of internal phosphorus release noted above.

POLLUTION LOADINGS AND SOURCES

Currently, there are no known point source discharges of pollutants to Whitewater and Rice Lakes or to the surface waters tributary to Whitewater and Rice Lakes. Nonpoint sources of water pollution include urban sources, such as runoff from residential, commercial, transportation, construction, and recreational activities, and rural sources, such as runoff from agricultural lands and woodlands. In order to estimate the amount of pollution contributed by these sources to Whitewater and Rice Lakes, and eventually to the downstream Tripp

[9] *U.S. Geological Survey Water-Resources Investigations Report No. 94-4101, Hydrology and Water Quality of Whitewater and Rice Lakes in Southeastern Wisconsin, 1990-91, 1994, p.27.*

Lake, annual loading budgets for phosphorus were developed for the watershed as part of the 1990-1991 U.S. Geological Survey study. The phosphorus budgets for Whitewater and Rice Lakes are shown in Tables 16 and 17. Total annual phosphorus loadings of about 560 and 60 pounds are estimated to be contributed to Whitewater and Rice Lakes, respectively.

The tributary drainage areas of Whitewater and Rice Lakes are 7.2 and 7.8 square miles in size, respectively, as discussed in Chapter II. As previously discussed, there is normally no flow over the dam at the outlet of Whitewater Lake with no observation of such discharge during water year 1990 and 1991 and limited to discharges subsequent to that. Thus, the tributary area to Rice Lake is normally effectively limited to the 350-acre drainage area located downstream of Whitewater Lake. Furthermore, the 1990-1991 U.S. Geological Survey Study of lake hydrology and water quality indicates that due to the rough topography and soils in the tributary area, there are normally only about 1.4 square miles and 0.3 square mile of land surface which actually contribute nutrients and pollutants to Whitewater and Rice Lakes, respectively. Due to this feature of the drainage area, a majority of the rural lands within the total tributary drainage areas to Whitewater and Rice Lakes were not considered to be contributing nonpoint source pollutants to the Lakes. Thus, the most significant land use areas contributing nutrients to Whitewater and Rice Lakes are located in the shoreland areas around these waterbodies. While these lands are in part occupied by agricultural uses, the majority of the areas concerned are in urban residential uses.

The U.S. Geological Survey estimated the average annual phosphorus loads from shoreland areas contributing to the Whitewater and Rice Lakes watersheds to be about 237 pounds and about 37 pounds of phosphorus for Whitewater and Rice Lakes, respectively, as shown in Tables 16 and 17. This source of phosphorus was the single largest source of phosphorus to these Lakes comprising 42 and 59 percent of the total loading to Whitewater and Rice Lakes respectively.

As of 1995, about 95 shoreline residences located in the drainage area of Whitewater and Rice Lakes were located in areas of the shorelands where the groundwater may be expected to discharge to the Lakes. All of these homes were served by onsite sewage systems. Onsite sewage disposal systems are designed to remove phosphorus by adsorption to soil in a drainfield. Removal capacity decreases with increasing soil particle size and all soils have a fixed adsorptive capacity which will eventually become exhausted. Onsite sewage disposal systems include conventional septic tank systems, septic systems with seepage pit disposal systems, septic tanks with alternative distribution systems such as ground pressurized systems, seepage pits, mound systems, and holding tanks. Holding tanks store wastewater temporarily until it is pumped and conveyed by tank truck to a sewage treatment plant, storage lagoon, or land disposal site. All of the other types of onsite sewage disposal systems discharge effluent to the groundwater, and in some locations through the groundwater inflow to the Lakes.

Provided that onsite systems are located, installed, used, and maintained properly, the system may be expected to operate with few problems for periods of about 20 years. Failure of a septic tank system occurs when the soil surrounding the seepage area will no longer accept or properly stabilize the septic tank effluent. Further, not all residential areas within the Whitewater and Rice Lakes drainage area served by onsite sewage disposal systems are located in areas covered by soils suitable for septic tank use as shown on Map 8 and septic system failure may result from improper location, poor installation, or inadequate maintenance.

While many older onsite sewage disposal systems may have met Wisconsin Administrative Code requirements when installed, these requirements have changed over the years, with the effect that many older systems no longer conform to present practices. Also, some installations, designed for vacation use are now in use year-round and are potentially subject to overloading. The precise identification of potential septic tank problems requires a sanitary survey.

Table 16

TOTAL PHOSPHORUS BUDGET FOR WHITEWATER LAKE: 1990-1991

Budget Item	Total Phosphorus Load (pounds)	Percent of Total Inputs
Precipitation	101	18
Inlet	70[a]	13
Stormwater Runoff	237	42
Groundwater	44	8
Onsite Sewage Disposal Systems	106	19
Total	558	100

[a]*Whitewater Lake inlet base flow.*

Source: U.S. Geological Survey and SEWRPC.

Table 17

TOTAL PHOSPHORUS BUDGET FOR RICE LAKE: 1990-1991

Budget Item	Total Phosphorus Loads (pounds)	Percent of Total Inputs
Precipitation	24	38
Inlet	0[a]	0
Stormwater Runoff	37	59
Groundwater	2	3
Onsite Sewage Disposal Systems	0	0
Total	63	100

[a]*Rice Lake inlet (Whitewater Lake outlet)—as Whitewater Lake did not overflow during the study period, phosphorus export to Rice Lake in the inlet is assumed to be negligible.*

Source: U.S. Geological Survey and SEWRPC.

The annual phosphorus loading to Whitewater Lake from onsite sewage disposal systems is estimated to be about 106 pounds of phosphorus or 19 percent of the total loading to Whitewater Lake, as shown in Table 16. Onsite sewage treatment systems did not contribute significant amounts of phosphorus to Rice Lake, as shown in Table 17.

The remaining loadings to the Lakes are contributed by precipitation and groundwater inflow, and in the case of Whitewater Lake, the inlet draining upstream lands. Phosphorus loads may be expected to remain relatively stable from the direct drainage areas of Whitewater and Rice Lakes.

In addition to the external phosphorus load, the U.S. Geological Survey study estimated that an additional 582 pounds of phosphorus may be expected to be added to the lake water column of Whitewater Lake, and an additional 295 pounds of phosphorus to the water column of Rice Lake, as the result of internal loading during periods of stratification.[10] This estimate is about half of the total nutrient loads to the Lakes. As noted above, the effect of this internal loading can be seen in the elevated hypolimnetic phosphorus concentrations reported in Tables 8 through 14.

Approximately 77 percent of the total phosphorus load—calculated as the combined internal and external nutrient loads—or about 882 pounds, was used by the biomass within Whitewater Lake or deposited in the sediments, as was about 85 percent, or about 305 pounds, of the phosphorus load to Rice Lake. No significant amounts of phosphorus were transferred between Whitewater and Rice Lakes, or between Rice Lake and the downstream Tripp Lake, during the U.S. Geological study as neither Lake had an outflow during the 1990-1991 study period. On the other hand, it was estimated that at least a portion of this mass of retained phosphorus was removed from the Lakes as the result of aquatic plant harvesting. Between 1,500 and 2,500 pounds of phosphorus were calculated as being removed from Whitewater Lake, and between 15 and 60 pounds from Rice Lake, during the 1990 and 1991 plant harvesting seasons—May to September annually.[11] The difference between these estimates and the calculated nutrient loads to the Lakes probably reflects methodological constraints, although it is possible that the larger mass of phosphorus calculated as being contained in the harvested plants could be supplied from phosphorus present in the lake sediment, not exchanged with the water column, given that most of the plants harvested are rooted macrophytes.

The regional water quality management plan recommends that lands in the areas tributary to Whitewater and Rice Lakes continue to be served by onsite sewage disposal systems.[12]

RATING OF TROPHIC CONDITION

Lakes are commonly classified according to their degree of nutrient enrichment or trophic status. The ability of lakes to support a variety of recreational activities and healthy fish and aquatic life communities is often correlated to the degree of nutrient enrichment that has occurred. There are three terms usually used to describe the trophic status of a lake: oligotrophic, mesotrophic, and eutrophic. Oligotrophic lakes are nutrient-poor lakes. These lakes characteristically support relatively few aquatic plants and often do not contain productive fisheries. Because of the naturally fertile soils and the intensive land use practices employed in the State, there are relatively few oligotrophic lakes in Southeastern Wisconsin. Mesotrophic lakes are moderately fertile lakes that support abundant aquatic plant growths and may support productive fisheries. Nuisance growths of algae and aquatic plants are usually not exhibited by mesotrophic lakes. Many of the cleaner lakes in Southeastern Wisconsin are classified as mesotrophic. Eutrophic lakes are defined as nutrient-rich lakes. These lakes are often characterized by excessive growths of aquatic weeds and experience frequent algal blooms. Many eutrophic lakes support very productive fisheries. In shallow eutrophic lakes, fish winterkills may also be common. Many of the more polluted lakes in Southeastern Wisconsin are classified as eutrophic. In extreme cases eutrophic lakes may be classified as hypertrophic.

Several numeric "scales," based on one or more water quality parameters, have been developed to define the trophic condition of a lake. Because trophic state is actually a continuum from very nutrient poor to very nutrient rich, a numerical scale is useful for comparing lakes and for evaluating trends in water quality conditions. Care

[10] *U.S. Geological Survey Water-Resources Investigations Report No. 94-4101, Hydrology and Water Quality of Whitewater and Rice Lakes in Southeastern Wisconsin, 1990-91, 1994, p.27.*

[11] *U.S. Geological Survey Water-Resources Investigations Report No. 94-4101, Hydrology and Water Quality of Whitewater and Rice Lakes in Southeastern Wisconsin, 1990-91, 1994, p. 17.*

[12] *SEWRPC Memorandum Report No. 93, A Regional Water Quality Management Plan for Southeastern Wisconsin: An Update and Status Report, March 1995.*

must be taken, however, that the particular scale used are appropriate for the lakes to which it is applied. In this case, two indices are commonly used; namely, the Vollenweider-OECD open-boundary trophic classification system, shown in Figures 13 and 14,[13] and the Carlson Trophic State Index (TSI), shown in Figure 15.[14] The Carlson Index has recently been supplemented by the more appropriate Wisconsin Trophic State Index developed by the Wisconsin Department of Natural Resources to account for the peculiar characteristics of Wisconsin lakes, generally related to their higher levels of dissolved—humic—color.[15] A third measure of lake water quality, a comparison of conditions in an individual waterbody with typical conditions in similar waterbodies within a specific geographic area, is shown as Figures 16 and 17. The basis of this rating is the average condition of 1,140 Wisconsin lakes conducted over a 14-year period by Lillie and Mason.[16]

[13]*Organization for Economic Cooperation and Development, Eutrophication of Waters: Monitoring, Assessment and Control, Paris, 1982; S.O. Ryding and W. Rast, The Control of Eutrophication in Lakes and Reservoirs, UNESCO/MAB Series 1, Parthenon Press, 1989; and H. Olem and G. Flock, The Lake and Reservoir Restoration Guidance Manual, 2nd Edition, USEPA Report EPA-440/4-90-006, Office of Water (WH-553), Washington, D.C., 1990.*

[14]*R.E. Carlson, "A Trophic State Index for Lakes," Limnology and Oceanography, Vol. 22, No. 2, 1977.*

[15]*R.A. Lillie, S. Graham, and P. Rasmussen, "Trophic State Index Equations and Regional Predictive Equations for Wisconsin Lakes," Research Management Findings, No. 35, Wisconsin Department of Natural Resources Publication No. RS-735-93, 1993.*

[16]*R.A. Lillie and J.W. Mason, Limnological Characteristics of Wisconsin Lakes, Technical Bulletin No. 138, Wisconsin Department of Natural Resources, 1983.*

Vollenweider-OECD Trophic Classification System

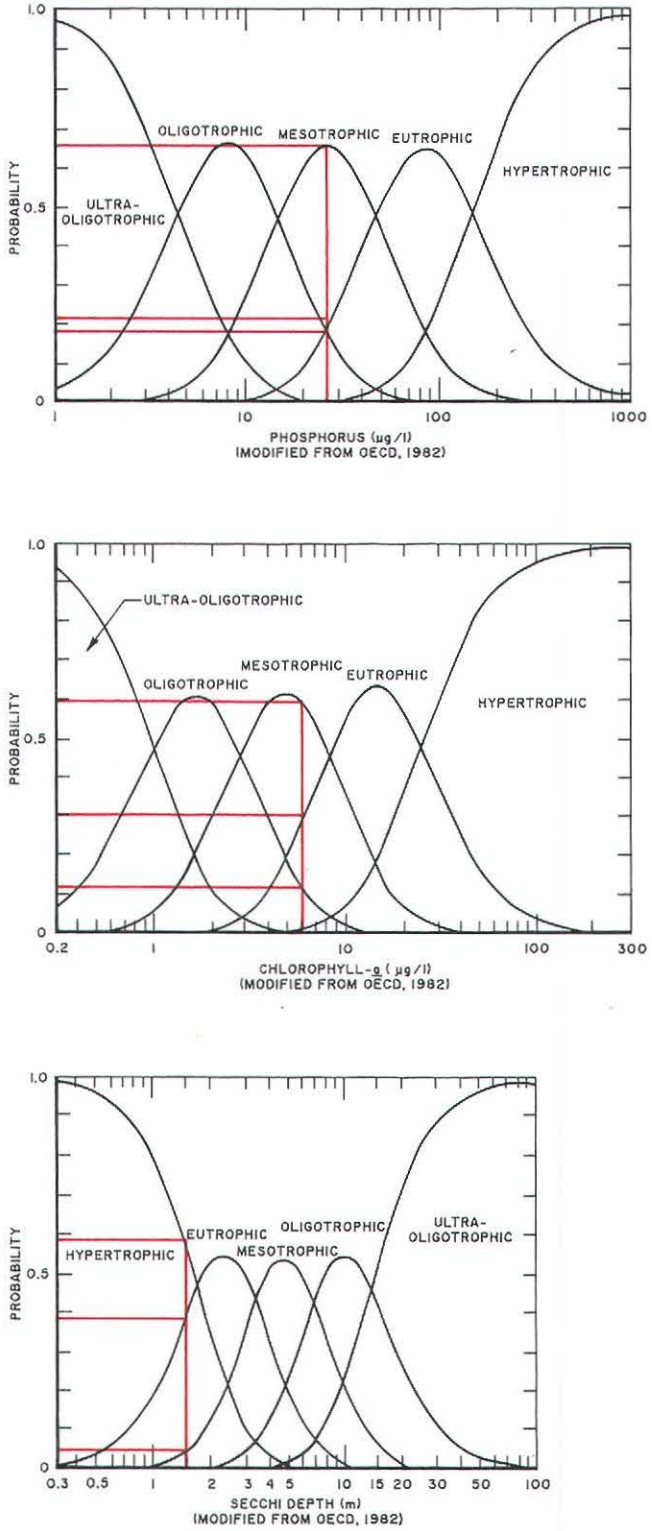
The European Organization for Economic Cooperation Development (OECD) investigated numerous lakes and reservoirs from around the world with the majority of their approximately 750 lakes being in Europe and North America and developed a number of empirical relationships between chlorophyll-a, Secchi-disk transparency, phosphorus, nitrogen, primary productivity, and trophic state. The result was both a set of predictive models and a set of trophic boundary descriptors. Applying the latter to the Whitewater—deep water, main basin station—and Rice Lakes data given in Table 10 indicates that Whitewater Lake has a 65 percent probability of being mesotrophic, a 20 percent probability of being eutrophic, and a 15 percent probability of being oligotrophic; and Rice Lake has a 63 percent probability of being mesotrophic, a 25 percent probability of being oligotrophic, a 12 percent probability of being eutrophic, based on the total phosphorus concentration, as shown in Figures 13 and 14. Similarly, using chlorophyll-a concentration, Whitewater Lake has a 56 percent probability of being mesotrophic, a 30 percent probability of being eutrophic, and an 11 percent probability of being oligotrophic; Rice Lake has a 59 percent probability of being mesotrophic, and a 29 percent probability of being eutrophic, an 11 percent probability of being oligotrophic and a 1 percent probability of being hypertrophic. The Secchi-disk-based classification yields a similar result: Whitewater Lake has a 57 percent probability of being hypertrophic, a 38 percent probability of being eutrophic, and a 5 percent probability of being mesotrophic, while Rice Lake has a 46 percent probability of being hypertrophic, a 46 percent probability of being eutrophic, and a 8 percent probability of being mesotrophic also as shown in Figures 13 and 14. Thus, Whitewater and Rice Lakes should be classified as eutrophic lakes, or lakes having water quality conditions that would be considered impaired for many uses.

Trophic State Index

The Trophic State Index (TSI) assigns a numerical trophic condition rating based on Secchi-disk transparency and total phosphorus and chlorophyll-a concentrations. The original Trophic State Index developed by Carlson has been modified for Wis-

Figure 13

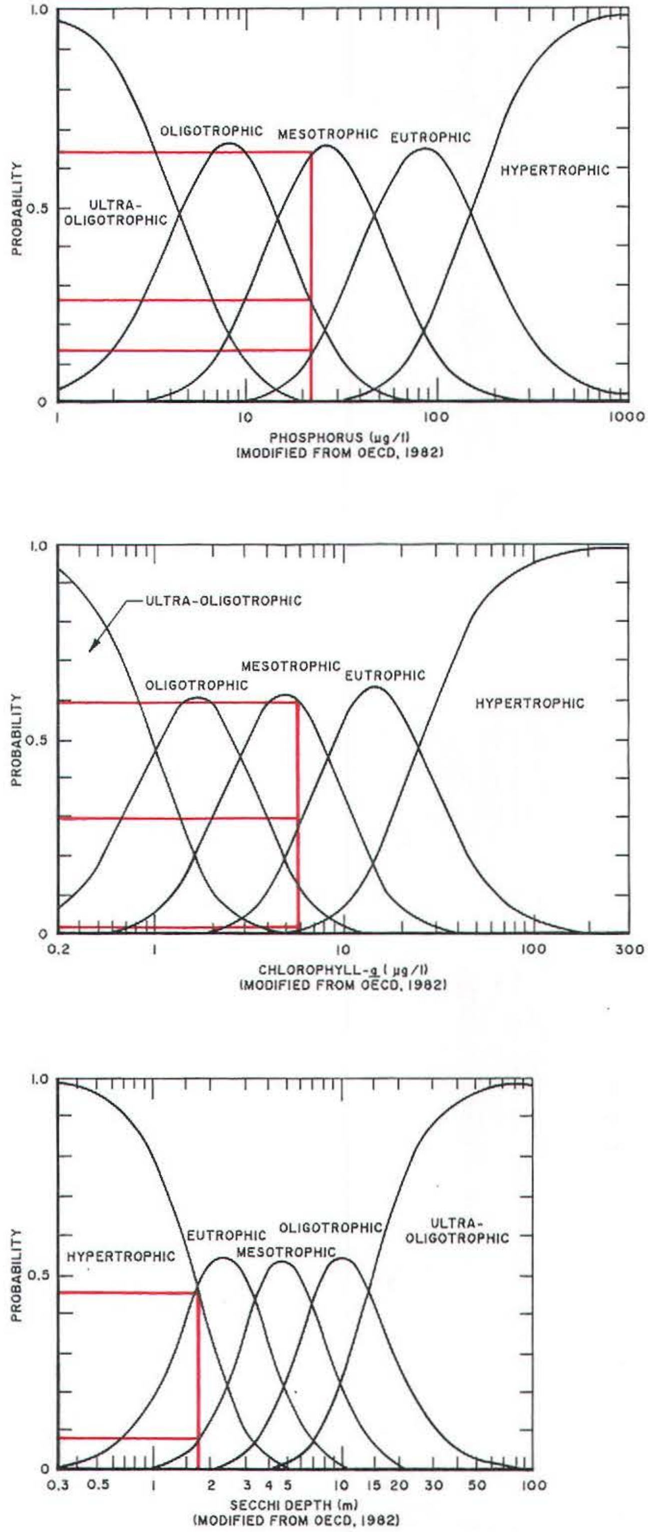
TROPHIC STATE CLASSIFICATION OF WHITEWATER LAKE BASED ON THE VOLLENWEIDER MODEL



Source: S. Ryding and W. Rast, The Control of Eutrophication of Lakes and Reservoirs, Vol. 1, 1989, and SEWRPC.

Figure 14

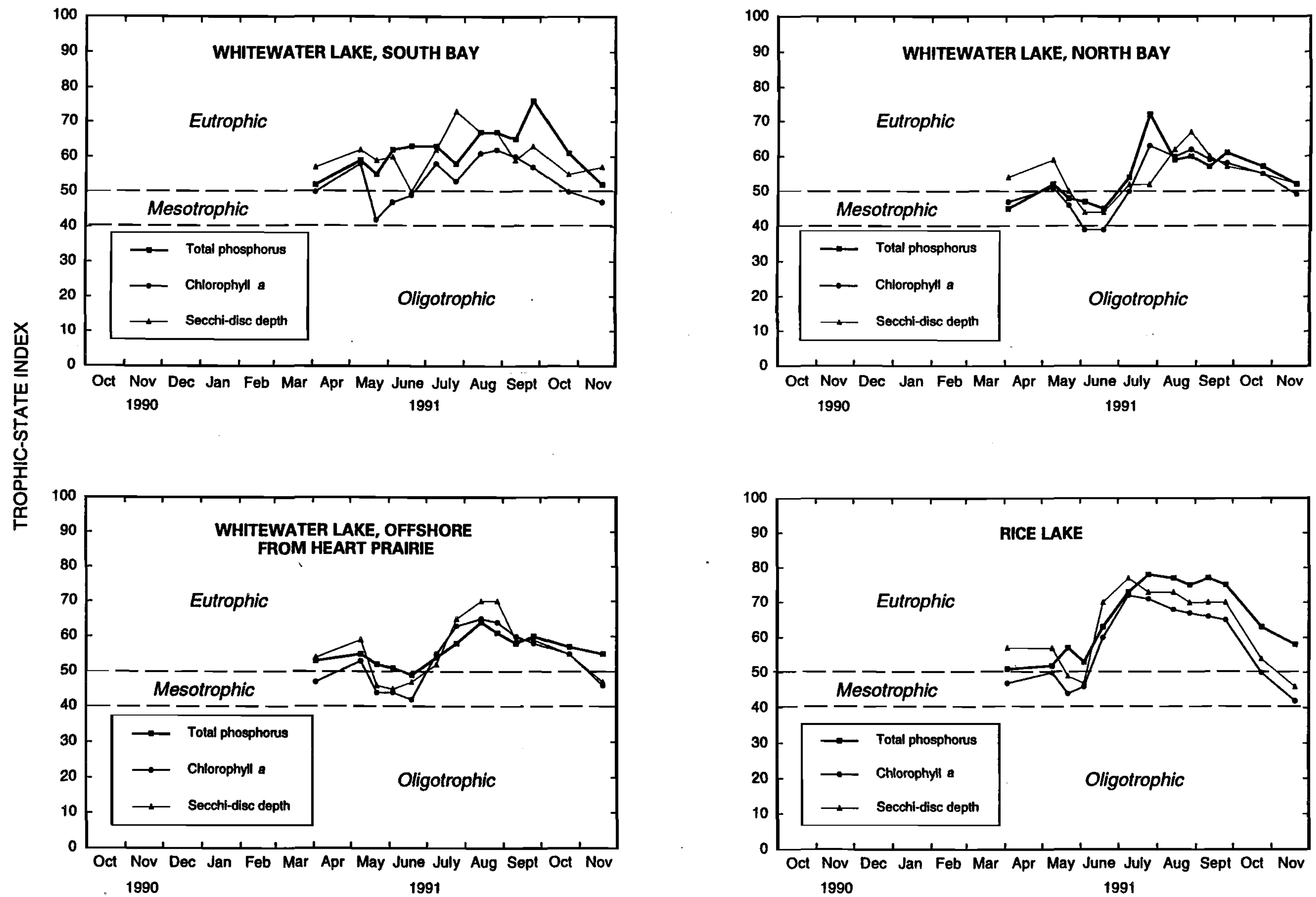
TROPHIC STATE CLASSIFICATION OF RICE LAKE BASED ON THE VOLLENWEIDER MODEL



Source: S. Ryding and W. Rast, The Control of Eutrophication of Lakes and Reservoirs, Vol. 1, 1989, and SEWRPC.

Figure 15

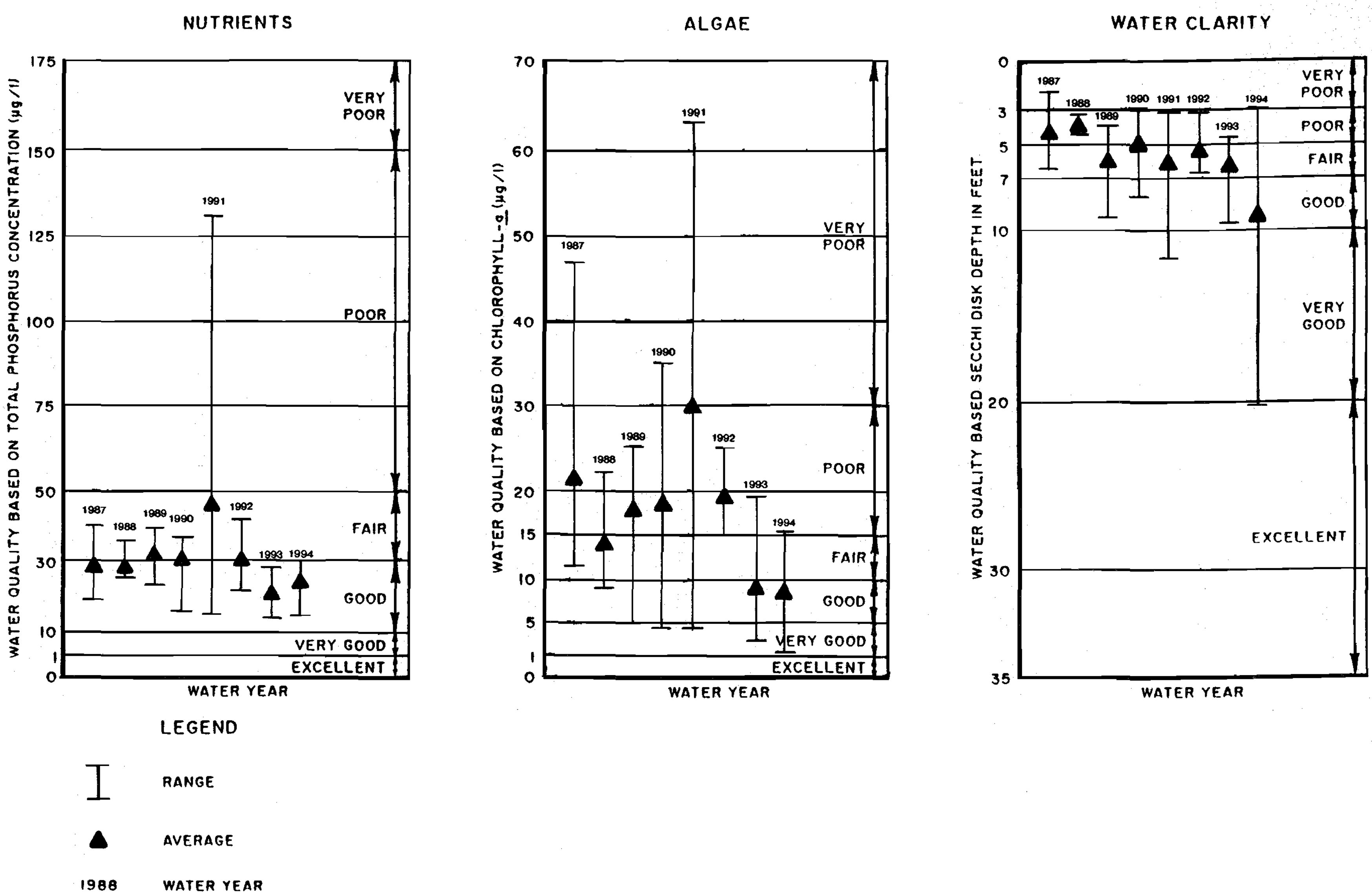
TROPHIC STATE INDEX FOR WHITEWATER AND RICE LAKES MONITORING STATIONS



Source: U.S. Geological Survey

Figure 16

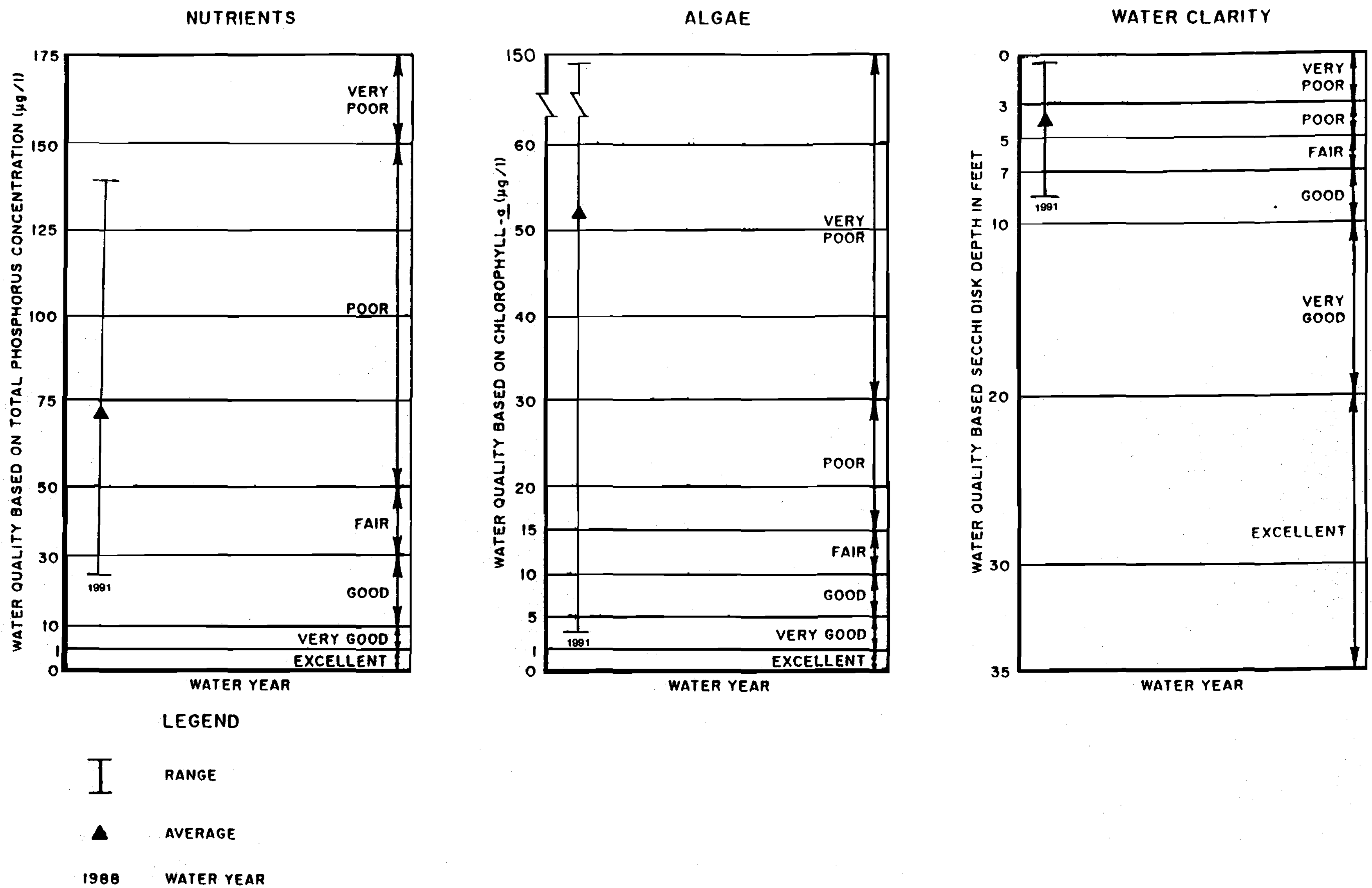
WHITEWATER LAKE PRIMARY WATER QUALITY INDICATORS: 1987-1994



Source: U. S. Geological Survey and SEWRPC.

Figure 17

RICE LAKE PRIMARY WATER QUALITY INDICATORS: 1987-1994



Source: U. S. Geological Survey and SEWRPC.

consin lakes by the Wisconsin Department of Natural Resources using data on 184 lakes throughout the State.[17] The Trophic State Index ratings for Whitewater and Rice Lakes ranged from about 40 to 70, and from about 40 to 80, respectively, over the study period as shown in Figure 15. The Wisconsin Trophic State Index (WTSI) varied similarly as a function of sampling date. Based on these Trophic State Index ratings, Whitewater and Rice Lakes may also be classified as eutrophic.

Water Quality Index

The Lillie and Mason Water Quality Index compares the range of conditions in a specific waterbody to a range of conditions observed in other Wisconsin lakes. Ratings of water quality, ranging from very poor to excellent reflect a statistical analysis of lake condition as related to multiple recreational uses. This rating system is approximately analogous to the trophic state rating system described above and in other indices, with excellent water quality being equivalent to ultraoligotrophic conditions and very poor water quality being equivalent to hypertrophic conditions. The ratings applied to Whitewater Lake ranged from very good to very poor, with most indicators being fair or good on average. Water clarity was always fair to poor on average, which probably reflects the humic coloration in the water rather than excessive algal growth under normal conditions, as shown in Figure 16. The ratings applied to Rice Lake were fair to very poor, with the poor water clarity reflecting a relatively high, very poor chlorophyll-a value, as shown in Figure 17. Such ratings are consistent with the characteristics of both Lakes as eutrophic.

SUMMARY

Whitewater and Rice Lakes are enriched hardwater, alkaline Lakes that have water quality characteristics associated with high nutrient loadings. Physical and chemical parameters measured during the 1990-1991 study period indicate that the water quality is considered fair based upon the phosphorus and chlorophyll concentrations, but very poor based upon water clarity compared to other lakes in Southeastern Wisconsin. Total phosphorus levels were found to be above the level considered to cause nuisance algal and aquatic plant growths. During summer stratification, the waters below a depth of 15 feet in Whitewater Lake, and five feet in Rice Lake, became devoid of oxygen, while the upper waters remained well oxygenated and supported a healthy fish population. Winterkill was not found to be a problem in Whitewater and Rice Lakes because dissolved oxygen levels were found to be adequate for the support of fish throughout the winter.

In 1995, there were no known point sources of pollutants in the drainage area directly tributary to Whitewater and Rice Lakes. The 1990-1991 U.S. Geological Survey Study of lake hydrology and water quality indicated that due to the rough topography and soils in the area, normally only about 1.4 square miles and 0.3 square mile of land surface actually contribute nutrients and pollutants to Whitewater and Rice Lakes, respectively. Thus, only about 1.7 square miles of the total 7.8-square-mile area, generally considered as the tributary watershed of the Lakes normally contribute surface water runoff directly to the Lakes. Never-the-less, pollutant loadings from the directly contributing drainage area comprise the largest external source of phosphorus to the Lakes, contributing annually about 237 pounds and 42 percent; and 37 pounds and 59 percent, of the total phosphorus loading to Whitewater and Rice Lakes, respectively. The annual phosphorus loading to Whitewater Lake from onsite sewage disposal systems is estimated to be about 106 pounds of phosphorus or 19 percent of the total loading to Whitewater Lake. These loadings reach the Lakes through groundwater inflow. Onsite sewage disposal systems do not contribute any significant amounts of phosphorus to Rice Lake. The remaining phosphorus loadings to the Lakes are contributed by precipitation and groundwater inflow, and in the case of Whitewater Lake, the inlet draining upstream lands. Phosphorus loadings from the drainage areas of Whitewater and Rice Lakes may be expected to remain relatively stable.

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[17] *R.A. Lillie, S. Graham, and P. Rasmussen, "Trophic State Index Equations and Regional Predictive Equations for Wisconsin Lakes,"* *Research Management Findings, No. 35, Wisconsin Department of Natural Resources Publication PUBL-RS-735 93, 1993.*

In addition to the phosphorus loadings contributed by direct sewage system runoff, groundwater inflow, and precipitation, about 582 pounds of phosphorus were estimated to be added to the water column of Whitewater Lake annually, and 295 pounds to the water column of Rice Lake annually, through internal loading from the bottom sediments, particularly under stratified conditions. Approximately 77 percent of the total annual phosphorus loading—calculated as the combined internal and external nutrient loading, or about 882 pounds—was estimated to be taken up by the biomass within Whitewater Lake or deposited in the sediments; as was about 85 percent, or about 305 pounds, of the phosphorus loading to Rice Lake. No significant amounts of phosphorus were transferred between Whitewater and Rice Lakes, or between Rice Lake and the downstream Tripp Lake, during the U.S. Geological study as neither Lake had an outflow during the 1990-1991 study period. A portion of the annual phosphorus loading is taken up by the biomass and removed from the Lakes through aquatic plant harvesting. Approximately 2,000 pounds per year and 30 pounds per year of phosphorus were estimated to have been removed from Whitewater and Rice Lakes, respectively, during the 1990 and 1991 aquatic plant harvesting seasons. It should be noted that the amounts of phosphorus being removed through harvesting are larger than the entire loading to the water column. This is due to the fact that a portion of the phosphorus contained in the harvested plants is being supplied from phosphorus present in the lake sediment, given that most of the plants harvested are rooted macrophytes. The phosphorus removed from the sediments should, over time, help to reduce the amount of phosphorus added to the water column through internal loading from the bottom sediments.

Based on the Vollenweider phosphorus loading model and the Trophic State Index ratings calculated from Whitewater and Rice Lakes data (1990-1991), Whitewater and Rice Lakes may be classified as eutrophic Lakes. Water quality in these Lakes is fair to poor compared to other Wisconsin lakes.

Subsequent sections of this report consider potential management alternatives for reducing pollutant loadings to the Lakes. In this respect, it must be recognized, however, that the nature of Whitewater and Rice Lakes is such that attainment of water quality conditions which would fully eliminate aquatic plant and algae problems, will not likely be possible. Thus, there is a need to consider alternative management measures that address the aquatic plant and algae growth problems directly in order to facilitate a recreational use of the Lakes.

Chapter V

AQUATIC BIOTA, ECOLOGICALLY VALUABLE AREAS, AND RECREATIONAL ACTIVITIES

INTRODUCTION

Whitewater and Rice Lakes are an important part of the natural resource base of the Towns of Whitewater and Richmond. The Lake, its biota, and the adjacent park and residential lands combine to contribute to the quality of life in the area. When located in urban settings resource features such as lakes and wetlands are typically subject to intensive recreational use and high levels of pollutant discharges, common forms of stress to aquatic systems, and thus may result in the deterioration of these natural resource features. For this reason, the formulation of sound management strategies must be based on a thorough knowledge of the pertinent characteristics of the individual resource features as well as of the urban development in the area concerned. Accordingly, this chapter provides information concerning the natural resource features of the drainage area tributary to Whitewater and Rice Lakes, including data on primary environmental corridors, wetlands, aquatic macrophytes, fish and wildlife. In addition, recreational activities relating to the use of these natural resource features are described.

AQUATIC PLANTS

Aquatic plants include larger plants, or macrophytes, and microscopic algae, or phytoplankton. These form an integral part of the aquatic food web, converting inorganic nutrients present in the water and sediments into organic compounds which are directly available as food for other aquatic organisms. In this process, known as photosynthesis, plants utilize energy from sunlight and release oxygen required by other aquatic life forms.

Aquatic Macrophytes

Aquatic macrophytes are an important factor in the ecology of Southeastern Wisconsin lakes. They can be either beneficial or a nuisance, depending on their distribution and abundance and the activities taking place on the water body. Macrophytes are usually an asset because they provide food and habitat for fish and other aquatic life, produce oxygen, and may remove nutrients and pollutants from the water that could otherwise cause algal blooms or other problems. Aquatic plants become a nuisance when their presence reaches densities that interfere with swimming and boating and the normal functioning of a lake ecosystem. Many factors, including lake configuration, depth, water clarity, nutrient availability, bottom substrate, wave action, and type of fish populations present, determine the distribution and abundance of aquatic macrophytes in a lake. Some nonnative plant species, lacking natural controls, may be especially favored by the habitats available in this Region and can exhibit explosive growths to the detriment not only of lake users but also of indigenous aquatic life and native plant species.

To document the types and relative abundances of aquatic macrophytes in Whitewater Lake, an aquatic plant survey was conducted by the Wisconsin Department of Natural Resources during 1990.[1] The aquatic plant survey was designed to determine species composition. A subsequent survey of aquatic plant community distributions in both Whitewater and Rice Lakes was conducted by Commission staff in July of 1995.

During the July 1995 survey, eight species of aquatic macrophytes were identified in Rice Lake and nine in Whitewater Lake all of which are listed in Tables 18 and 19 along with their ecological significance. Maps 17 and 18 show the distribution

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[1] *Wisconsin Department of Natural Resources, Aquatic Plant Management Sensitive Area Designation for Whitewater Lake, Walworth County, Wisconsin, July 1992.*

Table 18

AQUATIC PLANT SPECIES PRESENT IN RICE LAKE AND THEIR POSITIVE ECOLOGICAL SIGNIFICANCE

Aquatic Plant Species Present	Relative Abundance	Ecological Significance[a]
Chara Vulgaris (muskgrass)	Common	Excellent producer of fish food especially for young trout, bluegills, small and largemouth bass, stabilizes bottom sediments, and has softening effect on the water by removing lime and carbon dioxide
Myriophyllum sp. (water milfoil)	Abundant	Provides shelter and is a valuable food producer supporting many insects eaten by fish
Myriophyllum spicatum (Eurasian water milfoil)	Abundant	None known
Potamogeton amphibium (water knotweed)	Isolated stands	Provides food and shelter, leaves are eaten by bluegills, and has softening effect on the water
Potamogeton crispus (curly-leaf pondweed)	Abundant	Provides good food and shelter, and shade for early spawning fish
Potamogeton pectinatus (sago pondweed)	Isolated stands	Provides food and shelter for young trout and other fish; supports insects valuable as food for fish and ducklings
Potamogeton zosteriformis (flat-stemmed pondweed)	Isolated stands	Provides food and shelter for fish
Ceratophyllum demersum (coontail)	Abundant	Provides good shelter for young fish, and supports insects valuable as food for fish and ducklings

[a] *Information obtained from A Manual of Aquatic Plants, by Norman C. Fassett and Guide to Wisconsin Aquatic Plants, Wisconsin Department of Natural Resources.*

Source: SEWRPC.

of common species during the July 1995 surveys. Aquatic macrophytes occurred throughout both Whitewater and Rice Lakes, although diversity on Whitewater Lake was greatest in the vicinity of the lower central basin as shown on Map 17. The most diverse growths on Rice Lake occurred in the proximity of the southern most bay area.

Eurasian water milfoil (Myriophyllum spicatum) was the most abundant species on both Whitewater and Rice Lakes, dominating the vegetated areas of the Lakes. Eurasian water milfoil is an exotic aquatic plant species native to Europe, Asia and northern Africa. Eurasian is a biological pollutant that can outcompete important native aquatic plant communities which can lead to loss of plant diversity, degraded water quality, and reduced habitat for fish, invertebrates and wildlife.[2] Coontail (Ceratophyllum demersum), curly-leaf pondweed (Potamogeton crispus) and native milfoil species were also abundant on both lakes. Cattails and bulrush dominated the emergent flora along the shores of the Lakes.

In general, both Whitewater and Rice Lakes supported healthy aquatic plant communities, although species such as milfoil and coontail had a tendency to form dense mats that may interfere with boat traffic; harvesting has been necessary in selected areas to ameliorate the adverse effects of excessive macrophyte growth.

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[2] *Wisconsin Department of Natural Resources, Eurasian Water Milfoil in Wisconsin: A Report to the Legislature, 1992.*

Table 19

AQUATIC PLANT SPECIES PRESENT IN WHITEWATER LAKE AND THEIR POSITIVE ECOLOGICAL SIGNIFICANCE

Aquatic Plant Species Present	Relative Abundance	Ecological Significance[a]
Chara Vulgaris (muskgrass)	Common	Excellent producer of fish food especially for young trout, bluegills, small and largemouth bass, stabilizes bottom sediments, and has softening effect on the water by removing lime and carbon dioxide
Myriophyllum sp. (water milfoil)	Abundant	Provides shelter and is a valuable food producer supporting many insects eaten by fish
Myriophyllum spicatum (Eurasian water milfoil)	Abundant	None known
Potamogeton crispus (curly-leaf pondweed)	Abundant	Provides good food and shelter, and shade for early spawning fish
Potamogeton pectinatus (sago pondweed)	Isolated stands	Provides food and shelter for young trout and other fish; supports insects valuable as food for fish and ducklings
Potamogeton zosteriformis (flat-stemmed pondweed)	Isolated stands	Provides food and shelter for fish
Heteranthia Dubia (waterstar grass)	Isolated stands	Provides food and shelter for fish
Ceratophyllum demersum (coontail)	Common	Provides good shelter for young fish, and supports insects valuable as food for fish and ducklings
Elodea canadensis (waterweed)	Common	Provides shelter and support for insects valuable as fish food

[a]Information obtained from A Manual of Aquatic Plants by Norman C. Fassett and Guide to Wisconsin Aquatic Plants, Wisconsin Department of Natural Resources.

Source: SEWRPC.

Phytoplankton

Phytoplankton, or algae, are small, generally microscopic plants that are found in all lakes and streams. They occur in a wide variety of forms, in single cells or colonies, and can be either attached or free floating. Phytoplankton abundance varies seasonally with fluctuations in solar irradiance, turbulence due to prevailing winds, and nutrient availability. In lakes with high nutrient levels, heavy growths of phytoplankton, or algal blooms, may occur.

Algal blooms, historically, were the dominant form of vegetation in Whitewater Lake consisting of pollution tolerant blue-greens such as Microcystis, Anacystis, and Anabena.[3] Algae presently occurs on both Whitewater and Rice Lakes, as indicated by chlorophyll-a concentrations in excess of 20 micrograms per liter as shown in Table 8. However, these algae have not been considered a significant problem.

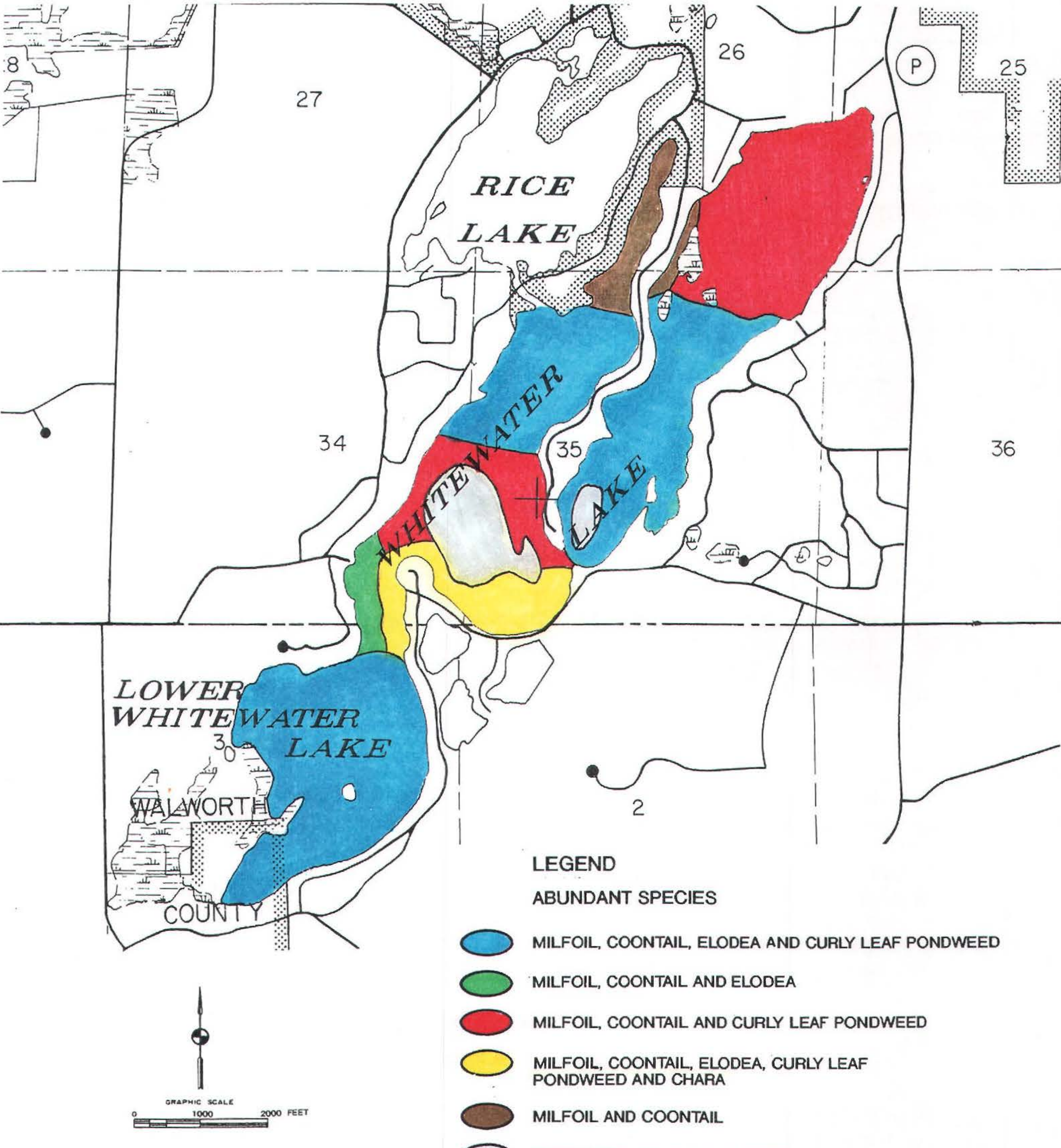
Aquatic Plant Management

Records of aquatic plant management efforts on Wisconsin lakes were not maintained by the Wisconsin Department of Natural Resources prior to 1950. Therefore, while previous interventions

[3]*Willard L. Gross, A Progress Report On Feasibility Study Of Whitewater Lake, November 1, 1971.*

Map 17

AQUATIC PLANT COMMUNITY DISTRIBUTION IN WHITEWATER LAKE: JUNE 1995



LEGEND

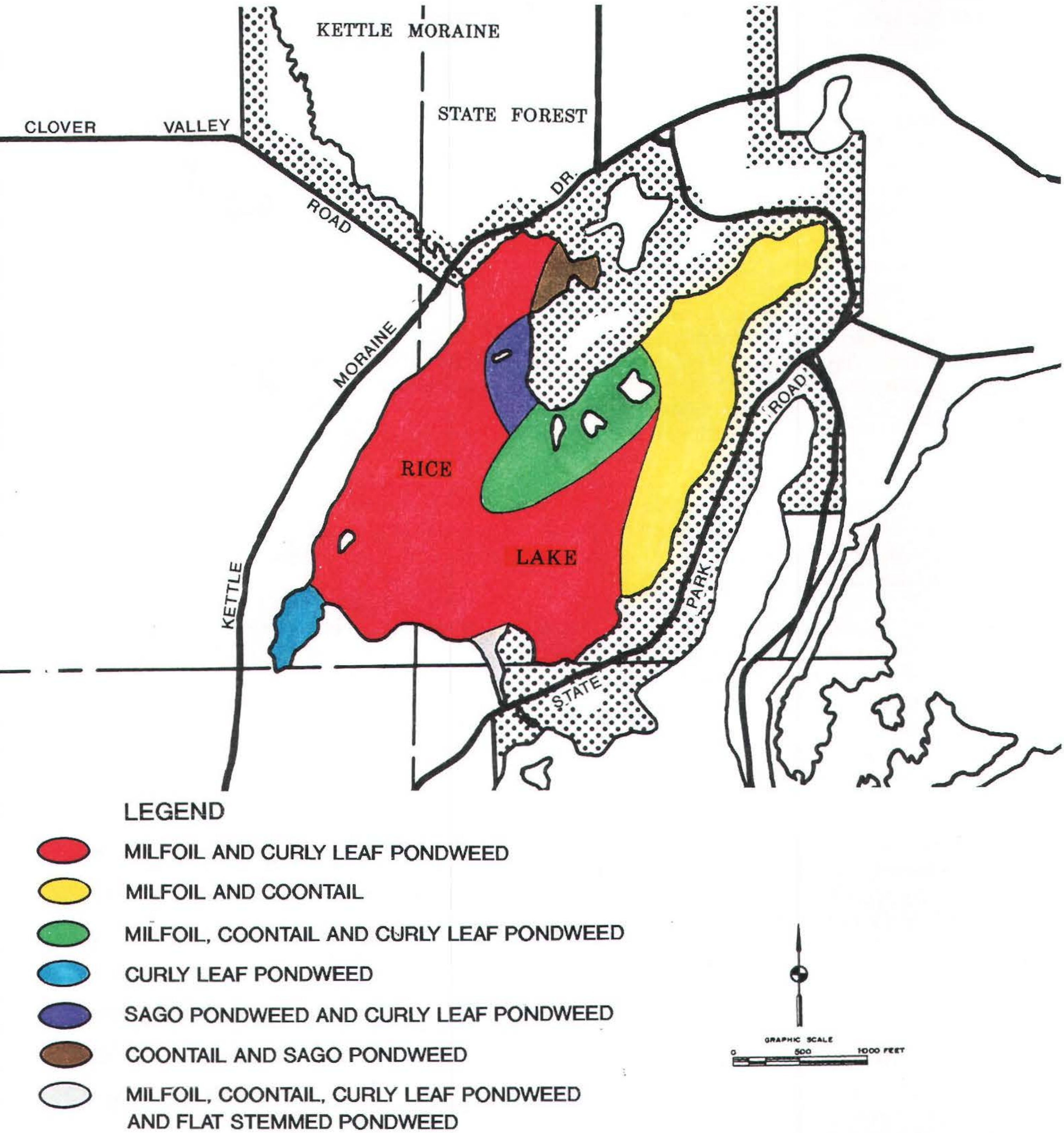
ABUNDANT SPECIES

- MILFOIL, COONTAIL, ELODEA AND CURLY LEAF PONDWEED
- MILFOIL, COONTAIL AND ELODEA
- MILFOIL, COONTAIL AND CURLY LEAF PONDWEED
- MILFOIL, COONTAIL, ELODEA, CURLY LEAF PONDWEED AND CHARA
- MILFOIL AND COONTAIL
- DEPTH GREATER THAN 12 FEET

Source: SEWRPC.

Map 18

AQUATIC PLANT COMMUNITY DISTRIBUTION IN RICE LAKE: JUNE 1995



Source: SEWRPC.

were likely, the first recorded efforts to manage the aquatic plants in Whitewater and Rice Lakes took place in 1950. Aquatic plant management activities in Whitewater and Rice Lakes can be categorized as macrophyte harvesting, chemical macrophyte control, and chemical algae control.

Excessive macrophyte growth on Whitewater and Rice Lakes has historically resulted in a control program that used both harvesting and chemicals. Under the existing macrophyte control program, the Whitewater and Rice Lakes Management District harvests macrophytes with an Aquarius Systems H-820 harvester. Since chemical herbicides are generally applied to Whitewater and Rice Lakes in early summer, harvesting is initiated in the nearshore areas only after the macrophytes become reestablished. Typically, only the macrophytes growing along the immediate shoreline of the Lake are chemically treated, although excessive macrophyte growths occur in other shallow portions of the Lake away from the shoreline. The shoreline areas are harvested to improve navigation and enhance swimming opportunities. No permit is currently required to cut vegetation in lakes mechanically, although the harvested plant material must be removed from the water.

Since 1941, the use of chemicals to control aquatic plants has been regulated in Wisconsin. In 1926, sodium arsenite, an agricultural herbicide, was first applied to lakes in the Madison area, and, by the 1930s, sodium arsenite was widely used throughout the State for aquatic plant control. No other chemicals were applied in significant amounts to control macrophytes until recent years, when a number of organic chemical herbicides came into general use. The amounts of sodium arsenite applied to the 12 lakes receiving the largest amounts of sodium arsenite in Southeastern Wisconsin, including Whitewater Lake, are listed in Table 20.

Sodium arsenite was usually sprayed onto the lake surface within an area of up to 200 feet from the shoreline. Treatment typically occurred between mid-June and mid-July. The amount of sodium arsenite used was calculated to result in a concentration of about 10 milligrams per liter (mg/l) sodium arsenite (about 5 mg/l arsenic) in the treated lake water. The sodium arsenite typically remained in the water column for less than 120 days. Although the arsenic residue was naturally converted from a highly toxic form to a less toxic and less biologically active form, much of the arsenic residue was deposited in the lake sediments.

When it became apparent that arsenic was accumulating in the sediments of treated lakes, the use of sodium arsenite was discontinued in the State of Wisconsin in 1969. The applications and accumulations of arsenic were found to present potential health hazards to both humans and aquatic life. In drinking water supplies, arsenic was suspected of being carcinogenic and, under certain conditions, arsenic has leached into and contaminated groundwaters, especially in sandy soils that serve as a source of drinking water in some communities. The U.S. Environmental Protection Agency-recommended drinking water standard for arsenic is a maximum level of 0.05 mg/l.

During anaerobic conditions, arsenic may be released from the bottom sediments to the water column above. In this way, some dissolved arsenic probably continues to be removed from Whitewater Lake during flushing events or periods of increased outflow. However, the arsenic-laden sediments are continually being covered by new sediments; thus, the level of arsenic in the water and in the surface sediments may be expected to decrease with passage of time. There is some evidence that the arsenic-laden sediments in Whitewater Lake have been covered by such additional debris which has entered the Lakes and do not appear to be releasing arsenic into the water column.

As shown in Table 21, the aquatic herbicides Aquathol, and 2,4-D have been applied to Whitewater and Rice Lakes in addition to Diquat and Hydrothol to Whitewater Lake to control aquatic macrophyte growth since 1980. Diquat, Aquathol, and Hydrothol are contact herbicides and kill plant parts exposed to the active ingredient. Diquat use is restricted to the control of duckweed (Lemna sp.), milfoil (Myriophyllum spp.), and waterweed (Elodea sp.). However, this herbicide is nonselective and will kill many other aquatic plants such as pondweeds (Potamogeton spp.), bladderwort (Utricularia sp.), and naiads (Najas spp.). Aquathol and Hydrothol kill primarily pondweeds but do not control such nuisance species as Eurasian water milfoil (Myriophyllum spicatum). The

Table 20

LAKES RECEIVING THE 12 LARGEST AMOUNT OF SODIUM ARSENITE IN WISCONSIN FOR AQUATIC MACROPHYTE CONTROL: 1950-1969

Lake	County	Amount of Sodium Arsenite (pounds)
Pewaukee	Waukesha	334,232
Okauchee	Waukesha	181,580
Big Cedar	Washington	179,164
Pine	Waukesha	129,337
Fowler	Waukesha	87,456[a]
Nagawicka	Waukesha	87,214
Lac La Belle	Waukesha	77,858
Onalaska	La Crosse	64,676
Shangrila	Kenosha	59,020
Browns	Racine	56,600
Whitewater	Walworth	55,920
Little Muskego	Waukesha	47,096
Total	- -	1,360,015[b]

[a]*Includes applications of sodium arsenite to the Oconomowoc River near Fowler Lake.*

[b]*The 1,036,015 pounds of sodium arsenite applied to these lakes constitutes 63 percent of the total amount of sodium arsenite applied to a total of 167 lakes and streams in Wisconsin from 1950 through 1969.*

Source: Wisconsin Department of Natural Resources.

Table 21

HERBICIDE USE AT WHITEWATER LAKE FROM 1950 THROUGH 1993[a]

Year	Macrophyte Control					Algal Control	
	Sodium Arsenite (pounds)	Diquat (gallons)	Aquathol K (pounds)	Hydrothol (pounds)	2,4-D (gallons)	Copper Sulfate (pounds)	Cutrine-Plus (gallons)
1950	55,920	- -	- -	- -	- -	- -	- -
1969	- -	- -	- -	150	- -	- -	- -
1970	- -	- -	- -	45	- -	1,500	- -
1971	- -	- -	- -	- -	- -	1,300	- -
1972	- -	- -	- -	- -	- -	1,895	- -
1973	- -	- -	- -	- -	- -	1,850	- -
1974	- -	- -	- -	- -	- -	2,525	- -
1975	- -	- -	- -	- -	- -	- -	- -
1984	- -	- -	15.0	- -	42.5	- -	- -
1987	- -	- -	2.0	- -	- -	- -	2.0
1988	- -	0.50	1.0	- -	2.0	- -	2.5
1989	- -	- -	- -	- -	17.5	- -	- -
1991	- -	24.75	- -	- -	236.0	- -	1.0
1993	- -	10.00	7.5	- -	5.0	- -	
Total	55,920	35.25	25.5	195	303.0	9,070	19.5

[a]*Rice Lake used a total of 78 gallons of 2,4-D, and 0.5 gallons Aquathol-K between the years 1968 and 1994.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

herbicide 2,4-D is a systemic herbicide which is absorbed by the leaves and translocated to other parts of the plant; it is more selective than the other herbicides listed above and is generally used to control Eurasian water milfoil. However, it will also kill more valuable species, such as water lilies (Nymphaea sp. and Nuphar sp.). The present restrictions on water uses after application of these herbicides are given in Table 22.

At present, the Whitewater and Rice Lakes Management District holds State permits for chemical treatment of aquatic plants required under Chapter NR 107 of the Wisconsin Administrative Code. Chemicals are applied annually on a contractual basis by a licensed local applicator. As already noted, herbicide application usually takes place in late spring or early summer with, occasionally, a second treatment of a smaller area, if necessary, in late July or early August. Map 19 shows the areal extent of those portions of Whitewater and Rice Lakes to which chemicals were applied between 1988 and 1994. All chemicals for aquatic plant control used today must be approved by the U.S. Environmental Protection Agency and the Wisconsin Department of Natural Resources and are registered in terms of the Federal Insecticide, Fungicide, and Rodenticide Act as amended in 1972.

In addition to the chemical herbicides used to control large aquatic plants, algicides have also been applied to both Whitewater Lake. As shown in Table 21, Cutrine Plus has been applied to Whitewater Lake, on occasion, since 1972, primarily to control the algae. Like arsenic, copper, the active ingredient in many algicides including Cutrine Plus, may accumulate in the bottom sediments. Excessive levels of copper have been found to be toxic to fish and benthic organisms but have not been found to be generally harmful to humans. Restrictions on water uses after application of Cutrine Plus are also given in Table 22.

AQUATIC ANIMALS

Aquatic animals include microscopic zooplankton; benthic, or bottom-dwelling invertebrates; fish and reptiles; amphibians; mammals; and waterfowl that inhabit the Lake and its shorelands. These make up the primary and secondary consumers of the food web.

Zooplankton

Zooplankton are minute, free-floating animals inhabiting the same environment as phytoplankton. Zooplankton are primary consumers in the aquatic food chain, feeding to a large extent on such phytoplankton as green algae and diatoms. The zooplankton, in turn, are preyed upon by fish, particularly the larvae and fry of bluegills, pumpkinseeds, sunfish, and largemouth bass. While the zooplankton population is an indicator of the trophic status of a lake and of the diversity of aquatic habitat, zooplankton were not sampled during the U.S. Geological Survey inventory; no information on the species composition or relative abundance is available for Whitewater and Rice Lakes. However, given the composition and condition of the fish community in Whitewater and Rice Lakes, it may be assumed that the zooplankton population is sufficiently robust and diverse to support a relatively healthy fishery.

Fish of Whitewater and Rice Lakes

Both Whitewater and Rice Lakes support a moderately diverse fish community. A Wisconsin Department of Natural Resources fish survey conducted in 1991 recorded the presence of 17 species of fish representing six families, as shown in Table 23.

Important predator fishes in Whitewater and Rice Lakes include northern pike, walleyed pike, and largemouth bass. These species are carnivorous, feeding primarily on other fish, crayfish, and frogs. These species are among the largest and most prized gamefish sought by Whitewater and Rice Lake anglers. As indicated in Tables 24 and 25, the Wisconsin Department of Natural Resources, in addition to the Whitewater and Rice Lakes Management District, currently stock the Lakes to supplement the natural fishery.

"Panfish" is a common term applied to a broad group of smaller fish with a relatively short and usually broad shape. Panfish species present in Whitewater and Rice Lakes include bluegills, pumpkinseeds, green sunfish, black crappies, white suckers, golden shiners, yellow perch, and bullheads. The habitats of panfish vary widely among

Table 22

PRESENT RESTRICTIONS ON WATER USES AFTER APPLICATION OF AQUATIC HERBICIDES[a]

Use	Days After Application			
	Cutrine-Plus	Diquat	Hydrothol and Aquathol	2,4-D
Drinking	0	14	7-14	- -[b]
Fishing	0	14	3	0
Swimming	0	1	- -	0
Irrigation	0	14	7-14	- -[b]

[a]*The U. S. Environmental Protection Agency has indicated that, if these water use restrictions are observed, pesticide residues in water, irrigated crops, or fish should not pose an unacceptable risk to humans and other organisms using or living in the treatment zone.*

[b]*2,4-D products are not to be applied to waters used for irrigation, animal consumption, drinking, or domestic uses, such as cooking and watering vegetation.*

Source: Wisconsin Department of Natural Resources.

the different species, but their cropping of the plentiful supply of insects and plants, coupled with prolific breeding rates, leads to large populations with a rapid turnover. Some lakes within Southeastern Wisconsin have stunted, or slow-growing, panfish populations because their numbers are not controlled by predator fishes.[4] Panfish frequently feed on the fry of predator fish and, if the panfish population is overabundant, they may quickly deplete the predator fry population. Figure 18 illustrates the importance of a balanced predator-prey relationship, using walleyed pike and perch as an example.

"Rough fish" is a broad term applied to species such as carp that do not readily bite on hook and line, but feed on game fish, destroy habitat needed by more desirable species, and which are commonly considered within Southeastern Wisconsin undesirable for human consumption because of numerous bones or undesirable flavors. Carp are known to be present in Whitewater and Rice Lakes, but do not represent a significant problem.[5]

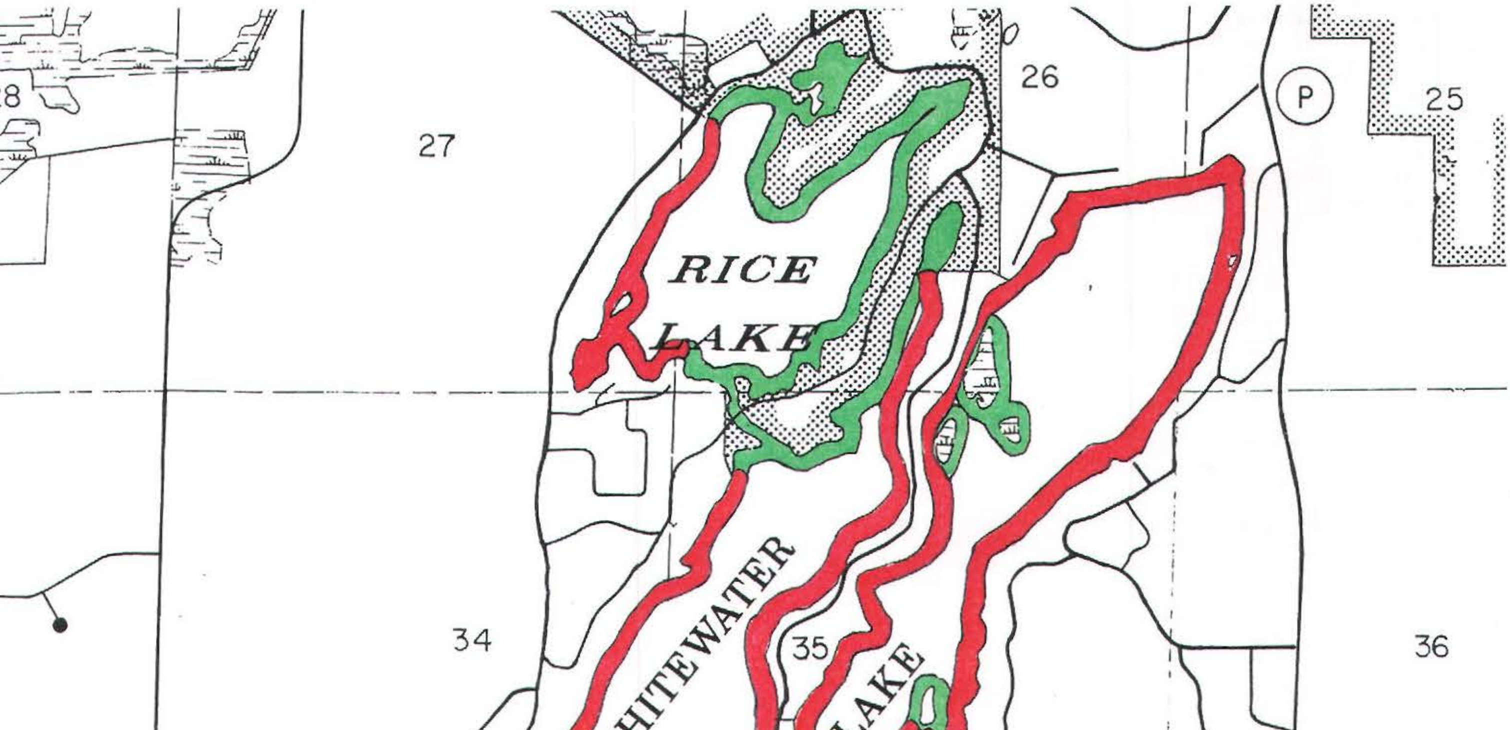
The Lake is currently managed for the production of bluegills, walleyed pike, and northern pike. It has been hypothesized that an overharvest of northern pike, and larger bluegills may have contributed to an unbalanced, slow-growing panfish population because of a lack of predation. In order to enhance and maintain sport fishing opportunities for anglers using the Lakes, the Whitewater and Rice Lakes Management District has stocked the Lakes with walleyed and northern pike, as shown in Tables 24 and 25. The District plans to continue to stock Whitewater and Rice Lakes with northern and walleyed pike on alternating years.

[4]*Personal communication, Dr. Ron Crunkilton, University of Wisconsin-Stevens Point College of Natural Resources, 1992.*

[5]*According to the Wisconsin Department of Natural Resources, carp are typically considered a significant problem if they are the most populous fish species in the lake, or if they appear stressed or cause stress among other fish populations in the lake.*

Map 19

SHORELINE AREAS OF WHITEWATER AND RICE LAKES HISTORICALLY TREATED WITH HERBICIDES



LEGEND

AREAS TO WHICH CHEMICALS HAVE BEEN APPLIED

AREAS WITH NO RECORD OF CHEMICAL APPLICATION

Source: Whitewater and Rice Lakes Management District and SEWRPC.

Table 23

SPECIES OF FISH IDENTIFIED DURING THE WHITEWATER AND RICE LAKES FISH SURVEY: 1992

Common Name	Family Name	Species Name
Walleyed Pike	Percidae	Stizostedion vitreum
Northern Pike	Esocidae	Esox lucius
Largemouth Bass	Centrarchidae	Micropterus salmoides
White Bass	Percichthyidae	Morone chrysops
Rock Bass	Centrarchidae	Amblopites rupestris
Yellow Perch	Percidae	Perca flavescens
Bluegill	Centrarchidae	Lepomis macrochirus
Pumpkinseed	Centrarchidae	Lepomis gibbosus
Green Sunfish	Centrarchidae	Lepomis cyanellus
Black Crappie	Centrarchidae	Pomoxis nigromaculatus
Warmouth	Centrarchidae	Lepomis gulosus
Golden Shiner	Cyprinidae	Notemigonus crysoleucas
Black Bullhead	Ictaluridae	Ictalurus melas
Yellow Bullhead	Ictaluridae	Ictalurus natalis
Brown Bullhead	Ictaluridae	Ictalurus nebulosus
White Sucker	Catostomidae	Catostomus commersoni
Carp	Cyprinidae	Cyprinus carpio

Source: Wisconsin Department of Natural Resources.

Table 24

WHITEWATER LAKE STOCKING RECORD

Year	Species	Number	Size
1980	Northern pike	1,100,000	Fry
1985	Walleyed pike[a]	3,700	3 inch
1987	Walleyed pike[b]	29,000	2 inch to 5 inch
1988	Walleyed pike[a]	9,000	4 inch
1989	Walleyed pike[b]	12,267	1 inch to 14 inch
1991	Northern pike[a]	1,000	3 inch to 4 inch
1991	Walleyed pike	20,000	2 inch to 3 inch
1992	Northern pike[a]	2,500	3.5 inch
1993	Walleyed pike[a]	1,500	7 inch
1994	Northern pike	1,280	7 inch
1995	Walleyed pike[a]	3,000	6 inch

[a]Purchased by the Whitewater-Rice Lakes Management District.

[b]The walleyed pike stocked in 1987, and 11,500 walleyed pike stocked in 1989 were cooperatively raised by the Wisconsin Department of Natural Resources and the Whitewater-Rice Lakes Management District.

Source: Wisconsin Department of Natural Resources.

Other Wildlife

Although a quantitative field inventory of amphibians, reptiles, birds, and mammals was not conducted as a part of the Whitewater and Rice Lakes study, a field reconnaissance was undertaken by the Wisconsin Department of Natural Resources during July 1992. The procedures used involved compiling the inventory lists of those amphibians, reptiles, birds, and mammals known to exist, or known to have existed, in Walworth County;

Table 25

RICE LAKE FISH STOCKING RECORD

Year	Species	Number	Size
1982	Northern pike	270	9 inch
1985	Northern pike	270	9 inch
1989	Walleyed pike	4,000	2.5 inch
1991	Northern pike[a]	500	3.5 inch
1991	Northern pike	600	7.5 inch
1992	Northern pike	270	8.2 inch
1994	Northern pike	274	7 inch

[a]*Purchased by the Whitewater-Rice Lakes Management District.*

Source: Wisconsin Department of Natural Resources.

associating these lists with the historic and remaining habitat areas in the Whitewater and Rice Lakes area as inventoried; and projecting the appropriate amphibian, reptile, bird, and mammal species into the Whitewater and Rice Lakes area. The net result of the application of this technique is a testing of those species which were probably once present in the drainage area, those species which may be expected to still be present under currently prevailing conditions, and those species which may be expected to be lost or gained as a result of continued urbanization within the area.

Amphibians and reptiles are vital components of the ecosystem in an environmental unit like the drainage area tributary to Whitewater and Rice Lakes. Examples of amphibians native to the area include frogs, toads, and salamanders. Turtles and snakes are examples of reptiles common to the Whitewater and Rice Lakes area. Table 26 lists the 12 amphibian and 14 reptile species which may be expected to be present in the Whitewater and Rice Lakes area under present conditions and identifies those species most sensitive to urbanization.

A large number of birds, ranging in size from large game birds to small songbirds, are found in the drainage area tributary to Whitewater and Rice Lakes study area. Table 27 lists those birds that may be expected occur in the drainage area. Each bird is classified as to whether it may be expected to breed within the area, visit the area only during the annual migration periods, or visit the area only on rare occasions.

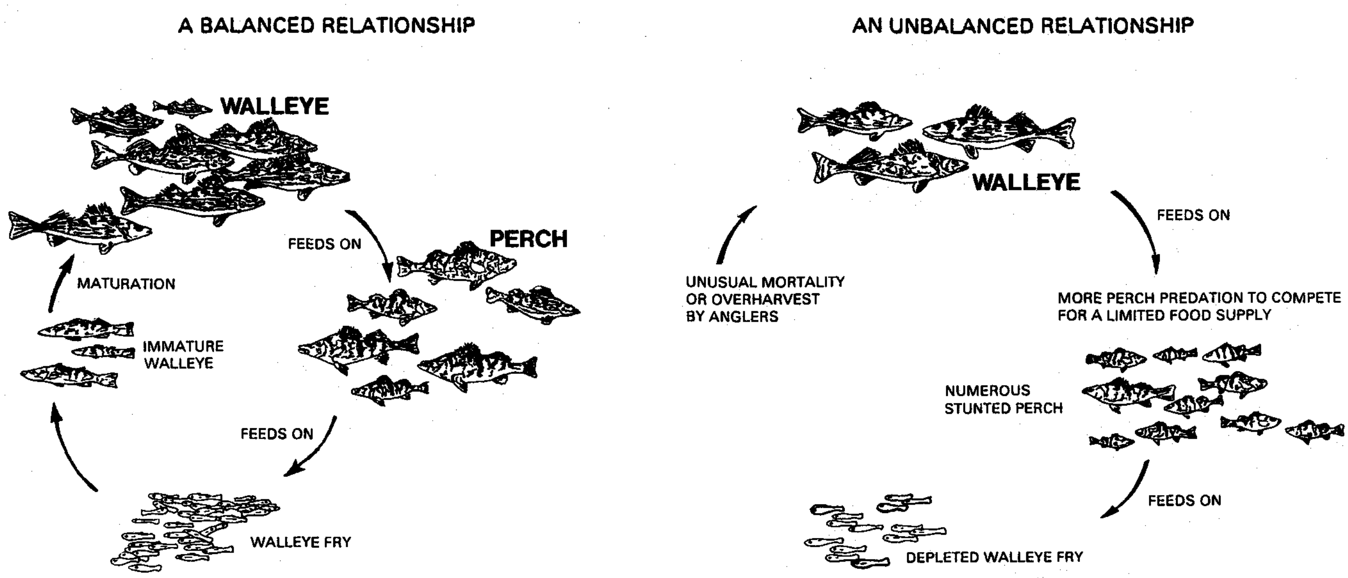
Game birds which are found in the drainage area tributary to Whitewater and Rice Lakes include the pheasants, partridges, woodcocks, snipe, dabbling ducks, diving ducks, and geese. Pheasants and partridges are upland game birds and provide some opportunities for hunting. Although the drainage area lies within the Mississippi flyway, opportunities for waterfowl hunting are constrained because of habitat deterioration and urbanization. The fall pheasant population within the drainage area is irregularly distributed, but fair populations are known to reside in the larger habitat areas. Winter flocks require good cover interspersed with fields containing waste grain, such as corn, from farming operations. Supplemental feeding of such flocks will greatly aid in their survival during severe winters. However, predators, such as fox and coyote, can impact the pheasant and other ground-nesting bird populations.

A variety of mammals, ranging in size from large animals like the northern white-tailed deer to small animals like the cinereous shrew, are found in the Whitewater and Rice Lakes area. Table 28 lists 35 mammals whose ranges may be expected to include the area.

The larger mammals that are still fairly common in the less densely populated areas of the drainage

Figure 18

THE PREDATOR-PREY RELATIONSHIP



Source: Wisconsin Department of Natural Resources.

area include the white-tailed deer, cottontail rabbits, gray squirrels, fox squirrels, muskrats, minks, weasels, raccoons, red foxes, skunks, and opossums. The first four may be considered game mammals, while the rest may be classified as fur-bearing mammals. White-tailed deer are generally restricted to the larger wooded areas, the open meadows and croplands adjacent to the woodlots, and to the shrub swamps. Deer may create problems in more densely developed urban and suburban areas. When deer wander, or are forced, into residential, commercial, or industrial areas, they typically exhibit panic, and may run wildly, presenting a threat to the safety of people, as well as to themselves. Foraging deer may cause damage to gardens, ornamental trees, croplands, and orchards. Deer-automobile collisions often occur on the fringes of urban areas, while hunters stalking the animals in urbanizing areas may create yet another hazard.

Small mammals fairly common in the area include the short-tailed shrew, striped ground squirrel or gopher, meadow vole, white-footed mouse, and little brown bat. These small mammals, with the exception of the bats, are commonly associated with meadows, fence rows, and utility and transportation rights-of-way. People view their importance differently depending on whether they consider these mammals to be insect predators and food sources for larger mammals and such raptors as hawks and owls, or pests in croplands, gardens, and lawns.

The complete spectrum of wildlife species originally native to Walworth County has, along with its habitat, undergone significant change in terms of diversity and population size since European settlement of the area. This change is a direct result of the conversion of land by the settlers from its natural state to agricultural and urban uses,

Table 26

AMPHIBIANS AND REPTILES OF THE WHITEWATER AND RICE LAKES AREA

Scientific (family) and Common Name	Species Which May Be Expected to Be Reduced or Dispersed with Full Area Urbanization	Species Which May Be Expected to Be Lost with Full Area Urbanization
Amphibians		
Proteidae		
Mudpuppy	X	- -
Ambystomatidae		
Blue-Spotted Salamander	- -	X
Eastern Tiger Salamander	X	- -
Salamandridae		
Central Newt	X	- -
Bufonidae		
American Toad	X	- -
Hylidae		
Western Chorus Frog	X	- -
Northern Spring Peeper	- -	X
Cope's Gray Tree Frog	- -	X
Eastern Gray Tree Frog	- -	X
Ranidae		
Bull Frog	- -	X
Green Frog	X	- -
Northern Leopard Frog	- -	X
Reptiles		
Chelydridae		
Common Snapping Turtle	X	- -
Kinosternidae		
Musk Turtle (stinkpot)	X	- -
Emydidae		
Painted Turtle	X	- -
Blanding's Turtle[a]	- -	X
Trionychidea		
Eastern Spiny Softshell	X	- -
Colubridae		
Northern Water Snake	X	- -
Northern Brown Snake	X	- -
Red-Bellied Snake	X	- -
Eastern Garter Snake	X	- -
Butler's Garter Snake	X	- -
Eastern Hognose Snake	X	- -
Eastern Plains Garter Snake	X	- -
Smooth Green Snake	X	- -
Eastern Milk Snake	- -	X

[a] *Indentified as threatened in Wisconsin.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

beginning with the clearing of the forests and prairies, the draining of wetlands, and ending with the development of extensive urban areas. Successive cultural uses and attendant management practices, both rural and urban, have been superimposed on the land use changes and have also affected the wildlife and wildlife habitat. In agricultural areas, these cultural management practices

Table 27

BIRDS KNOWN OR LIKELY TO OCCUR IN THE WHITEWATER AND RICE LAKES AREA

Scientific (family) and Common Name	Breeding	Wintering	Migrant
Gaviidae			
Common Loon	--	--	R
Podicipedidae			
Pied-Billed Grebe	X	--	X
Horned Grebe	--	--	X
Ardeidae			
American Bittern	X	--	--
Least Bittern	X	--	--
Great Blue Heron	X	--	--
Great Egret[a]	--	--	--
Cattle Egret[b]	--	--	--
Green-Backed Heron	X	--	--
Black-Crowned Night Heron	X	--	--
Gruidae			
Sandhill Crane	X	--	--
Anatidae			
Tundra Swan	--	--	X
Mute Swan[b]	X	--	X
Snow Goose	--	--	X
Canada Goose	X	--	X
Wood Duck	X	X	X
Green-Winged Teal	X	X	X
American Black Duck	--	--	X
Mallard	X	--	X
Northern Pintail	X	--	X
Blue-Winged Teal	X	--	X
Northern Shoveler	X	--	X
Gadwall	--	--	X
American Wigeon	X	--	X
Canvas Back	R	--	X
Redhead	X	--	X
Ring-Necked Duck	--	--	X
Lesser Scaup	--	--	X
Common Goldeneye	--	--	X
Bufflehead	--	--	X
Hooded Merganser	X	--	X
Common Merganser	--	--	X
Red-Breasted Merganser	--	--	X
Ruddy Duck	X	--	X
Cathartidae			
Turkey Vulture	X	--	--
Accipitridae			
Osprey[a]	--	--	X
Bald Eagle[a,c]	--	--	X
Northern Goshawk	--	--	R
Cooper's Hawk	--	--	--
Sharp-Shinned Hawk	X	--	--
Northern Harrier	X	--	--
Red-Shouldered Hawk[a]	R	--	--

Table 27 (continued)

Scientific (family) and Common Name	Breeding	Wintering	Migrant
Accipitridae (continued)			
Broad-Winged Hawk	- -	- -	X
Red-Tailed Hawk	X	- -	- -
Rough-Legged Hawk	- -	- -	X
American Kestrel	X	- -	- -
Merlin	- -	- -	X
Phasianidae			
Gray Partridge[b]	X	- -	- -
Ring-Necked Pheasant	X	- -	- -
Wild Turkey	X	X	- -
Northern Bobwhite[d]	X	- -	- -
Rallidae			
Virginia Rail	X	- -	- -
Sora	X	- -	- -
Common Moorhen	X	- -	- -
American Coot	X	- -	- -
Charadriidae			
Black-Bellied Plover	- -	- -	X
Lesser Golden Plover	- -	- -	X
Killdeer	X	- -	- -
Scolopacidae			
Greater Yellowlegs	- -	- -	X
Lesser Yellowlegs	- -	- -	X
Solitary Sandpiper	- -	- -	X
Spotted Sandpiper	X	- -	- -
Upland Sandpiper	X	- -	- -
Pectoral Sandpiper	- -	- -	X
Common Snipe	- -	- -	X
American Woodcock	X	- -	- -
Wilson's Phalarope	X	- -	- -
Laridae			
Bonaparte's Gull	- -	- -	X
Ring-Billed Gull	- -	- -	- -
Herring Gull	- -	- -	- -
Common Tern[e]	- -	- -	R
Forster's Tern[e]	R	- -	- -
Black Tern	X	- -	- -
Columbidae			
Rock Dove[b]	X	- -	- -
Mourning Dove	X	- -	- -
Cuculidae			
Black-Billed Cuckoo	X	- -	- -
Yellow-Billed Cuckoo	X	- -	- -
Strigidae			
Eastern Screech Owl	X	- -	- -
Great Horned Owl	X	- -	- -
Snowy Owl	- -	R	- -
Barred Owl	X	- -	- -

Table 27 (continued)

Scientific (family) and Common Name	Breeding	Wintering	Migrant
Strigidae (continued)			
Long-Eared Owl	--	R	--
Short-Eared Owl	--	X	--
Northern Saw-Whet Owl	--	X	--
Caprimulgidae			
Common Nighthawk	X	--	--
Apodidae			
Chimney Swift	X	--	--
Trochilidae			
Ruby-Throated Hummingbird	X	--	--
Alcedinidae			
Belted Kingfisher	X	--	--
Picidae			
Red-Headed Woodpecker	X	--	--
Yellow-Bellied Woodpecker	X	--	--
Yellow-Bellied Sapsucker	--	--	X
Downy Woodpecker	X	--	--
Hairy Woodpecker	X	--	--
Northern Flicker	X	--	--
Pileated Woodpecker	--	--	--
Tyrannidae			
Olive-Sided Flycatcher	--	--	X
Eastern Wood-Pewee	X	--	--
Yellow-Bellied Flycatcher	--	--	--
Arcadian Flycatcher[a]	X	--	--
Alder Flycatcher	X	--	--
Willow Flycatcher	X	--	--
Least Flycatcher	X	--	--
Eastern Phoebe	X	--	--
Great Crested Flycatcher	X	--	--
Eastern Kingbird	X	--	--
Alaudidae			
Horned Lark	X	--	--
Hirundinidae			
Purple Martin	X	--	--
Tree Swallow	X	--	--
Northern Rough-Winged Swallow	X	--	--
Bank Swallow	X	--	--
Cliff Swallow	X	--	--
Barn Swallow	X	--	--
Corvidae			
Blue Jay	X	--	--
American Crow	X	--	--
Titmice			
Black-Capped Chickadee	X	--	--
Sittidae			
Red-Breasted Nuthatch	--	X	--
White-Breasted Nuthatch	X	--	--

Table 27 (continued)

Scientific (family) and Common Name	Breeding	Wintering	Migrant
Certhiidae			
Brown Creeper	- -	- -	X
Troglodytidae			
House Wren	X	- -	- -
Winter Wren	- -	- -	X
Sedge Wren	X	- -	- -
Marsh Wren	X	- -	- -
Muscicapidae			
Golden-Crowned Kinglet	- -	- -	X
Ruby-Crowned Kinglet	- -	- -	X
Blue-Gray Gnatcatcher	X	- -	- -
Eastern Bluebird	X	- -	- -
Veery	X	- -	- -
Gray-Cheeked Thrush	- -	- -	X
Swainson's Thrush	- -	- -	X
Hermit Thrush	- -	- -	X
Wood Thrush	X	- -	- -
American Robin	X	- -	- -
Mimidae			
Gray Catbird	X	- -	- -
Brown Thrasher	X	- -	- -
Motacillidae			
American Pipit	- -	- -	R
Bombycillidae			
Bohemian Waxwing	- -	R	- -
Cedar Waxwing	X	- -	- -
Lanniidae			
Northern Shrike	- -	- -	R
Loggerhead Shrike[e]	- -	- -	R
Sturnidae			
European Starling[b]	X	- -	- -
Vireonidae			
White-Eyed Vireo	- -	- -	X
Solitary Vireo	- -	- -	X
Yellow-Throated Vireo	X	- -	- -
Warbling Vireo	X	- -	- -
Red-Eyed Vireo	X	- -	- -
Emberizidae			
Blue-Winged Warbler	- -	- -	X
Golden-Winged Warbler	- -	- -	X
Tennessee Warbler	- -	- -	X
Orange-Crowned Warbler	- -	- -	X
Nashville Warbler	- -	- -	X
Northern Parula	- -	- -	X
Yellow Warbler	X	- -	- -
Chestnut-Sided Warbler	- -	- -	X
Black-Throated Blue Warbler	- -	- -	X
Yellow-Rumped Warbler	- -	- -	X
Black-Throated Green Warbler	- -	- -	X

Table 27 (continued)

Scientific (family) and Common Name	Breeding	Wintering	Migrant
Emberizidae (continued)			
Blackburnian Warbler	--	--	X
Yellow-Throated Warbler	--	--	X
Pine Warbler	--	--	X
Prairie Warbler	--	--	X
Palm Warbler	--	--	X
Bay-Breasted Warbler	--	--	X
Blackpoll Warbler	--	--	X
Cerulean Warbler[a]	--	--	X
Black-and-White Warbler	--	--	X
American Redstart	X	--	--
Prothonotary Warbler	--	--	X
Ovenbird	--	--	X
Northern Waterthrush	--	--	X
Louisiana Warbler	--	--	X
Common Yellowthroat	X	--	--
Wilson's Warbler	--	--	X
Canada Warbler	--	--	X
Scarlet Tanager	--	--	--
Rose-Breasted Grosbeak	X	--	--
Indigo Bunting	X	--	--
Dickcissel	X	--	--
Rufous-Sided Towhee	X	--	--
American Tree Sparrow	--	X	--
Chipping Sparrow	X	--	--
Field Sparrow	X	--	--
Vesper Sparrow	X	--	--
Lark Sparrow	X	--	--
Savannah Sparrow	X	--	--
Grasshopper Sparrow	X	--	--
Henslow's Sparrow	R	--	--
Fox Sparrow	--	--	X
Song Sparrow	X	--	--
Lincoln's Sparrow	--	--	R
Swamp Sparrow	X	--	--
White-Throated Sparrow	--	--	X
White-Crowned Sparrow	--	--	X
Dark-Eyed Junco	--	X	--
Snow Bunting	--	--	--
Bobolink	X	--	--
Red-Winged Blackbird	X	--	--
Eastern Meadowlark	X	--	--
Yellow-Headed Blackbird	X	--	--
Common Grackle	X	--	--
Brown-Headed Cowbird	X	--	--
Orchard Oriole	--	--	X
Northern Oriole	X	--	--
Purple Finch	--	X	--
House Finch	X	--	--
Common Redpoll	--	X	--
Pine Siskin	--	X	--

Table 27 (continued)

Scientific (family) and Common Name	Breeding	Wintering	Migrant
Emberizidae (continued)			
American Goldfinch	X	--	--
Evening Grosbeak	--	X	--
Passeridae			
House Sparrow[b]	X	--	--

NOTE: Total number of bird species: 211
Number of alien, or nonnative, bird species: 6 (3 percent)

Breeding: Nesting species
Foraging: Nonnesting species present in summer
Wintering: Present January through February
Migrant: Spring and/or fall transient

X - Present, not rare
R - Rare

[a] *State-designated threatened species.*

[b] *Alien, or nonnative, bird species.*

[c] *Federally-designated threatened species.*

[d] *Occurs in the lake study area as escapes from managed hunt programs.*

[e] *State-designated endangered species.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

include draining land by ditching and tiling and the expanding use of fertilizers, herbicides, and pesticides. In urban areas, cultural management practices that affect wildlife and their habitat include the use of fertilizers, herbicides, and pesticides; road salting; heavy motor vehicle traffic that produces disruptive noise levels and air pollution; and the introduction of domestic pets.

WILDLIFE HABITAT AND RESOURCES

Wildlife habitat areas remaining in the Region were inventoried by the Wisconsin Department of Natural Resources in cooperation with the Regional Planning Commission in 1985. The wildlife habitat areas were categorized as either Class I, high-value; Class II, medium-value; or Class III, good-value, habitat areas. The five major criteria used to determine the value of these wildlife habitat areas are listed below:

1. Diversity
An area must maintain a high but balanced diversity of species for a temperate climate, balanced in such a way that the proper predatory-prey (consumer-food) relationships can occur. In addition, a reproductive interdependence must exist.

2. Territorial Requirements
The maintenance of proper spatial relationships among species, allowing for a certain minimum population level, can occur only if the territorial requirements of each major species within a particular habitat are met.

Table 28

MAMMALS OF THE WHITEWATER AND RICE LAKES AREA

Didelphidae
Common Opossum
Soricidae
Cinereous Shrew
Short-Tailed Shrew
Vespertilionidae
Little Brown Bat
Silver-Haired Bat
Big Brown Bat
Red Bat
Hoary Bat
Leporidae
Mearns's Cottontail Rabbit
Sciuridae
Woodchuck
Striped Ground Squirrel (gopher)
Eastern Chipmunk
Grey Squirrel
Fox Squirrel
Red Squirrel
Southern Flying Squirrel
Castoridae
Beaver
Cricetidae
Prairie Deer Mouse
Northern White-Footed Mouse
Meadow Vole
Prairie Vole
Muskrat
Muridae
Norway Rat
House Mouse
Zapodidae
Hudsonian Meadow Jumping Mouse
Canidae
Coyote
Red Fox
Gray fox
Procyonidae
Raccoon
Mustelidae
Least Weasel
Long-Tailed Weasel
Mink
American Badger (occasional visitor)
Northern Plains Skunk
Otter (occasional visitor)
Cervidae
White-Tailed Deer

Source: H. T. Jackson, Mammals of Wisconsin, 1961, and SEWRPC.

3. Vegetative Composition and Structure
   The composition and structure of vegetation must be such that the required levels for nesting, travel routes, concealment, and protection from weather are met for each of the major species.

4. Location with Respect to Other Wildlife Habitat Areas
   It is very desirable that a wildlife habitat maintain proximity to other wildlife habitat areas.

5. Disturbance
   Minimum levels of disturbance from human activities are necessary, other than those activities of a wildlife management nature.

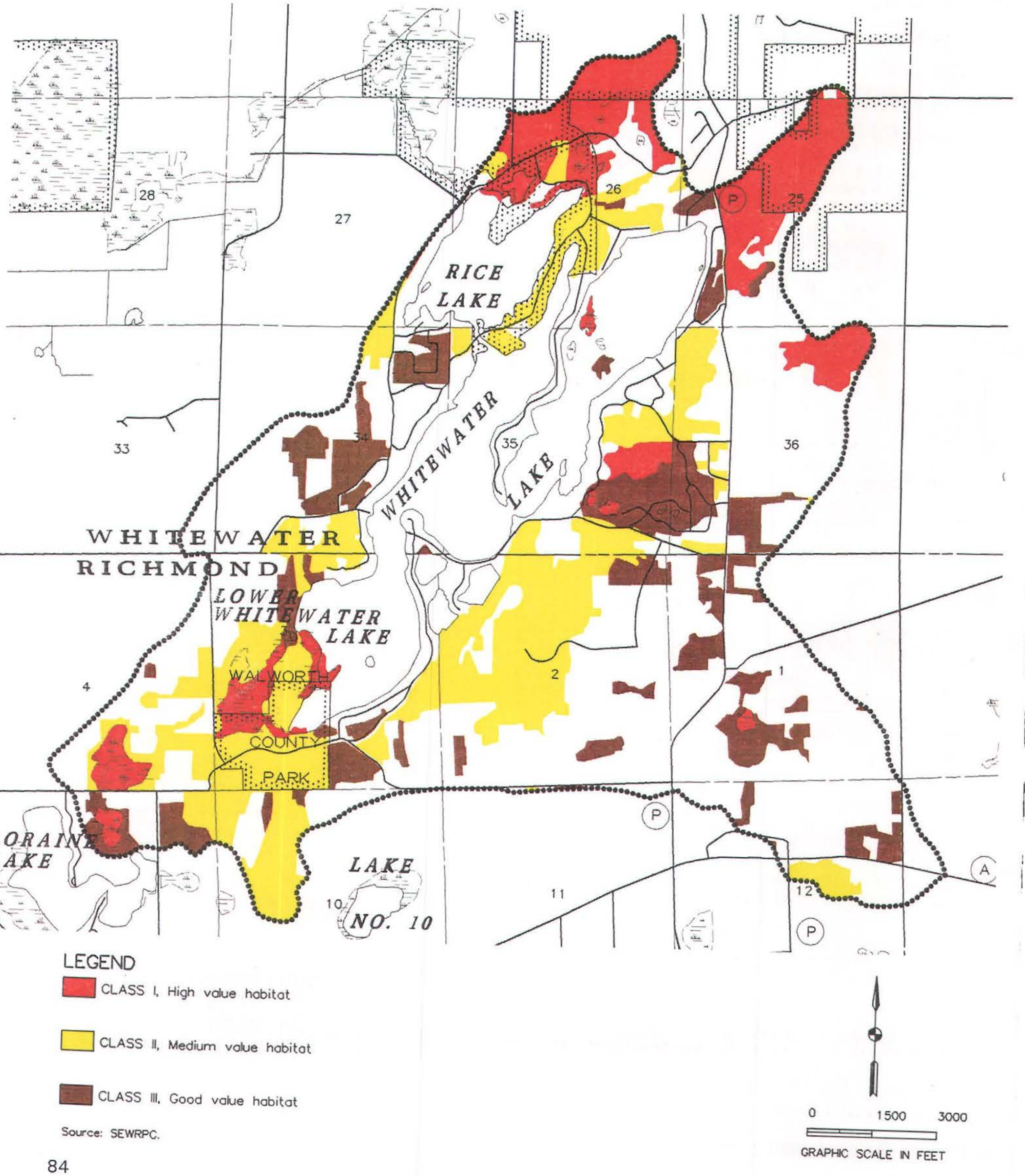
On the basis of these five criteria, the wildlife habitat areas in the Whitewater-Rice Lakes drainage area were categorized as either Class I, High-Value; Class II, Medium-Value; or Class III, Good-Value, habitat areas.

Class I wildlife habitat areas contain a good diversity of wildlife, are adequate in size to meet all of the habitat requirements for the species concerned, are generally located in proximity to other wildlife habitat areas, and meet all five criteria listed above. Class II wildlife habitat areas generally fail to meet one of the five criteria in the preceding list for a high-value wildlife habitat. However, they do retain a good plant and animal diversity. Class III wildlife habitat areas are remnant in nature in that they generally fail to meet two or more of the five criteria for a high-value wildlife habitat, but may, nevertheless, be important if located in proximity to medium- or high-value habitat areas if they provide corridors linking wildlife habitat areas of higher value or if they provide the only available range in an area.

As shown on Map 20, approximately 1,855 acres, or 37 percent, of the drainage area tributary to Whitewater and Rice Lakes, were identified as wildlife habitat. About 488 acres, or 10 percent, of the drainage area were classified as Class I habitat; 877 acres, or 18 percent, of the drainage area, were classified as Class II habitat; and 489

Map 20

WILDLIFE HABITAT AREAS WITHIN THE DRAINAGE AREA TRIBUTARY TO WHITEWATER AND RICE LAKES



Source: SEWRPC.

acres, or 9 percent, of the drainage area, were classified as Class III habitat.

WETLANDS

Wetlands are defined by the U.S. Natural Resource Conservation Service (NRCS), formerly the U.S. Soil Conservation Service, as areas that have a predominance of hydric soils and that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and under normal circumstances do support, a prevalence of hydrophytic vegetation typically adapted for life in saturated soil conditions. The U.S. Army Corps of Engineers and U.S. Environmental Protection Agency definition used by the Commission in the Southeastern Wisconsin Region is essentially the same as the NRCS definition.[6]

A third definition, which is applied by the State of Wisconsin Department of Natural Resources and which is set forth in Chapter 23 of the State Statutes, defines a wetland as "an area where water is at, near, or above the land surface long enough to be capable of supporting aquatic or hydrophytic vegetation, and which has soils indicative of wet conditions." In practice, the Department definition differs from the Federal/ Commission definition in that the Department considers very poorly drained, poorly drained, and some of the somewhat poorly drained soils as wetland soils meeting their "wet condition" criterion. The Federal/Commission definition only considers the very poorly drained and poorly drained soils as meeting the "hydric soil" criterion. Thus the State definition as actually applied is more inclusive than the Federal/Commission definition in that the Department may include some soils that do not show hydric field characteristics as wet soils, however, are, in fact, capable of supporting wetland vegetation, a condition which may occur in some floodlands.[7]

As a practical matter, application of either the Wisconsin Department of Natural Resources wetland definition or the U.S. Environmental Protection Agency, U.S. Army Corps of Engineers, and Regional Planning Commission definition, has been found to produce reasonably consistent wetland identifications and delineations in the majority of situations within the Southeastern Wisconsin Region. That consistency is due in large part to the provision in the Federal wetland delineation manual which allows for the application of professional judgement in cases where satisfaction of the three criteria for wetland identification is unclear.

Wetlands in Southeastern Wisconsin are classified predominantly as deep marsh, shallow marsh, southern sedge meadow, fresh (wet) meadow, shrub carr, alder thickets, low prairie, fens, bogs, southern wet- and wet-mesic hardwood forest, and conifer swamp. Wetlands form an important part of the landscape in and adjacent to Whitewater and Rice Lakes in that they perform an important set of natural functions that make them ecologically and environmentally invaluable resources. Wetlands affect the quality of water by acting as a filter or a buffer zone allowing silt and sediments to settle out. They also influence the quantity of water by providing water during periods of drought and holding it back during periods of flood. When located along shorelines of lakes and streams, wetlands help protect those shorelines from erosion. Wetlands also may serve as groundwater discharge

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[6]*Lands designated as prior converted cropland, that is, lands that were cleared, drained, filled, or otherwise manipulated to make them capable of supporting a commodity crop prior to December 23, 1985, may meet the criteria of the NRCS wetland definition, but they would not be regulated under Federal wetland programs. If such lands are not cropped, managed, or maintained for agricultural production, for five consecutive years, and in that time the land reverts back to wetland, the land would then be subject to Federal wetland regulations.*

[7]*Although prior converted cropland is not subject to Federal wetland regulations unless cropping ceases for five consecutive years and the land reverts to a wetland condition, the State may consider prior converted cropland to be subject to State wetland regulations if the land meets the criteria set forth in the State wetland definition before it has not been cropped for five consecutive years.*

and recharge areas in addition to being important resources for overall ecological health and diversity by providing essential breeding and feeding grounds, shelter, and escape cover for many forms of fish and wildlife.

Wetlands are poorly suited to urban use. This is due to the high soil compressibility and instability, high water table, low load-bearing capacity, and high shrink-swell potential of wetland soils, and, in some cases, to the potential for flooding. In addition, metal conduits placed in some types of wetland soils may be subject to rapid corrosion. These constraints, if ignored, may result in flooding, wet basements and excessive operation of sump pumps, unstable foundations, failing pavements, broken sewer and water lines, and excessive infiltration of clear water into sanitary sewerage systems. In addition, there are significant onsite preparation and maintenance costs associated with the development of wetlands, particularly as they relate to roads, foundations, and public utilities.

The Regional Planning Commission maintains an inventory of wetlands which is updated every five years. As shown on Map 21, in 1990, wetlands covered about 110 acres, or 2 percent, of the drainage area tributary to Whitewater and Rice Lakes. The amount and distribution of wetlands in the area should remain relatively constant if the recommendations contained in the adopted regional land use plan are followed.

WOODLANDS

Woodlands are defined by the Regional Planning Commission as those areas containing a minimum of 17 trees per acre with a diameter of at least four inches at breast height (4.5 feet above the ground).[8] The woodlands are classified as mature pine plantations, dry, dry-mesic, mesic, wet-mesic, wet hardwood, and conifer swamp forests. The last three are also considered wetlands. In the Whitewater and Rice Lakes drainage area, shown on Map 21, approximately 1,195 acres of woodland were inventoried in 1990. These woodlands covered about 24 percent of the drainage area. The major tree species include the black willow (Salix nigra), quaking aspen (Populus tremuloides), ironwood (ostrya virginiana), black cherry (Prunus serotina), green ash (Fraxinus pennsylvanica), box elder (Acer negundo) silver maple (Acer saccharinum), American elm (Ulmus americana), basswood (Tilia americana), northern red oak (Quercus rubra), bur oak (Quercus macrocarpa), and shagbark hickory (Carya ovata). Some planted pine plantations also occur in the drainage area. Conifers planted in these plantations include red pine (Pinus resinosa), white pine (Pinus strobus),and Norway spruce (Picea abies).

The amount and distribution of woodlands in the area should also remain relatively stable if the recommendations contained in the regional land use plan are followed.

ENVIRONMENTAL CORRIDORS

One of the most important tasks undertaken by the Regional Planning Commission in its work program has been the identification and delineation of those areas of the Region having concentrations of natural, recreational, historic, aesthetic, scenic resources, and which, as such should be preserved and protected in order to maintain the overall quality of the environment. Such areas normally include one or more of the following seven elements of the natural resource base which are essential to the maintenance of both the ecological balance and the natural beauty of the Region: 1) lakes, rivers, and streams and the associated undeveloped shorelands and floodlands, 2) wetlands, 3) woodlands, 4) prairies, 5) wildlife habitat areas, 6) wet, poorly drained, and organic soils, and 7) rugged terrain and high-relief topography. While the foregoing seven elements constitute integral parts of the natural resource base, there are five additional elements which, although not a part of the natural resource base per se, are closely related, to or centered on, that base and, therefore, are important considerations in identifying and delineating areas with scenic, recreational, and educational value. These additional elements are: 1) existing outdoor recreation sites, 2) potential outdoor recreation and related open space sites,

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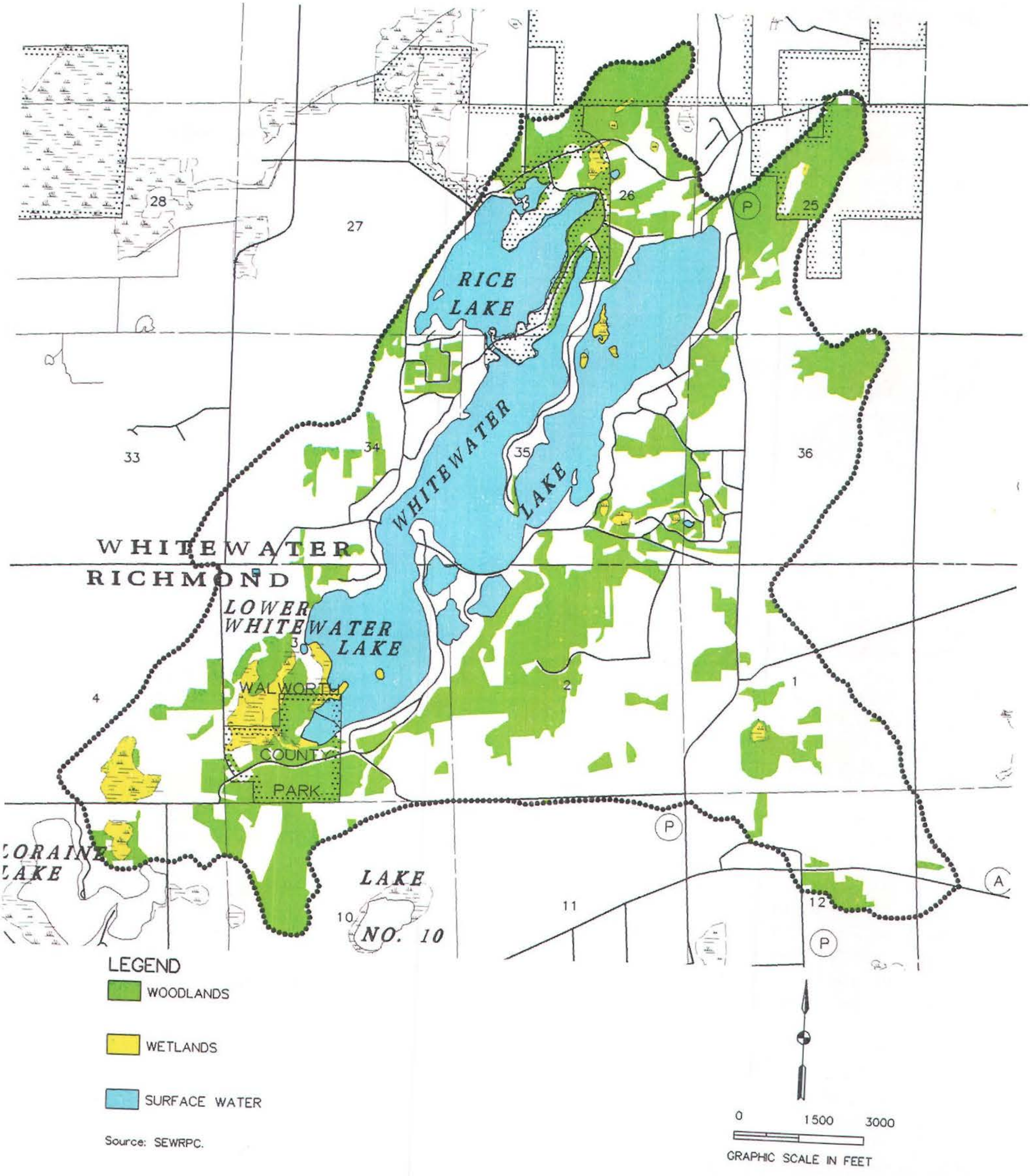
[8] *SEWRPC Technical Record, Vol. 4, No. 2, March 1981.*

Map 21

EXISTING WETLANDS IN THE DRAINAGE AREA TRIBUTARY TO WHITEWATER AND RICE LAKES



3) historic, archaeological, and other cultural sites, 4) significant scenic areas and vistas, and 5) natural and scientific areas.

In Southeastern Wisconsin, the delineation of these 12 natural resource and natural resource-related elements on maps results in an essentially linear pattern of relatively narrow, elongated areas which have been termed "environmental corridors" by the Commission. Primary environmental corridors include a wide variety of the aforelisted important resource and resource-related elements and are, by definition, at least 400 acres in size, two miles in length, and 200 feet in width. The primary environmental corridors identified in the Whitewater and Rice Lake drainage area are contiguous with environmental corridors and isolated natural areas lying within the Whitewater Creek watershed, and, consequently, meet these size and natural resource element criteria.

It is important to note here that, because of the many interlocking and interacting relationships between living organisms and their environment, the destruction or deterioration of one element of the total environment may lead to a chain reaction of deterioration and destruction. The drainage of wetlands, for example, may have far-reaching effects, since such drainage may destroy fish spawning grounds, wildlife habitat, groundwater recharge areas, and natural filtration and floodwater storage areas in interconnected lake and stream ecosystems. The resulting deterioration of surface water quality may, in turn, lead to a deterioration of the quality of the groundwater which serves as a source of domestic, municipal, and industrial water supplies and provides a basis for low flows in rivers and streams. Similarly, the destruction of woodland cover, which may have taken a century or more to develop, may result in soil erosion and stream siltation, and in more rapid runoff and increased flooding, as well as in the destruction of wildlife habitat. Although the effects of any one of these environmental changes may not in and of itself be overwhelming, the combined effects may lead eventually to the deterioration of the underlying and supporting natural resource base, and of the overall quality of the environment for life. The need to protect and preserve the remaining environmental corridors within the Whitewater and Rice drainage area thus becomes apparent and critical.

Primary environmental corridors were first identified within the Region in 1963 as part of the original regional land use planning effort of the Commission and were subsequently refined under the Commission watershed studies and regional park and open space planning programs. The primary environmental corridors in Southeastern Wisconsin generally lie along major stream valleys and around major Lakes and contain almost all the remaining high-value woodlands, wetlands, and wildlife habitat areas, and all the major bodies of surface water and related undeveloped floodlands and shorelands.

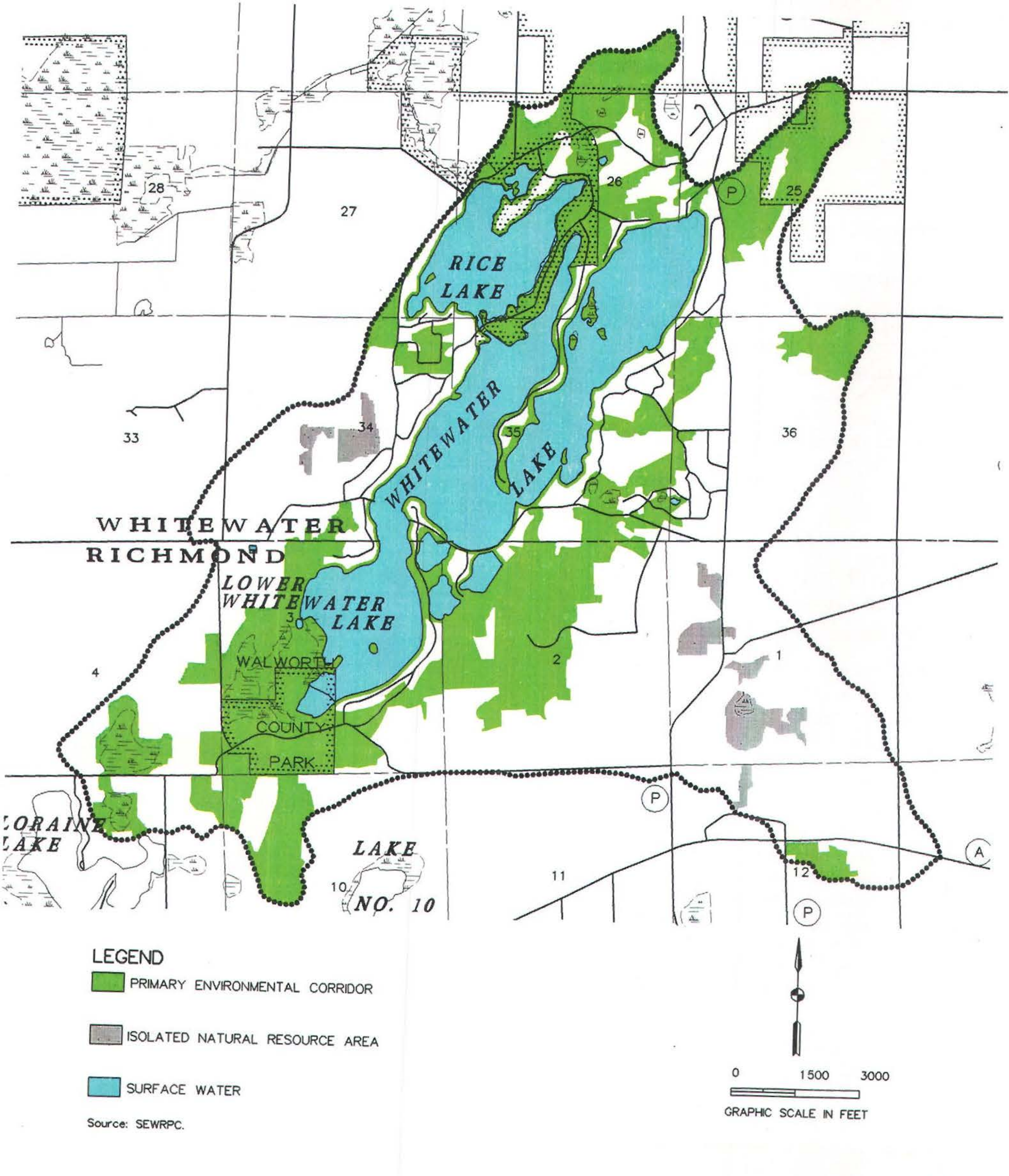
Primary environmental corridors in the drainage area tributary to Whitewater and Rice Lakes are shown on Map 22. About 1,498 acres, or 30 percent, of the drainage area are identified as primary environmental corridor. The corridor areas are largely, but not entirely, located around the shorelands of both Whitewater and Rice Lakes, and some of these corridor areas are in public ownership. An additional 103 acres, or 2 percent of the drainage area, however, are classed as isolated natural areas.

Environmental corridors may be subject to urban encroachment because of their desirable natural resource amenities. Unplanned or poorly planned intrusion of urban development into these corridors not only tends to destroy the very resources and related amenities sought by the development, but also tends to create severe environmental and developmental problems as well. These problems include, among others, water pollution, flooding, wet basements, failing foundations for roads and other structures, and excessive infiltration of clear water into sanitary sewerage systems. The preservation of as yet undeveloped corridors is one of the major ways in which the water quality can be protected and perhaps improved at relatively little additional cost to the taxpayers of the area.

In the Whitewater and Rice Lakes drainage area, the river banks and lakeshores located within the environmental corridors should be candidates for immediate protection through proper zoning or

Map 22

ENVIRONMENTALLY VALUABLE AREAS WITHIN THE DRAINAGE AREA TRIBUTARY TO WHITEWATER AND RICE LAKES



Source: SEWRPC.

through public ownership. Of the corridor areas not already publicly owned, the remaining areas of natural shoreline, shown on Map 3, are perhaps the most sensitive areas in need of greatest protection. Of these, the islands along the perimeter of the main lake basin, the park areas on the southern end of Whitewater Lake and on all but the western shore of Rice Lake, are all extremely valuable habitat areas and most susceptible to erosion.

RECREATIONAL USE

Existing Public Parks and Recreational Facilities

Whitewater and Rice Lakes, lying in the vicinity of the Kettle Moraine State Forest, provide an ideal setting for the provision of park and open space sites and facilities. Rice Lake is surrounded by the Kettle Moraine State Forest on the northern, and eastern shorelines. The forest lands incorporate a boat launch and picnic area within the Whitewater Lake Recreation Area. Whitewater Lake lies adjacent to the Kettle Moraine State Forest on the western shore of the upper basin. These forest lands also incorporate a boat launch and picnic area in addition to a beach area. The southwestern tip of Whitewater Lake is adjacent to Walworth County parkland which offers picnicking areas and hiking trails.

Water-based outdoor recreational activities on Whitewater and Rice Lakes include boating, fishing, swimming, and other active and passive recreational pursuits. Because of its size, Whitewater Lake receives a significant amount of powerboat and sailboat use, and many of these craft are moored along the shore.

It is important to note that the provision of park and open space sites in the Whitewater and Rice Lakes drainage area should be guided, to a large extent, by the recommendations contained in the Walworth County park and open space plan.[9] The purpose of that plan is to guide the preservation, acquisition, and development of land for park, outdoor recreation, and related open space purposes and to protect and enhance the underlying and sustaining natural resource base of the County. With respect to the drainage area tributary to Whitewater and Rice Lakes, the plan recommends the maintenance of existing park and open space sites in the area. In addition, the plan recommends that the undeveloped lands in the primary environmental corridor around Whitewater and Rice Lakes be retained and maintained as natural open space through zoning or public acquisition.

Wisconsin Department of Natural Resources Recreational Rating

A rating technique has been developed by the Wisconsin Department of Natural Resources to characterize the recreational value of inland lakes. As shown in Table 29, under this rating technique, Whitewater Lake would receive 47 out of the possible 72 points, indicating that moderately diverse recreational opportunities are provided by the Lake. Favorable features include the healthy fishery and boating opportunities provided. In contrast, unfavorable features include relatively poor water quality and aquatic macrophyte growth.

Under this rating technique, Rice Lake would receive 43 points out of a possible 72 points, also indicating that moderately diverse recreational opportunities are provided by the lake as shown in Table 30.

In general, both Whitewater and Rice Lakes provide good opportunities for a variety of outdoor recreational activities, particularly boating, fishing, swimming, and aesthetic enjoyment. The natural resource features associated with Whitewater and Rice Lakes provides an aesthetically pleasing setting for an attractive urban environment which encourages public participation in outdoor recreation activities. In order to assure that Whitewater and Rice Lakes will continue to provide such recreational opportunities, the resource values of the Lake must be protected.

SUMMARY

Both Whitewater and Rice Lakes suffer from an excessive abundance of aquatic plants, predominantly the nuisance species Myriophyllum spicatum

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[9]*SEWRPC Community Assistance Planning Report No. 135, A Park and Open Space Plan for Walworth County, February 1991.*

Table 29

RECREATIONAL RATING OF WHITEWATER LAKE: 1995

Space: Total Area—640 acres   Total Shore Length—10 miles

Ratio of Total Area to Total Shore Length: 0.010

Quality (18 maximum points for each item)

Fish:		
X 9 High production	___ 6 Medium production	___ 3 Low production
___ 9 No problems	X 6 Modest problems such as infrequent winterkill, small rough fish problems	___ 3 Frequent and overbearing problems such as winterkill, carp, excessive fertility
Swimming:		
___ 6 Extensive sand or gravel substrate (75 percent or more)	___ 4 Moderate sand or gravel substrate (25 to 50 percent)	X 2 Minor sand or gravel substrate (less than 25 percent)
___ 6 Clean water	___ 4 Moderately clean water	X 2 Turbid or darkly stained water
___ 6 No algae or weed problems	___ 4 Moderate algae or weed problems	X 2 Frequent or severe algae or weed problems
Boating:		
___ 6 Adequate water depths (75 percent of basin more than five feet deep)	___ 4 Marginally adequate water depths (50 to 75 percent of basin more than five feet deep)	X 2 Inadequate depths (less than 50 percent of basin more than five feet deep)
___ 6 Adequate size for extended boating (more than 1,000 acres)	X 4 Adequate size for some boating (200 to 1,000 acres)	___ 2 Limit of boating challenge and space (less than 200 acres)
___ 6 Good water quality	X 4 Some inhibiting factors such as weedy bays, algae blooms, etc.	___ 2 Overwhelming inhibiting factors such as weed beds throughout
Aesthetics:		
X 6 Existence of 25 percent or more wild shore	___ 4 Less than 25 percent wild shore	___ 2 No wild shore
X 6 Varied landscape	___ 4 Moderately varied	___ 2 Unvaried landscape
___ 6 Few nuisances such as excessive algae carp, etc.	X 4 Moderate nuisance conditions	___ 2 High nuisance condition

Total Quality Rating: 47 out of a possible 72

Source: Wisconsin Department of Natural Resources and SEWRPC.

(Eurasian water milfoil), and Ceratophyllum demersum (coontail). These aquatic plants have historically been managed using a combination of chemical and mechanical control. Chemical controls, previously effected with sodium arsenite and more recently with Cutrine Plus and various synthetic organic herbicides such as Diquat, Aquathol, and 2,4-D, are applied in late spring, with a possible follow-up treatment in late summer. Mechanical harvesting is carried out with an Aquarius H-820 harvester during the entire aquatic plant growing season.

Table 30

RECREATIONAL RATING OF RICE LAKE: 1995

Space: Total Area—137 acres	Total Shore Length— 3.3 miles	
Ratio of Total Area to Total Shore Length: 0.065		
Quality (18 maximum points for each item)		
Fish:		
X 9 High production	___ 6 Medium production	___ 3 Low production
___ 9 No problems	X 6 Modest problems such as infrequent winterkill, small rough fish problems	___ 3 Frequent and overbearing problems such as winterkill, carp, excessive fertility
Swimming:		
___ 6 Extensive sand or gravel substrate (75 percent or more)	___ 4 Moderate sand or gravel substrate (25 to 50 percent)	X 2 Minor sand or gravel substrate (less than 25 percent)
___ 6 Clean water	___ 4 Moderately clean water	X 2 Turbid or darkly stained water
___ 6 No algae or weed problems	___ 4 Moderate algae or weed problems	X 2 Frequent or severe algae or weed problems
Boating:		
___ 6 Adequate water depths (75 percent of basin more than five feet deep)	___ 4 Marginally adequate water depths (50 to 75 percent of basin more than five feet deep)	X 2 Inadequate depths (less than 50 percent of basin more than five feet deep)
___ 6 Adequate size for extended boating (more than 1,000 acres)	X 4 Adequate size for some boating (200 to 1,000 acres)	___ 2 Limit of boating challenge and space (less than 200 acres)
___ 6 Good water quality	___ 4 Some inhibiting factors such as weedy bays, algae blooms, etc.	X 2 Overwhelming inhibiting factors such as weed beds throughout
Aesthetics:		
X 6 Existence of 25 percent or more wild shore	___ 4 Less than 25 percent wild shore	___ 2 No wild shore
___ 6 Varied landscape	X 4 Moderately varied	___ 2 Unvaried landscape
___ 6 Few nuisances such as excessive algae carp, etc.	X 4 Moderate nuisance conditions	___ 2 High nuisance condition
Total Quality Rating: 43 out of a possible 72		

Source: Wisconsin Department of Natural Resources and SEWRPC.

Although unbalanced, the Lake supports a relatively healthy, diverse, fish community, including sport fish, panfish, and rough fish that are heavily sought by anglers. Walleyed pike and northern pike are stocked by the Whitewater and Rice Lakes Management District and the Wisconsin Department of Natural Resources.

Other aquatic life and wildlife present in the drainage area of the Lake include amphibians and reptiles (frogs, toads, turtles, and snakes), birds (including migratory waterfowl, raptors, and songbirds), and small and large mammals (mice, rabbits, squirrels, fox, skunk, and deer). While many of the wetland habitats frequented by many of these animals may be expected to remain intact if recommendations contained in the adopted regional land use plan are followed, some of the woodlands that house much of the terrestrial fauna are potential sites for further urban residential and recreational development (Tables 6 and 7). Nevertheless, the drainage area tributary to Whitewater and Rice Lakes provides an adequate refuge for a healthy and diverse fauna.

The preservation of the shorelands and major portion of the drainage area tributary to Whitewater and Rice Lakes which are incorporated into the primary environmental corridor lands as recommended in the adopted Regional and County park and open space plans would be an important step toward the preservation of a relatively high quality of the environment in the Whitewater and Rice Lakes area. The present park and other open spaces surrounding Whitewater and Rice Lakes, including public lands are well used for such more passive pursuits as picnicking, playing, walking, and scenic viewing. Fishing is also a popular pastime at both Whitewater and Rice Lakes, reinforcing the relatively high score which the Lake received during a recent Wisconsin Department of Natural Resources recreational rating.

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Chapter VI

CURRENT WATER USES AND WATER USE OBJECTIVES

INTRODUCTION

Nearly all major lakes in the Southeastern Wisconsin Region serve multiple purposes, ranging from recreation to receiving waters for stormwater runoff. Recreational uses range from noncontact, passive recreation such as picnicking and walking along the shoreline, to full-contact, active recreation such as swimming and water skiing. Water use objectives and supporting water quality standards have been adopted by the Southeastern Wisconsin Regional Planning Commission as set forth in the adopted regional water quality management plan[1] for all major lakes and streams in the Region. The current water uses as well as the water use objectives and supporting water quality standards for Whitewater and Rice Lakes are described in this chapter.

WATER USES

Chapter V of this report presents information on the current uses of Whitewater and Rice Lakes. Based upon recreational user and boating counts and upon a return mail survey of the Lake District residents conducted in 1995, boating, swimming, and fishing were the predominant uses of Whitewater and Rice Lakes. The resident survey is further summarized in Appendix A. In addition, water skiing and picnicking in the areas adjacent to the Lake were significant uses. While numerous boats were observed using Whitewater and Rice Lakes during the 1995 survey, many more craft were either moored or trailered on the shore. Respondents to the Lake District resident survey indicated the excessive aquatic plant growth and turbidity were the most significant concerns threatening the desired lake uses.

WATER USE OBJECTIVES

The regional water quality management plan recommended the adoption of full recreational and warmwater sport fishery objectives for both Whitewater and Rice Lakes. The findings of the inventories of the natural resource base set forth in Chapters III through V indicate that the resources of the area are generally supportive of these objectives, although remedial measures will be required if the Lakes are to fully meet the objectives. The scope of the recreational uses actually engaged in on Whitewater and Rice Lakes, as described above, are sufficiently broad to be consistent with the recommended water use objective providing for full recreational use.

The recommended warmwater sport fishery objective is supported for Whitewater Lake by an existing sport fishery based largely on walleyed pike, northern pike, bass, and panfish. These fishes have traditionally been sought-after in Whitewater Lake with panfish noted as being abundant, bass being noted as common, and both northern and walleyed pike noted as present. The recommended warmwater sport fishery objective for Rice Lake is supported by an existing sport fishery based largely on panfish, largemouth bass, and pike. Panfish are noted as being abundant, while largemouth bass and pike are indicated as being present.[2]

WATER QUALITY STANDARDS

The water quality standards supporting the warmwater fishery and full recreation use objectives as established for planning purposes in the regional

[1] *SEWRPC Planning Report No. 30, A Regional Water Quality Management Plan for Southeastern Wisconsin: 2000, Volume One, Inventory Findings, September 1978; Volume Two, Alternative Plans, 1979; Volume Three, Recommended Plan, June 1979.*

[2] *Wisconsin Department of Natural Resources, Wisconsin Lakes, Publication PUB-FM-800 95REV, 1995.*

Table 31

RECOMMENDED WATER QUALITY STANDARDS TO SUPPORT RECREATIONAL AND WARMWATER FISH AND AQUATIC LIFE USE

Water Quality Parameter	Water Quality Standard
Maximum Temperature	89°F[a,b]
pH Range	6.0-9.0 standard units
Minimum Dissolved Oxygen	5.0 mg/l[b]
Maximum Fecal Coliform	200/400 MFFCC/100 ml[c]
Maximum Total Phosphorus	0.02 mg/l[d]
Other	- -[e,f]

[a]*There shall be no temperature changes that may adversely affect aquatic life. Natural daily and seasonal temperature fluctuations shall be maintained. The maximum temperature rise at the edge of the mixing zone above the existing natural temperature shall not exceed 3°F for lakes.*

[b]*Dissolved oxygen and temperature standards apply to the epilimnion of stratified lakes and to the unstratified lakes; the dissolved oxygen standard does not apply to the hypolimnion of stratified inland lakes. Trends in the period of anaerobic conditions in the hypolimnion of stratified inland lakes should be considered important to the maintenance of water quality, however.*

[c]*The membrane filter fecal coliform count per 100 milliliters (MFFCC/100 ml) shall not exceed a monthly geometric mean of 200 per 100 ml based on not less than five samples per month, nor a level of 400 per 100 ml in more than 10 percent of all samples during any month.*

[d]*This standard for lakes applies only to total phosphorus concentrations measured during spring when maximum mixing is underway.*

[e]*All waters shall meet the following minimum standards at all times and under all flow conditions: Substances that will cause objectionable deposits on the shore or in the bed of any body of water shall not be present in such amounts as to interfere with public rights in waters of the State. Floating or submerged debris, oil, scum, or other material shall not be present in such amounts as to interfere with public rights in the waters of the State. Materials producing color, odor, taste, or unsightliness shall not be present in amounts which are acutely harmful to animal, plant, or aquatic life.*

[f]*Unauthorized concentrations of substances are not permitted that alone or in combination with other material present are toxic to fish or other aquatic life. Standards for toxic substances are set forth in Chapter NR 105 of the Wisconsin Administrative Code.*

Source: SEWRPC.

water quality management plan, are set forth in Table 31. These standards are similar to those set forth in Chapters NR 102 and 104 of the Wisconsin Administrative Code, but were refined for regional water quality management planning purposes. Standards are recommended for temperature, pH, dissolved oxygen, fecal coliforms, and total phosphorus. These standards are intended to apply to the epilimnion of the Lakes. The total phosphorus standard is intended to apply to spring turnover concentrations measured in the Lakes. Such contaminants as oil, debris, scum; or odor, taste, and color-producing substances; and toxins are not permitted in concentrations harmful to the aquatic life as set forth in Chapters NR 102 of the Wisconsin Administrative Code.

The adoption of these standards is intended to specify conditions in the waterways concerned that mitigated against excessive macrophyte and algal growths and promoted all forms of recreational use, including angling, in these waters. Of particular concern in Whitewater and Rice Lakes is the standard for total phosphorus of 0.02 milligrams per liter. Based upon review of the current conditions and the controllable phosphorus inputs into Whitewater and Rice Lakes, it is expected that the phosphorus standard will likely not be fully attainable. Thus, the alternative lake management measures considered in Chapter VII include not only measures to reduce the pollutant loading to the Lake, but also in-lake measures—such as aquatic plant management—to treat the symptom of higher-than-desirable nutrient concentrations.

SUMMARY

The regional water quality management plan includes recommendations for full recreational use and a warmwater sport fishery as the water use objectives for both Whitewater and Rice Lakes. Based upon discussions with Lake District Commissioners, a field survey of current recreational uses, and a lake resident survey, it is concluded that strong support exists for those water use objectives. In addition, the existing fishery on both Lakes is consistent with the warmwater sport fishery objective. The achievement of these objectives is expected to require management interventions aimed at controlling sediment and nutrient loading, algal and plant growth responses, and habitat degradation in the Lake. These actions will form the basis for the management plan hereafter recommended.

Chapter VII

ALTERNATIVE LAKE MANAGEMENT MEASURES

INTRODUCTION

Based upon review of the lake resident survey conducted in 1995, and a review of the inventory and analyses set forth in Chapters II through VI, the following issues were identified requiring consideration in the formulation of alternative and recommended lake management measures: 1) need for water quality improvement; 2) need for aquatic plant management—including management of floating vegetated mats and mats of accumulated floating aquatic vegetation;[1] 3) need for protection of environmentally sensitive lands; 4) need for regulation of onsite sewage disposal systems; 5) need for recreational lake use restrictions; and 6) need for fishery management.

Potential effective measures for the management of the Whitewater and Rice Lakes include watershed management measures, including land use planning and zoning, and in-lake rehabilitation techniques. Watershed management and land use planning and zoning measures can serve to protect the Lakes by promoting and maintaining sound land use pattern in the area; protecting groundwater recharge areas; and helping to reduce pollutant runoff to the Lakes, thus, improving water quality and fishery conditions. In-lake rehabilitation techniques would seek to treat directly identified problems of water quality and lake use.

[1] *Three types of floating vegetated mats exist on Whitewater Lake which, in this report, are referred to as floating islands, vegetated mats, and floating plants. Floating islands are what are referred to in the Wisconsin Department of Natural Resources designated sensitive areas and are identified sensitive areas due to their valuable aquatic habitat. Vegetated mats are commonly referred to as "floating bogs" which seasonally appear during late summer as a result of the formation of gaseous decomposition products in the lake bottom. Floating plants refer to the mats of aquatic plants which build up on the shorelines as a result of being uprooted or being cut.*

LAND USE PLANNING AND ZONING

A basic element of water quality management effort for any lake, including the Whitewater and Rice Lakes, is the promotion of sound land use development and management in the tributary watershed. The type and location of future urban and rural land uses in the watershed will determine, to a large degree, the character, magnitude, and distribution of nonpoint sources of pollution; the practicality of, as well as the need for, various forms of land management; and, to some degree, the water quality of the Lakes.

In the case of Whitewater and Rice Lakes, the groundwater inflow is a particularly important determinant in lake water quality, as discussed in Chapter II. The hydrologic and phosphorus loading budgets for Whitewater and Rice Lakes presented in Chapter II indicated that, in a normal year, although groundwater contributes about 57 and 8 percent of the total water inflows for Whitewater and Rice Lakes, respectively, it contributes only about 8 and 3 percent, respectively, of the total phosphorus loading to the Lakes. Groundwater, therefore, is a source of good quality water to Whitewater and Rice Lakes and serves to dilute other inflows of water having higher concentrations of pollutants, particularly phosphorus. Therefore, protection of areas which serve to recharge the groundwater system—that is, areas where precipitation is likely to reach the water table—should be an important component of any comprehensive management plan for Whitewater and Rice Lakes. Nearshore wooded areas and wetlands which serve as groundwater recharge areas are located almost entirely within Regional Planning Commission-designated primary environmental corridor lands, as discussed in Chapter V. These corridor lands are recommended to be preserved in essentially natural, open space uses. Preservation of these corridor lands would serve not only to reduce nonpoint source pollutant runoff to the Lakes, but also to maintain good quality groundwater inflow to the Lakes.

Existing 1990 and planned year 2010 land use patterns and existing zoning regulations in the tributary area to Whitewater and Rice Lakes have been described in Chapter III. The planned year 2010 land use conditions set forth in the regional land use plan envision no significant conversion of land from rural to urban use in the watershed area concerned, with only limited new residential land uses largely occurring through infilling on existing platted lots. Increases in urban lands and impervious surface will increase runoff into the Lakes and will increase some pollutant loadings unless mitigative measures are taken. In addition, groundwater recharge patterns may be altered. Additional urban development, or redevelopment, in the direct drainage area may also increase recreational use pressures on the Lakes. Given these concerns, land use development or redevelopment proposals around the shorelines of Whitewater and Rice Lakes should be limited as recommended in the regional land use plan and any proposed changes in land use carefully evaluated for potential adverse impacts on the Lakes. The existing zoning is generally consistent with the recommended future land use pattern within the Whitewater and Rice Lakes drainage area.

Wetland and groundwater recharge area protection can be accomplished through regulation and acquisition, and both are measures that should be considered for inclusion in the recommended Whitewater and Rice Lakes management plan. Wetlands in the drainage area tributary to Whitewater and Rice Lakes are currently protected to a degree by the U.S. Army Corps of Engineers 404 Permit Program, the Wisconsin Shoreland Zoning Program, and local zoning ordinances. The wetlands protected under these regulatory programs are shown on Map 20. Nearly all wetland areas in the Whitewater and Rice Lakes drainage area are protected under one or more of the Federal, State, County, and local regulations.

WATERSHED MANAGEMENT MEASURES

Watershed management measures may be used to reduce nonpoint source pollutant loadings from such rural sources as runoff from cropland and pastureland; from such urban sources as runoff from residential, commercial, transportation, and recreational land uses; from construction activities; and from onsite sewage disposal systems. The alternative, watershed-based nonpoint source pollution control measures considered in this report are based upon the recommendations set forth in the regional water quality management plan,[2] the Walworth County soil erosion control plan,[3] and information presented by the U.S. Environmental Protection Agency.[4]

An estimate of the nonpoint source pollutant loadings from the various pollution sources in the drainage area is presented in Chapter IV. As previously reported, the detailed evaluations of the hydrology of Whitewater and Rice Lakes conducted by the U.S. Geological Survey[5] have concluded that—because of the rolling topography and relatively pervious soils—only relatively small areas immediately adjacent to the lakeshore and lakeshore wetlands actually contribute runoff to the Lakes during normal rainfall periods. The areas contributing runoff to the Lakes are comprised primarily of the existing developed shoreline with only

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[2]*SEWRPC Planning Report No. 30, A Regional Water Quality Management Plan for Southeastern Wisconsin: 2000, Volume One, Inventory Findings, 1978; Volume Two, Alternative Plans, 1979; and Volume Three, Recommended Plan, 1979.*

[3]*Walworth County Land Conservation Department and R.A. Smith & Associates, Inc., Walworth County Soil Erosion Control Plan, November 1988.*

[4]*U.S. Environmental Protection Agency, Report No. EPA-440/4-90-006, The Lake and Reservoir Restoration Guidance Manual, 2nd Edition, August 1990; and its technical supplement, U.S. Environmental Protection Agency, Report No. EPA-841/R-93-002, Fish and Fisheries Management in Lakes and Reservoirs: Technical Supplement to the Lake and Reservoirs Restoration Guidance Manual, May 1993.*

[5]*U.S. Geological Survey, Hydrology and Water Quality of Whitewater and Rice Lakes in Southeastern Wisconsin, 1990-91.*

limited areas in agricultural and open space uses. Thus, nonpoint source controls for the residential lands adjacent to the Lakes are of the most significance.

Appendix B presents a list of alternative nonpoint source pollution management measures that could be considered for use in or around Whitewater and Rice Lakes to reduce loadings from nonpoint sources of pollution. Information on the cost and effectivity of the measures are also presented in this appendix.

Urban Nonpoint Source Controls

The regional water quality management plan recommends that the nonpoint source pollutant loadings from the urban areas tributary to Whitewater and Rice Lakes be reduced by about 25 percent in addition to reductions from urban construction erosion control, onsite sewage disposal system management, and streambank and shoreline erosion control measures; thus, providing a total reduction in nonpoint source pollutant loadings of about 30 percent. Data provided in Chapters IV and VI indicate that a reduction in phosphorus concentrations within Whitewater Lake of from 50 to 60 percent would be required to fully meet the water quality standard associated with full recreational use objectives. As described in Chapter IV, the only controllable loadings within the watershed to the Lake are loadings from the runoff from the drainage area tributary to the Lakes and from onsite sewage disposal systems. These loadings constitute only about 30 and 10 percent, respectively, of the total loading to Whitewater and Rice Lakes, when internal recycling of phosphorus is considered. Thus, it is unlikely that management measures to reduce nonpoint source pollutant loadings to the Lake will result in the phosphorus standard being fully achieved. Nevertheless, consideration should be given to reducing the pollutant loadings from these controllable sources to the extent practicable in order to minimize the negative results of higher-than-desirable nutrient loadings.

Potentially applicable urban nonpoint source control measures include wet detention basins, grassed swales, and good urban "housekeeping" practices. Generally, the application of low-cost urban housekeeping practices may be expected to reduce nonpoint source loadings from urban lands by about 25 percent. Public education programs can be developed to encourage good urban housekeeping practices, to promote the selection of building and construction materials which reduce the runoff contribution of metals and other toxic pollutants, and to promote the acceptance and understanding of the proposed pollution abatement measures and the importance of lake water quality protection. Urban housekeeping practices and source controls include restricted use of fertilizers and pesticides; improved pet waste and litter control; the substitution of plastic for galvanized steel and copper roofing materials and gutters; proper disposal of motor vehicle fluids; increased leaf collection; and reduced use of street deicing salt. Particular attention should be given to reducing pollutant loadings from high pollutant loading areas, such as commercial sites, parking lots, and material storage areas. To the extent practicable, parking lot stormwater runoff should be diverted to areas covered by pervious soils and appropriate vegetation, rather than being directly discharged to impervious surface and storm sewers. Material storage areas may be enclosed or periodically cleaned, and diversion of stormwater away from these sites may further reduce pollutant loadings.

It is estimated that implementation of good urban housekeeping practices and the use of grassed swales in selected areas may reduce the total pollutant loading to Whitewater and Rice Lakes by about 10 to 15 percent.

Proper design and application of urban nonpoint source control measures such as grassed swales and detention basins requires the preparation of a detailed stormwater management system plan that addresses stormwater drainage problems and controls nonpoint sources of pollution. Based on a preliminary evaluation, however, it is estimated that the practices which could be effective on the tributary area are limited largely to good urban housekeeping practices and grassed swales. Review of the distribution of the pollutant loadings relative to the location of the potential sites for the detention basins indicates that such basins would be relatively ineffective as well as costly, since stormwater flow to the Lakes generally occurs in the form of short overland sheet flows, making it difficult to collect and detain stormwater runoff from reasonably large areas at one location.

Developing areas can generate significantly higher pollutant loadings than established areas of similar size. Developing areas include a wide array of activities, including urban renewal projects, individual site development within the existing urban area, and new land subdivision development. The regional land use plan envisions no significant new urban development within the drainage area. Thus, if that plan is followed, development activities should be largely limited to infilling on previously platted lots; to some redevelopment of existing lots; and to some small areas of new development.

Construction sites, especially, can be expected to produce suspended solids and phosphorus at rates several times higher than established urban land uses. Control of sediment loss from construction sites can be provided by measures set forth in the model ordinance developed by the Wisconsin Department of Natural Resources in cooperation with the Wisconsin League of Municipalities,[6] and adopted by Walworth County. These controls are temporary measures taken to reduce pollutant loadings from construction sites during stormwater runoff events. Construction erosion controls may be expected to reduce pollutant loadings from construction sites by about 75 percent. Such practices are expected to have only a minimal impact on the total pollutant loading to the Lakes due to the relatively small amount of land proposed to be developed. However, such controls are important pollution control measures in order to prevent localized short-term loadings of phosphorus and sediment from the drainage area and the upstream tributary area. The control measures include such revegetation practices as temporary seeding, mulching, and sodding and such runoff control measures as filter fabric fences, straw bale barriers, storm sewer inlet protection devices, diversion swales, sediment traps, and sedimentation basins.

At the present time Walworth County has adopted a construction site erosion control ordinance which is administered and enforced by the County in both the shoreland and nonshoreland areas of the Towns of Whitewater and Richmond. Thus, this component of the nonpoint source pollutant reduction plan element is generally in place.

Rural Nonpoint Source Pollution Controls

The topography and soils in the drainage area are such that runoff from only a limited amount of agricultural land actually drains to Whitewater and Rice Lakes. The regional water quality management plan recommends measures be taken to provide about a 25 percent reduction in nonpoint source pollutant loading from rural lands in the watershed. In addition, the County soil erosion control plan recommends farm management practices intended to reduce cropland soil erosion to tolerable levels which can be sustained without impairing productivity. Implementation of these recommendations is considered to be adequate for water quality management purposes related to Whitewater and Rice Lakes. Detailed farm conservation plans will be required to adapt and refine erosion control practices for individual farm units. Generally prepared with the assistance of the U.S. Natural Resource Conservation Service or County Land Conservation Department staffs, such plans identify desirable tillage practices, cropping patterns, and rotation cycles, considering the specific topography, hydrology, and soil characteristics of the farm; identify the specific resources of the farm operator; and articulate the farm operator's objectives as owner and manager of the land.

Onsite Sewage Disposal System Management

As reported in Chapter IV, onsite sewage disposal systems are estimated to contribute about 19 percent of the total phosphorus loading to Whitewater Lake and no significant contribution to Rice Lake. In addition to lake water quality considerations, sewage disposal options in the area have implications for groundwater quality and property values. Thus, consideration of onsite systems is important in the entire drainage area and not just for those areas where the groundwater flow is toward the Lake, as described in Chapter II. Two basic alternatives can be considered for abatement of pollution from onsite sewage disposal systems: 1) continued reliance on, and management of, the onsite sewage disposal systems; and, 2) construction of a public sanitary sewer system.

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[6] *Wisconsin League of Municipalities and Wisconsin Department of Natural Resources, Wisconsin Construction Site Best Management Practices Handbook, 1989.*

In the regional water quality management plan the concentrations of urban development located along the shorelines of Whitewater and Rice Lakes were not included within recommended public sanitary sewer service areas. Information available at the time of preparation of that plan did not indicate a need to provide centralized sanitary sewer service to those lake communities. Thus, the areawide water quality management plan as currently adopted recommends that sewage disposal needs in the two lake communities concerned be provided through onsite sewage disposal systems.

The regional plan, however, also recommended that sewerage needs in these communities be periodically reevaluated in light of changing conditions. The nearest existing public sanitary sewerage system to the Whitewater and Rice Lakes area is the City of Whitewater system located about five miles to the north. Given that it is unlikely that a new public sewage treatment plant to serve the Whitewater and Rice Lakes area would be cost-effective, connection to the City of Whitewater sewerage system would be the alternative most likely to be viable if there was an identified need to provide a public sewer system to serve the urban development in the Whitewater and Rice Lakes drainage area. Based upon available information, however, the need for the installation of a public sanitary sewerage system cannot be shown at this time. Therefore, the continued use of onsite wastewater disposal systems may be expected. Given this situation, consideration should be given to developing a septic system management program.

The basic objective of an onsite sewage disposal management program is to ensure the proper installation, operation, and maintenance of existing systems, and of any new systems that may be required to serve existing urban development in the drainage area tributary to Whitewater and Rice Lakes. An onsite sewage disposal system management program could potentially include the establishment of an active Sanitary District to raise and administer funds; inspect, design, and construct upgraded systems; ensure proper operation and maintenance of the systems; and monitor the performance of systems. Some of these services are presently provided by the Walworth County Planning, Zoning, Sanitation, and Solid Waste Management Department. However, a Sanitary District could expand the services to include administration of an inspection program and technical assistance. The current Lake District could undertake this responsibility by assuming Sanitary District powers, or a separate Sanitary District could be created.

The major responsibility of such a Sanitary District would be to establish and implement an onsite sewage disposal system management program. A major component of such a program would be a regular inspection program. Such a program should include the visual inspection and, as appropriate, the testing of each onsite sewage disposal system by trained and experienced personnel. The purpose of the inspection would be to identify any malfunctioning systems. Ideally, each system would be inspected once every five years and, accordingly, about one-fifth of all such systems would be inspected annually. The inspection program may result in the issuance of orders, as necessary, to abate improper practices and take appropriate corrective measures. A secondary benefit of an inspection program would be the knowledge system owners would gain from the periodic inspection of these systems and identification of any deficiencies.

A continuing informational and educational effort should also be included in an onsite sewage system management plan. Homeowners should be advised of the rules, regulations, and system limitations governing onsite sewage disposal systems, and should be encouraged to undertake preventive maintenance programs.

As an alternative to formation of a Sanitary District or assumption of Sanitary District powers by the existing Lake Management District, a viable alternative would be to have the current Lake Management District take the lead in the public informational and educational program and to work cooperatively with the Walworth County Planning, Zoning, Sanitation, and Solid Waste Management Department to encourage property owners to have their onsite system inspected and any needed remediation measures undertaken.

IN-LAKE MANAGEMENT

The reduction of external nutrient loadings to Whitewater and Rice Lakes by the measures described above should help to prevent deterioration of lake water quality conditions, but are not expected to eliminate existing water quality and lake-use problems. In mesotrophic and eutrophic lakes, particularly in the presence of such anaerobic conditions in the hypolimnion—as occur in Whitewater Lake during the summer—significant amounts of phosphorus can be released from the existing sediments to the overlying water column. Consequently, the water quality improvements expected from a reduced nutrient input may be masked by this condition. Because of this and because of other characteristics of the Lake, such as abundant macrophyte growth, which can result in restricted water use potential, the application of in-lake rehabilitation techniques should be considered.

The applicability of specific in-lake rehabilitation techniques is highly dependent on lake characteristics. The success of any lake rehabilitation technique can seldom be guaranteed since the technology is still in the early stages of development. Because of the relatively high cost of applying most techniques, a cautious approach to implementing in-lake rehabilitation techniques is generally recommended. Certain in-lake rehabilitation techniques should be applied only to lakes in which: 1) nutrient inputs have been reduced below the critical level, 2) there is a high probability of success in applications of the particular technology to lakes of similar size, shape, and quality, and 3) the possibility of adverse environmental impacts is minimal. Finally, it should be noted that some in-lake rehabilitation techniques require the issuance of permits from appropriate State and Federal agencies prior to implementation.

Alternative lake rehabilitation measures include in-lake water quality, water level, aquatic plant and fish management measures. Each of these groups of management measures, together with the attendant costs, are described below.

Water Quality Management Measures

This group of in-lake management practices includes a variety of measures designed to directly modify the magnitude of either a water quality problem or its biological response, although specific measures aimed at managing aquatic plants and the fishery are detailed separately below.

Dilution/Flushing: Dilution is a restoration measure which reduces the impact of contamination by blending—diluting—contaminated waters with less contaminated waters, or using less contaminated waters to push—flush—the contaminated waters out of the lake basin. Costs are extremely variable and depend upon the availability and location of a suitable source of flushing or diluent water; where pumping is required, this technique can be very costly. Effectiveness also varies directly with the quality of the diluent and flushing water quality. Impacts can include over-topping of, and/or damage to, control structures—hydraulic over-loading—and transferal of the problem contaminants downstream. Use of this technique in Whitewater and Rice Lakes is limited by the lack of an upstream water source of better quality than currently exists in the Lakes. In regards to Rice Lake, the upstream waterbody is also an enriched lake ecosystem and there is flow from the upper lake during most periods. For these reasons, use of this technique is not recommended.

Phosphorus Precipitation/Inactivation: Nutrient inactivation is a restoration measure that is designed to limit the biological availability of phosphorus by chemically binding the element in the lake sediments using a variety of divalent or trivalent cations—highly positively charged elements. Aluminum sulphate (alum), ferric chloride and ferric sulphate are commonly used cation sources. The use of these techniques to remove phosphorus from nutrient-rich lake waters is an extension of common water supply and wastewater treatment processes. Costs depend on the lake volume and type and dosage of chemical used, with alum costing about $150 per ton. Approximately 100 tons of alum can treat a lake area of about 40 acres. Effectiveness depends in part on the ability of the alum flocculent to form a stable "blanket" on the lakebed. This is dependent upon on flushing time, turbulence, lake water acidity (pH) and rate of continued sedimentation. Impacts can include the release of toxic quantities of free aluminum into the water. Improved water clarity can also encourage the spread of rooted aquatic plants.

Liming, or the use of calcium carbonate to precipitate nutrients and contaminants, is a restoration measure identical to that described above for phosphorus precipitation/inactivation. In addition to such use, lime also offers the benefit of neutralizing acidic compounds. Costs associated with the application of lime are similar to those cited for the other cationic compounds. Effectiveness and potential impacts are also similar.

Alum, or one of the other compounds, is typically applied to a lake surface over the deeper parts of the lake in a liquid form, resulting in the formation of a precipitate—in the case of alum, the precipitate is aluminum hydroxide. Aluminum hydroxide has a high capacity to absorb phosphorus and make it unavailable to plants and algae. It is also relatively inexpensive and any free aluminum that might result has a relatively low toxicity to most forms of aquatic life. The aluminum hydroxide not only rapidly removes available phosphorus from the water column but, at the same time, prevents the release of phosphorus from the lake sediments, thus limiting the availability of the nutrient for the growth of planktonic plants. The floc absorbs phosphorus in the water column and forms a chemical and physical layer which retards the transfer of the nutrient from the sediments. When it is successful, results appear relatively quickly, and, if external sources of nutrients and in-lake turbulence are low, the effects are generally long-lasting.

The rate of application will depend on the compound used, the phosphorus concentration and the buffering capacity of the lake. It is important that aluminum not be added in higher concentrations than the absorptive ability of the water to prevent toxicity to aquatic organisms. Bench scale testing is desirable before alum or other compounds are used. The application of alum to the hypolimnion of Whitewater Lake, as shown on Map 23, would cost about $32,000, including labor and equipment cost of the application of $12,000, and chemical cost of about $20,000.

As previously noted, internal loading of phosphorus presently accounts for a significant component, comprising almost 51 and 82 percent, of the total phosphorus load to Whitewater and Rice Lakes, respectively. However, due to the limited amount of hypolimnion area in Whitewater and Rice Lakes in respect to the size of the Lakes, nutrient inactivation is not expected to be effective and is not recommended for Whitewater and Rice Lakes.

Aeration/Destratification: Aeration, including hypolimnetic aeration and artificial circulation, is a management measure designed to partially or completely oxygenate the water column of a lake. Hypolimnetic aeration is the process of injecting oxygen into the water column, while artificial circulation is the process of destratifying and mixing the water column. The two processes are related in that compressed or pumped air is the medium used to inject oxygen and/or circulate the water. Costs associated with the hardware required for an aeration system including piping and compressors, and operating costs tend to be high, ranging from $160 to $2,600 per acre per year. Effectiveness has been site and use dependent.

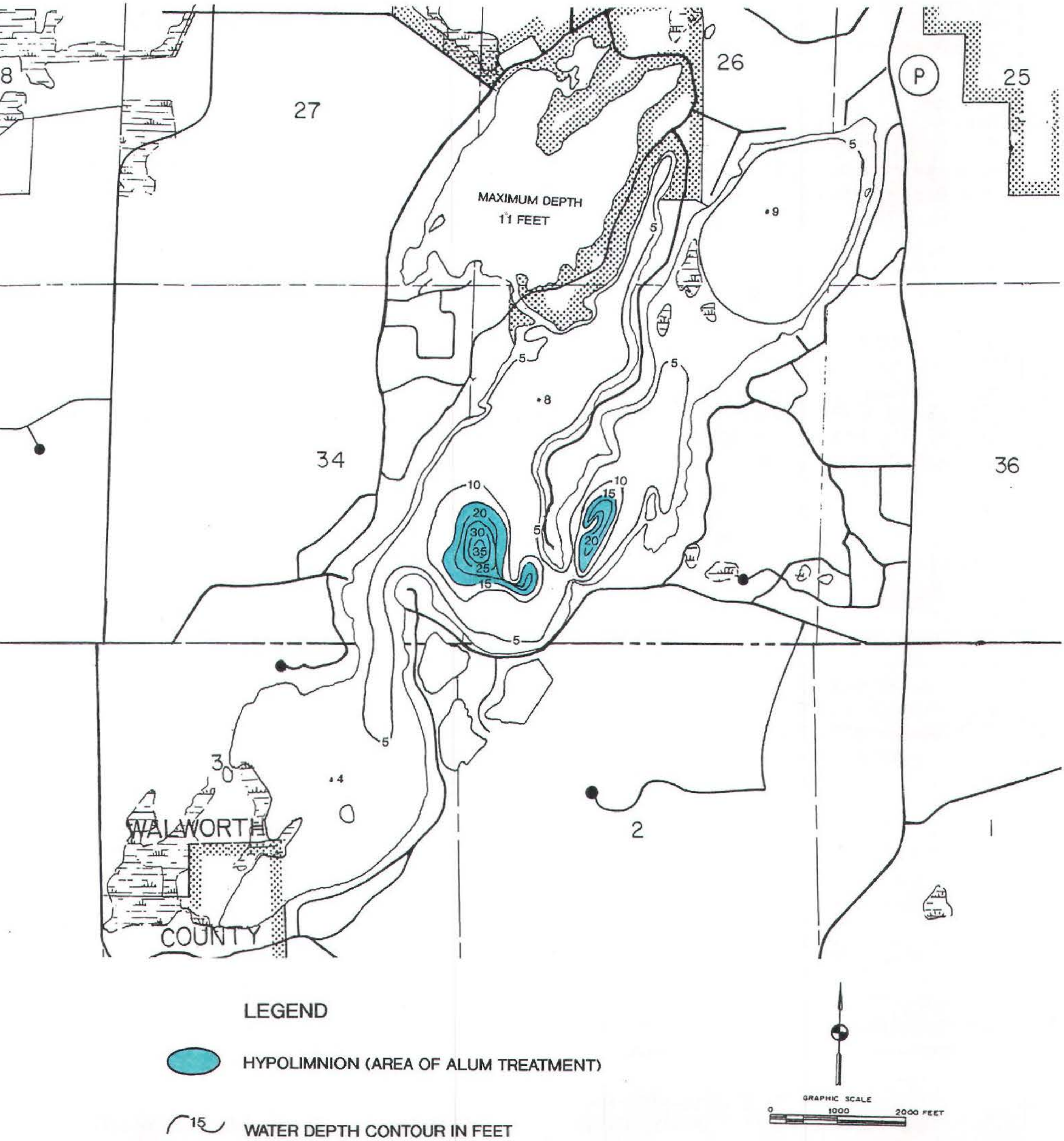
In complete aeration, water is lifted to the surface, where it can come in contact with the atmosphere. At the water atmospheric interchange, the greatest absorption of oxygen to the water takes place. With artificial circulation, water temperatures in the lake become relatively uniform from top to bottom. Complete circulation has been shown in some cases to reduce algal blooms by physically disturbing nuisance algae species. However, in some cases, phosphorus and turbidity have increased where sediments and phosphorus are resuspended into the upper areas of the lake. Another adverse impact of complete circulation may be the reduction in ecological diversity resulting from a uniform water temperature within the lake.

Because of the temporary and unpredictable nature of artificial circulation, it is not possible to estimate a phosphorus load reduction expected through the implementation of this technique. As already noted, if total circulation does not take place, phosphorus levels may actually increase. The summer anoxic conditions in Whitewater and Rice Lakes that may be alleviated by artificial circulation are not a threat to the fish population because a relatively large area of the Lake remains well oxygenated. Because of the cost and the potential negative aspects of this technique and the limited water surface areas of Whitewater and Rice Lakes which could benefit from the measures, it is not recommended for these Lakes.

The purpose of hypolimnetic aeration is to provide oxygen to the hypolimnion of a stratified lake

Map 23

AREAS FOR POSSIBLE NUTRIENT INACTIVATION (ALUM) IN WHITEWATER LAKE



Source: SEWRPC.

without disrupting the stratification. To provide hypolimnetic aeration, the bottom water is typically airlifted through a vertical tube, with the oxygenated water returned to the hypolimnion. Aeration of the hypolimnion increases the decomposition of organic matter and promotes sorption of phosphorus by the hydrous oxides of iron and manganese present in the lake bottom sediments. As a result, the concentration of phosphorus in the bottom waters may be reduced and oxygen levels improved, providing better conditions for fish and aquatic life.

Hypolimnetic aeration has been effective in temporarily reducing the internal phosphorus cycling and decreasing undesirable gases on the lake bottom. Phosphorus concentrations in the water column may not be reduced sufficiently to improve water quality, however, if phosphorus inputs from external sources cannot be controlled. This method is not a long-range solution for algae control and the benefits often disappear once the aeration is ceased. Because of the cost and applicability of this practice to only limited water surface areas on Whitewater and Rice Lakes, the measure is not recommended.

Nutrient Load Reduction: Nutrient diversion is a restoration measure, similar to toxicant reduction/elimination, which is designed to reduce the trophic state or degree of over-feeding of a waterbody and thereby control the growth response of the aquatic plants in the system. Control of nutrients in surface water runoff in the watershed is generally preferable to attempting such control within a lake. In-lake control of nutrients generally involves removal of sediments by dredging, encapsulation of nutrients by chemical binding, or creating an oxygen regime that limits the release of the contaminant. Hypolimnetic withdrawal or the removal of nutrient-rich bottom waters from stratified lakes is a special case of flushing, while direct injection of nitrate into an anaerobic hypolimnion—the Riplox technique using a nitrogenous oxygen source—is a special case of aeration; both can also be used in reducing the internal nutrient supply to a lake. Costs are generally high, involving an engineered design and usually some form of pumping or excavation. Effectiveness is variable. Impacts include the re-release of nutrients into the environment. For these reasons this measure is not recommended for Whitewater and Rice Lakes.

Water Level Management Measures

This group of in-lake management measures consists of actions designed to modify the depth of water in the waterbody. Generally, the objective of such manipulation is to enhance a particular class of recreational uses and/or to control the types and densities of organisms within a waterbody.

Drawdown: Water level management refers to a the manipulation of lake water levels, especially in man-made lakes, in order to change or create specific types of habitat and thereby manage species composition within a waterbody. Water level management may be used to control aquatic plant growth and to manage fisheries. With regard to aquatic plant management, periodic drawdowns can reduce the growth of some shoreland plants by exposing the plants to climatic extremes, while the growth of others is unaffected or enhanced. Both desirable and undesirable plants are affected by such actions. Costs are primarily associated with loss of use of the waterbody surface area during drawdown—provided there is a means of controlling water level in place, such as a dam or other outlet control structure. Effectiveness is variable, with the most significant side effect being the potential for increased plant growth. Drawdown can also affect lake fisheries both indirectly—by reducing the numbers of food organisms—and directly—by reducing available habitat and desiccating (drying out) eggs and spawning habitat.

Sediment exposure and desiccation by means of lake drawdown has been used as a means of stabilizing bottom sediments, retarding nutrient release, reducing macrophyte growth, and reducing the volume of bottom sediments. During the period of drawdown, the exposed sediments are allowed to oxidize and consolidate. It is believed that by reducing the sediment oxygen demand and increasing the oxidation state of the surface layer of the sediments, drawdown may retard the subsequent movement of phosphorus from the sediments. Sediment exposure may also curb sediment nutrient release by physically stabilizing the upper flocculent (sediment-water interface) zone of the sediments which plays an important role in the exchange reaction and mixing of the sediments with the overlying water. Drawdown may thus deepen the lake by dewatering and compacting the bottom sediments. The amount of compaction depends upon the organic content of the sediment, the thickness of sediment exposed above the water table, and the timing and duration of the drawdown.

Lake drawdown is an effective technique for the control of several nuisance macrophyte species. The objective is to retard macrophyte growth by destroying seeds and vegetative reproductive structures through exposure to drying and/or freezing conditions and by altering their substrate by dewatering and consolidating of sediments. Table 32 lists several species controlled by lake drawdown. This control generally lasts from one to two years. While drawdown can control the regrowth of several plants, it can also stimulate the growth of others, such as Bushy pondweed (Najas flexils), Flatstem pondweed (Potamogeton zosteriformis), and several sedges and shoreline species.

Possible improvements resulting from a lake drawdown include reduced turbidity from wind action, improved game fishing, an opportunity to collect fish more effectively in fish removal programs, an opportunity to improve docks and dams, and an opportunity to clean and repair shorelines and deepen areas using conventional earth-moving equipment. Depending on the timing and duration of the drawdown, drawbacks include loss of fish breeding habitat, loss of benthic food organisms, and disruption of waterfowl feeding and roosting patterns. Increased turbidity and unpleasant odors from rotting organic matter may occur during the period of the drawdown. Other adverse impacts of lake drawdown include algal blooms after reflooding, loss of use of the lake during the drawdown, changes in species composition, and a reduction in the density of benthic organisms following drawdown and reflooding. In some drawdown projects, it has been found that several years after reflooding, flocculent sediments began to reappear because of algae and macrophyte sedimentation. With the type of organic sediments that exist in both Whitewater and Rice Lakes, sedimentation of this type may take place. Therefore, to maintain the benefits of a drawdown project, the Lakes may have to be drawn down every five to 10 years to recompact any new sediments.

The timing of a drawdown project is an important factor affecting the success of the project. Winter drawdowns have been employed successfully in several projects in Wisconsin. The potential advantages of a winter drawdown are: 1) it would not interfere with summer boating, fishing, recreation, and irrigation activities, 2) the freezing and thawing of the sediments would facilitate dewatering, 3) the frozen sediment would provide a surface for access of earth-moving equipment, and 4) the freezing of the sediment would provide increased macrophyte mortality. The longer the sediments are exposed, the greater the benefit of the drawdown. Lakes are typically drawn down after Labor Day and so left until March of the following year, allowing seven months of sediment exposure. A disadvantage of the winter drawdown is increased potential for fish winterkill due either to an oxygen deficit or to a whole lake freeze. The water control structures on Whitewater and Rice Lakes are fixed-sill dams with 12- and eight-foot heads for Whitewater and Rice Lakes, respectively. Based upon the data set forth in Chapter II, refilling of Whitewater and Rice Lakes following a major drawdown would take over a year. Added to this is the unpredictability of the results, the impairment of recreational uses, and the temporary nature of the beneficial effects of a drawdown. Thus, drawdown is not recommended for Whitewater and Rice Lakes.

Dredging: Sediment removal is a restoration measure that is carried out using a variety of techniques, both land-based and water-based, depending on the extent and nature of the sediment removal to be carried out. For large-scale applications, a barge-mounted hydraulic or cutter-head dredge is generally used, while for smaller-scale operations a mud-cat or drag-line bucket, shore-based system is typically employed. Both methods are expensive, especially if a suitable disposal site is not located close to the dredge site. Costs start at between $10 and $15 per cubic yard—sediment removal alone starts at between $3.00 and $5.00 per cubic yard. Effectiveness varies with the effectiveness of watershed controls in reducing or minimizing the sediment source. Impacts relate to increased turbidity during the dredging operation, toxicity from dissolved constituents released from the lake sediments, and algal blooms. Federal—U.S. Army Corps of Engineers—permits are required to utilize this option.

Table 32

AQUATIC PLANTS CONTROLLED BY LAKE DRAWDOWN

Common Name	Scientific Name
Water Shield	Brasenia schreberi
Coontail	Ceratophyllum demersum
Stonewort	Chara sp.
Elodea	Elodea sp.
Milfoil	Myriophyllum sp.
American Lotus	Nelumbo lutea
Yellow Water Lily	Nuphar sp.
White Water Lily	Nymphaea odorata
White Water Lily	Nymphaea tuberosa
Clasping-Leaf Pondweed	Potamogeton robbinsii
Large-Leaf Pondweed	Potamogeton amplifolius
Swamp Fivefinger	Potentilla palustris
Arrowhead	Sagittaria heterophylla
Bladderwort	Utricularia vulgaris
Wild Celery	Vallisneria americana

Source: U.S. Environmental Protection Agency and SEWRPC.

Dredging is the only restoration technique that directly removes the accumulated products of degradation and sediment from a lake system and can return a lake to a younger "age." If carried to the extreme, dredging can be used to construct a new lake on the present site with a size and depth to suit the management objectives. Dredging has been used to increase water depth; remove toxic materials; decrease sediment oxygen demand, preventing fish winterkills and nutrient recycling; and decrease macrophyte growth.

Dredging may have serious, though generally short-term, adverse effects on the Lakes. These adverse effects could include increased turbidity caused by sediment resuspension, oxygen depletion as organic sediments mix with the overlying water, water temperature alterations, and destruction of benthic habitats. There may also be impacts at upland disposal sites, such as odor problems, restricted use of the site, and disturbances associated with heavy truck traffic.

Dredging of lakebed material from navigable waters of the State requires a Wisconsin Department of Natural Resources Chapter 30.20 permit and a U.S. Army Corps of Engineers Chapter 404 permit. In addition, current solid waste disposal regulations define dredge material as a solid waste. Chapter NR 180.13 of the Wisconsin Administrative Code requires that any dredging project of over 3,000 cubic yards submit preliminary disposal plans to the Wisconsin Department of Natural Resources for review and potential solid waste licensing of the disposal site. Because of the large amounts of sodium arsenite that were applied to Whitewater Lake in the 1950s and 1960s, as noted in Chapter V, sediment samples may need to be analyzed to determine the extent and severity of any residual arsenic contamination.

Dredging Whitewater and Rice Lakes could be accomplished with several different types of equipment, including a hydraulic cutterhead dredge mounted on a floating barge; or bulldozer and backhoe equipment if part of the Lakes were drained; or a clamshell, or bucket, dragline dredge from the shoreline.

Hydraulic cutterhead dredging is the most commonly employed method in the United States. The dredge is typically a rotating auger or cutterhead on the end of a ladder that is lowered to the sediment-water interface. Sediment excavated by the cutterhead is pumped in a slurry of 10 to 20 percent solids by a centrifugal pump to the disposal site. This pumping usually limits the distance between the lake and disposal site to less than a mile, even using intermediate booster pumps. Because of the large volume of slurry produced, a relatively large disposal site would be required. Water returned from the disposal site, whether returned to the lake or a stream, would have to meet effluent water quality standards of the State and would be subject to State permitting.

Draining the lake and removing sediment with conventional earth-moving equipment has some advantages over hydraulic dredging since it would not require a large disposal or dewatering site in the immediate area. Draining is also more advantageous than dragline dredging because it would not require the removal of a large number of trees and would probably involve less disturbance of the shoreline to provide access for trucks and equipment.

Shoreline dredging of 25 percent of the Lakes shoreline to remove and dispose of about 13,000 cubic yards of sediment would cost approximately $150,000. The potential negative environmental effects of a large-scale lakewide dredging project and the high cost associated with dredge spoil disposal, indicates this option should be considered only on a limited basis for small-scale projects designed to improve hydraulic capacity or boating access.

Aquatic Plant Management Measures

Aquatic plant management refers to a group of management and restoration measures aimed at both removal of nuisance vegetation and manipulation of species composition in order to enhance and provide for recreational water use. Generally, aquatic plant management measures are classed into four groups: physical measures which include water level management; manual and mechanical removal measures which include harvesting and removal; chemical measures which include using aquatic herbicides; and biological controls which include the use of various organisms, including insects. Of these, chemical and biological measures are stringently regulated and require a State permit. Costs range from minimal for manual removal of plants using rakes and hand pulling to upwards of $80,000 for the purchase of a large mechanical plant harvester—the operational costs for which can approach $10,000 to $20,000 per year depending on staffing and operating policies.[7] Harvesting is probably the measure best applicable to large areas, while chemical controls may be best suited to use in confined areas and for initial control of invasive plants. Planting of native plant species is largely experimental in the lake but can be considered a specialized shoreland management zone at the water's edge. Physical controls and mechanical harvesting may have side effects in the expansion of plant habitat and the spread of vegetative fragments.

Aquatic Herbicides: Chemical treatment with aquatic herbicides is a short-term method of controlling heavy growths of aquatic macrophytes and algae. Chemicals are applied to the growing plants in either liquid or granular form. The advantages of using chemical herbicides to control aquatic macrophyte growth are the relatively low cost and the ease, speed, and convenience of application. However, the potential disadvantages associated with chemical control include the following:

1. The short-term, lethal effects of chemicals are relatively well known, however, properly applied chemical applications should not result in such effects. Potential long-term, sublethal effects, especially on fish, fish-food organisms, and humans, are relatively unknown.

2. The elimination of macrophytes eliminates their competition with algae for light and nutrients. Algal blooms may then develop unless steps are taken simultaneously to control the sources of nutrient input.

3. Since much of the dead plant materials is left to decay in the lake, nutrients contained in them are rapidly released into the water and fuel the growth of algae. The decomposition of the dead plant material also consumes dissolved oxygen and increases the potential for fish kills. Accretion of additional organic matter in the sediments as a result of decomposition also increases the organic content of the soils and predisposes the sediments toward reintroduction of other (or the same) nuisance plant species. Long-term deposition of plant material may result in the need for other management measures, such as dredging.

4. The elimination of macrophyte beds destroys important cover, food sources, and spawning areas for desirable fish species.

5. Adverse impacts on other aquatic organisms may be expected. At the concentrations used for macrophyte control, Diquat has been known to kill the zooplankton Daphnia and Hyalella, both important fish foods. Daphnia is the primary food for the young of nearly all fish species found in the Region's lakes.[8]

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[7] *Excluding any depreciation of equipment.*

[8] *P.A. Gilderhus, "Effects of Diquat on Bluegills and Their Food Organisms," The Progressive Fish-Culturist, Vol. 2, No. 9, 1967, pp. 67-74.*

6. Areas must be treated again in the following season and weed beds may need to be treated more than once in a summer.

7. Many of the chemicals available are nonselective, often affecting nontarget, desirable species as well as the "weeds."

The advantages and disadvantages of chemical macrophyte control also apply to the chemical control of algae. Copper, the active ingredient in algicides, may accumulate in the bottom sediments, where excessive amounts are toxic to fish and benthic animals. Fortunately, copper is rapidly eliminated from human systems and few cases of copper sensitivity among humans are known.[9]

Costs of chemical treatments vary widely. Large, organized treatments are more efficient and tend to decrease unit costs for commercial applications compared to individual treatments. Other factors, such as the type of chemical used and the number of treatments needed, are also important. Estimated costs for lakes in Southeastern Wisconsin range from $240 to $480 per acre. The District currently budgets approximately $8,000 per year for chemical treatments. Chemical treatments must be permitted by the State under Chapter NR 107 of the Wisconsin Administrative Code. Because the demonstrated need to control aquatic plants in selected areas of Whitewater and Rice Lakes and the relatively low cost of chemical treatment and because current management decisions have indicated a need for some chemical treatment, chemical treatment is considered to be a viable management option to be considered further for Whitewater and Rice Lakes.

Aquatic Plant Harvesting: Aquatic macrophytes are mechanically harvested with specialized equipment consisting of a cutting apparatus which cuts up to five feet below the water surface and a conveyor system which picks up the cut plants and hauls them to shore. Advantages of macrophyte harvesting include the following:

1. Harvesting removes the plants from the lake. The removal of this plant biomass decreases the rate of accumulation of organic sediment. A typical harvest of submerged macrophytes from eutrophic lakes in Southeastern Wisconsin can yield between 140 and 1,100 pounds of biomass per acre per year.[10]

2. Harvesting removes plant nutrients, including nitrogen and phosphorus, which would otherwise "refertilize" the lake as the plants decay. A typical harvest of submerged macrophytes from eutrophic lakes in Southeastern Wisconsin can remove between four and 34 pounds of nitrogen and 0.4 to 3.4 pounds of phosphorus per acre per year. In addition to the physical removal of nutrients, plant harvesting may reduce internal nutrient recycling. Several studies have shown that aquatic macrophytes can act as nutrient pumps, recycling nutrients from the bottom sediments into the water column. Ecosystem modeling results, have indicated that a harvest of 50 percent of the macrophytes in Lake Wingra, Wisconsin, could reduce instantaneous phosphorus availability by about 30 percent, with a maximum reduction of 40 to 60 percent, depending on the season.

3. Repeated macrophyte harvesting may reduce the regrowth of certain aquatic macrophytes. The regrowth of milfoil has been reported to have decreased as harvesting frequency was increased.

4. Where dense growths of filamentous algae are closely associated with macrophyte stands, they may be harvested simultaneously.

5. The macrophyte stalks remaining after harvesting provide cover for fish and fish-

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[9]*J.A. Thornton and W. Rast, "The Use of Copper and Copper Compounds as an Algicide," Copper Compounds Applications Handbook, H.W. Richardson, ed., Dekker, New York, 1997.*

[10]*James E. Breck, Richard T. Prentki, and Orie L. Loucks, editors, Aquatic Plants, Lake Management, and Ecosystem Consequences of Lake Harvesting, Proceedings of Conference at Madison, Wisconsin, February 14-16, 1979.*

food organisms, and stabilize the bottom sediment against wind erosion.

6. Selective macrophyte harvesting may reduce stunted populations of panfish in lakes where excessive cover has adversely influenced predator-prey relationships. By allowing an increase in predation on young panfish, both gamefish and the remaining panfish may show increased growth.[11]

7. The cut plant material can be used as mulch.

The disadvantages of macrophyte harvesting include the following:

1. Harvesting is most effective in water depths greater than two feet. Large harvesters cannot operate in shallow water or around docks and buoys.

2. The reduction in aquatic macrophytes by harvesting reduces their competition with algae for light and nutrients. Thus, algal blooms may develop.

3. Fish, especially young-of-the-year bluegills and largemouth bass, as well as fish-food organisms, are caught in the harvester. As much as 5 percent of the juvenile fish population can be removed by harvesting. A Wisconsin Department of Natural Resources study found that four pounds of fish were removed per ton of plants harvested.[12]

4. The reduction in aquatic macrophyte biomass by harvesting or chemical control can reduce the diversity and productivity of macroinvertebrate fish-food organisms feeding on the epibiota.[13] Bluegills generally move into the shoreline area after sunset, where they consume these macroinvertebrates. After sunrise they migrate to open water, where they graze, primarily on zooplankton.[14] If harvesting or chemical control shifts the dominance of the littoral macroinvertebrate fauna to sediment dwellers, the macroinvertebrate component of the bluegill diet could be restricted. This would increase predation pressure on zooplankton and reduce the growth rate of the panfish; it could eventually lead to undesirable ramifications throughout the food web in a lake.

5. Macrophyte harvesting may influence the community structure of macrophytes by favoring such plants as milfoil (Myriophyllum sp.) that propagate from cut fractions. This may allow these plants to spread into new areas through the rerooting of the cut fractions.

6. Certain species of plants, such as coontail, may be difficult to harvest due to lack of root system.

7. The efficiency of macrophyte harvesting is greatly reduced around piers, rafts, and buoys because of the difficulty in maneuvering the harvesting equipment in those restricted areas and because of the liability which can be incurred as a result. Manual methods have to be used in these areas.

8. High capital and labor costs are associated with harvesting programs. Macrophyte harvesting on Whitewater and Rice Lakes could be continued by the Whitewater-Rice Lakes Management District staff or be con-

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[11] *James E. Breck, and J.F. Kitchell, "Effects of Macrophyte Harvesting on Simulated Predator-Prey Interactions," edited by Breck et al., 1979, pp. 211-228.*

[12] *Wisconsin Department of Natural Resources, Environmental Assessment Aquatic Nuisance Control (NR 107) Program, 3rd Edition, 1990, 213 pp.*

[13] *James E. Breck, Richard T. Prentki, and Orie L. Loucks, editors, Aquatic Plants, Lake Management, and Ecosystem Consequences of Lake Harvesting, Proceedings of Conference at Madison, Wisconsin, February 14-16, 1979.*

[14] *Ibid.*

tracted to a private company. The annual cost of harvesting by the District staff in 1995 was approximately $26,000. These monies are largely staff costs and operating costs such as fuel, oil, and maintenance.

Various types of harvesters and harvesting practices are available to address the many issues encountered on Whitewater and Rice Lakes. The District currently operates with one Aquarius System H-820 harvester and one transporter to harvest selected areas of Whitewater and Rice Lakes. Issues that presently need to be addressed at Whitewater and Rice Lakes include manueverablity of machinery between piers and shoreline to enable shoreline cleanup; collection of floating vegetation which builds up along the shoreline becoming unsightly and at times foul smelling, and may interfere with recreational boating activities; the convenience and transportability of the harvester from Whitewater Lake to Rice Lakes on a regular basis; and the need to address areas with extensive shallow areas.

Of the various types of harvesters, one possible alternative to address the issues previously mentioned would be to purchase a second, smaller, aquatic harvester with about a seven-foot removable cutter bar which could then also be operated for cleanup of floating vegetation in shallower areas. This size harvester has the ability to cut and hold about 8,500 pounds of vegetation. Options exist which would allow for the elimination of the paddlewheel to be replaced by a hydraulically powered propeller drive system decreasing the width of the machine. This particular system can be operated with diesel fuel which is more economical than the standard paddlewheel option and is compatible with a transporter. Being a smaller version of the larger harvesters, having a width of eight feet, it could more easily be transported between Whitewater and Rice Lakes.

Smaller harvesters are also available, comparable to the size of a pontoon boat, with a four-foot cutting bar. The small size of the harvester would allow for easy maneuvering between piers and shoreline in addition to easy portaging between the Lakes. The storage capacity allows for approximately 1,500 pounds of vegetation which in areas of dense vegetation could require unloading approximately every 15 minutes.

A harvesting program should be designed to provide optimal benefits and minimal adverse impacts. Small fish are common in dense macrophyte beds, but larger fish, such as largemouth bass, do not utilize these dense beds.[15] Narrow channels may be harvested to provide navigational access and "cruising lanes" for predator fish to migrate into the macrophyte beds to feed on smaller fish. "Shared access" lanes may also be cut, allowing several residents to use the same lane. Increased use of these lanes should keep them open for longer periods than would be the case if a less directed harvesting program was followed. "Clear-cutting" of aquatic plants and denuding the lake bottom of flora should be avoided. Top-cutting of plants such as Eurasian water milfoil (EWM)is suggested—the harvest of water lilies and other emergent native plants, however, should be avoided. Because of the demonstrated need for control of aquatic plants in Whitewater and Rice Lakes and because the current lake management decisions have indicated a need for aquatic plant harvesting, harvesting is considered a viable management option to continue.

Cleanup Crew: Decomposing floating aquatic plants which build up along the shorelines limit the use of the riparians shoreline and can be extremely unsightly and foul smelling. Shoreline cleanup is a laborious job which can require a substantial amount of labor and time. Given that a significant number of lake home owners are seasonal and/or elderly it is not always feasible for them clean their shoreline when needed. The Lake Pewaukee Sanitary District has incorporated a shoreline cleanup crew into their harvesting program to alleviate this

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[15]*S. Nichols, "Mechanical and Habitat Manipulation for Aquatic Plant Management: A Review of Techniques," Wisconsin Department of Natural Resources Technical Bulletin No. 77, 1974.*

problem.[16] Retention of two or three people for a continuous cleanup crew would provide for the removal of substantial amounts of vegetation which if not removed would contribute to accumulation of organic sediment to the bottom of the lake and to the continued proliferation of aquatic plants. Such a crew operates using a flat barge occupied by a driver and one to two people wading in the water or standing on the barge to pick up floating aquatic plants and deposit them onto the barge. This method leaves the rooted vegetated area between piers to the responsibility of the riparian owner. A custom-built flat barge is estimated to cost about $15,000. Because of the demonstrated need for the regular cleanup of floating vegetation on Whitewater and Rice Lakes, provision of a shoreline cleanup crew is considered a viable management measure.

Another option for shoreline cleanup could include a "pier pickup" where the harvesting crew would pickup the plants from the plants from the end of pier using a transport barge on a designated day. This would leave the responsibility of gathering the plants from the shoreline to the riparian owner.

Manual Harvesting: Due to an inadequate depth of water it is not always possible for harvesters to reach the shoreline of every property. Another measure, implemented by the Lake Pewaukee Sanitary District, involved the purchase of a dozen specially designed rakes which are designed specifically to manually remove aquatic plants from the shoreline area. The rakes were made available for the riparian owners to use on a trial basis to test their operability before purchasing them. The advantage of the rake is that it is easy and quick to use, immediately removing the plants where as chemical treatment involves a waiting period. Using this method also removes the plants from the lake avoiding the accumulation of organic matter on the lake bottom adding to the nutrients which favor more plant growth. This method also gives the harvester more time to cover larger areas of the lake as maneuvering between the piers takes time and skill. In areas where mechanical harvesting is not practical, an option would be for shoreline cleanup crews to assist property owners.

Biological Controls: Another alternative approach to controlling nuisance weed conditions, in this particular case Eurasian water milfoil (EWM), is biological control. Classical biological control has been successfully used to control both weeds and herbivorous insects.[17] Recent documentation states that Eurhychiopsis lecontei, an aquatic weevil species, has the potential as a biological control agent for EWM. In 1989, the weevil was discovered during a study investigating a decline of EWM growth in a Vermont pond. Eurhychiopsis proved to have significant negative effects on EWM in the field and in the lab. The adult weevil feeds on the milfoil causing lesions which make the plant more susceptible to pathogens such as bacteria or fungi while the weevil larvae burrows in the stem of the plant causing enough tissue damage for the plant to lose buoyancy and collapse.[18] The few studies that have been done since that time have indicated the following potential advantages to use of this weevil as a means of EWM control:

1. Eurhychiopsis lecontei is known to cause fatal damage to the EWM plant and over a period of time has the potential to cause a decrease in the milfoil population.

2. Eurhychiopsis lecontei larvae are easy to produce.

3. Eurhychiopsis lecontei are not known to cause damage to existing native aquatic plants.

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[16]*Charlie Shong, Lake Pewaukee Sanitary District, oral communication, 1995.*

[17]*C.B. Huffacker, D.L. Dahlsen, D.H. Janzen, and G.G. Kennedy, Insect Influences in the Regulation of Plant Population and Communities, 1984, pp. 659-696; C.B. Huffacker and R.L. Rabb, editors, Ecological Entomology, Kohn Wiley, New York, New York, USA.*

[18]*Sally P. Sheldon, "The Potential for Biological Control of Eurasian Water Milfoil (Myriophyllum spicatum) 1990-1995 Final Report," Department of Biology Middlebury College, February 1995.*

The potential disadvantages of using Eurhychiopsis lecontei include:

1. The studies done on Eurhychiopsis are very recent and more tests are necessary to determine if there are significant adverse effects.

2. Since the upper portion of the EWM plant is preferred by the weevil, harvesting would have to be extremely limited or not used at all in conjunction with this type of aquatic plant management control.

Very few studies have been completed using Eurhychiopsis lecontei as a means of aquatic plant management control thus it is not practical to recommend this type of control on Whitewater and Rice Lakes at this time except on an experimental basis.

Lake Bottom Covering: Lake bottom covers and light screens provide limited control of rooted plants by creating a physical barrier which reduces or eliminates the sunlight available to the plants. They have been used to create swimming beaches on muddy shores, to improve the appearance of lakefront property, and to open channels for motorboating. Sand and gravel are usually readily available and relatively inexpensive to use as cover materials, but plants readily recolonize areas so covered in about a year. Synthetic material, such as polyethylene, polypropylene, fiberglass, and nylon, can provide relief from rooted plants for several years. The screens are flexible and can be anchored to the lakebed in spring or draped over plants in summer.

The advantages of bottom covers and screens are that control can be confined to specific areas, the covers and screens are usually unobtrusive and create no disturbance on shore, and the covers are relatively easy to install over small areas. The disadvantages of bottom covers and screens are that they do not reduce eutrophication of the lake, they are expensive, they are difficult to spread and anchor over large areas or obstructions, they can slip on steep grades or float to the surface after trapping gases beneath them, and they may be difficult to remove or relocate.

Screens and covers should not be used in areas of strong surfs, heavy angling, or shallow waters where motor boating occurs. They should also not be used where aquatic vegetation is desired for fish and wildlife habitat. To minimize interference with fish spawning, screens should be placed before or after spawning. A permit from the Wisconsin Department of Natural Resources is required for use of sediment covers and light screens. Permits require inspection by the Department staff during the first two years, with subsequent permits issued for three-year periods.

The estimated cost of lake bottom covers that would control plant growth along a typical shoreline property, an area of about 700 square feet, ranges from $40 for burlap to $220 for aquascreen. Because of the limitations involved, lake bottom covers as a method to control aquatic plant growth are not recommended for Whitewater and Rice Lakes, except on a limited individual homeowner basis.

Public Information: Aquatic plant management usually centers on the eradication of nuisance aquatic plants for the improvement of recreational lake use. The majority of the public view all aquatic plants as "weeds" and residents often spend considerable time and money removing desirable plant species from a lake without considering their environmental impacts. Thus, public information is an important component of an aquatic plant management program and should include information and education on:

1. The types of aquatic plants in Whitewater and Rice Lakes and their value to water quality, fish, and wildlife.

2. The preservation of existing stands of desirable plant species.

3. The identification of nuisance species and the methods of preventing their spread.

4. Alternative methods for controlling existing nuisance plants including the positive and negative aspects of each method.

An organized aquatic plant identification/education day is one method of providing hands-on education to lake residents. Other sources of information and technical assistance include the Wisconsin Department of Natural Resources Aquatic Plant Monitoring Program and the UW-Extension Service. The aquatic plant species list provided in Chapter V and the illustrations provided in Appendix C may serve as a checklist for individuals interested in identifying the plants near their residences. Residents can observe and record changes in the abundance and types of plants in their part of a lake on an annual basis.

Of the submerged floating and free-floating aquatic plant species found in Whitewater and Rice Lakes, Eurasian water milfoil is one of the few species likely to cause lake-use problems. As discussed in Chapter V, milfoil, like most aquatic plants, can reproduce from fragments and often forms dense beds. Residents should be encouraged to collect fragments that wash ashore after storms, from weekend boat traffic, and after harvesting. The plant fragments can be used as mulch on flower gardens or ornamental planting areas.

Milfoil and other aquatic plants can be transported between lakes as fragments on boats and boat trailers. To prevent unwanted introductions of plants into lakes, boaters should remove all plant fragments from their boats and trailers when exiting the lake. Providing the opportunity for the removal of plant fragments at the boat landings on Whitewater and Rice Lakes may help motivate boaters to utilize this measure. Posters and pamphlets are available from the University that provide information and illustrations of milfoil, discuss the importance of removing plant fragments from boats, and remind boaters of their duty in this regard.

Fish Management Measures

Whitewater and Rice Lakes provides a quality habitat for a healthy, warmwater fishery. Adequate water quality, dissolved oxygen levels, and a diverse aquatic plant community contribute to the maintenance of a fish population that is dominated by desirable sport fish. Fish surveys show that both Whitewater and Rice Lakes support abundant populations of largemouth bass and bluegills. Northern pike are stocked on alternate years in both Whitewater and Rice Lakes and walleyed pike are stocked in Whitewater Lake to enhance their population, improve panfish sized through predation, and provide increased angling opportunities.[19]

Habitat Protection: Habitat protection refers to a range of conservation measures designed to maintain existing fish spawning habitat, including measures such as restricting recreational and other intrusions into gravel-bottomed shoreline areas during the spawning season—for bass this is spring, mid-April to mid-June. Use of natural vegetation in shoreland management zones and other "soft" shoreline protection options aid in habitat protection. Costs are generally low unless the habitat is already degraded. Ordinance modification is an option which can be used to impose boating restrictions or similar constraints on recreational use in selected areas which are of importance for fishery management. Effectiveness is variable depending in part on community acceptance and enforcement. Generally, it is more effective to maintain a good habitat than to restore a habitat after it is degraded.

Loss of habitat should be a primary concern of any fish management program. The environmentally valuable areas identified in Chapter V are the most important areas to be protected. Limiting or restricting power boats in these areas will prevent significant disturbance of fish nests and aquatic plant beds. Aquatic plant control should be avoided in these areas. Dredging, filling, and the construction of piers and docks should be discouraged in these areas.

Water level fluctuations can also alter fish habitat. The potential effects of any proposed perturbations in water levels on the fishery should be well studied before considering implementation. Finally, the importance of maintaining good water quality cannot be overemphasized as a fish habitat protection measure.

Habitat Creation: In lakes where vegetation is lacking or where plant species diversity is low, artificial habitat may need to be developed. Northern pike artificial spawning habitat can be created by

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[19] *Douglas Welch, Wisconsin Department of Natural Resources, correspondence, October 26, 1995.*

impounding small streams entering the lake.[20] Such impoundments usually have extensive shallows and marshy habitats that are prime northern pike habitat. Artificial walleyed pike spawning beds have been constructed from rocks and boulders, but the success has varied among lakes. In lakes that lack a healthy and diverse native aquatic plant community, transplant experiments have also been attempted to increase the available fish habitat.[21]

Spawning habitat improvement and creation refers to a range of restoration measures designed to repair, replace or create additional habitat areas for fish in a lake. Where protection measures have not worked or have proven inadequate, improvement or creation of additional habitat may be warranted. Techniques to be considered include shoreland management zones—see above—and flushing gravel beds or underwater springs to keep these areas free of silt prior to the spawning season. Water level control with reference to the fishery is also a potential practice for spawning habitat improvement. Artificially creating spawning habitat by constructing rock reefs and gravel beds at depths of 1.5 to four feet for walleye spawning is another alternative. In such cases, provision of additional structures for protection of juvenile fishes is usually a concurrent activity. Brush piles, cribs, stake beds, pipe pyramids, and rubble piles can provide necessary cover and habitat for food organisms. Costs are generally modest. Effectiveness has been demonstrated but is not well documented. Impacts are few, if any. State permits may be needed to employ this measure.

Modification of Species Composition: Species composition management refers to a group of conservation and restoration measures which include selective harvesting of undesirable fish species and stocking of desirable species designed to enhance the angling resource value of a lake. These measures include water level manipulation both to aid in the breeding of desirable species—for example, increasing water levels in spring to provide additional breeding habitat for pike—and to disadvantage undesirable species—for example, drawing a lake down to concentrate forage fish and increase predation success and also to strand juveniles and desiccate the eggs of undesirable species. Costs, as with water level management above, are primarily associated with loss of use; effectiveness is good but by no means certain; and side effects include collateral damage to desirable fish populations.

More extreme measures include fish jamborees, such as "Carp-Outs" that encourage increased angling pressure on undesirable species, poisoning, and enhancement of predation by stocking. In lakes with an unbalanced fishery, dominated by carp and other rough fish, chemical eradication is an option which can be used to manage the fishery. The fish toxicant Rotenone is used to eradicate the existing fish population with the desired predator fish and panfish reintroduced. Lake drawdown is often required along with the chemical treatment. Drawdown will expose spawning areas and eggs and concentrate fish in shallow pools, thereby increasing their availability to anglers, commercial harvesters, or chemical eradication treatments. The newly created habitat will also benefit desired gamefish populations. Fish barriers are usually used to prevent reintroduction of undesirable species from up- or downstream. Chemical eradication is a drastic, costly measure and the end result may be highly unpredictable, although effectiveness is generally good. The estimated cost of a Rotenone treatment of Whitewater and Rice Lakes exceeds $50,000; most of this cost being for the chemical itself. Additional costs would be incurred for restocking. Because the rough fish do not currently represent a significant problem, such extreme measures are not recommended for Whitewater and Rice Lakes where the fisheries resource has been assessed as good.

The more common management measure is stocking of game fishes, to encourage a desirable mixture of species as determined by the stocking objectives, usually supplementing an existing population, maintaining a population that cannot reproduce itself, adding a new species to a vacant niche in the

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[20]*G.C. Becker, Fishes of Wisconsin, The University of Wisconsin Press, Madison, Wisconsin, 1983.*

[21]*D.H. Les, G. Guntenspergen, J. Keough, and F. Stearns, "Feasibility of Increasing Native Aquatic Macrophytes in Lac La Belle and Okauchee Lakes, Wisconsin: Final Report on 1987 Field Study," unpublished report to the Wisconsin Department of Natural Resources, January 1988.*

food web, replacing species lost due to a natural or man-made disaster, or establishing a fish population in a depopulated lake. Costs vary with species stocked and their relative availability, the numbers to be stocked and their year class or age, and the location and timing of the stocking. Effectiveness is variable, depending on the aforementioned factors, but can be good for many species. Impacts on other parts of the fish community are possible, especially if nonnative fish species are stocked, and other stresses may be imposed by an altered species composition and/or population structure.

Fish stocking is a management method used to supplement naturally reproducing species or to maintain populations of species with poor natural reproduction. Stocking of sport fish encourages angler use of a lake and can be used to maintain a balanced predator-prey relationship. Proper stocking of fish requires a thorough understanding of the existing fish population. Predator fish should not normally be stocked to control a panfish population that is already stunted. Once panfish become so abundant that the population is stunted, the number of predators required to control them is probably higher than the capacity of the lake in question for predators.[22] Overstocking or stocking when native predators are already present in adequate numbers may result in one or more of the following problems: 1) competition of stocked fish and native fish may force stocked fish out of a lake and into adjacent waterbodies where their presence may be undesirable, 2) overcrowded fish populations may be more susceptible to bacterial, viral, and parasitic infections, and 3) overstocking may have an unfavorable effect on angling success.[23]

Regulations and Public Information: To reduce the risk of overharvest, the Wisconsin Department of Natural Resources has placed restrictions on the number and size of certain fish species caught by anglers. The open season, size limits, and bag limits for the fish species of Whitewater and Rice Lakes are given in Table 33. Enforcement of these regulations is critical to the success of any sound fish management program.

Shoreline Maintenance

Shoreline erosion was found to exist only at isolated locations on Whitewater and Rice Lakes, as discussed in Chapter III and no serious problems were identified. This limited erosion may be attributed to the following factors:

1. Maintenance of lawns to the lake edge can increase the rate of shoreline erosion. The shallow root system of lawn grass fails to bind the soil in place sufficiently and allows undercutting and the filtering of sediment particles through the unstable shore slopes into the water. The lack of vegetation at the waterline serves as an indicator of active erosion.

2. Wave action is the primary direct cause of shoreline erosion when a lake is not ice covered. Shoreline erosion by wave action is most evident along the eastern shoreline of lakes within Southeastern Wisconsin because of prevailing westerly winds. The waves undercut the exposed shoreline slopes, resulting in sloughing of the shore into the lake.

3. High lake levels may increase the shoreline erosion by exposing higher areas to direct wave action and by saturating normally unsaturated shoreline soils, thereby reducing the adhesiveness of the soil particles.

4. Ice action may be the single-most important cause of shoreline erosion on the Lakes. Whitewater and Rice Lakes is normally covered by ice from about early December to late March. During this time, thermal expansion of the ice may force a layer of ice up onto the shore, while during spring breakup, windblown floating ice blocks and fragments can be forced onto the shore. Under high lake-level conditions, freeze-thaw phenomena may also weaken sub-

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[22] *H. Snow, "Effects of Stocking Northern Pike in Murphy Flowage, Wisconsin," Wisconsin Department of Natural Resources Technical Bulletin No. 50, 1974, 25 pp.*

[23] *G.C. Becker, Fishes of Wisconsin, The University of Wisconsin Press, Madison, Wisconsin, 1983.*

Table 33

1995 OPEN SEASON, SIZE LIMITS, AND BAG LIMITS FOR FISH SPECIES IN WHITEWATER AND RICE LAKES[a]

Species	Open Season	Daily Limit	Minimum Size
Northern Pike	May 6 to March 1	2	26 inches
Walleyed Pike	May 6 to March 1	5	15 inches
Largemouth Bass	May 6 to March 1	5	14 inches
Bluegill, Pumpkinseed (Sunfish), Crappie, and Yellow Perch	Open all year	50	None
Bullhead	Open all year	None	None
Rough Fish	Open all year	None	None

[a]The limits and sizes set forth in this table are specifically for Whitewater and Rice Lakes. Daily limits and minimum sizes vary between lakes in Wisconsin.

Source: Wisconsin Department of Natural Resources.

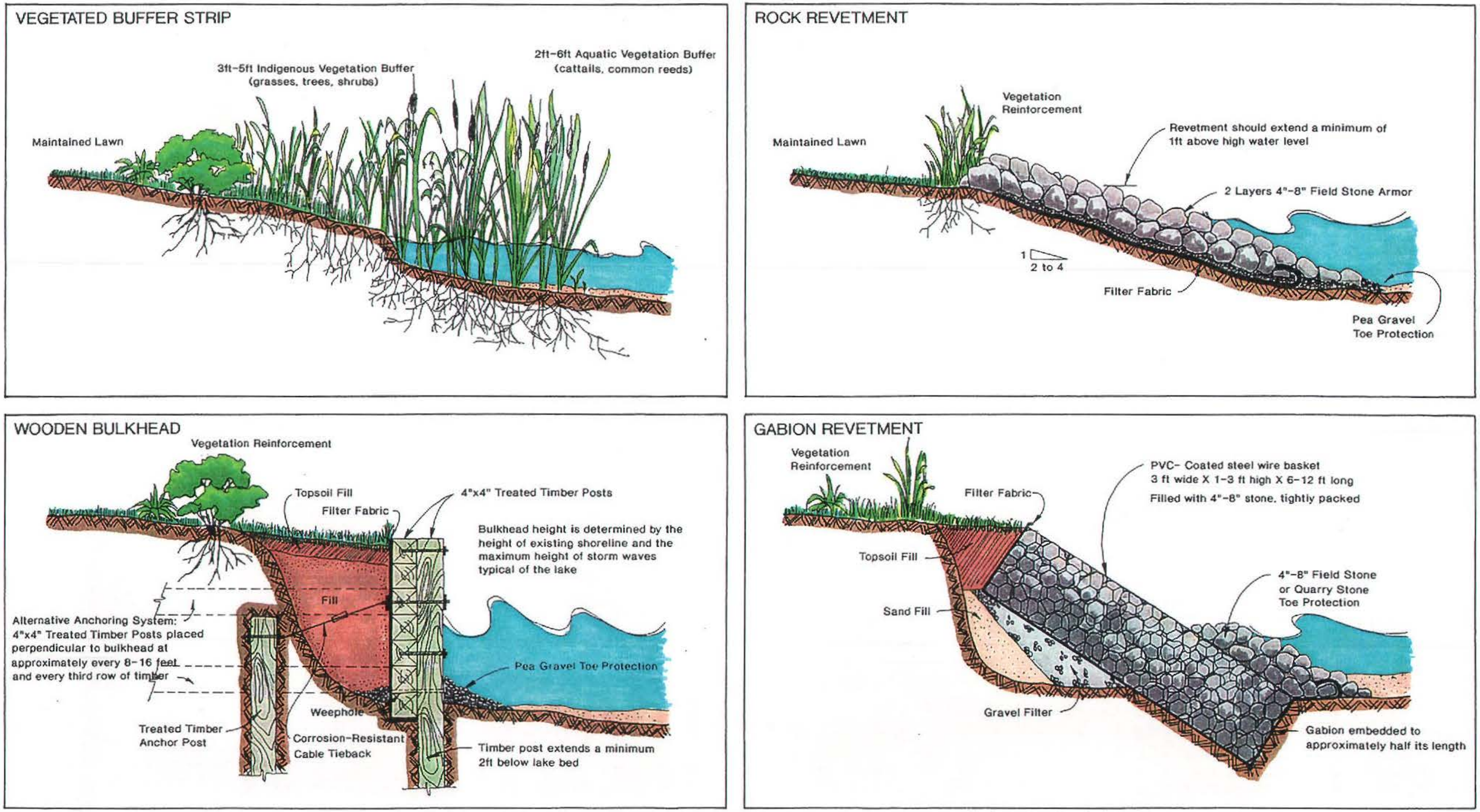
merged shore slopes. Together these ice-related activities physically scour the shoreline and prevent the establishment of a stable vegetative cover.

Four alternative shoreline erosion control techniques were considered: vegetative buffer strips, rock revetments, wooden bulkheads, and gabions. These alternatives considered were selected because they can be constructed, at least partially, by local residents; because most of the construction materials involved are readily available; because the technique would, in most cases, enable the continued use of the immediate shoreline; and because the measures are visually "natural" or "semi-natural" and should not significantly affect the aesthetic qualities of the lake shoreline.

The simplest, least costly, and most natural method of reducing shoreline erosion is the provision of a vegetative buffer strip immediately adjacent to the lake, as shown in Figure 19. This technique employs natural vegetation, rather than maintained lawns, within five to 10 feet of the lakeshore or the establishment of emergent aquatic vegetation from two to six feet lakeward of the eroding shoreline. Aquatic species, such as cattails (Typha spp.) and common reed (Phragmites communis), may be suitable in the littoral areas along the eroding shores. Taller grasses invaded initially by weeds, and later by other species of grasses, forbs, and shrubs, should be encouraged on the shoreline. Some transplanting or seeding with carefully chosen indigenous plant types can decrease the time of this succession of plant species. Desirable plant species which may be expected and encouraged to invade the buffer strip, or which could be planted, include arrowhead (Sagittaria latifolia), cattail (Typha spp.), common reed (Phragmites communis), water plantain (Alisma plantago-aquatica), bur-reed (Sparganium eurycarpum), and blue flag (Iris versicolor) in the wetter areas; and jewelweed (Impatiens biflora), elderberry (Sambucus canadensis), giant goldenrod (Solidago gigantea), marsh aster (Aster simplex), red-stem aster (Aster puniceus), and white cedar (Thuja occidentalis) in the drier areas. In addition, trees and shrubs such as silver maple (Acer saccharinum), American elm (Ulmus americana), black willow (Salix nigra), and red-osier dogwood (Cornus stolonifera) could become established. These plants will develop a more extensive root system than the lawn grass and the aboveground portion of the plants will protect the soil against the erosive forces of rainfall and wave action. A narrow path to the lake can still be maintained as lake access for boating, swimming, fishing, and other activities. A vegetative buffer strip would also serve to trap nutrients and sedi-

Figure 19

PLAN ALTERNATIVES FOR SHORELINE EROSION CONTROL



NOTE: Design specifications shown herein are for typical structures. The detailed design of shore protection measures must be based on detailed analysis of local conditions.

Source: SEWRPC.

ments washing into the lake via direct overland flow. This alternative would involve only minimal cost.

Rock revetments, or riprap, are a highly effective method of shoreline erosion control applicable to many types of erosion problems, especially in areas of low banks and shallow water. Some of these structures are already in place at Whitewater and Rice Lakes. The technique, as shown in Figure 19, involves the shaping of the shoreline slope, the placement of a porous filter material, such as sand, gravel, or pebbles, on the slope and the placement of rocks on top of the filter material to protect the slope against the actions of waves and ice. The disadvantages of rock revetment are that it limits the use of the immediate shoreline in that the rough, irregular rock surfaces are unsuitable for walking; a relatively large amount of filter material and rocks need to be transported to the lakeshore; and excavation and shaping of the shore slope may cause temporary disruptions and contribute sediment to the lake. Even if properly constructed, the revetment may fail because of washout of the filter material. A rock revetment constructed along a 300-foot shoreline by a private contractor would involve a total capital cost of about $7,500, or about $55 per linear foot. By providing labor and some materials, Whitewater and Rice Lakes residents could reduce this cost by up to 50 percent.

Wooden bulkheads, as shown in Figure 19, prevent the sliding of land or slope failure and provide protection against wave action and, to a lesser extent, ice action. A series of horizontal boards are bolted to a series of vertical posts sunk into the soil at the waterline. Alternatively, a close-set series of vertical poles three to six inches in diameter can be erected. A stone toe is usually provided on the lakeward side to protect against undercutting. A sunken cable tieback to an anchored "deadman" may be used to prevent the bulkhead from slipping towards the lake. Advantages of a wooden bulkhead are that it provides substantial protection and maintains the shoreline in a fixed position and that the materials are readily available. Bulkheads, depending on their type, may be considered less visually appealing than rock revetments; are less flexible and more susceptible to ice damage; and are considerably more difficult and expensive to repair than a rock revetment. A wooden bulkhead installed by a private contractor would involve a total capital cost of about $2,200, or about $7.50 per linear foot. As with rock revetments, the provision of labor and some materials by local residents could substantially reduce this cost.

A gabion is a steel wire-mesh basket filled with rock. Gabions are commercially available in a variety of sizes and are constructed and filled with rocks at the site of placement. A single gabion three feet high and three feet wide, sunk into the soil to about one-half its height, as shown in Figure 19, may be expected to protect the shoreline of Whitewater and Rice Lakes adequately. An underlying filter cloth prevents the erosion of finer particles below and behind the gabion, which could cause excessive movement and settling of the gabion. A rock toe may also be provided to prevent undercutting. The advantages of gabions are that they are flexible, relatively easy to construct, and are effective against ice movement. Gabions often become covered with vegetation, which adds to their visual appeal. The disadvantages of gabions are their relatively high cost, the potential for damage and breakage of the wire-mesh basket, and the considerable excavation needed to implant them. Gabions installed by a private contractor along a 300-foot shoreline would cost about $10,800, or about $36 per linear foot. If labor and some materials could be provided by local residents, this cost could be substantially reduced.

Currently about 70 percent of the shoreline of Whitewater Lake is protected by some type of structural measure. Only limited portions of the Rice Lake shoreline are so protected.

Because of the system of shoreline armor already in place at Whitewater and Rice Lakes, armoring the limited additional unprotected shoreline in the main basin of the Lakes would appear to be a viable option. If additional shore protection is installed, it is recommended that consideration be given to the visual aesthetics of blending various types of construction along the shore. This will not only enhance the visual appeal of the shoreline but minimize the edge effects that can occur as the result of two dissimilar abutting styles of construction. These boundaries can become points of weakness, susceptible to undercutting, overtopping or back erosion, which could undermine both sets of abutting structures. Vegetative buffer strips may be highly desirable in this Lakes.

Recreational Use Management and Environmentally Sensitive In-Lake Area Protection

Measures are available to control lake and lake shoreland use. On land, shoreland zoning, requiring set backs and shoreland buffers can protect and preserve views both from the water and from the land, control development around a lake to minimize its environmental impacts and manage public and private access to a waterbody. On water, recreational use zoning and other management measures can provide for safe and multiple-purpose use of waterbody by various groups of lake users and protect environmentally sensitive areas in a lake. Use zoning can also take the form of allocating times of use, such as the annual fishing season established by the state. A key issue in zoning a waterbody for use is equity; the same rules must apply to both riparian owners and off-lake users. This condition is usually met in situations where use zoning is motivated by the protection of fish habitat, for example, as both on- and off-lake users would have use of an enhanced fishery. Initial costs are relatively low—associated with creating and posting the ordinance—and effectiveness can be good with regular/consistent enforcement. Costs increase for measures requiring bouyage. Enforcement can be significant.

Restrictive boating ordinances that limit the time and area of use and the velocity of the boating traffic, are in use on Whitewater and Rice Lakes to protect such recreational opportunities. These same restrictions could be used to protect sensitive fish breeding areas or aquatic plant beds.

Whitewater Lake is marked by small floating islands which generally occur in the western portion of the North Bay, in areas designated as environmentally sensitive by the Wisconsin Department of Natural Resources.

In addition to the floating islands, during the summer and early fall seasons vegetated mats, commonly referred to as bogs, rise to the lakes surface creating a hazard to boaters, in addition to making some areas of the Lake unnavigable. These vegetated mats are reported to be composed of decaying vegetation. It is recommended that buoys be placed in the general areas of the sedge mats to remind boaters to be particularly observant in these areas. Informational buoys should be cylindrical in shape, seven or more inches in diameter, and extend 30 or more inches above the waterline. As such mats become a significant impediment to navigation or a safety hazard, they could be removed as an adjunct to the aquatic plant management program, if they are not connected to the lake bottom. A permit for removal may be required from the Wisconsin Department of Natural Resources. Chapter 30, Wisconsin Statutes, allows local authorities having jurisdiction over the waters involved to place danger buoys or informational buoys without an ordinance, although a State permit is still required. Buoyage can be expensive to obtain, install and maintain, but has the advantage of being visible to recreational boaters. Also, grant money is available for buoyage through Wisconsin Waterways Commission.

Public Informational and Educational Programs

Educational and informational brochures and pamphlets, of interest to homeowners and supportive of the recreational use and shoreland zoning regulations, are available from the University. These latter cover topics such as beneficial lawn care practices and household chemical use guidelines. These brochures could be provided to homeowners through local media, direct distribution or targeted library/civic center displays. An annual Community Festival, for example, could include a nature or environmental component similar to the historic tours offered during previous events. Such interventions could also rekindle public interest in the activities of the Whitewater-Rice Lake Management District. Many of the foregoing ideas can be integrated into ongoing, larger-scale activities, such as lakeside litter collections, which can reinforce antilittering campaigns, recycling drives and similar pro-environment activities.

Finally, the participation of Whitewater and Rice Lakes in the Wisconsin Department of Natural Resources volunteer "Self-Help Monitoring" program, which involves citizens in taking Secchi-disk transparency readings and collecting water quality data in the Lakes at regular intervals, should be continued. Data gathered as part of this program should be presented by the volunteer at the annual meeting of the Lake District, where the citizen-monitors could be given some recognition for their work. The Lake Coordinator of the Wisconsin Department of Natural Resources Southeast District could assist in enlisting volunteers in this program. The information gained at first hand by the public during participation in this program increases the credibility of the proposed changes in the nature and intensity of use to which the Lake is subjected.

SUMMARY

This chapter has described options that could be employed in managing the types of problems found to occur in the Whitewater and Rice Lakes and which could, singly, or in combination, assist in achieving and maintaining the water quality objectives set forth in Chapter VI. Selected characteristics of these measures are summarized in Table 34.

An evaluation of the potential management measures was carried out on the basis of the effectiveness of the measures for improving the lake water quality by dealing with pollutant loadings at their source and on the basis of cost and technical feasibility of the measure. Those alternative measures eliminated from further consideration were: flushing/dilution, destratification, nutrient inactivation, drawdown, dredging, and bottom covering. The remaining measures are considered further for incorporation in a recommended lake management plan as described in Chapter VIII.

Table 34

SELECTED CHARACTERISTICS OF ALTERNATIVE LAKE MANAGEMENT MEASURES FOR WHITEWATER AND RICE LAKES

Alternative Measure	Description	Estimated Costs		Considered Viable for Inclusion in Recommended Lake Management Plan
		Capital	Operation and Maintenance	
Rural Nonpoint Source Pollutant Control	Conservation tillage, contour farming, contour strip cropping, crop rotation, grassed waterways, and pasture and streambank management	- -	- -	Yes[a]
Urban Nonpoint Source Pollutant Control	Detention and infiltration basins	- -	Variable	Yes
Construction Erosion Control	Soil stabilization, surface roughening	$250 per acre	$25 per acre	Yes
Onsite Sewage Disposal System Management	Septic tank management program	Variable	Variable	Yes
Dilution/Flushing	Reduce contaminant concentrations in Lake	- -	- -	No
Nutrient/Toxicant Inactivation	Alum treatment	- -	$72,000	No
Aeration	Circulation of water column	$300,000	$160 to $2,600 per acre	No
Nutrient Load Reduction	Nutrient diversion	- -	Variable	No
Water Level Management	Drawdown Dredging	- - - -	- - - -	No - -[b]
Aquatic Plant Management	Herbicides Harvesting Shoreline cleanup Manual harvesting Biological controls Sediment covering	- - $26,000 $15,000 $1,080 - - - -	$8,000 $20,000 $10,000 - - N/A $40 to $220 per 700 square feet	Yes Yes Yes Yes No[c] - -[b]
Fish Management	Habitat protection Habitat creation Species modification Stocking Shoreline maintenance	- - - - - - - - $7.50 to $36 per linear foot	- - - - - - $0.70 to $0.75 per fish - -	Yes Yes No Yes Yes
Recreational Use Zoning	Space and time zoning to maximize public safety	- -	- -	Yes
Educational Measures	Public information programming	- -	- -	Yes

[a] *Nonpoint source pollution abatement is likely to be undertaken as part of a future priority watershed planning program for the Lower Rock River basin.*

[b] *Should be limited to small-scale projects and evaluated on a case-by-case basis.*

[c] *The use of Eurhychiopsis on an experimental basis to control Eurasian water milfoil is being monitored in Whitewater Lake by the Wisconsin Department of Natural Resources and the University of Wisconsin-Stevens Point from 1995 through 1998.*

Source: SEWRPC.

Chapter VIII

RECOMMENDED MANAGEMENT PLAN FOR WHITEWATER AND RICE LAKES

INTRODUCTION

This chapter presents a recommended management plan, including attendant costs, for Whitewater and Rice Lakes. The plan is based upon analyses of the land use, land and water management, and physical, biological, water quality and pollution source inventory findings; the assessment of the concerns of lake residents as identified by a survey of those residents conducted in 1995; and an evaluation of alternative lake management plans described in Chapter VII of this report. The recommended plan sets forth means for: 1) improving water quality conditions, 2) reducing the severity of existing nuisance problems due to excessive macrophyte growth, which constrains or precludes desired water uses, 3) improving opportunities for water-based recreational activities, and 4) protecting environmentally sensitive areas. The recommended plan is comprised of components which were selected from among the alternatives considered and described in Chapter VII, considering the degree to which the desired water-use and related biological and recreational use objectives may be expected to be met by the alternative measures considered and considering the costs and feasibility of implementation.

Analyses of water quality and biological conditions indicate that the general water quality conditions in Whitewater and Rice Lakes are relatively poor, and that water-based recreational uses are limited by nuisance growths of aquatic macrophytes. In addition to in-lake management measures, the recommended plan also sets forth recommendations for land use controls, and land management measures. These measures complement the watershed-based land use controls and management measures set forth in the regional water quality management plan.[1]

[1] *SEWRPC Planning Report No. 30, A Regional Water Quality Management Plan for Southeastern Wisconsin: 2000, Volume Three, Recommended Plan, June 1979.*

The recommended management measures for Whitewater and Rice Lakes are graphically summarized on Maps 24 and 25 and are listed in Table 35. It is recommended that the Whitewater-Rice Lakes Management District assume the lead in implementing the plan.

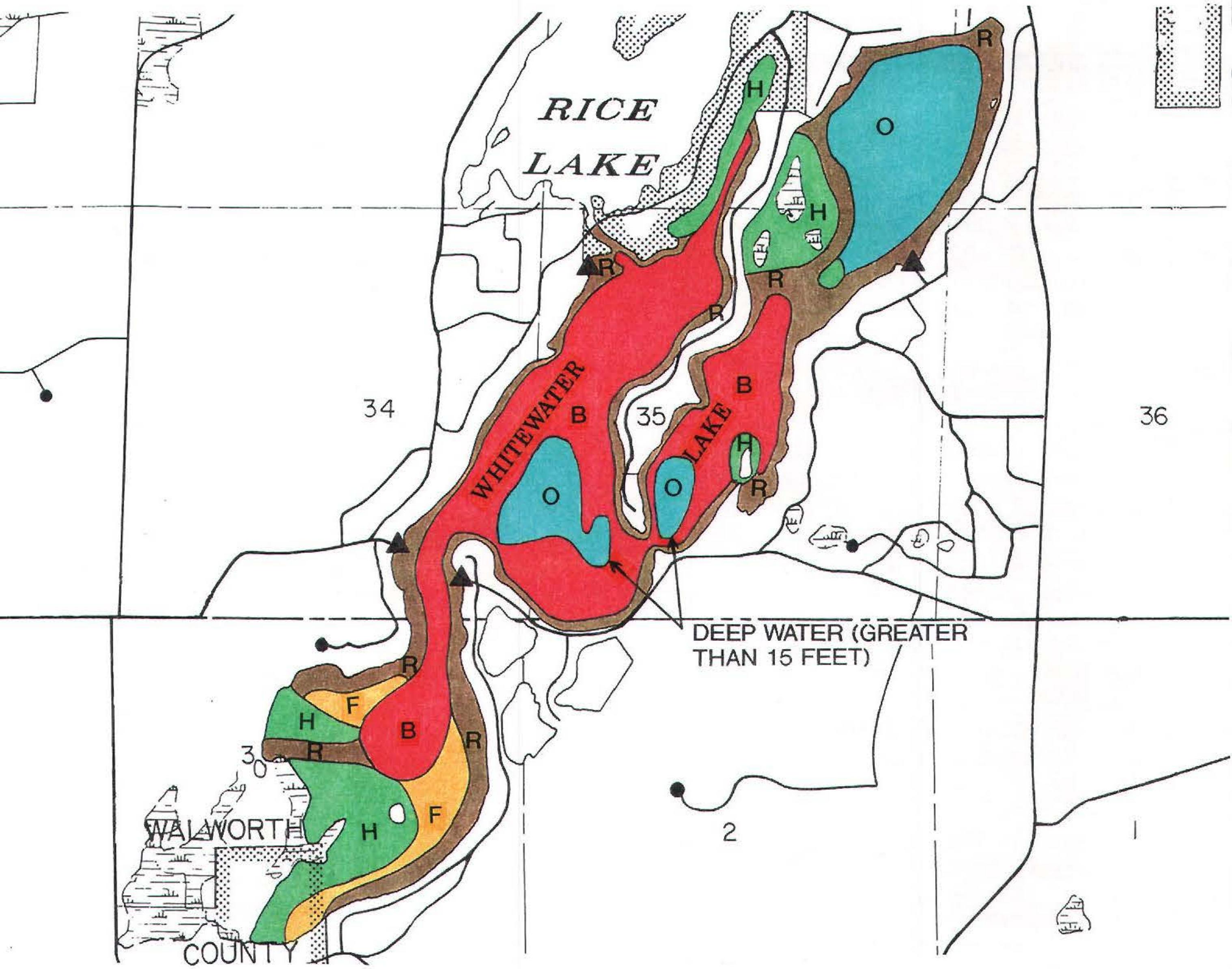
LAND USE AND ZONING MEASURES

A fundamental element of a sound management plan and program for Whitewater and Rice Lakes is the proper development of the lands lying in the tributary drainage area to the Lakes. The type and location of urban and rural land uses in the drainage area determines the character, magnitude, and distribution of nonpoint sources of pollution; the practicality of, as well as the need for, various land management measures; and, ultimately, the water quality of the Lakes. Land uses are also an important consideration with respect to groundwater recharge and quality protection, groundwater being an important factor in determining the water quality and quantity of Whitewater and Rice Lakes.

The recommended land use plan for the tributary drainage area to Whitewater and Rice Lakes has a 2010 design year and is described in Chapter III. The content of, and framework for, the plan is the regional land use plan as prepared and adopted by the Regional Planning Commission. The recommended regional land use plan recommends that only limited additional urban land use development take place in the tributary drainage area to Whitewater and Rice Lakes. Such development would consist primarily of infilling of platted lots, and limited additional development in the areas adjacent to the existing development. Urban land use development should be allowed to occur, however, only in areas which are covered by soils suitable for the intended use; which are not subject to special hazards such as flooding; and which are not environmentally sensitive, that is, are not encompassed within the Regional Planning Commission-delineated environmental corridors described in

Map 24

RECOMMENDED LAKE MANAGEMENT PLAN FOR WHITEWATER LAKE



LEGEND

LAKE USE ZONES

- F FISHING
- O OPEN WATER
- H HABITAT
- R RIPARIAN ACCESS
- B BOATING

AQUATIC PLANT MANAGEMENT

- HARVESTING: LOW PRIORITY
  CHEMICALS: NONE
- HARVESTING: MODERATE
  CHEMICALS: LIMITED
- HARVESTING: NONE
  CHEMICALS: NONE
- HARVESTING: HIGH PRIORITY
  CHEMICALS: LIMITED
- HARVESTING: MODERATE
  CHEMICALS: NONE

ACCESS SITES

DESIGNATED SENSITIVE AREAS - SLOW NO-WAKE BOATING ONLY

MONITORING PROGRAM

- CONDUCT FISH SURVEY
- CONTINUE WATER QUALITY MONITORING
- CONDUCT SUPPLEMENTAL AQUATIC PLANT SURVEYS

LAND USE MANAGEMENT

- PROTECT ENVIRONMENTALLY SENSITIVE AREAS

WATERSHED MANAGEMENT

- CARRY OUT IMPLEMENTATION OF GOOD HOUSE-KEEPING PRACTICES

FISH MANAGEMENT

- CONTINUE STOCKING AS REQUIRED

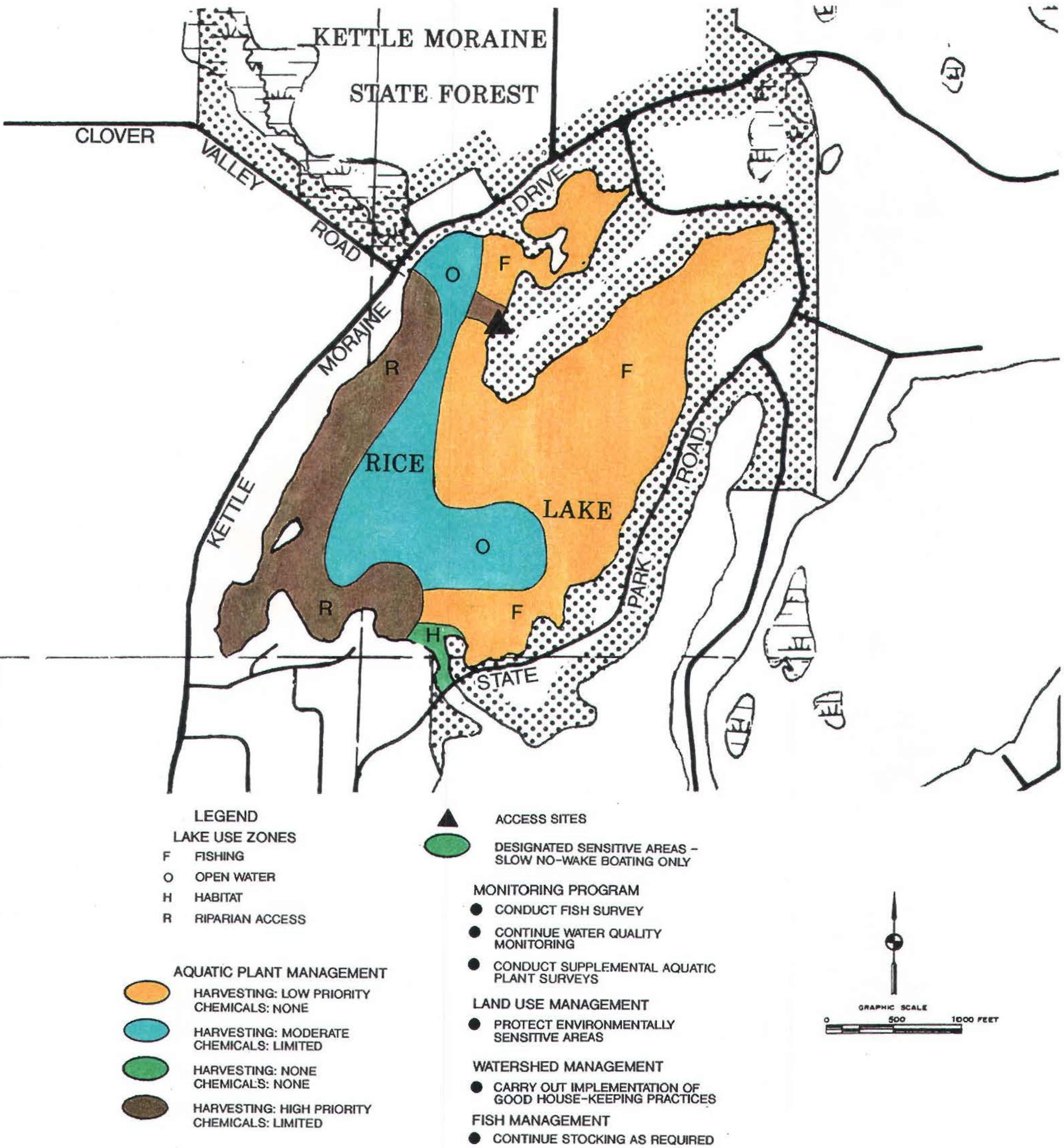
GRAPHIC SCALE

0 1000 2000 FEET

Source: SEWRPC.

Map 25

RECOMMENDED LAKE MANAGEMENT PLAN FOR RICE LAKE



Source: SEWRPC.

Table 35

RECOMMENDED MANAGEMENT PLAN ELEMENTS FOR WHITEWATER AND RICE LAKES

Plan Element	Subelement	Location	Management Measures
Land Use Control and Management	Land use development planning	Entire watershed	Observe guidelines set forth in regional land use plan
	Density management	Lakeshore areas	Maintain historic lake front residential dwelling densities to extent practicable
Watershed Land Management	Construction site erosion control	Entire watershed	Adopt construction site control ordinance pursuant to model ordinance
	Urban nonpoint source controls	Entire watershed	Educate and promote good urban housekeeping practices
	Rural nonpoint source controls	Entire watershed	Continue implementation of nonpoint source conservation controls discussed in Chapter VII and Appendix A
	Environmentally sensitive lands	Entire watershed	Establish adequate protection of islands and wetlands as appropriate. Explore possibility of study on floating vegetated mats with University of Wisconsin-Whitewater
	Onsite sewage disposal system management	Entire watershed	Develop informational and educational program to promote sound practices and periodic inspections
Water Quality Management	Water quality monitoring	Entire Lake	Continue participation in DNR Self-Help Monitoring Program supplemented by USGS monitoring
Aquatic Plant Management	Comprehensive plan refinement	Entire Lake	Update aquatic plant management plan every three to five years
	Major channel harvesting	Zones B and R	Harvest aquatic plants as required
	Minor channel harvesting	Zones F and O	Provide active recreational areas (Zones O and R); harvest fish lanes
	Chemical treatment	Zone R	Limited to control of nuisance aquatic plant growth where necessary for navigation
Boating Access	Dredging	Limited localized areas of lake shoreline	Small-scale dredging projects
Fish Management	Fish survey	Selected areas of Lake	Conduct fish survey to determine stocking needs; conduct periodic creel census
	Fish stocking	Entire Lake	Stock fish as required

Table 35 (continued)

Plan Element	Subelement	Location	Management Measures
Habitat Protection and Lake Use Management	Restrict boating	Zone H	Establish "Slow-No-Wake" zones as shown on Maps 24 and 25
	Restrict harvesting	Zones F and H	Restrict harvesting to access only as shown on Maps 24 and 25
	Restrict chemical treatments[a]	Zone B	Limit chemical treatments, harvest access lane
		Zone F	Limit chemical treatments and harvesting
		Zone H	Restrict chemical treatments and harvesting
		Zone O	Limit chemical treatments; harvest aquatic plants in selected areas
		Zone R	Limit chemical treatments to nuisance aquatic plant growth areas
Shoreland Protection	Maintain structures	Entire Lake	Maintain existing structures and repair as necessary
	Install erosion protection	Lake shoreline	Install erosion control measures
Informational and Educational Program	Public informational and educational programming	Entire watershed	Continue public awareness and information programming

[a]Due to excessive milfoil growth on Whitewater and Rice Lakes, annual preventative chemical treatments may be required in larger areas of the Lakes in late May to early June subject to approval by the Wisconsin Department of Natural Resources.

Source: SEWRPC.

Chapter V. Under the recommended plan, by the year 2010, urban development in the Whitewater and Rice Lakes tributary drainage area to the Lakes may be expected to increase from about 380 to about 420 acres. As discussed in Chapter III, the applicable existing county-town zoning ordinances are generally consistent with the recommended future land use pattern within the tributary drainage area to Whitewater and Rice Lakes, and serve to implement the recommended land use plan.

Groundwater inflow is a particularly important determinant of the water quality and quantity of Whitewater and Rice Lakes. Therefore, protection of groundwater recharge areas—areas where precipitation is likely to reach the water table—should be an important component of any comprehensive management plan for Whitewater and Rice Lakes. Nearshore forested areas and wetlands which serves as groundwater recharge areas are located almost entirely within Regional Planning Commission-designated primary environmental corridor lands, as indicated in Chapter V. Preservation and protection of these areas would serve to not only reduce nonpoint source pollutant loadings to the Lakes, but also to maintain good quality groundwater inflow to the Lakes.

A land use issue which has the potential to affect the Lakes is the redevelopment of existing lake-front properties, replacing lower-density uses with higher-density, multi-family dwellings with increased roof areas, parking areas, and areas of other impervious surfaces. Replacement of a pervious land surface with an impervious surface will increase the rate at which stormwater enters the Lakes and increases certain pollutant loading to the Lakes and reduces groundwater recharge. While these effects can be moderated to some extent through structural stormwater management measures, there is likely to be some residual adverse impact on the Lakes from redevelopment involving higher-density land uses. For this reason, maintenance of the historic low- and medium-density shoreline homes on Whitewater and Rice Lakes to the maximum extent practical is recommended.

WATERSHED LAND MANAGEMENT MEASURES

The recommended watershed land management measures are specifically aimed at reducing the water quality impacts of nonpoint sources of pollution within the tributary drainage area to Whitewater and Rice Lakes watershed. These measures are set forth in the aforereferenced regional water quality management plan. On the basis of a review of the sources of phosphorus loadings to Whitewater and Rice Lakes, as described in Chapters IV and VII, the only significant sources of phosphorus to the Lakes in the tributary watershed area subject to control are urban nonpoint sources and onsite sewage disposal systems.

As indicated in Chapters II and VII, because of the topography and relatively pervious soils, only the urban development immediately adjacent to the lakeshore, together with certain wetlands and woodlands, actually contribute runoff to the Lakes during periods normal rainfall. Only a very limited area in agricultural uses contributes runoff to the Lakes. Thus, only nonpoint source controls for the residential lands adjacent to the Lakes are of significant importance.

The recommended management agency responsibilities for watershed land management are set forth in Table 36.

Urban Nonpoint Source Control

The development of urban nonpoint source pollution abatement measures for the Whitewater and Rice Lakes area is expected to be primarily the responsibility of private property owners. Accordingly, it is recommended that the Whitewater and Rice Lakes Management District work with property owners to achieve good urban land management practices. Such practices should consist of good urban housekeeping practices, such as fertilizer and pesticide use management, critical area protection, litter and pet waste controls, and leaf and yard waste storage and disposal controls. In addition, it is recommended that grassed swales be used to convey stormwater throughout the urbanized area to the maximum extent practicable. The promotion of these measures will require a public informational and educational program. Additionally, the public education program should present information on the groundwater resources of the area and on the measures, such as onsite sewage disposal system management and waste disposal, required to protect these resources.

As indicated in Chapter VII, the inclusion of additional facilities to provide for a "high level" of urban nonpoint source control, including stormwater treatment facilities such as detention basins, does not appear to be an effective and necessary element of a water quality management plan for the existing urban areas surrounding Whitewater and Rice Lakes. This conclusion was reached because the stormwater flow to the Lakes is relatively diffuse, with no practical means for concentrating the flow at treatment facilities.

As an initial step in carrying out the recommended urban practices, it is suggested that a fact sheet identifying specific residential land management practices beneficial to the water quality of Whitewater and Rice Lakes be prepared and distributed to property owners by the Whitewater and Rice Lakes Management District with the assistance of the University of Wisconsin-Extension service. The recommended urban measures may be expected to provide about a 25 percent reduction in urban nonpoint source pollution runoff, and about a 10 to 15 percent reduction in total phosphorus loading to the Lakes.

Construction Site Erosion Control

Walworth County has adopted a construction site erosion control ordinance pursuant to the model ordinance developed by the Wisconsin Department

Table 36

LOCAL GOVERNMENTAL MANAGEMENT AGENCY RESPONSIBILITIES FOR PLAN IMPLEMENTATION

Plan Element	Subelement	Agency				
		Walworth County	Whitewater-Rice Lakes Management District	Town of Whitewater	Town of Richmond	Department of Natural Resources
Land Use Control and Management	Development planning	X	- -	X	X	- -
	Density management	X	- -	X	X	- -
Watershed Land Management	Construction sit erosion control	X	- -	- -	- -	- -
	Urban nonpoint source control	X	X[a]	- -	- -	- -
	Rural nonpoint source control	X	- -	- -	- -	- -
	Environmentally sensitive lands protection	X	X	X	X	- -
	Onsite sewage disposal system management	X	X	- -	- -	- -
Water Quality Management	Water quality monitoring	- -	X	- -	- -	X
Aquatic Plant Management	Management planning	- -	X	- -	- -	X[b]
	Major channel harvesting	- -	X	- -	- -	- -
	Minor channel harvesting	- -	X	- -	- -	- -
	Chemical treatment	- -	X	- -	- -	X[c]
Fish Management	Fish survey	- -	X	- -	- -	X
	Fish stocking	- -	X	- -	- -	X
Habitat Protection and Lake Use Management	Restrict boating	- -	X	X	X	X[b]
	Restrict harvesting	- -	X	- -	- -	- -
	Restrict chemical treatments	- -	X	- -	- -	X[c]
Shoreland Protection	Maintain structures	- -	X[a]	X	X	- -
	Install erosion protection	- -	X[a]	- -	- -	X[c]
Informational and Educational Programs	Public informational and educational programming	X[d]	X	- -	- -	- -

[a]*Resident responsibility; the District can provide guidance, facilitate technical support and potentially offer cost-sharing of expenses.*

[b]*The Wisconsin Department of Natural Resources reviews aquatic plant management plans, revisions thereof, and boating ordinances for compliance with State rules.*

[c]*This activity requires a Wisconsin Department of Natural Resources permit.*

[d]*County assistance is provided through the Land Conservation Division of the County Environmental Resources Department, and the University of Wisconsin Extension.*

Source: SEWRPC.

of Natural Resources in cooperation with the Wisconsin League of Municipalities.[2] The County enforces that ordinance in both the shoreline and nonshoreline areas of the Towns of Richmond and Whitewater. Enforcement by the County is generally considered to be effective. Construction site erosion controls may include the use of silt fences, sedimentation basins, rapid revegetation of disturbed areas; the control of "tracking" from the site; and careful planning of the construction sequence to minimize the areas disturbed. Construction site erosion control is particularly important in minimizing the more severe localized short-term nutrient and sediment loadings to Whitewater and Rice Lakes that can result from uncontrolled construction sites.

Rural Nonpoint Source Pollution Control

The implementation of nonpoint source pollution controls in rural areas is recommended to be a cooperative effort of the Walworth County Land Conservation Committee and private landowners. Additional technical assistance can be provided by the U.S. Department of Agriculture Natural Resource Conservation Service; the Wisconsin Department of Agriculture, Trade and Consumer Protection; and the University of Wisconsin-Extension. The recommendations set forth in the regional water quality management plan to reduce the pollutant loadings from rural nonpoint sources by about 25 percent, and the recommendation of the County Soil Control plan to achieve "tolerant" soil loss levels or levels which can be sustained without impairing the productivity of the soil should be implemented.

Highly localized, detailed, and site-specific measures are required to effectively reduce soil loss and contaminant runoff in rural areas. These measures are best defined and implemented at the local level through the preparation of detailed farm conservation plans. Practices which are considered most applicable in the Whitewater and Rice Lakes area include conservation tillage and pasture management. In addition, it is recommended consideration be given to cropping patterns and crop rotation cycles, with attention to the specific topography, hydrology, and soil characteristics of each farm. The cost of these measures varies and depends upon the details of the recommended farm conservation plans. The costs may be expected to be incurred to a large extent for purposes of agricultural land erosion control in any case.

As discussed in Chapter II, there are only very limited agricultural lands which contribute runoff to Whitewater and Rice Lakes. However, given the need for groundwater protection, it is recommended that farm conservation plans directed toward both surface water runoff control and groundwater protection be prepared for the farmlands in the drainage area.

Onsite Sewage Disposal System Management

As reported in Chapter IV, onsite sewage disposal systems are estimated to contribute about 19 percent of the total phosphorus loading to Whitewater Lake. In addition to lake water quality considerations, onsite sewage disposal system operation in the drainage area have implications for groundwater quality and property values. Thus, the proper management of onsite sewage disposal systems is important to the entire area and not just for those subareas where groundwater flow is toward the Lakes.

In the regional water quality management plan the concentrations of urban development located around the shorelines of Whitewater and Rice Lakes were not included within recommended public sanitary sewer service areas. Information available at that time did not indicate a need to provide centralized sanitary sewer service to those lake communities. Thus, the areawide water quality management plan as currently adopted recommends that sewage disposal needs in the two lake communities concerned be provided through onsite sewage disposal systems. The regional plan, however, also recommends that sewage disposal needs in these communities be periodically reevaluated in light of changing conditions.

The nearest existing public sanitary sewerage system to the Whitewater and Rice Lakes area is the City of Whitewater system, located about five miles to the north. Given that it is unlikely that a new public sewage treatment plant to serve the Whitewater and Rice Lakes area would be cost-effective, connection to the City of Whitewater sewerage

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[2] *Wisconsin League of Municipalities and Wisconsin Department of Natural Resources, Wisconsin Construction Site Best Management Practices Handbook, 1989.*

system would be the alternative most likely to be viable if there was an identified need to provide a public sewer system to serve the urban development in the drainage area tributary to Whitewater and Rice Lakes. The available information, however, indicates that a need for the installation of a public sanitary sewerage system to serve the lake communities is not required at this time. Thus, for the present time, continued use of onsite wastewater disposal systems is considered as the most viable alternative for the treatment and disposal of sanitary wastes. Given this conclusion, it is recommended that the Whitewater-Rice Lakes Management District work cooperatively with the Walworth County Planning, Zoning, Sanitation, and Solid Waste Management Department to develop an onsite sewage disposal system management program. The basic objective of such a program is to ensure the proper operation and maintenance of existing onsite sewage disposal systems, and the proper installation of any new systems that may be required to serve urban development in the area tributary to Whitewater and Rice Lakes.

An onsite sewage disposal system management program could potentially include the establishment of a Sanitary District to administer funds; inspect, design, and construct upgraded systems; ensure proper operation and maintenance of the systems; and monitor the performance of systems. In this regard, however, it is recommended that the Lake Management District assume the lead in providing the public informational and educational programs, working cooperatively with the Walworth County Planning, Zoning, Sanitation, and Solid Waste Management Department, who will retain primary responsibility for the management program, to encourage property owners to have the existing onsite systems inspected and any needed remediation measures undertaken. Homeowners should be advised of the rules and regulations governing, and the limitation of, onsite sewage disposal systems, and should be encouraged to undertake preventive maintenance programs. The purpose of the recommended inspection program would be to identify any malfunctioning sewage disposal systems. Ideally, each system would be inspected once every three years and, accordingly, about one-fifth of all such systems would be inspected annually, unless more frequent inspections are required by Walworth County for systems installed after 1983. A secondary benefit of an inspection program would be the knowledge system owners would gain from the periodic inspection of these systems and identification of any shortcomings.

IN-LAKE MANAGEMENT MEASURES

The recommended in-lake management measures for Whitewater and Rice Lakes are summarized in Table 35 and are graphically summarized on Maps 24 and 25. The major plan elements include water quality monitoring, aquatic plant management, fishery management, habitat protection, recreational use zoning, and public informational and educational programs.

Water Quality Monitoring

Continued water quality monitoring of Whitewater and Rice Lakes is recommended. Continued enrollment of one or more Lake Management District residents as Wisconsin Department of Natural Resources Self-Help Monitoring Program volunteers is recommended. Such enrollment can be accomplished through the Southeast District Office of the Department at no cost to the Lake Management District. A firm commitment of time is required of the volunteers. In addition, participation in the trophic status index (TSI) self-help monitoring program, measuring nutrients, chlorophyll-a, and temperature, is recommended. Such monitoring should be conducted in at least one location on each Lake and at least five times per year.

Aquatic Plant Monitoring and Management

An aquatic macrophyte control plan consistent with Chapters NR 103 and NR 107 of the Wisconsin Administrative Code is included in Appendix C of this report. The plan recommends that continued aquatic macrophyte surveys be conducted at three- to five-year intervals, depending upon the observed degree of change in the aquatic plant communities. In addition, information on the aquatic plant control program should be recorded and should include descriptions of:

1. Major areas of nuisance plant growth;
2. Areas harvested and/or chemically treated;
3. Species harvested and amounts of plant material removed from lake; and

4. Species and approximate numbers of fish caught in the harvest.

A daily harvester log, containing this information, should be maintained as set out in the aquatic plant management plan. This information, in conjunction with the conduct of the recommended aquatic macrophyte surveys, will allow evaluation of the effectiveness of the aquatic plant control program and allow adjustments to be made in the program to maximize its benefit.

It is also recommended that the Management District develop a demonstration program for monitoring the aquatic plant growth and sediment depths in carefully selected areas with differing aquatic plant management programs. The purpose of this demonstration project would be to determine over time the impacts—both positive and negative—of the different management measures, including: 1) harvesting only, 2) chemical treatments only, and 3) chemical treatment and harvesting. Such a demonstration program could be developed by the Lake Management District in cooperation with the University of Wisconsin-Whitewater.

Modifications of the existing aquatic plant management activities are recommended to enhance the use of the Lakes while maintaining the quality and diversity of the biological communities. The following guidelines are recommended:

1. Mechanical harvesting is recommended as the primary management method. As discussed in Chapter VII, this will, in the long-term, improve water quality conditions by removing materials which are currently contributing to an accumulation of decomposing vegetation and the associated nutrient recycling.

2. Shared-access lanes should be harvested rather than clear-cutting large open areas to minimize the potential detrimental effects on the fish and invertebrate communities. Directing boat traffic through these common lanes should delay the regrowth of vegetation in these areas.

3. Surface harvesting is recommended, cutting to a depth of approximately two-feet deep, nonnative aquatic plants, such as Eurasian water milfoil, should provide a competitive advantage to the low-growing native plants present in the Lakes. By not disturbing these low-growing species, the resuspension of sediments in Whitewater and Rice Lakes will be minimized.

4. Mechanical harvesting should not be conducted between piers of adjacent riparian owners at the discretion of the District only where feasible without causing damage to property or disturbing the lake substrate.

5. Chemical herbicide use should be strictly limited to the absolute minimum required to control nuisance growth of nuisance species, such as Eurasian water milfoil. Only herbicides that selectively control nuisance species, such as 2,4-D, should be used.

6. Chemical herbicide use should be restricted to those areas of nuisance aquatic macrophyte growth in shallow water within 50 feet of docks and other areas where mechanical harvesting is not feasible.

7. Chemical application, if required, should occur in early summer followed by mechanical harvesting after macrophytes have become reestablished.

8. Use of algicides, such as Cutrine Plus, are not recommended unless there is a significant filamentous or planktonic algae problems in the Lakes. Valuable macroscopic algae, such as Chara and Nitella, can be killed by this chemical.

The recommended plan partitions both Whitewater and Rice Lakes into zones, for aquatic plant management, with control measures in each zone designed to optimize desired recreational opportunities and to protect the aquatic resources. The recommended aquatic plant control zones are shown on Maps 24 and 25 and the controls recommended for each zone are described in Table 37.

In order to implement the recommended aquatic plant management program the following management actions are recommended:

Table 37

RECOMMENDED AQUATIC PLANT MANAGEMENT TREATMENTS FOR WHITEWATER AND RICE LAKES

Zone and Priority	Recommended Aquatic Plant Management Treatment	
	Whitewater Lake	Rice Lake
Zone B (Boating) Moderate-Priority Harvesting	Harvesting limited to maintaining 15-feet-wide navigational channels along the perimeter of the Lake, and 30-foot-wide shared access lanes perpendicular to the shoreline extending towards the center of the Lake to allow boat access to the open water area of the Lake Limited late season harvesting—late August to early September—may be necessary to maintain adequate open water areas in the central portion of the Lake Total area harvested on the Lake would be approximately 40 acres	Not applicable
Zone F (Fishing) Low-Priority Harvesting	Zone F is intended to accommodate fishing from a boat It is recommended that approximately 15-foot-wide channels be harvested perpendicular to the shore at about 100-foot intervals Total area recommended to be harvested approximates 15 acres Chemical use, if required, should be restricted to selective control of nuisance species near the public access	Zone F is intended to accommodate fishing from a boat It is recommended that approximately 15-foot-wide channels be harvested perpendicular to the shore at about 100-foot intervals Total area recommended to be harvested approximates 10 acres Chemical use, if required, should be restricted to selective control of nuisance species near the public access
Zone H (Habitat) No Harvesting	It is recommended that selected areas of the Lake be preserved as high-quality habitat area This zone and adjacent lands should be managed for fish habitat No harvesting or in-lake chemical application should be permitted, except in special instances where selective herbicide application may be allowed for the control of nuisance species Debris and litter cleanup would be needed in some adjacent areas; the immediate shoreline should be preserved in natural, open use to the extent possible This zone totals about 15 acres in areal extent	It is recommended that selected areas of the Lake be preserved as high-quality habitat area This zone and adjacent lands should be managed for fish habitat No harvesting or in-lake chemical application should be permitted, except in special instances where selective herbicide application may be allowed for the control of nuisance species Debris and litter cleanup would be needed in some adjacent areas; the immediate shoreline should be preserved in natural, open use to the extent possible This zone totals about one acre in areal extent

Table 37 (continued)

Zone and Priority	Recommended Aquatic Plant Management Treatment: Whitewater Lake	Recommended Aquatic Plant Management Treatment: Rice Lake
Zone O (Open Water) Moderate-Priority Harvesting[a]	This zone should supplement those areas designate specifically for fishing Harvesting should be conducted in selected areas of the deeper water to provide a larger shared space for boating and fishing Navigation channels approximately 30 feet in width, should be harvested The total area to be harvested approximates 15 acres	This zone should supplement those areas designate specifically for fishing Harvesting should be conducted in selected areas of the deeper water to provide a larger shared space for boating and fishing Navigation channels approximately 30 feet in width, should be harvested The total area to be harvested approximates six acres
Zone R (Riparian Access) High-Priority Harvesting	The entire area may not require intensive plant management Nuisance aquatic macrophyte growth within 150 feet of shoreline should be harvested to provide maximum opportunities for boating, fishing, and limited swimming Areas between piers should not be harvested due to potential liability and maneuverability problems. Residents are encouraged to manually harvest aquatic plants in these areas	The entire area may not require intensive plant management Nuisance aquatic macrophyte growth within 150 feet of shoreline should be harvested to provide maximum opportunities for boating, fishing, and limited swimming Areas between piers should not be harvested due to potential liability and maneuverability problems. Residents are encouraged to manually harvest aquatic plants in these areas
	Additional 30-foot-wide shared access channels should be harvested to extend to the center of the Lake Harvesting should be concentrated in areas of abundant macrophyte growth Patterns of harvesting will vary yearly dependant on macrophyte abundance Chemical use, if required, should be restricted to pier and dock areas and should not extend more than 100 feet from shore—subject to permit requirements The total area to be harvested approximates 20 acres	Additional 30-foot-wide shared access channels should be harvested to extend to the center of the Lake Harvesting should be concentrated in areas of abundant macrophyte growth Patterns of harvesting will vary yearly dependant on macrophyte abundance Chemical use, if required, should be restricted to pier and dock areas and should not extend more than 100 feet from shore—subject to permit requirements The total area to be harvested approximates four acres
Approximate Total Area to Be Harvested	105 acres	22 acres

[a]*Excludes areas greater than 15 feet which require no harvesting.*

Source: SEWRPC.

1. The continued operation by the Lake Management District of the existing harvester and transport equipment. This equipment would be operated primarily on Whitewater Lake. This will require the replacement of the drive motor for this transporter barge, which has been found to be impractical to repair.

2. The purchase and operation by the Lake Management District of a second harvester—an Aquarius System HM-420 model or equivalent—and a compatible trailer and shore conveyor. This additional equipment would be operable on Rice Lake with use on Whitewater Lake during peak-demand periods, in addition to being used to pick up floating vegetation.

3. The purchase and operation by the Lake Management District of a custom-built, barge-type boat designed to allow for temporary storage of aquatic plants, and for shallow water operation and shoreline cleanup. This boat would be operated by a cleanup crew, composed of two to three people, to work in conjunction with the mechanical harvesting operation to remove floating vegetation. The crew could work part-time operating the shore barge and part-time working the second harvester depending on the needs at any given time.

4. The possible removal of some of the unattached vegetated floating mats, by the Lake Management District on a contractual basis, as such mats can become a significant impediment to navigation and a safety hazard. It is also recommended that the Lake Management District explore the possibility of a cooperative study with the University of Wisconsin-Whitewater on the composition, source, and ecological significance of the vegetated floating mats—and of practical means of control—as little information about these mats is currently available.

5. The application of aquatic herbicides should be restricted to the control of nuisance plant species at the public boat launch area, and around docks and piers unless otherwise authorized under Wisconsin Department of Natural Resources permits. Treated areas should be delineated for future reference and the amounts of herbicide used in each area carefully documented on maps provided by the Lake Management District.

6. The control of rooted vegetation between adjacent piers in areas less than five feet depth is recommended to be left to the riparian owners concerned, as it is time consuming and costly for the mechanical harvester to maneuver between the piers and boats and such maneuvering may entail liability for damage to boats and piers. It is recommended that the Lake Management District obtain informational brochures regarding shoreline maintenance and distribute these to the residents. In addition, the Lake Management District should consider purchasing several specialty rakes designed for the removal of vegetation from shoreline property and make these available to riparian owners. This would allow the riparian owners to use the rakes on a trial basis before purchasing their own. The rakes cost approximately $90 each, and do not require a permit for use.

7. The incorporation by the Lake Management District into an overall public educational program of information on the types of aquatic plants in the Whitewater and Rice Lakes and the value of and impacts of these plants on water quality, fish, and on wildlife; and alternative methods for controlling existing nuisance plants including the positive and negative aspects of each method. An organized aquatic plant identification day is one method of providing effective education to lake residents. Other sources of information and technical assistance include the Wisconsin Department of Natural Resources Aquatic Plant Monitoring Program and the University of Wisconsin-Extension service. The aquatic plant species list provided in Chapter V, and the illustrations provided in Appendix C, may assist individuals interested in identifying plants near their residences. Residents should be

encouraged to observe and document changes in the abundance and types of aquatic plants in their part of the Lake on an annual basis.

The recommended aquatic plant management plan represents an expansion of the ongoing aquatic plant management activities conducted by the Whitewater and Rice Lakes Management District. Implementation of this plan would entail a capital cost of approximately $112,500, and an annual operation and maintenance cost of about $60,200.[3] These costs are displayed in Table 38 and discussed in further detail in Appendix C.

<u>Boating Access</u>

The use of dredging is recommended to be conducted only on a very limited as needed basis for small-scale projects which riparians or public access boating is inadequate. The associated environmental impacts of each of these small-scale projects should be identified and evaluated for severity on a case-by-case basis.

<u>Groundwater Management</u>

Most of the groundwater recharge and discharge areas associated with Whitewater and Rice Lakes are located in the Regional Planning Commission-identified primary environmental corridors. These areas are recommended to remain in essentially natural, open use. It is also recommended that the District closely monitor any proposals that have the potential to draw significant quantities of water from the groundwater aquifer as groundwater is the dominant source of water for Whitewater Lake, accounting for 57 percent of the inflow budget. Accordingly, significant variations in the groundwater level could potentially lead to fluctuating lake levels.

<u>Fish Monitoring and Management</u>

The aquatic plant management strategy set forth above recognizes the importance of fishing as a recreational use of Whitewater and Rice Lakes. Integral to the aquatic plant management strategy is the protection and preservation of fish breeding habitat.

Two specific actions by the Lake Management District are recommended with respect to fisheries management: conduct of a fishery survey and assessment of angling pressures. The fishery survey should be conducted by the Wisconsin Department of Natural Resources at the request of the Lake Management District, and would have several objectives:

1. To identify any changes in fish species composition—including an assessment of carp population—that may have taken place in the Lakes since the previous fishery survey conducted in 1993;

2. To relate any changes in fish populations, species composition, and condition factors to such known interventions as stocking programs, water pollution control activities, and aquatic plant management programs;

3. To refine and update information on fish breeding areas, breeding success, and survival rates.

The second action relative to a fishery management program is the assessment of angling pressures on the Lakes. This program would:

1. Provide information on the survival of walleyed and northern pike currently stocked into Whitewater and Rice Lakes;

2. Provide data to determine the intensity of public use of the Whitewater and Rice Lakes fisheries through creel surveys, citizen reporting activities, and evaluation of the fishery survey data.

<u>Habitat Protection</u>

Habitat protection measures recommended for Whitewater and Rice Lakes are, in part, provided for by the recommended aquatic plant management program activities. The aquatic plant management plan is designed to provide for such habitat protection measures, as being aware of fish breeding areas and avoiding disturbances in these areas during spring and autumn; reducing the use of aquatic plant herbicides in these areas; and maintaining stands of existing native aquatic plants.

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[3]*This estimate does not take into account equipment depreciation.*

In addition, it is recommended that environmentally sensitive lands, including wetlands along the southern shore of Whitewater Lake be preserved and protected. In particular, this recommendation also extends to the maintenance of the floating islands located in the eastern and southern lobes of the Whitewater Lake basin, within the habitat areas, Zone H, as shown on Map 24. It is recommended that the island shorelines be stabilized with native aquatic plants so as to enhance the available habitat, and "Slow-No-Wake" restrictions imposed in their vicinities to minimize further erosion of their shorelines, as set forth below.

At this time, the accumulation of silt in the marginal areas of the lake has caused concern among lakeshore residents. The silt accumulates above the sand and gravel areas preferred for game fish spawning and can cause mortality of fish larvae by suffocation and burial. The use of natural shoreland stabilization practices such as vegetation, or the use of rock riprap, can mitigate the effects of shoreline erosion and should stabilize breeding habitat. In addition, the vegetation, itself, provides shelter for juvenile fishes and spawning substrate for fishes that deposit their eggs on plant material. Additional measures—such as placement of spawning cribs or similar artificial breeding substrate—do not appear to be warranted at present, but may be employed in the future after shorelines have been stabilized with natural vegetation, and as indicated by the results of the fish survey recommended to be conducted by the Wisconsin Department of Natural Resources.

Recreational Use Zoning

The principle actions required in terms of this task would include the imposition by the Lake Management District of "Slow-No-Wake" restrictions on those portions of the Lakes bordering sensitive areas and where boating activities could be expected to come into conflict with other uses such as angling in Zone F, swimming in Zone R, and habitat areas in Zone H. The boating regulation ordinance adopted by the Towns of Richmond and Whitewater forms the legal basis necessary to carry out this action; this ordinance is included as Appendix D.

Shoreline Protection

Most of the Whitewater and Rice Lakes shorelines was found to be in stable condition with areas of erosion identified at isolated locations along the shores. Various possible protection options have been outlined in Chapter VII to be considered to repair or replace existing protection structures. Adoption of the vegetated buffer strip method is recommended along the island shorelines and throughout the drainage area in order to maintain habitat value and the natural ambience of the lakeshore. Continued maintenance of existing revetments and bulkheads is also recommended.

PUBLIC INFORMATIONAL AND EDUCATIONAL PROGRAMS

It is recommended that the Lake Management District assume the lead in the development of a public informational and educational program dealing with various lake management-related topics including, onsite sewage disposal system management, water quality management, land management, groundwater protection, aquatic plant management, fishery management, and recreational use. The District newsletter can provide an medium for the conduct of such a program.

Educational and informational brochures and pamphlets, of interest to homeowners and supportive of the recreational use and shoreland zoning regulations, are available from the Wisconsin Department of Natural Resources and the University of Wisconsin-Extension. These cover topics such as beneficial lawn care practices and household chemical use. Such brochures should be provided to homeowners through local media, direct distribution or targeted library and civic center displays. Such distribution can also be integrated into ongoing, larger-scale activities, such as lakeside litter collections, which can reinforce anti-littering campaigns, recycling drives, and similar environmental protection activities.

PLAN IMPLEMENTATION AND COSTS

The actions recommended in this plan largely represent an extension of ongoing actions being carried out by the Towns of Whitewater and Richmond, Walworth County, and the Whitewater-Rice Lakes Management District. The recommended plan introduces few new elements, although some of the

Table 38

ESTIMATED COSTS OF RECOMMENDED LAKE MANAGEMENT MEASURES FOR WHITEWATER AND RICE LAKES

Plan Element	Subelement	Estimated Cost 1995-2010[a]		Potential Funding Sources[b]
		Capital	Average Annual Expenditure	
Land Use Management	Development planning	- -[c]	- -[c]	DNR
	Density management	- -[c]	- -[c]	DNR
Watershed Land Management	Construction site erosion control	- -[d]	- -[d]	Private firms, individuals
	Urban nonpoint source control	- -[e]	- -[e]	- -
	Rural nonpoint source controls	- -[f]	- -[f]	- -
	Onsite sewage disposal systems management	- -[g]	- -[g]	- -
Water Quality Management	Water quality monitoring	- -	- -[h]	DNR
Aquatic Plant Management	Aquatic plant surveys	- -	\$ 1,000[i]	DNR, USGS
	Major/minor channel harvesting	\$ 95,000[j,k]	\$45,000	DNR (Waterways Commission)
	Chemical treatment	- -	\$ 5,000	- -
Fish Management	Fish survey	\$ 16,000	- -	DNR
	Fish stocking	- -	\$ 3,000	DNR
Habitat Protection and Lake Use Management	Restrict boating	\$ 1,500	\$ 200	DNR
	Restrict harvesting	- -	- -	- -
	Restrict chemical treatments	- -	- -	- -
Shoreland Protection	Maintain structures	- -	- -	Residents
	Install erosion protection	- -[l]	- -	- -
Informational and Educational Program	Public informational and educational programming	- -	\$ 1,500[m]	UWEX, DNR
Miscellaneous	General administrative costs	- -	\$ 4,500	- -
Total	- -	\$112,500[n]	\$60,200[n]	- -

Table 38 Footnotes

[a]*All costs expressed in June 1995 dollars.*

[b]*Unless otherwise specified, DNR is the Wisconsin Department of Natural Resources, County is Walworth County, and District is the Whitewater-Rice Lakes Management District. UWEX is the University of Wisconsin Extension.*

[c]*Cost-share assistance may be available for ordinance review, revision, and writing under the NR 191 Lake Protection Grant Program.*

[d]*Cost varies with amount of land under development in any given year.*

[e]*Measures recommended generally involve low or no cost and would be borne by private property owners. cost is included under public informational and educational component.*

[f]*Costs vary and will depend upon preparation of individual farm plans.*

[g]*Cost will depend upon needs identified by homeowner inspection. Cost for District included under public informational and educational component.*

[h]*The DNR Self-Help Monitoring Program involves no cost but does entail a time commitment from the volunteer.*

[i]*This cost is based upon surveys conducted at about five-year intervals at $3,000 to $4,000 per survey. This cost could be reduced or eliminated if the District joined the Self-Help Aquatic Plant Monitoring Program in which volunteers are trained to complete aquatic plant surveys on their lake.*

[j]*Figures are based on the assumption that a new harvester and ancillary equipment will be purchased; cost-share assistance for harvester purchase may be available from the Wisconsin Waterways Commission Recreational Boating Facilities Grant Program.*

[k]*Does not include depreciation of equipment.*

[l]*Cost will vary according to project size and type of control used.*

[m]*Expenditures used for compiling and distributing newsletters and other public informational and educational materials..*

[n]*The total annual cost of capital and operation and maintenance is estimated to be $75,800, assuming an 8 percent interest rate and a five-year payment period for capital cost. The total annual cost of capital and operation and maintenance would be $68,000, assuming a 50 percent cost share is available for capital costs.*

Source: SEWRPC.

plan recommendations represent expansions of current programs. This is particularly true in the case of the aquatic plant management program, where additional measures are recommended.

Generally, fisheries and aquatic plant management practices such as stocking, harvesting, and public information awareness campaigns currently implemented by the Lakes Management District are recommended to be continued with the refinements proposed herein. Some aspects of these programs lend themselves to citizen involvement through volunteer-based creel surveys, participation in the Wisconsin Department of Natural Resources Self-Help Monitoring Program, and identification with environmentally sound owner-based land management activities. It is recommended that the Lakes Management District assume the lead in the promotion of these citizen actions, with a view toward building community commitment and involvement. Assistance is generally available toward this end from agencies such as the Wisconsin Department of Natural Resources, and the University of Wisconsin-Extension.

The major cost relating to new elements herein recommended relates to the purchase of new equipment to implement changes in the aquatic plant harvesting program. Implementation of the recommended plan would entail a capital expenditure of about $112,500 and an annual operation and maintenance expenditure of about $60,000, including existing expenditures, as shown in Table 38, over the next few years. The Lakes current budget for annual operation and maintenance is approximately 60,000. Some of the capital costs could be met with grants from the Wisconsin Waterways Commission under Chapters NR 103 and NR 107 of the Wisconsin Administrative Code.

The suggested lead agency or agencies for initiating program-related activities, by plan element, are set forth in Table 36 and the estimated costs of these elements, linked to possible funding sources where such are available, are summarized in Table 38.

Chapter IX

SUMMARY

The management plan for Whitewater and Rice Lakes as herein described was prepared by the Southeastern Wisconsin Regional Planning Commission in cooperation with the Whitewater and Rice Lakes Management District, the Wisconsin Department of Natural Resources, and the U.S. Geological Survey. Inventories and analyses were conducted of the existing and recommended future land use patterns within the watershed of the Lakes, the associated pollutant loadings and sources, the physiography and natural resource base of the watershed, the recreational uses of the Lakes, and the management practices employed both on the Lakes and in their watershed. In addition, the planning effort also included the results of an aquatic plant survey conducted as part of this study for the Lakes, and analysis of the results from previously conducted water quality sampling programs. Field studies associated with these activities were conducted between 1987 through 1994 by the Wisconsin Department of Natural Resources, during 1990 and 1991 by the U.S. Geological Survey, and during 1995 by Commission staff.

The primary management objectives for Whitewater and Rice Lakes include: 1) to contribute to the overall conservation and wise use of Whitewater and Rice Lakes through environmentally sound management of vegetation, fish, and wildlife in and around the Lakes; 2) to provide the potential for high-quality, water-based recreational experiences by residents and visitors to Whitewater and Rice Lakes; and 3) to effectively control the quantity and density of aquatic plant growth in portions of the Whitewater and Rice Lakes basin to better facilitate the conduct of water-related recreation, to improve the aesthetic value of the resource to the communities, and to enhance the resource value of the waterbody. This plan is intended to serve as a practical guide to achieving these objectives over time in a technically sound manner.

Whitewater Lake is a 697-acre impoundment located in the Towns of Whitewater and Richmond in Walworth County. Rice Lake, immediately downstream of Whitewater Lake, is a 162-acre drainage lake located entirely in the Town of Whitewater. Whitewater Lake, as it now exists, was created by the construction of a dam on the site of a chain of three smaller lakes in 1947. Rice Lake was created in 1954 by constructing a dam across Whitewater Creek. The deepest area of Whitewater Lake—approximately 40 feet—is located in the main, or central, basin while the northern basin has a maximum depth of about 13 feet, and the southern basin has a maximum depth of about seven feet. Rice Lake, generally oval in shape, has a maximum depth of about 11 feet.

The tributary drainage areas of Whitewater and Rice Lakes are 7.2 and 7.8 square miles in size, respectively, with Whitewater Lake draining to Rice Lake. However, no discharge was observed over the outlet dam of Whitewater Lake during the period of November 15, 1990 through November 14, 1991—the study period for the hydrologic and water quality study conducted on the Lakes by the U.S. Geological Survey. Limited discharges have been observed subsequent to that study period. This, in effect, limits the tributary area of Rice Lake to about a 350-acre drainage area most of the time. In addition, due to the rough topography and soils in the area, the tributary drainage areas of Whitewater and Rice Lakes normally consist of about 1.4 square miles and 0.3 square mile of land surface, respectively, actually contributing nutrients and pollutant to the Lakes. Thus, only about 1.7 square miles of the total 7.8 square mile drainage area generally considered as the tributary watershed of the Lakes, normally contribute surface runoff to the Lakes.

Whitewater and Rice Lakes are both enriched hard-water, alkaline lakes that have water quality characteristics associated with high nutrient loadings. Physical and chemical parameters measured during the 1990-1991 study period indicated that the water quality is within the "fair-to-poor" range. Total phosphorus levels were found to be above the level considered to cause nuisance algal and aquatic plant growths. During the summer stratification of Whitewater Lake, the water below a depth of 15 feet was found to be devoid of oxygen, while the upper waters remained well oxygenated and supported a healthy fish population. Winterkill was not found to be a problem in Whitewater and Rice Lakes, with dissolved oxygen levels being adequate for the support of fish throughout the winter.

INVENTORY AND ANALYSIS FINDINGS

Population

- The resident population of the drainage area tributary to Whitewater and Rice Lakes increased steadily between 1963 and 1980, and then remained relatively stable through 1990. The 1990 resident population of the Whitewater and Rice Lakes drainage area of approximately 950 persons, was about three-fold the estimated 1963 population of about 340 persons. In 1990, there also were about 680 persons occupying part-time or seasonal residences in the tributary drainage area.

- Population forecasts prepared by the Regional Planning Commission, on the basis of a normative regional land use plan, indicate that the population of the drainage area tributary to Whitewater and Rice Lakes may be expected to remain relatively stable, with a small increase to about 1,000 persons by the year 2010.

Land Use

- Urban land uses in 1990 occupied about 760 acres, or about 14 percent of the drainage area tributary to Whitewater and Rice Lakes. The dominant urban land use was residential, encompassing 416 acres, or about 54 percent of the area in urban use.

- As of 1990, about 4,700 acres, or about 86 percent of the drainage area tributary to Whitewater and Rice Lakes, were still in rural land uses. About 1,915 acres, or about 41 percent of the rural area, were in agricultural land uses. Woodlands, wetlands, and surface water, including the surface area of Whitewater and Rice Lakes, accounted for approximately 2,505 acres, or 53 percent of the area in rural use.

Water Budget

- During the period from November 15, 1990, through November 14, 1991, an estimated 7,051 acre-feet and 499 acre-feet of water entered Whitewater and Rice Lakes, respectively. Estimated stream inflow volumes ranged from approximately 1,050 acre-feet for Whitewater Lake to no inflow for Rice Lake. The remainder of the lake inflow came from surface runoff draining directly to the Lakes, direct precipitation on the Lakes and groundwater.

- An estimated 7,050 acre-feet, and 440 acre-feet, of water per year was lost from Whitewater and Rice Lakes, respectively, via groundwater flows and evaporation from the Lakes surfaces during the study period.

Water Quality

- Water quality data collected during the November 15, 1990, through November 14, 1991, study period indicate that the range of values for specific conductance, chloride, and alkalinity and hardness all fall within the normal range of lakes in Southeastern Wisconsin.

- Physical and chemical parameters measured on Whitewater Lake during the 1987 through 1994 study period indicated that the water quality is considered poor to fair based upon the phosphorus and water clarity readings, and poor based upon chlorophyll concentrations compared to other lakes in Southeastern Wisconsin. Parameters measured on Rice Lake during the 1990-1991 study period indicated that the water quality is considered poor based upon chlorophyll concentrations, phosphorus, and water clarity readings. Both Lakes are considered to be eutrophic.

Phosphorus Loads

- About 560 pounds and 60 pounds of phosphorus, respectively, is estimated to enter Whitewater and Rice Lakes annually, with direct drainage shoreland areas as the major source, contributing 42 and 59 percent of the loading, respectively; followed by onsite sewage disposal systems on Whitewater Lake at 19 percent and precipitation on Rice Lake at 38 percent.

- About 582 pounds and 295 pounds of phosphorus, respectively, is estimated to be added to the water column of Whitewater and Rice Lakes annually as a result of internal loading from the lake sediments during periods of stratification.

- Of the total phosphorus loading—calculated as the combined internal and external nutrient loads—to Whitewater and Rice Lakes, approximately 77 percent of the total phosphorus, or about 882 pounds, and 85 percent, or about 305 pounds, respectively, was estimated to be used in the process of aquatic biomass growth annually within the Lakes or deposited in sediments. The remainder of the annual phosphorus load was retained within the Lakes as dissolved phosphorus in the water column or lost from the system through groundwater outflow.

Natural Resource Base

- In 1990, high-value wildlife habitat, as shown on Map 20, covered approximately 1,855 acres, or about 37 percent of the drainage area tributary to Whitewater and Rice Lakes.

- In 1990, wetlands areas, as shown on Map 21, covered about 110 acres, or about 2 percent of the drainage area tributary to Whitewater and Rice Lakes.

- Primary environmental corridors, as shown on Map 22, covered about 1,498 acres, or about 30 percent of the drainage area to Whitewater and Rice Lakes. Such corridors also encompass the Lakes surfaces. These corridor areas include almost all the remaining high-value woodlands, wetlands, and wildlife habitat areas in and around Whitewater and Rice Lakes.

- Environmentally valuable areas within Whitewater and Rice Lakes provide aquatic habitat used for shelter, spawning, and feeding by aquatic animals and include lake bottom and shoreline areas adjacent to wetlands and, in the case of Whitewater Lake, the three islands in the northeastern basin, the island in the western main basin, and the island in the southern basin and surrounding waters.

Recreational Use

- Rice Lake is surrounded by the Kettle Moraine State Forest lands on the northern and eastern shorelines in which a boat launch and picnic area are incorporated within the Whitewater Lake Recreation Area. Whitewater Lake lies adjacent to the Kettle Moraine State Forest on the western shore of the upper basin which also incorporates a boat launch and a picnic area in addition to a beach area. The southwestern tip of Whitewater Lake is adjacent to Walworth County parkland which offers picnicking areas and hiking trails.

- Water-based outdoor recreational activities on Whitewater and Rice Lakes include boating, fishing, swimming, and other active and passive recreational pursuits. Because of its size, Whitewater Lake receives a significant amount of powerboat and sailboat use.

- In a recreational rating technique developed by the Wisconsin Department of Natural Resources to characterize the recreational value of inland lakes, Whitewater Lake received 47 out of a possible 72 points, and Rice Lake received 43, indicating that moderately diverse recreational opportunities are provided by the Lakes.

ALTERNATIVE LAKE MANAGEMENT MEASURES

Alternative management techniques, including watershed, lake rehabilitation, and in-lake measures, were evaluated based on effectiveness, cost, and technical feasibility. Those alternative measures eliminated from further consideration, after careful evaluation, included: dilution and flushing, nutrient inactivation, aeration, nutrient load reduction, and drawdown. The alternative measures which were incorporated into the recommended plan are described below.

THE RECOMMENDED PLAN

Analyses of water quality and biological conditions indicate that the general water quality conditions of Whitewater and Rice Lakes may be considered to range from fair to poor. Water-based recreational uses are limited by nuisance growths of aquatic macrophytes and in some areas by sediment deposition. Major in-lake water quality-related measures are recommended for the Lakes to meet the full aquatic resource and recreation uses. In addition to in-lake management measures, the recommended plan also sets forth recommendations for land use control and land management measures in the drainage area tributary to the Lakes.

The recommended Whitewater and Rice Lakes management measures are graphically summarized on Maps 24 and 25 and are listed in Table 35. Those measures include:

For protection of the natural resource base:

1. Monitoring and participation in the application process for changes in county and local zoning in order to continue to preserve and enhance the existing natural resource base of the drainage areas tributary to Whitewater and Rice Lakes, and to maintain the historic low- and medium-density shoreline development in Whitewater and Rice Lakes.

2. The preservation, protection, and enhancement in essentially natural open uses of all lands designated as primary environmental corridors. Preservation and protection of these areas would serve to not only reduce nonpoint source pollutant loadings to the Lakes, but also to maintain good quality groundwater inflow to the Lakes.

3. The development of a public educational program presenting information on the groundwater resources of the area and on the measures, such as onsite sewage disposal system management and waste disposal, required to protect these resources.

For the protection and maintenance of water quality conditions:

1. Continued implementation of the nonpoint source controls recommended in the regional water quality management plan.

2. For rural areas, the implementation of land management measures. Such measures should be more specifically defined and implemented through the preparation of detailed farm conservation plans. It is recommended that such plans be prepared for farms occupying a total of about 1,600 acres of rural land. Practices which are considered most applicable in the Whitewater and Rice Lakes area include conservation tillage and pasture management. In addition, it is recommended consideration be given to cropping patterns and crop rotation cycles, with attention to the specific hydrology and soil characteristics of each farm.

3. For urban areas, the adoption and implementation of good urban land management and urban housekeeping practices such as limiting use of fertilizers and pesticides, controlling litter and pet waste, and managing leaf and yard waste. In this regard, it is recommended that the Whitewater and Rice Lakes Management District utilize its newsletter to distribute fact sheets for residents describing specific residential land management practices that would be beneficial to the water quality of Whitewater and Rice Lakes.

4. Continued enrollment by lake residents in the Wisconsin Department of Natural Resources Self-Help Monitoring Program and participation in the expanded program offered by the Department.

5. The continued enforcement by the local units of government concerned of construction site erosion control ordinances in the entire tributary drainage area to the Lakes.

6. The development of an onsite sewage disposal system management program which could potentially include the establishment of a sanitary district to administer funds; inspect, design, and construct upgraded systems; ensure proper operation and maintenance of the systems; and monitor the performance of systems.

For the enhancement of recreational opportunities:

1. Adoption and maintenance of the modified aquatic plant management plan provided in Appendix C of this plan. Adoption of this plan would entail modification of the existing aquatic plant management practices by specifying mechanical harvesting as the primary management method; limiting the use of herbicides to the control of nonnative plants such as Eurasian water milfoil; and restricting herbicide use to shallow water areas near docks and areas where harvesting is not feasible. Chemical application, if required in selected areas, should occur in early summer followed by mechanical harvesting after macrophytes have become reestablished. The implementation of this plan would entail the continued operation of the existing harvesting equipment in addition to the purchase and operation of a second harvester, an Aquarius System HM-420 model or equivalent, a compatible trailer and shore conveyor, and a custom-built, barge-type boat.

2. Adoption of lake use zoning is recommended, as summarized on Maps 24 and 25 and Table 37, to provide for multiple-purpose recreational use of Whitewater and Rice Lakes. Zoning is recommended to provide for boating access from the boat launching sites and riparian areas to the main lake basin, Zone R; boating access to and from the public launch sites and primary residential areas to open areas where more active recreation is better accommodated, Zone B; boating access to areas designated for fishing, Zone F; boating access to areas for deeper-water recreational activities in designated portions of the Lakes, Zone O; and habitat preservation within environmentally valuable areas, Zone H.

For the protection and enhancement of fish and other aquatic resources, including wildlife habitat, woodlands, and wetlands:

1. Conduct of a fish survey to assess changes in species composition of, and in angling-related pressures on, the fishery of the Lakes since the previous fisheries survey conducted in 1991. Such a survey would provide information needed to better manage the ongoing fish stocking program for the Lakes.

2. Exploration of the possibility of a cooperative study with the University of Wisconsin-Whitewater on the composition, source, and ecological significance of the vegetated floating mats found on Whitewater Lake and a practical means of control of these mats.

3. Continued proper maintenance of the shoreline protection structures, including the repair and/or replacement of failed structures and the erection of suitable structures along eroding shorelines.

For public information and education:

1. The continuation of the ongoing public informational and educational programs directed toward comprehensive lake management through the use of newsletters and other media.

The recommended plan is based largely on existing and ongoing lake management measures being employed by the Towns of Whitewater and Richmond and the Whitewater and Rice Lakes Management District. The Whitewater and Rice Lakes Management District is recommended to undertake the primary responsibility for implementing this plan, with assistance from the Towns and the Wisconsin Department of Natural Resources.

Implementation of the plan would entail a capital expenditure of about $112,500 over the next 20 years and an annual operations and maintenance expenditure of about $60,200, as shown in Table 38, including existing expenditures.

Whitewater and Rice Lakes are valuable natural resources in the Southeastern Wisconsin Region and a particularly valuable asset to the Towns of Whitewater and Richmond. The delicate, complex relationship between water quality conditions in Whitewater and Rice Lakes and the land uses within their tributary drainage area is likely to be subject to continuing pressures as demands for water-based recreation in the Lakes and for urban development within their watershed resulting from increases in population, income, leisure, and individual mobility for the Region. To provide the water quality protection needed to maintain in Whitewater and Rice Lakes conditions conducive to meeting such pressures, it will be necessary to adopt and administer an effective program of lake management based upon comprehensive water quality management and related plans. This plan comprises an important element of such a program and is consistent with previously adopted comprehensive land use, water quality management, recreation and open space, soil erosion control, and sanitary sewer service area plans for the Southeastern Wisconsin Region and Walworth County.

APPENDICES

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Appendix A

PUBLIC OPINION OF WATER USE AND QUALITY IN WHITEWATER AND RICE LAKES, WALWORTH COUNTY, WISCONSIN

SUMMARY OF STATISTICAL DATA AND RESULTS

I. METHODOLOGY

A. Questionnaire survey using a mail-back survey during summer 1995.

B. Analysis based upon 213 responses out of 646 possible.

II. RESPONDENT PROFILE

A. Majority of respondents (51 percent) were weekend residents; 42 percent were annual residents.

B. Majority of respondents (62 percent) had used Whitewater-Rice Lakes for more than 10 years.

C. Majority of respondents (83 percent) used the Lakes with family.

III. LAKE USE

A. Categories of Use

1. Power boating was the personally most important use (rated 1.9 on a five-point scale, where 1.0 is the most important use), closely followed by swimming and walking/jogging (both rated 2.1); picnicking and waterskiing were third (both rated 2.4). Bicycling was often mentioned.

2. Jet-skiing was the least personally most important use (rated 3.5 on a five-point scale, where 5.0 was the least important use).

B. Intensity of Use

1. Moderate (61 percent) to heavy (36 percent) use.

C. Frequency of Use

1. On an annual basis, bird watching was the most frequently engaged-in activity (averaging 120 days per year), walking/jogging was the second most frequently engaged-in activity (averaging 89 days per year).

2. During spring and summer, bird watching was the most frequently engaged-in activity (averaging 48 days), closely followed by power boating (36 days), walking/jogging (35 days), and jet-skiing (34 days).

3. During autumn and winter, bird watching was the most frequently engaged-in activity (averaging 44 days), with walking/jogging second (averaging 27 days).

4. On average, respondents spent 25 days per year fishing during open water periods, and four days ice fishing.

D. Use of Lakes

1. Use of both Lakes was generally lake-wide, although the eastern bay of Whitewater Lake seemed to be used more extensively than other sites on either Lake.

E. Levels of Satisfaction

1. Majority of respondents rated the fishing quality of the Lakes fair (29 percent) to good (22 percent); panfish (caught by 54 percent of respondents) and largemouth bass (caught by 34 percent) were the more common angling species—both species and carp were generally thought to have increased in numbers over time at the expense of other species, especially northern pike.

2. Majority of respondents (88 percent) were not dissatisfied with the general level of law enforcement on the Lakes; 44 percent were satisfied with law enforcement.

3. Majority of respondents (86 percent) were not dissatisfied with the level of land use regulation in the watershed; 43 percent were satisfied with current regulations.

IV. WATER QUALITY

A. Assessment

1. Based on water clarity, the majority of respondents (56 percent) rated the Lakes as having good water quality.

2. Based on aquatic plant growth, the majority of respondents (69 percent) rated the Lakes as having poor water quality.

3. Based on biological conditions, the majority of respondents (44 percent) rated the Lakes as having good water quality.

4. The majority of respondents (46 percent) perceived a decline in water quality over time; an equal number of respondents felt that the Lakes had stayed the same of improved.

5. Most respondents (89 percent) felt that the Lakes had excessive plant growth.

6. Respondents generally thought that game fish (northern pike and walleye) populations have decreased relative to panfish, carp, and largemouth bass populations over time.

B. Management

1. The majority of those respondents indicating excessive aquatic plant growth preferred controlling it by mechanical harvesting (48 percent) and use of chemicals (35 percent); while less than 25 percent of respondents preferred fertilizer and development controls, and dredging as alternatives.

2. Respondents were almost equally divided between those willing (45 percent) and those unwilling (49 percent) to pay more for lake-related improvements.

3. Some respondents (18.5 percent of those commenting) indicated a desire for a greater monetary contribution from the State (park) as a major riparian owner and collector of fees for lake use.

4. Some respondents (28 percent of those commenting) suggested a lake use charge, such as increased boat launch fees, as a means of raising money for lake improvements.

5. The majority of respondents (69 percent of those commenting) thought that the Lake Management District was doing a good job.

6. Some respondents (5 percent of those commenting) felt that Rice Lake should receive greater attention, generally with regard to aquatic plant management.

C. Concerns

1. The majority of respondents (77 percent) were concerned about general water quality and the number of jet-skiers (63 percent); about half (47 percent) were concerned about the use of the Lakes and access sites by nonresidents.

2. A number of respondents (7 percent of those commenting) indicated a desire to explore installation of public sanitary sewers, acquisition of sanitary district powers by the Lake Management District, and inspections of septic tanks within the District.

3. A number of respondents (10 percent of those commenting) suggested better enforcement of ordinances, especially on Whitewater Lake.

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Appendix B

NONPOINT SOURCE POLLUTION CONTROL MEASURES

Nonpoint, or diffuse, sources of water pollution include urban sources such as runoff from residential, commercial, industrial, transportation, and recreational land uses; construction activities; and onsite sewage disposal systems and rural sources such as runoff from cropland, pasture, and woodland, atmospheric contributions, and livestock wastes. These sources of pollutants discharge to surface waters by direct overland drainage, by drainage through natural channels, by drainage through engineered stormwater drainage systems, and by deep percolation into the ground and subsequent return flow to the surface waters.

A summary of the methods and estimated effectiveness of nonpoint source water pollution control measures is set forth in Table B-1. These measures have been grouped for planning purposes into two categories: basic practices and additional. Application of the basic practices will have a variable effectiveness in terms of control level of pollution control depending upon the subwatershed area characteristics and the pollutant considered. The additional category of nonpoint source control measures has been subdivided into four subcategories based upon the relative effectiveness and costs of the measures. The first subcategory of practices can be expected to generally result in about a 25 percent reduction in pollutant runoff. The second and third subcategory of practices, when applied in combination with the minimum and additional practices, can be expected to generally result in up to a 75 percent reduction in pollutant runoff, respectively. The fourth subcategory would consist of all of the preceding practices, plus those additional practices that would be required to achieve a reduction in ultimate runoff of more than 75 percent.

Table B-1 sets forth the diffuse source control measures applicable to general land uses and diffuse source activities, along with the estimated maximum level of pollution reduction which may be expected upon implementation of the applicable measures. The table also includes information pertaining to the costs of developing the alternatives set forth in this chapter.[1] These various individual nonpoint source control practices are summarized by group in Table B-2.

Of the sets of practices recommended for various levels of diffuse source pollution control presented in Table B-2, not all practices are needed, applicable, or cost-effective for all watersheds, due to variations in pollutant loadings and land use and natural conditions among the watersheds. Therefore, it is recommended that the practices indicated as needed for nonpoint source pollutant control be refined by local level nonpoint source control practices planning, which would be analogous to sewerage facilities planning for point source pollution abatement. A locally prepared plan for nonpoint abatement measures should be better able to blend knowledge of current problems and practices with a quickly evolving technology to achieve a suitable, site specific approach to pollution abatement.

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[1] *Costs are presented in more detail in the following SEWRPC Technical Reports: No. 18, State of the Art of Water Pollution Control in Southeastern Wisconsin, Volume Three, Urban Storm Water Runoff, July 1977, and Volume Four, Rural Storm Water Runoff, December 1976; and No. 31, Costs of Urban Nonpoint Source Water Pollution Control Measures, June 1991.*

Table B-1

GENERALIZED SUMMARY OF METHODS AND EFFECTIVENESS OF DIFFUSE SOURCE WATER POLLUTION CONTROL MEASURES

Applicable Land Use	Control Measures[a]	Summary Description	Approximate Percent Reduction of Released Pollutants[b]	Assumptions for Costing Purposes
Urban	Litter and pet waste control ordinance	Prevent the accumulation of litter and pet waste on streets and residential, commercial, industrial, and recreational areas	2-5	Ordinance administration and enforcement costs are expected to be funded by violation penalties and related revenues
	Improved timing and efficiency of street sweeping, leaf collection and disposal, and catch basin cleaning	Improve the scheduling of these public works activities, modify work habits of personnel, and select equipment to maximize the effectiveness of these existing pollution control measures	2-5	No significant increase in current expenditures is expected
	Management of onsite sewage treatment systems	Regulate septic system installation, monitoring, location, and performance; replace failing systems with new septic systems or alternative treatment facilities; develop alternatives to septic systems; eliminate direct connections to drain tiles or ditches; dispose of septage at sewage treatment facility	10-30	Replace one-half of estimated *existing* failing septic systems with properly located and installed systems and replace one-half with alternative systems, such as mound systems or holding tanks; all existing and proposed onsite sewage treatment systems are assumed to be properly maintained; assume system life of 25 years. The estimated cost of a septic tank system is $5,000-$6,000 and the cost of an alternative system is $10,000. The annual maintenance cost of a disposal system is $250. An in-ground pressure system is estimated to cost $6,000-$10,000 with an annual operation and maintenance cost of $250. A holding tank would cost $5,500-$6,500 with an annual operation and maintenance cost of $1,800
	Increased street sweeping	On the average, sweep all streets in urban areas an equivalent of once or twice a week with vacuum street sweepers; require parking restrictions to permit access to curb areas; sweep all streets at least eight months per year; sweep commercial and industrial areas with greater frequency than residential areas	30-50	Estimate curb miles based on land use, estimated street acreage, and Commission transportation planning standards; assume one street sweeper can sweep 2,000 curb miles per year; assume sweeper life of 10 years; assume residential areas swept once weekly, commercial and industrial areas swept twice weekly. The cost of a vacuum street sweeper is approximately $120,000. The cost of the operation and maintenance of a sweeper is about $25 per curb/mile swept
	Increased leaf and clippings collection and disposal	Increase the frequency and efficiency of leaf collection procedures in fall; use vacuum cleaners to collect leaves; implement ordinances for leaves, clippings, and other organic debris to be mulched, composted, or bagged for pickup	2-5	Assume one equivalent mature tree per residence plus five trees per acre in recreational areas; 75 pounds of leaves per tree; 20 percent of leaves in urban areas not currently disposed of properly. The cost of the collection of leaves in a vacuum sweeper and disposal is estimated at $180-$200 per ton of leaves
	Increased catch basin cleaning	Increase frequency and efficiency of catch basin cleaning; clean at least twice per year using vacuum cleaners; catch basin installation in new urban development not recommended as a cost-effective practice for water quality improvement	2-5	Determine curb miles for street sweeping; vary percent of urban area served by catch basins by watershed from Commission inventory data; assume density of 10 catch basins per curb mile; clean each basin twice annually by vacuum cleaner. The cost of cleaning a catch basin is approximately $10

Table B-1 (continued)

Applicable Land Use	Control Measures[a]	Summary Description	Approximate Percent Reduction of Released Pollutants[b]	Assumptions for Costing Purposes
Urban (continued)	Reduced use of deicing salt	Reduce use of deicing salt on streets; salt only intersections and problem areas; prevent excessive use of sand and other abrasives	Negligible for pollutants addressed in this plan but helpful for reducing chlorides and associated damage to vegetation	Increased costs, such as for slower transportation movement, are expected to be offset by benefits such as reduced automobile corrosion and damage to vegetation
	Improved street maintenance and refuse collection and disposal	Increase street maintenance and repairs; increase provision of trash receptacles in public areas; improve trash collection schedule; increase cleanup of parks and commercial centers	2-5	Increase current expenditures by approximately 15 percent
	Parking lot stormwater temporary storage and treatment measures	Construct gravel-filled trenches, sediment basins, or similar measures to store temporarily the runoff from parking lots, rooftops, and other large impervious areas; if treatment is necessary, use a physical-chemical treatment measure such as screens, dissolved air flotation, or a swirl concentrator	5-10	Design gravel-filled trenches for 24-hour, five year recurrence interval storm; apply to off-street parking acreages. For treatment—assume four-hour detention time. The capital cost of stormwater detention and treatment facilities is estimated at $40,000-$80,000 per acre of parking lot area, with an annual operation and maintenance cost of about $200 per acre
	Onsite storage—residential	Remove connections to sewer systems; construction onsite stormwater storage measures for subdivisions	5-10	Remove roof drains and other connections from sewer system wherever needed; use lawn aeration if applicable; apply dutch drain storage facilities to 15 percent of residences. The capital cost would approximate $500 per house, with an annual maintenance cost of about $25
	Stormwater infiltration—urban	Construct gravel-filled trenches for areas of less than 10 acres or basins to collect and store temporarily stormwater runoff to reduce volume, provide groundwater recharge and augment low stream flows	45-90	Design gravel-filled trenches or basins to store the first 0.5 inch of runoff; provide at least a 25-foot grass buffer strip to reduce sediment loadings. The capital cost of a stormwater infiltration is estimated at $12,000 for a six-foot deep, 10-foot wide trench, and at $70,000 for a one-acre basin, with an annual maintenance cost of about $10-$350 for the trench, and of about $2,500 for the basin
	Stormwater storage—urban	Store stormwater runoff from urban land in surface storage basins or, where necessary, subsurface storage basins	10-35	Design all storage facilities for a 1.5 inch of runoff event, which corresponds approximately to a five-year recurrence interval event with a storm event being defined as a period of precipitation with a minimum antecedent and subsequent dry period of from 12 to 24 hours; apply subsurface storage tanks to intensively developed existing urban areas where suitable open land for surface storage is unavailable; design surface storage basins for proposed new urban land, existing urban land not storm sewered, and existing urban land where adequate open space is available at the storm sewer discharge site. The capital cost for stormwater storage would range from $35,000 to $110,000 per acre of basin, with an annual operation and maintenance cost of about $40-$60 per acre

Table B-1 (continued)

Applicable Land Use	Control Measures[a]	Summary Description	Approximate Percent Reduction of Released Pollutants[b]	Assumptions for Costing Purposes
Urban (continued)	Stormwater treatment	Provide physical-chemical treatment which includes screens, microstrainers, dissolved air flotation, swirl concentrator, or high-rate filtration, and/or disinfection, which may include chlorination, high-rate disinfection, or ozonation to stormwater following storage	10-50	To be applied only in combination with stormwater storage facilities above; general cost estimates for microstrainer treatment and ozonation were used; same costs were applied to existing urban land and proposed new urban development. Stormwater treatment has an estimated capital cost of from $900-$7,000 per acre of tributary drainage area, with an average annual operation and maintenance cost of about $35-$100 per acre
Rural	Conservation practices	Includes such practices as strip cropping, contour plowing, crop rotation, pasture management, critical area protection, grading and terracing, grassed waterways, diversions, wood for management, fertilization and pesticide management, and chisel tillage	Up to 50	Costs for Natural Resources Conservation Service (NRCS)-recommended practices are applied to agricultural and related rural land; the distribution and extent of the various practices were determined from an examination of 56 existing farm plan designs within the Region. The capital cost of conservation practices ranges from $3,000-$5,000 per acre of rural land, with an average annual operation and maintenance cost of from $5-$10 per rural acre
	Animal waste control system	Construct stream bank fencing and crossovers to prevent access of all livestock to waterways; construct a runoff control system or a manure storage facility, as needed, for major livestock operations; prevent improper applications of manure on frozen ground, near surface drainageways, and on steep slopes; incorporate manure into soil	50-75	Cost estimated per animal unit; animal waste storage (liquid and slurry tank for costing purposes) facilities are recommended for all major animal operations within 500 feet of surface water and located in areas identified as having relatively high potential for severe pollution problems. Runoff control systems recommended for all other major animal operations. It is recognized that dry manure stacking facilities are significantly less expensive than liquid and slurry storage tanks and may be adequate waste storage systems in many instances. The estimated capital cost and average operation and maintenance cost of a runoff control system is $100 per animal unit and $25 per animal unit, respectively. The capital cost of a liquid and slurry storage facility is about $1,000 per animal unit, with an annual operation and maintenance cost of about $75 per unit. An animal unit is the weight equivalent of a 1,000-pound cow
	Base-of-slope detention storage	Store runoff from agricultural land to allow solids to settle out and reduce peak runoff rates. Berms could be constructed parallel to streams	50-75	Construct a low earthen berm at the base of agricultural fields, along the edge of a floodplain, wetland, or other sensitive area; design for 24-hour, 10-year recurrence interval storm; berm height about four feet. Apply where needed in addition to basic conservation practices; repair berm every 10 years and remove sediment and spread on land. The estimated capital cost of base-of-slope detention storage would be about $500 per tributary acre, with an annual operation and maintenance cost of $25 per acre
	Bench terraces	Construct bench terraces, thereby reducing the need for many other conservation practices on sloping agricultural land	75-90	Apply to all appropriate agricultural lands for a maximum level of pollution control. Utilization of this practice would exclude installation of many basic conservation practices and base-of-slope detention storage. The capital cost of bench terraces is estimated at $1,500 per acre, with an annual operation and maintenance cost of $100 per acre

Table B-1 (continued)

Applicable Land Use	Control Measures[a]	Summary Description	Approximate Percent Reduction of Released Pollutants[b]	Assumptions for Costing Purposes
Urban and Rural	Public education programs	Conduct regional- and county-level public education programs to inform the public and provide technical information on the need for proper land management practices on private land, the recommendations of management programs, and the effects of implemented measures; develop local awareness programs for citizens and public works officials; develop local contact and education efforts	Intermediate	For first 10 years includes cost of one person, materials, and support for each 25,000 population. Thereafter, the same cost can be applied to for every 50,000 population. The cost of one person, materials, and support is estimated at $55,000 per year
	Construction erosion control practices	Construct temporary sediment basins; install straw bale dikes; use fiber mats, mulching and seeding; install slope drains to stabilize steep slopes; construct temporary diversion swales or berms upslope from the project	20-40	Assume acreage under construction is the average annual incremental increase in urban acreage; apply costs for a typical erosion control program for a construction site. The estimated capital cost and operation and maintenance cost for construction erosion control is $250-$5,500 and $250-$1,500 per acre under construction, respectively
	Materials storage and runoff control facilities	Enclose industrial storage sites with diversions; divert runoff to acceptable outlet or storage facility; enclose salt piles and other large storage sites in crib and dome structures	5-10	Assume 40 percent of industrial areas are used for storage and to be enclosed by diversions; assume existing salt storage piles enclosed by cribs and dome structures. The estimated capital cost of industrial runoff control is $2,500 per acre of industrial land. Material storage control costs are estimated at $75 per ton of material
	Stream protection measures	Provide vegetative buffer zones along streams to filter direct pollutant runoff to the streams; construct stream bank protection measures, such as rock riprap, brush mats, tree revetment, jacks, and jetted willow poles where needed	5-10	Apply a 50-foot-wide vegetative buffer zone on each side of 15 percent of the stream length; apply stream bank protection measures to 5 percent of the stream length. Vegetative buffer zones are estimated to cost $21,200 per mile of stream, and streambank protection measures cost about $37,000 per stream mile
	Pesticide and fertilizer application restrictions	Match application rate to need; eliminate excessive applications and applications near or into surface water drainageways	0-3	Cost included in public education program
	Critical area protection	Emphasize control of areas bordering lakes and streams; correct obvious erosion and other pollution source problems	Intermediate	Intermediate

[a]Not all control measures are required for each subwatershed. The characteristics of the watershed, the estimated required level of pollution reduction needed to meet the applicable water quality standards, and other factors will influence the selection and estimation of costs of specific practices for any one subwatershed. Although the control measures costed represent the recommended practices developed at the regional level on the basis of the best available information, the local implementation process should provide more detailed data and identify more efficient and effective sets of practices to apply to local conditions.

[b]The approximate effectiveness refers to the estimated amount of pollution produced by the contributing category (urban or rural)that could be expected to be reduced by the implementation of the practice. The effectiveness rates would vary greatly depending on the characteristics of the watershed and individual diffuse sources. It should be further noted that practices can have only a "sequential" effect, since the percent pollution reduction of a second practice can only be applied against the residual pollutant load which is not controlled by the first practice. For example, two practices of 50 percent effectiveness would achieve a theoretical total effectiveness of only 75 percent control of the initial load. Further, the general levels of effectiveness reported in the table are not necessarily the same for all pollutants associated with each source. Some pollutants are transported by dissolving in water and others by attaching to solids in the water; the methods summarized here reflect typical pollutant removal levels.

[c]For highly urbanized areas which require retrofitting of facilities into developed areas, the costs can range from $400,000 to $1,000,000 per acre of storage.

Source: SEWRPC.

Table B-2

ALTERNATIVE GROUPS OF DIFFUSE SOURCE WATER POLLUTION CONTROL MEASURES PROPOSED FOR STREAMS AND LAKE WATER QUALITY MANAGEMENT

Pollution Control Category	Level of Pollution[b] Control	Practices to Control Diffuse Source Pollution from Urban Areas[c]	Practices to Control Diffuse Source Pollution from Rural Areas[b]
Basic Practices	Variable	Construction erosion control; onsite sewage disposal system management; streambank erosion control	Streambank erosion control
	25 percent	Public education programs; litter and pet waste control; restricted use of fertilizers and pesticides; construction erosion control; critical areas protection; improved timing and efficiency of street sweeping, leaf collection, and catch basin cleaning; material storage facilities and runoff control	Public education programs; fertilizer and pesticide management; critical area protection; crop residue management; chisel tillage; pasture management; contour plowing; livestock waste control
Additional Diffuse Source Control Practices[a]	50 percent	Above, plus: Increased street sweeping; improved street maintenance and refuse collection and disposal; increased catch basin cleaning; stream protection; increased leaf and vegetation debris collection and disposal; stormwater storage; stormwater infiltration	Above, plus: Crop rotation; contour strip-cropping; grass waterways; diversions; wind erosion controls; terraces; stream protection
	75 percent	Above, plus: An additional increase in street sweeping, stormwater storage and infiltration; additional parking lot stormwater runoff storage and treatment	Above, plus: Base-of-slope detention storage
	More than 75 percent	Above, plus: Urban stormwater treatment with physical-chemical and/or disinfection treatment measures	Bench terraces[c]

[a] *In addition to diffuse source control measures, lake rehabilitation techniques may be required to satisfy lake water quality standards.*

[b] *Groups of practices are presented here for general analysis purposes only. Not all practices are applicable to, or recommended for, all lake and stream tributary watersheds. For costing purposes, construction erosion control practices, public education programs, and material storage facilities and runoff controls are considered urban control measures and stream protection is considered a rural control measure.*

[c] *The provision of bench terraces would exclude most basic conversation practices and base-of-slope detention storage facilities.*

Source: SEWRPC.

Appendix C

AN AQUATIC PLANT MANAGEMENT PLAN FOR WHITEWATER AND RICE LAKES, WALWORTH COUNTY, WISCONSIN

INTRODUCTION

An aquatic plant management plan is an integral part of the Whitewater and Rice Lakes Management Plan and represents an important element of the ongoing commitment of the Towns of Whitewater and Richmond and the Whitewater-Rice Lakes Management District to sound environmental management with respect to the Lakes. The aquatic plant management portion of the lake management plan was prepared during 1994-1995 by the Regional Planning Commission, and is based on field surveys conducted by the Commission staff during 1995. The plan follows the format adopted by the Wisconsin Department of Natural Resources (DNR) for aquatic plant management plans pursuant to Chapters NR 103 and NR 107 of the Wisconsin Administrative Code. Its scope is limited to those management measures which can be effective in the control of aquatic plant growth; those measures which can be readily undertaken by the Towns and Lake Management District concerned in concert with the riparian residents; and those measures which will directly affect the uses of Whitewater and Rice Lakes. The aquatic plant management plan for the Whitewater and Rice Lakes is comprised of seven elements:

1. A set of aquatic plant management objectives;
2. A brief description of the Lake and its watershed;
3. A statement of the current use restrictions and the need for aquatic plant management in the Whitewater and Rice Lakes;
4. An evaluation of alternative means of aquatic plant management and a recommended plan for such management;
5. A description of the recommended plan;
6. A description of the equipment needs for the recommended plan; and
7. A recommended means of monitoring and evaluating the efficacy of the plan.

STATEMENT OF AQUATIC PLANT MANAGEMENT OBJECTIVES

The aquatic plant management program objectives for the Whitewater and Rice Lakes were developed in consultation with the Lakes Management District and the Towns of Whitewater and Richmond. The objectives are to:

1. Effectively control the quantity and density of aquatic plant growths in the Whitewater and Rice Lakes to enhance water-related recreational activities; to improve the aesthetic character of the resource; and to preserve and enhance the overall value of the waterbody;

2. Contribute to the overall conservation and wise use of the Whitewater and Rice Lakes through the environmentally sound management of vegetation, fishes and wildlife populations in and around the Lakes; and,

3. Promote a high-quality, water-based recreational experience for residents and visitors to the Whitewater and Rice Lakes.

WHITEWATER AND RICE LAKES AND THEIR WATERSHED CHARACTERISTICS

Whitewater and Rice Lakes are located southwest of the City of Whitewater on the southern most portion of the Kettle Moraine State Forest in Walworth County. Both lakes are man-made drainage lakes; Whitewater Lake was created by the damming of three smaller lakes. Rice Lake was created by constructing a dam across Whitewater Creek. Rice Lake is connected to Whitewater Lake by a 300 feet intermittent stream, as shown on Map C-1.

Whitewater Lake has a surface area of 697 acres, with a maximum depth of about 40 feet, the deepest area being located in the central basin. Fifty-four percent of total lake volume is five or less feet in depth and 90 percent of the Lake is 10 or less feet in depth. Whitewater Lake is about 2.6 miles long. Rice Lake, located downstream of Whitewater Lake, has a surface area of about 162 acres, with a maximum depth of about 11 feet. The Lake is roughly oval in shape with the deepest area being located near the center of the Lake.

The tributary drainage areas of Whitewater and Rice Lakes are about 7.2 and 7.8 square miles in extent, respectively, as shown on Map C-1. No flow over the dam located at the outlet of Whitewater Lake, was observed from 1986 through 1991. Thus, the tributary drainage area to Rice Lake is, at times, limited to the 0.6 square mile drainage area downstream of Whitewater Lake. Flow over the dam was documented in 1994 and 1995. The U.S. Geological Survey study[1] of lake hydrology and water quality conducted over the period from 1990 through 1991 indicates that due to the topography and soils in the tributary drainage areas concerned, there are normally only about 1.4 square miles and 0.3 square mile of land surface which actually contribute drainage to Whitewater and Rice Lakes, respectively.

Land Use and Shoreline Development

As of 1990, there were three public access sites located on Whitewater Lake and one public access site located on Rice Lake. All four of these sites were located within the Town of Whitewater. The shoreland of Whitewater Lake is used primarily for residential development, with the exception of the western and southern shore of the south bay and the western shore of the northwestern bay, which remains in park and open space use. The shoreland of Rice Lake is primarily in park and open space use, with some residential development being located along the western shoreline. Nearly all of the shoreline around Whitewater and Rice Lakes has some form of shoreline protection. The island areas and park areas on both Lakes which do not have any structured shoreline protection are somewhat protected by vegetation.

Aquatic Plants, Distribution, and Management Areas

A 1995 macrophyte survey done by the Commission staff found the flora of both Whitewater and Rice Lakes dominated by Eurasian water milfoil. Eurasian water milfoil is an exotic aquatic plant species, not native to North America, which proliferates excessively creating thick beds of vegetation. In shallower depths of water, such as are present over much of Whitewater and Rice Lakes, Eurasian water milfoil is able to grow

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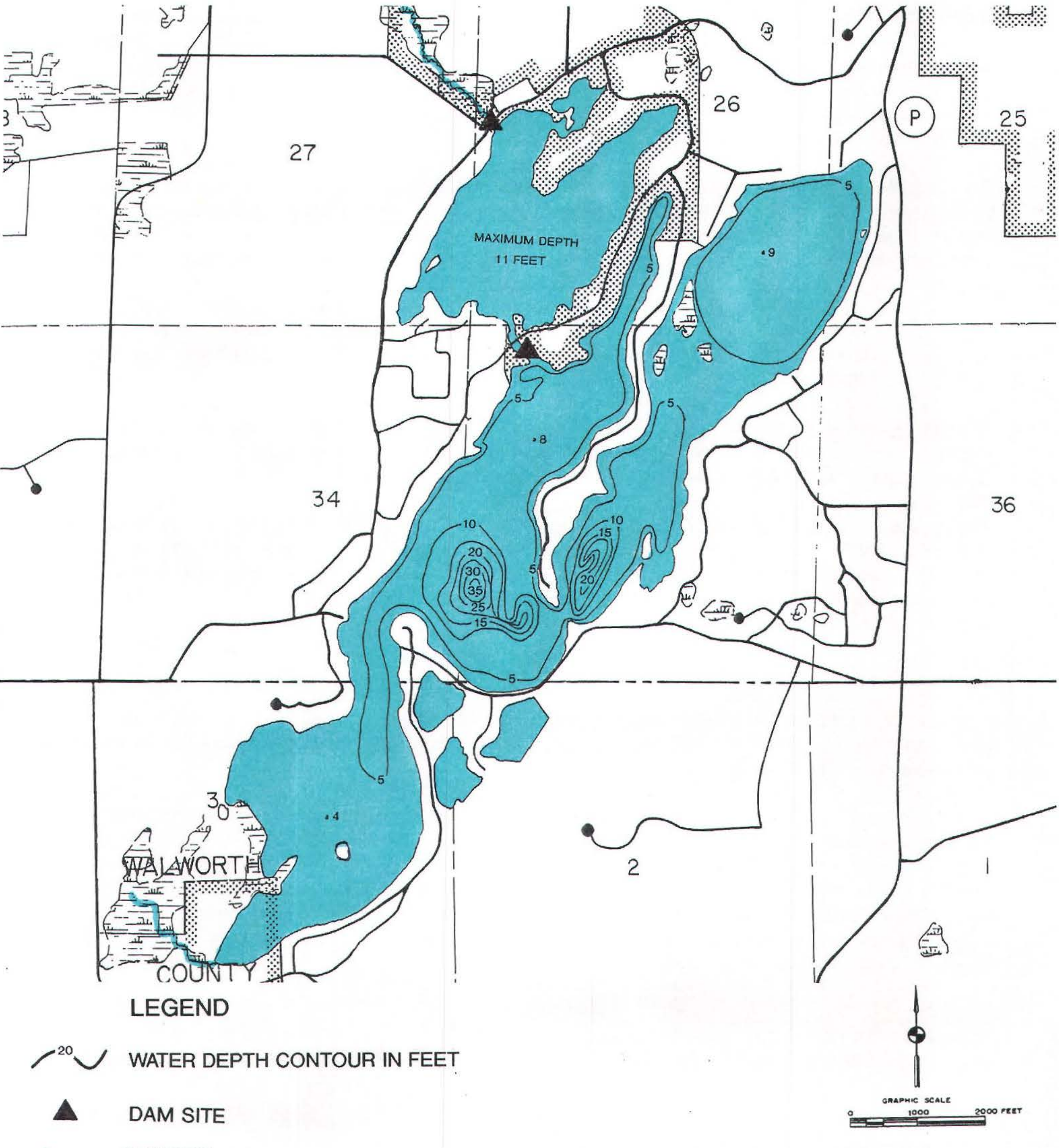
[1]*U.S. Geological Survey, Water Resources Investigation Report 44-410, "Hydrology and Water Quality of Whitewater and Rice Lakes in Southeastern Wisconsin, 1990-1991," 1994.*

Map C-1

BATHYMETRIC MAP OF WHITEWATER AND RICE LAKES



Source: SEWRPC.

to the surface making certain recreational uses less enjoyable, if not dangerous; and impairing the aesthetic quality of the waterbodies. In addition to interfering with recreational activities, Eurasian water milfoil disrupts the ecosystem of the Lake. This particular species of milfoil has been known to become the dominant plant present in lakes with its ability to regenerate, to replace native vegetation, and to reduce the quality of fish and wildlife habitat. Further, when Eurasian water milfoil is fragmented by boat propellers, or any other means, the torn shoots are able to sprout new roots, colonizing new sites. These shoots can also cling to boats, trailers, motor props, or bait buckets; and can stay alive for weeks facilitating transfer to other lakes. For this reason it very important to remove all vegetation from boats and trailers after removing them from the water.[2]

Aquatic plant surveys conducted in 1990 by the Wisconsin Department of Natural Resources and in 1995 by the Commission staff found the greatest diversity of plants in Whitewater Lake to be present in the lower central basin of the Lake surrounding the area of deepest water. Coontail, elodea, chara, curly-leaf pondweed and milfoil were found scattered in various locations in these areas of the Lake. Coontail and elodea, along with milfoil, were found to be abundant in the southernmost basin as well as in the upper central portions of Whitewater Lake. Five areas on Whitewater Lake have been designated as environmentally sensitive areas by the Wisconsin Department of Natural Resources because of the importance of these areas to the maintenance of good water quality conditions in, and the biological integrity of, the Lake. These areas are shown on Map C-2.

The uniform shallowness of Rice Lake facilitates the growth of aquatic vegetation throughout the Lake. The greatest plant diversity was found in the southern most area of the Lake, where curly-leaf pondweed, milfoil, coontail, and flat-stemmed pondweed were found to be present.

A species list, compiled from the results of the Regional Planning Commission aquatic plant surveys, is set forth in Tables C-1 and C-2 along with comments on the ecological significance of each plant on the list. The survey identified nine different species of plants in both Whitewater and Rice Lakes. The areas in which concentrations of the various plants were found are shown on Maps C-3 and C-4. Representative illustrations of the these aquatic plants can be found in Appendix E.

Fisheries, Wildlife, and Waterfowl

Whitewater and Rice Lakes both support moderately diverse fish communities. The most prevalent predator fishes in the Lakes include northern pike, walleyed pike and largemouth bass. Panfish species present in the Lakes include bluegills, pumpkinseeds, green sunfish, black crappies, white suckers, golden shiners, yellow perch, and bullheads.

Given the land uses present around the shorelands of the Lakes, only smaller animals and waterfowl generally inhabit the two Lakes. Muskrats and cottontail rabbits are probably the most abundant and widely distributed fur-bearing mammals in the immediate riparian areas. Larger mammals, such as the whitetail deer, are generally confined to the larger wooded areas and the open meadows found in the park and open space lands within the drainage areas of the Lakes. The Whitewater and Rice Lakes drainage areas support a significant population of waterfowl including mallards and teals. During the migration seasons a greater variety of waterfowl may be present and in greater numbers.

Recreation

Whitewater and Rice Lakes are both multi-purpose waterbodies serving all forms of recreation, including boating, swimming, and year around fishing. Because of its size, Whitewater Lake receives a significant

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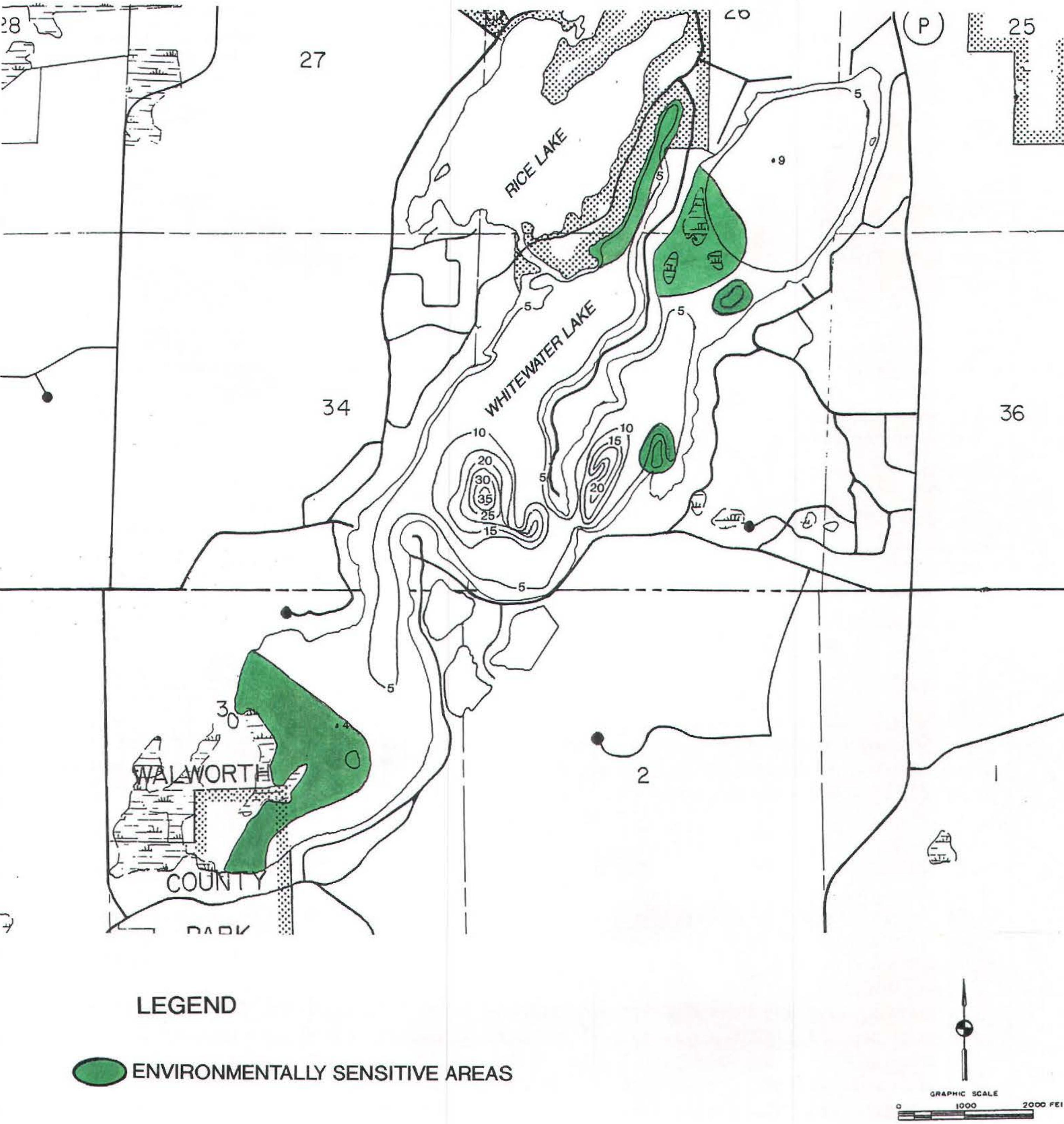
[2] *Wisconsin Department of Natural Resources, Eurasian Water Milfoil in Wisconsin: A Report to the Legislature, 1992.*

Map C-2

ENVIRONMENTALLY SENSITIVE AREAS IN WHITEWATER LAKE



Source: Wisconsin Department of Natural Resources and SEWRPC.

Table C-1

AQUATIC PLANT SPECIES PRESENT IN WHITEWATER LAKE AND THEIR POSITIVE ECOLOGICAL SIGNIFICANCE: 1995

Aquatic Plant Species Present	Relative Abundance	Ecological Significance
Chara vulgaris (muskgrass)	Common	Excellent producer of fish food especially for young trout, bluegills, small and largemouth bass, stabilizes bottom sediments, and has softening effect on the water by removing lime and carbon dioxide
Myriophyllum sp. (water milfoil)	Abundant	Provides shelter and is a valuable food producer supporting many insects eaten by fish
Myriophyllum spicatum (Eurasian water milfoil)	Abundant	None known
Potamogeton crispus (curly-leaf pondweed)	Abundant	Provides good food and shelter, and shade for early spawning fish
Potamogeton pectinatus (sago Pondweed)	Isolated stands	Provides food and shelter for young trout and other fish; supports insects valuable as food for fish and ducklings
Potamogeton zosteriformis (flat-stemmed pondweed)	Isolated stands	Provides food and shelter for fish
Heteranthia dubia (waterstar grass)	Isolated stands	Provides food and shelter for fish
Ceratophyllum demersum (coontail)	Common	Provides good shelter for young fish, and supports insects valuable as food for fish and ducklings
Elodea canadensis (waterweed)	Common	Provides shelter and support for insects valuable as fish food

Source: Norman C. Fassett, A Manual of Aquatic Plants; Wisconsin Department of Natural Resources, Guide to Wisconsin Aquatic Plants; and SEWRPC.

amount of powerboat and sailboat use. Maximum boater use of lakes in Southeastern Wisconsin generally occurs between the hours of 10:00 a.m. and 2:00 p.m. A boat survey conducted by the Commission staff on June 21, 1995, between these hours indicated that about 21 watercraft of all descriptions were typically in use on the Lake during the summer at one time.

USE RESTRICTIONS IMPOSED BY AQUATIC PLANTS

Excessive plant growth on both Whitewater and Rice Lakes impedes boat traffic, making some areas of the Lakes impassable without aquatic plant control. Boating access in the shallower basins of the Lakes is often restricted to narrow bands along the edges of the waterbody. The dense plant growths, including mats of floating aquatic plants, generally occur in the western portion of the north bay, severely restricting boating and shoreline angling and swimming, and even impairing the aesthetic enjoyment of the waterbody. The plant growth limits recreational use of the Lake and shoreline, and results in public complaints throughout the summer season. Failure to remove floating vegetation which is left behind by the plant harvesters, equipment, or cut by boat propellers leads to a build-up of vegetation along the shoreline which has, at times, been observed to reach a thickness of two feet. During the summer months, these beds of vegetation can become foul smelling and unsightly. The excessive plant growth also contributes to the accumulation of organic sediment on the bottom of the Lakes.

Table C-2

AQUATIC PLANT SPECIES PRESENT IN RICE LAKE AND THEIR POSITIVE ECOLOGICAL SIGNIFICANCE: 1995

Aquatic Plant Species Present	Relative Abundance	Ecological Significance
Chara vulgaris (muskgrass)	Common	Excellent producer of fish food especially for young trout, bluegills, small and largemouth bass, stabilizes bottom sediments, and has softening effect on the water by removing lime and carbon dioxide
Myriophyllum sp. (water milfoil)	Abundant	Provides shelter and is a valuable food producer supporting many insects eaten by fish
Myriophyllum spicatum (Eurasian water milfoil)	Abundant	None known
Potamogeton amphibium (water knotweed)	Isolated stands	Provides food and shelter, leaves are eaten by bluegills, and has softening effect on the water
Potamogeton crispus (curly-leaf pondweed)	Abundant	Provides good food and shelter, and shade for early spawning fish
Potamogeton pectinatus (sago Pondweed)	Isolated stands	Provides food and shelter for young trout and other fish; supports insects valuable as food for fish and ducklings
Potamogeton zosteriformis (flat-stemmed pondweed)	Isolated stands	Provides food and shelter for fish
Ceratophyllum demersum (coontail)	Abundant	Provides good shelter for young fish, and supports insects valuable as food for fish and ducklings

Source: Norman C. Fassett, A Manual of Aquatic Plants; Wisconsin Department of Natural Resources, Guide to Wisconsin Aquatic Plants; and SEWRPC.

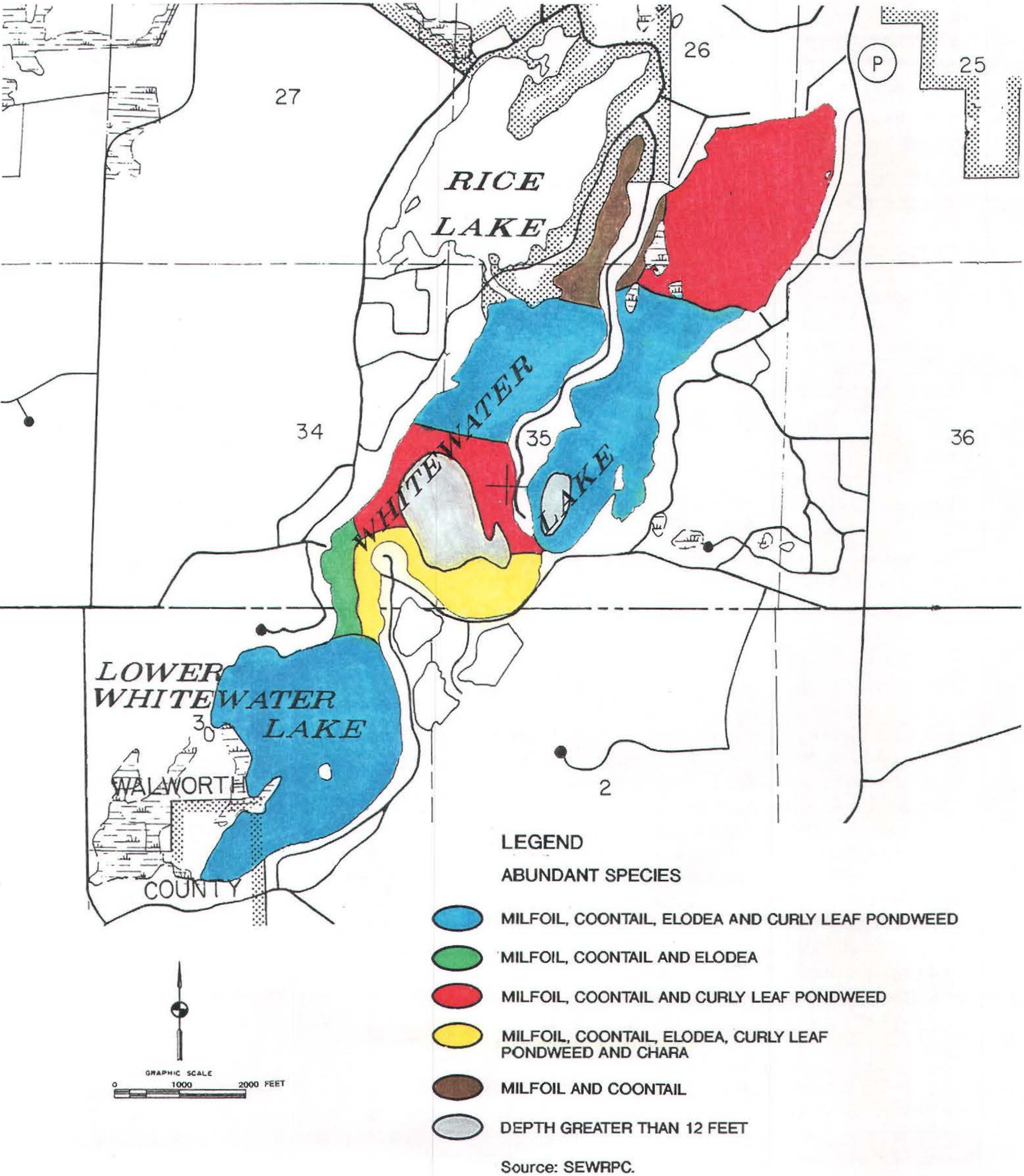
PAST AND PRESENT AQUATIC PLANT MANAGEMENT PRACTICES

Aquatic herbicides have been used on both Whitewater and Rice Lakes under permits issued by the Wisconsin Department of Natural Resources since the 1950s, when records of such control programs began to be kept. The aquatic plant control measures initially involved the use of sodium arsenite. Whitewater Lake is noted as being one of the 15 most heavily dosed waterbodies in Wisconsin, receiving more than 27 tons of sodium arsenite during the 20-year period from 1950 through 1969. Applications of sodium arsenite were discontinued in 1969 after arsenic accumulations were found in the Lake sediments and concerns were expressed over possible human health impacts. More recent chemical treatments have made use of more specific systemic herbicides such as 2,4-D, as set forth in Table C-3. All current chemical treatments of Whitewater and Rice Lakes are applied by State-licensed personnel and conform to the requirements of permits issued under Chapter NR 107 of the Wisconsin Administrative Code, "Aquatic Plant Management," to the Whitewater-Rice Lakes Management District. Chemical applications are normally made in late spring and early summer as the plants begin to grow, with occasional follow-up treatments being applied in mid-summer.

Aquatic plant harvesting has been used in concert with a herbicide treatment to control aquatic plant growth in both Whitewater and Rice Lakes. The Whitewater-Rice Lakes Management District has purchased and currently operates an Aquarius System H-820 aquatic plant harvester and associated conveying and transport equipment on the Lakes. Past procedures have been to initiate harvesting after the plants have become reestablished following chemical applications.

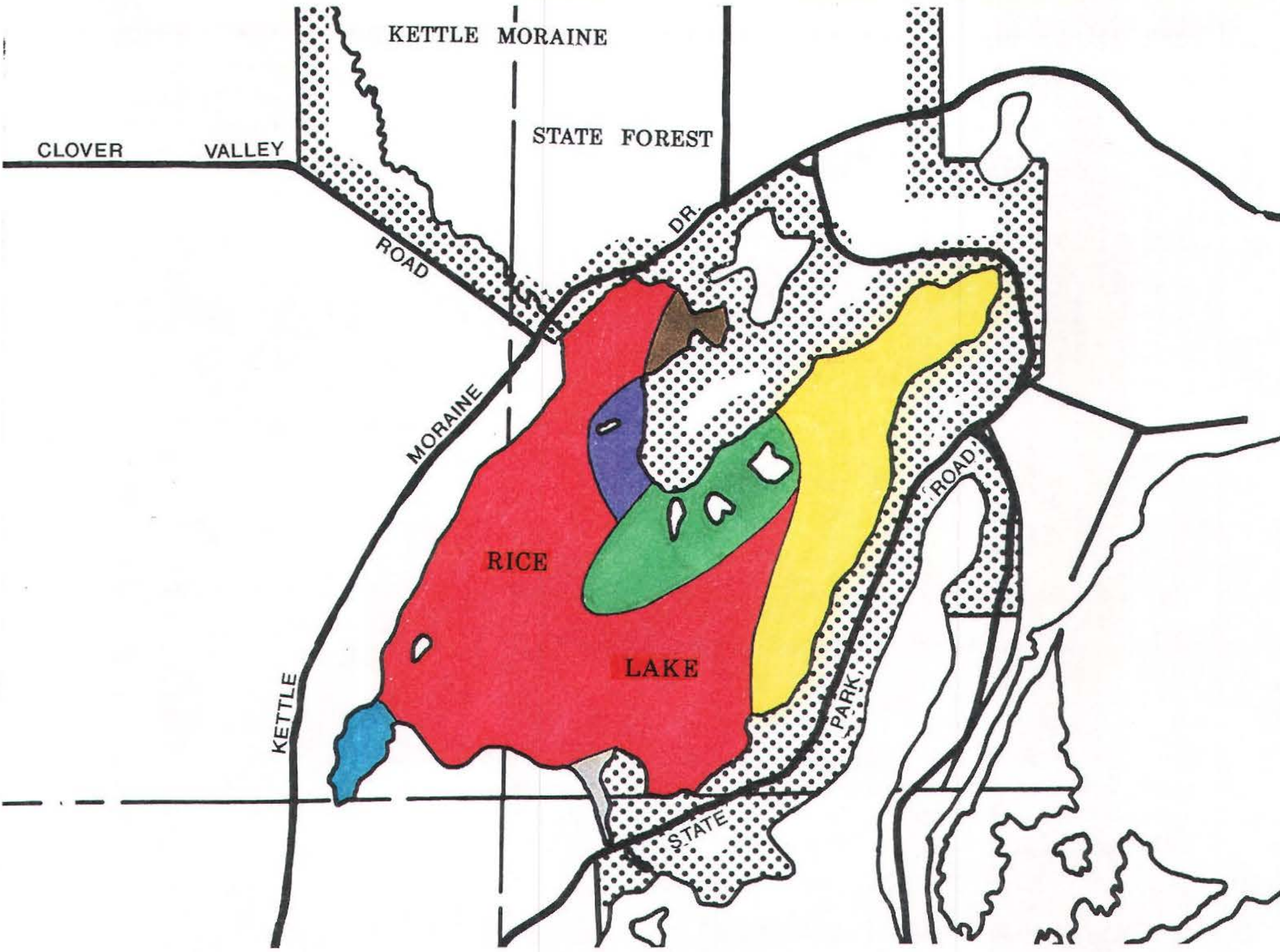
Map C-3

AQUATIC PLANT COMMUNITY DISTRIBUTION IN WHITEWATER LAKE: JUNE 1995



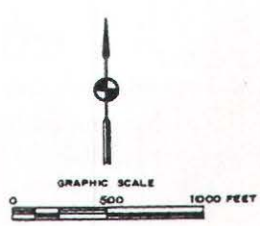
Map C-4

AQUATIC PLANT COMMUNITY DISTRIBUTION IN RICE LAKE: JUNE 1995



LEGEND

- MILFOIL AND CURLY LEAF PONDWEED
- MILFOIL AND COONTAIL
- MILFOIL, COONTAIL AND CURLY LEAF PONDWEED
- CURLY LEAF PONDWEED
- SAGO PONDWEED AND CURLY LEAF PONDWEED
- COONTAIL AND SAGO PONDWEED
- MILFOIL, COONTAIL, CURLY LEAF PONDWEED AND FLAT STEMMED PONDWEED



Source: SEWRPC.

Table C-3

HERBICIDE USE AT WHITEWATER LAKE FROM 1950 THROUGH 1993[a]

Year	Macrophyte Control					Algal Control	
	Sodium Arsenite (pounds)	Diquat (gallons)	Aquathol K (pounds)	Hydrothol (pounds)	2,4-D (gallons)	Copper Sulfate (pounds)	Cutrine-Plus (gallons)
1950	55,920	- -	- -	- -	- -	- -	- -
1969	- -	- -	- -	150	- -	- -	- -
1970	- -	- -	- -	45	- -	1,500	- -
1971	- -	- -	- -	- -	- -	1,300	- -
1972	- -	- -	- -	- -	- -	1,895	- -
1973	- -	- -	- -	- -	- -	1,850	- -
1974	- -	- -	- -	- -	- -	2,525	- -
1975	- -	- -	- -	- -	- -	- -	- -
1984	- -	- -	15.0	- -	42.5	- -	- -
1987	- -	- -	2.0	- -	- -	- -	2.0
1988	- -	0.50	1.0	- -	2.0	- -	2.5
1989	- -	- -	- -	- -	17.5	- -	- -
1991	- -	24.75	- -	- -	236.0	- -	1.0
1993	- -	10.00	7.5	- -	5.0	- -	
Total	55,920	35.25	25.5	195	303.0	9,070	19.5

[a]Rice Lake used a total of 78 gallons of 2,4-D, and 0.5 gallons Aquathol-K between the years 1968 and 1994.

Source: Wisconsin Department of Natural Resources and SEWRPC.

One of the objectives of the aquatic plant management program for Whitewater and Rice Lakes that aquatic herbicide use be minimized and synchronized with the aquatic plant harvesting operation to maximize impacts. Herbicide application should be confined to nearshore areas to control nuisance plants such as milfoil and coontail which are difficult to control in any other way.

ALTERNATIVE METHODS FOR AQUATIC PLANT CONTROL

Background

Various aquatic plant management techniques—manual, mechanical, physical and chemical—are potentially applicable to the Whitewater and Rice Lakes.[3] A number of these methods have been employed with varying success on the Whitewater and Rice Lakes in the past.

Physical Controls

One physical method of aquatic plant control involves the drawing down of a waterbody in order to change or create specific types of habitat and thereby manage species composition within the waterbody. Such drawdown was not considered to be practicable on Whitewater and Rice Lakes due to the heavy recreational demands placed on the Lakes throughout the year.

[3]The various methods referred to in the text are described in more detail in U.S. Environmental Protection Agency Report No. EPA-440/4-90-006, The Lake and Reservoir Restoration Guidance Manual, August 1990.

Other physical controls, such as the placement of bottom barriers and use of shoreline protection structures such as rip-rap, may be practicable. Bottom barriers provide limited control of rooted plants by creating a physical barrier which reduces or eliminates the sunlight available to the plants. Barriers should not be used in areas of strong surf, heavy angling, or shallow water where motor boating occurs.

Extensive use has been made of shoreline protection structures along the developed areas of the Whitewater and Rice Lakes shoreline, as shown on Maps C-5 and C-6. Because of the uniqueness of each shoreline situation these control methods are not recommended for Whitewater and Rice Lakes, except on a limited homeowner basis. Both types of controls require permits from the Wisconsin Department of Natural Resources.

Chemical Controls

Chemical control measures are viewed by the community as having uncertain long-term environmental impacts as well as possible consequences for human health. While the herbicides recently used on the Whitewater and Rice Lakes have met applicable U.S. Environmental Protection Agency standards, and are applied by licensed personnel, the use of chemical control measures can contribute to an ongoing aquatic plant problem by augmenting the natural rates of accumulation of decayed organic matter in the lake sediments, releasing the nutrients contained in the plants back into the water column where they can be re-used in new plant, including algal, biomass production. The use of chemical control measures may also damage or destroy nontarget plant species that provide needed habitat for fish and other aquatic life. Accordingly, chemical control measures should not be relied upon to fully control the infestations of aquatic plants in Whitewater and Rice Lakes.

However, chemical control measures are recommended for the control of the nuisance conditions over relatively small areas of the Lakes. If considered necessary, chemical applications should be made in accordance with current Wisconsin Department of Natural Resources rules, under the authority of a State permit, by a licensed applicator working under the supervision of State staff. Records accurately delineating treated areas and the type and amount of herbicide used in each area, should be carefully recorded and used as a reference in applying for permits in the following year. A recommended checklist is provided as Figure C-1.

Manual Controls

Manual methods of aquatic plant control, such as raking or hand-pulling, while environmentally sound, are difficult to employ on a large-scale. Although very effective in small-scale applications, as for example, in and around docks and piers—manual techniques are generally not practicable for large-scale plant control methods. Manual means are considered a viable option on the Whitewater and Rice Lakes to control nearshore plant growths.

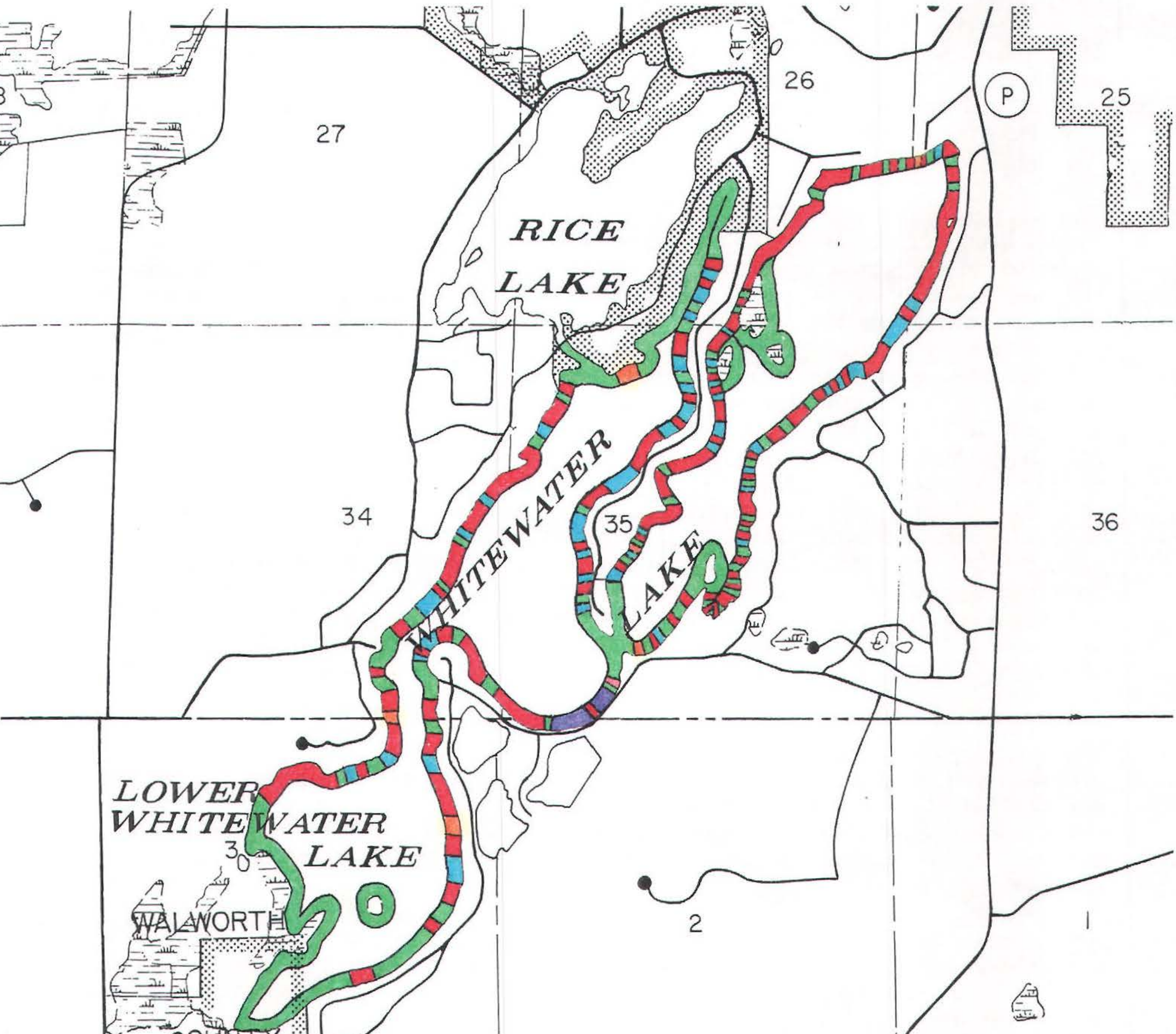
An option for the Whitewater-Rice Lakes Management District to consider is the purchase of several specially designed aquatic plant removal rakes to lend to riparian owners on a trial basis to encourage the purchase of such rakes for removal of rooted vegetation along shorelines and around docks by individual riparian land owners. Information could also be distributed on shoreline maintenance and on various hand weed cutters that are available for purchase—such information being available through the University of Wisconsin-Extension. The advantages to these manual control methods, as opposed to chemical treatment, is that the response is immediate, no permits are required, and potential long-term affects of chemicals are not a concern.

Mechanical Controls

Based on previous experience employing mechanical harvester technologies on the Whitewater and Rice Lakes, mechanical harvesting of aquatic plants appears to be a practicable and efficient primary means of controlling plant growth in the Lakes in an environmentally sensitive manner. Harvesting removes the plant

Map C-5

SHORELINE PROTECTION CONDITIONS ON WHITEWATER LAKE: 1995



LEGEND

VEGETATION

RIP-RAP

BULKHEAD

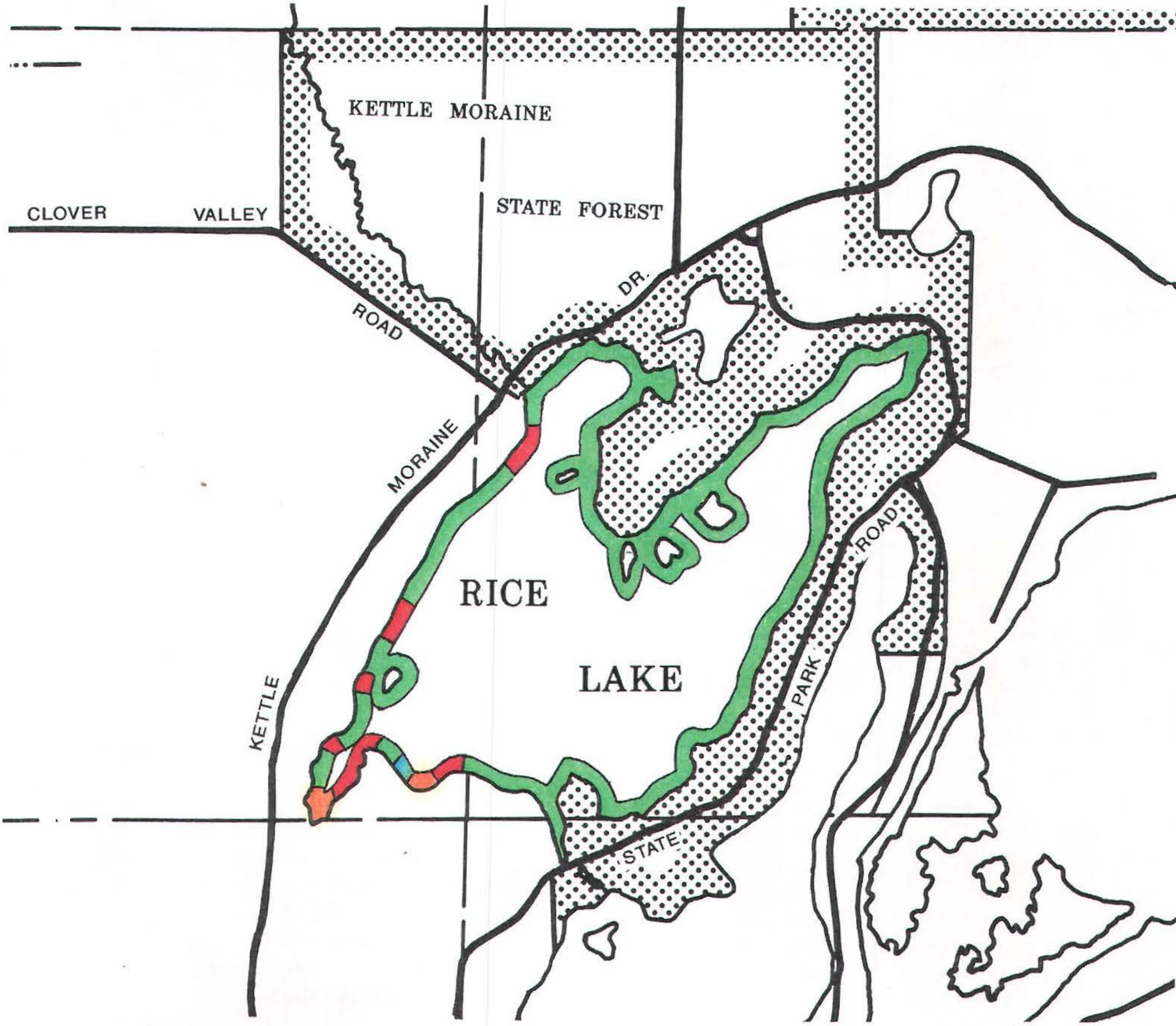
BEACH

REVETMENT

Source: SEWRPC.

Map C-6

SHORELINE PROTECTION CONDITIONS ON RICE LAKE: 1995



LEGEND

- VEGETATION
- RIP-RAP
- BEACH
- BULKHEAD

Source: SEWRPC.

Figure C-1

DISTRICT CHECKLIST FOR HERBICIDE APPLICATION

- [ ] Nuisance report completed defining areas of potential treatment
- [ ] Permit filed with the Wisconsin Department of Natural Resources
- [ ] Certified applicator hired[a]
- [ ] Required public notice in the newspaper
- [ ] Public informational meeting (required if five or more parties request a meeting)
- [ ] Posting of areas to be treated in accordance with regulations (discussed previously in report)
- [ ] Weather conditions cooperating
  - Wind direction and velocity
  - Temperature

[a]A licensed applicator will determine the amount of herbicide to be used, based upon discussions with appropriate staff from the Wisconsin Department of Natural Resources, and will keep records of the amount applied.

Source: SEWRPC.

biomass, and nutrients from the Lakes. While mechanical harvesting can potentially impact fish and other aquatic life caught up by the machine, disturb loosely consolidated lake bottom sediments, and result in the fragmentation and spread of some aquatic plants, it has also been shown to have some benefit in ultimately reducing the re-growth of other plants and removing phosphorus from the Lakes.[4] In 1991, the estimates of phosphorus removed through the harvesting program were 1,671 pounds from Whitewater Lake and 14 pounds from Rice Lake.[5] Harvesting also removes attached, epiphytic algal growths with the harvested plant material, and leaves sufficient plant material in the Lakes to continue to provide forage and shelter for fish and other aquatic life while stabilizing the lake sediments to prevent increased turbidity due to wave resuspension.

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[4]*Environmental Protection Agency, The Lake and Reservoir Restoration Guidance Manual, 2nd Edition, August 1990, p. 146.*

[5]*U.S. Geological Survey, Hydrology and Water Quality of Whitewater and Rice Lakes in Southeastern Wisconsin: 1990-91.*

Of the various types of harvesters available, one possible alternative would be to purchase a second smaller harvester, with about a seven-foot removable cutter bar which could then also be operated for cleanup of floating aquatic plants. The removal of the cutting bar would allow the harvester to operate in somewhat shallower water. This type of harvester has the ability to cut and hold about 8,500 pounds of vegetation and to operate in areas as shallow as three feet. Options exist which could allow for the elimination of the paddlewheel to be replaced by a hydraulically powered propeller system decreasing the width of the machine. This particular system can be operated with diesel fuel which is more economical than the standard paddlewheel option and is compatible with a transporter. Being a smaller version of the larger harvesters, having a maximum width of eight feet, it could more easily be transported between Whitewater and Rice Lakes and would have the capacity needed for the areas to be harvested on Rice Lake. Theoretically, using this equipment it would take about 50 hours to harvest the recommended 22 acres of Rice Lake, plus time to transport the harvested materials to shore and unload. In total, the time to harvest Rice Lake each time would be about one and one-half weeks. This would allow use of the harvester on Whitewater Lake during peak harvesting periods.

Another smaller harvester is also available which is comparable to the size of a pontoon boat, with a four-foot cutting bar. The small size of the harvester would allow for easy maneuvering in addition to easy portaging between the Lakes. The storage capacity allows for approximately 1,500 pounds of vegetation. In areas of dense vegetation this capacity could require unloading approximately every 15 minutes. Theoretically, using this equipment it would take about 150 hours to harvest the recommended 22 acres of Rice Lake, plus time to transport the harvested materials to shore and unload. In total, the time to harvest Rice Lake each time would be over five weeks. This would not be adequate during peak harvesting periods.

A middle-line option would be to purchase a smaller per ton harvester which has over double the capacity of the harvester with a four-foot cutting bar, approximately 3,200 pounds; but less than half the capacity of the harvester with a seven-foot cutting bar. Theoretically, using only this equipment, it would take approximately 75 hours to harvest the recommended 22 acres of Rice Lake, plus time to transport the harvested material to shore. In total, the time to harvest only Rice Lake would be about three weeks per cutting cycle. Since it is also planned to use this harvester on Whitewater Lake during peak harvesting periods, a larger capacity than this equipment provides is warranted.

Accessory equipment needed to accompany a new harvester would include a trailer to move the harvester and a shore conveyor to unload the plants if the new and currently owned harvesters are to work simultaneously. The options exist to buy each piece of equipment separately or to purchase one piece of equipment which is designed for both needs.

A harvesting program should be designed to provide optimal benefits and minimal adverse impacts. Small fish are common in dense macrophyte beds, but larger fish, such as largemouth bass, do not normally utilize these dense beds. Narrow channels may be harvested to provide navigational access and "cruising lanes" for predator fish to migrate into the macrophyte beds to feed on smaller fish. Shared access lanes may also be cut, allowing several residents to use the same lane. Increased use of these lanes should keep them open for longer periods than would be the case if a less directed harvesting program was followed. Because of the demonstrated need for control of aquatic plants in Whitewater and Rice Lakes and because the current lake management decisions have indicated a need for aquatic plant harvesting, harvesting is considered a viable management option which should be continued by the Lakes Management District.

<u>Shoreline Cleanup Crew</u>: Decomposing floating vegetation which builds up along the shorelines limits the use of the riparian shoreline and can be unsightly and foul smelling. Shoreline cleanup is a laborious job which can require substantial amounts of labor and time. Given that significant number of lake home owners are seasonal or elderly it is not always feasible for the riparian owners to clean their shoreline when needed. The Lake Pewaukee Sanitary District has incorporated a shoreline cleanup crew into their harvesting

program to alleviate this problem.[6] Retention of two to three people for a cleanup crew would provide for the removal of substantial amounts of vegetation which if not removed would contribute to the accumulation of organic sediment to the bottom of the Lake and to continued proliferation of aquatic plants. The crew could be rotated between harvesting on Rice Lake, as needed, and as cleanup crew the remainder of the time. Such a crew operates using a flat barge with attached conveyor occupied by a driver and one to two people wading in the water or standing on the barge to pick up floating vegetation and deposit it onto the barge-mounted conveyor which loads it onto the barge. On Pewaukee Lake the shoreline cleanup crew harvested nearly as much vegetation as did the machine operated harvesters.[7] This method leaves the maintenance of the rooted vegetated area between the piers to the responsibility of the riparian owner. A custom-built flat barge is estimated to cost $15,000. Because of the demonstrated need for regular shoreline cleanup the cleanup crew is considered a desirable management measure.

Biological Controls: Another alternative approach to controlling nuisance aquatic plant conditions, in this particular case Eurasian water milfoil, is biological control. Classical biological control has been successfully used to control both weeds and herbivorous insects.[8] Recent documentation states that Euhrychiopsis lecontei, an aquatic weevil species, has the potential as a biological control agent for Eurasian water milfoil. In 1989, the weevil was discovered during a study investigating a decline of Eurasian water milfoil growth in a Vermont pond. Euhrychiopsis proved to have significant effects on Eurasian water milfoil in the field and in the laboratory. The adult weevil feeds on the milfoil causing lesions which make the plant more susceptible to pathogens such as bacteria or fungi while the weevil burrows in the stem of the plant causing enough tissue damage for the plant to lose buoyancy and collapse.[9] Although studies thus far indicate that the weevil has the potential to be a biological control for Eurasian water milfoil, at present there is not enough supporting evidence and actual exposure to warrant recommending this type of control on Whitewater and Rice Lakes except on an experimental basis.

Information and Education

In addition to these in-lake rehabilitation methods, an ongoing campaign of community information would help to support the aquatic plant management program by encouraging the use of shoreland buffer strips, responsible use of household and garden chemicals, and environmentally friendly household and garden practices to minimize the input of nutrients from these riparian areas. This information program would also remind riparian residents of the habitat and other benefits, such as shoreline stabilization, provided by the aquatic flora of the Lakes, and promote the preservation of an healthy aquatic flora in the Whitewater and Rices Lakes.

RECOMMENDED AQUATIC PLANT MANAGEMENT PLAN

The recommended aquatic plant management plan consists of integrated used of mechanical and manual harvesting and chemical treatment designed to minimize the negative impacts on the ecologically valuable areas of the Lakes, while providing the control needed to achieve the desired recreational uses of the Lakes.

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[6] *Charlie Shong, Lake Pewaukee Sanitary District, oral communication, 1995.*

[7] *Ibid.*

[8] *C.B. Huffacker, D.L. Dahlsen, D.H. Janzen and G.G. Kennedy, Insect Influences in the Regulation of Plant Population and Communities, 1984, pp.659-696; C.B. Huffacker and R.L. Rabb, editors, Ecological Entomology, Kohl Wiley, New York, New York, USA.*

[9] *Sally P. Sheldon, "The Potential for Biological Control of Eurasian Water Milfoil (Myriophyllum spicatum) 1990-1995 Final Report," Department of Biology Middlebury College, February 1995.*

In order to implement the recommended aquatic plant management program the following management actions are recommended:

1. The continued operation by the Lake Management District of the existing harvester and transport equipment. This equipment would be operated primarily on Whitewater Lake. This will require the replacement of the drive motor for this transporter barge, which has been found to be impractical to repair.

2. The purchase and operation by the Lake Management District of a second harvester—an Aquarius System HM-420 model or equivalent—and a compatible trailer and shore conveyor. This additional equipment would be operated on Rice Lake with use on Whitewater Lake during peak demand periods in addition to being used to pick up floating aquatic plants.

3. The purchase and operation by the Lake Management District of a custom-built barge-type boat designed to allow for temporary storage of aquatic plants, and for shallow water operation and shoreline cleanup. This boat would be operated by a shoreline cleanup crew, composed of two to three people, to work in conjunction with the mechanical harvesting crew to remove floating aquatic plants. The shoreline crew could work part-time operating the shore barge and part-time working the second harvester depending on the needs at any given time.

4. The possible removal of some of the unattached floating vegetated mats, by the Lake Management District on a contractual basis, as such mats can become a significant impediment to navigation and a safety hazard. It is also recommended that the Lake Management District explore the possibility of a cooperative study with the University of Wisconsin-Whitewater on the composition, source, and ecological significance of the vegetated mats—and of practical means of control—as little information about these mats is currently available.

5. The application of aquatic herbicides should be restricted to the control of nuisance plant species at the public boat launch area, and around docks and piers. Treated areas should be delineated for future reference and the amounts of herbicide used in each area carefully documented on maps provided by the Lake Management District.

6. The control of rooted vegetation between adjacent piers is recommended to be left to the riparian owners concerned, as it time consuming and costly for the mechanical harvester to maneuver between the piers and boats and such maneuvering may entail liability for damage to boats and piers. However, if this service is required of the District, it is recommended that riparian residents requesting this service be required to sign a waiver of liability. It is recommended that the Lake Management District obtain informational brochures regarding shoreline maintenance and distribute these to the residents. In addition, the Lake Management District should consider purchasing several specialty rakes designed for the removal of vegetation from shoreline property and make these available to riparian owners. This would allow the riparian owners to use the rakes on a trial basis before purchasing their own. The rakes cost approximately $90 each, and do not require a permit for use.

7. The incorporation by the Lake Management District into an overall public educational program of information on the types of aquatic plants in the Whitewater and Rice Lakes and the value of and impacts of these plants on water quality, fish, and on wildlife; and alternative methods for controlling existing nuisance plants including the positive and negative aspects of each method. An organized aquatic plant identification day is one method of providing effective education to lake residents. Other sources of information and technical assistance include the Wisconsin Department of Natural Resources Aquatic Plant Monitoring Program and the University of Wisconsin-

Extension. The aquatic plant species list provided in Chapter V, and the illustrations provided in Appendix B, may assist individuals interested in identifying plants near their residences. Residents should be encouraged to observe and document changes in the abundance and types of aquatic plants in their part of the Lake on an annual basis.

Harvesting Plan

The recommended aquatic plant management plan for the Whitewater and Rice Lakes is graphically summarized on Maps C-7 and C-8. As indicated on the maps, it is proposed that aquatic plant management activities be restricted in certain ecologically valuable areas of the Lakes. For this reason, aquatic plant management activities should be confined to zones related to access (Zone A), boating (Zone B), fishing (Zone F), open water (Zone O), and recreation (Zone R) of the Lakes. Further, aquatic plant management operations will be concentrated in Zones B and O (especially near the boating access ramps and in the principal boating use and open water areas).

The environmentally sensitive areas, as identified by the Wisconsin Department of Natural Resources, should be restricted from harvesting, and should receive, only as necessary, limited chemical applications. These are depicted as Zone H. In addition, harvesting should not take place in shallow waters—generally five feet or less—to avoid disturbance of fish spawning areas and beds of native aquatic plants. Special care should be taken to avoid disturbing major spawning and habitat areas of bass in the Whitewater and Rice Lakes during the spring spawning season—May 1 to June 30, annually.

The primary objective of the management program is to accommodate recreational uses of the Lakes, and to enhance the public perception of the Lake without inflicting irreparable damage on the structure and functioning of the lake ecosystem. To accomplish this objective, only specified control measures should be applied in each of the various lake zones identified on Maps C-7 and C-8. The recommended sequence of the harvester operations on Whitewater and Rice Lakes is portrayed in Figures C-2 and C-3. The recommended aquatic plant management treatments that should be applied in each of the six lake zones are shown in Table C-4.

It is envisioned that the harvesting crew will be required to spend about 25 to 35 hours per week on Whitewater Lake and 20 to 60 hours per month on Rice Lake to accomplish the stated goals. In addition, at such time as a two-man shore cleanup crew is established, it is expected that that crew would be required for about 20 to 25 hours per week on average.

Depth of Harvesting and Treatment of Fragments

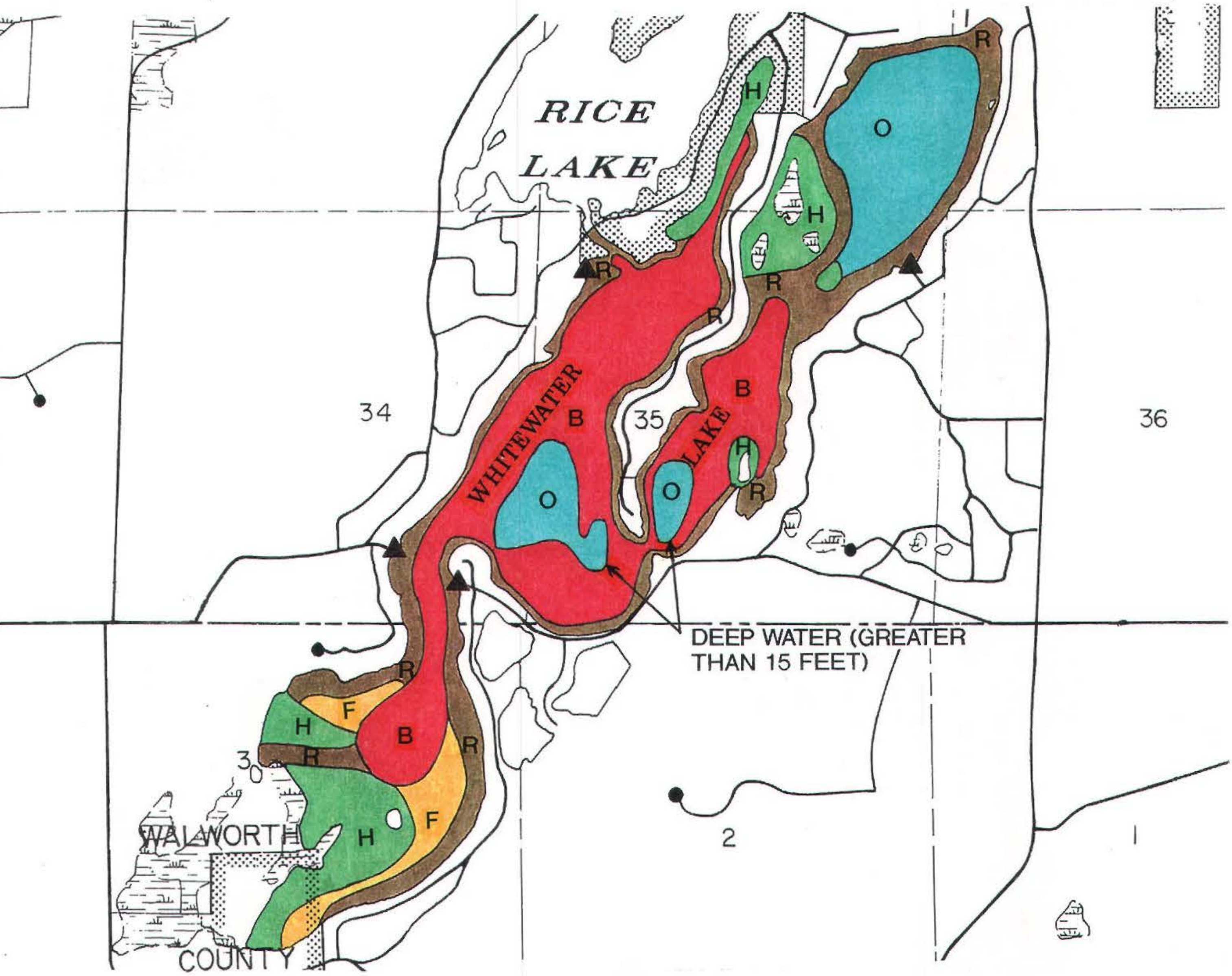
The harvesting equipment proposed to be used has a maximum cutting depth of five feet. While this may exceed the actual water depth in some areas it is not the intention of the owners or operators of the equipment to denude the Lake of aquatic plants given the heavy angling use of the waterbody, its morphology (which is not conducive to extensive motorized boat traffic), and the program goals. All plant cuttings and fragments will be collected *in situ* by the harvester. Those fragments accumulating along the shore land areas will be collected by the District or the riparian homeowners. Fragments can be used by the homeowners as garden mulch.

Buoyage

Temporary marker buoys may be used to direct harvesting operations in the lake basin by marking the areas to be cut. However, the size of the Lake generally precludes the need for such buoys except insofar as they are required for the control of boating traffic on the Lake. The harvester operators will be provided with a laminated copy of the harvesting plan, and made familiar with the plan and local landmarks to the degree necessary to carry out the plan without the use of buoyage. Harvesting operations are regularly supervised by the District Committee.

Map C-7

RECOMMENDED AQUATIC PLANT MANAGEMENT PLAN FOR WHITEWATER LAKE



LEGEND

LAKE USE ZONES

- F FISHING
- O OPEN WATER
- H HABITAT
- R RIPARIAN ACCESS
- B BOATING

AQUATIC PLANT MANAGEMENT

- HARVESTING: LOW PRIORITY CHEMICALS: NONE
- HARVESTING: MODERATE CHEMICALS: LIMITED
- HARVESTING: NONE CHEMICALS: NONE
- HARVESTING: HIGH PRIORITY CHEMICALS: LIMITED
- HARVESTING: MODERATE CHEMICALS: NONE

ACCESS SITES

DESIGNATED SENSITIVE AREAS - SLOW NO-WAKE BOATING ONLY

MONITORING PROGRAM

- CONDUCT FISH SURVEY
- CONTINUE WATER QUALITY MONITORING
- CONDUCT SUPPLEMENTAL AQUATIC PLANT SURVEYS

LAND USE MANAGEMENT

- PROTECT ENVIRONMENTALLY SENSITIVE AREAS

WATERSHED MANAGEMENT

- CARRY OUT IMPLEMENTATION OF GOOD HOUSE-KEEPING PRACTICES

FISH MANAGEMENT

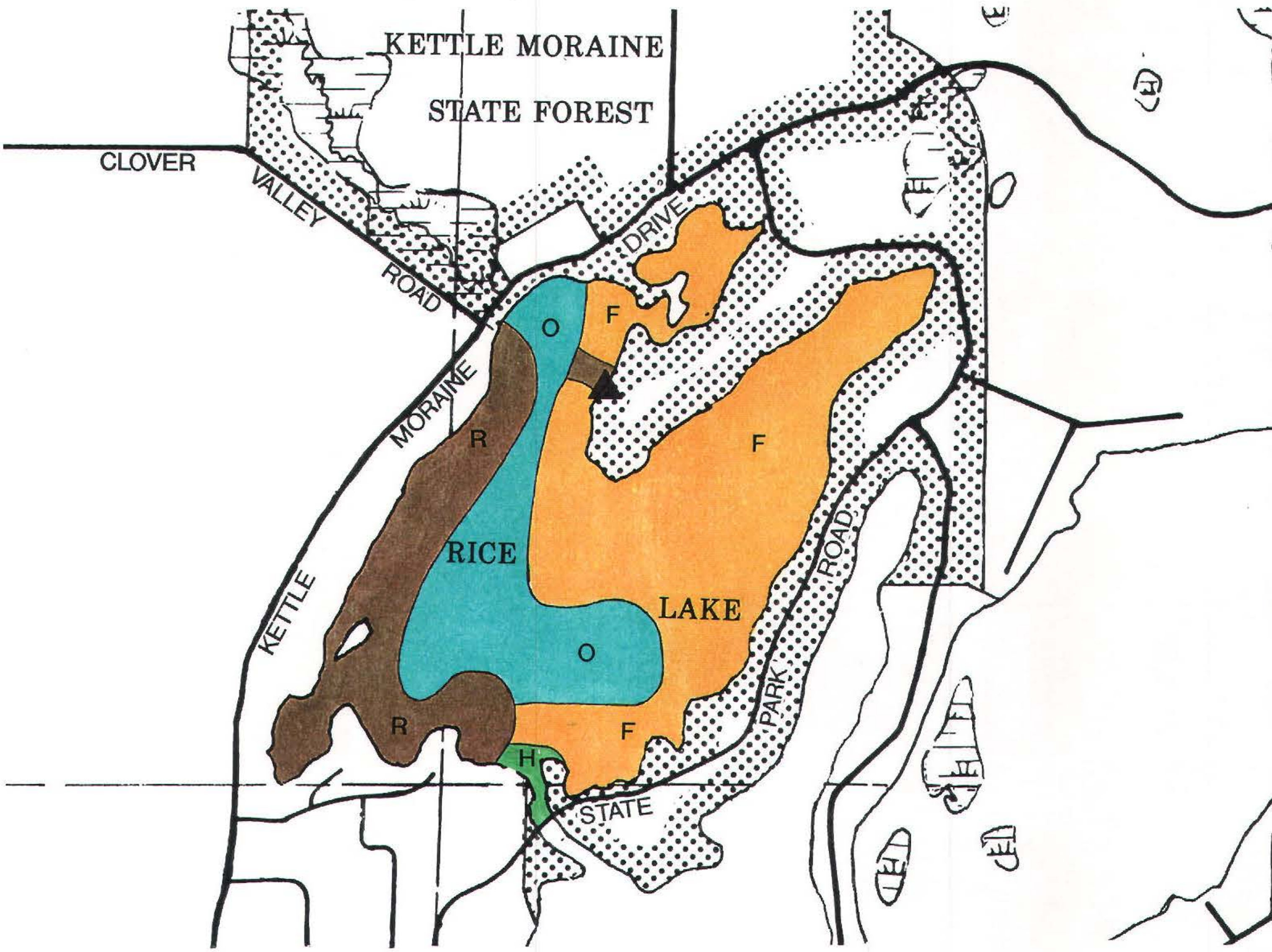
- CONTINUE STOCKING AS REQUIRED

GRAPHIC SCALE 0 1000 2000 FEET

Source: SEWRPC.

Map C-8

RECOMMENDED AQUATIC PLANT MANAGEMENT PLAN FOR RICE LAKE



LEGEND

LAKE USE ZONES

- F FISHING
- O OPEN WATER
- H HABITAT
- R RIPARIAN ACCESS

AQUATIC PLANT MANAGEMENT

- HARVESTING: LOW PRIORITY; CHEMICALS: NONE
- HARVESTING: MODERATE; CHEMICALS: LIMITED
- HARVESTING: NONE; CHEMICALS: NONE
- HARVESTING: HIGH PRIORITY; CHEMICALS: LIMITED

ACCESS SITES

DESIGNATED SENSITIVE AREAS - SLOW NO-WAKE BOATING ONLY

MONITORING PROGRAM

- CONDUCT FISH SURVEY
- CONTINUE WATER QUALITY MONITORING
- CONDUCT SUPPLEMENTAL AQUATIC PLANT SURVEYS

LAND USE MANAGEMENT

- PROTECT ENVIRONMENTALLY SENSITIVE AREAS

WATERSHED MANAGEMENT

- CARRY OUT IMPLEMENTATION OF GOOD HOUSE-KEEPING PRACTICES

FISH MANAGEMENT

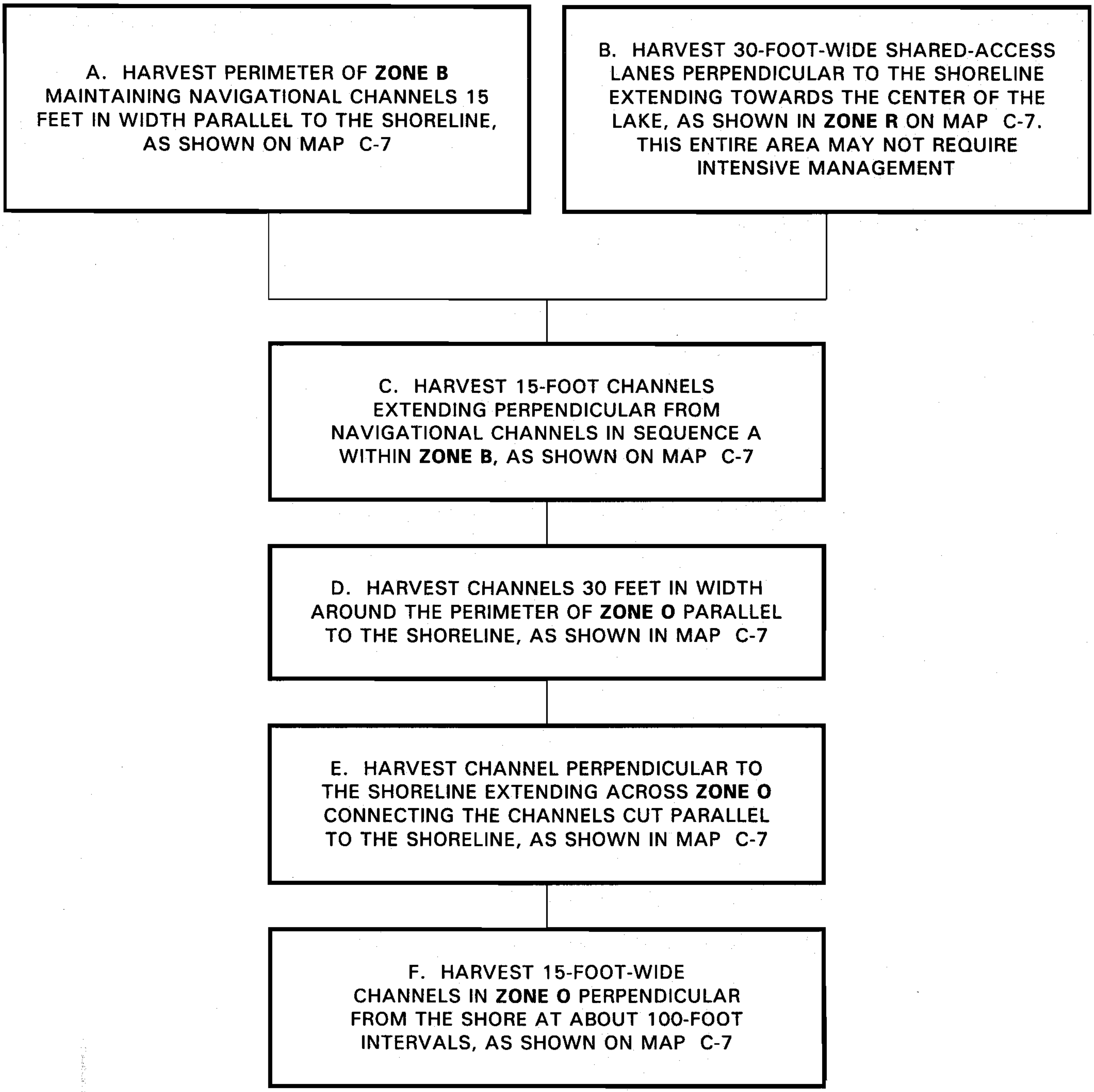
- CONTINUE STOCKING AS REQUIRED

GRAPHIC SCALE 0 500 1000 FEET

Source: SEWRPC.

Figure C-2

HARVESTING SEQUENCE FOR WHITEWATER LAKE[a]



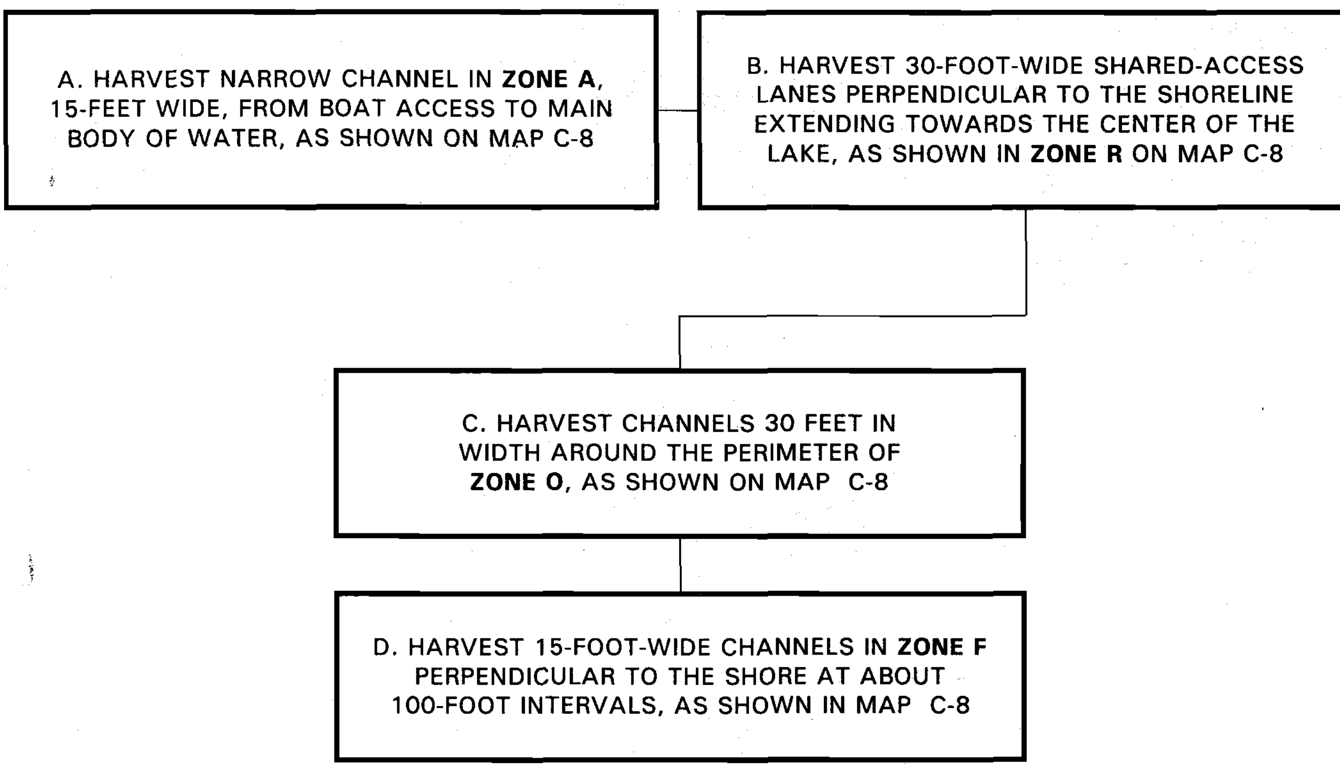
NOTE: Sequence A and B could be done concurrently in one area of the Lake as a time-saving measure.

[a]*No harvesting would be conducted in Zone H or within 100 feet of the island areas.*

Source: SEWRPC.

Figure C-3

HARVESTING SEQUENCE FOR RICE LAKE[a]



[a]*No harvesting would be conducted in Zone H or within 100 feet of the island areas.*

Source: SEWRPC.

Harvested Plant Material Transfer Site(s)
Plant material will be removed from the harvester on a transporter and conveyed to off-loading area, where it will be transferred to a dump truck using a conveyor and transported to disposal sites identified by the Whitewater-Rice Lakes Management District in consultation with the Towns of Whitewater and Richmond. Plant material will be collected and disposed of daily to avoid leaching of nutrients back into the Lake and to minimize the visual degradation of the environment near the boat launching site. The operators will stringently police the off-loading site to ensure minimal disruption of boaters and of the people using the riparian areas of the Lake.

Disposal of Harvested Plant Material
Harvested plant material will be used as land-spread on area farms and disposed of by land disposal on a site located on the east side of CTH P across from the tip of the northern basin, which has been used for disposal for several years by the Lake District and which is approved by the Wisconsin Department of Natural Resources.

Precautions to Protect Wildlife and Ecologically Valuable Areas
Operators will be provided with a laminated copy of the approved harvesting plan map as set forth in Maps C-7 and C-8 and Figures C-2 and C-3, showing the limits of harvesting operations. A copy of these

Table C-4

RECOMMENDED AQUATIC PLANT MANAGEMENT TREATMENTS FOR WHITEWATER AND RICE LAKES

Zone and Priority	Recommended Aquatic Plant Management Treatment	
	Whitewater Lake	Rice Lake
Zone B (Boating) Moderate-Priority Harvesting	Harvesting limited to maintaining 15-feet-wide navigational channels along the perimeter of the Lake, and 30-foot-wide shared access lanes perpendicular to the shoreline extending towards the center of the Lake to allow boat access to the open water area of the Lake Limited late season harvesting—late August to early September—may be necessary to maintain adequate open water areas in the central portion of the Lake Total area harvested on the Lake would be approximately 40 acres	Not applicable
Zone F (Fishing) Low-Priority Harvesting	Zone F is intended to accommodate fishing from a boat It is recommended that approximately 15-foot-wide channels be harvested perpendicular to the shore at about 100-foot intervals Total area recommended to be harvested approximates 15 acres Chemical use, if required, should be restricted to selective control of nuisance species near the public access	Zone F is intended to accommodate fishing from a boat It is recommended that approximately 15-foot-wide channels be harvested perpendicular to the shore at about 100-foot intervals Total area recommended to be harvested approximates 10 acres Chemical use, if required, should be restricted to selective control of nuisance species near the public access
Zone H (Habitat) No Harvesting	It is recommended that selected areas of the Lake be preserved as high-quality habitat area This zone and adjacent lands should be managed for fish habitat No harvesting or in-lake chemical application should be permitted, except in special instances where selective herbicide application may be allowed for the control of nuisance species Debris and litter cleanup would be needed in some adjacent areas; the immediate shoreline should be preserved in natural, open use to the extent possible This zone totals about 15 acres in areal extent	It is recommended that selected areas of the Lake be preserved as high-quality habitat area This zone and adjacent lands should be managed for fish habitat No harvesting or in-lake chemical application should be permitted, except in special instances where selective herbicide application may be allowed for the control of nuisance species Debris and litter cleanup would be needed in some adjacent areas; the immediate shoreline should be preserved in natural, open use to the extent possible This zone totals about one acre in areal extent

Table C-4 (continued)

Zone and Priority	Recommended Aquatic Plant Management Treatment	
	Whitewater Lake	Rice Lake
Zone O (Open Water) Moderate-Priority Harvesting[a]	This zone should supplement those areas designate specifically for fishing Harvesting should be conducted in selected areas of the deeper water to provide a larger shared space for boating and fishing Navigation channels approximately 30 feet in width, should be harvested The total area to be harvested approximates 15 acres	This zone should supplement those areas designate specifically for fishing Harvesting should be conducted in selected areas of the deeper water to provide a larger shared space for boating and fishing Navigation channels approximately 30 feet in width, should be harvested The total area to be harvested approximates six acres
Zone R (Riparian Access) High-Priority Harvesting	The entire area may not require intensive plant management Nuisance aquatic macrophyte growth within 150 feet of shoreline should be harvested to provide maximum opportunities for boating, fishing, and limited swimming Areas between piers should not be harvested due to potential liability and maneuverability problems. Residents are encouraged to manually harvest aquatic plants in these areas	The entire area may not require intensive plant management Nuisance aquatic macrophyte growth within 150 feet of shoreline should be harvested to provide maximum opportunities for boating, fishing, and limited swimming Areas between piers should not be harvested due to potential liability and maneuverability problems. Residents are encouraged to manually harvest aquatic plants in these areas
	Additional 30-foot-wide shared access channels should be harvested to extend to the center of the Lake Harvesting should be concentrated in areas of abundant macrophyte growth Patterns of harvesting will vary yearly dependant on macrophyte abundance Chemical use, if required, should be restricted to pier and dock areas and should not extend more than 100 feet from shore—subject to permit requirements The total area to be harvested approximates 20 acres	Additional 30-foot-wide shared access channels should be harvested to extend to the center of the Lake Harvesting should be concentrated in areas of abundant macrophyte growth Patterns of harvesting will vary yearly dependant on macrophyte abundance Chemical use, if required, should be restricted to pier and dock areas and should not extend more than 100 feet from shore—subject to permit requirements The total area to be harvested approximates four acres
Approximate Total Area to Be Harvested	105 acres	22 acres

[a] *Excludes areas greater than 15 feet which require no harvesting.*

Source: SEWRPC.

maps will be kept on the harvester at all times. Operations should normally not be carried out in those areas with less than three feet of depth to protect bass habitat and spawning areas. Harvesting operations in the areas identified as suitable for bass spawning will be restricted until mid-June to permit undisturbed spawning.

Public Information

It is the policy of the Whitewater-Rice Lakes Management District to maintain an active dialogue with the community. This dialogue is carried out through the medium of the public press and in public fora through various public meetings and other scheduled hearings. The Lake Management District regularly publishes summaries of these meetings in their newsletters.

Harvesting Schedule

The harvesting season will begin no earlier than May 15 and will end about September 30 of each year. Actual harvesting time, not including unloading, maintenance, and downtime, will average 30 to 35 hours per week over a five-day week on average, depending on weather conditions and plant growth, to minimize recreational conflicts. During peak growth periods, this time requirement may be increased somewhat. Further, harvesting will be confined to daylight hours to minimize public disturbances resulting from harvester and plant removal operations. As provided for above, the harvesting operations will also be modified to protect fish spawning areas and other ecologically valuable areas of the lake as set forth on Maps C-7 and C-8.

EQUIPMENT NEEDS AND OPERATION

Equipment Needs and Total Costs

Manufacturer: Aquarius Systems, D&D Products, Inc., North Prairie, Wisconsin, or other manufacturer with comparable equipment.

Existing Equipment Requiring Replacement: 90 horsepower outboard motor

Costs:	90 horsepower outboard motor to accommodate transporter barge	$ 6,000

Harvester: Aquarius Systems model HM-420 or equivalent.

Costs:	HM-420 Aquatic Plant Harvester or equivalent	$55,000
	TR 12 trailer	6,000
	Shore conveyor (for Rice Lake)	13,000

Shore Barge:

Costs:	Shore Barge with conveyor	$15,000
	Total Cost	$95,000

Maintenance Schedule, Storage, and Related Costs

Routine maintenance will be performed by the Whitewater-Rice Lakes Management District in accordance with the manufacturer's recommended maintenance schedule. Maintenance costs will be borne by the Whitewater-Rice Lakes Management District. Winter storage of the harvesting equipment will be the responsibility of the Whitewater-Rice Lakes Management District. The harvesting equipment is stored in a shed located a mile east of the Whitewater Town Hall.

Insurance Coverage

Insurance coverage on the harvesting equipment will be incorporated into the policy held by the Whitewater-Rice Lakes Management District on all capital equipment. Liability insurance for the operation of the harvesting equipment will also be borne by the District. The relevant certificates of insurance will be held by the Whitewater-Rice Lakes Management District.

Operators, Training, and Supervision

The harvesting equipment will be owned and operated by the Whitewater-Rice Lakes Management District, who will be responsible for day-to-day operations of the equipment. The District will provide operator training as required. District staff have extensive experience in the operation of this type of machinery. Initial training will be provided by manufacturers on delivery of the machinery.

Day-to-day supervision will be by the District staff, with oversight by Lake District Commissioners.

EVALUATION AND MONITORING

Daily Record-Keeping Relating to the Harvesting Operation

Daily harvesting activities will be recorded by the operators of the harvesting equipment in an operations log. An annual summary of the harvesting program will be submitted to the Whitewater-Rice Lakes Management District (or designated Committee thereof), and made available to the public at that time.

It is the intention of the Whitewater-Rice Lakes Management District to undertake a periodic, formal review of the harvesting program as set forth in the Management Plan for Whitewater and Rice Lakes, a copy of which has been lodged with the Department's Southeast District Office.

Daily Record-Keeping Relating to the Harvester

Daily maintenance and service records showing engine hours, fuel consumed and oil used, will be recorded in a harvester operations log.

Appendix D

BOATING ORDINANCE FOR WHITEWATER AND RICE LAKES

BOATING ORDINANCE FOR WHITEWATER LAKE
WALWORTH COUNTY, WISCONSIN

ORDINANCE NO. 7WR

A Uniform Ordinance to regulate water traffic boating and water sports upon the waters of Whitewater Lake, Walworth County, Wisconsin, and prescribing penalties for violation thereof.

The Town Board of the Town of Richmond and the Town Board of the Town of Whitewater, Walworth County, Wisconsin, do here ordain as follows:

SECTION I

REPEAL OF CONFLICTING ORDINANCES

All ordinances regulating water traffic, boats, boating or water sports upon the waters covered by this ordinance and all ordinances and parts of ordinances in conflict with this ordinance heretofore enacted by the Town of Whitewater and the Town of Richmond, Walworth County, Wisconsin, are hereby repealed.

SECTION I-A

APPLICABILITY AND ENFORCEMENT

The provisions of this ordinance shall apply to the waters of Whitewater Lake and adjoining channels and lying within the corporate limits of the Towns of Richmond and Whitewater, Walworth County, Wisconsin. The provisions of this ordinance shall be enforced by a Patrol officer or officers appointed by and under the jurisdiction of the Towns of Richmond and Whitewater, Walworth County, Wisconsin.

SECTION II

STATE BOATING AND WATER SAFETY LAWS ADOPTED

The statutory provisions describing and defining regulations with respect to water traffic, boats, boating and related water activities in the following enumerated sections of the Wisconsin Statutes, exclusive of any provisions therein relating to the penalties to be imposed or the punishment for violation of said statutes, are hereby adopted and by reference made a part of this ordinance as if fully set forth herein. Any act required to be performed or prohibited by the provisions of any statute incorporated by reference herein is required or prohibited by this ordinance.

30.50	Definitions
30.501	Capacity Plate on Boat
30.51	Operation of Unnumbered Boats Prohibited
30.52	Certificate of Number
30.53	Identification Number to be Displayed on Boat: Certificate to be Carried

30.54	(2) Transfer of Ownership of Numbered Boat
30.55	Notice of Abandonment or Destruction of Boat or Change of Address
30.60	Classification of Motor Boats
30.61	Lighting Equipment
30.62	Other Equipment
30.64	Patrol Boats Exempt from Certain Regulations
30.65	Traffic Rules
30.66	Speed Restrictions
30.675	Distress Signal Flag
30.67	Accident and Accident Reports
30.68	Prohibited Operations
30.69	Water Skiing
30.70	Skin Diving
30.71	Boats Equipped with Toilets
29.288	Throwing of Refuse in Water
947.047	Metal or Glass Debris in or on the Shore of any body of water

SECTION III

TRAFFIC LANE

A. A traffic lane is hereby established embracing the surface of Whitewater Lake, Walworth County, Wisconsin, in its entirety, excepting therefrom that portion of the waters thereof lying between the shoreline and a line parallel to and one hundred fifty (150) feet distant from the shoreline. This exception is designated a Slow-no-wake area. All channels shall be deemed a Slow-no-wake area and no boat shall anchor in any channel and no boat shall anchor for a distance of one hundred (100) feet in either direction from a line between the tip of the Moraine Heights peninsula and the point opposite.

B. No pier shall extend further into the lake from the shoreline than fifty (50) feet, no raft shall be anchored or moored where it extends into a traffic lane, no private buoy shall be located in a traffic lane, and no boat shall be moored where it can drift into a traffic lane.

SECTION IV

WATER SKIING

1. PROHIBITED AT CERTAIN TIMES: EXCEPTIONS

   a. Except as provided in paragraph (b), no person may operate a motor boat towing a person on water skis, aquaplane or similar device unless there is in the boat a competent person in addition to the operator in a position to observe the progress of the person being towed. An observer shall be considered competent if he can in fact observe the person being towed and can relay any signals to the operator. This observer requirement does not apply to motorboats classified as Class A Motorboats by the department actually operated by the person being towed and so constructed as to be incapable of carrying the operator in or on the motorboat. No person shall operate a boat for the purpose of towing a water skier or engage in water skiing except between the hours of 9:00 A.M. and 7:00 P.M. or sunset, whichever is earlier, Friday, Saturday and Holidays. ~~All other days Water Skiing and boat wakes are permitted from 9:00 A.M. until sunset.~~ Water skiing and boat wakes are permitted Sunday, Monday, Tuesday, Wednesday and Thursday from 9:00 A.M. to sunset except if one of these days would be a legal holiday.

b. Paragraph (a) does not apply to duly authorized water ski tournaments, competitions, exhibitions or trials therefore, where adequate lighting is provided.

2. CAREFUL AND PRUDENT OPERATION

A person operating a motorboat having in tow a person on water skis, aquaplane or similar device shall operate such boat in a careful and prudent manner and at a reasonable distance from the persons and property so as not to endanger the life or property of any person.

3. RESTRICTION

No boat towing persons engaged in water skiing, aquaplaning or similar activity on any lake shall engage in such activity within one hundred (100) feet of any occupied anchored boat or marked swimming area or public boat landing except where pickup and drop area are established and marked with regulatory markers.

4. There shall be no more than two (2) tow lines and only two (2) persons using said tow lines as a means of water skiing or similar sport: the persons being towed must be equipped with a life jacket, life belt or similar lifesaving device. No tow line shall exceed seventy-five (75) feet in length.

5. Any boat engaged in towing a person on water skis, aquaplane or similar device must conform to all sections of this ordinance and, in addition must operate in a counterclockwise pattern on both lakes and inlet and outlet in the traffic lane.

SECTION V

SPEED RESTRICTIONS

A. All boats shall operate at a slow-no-wake speed, from 7:00 P.M. or sunset, whichever is earlier, on Friday, Saturdays and Holidays, to 9:00 A.M. the following day. All other days, water skiing and boat wakes will be permitted from 9:00 A.M. until sunset. The maximum speed outside the traffic lane shall be Slow-no-wake at all times every day of the week.

B. The provision on paragraph (A) shall not apply to boats participating in duty authorized races, water ski tournaments, or exhibitions, or over a course laid out, plainly marked and adequately patrolled.

SECTION VI

SWIMMING REGULATIONS

A. Swimming from boats prohibited. No person shall swim from any boat unless such boat is anchored and unless the swimmers stay within twenty-five (25) feet of the boat. Boats used as bases for swimmers shall be adequately supplied with life preservers to be used in emergencies.

B. No person shall swim more than one hundred fifty (150) feet from the shore nor shall any person do any distance swimming unless he is accompanied by a boat containing a ring buoy or an approved life jacket or similar flotation device and person trained in life saving technique. For this type of swimming, if there be more than one swimmer, each shall be accompanied by a boat. No person shall swim in a traffic lane from sunset to sunrise.

SECTION VII

AIRCRAFT PROHIBITED

It is hereby prohibited for any aircraft to land upon the surface of Whitewater Lake covered by this ordinance. The surface shall include ice as well as water.

SECTION VIII

MOORING OF BOATS

No person, firm or corporation shall dock or moor any boat on the waters or along the shores of Whitewater Lake, Walworth County, Wisconsin, for the purpose of living, sleeping or camping.

SECTION IX

ORGANIZED EVENTS AND DISPLAYS

A. No person, persons or corporations shall organize or participate in any event or display upon the surface of Whitewater Lake without first obtaining a permit for such activity from the Town Board of the Town of Whitewater, Walworth County, Wisconsin.

B. Request for said permit for organized events or displays shall be presented to the Town Board of Whitewater in triplicate before the second Monday of the month preceding the event.

C. Request for said permit shall describe the event, time of the event, and area of the lake to be used.

D Upon action by the Town Board of Whitewater, one copy of said permit shall be returned to the applicant, one copy to the Water Safety Patrol or constable designated by the Town Board, and one copy to be retained by the Town Clerk.

E. It is unlawful for any person, persons or corporations during an organized event or display approved by the Township of Whitewater to anchor any boat within the designated area for the organized event or to in any way interfere with the participants of the organized event in any manner.

SECTION X

ADDITIONAL TRAFFIC RULES

In addition to the traffic rules in Section 30.65 of the Wisconsin Statutes adopted in Section II of this ordinance the following rules shall apply to boats using the waters covered by this ordinance.

A. Mooring lights required. No person shall moor or anchor any boat, raft, buoy or other floating object, or permit the same to drift in the traffic lane described in Section III of this ordinance between sunset and sunrise unless there is prominently displayed thereon a white light of sufficient size and brightness to be visible from any direction (360 degrees) for a distance of one (1) mile on a dark night with clear atmosphere. This paragraph does not apply to duly authorized water ski tournaments, competition exhibits, or displays or trials thereof where adequate lighting is provided.

B. The drivers or operators of all boats by means of which aquaplanes, water skis or similar objects are being towed, and the riders of such aquaplanes, water skis or similar objects, must conform to the same rules and clearances as provided for in this ordinance.

SECTION XI

PENALTIES AND DEPOSITS

A. Any person who shall violate the provisions of this ordinance and the provisions adopted by reference in Section II of this ordinance, shall upon conviction thereof, forfeit not more than Two Hundred ($200.00) Dollars or less than Ten ($10.00) Dollars, together with the costs of prosecution ~~and in default of payment of such forfeiture and costs shall be imprisoned in the County Jail until full payment there is made, but not exceeding sixty (60) days~~.

B. PROCEDURE ON ARREST

Whenever a person is arrested for violation of the provisions of this ordinance, the Water Safety Patrol officers or constable are authorized to permit such person to make a money deposit as provided in Section 30.76 of the Wisconsin Statutes; such deposit shall be made to the Town of Whitewater in an amount not to exceed the amount of the maximum forfeiture which may be imposed after the accused is found guilty, or other such amount as may be fixed by the court in setting up a bond schedule. When the accused makes such money deposit, he may be released from arrest until the Court having jurisdiction of the alleged violation opens or the next succeeding day in which the Court is in session, or until such other time as may be fixed for the hearing of the case.

C. FAILURE OF DEFENDANT TO APPEAR

If the person so arrested and released fails to appear personally or by an authorized attorney or agent before the Court at the time fixed for the hearing, the money deposited by the accused pursuant to the provisions in paragraph B above shall be retained and used for the payment of the forfeiture, which forfeiture may be imposed either with or without costs determined by the Court after the exparte hearing upon the accused. The excess, if any, shall be returned to the person who makes the deposit upon his making application for the same. If the accused is found not guilty, then the entire amount of the deposit shall be returned to the depositor.

D. ARREST FOR VIOLATION

Any person violating any of the terms of this section shall be subject to arrest, whether at the time of the arrest he is on the waterways or upon the shore, and any Water Patrol Officer may pursue the offender ashore to enforce the terms hereof.

SECTION XII

INTENT

It is the intent of this ordinance to provide free access to Whitewater Lake for all users and further provide safe and healthful conditions for the enjoyment of aquatic recreation consistent with public needs and the capacity of the water resource. To this end, the Township of Whitewater and the Township of Richmond, Walworth County, Wisconsin, sets forth the provisions of this ordinance.

SECTION XIII

WISCONSIN STATUTES DEFINED

Wisconsin Statutes of 1973 and applicable legislation of 1975 shall be applicable in this ordinance.

SECTION XIV

SEVERABILITY

The provisions of this ordinance shall be deemed severable and it is expressly declared that the Town Boards would have passed the other provisions of this ordinance irrespective as to whether or not one or more provisions may be declared invalid and if any provisions of this ordinance or the application thereof to any person or circumstances is held invalid, the remainder of the ordinance and the application of such Provisions to other persons or circumstances shall not be affected thereby.

SECTION XV

EFFECTIVE DATE AND CLERK'S DUTY

A. This ordinance shall take effect and be in full force from and after its passage and publication as provided by law.

B. The Clerk is directed to file a copy of this ordinance with the Wisconsin Department of Natural Resources in Madison, Wisconsin.

Adopted this 10 day of May, 1976.

TOWN OF RICHMOND
AYES 3
NOES 0
ABSENT 0
Adopted May 10, 1976
Published May 20, 1976
Signed:
Charles H. Cruse, Chairman
Town of Whitewater
Attest:
Alice Wimer, Clerk
Town of Whitewater

TOWN OF WHITEWATER
AYES
NOES
ABSENT

Signed:
William Johnson, Chairman
Town of Richmond
Attest:
Nancy Rowley, Clerk
Town of Richmond

Amended March 23, 1989
Amended January 10, 1990

BOATING ORDINANCE FOR RICE LAKE
WALWORTH COUNTY, WISCONSIN

ORDINANCE NO. 7-WRA

A Uniform Ordinance to regulate water traffic. floating and water sports upon the waters of Rice Lake Walworth County, Wisconsin, do ordain as follows:

SECTION I

REPEAL OF CONFLICTING ORDINANCES

All ordinances regulating water traffic, boats, floating or water sports upon the waters covered by this ordinance and all ordinances and parts of ordinances in conflict with this ordinance heretofore enacted by the Town of Whitewater, Walworth County, Wisconsin, are hereby repealed.

SECTION I-A

APPLICABILITY AND ENFORCEMENT

The provisions of this ordinance shall apply to the waters of Rice Lake and adjoining channels and lying within the corporate limits of the Town of Whitewater, Walworth County, Wisconsin. The provisions of this ordinance shall be enforced by a Patrol Officer or officers appointed by and under the jurisdiction of the Town of Whitewater, Walworth County, Wisconsin.

SECTION II

STATE BOATING AND WATER SAFETY LAWS ADOPTED

The statutory provisions describing and defining regulations with respect to water traffic, boats, boating and related water activities in the following enumerated sections of the Wisconsin Statutes, exclusive of any provisions therein relating to the penalties to be imposed or the punishment for violation of said statutes, are hereby adopted and by reference made a part of this ordinance as if fully set forth herein. Any act required to be performed or prohibited by the provisions of any statute incorporated by reference herein is required or prohibited by this ordinance.

310.50	Definitions
3O.501	Capacity Plate on Boat
30.51	Operation of unnumbered boats prohibited
30.52	Certificate of Number
30.53	Identification Number to be Displayed on Boat: Certificate to be carried
30.54	(2) Transfer of Ownership of Numbered Boat
30.55	Notice of Abandonment or Destruction of Boat or Change of Address
30.60	Classification of Motor Boats
30-61	Lighting Equipment
30.62	Other Equipment
30.64	Patrol Boats Exempt from Certain Regulations
30.65	Traffic Rules
3O.66	Speed Restrictions
30.675	Distress Signal Flag

30.67	Accident and Accident Reports
30.68	Prohibited Operations
30.69	Water Skiing
30.70	Skin Diving
30.71	Boats Equipped with Toilets
29.288	Throwing of Refuse in Water
947.047	Metal or Glass Debris in or on the Shore of any body of water

SECTION III

TRAFFIC LANE

A. A traffic lane is hereby established embracing the surface of Rice Lake, Walworth County, Wisconsin, in its entirety, excepting therefrom that portion of the waters thereof lying between the shoreline and a line parallel to one hundred fifty (150) feet distant from the shoreline, and excepting therefrom the Northwest, Northeast. and Southwest bays. These exceptions are designated Slow-no-wake areas. All channels shall be deemed Slow-no-wake areas.

B. No pier shall extend further into the lake from the shoreline than fifty (50) feet, no raft shall be anchored or moored where it extends into a traffic lane, no private buoy shall be located in a traffic lane, and no boat shall be moored where it can drift into a traffic lane. All provisions of this section shall be consistent with Sec. 30.13 of Wisconsin Statutes.

SECTION IV

WATER SKIING

1. PROHIBITED AT CERTAIN TIMES: EXCEPTIONS

   a. Except as provided in paragraph (b), no person may operate a motorboat towing a person on water skis, aquaplane or similar device unless there is in the boat a competent person in addition to the operator in a position to observe the progress of the person being towed. An Observer shall be considered competent if in fact can observe person bring towed and relay any signals to the operator. This observer requirement does not apply to motorboats classified as Class A Motorboats by the department actually operated by the person being towed and so constructed as to be incapable of carrying the operator in or on the motorboat. No person shall operate a boat for the purpose of towing a water skier or engage in water skiing except between the hours of 9 a.m. and 7 p.m. or sunset whichever is earlier, Friday, Saturday and Holidays. ~~All other days Water skiing is permitted in the traffic zone from 9:00 a.m. until sunset.~~ Water skiing and boat wakes are permitted Sunday, Monday, Tuesday, Wednesday and Thursday from 9:00 a.m. to sunset except if one of these days would be a legal holiday.

   b. Paragraph (a) does not apply to duly authorized water ski tournaments, competitions, exhibitions or trials therefore, where adequate lighting is provided.

2. CAREFUL AND PRUDENT OPERATION

   A person operating a motorboat having in tow a person on water skis, aquaplane or similar device shall operate such a boat in a careful and prurient manner and at a reasonable distance from the persons and property so as not to endanger the life or property of any person.

3. RESTRICTION

No boat towing persons engaged in water skiing, aquaplaning or similar activity on any lake shall engage in such activity within one hundred (100) feet of any occupied anchored boat or marked swimming area or public boat landing except where pickup and drop are established and marked with regulatory markers.

4. There shall be no more than two (2) tow lines and only two (2) persons using said tow lines as a means of water skiing or similar sport: the persons bring towed must be equipped with a Coast Guard approved personal flotation device. No tow line shall exceed seventy five (75) feet in length.

5. Any boat engaged in towing a person on water skis, aquaplane or similar device must conform to all sections of this ordinance and, in addition must operate in a counterclockwise pattern on both lakes and inlet and outlet in the traffic lane.

SECTION V

SPEED RESTRICTIONS

A. All boats shall operate at a slow no wake speed from 7:00 p.m. or sunset, whichever is earlier, on Fridays, Saturdays and Holidays, to 9:00 a.m. the following day. All other days, water skiing will be permitted from 9:00 a.m. until sunset. The maximum speed outside the traffic lane shall be Slow-no-wake at all times every day of the week.

B. The provision on paragraph (A) shall not apply to boats participating in duly authorized races, water ski tournaments, or exhibitions, or over a course laid out, plainly marked and adequately patrolled.

SECTION VI

SWIMMING REGULATIONS

A. Swimming from boats prohibited. No person shall swim from any boat unless such boat is anchored and unless the swimmers stay within twenty-five (25) feet of the boat. Boats used as bases for swimmers shall be adequately supplied with Coast Guard approved flotation devices to be used in emergencies.

B. No person shall swim more than one hundred fifty (150) feet from the shore nor shall any person do any distance swimming unless he or she is accompanied by a boat containing a ring buoy or Coast Guard approved personal flotation device and person trained in life saving technique. For this type of swimming, if there be more than one swimmer, each shall be accompanied by a boat. No person shall swim in a traffic lane from sunset to sunrise.

SECTION VII

AIRCRAFT PROHIBITED

It is hereby prohibited for any aircraft to land upon the surface of Rice Lake covered by this ordinance. The surface shall include ice as well as water. All provisions of this section shall be consistent with Section 114.105 Wisconsin Statutes.

SECTION VIII

MOORING OF BOATS

No person, firm or corporation shall dock or moor any boat on the waters or along the shores of Rice Lake, Walworth County, Wisconsin, for the purpose of living, sleeping, or camping.

SECTION IX

ORGANIZED EVENTS AND DISPLAYS

A. No person, persons or corporations shall organize or participate in any event or display upon the surface of Rice Lake without first obtaining a permit for such activity from the Town Board of the Town of Whitewater, Walworth County, Wisconsin.

B. Request for said permit for organized events or displays shall be presented to the Town Board of Whitewater in triplicate before the second Monday of the month preceding the event.

C. Request for said permit shall describe the event, time of the event, and area of the lake to be used.

D. Upon action by the Town Board of Whitewater, one copy of said permit shall be returned to the applicant, and one copy to the Water Safety Patrol or constable designated by the Town Board, and one copy to be retained by the Town Clerk.

E. It is unlawful for any person, persons or corporations during an organized event or display approved by the Town Board of Whitewater to anchor any boat within the designated area for the organized event or to in any way interfere with the participants or the organized event in any manner.

SECTION X

ADDITIONAL TRAFFIC RULES

In addition to the traffic rules in Section 30.65 of the Wisconsin Statutes adopted in Section II of this ordinance the following rules shall apply to boats using the waters covered by this ordinance.

A. Mooring lights required. No person shall moor or anchor any boat, raft, buoy or other floating object or permit same to drift in the traffic lane described in Section III of this ordinance between sunset and sunrise unless there is prominently displayed thereon a white light of sufficient size and brightness to be visible from any direction (360) for a Distance of one (1) mile on a dark night with clear atmosphere. This paragraph does not apply to duly authorized water ski tournaments, competition exhibits, or displays or trials thereof where adequate lighting is provided.

B. The drivers or operators of all boats by means of which aquaplanes, water skis or similar objects are being towed, and the riders of such aquaplanes, water skis or similar object, must conform to the same rules and clearances as provided for in this ordinance.

SECTION XI

PENALTIES AND DEPOSITS

Penalties for violation of any part or parts of this ordinance shall be assessed in accordance with Section 30.80 of the Wisconsin Statutes.

B. PROCEDURE ON ARREST

Whenever a person is arrested for violation of the provisions of this ordinance, the Water Safety Patrol Officers or constable are authorized to permit such person to make a money deposit as provided in Section 30.76 of the Wisconsin Statutes: such deposit shall be made to the Town of Whitewater in an amount not to exceed the amount of the maximum forfeiture which may be imposed after the accused is found guilty, or other such amount as may be fixed by the court in settling up a bond schedule. When the accused makes such money deposit, he may be released from arrest until the Court having jurisdiction of the alleged violation opens or the next succeeding day in which the Court is in session or until such other time as may be fixed for the hearing of the case.

C. FAILURE OF DEFENDANT TO APPEAR

If the person so arrested and released fails to appear personally or by an authorized attorney or agent before the Court at the time fixed for the hearing, the money deposited by the accused pursuant to the provisions in paragraph B above shall be retained and used for the payment of the forfeiture, which forfeiture may be imposed either with or without cost as determined by the Court after the exparte hearing upon the accused. The excess, if any, shall be returned to the person who makes the deposit upon his making application for the same. If the accused is found not guilty, then the entire amount of the deposit shall be returned to the depositor.

D. ARREST FOR VIOLATION

Any person violating any of the terms of this section shall be subject to arrest whether at the time of the arrest he is on the Waterways or upon the shore, and any Water Patrol office may pursue the offender ashore to enforce the terms hereof.

SECTION XII

INTENT

It is the intent of this ordinance to provide free access to Rice Lake for all users and further provide safe and healthful conditions for the enjoyment of aquatic recreation consistent with public needs and the capacity of the water resource. To this end, the Town of Whitewater, Walworth County, Wisconsin, sets forth the provisions of this ordinance.

SECTION XIII

WISCONSIN STATUTES DEFINED

Wisconsin Statutes of 1979-80 and applicable legislation of 1981 and 1982 shall be applicable to this ordinance.

SECTION XIV

SEVERABILITY

The provisions of this ordinance shall be deemed severable and it is expressly declared that the Town Board would have passed the other provisions of this ordinance if any provisions of this ordinance irrespective as to whether or not one or more provisions may be declared invalid and circumstances is held invalid, the remainder of the ordinance and the application of such provisions to other persons or circumstances shall not be affected thereby.

SECTION XV

EFFECTIVE DATE AND CLERK'S DUTY

A. This ordinance shall take effect and be in full force from and after its passage and publication as provided by law.

B. The Clerk is directed to file a copy of this ordinance with the Wisconsin Department of Natural Resources in Madison, Wisconsin.

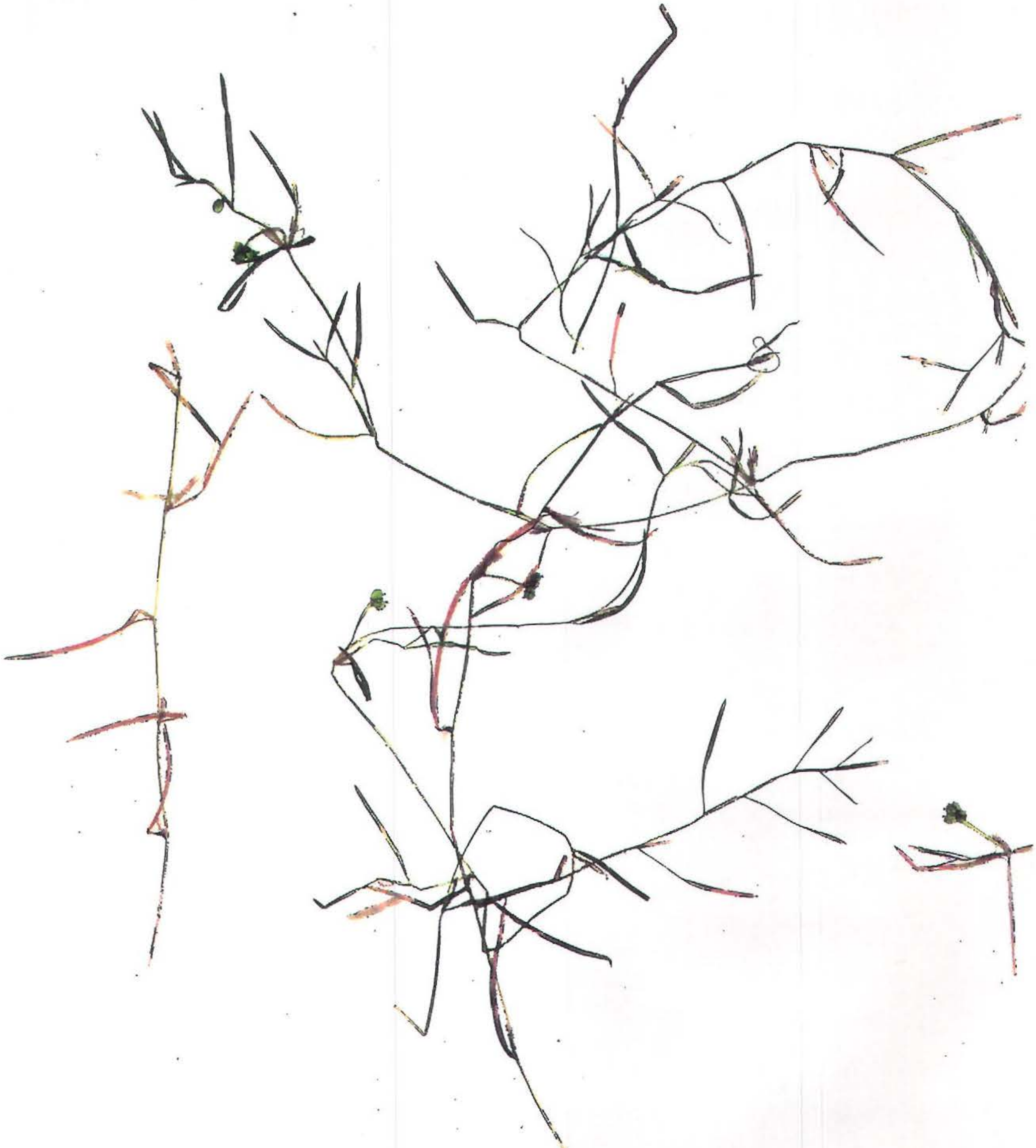
Adopted this 11th day of July, 1983
Town of Whitewater: AYES 3, NOES 0, ABSENT - none

Lowell Wilson, Chairman
Marvin Homburg, 1st Supervisor
Lloyd Addie, 2nd Supervisor
Gwen Vandiver, Clerk

Amended January 10, 1990

Appendix E

ILLUSTRATIONS OF COMMON AQUATIC PLANTS IN WHITEWATER AND RICE LAKES

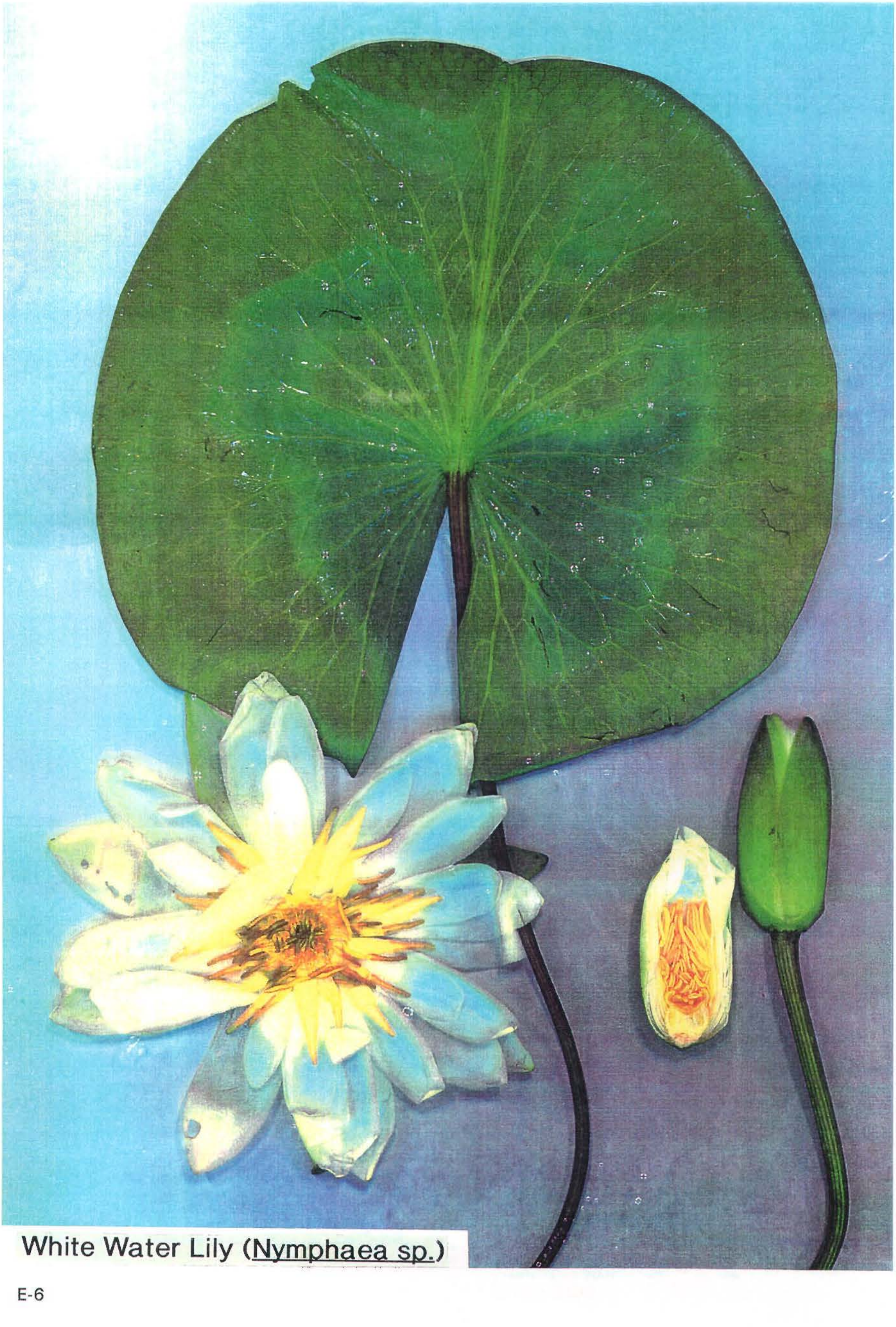


Water Star Grass (<u>Heteranthera dubia</u>)

Muskgrass (Chara sp.)

Flat-Stemmed Pondweed
(Potamogeton zosteriformis)

Coontail (Ceratophyllum demersum)



White Water Lily (<u>Nymphaea sp.</u>)

Yellow Water Lily (<u>Nuphar sp.</u>)

Waterweed (Elodea canadensis)

Eurasian Water Milfoil
(Myriophyllum spicatum)

Water Milfoil (Myriophyllum sp.)

Curly Leaf Pondweed (Potamogeton crispus)

Sago Pondweed
(Potamogeton pectinatus)

Cattail (<u>Typha sp.</u>)