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CONSULTING ENGINEERS

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State of Wisconsin
Department of Natural Resources

TIM RASMAN
Limnologist

Northeast Region Headquarters
1125 N. Military Ave., Box 10448
Green Bay, WI 54307-0448

(920) 492-5903
FAX (920) 492-5913
E-MAIL: rasmat@dnr.state.wi.us

LAKE PLANNING STUDY

FOR

WEST LAKE

Prepared for:

SPREAD EAGLE CHAIN OF LAKES ASSOCIATION

Florence, WI 54121

JUNE 1998

Prepared by:

MMA, INC.
CIVIL AND ENVIRONMENTAL ENGINEERS
2304 Bel-Aire Court P.O. Box 11507
Green Bay, Wisconsin 54304-1507
Phone: (414) 592-9606
Fax: (414) 592-9613

LAKE PLANNING STUDY
FOR
WEST LAKE

EXECUTIVE SUMMARY

West Lake is located in Sections 32 and 33 of Township 40 North, Range 19 East, in the Township of Florence in the northeastern portion of Florence County, Wisconsin. It is the most Western lake of the Spread Eagle Chain of Lakes.

The Spread Eagle Chain of Lakes consists of nine lakes totaling approximately 548 acres in size. West Lake is approximately 72 acres in size. The maximum depth of West Lake is approximately 25 feet (Ref. #3).

The watershed area of the Spread Eagle chain of Lakes consists of approximately 3,200 acres located primarily to the northwest of the Spread Eagle Chain of Lakes. Runoff from the watershed of Montgomery Lake flows down Montgomery Creek to West Lake. The watershed consists predominantly of forest and wetlands with a scattering of residential development. The inlet to West lake supplies much of the water coming into the Spread Eagle Chain of Lakes; springs and precipitation supply the remainder.

The outlet to the Spread Eagle Chain of Lakes is located on the south end of South lake. A small concrete compensation dam controls the lake level. Once water flows over the dam, it continues south and east as the Spread Eagle Outlet, flowing to the Menominee River.

Overall water quality of West Lake is "very good" compared to the state averages of Wisconsin lakes.

- Total Phosphorus levels are low (13 ug/l) and Nitrogen to Phosphorus (N:P) ratios are high (41:1), indicating Phosphorus is the limiting nutrient for plant growth. N:P ratios > 15:1 indicate Phosphorus limits plant growth.

- Samples were taken during spring turnover for total kjeldahl nitrogen, nitrate/nitrite, ammonia nitrogen, salts and metals. Results were all in the low to average range.

- Chlorophyll a results are low (3.3 ug/l), indicating a relatively small amount of algae growth.

- Color, Turbidity and Secchi depth (10 - 17 feet) indicate good water clarity.

- pH levels ranged from 6.8 (February) to 8.5 (August). pH levels over 7.0 indicate non-acidic conditions.

Based on the total phosphorus, chlorophyll a, and water clarity, West Lake is considered an Oligotrophic Lake (a lake with low nutrient levels).

West Lake has a well balanced population of desirable aquatic plants. There is sufficient plant growth in some of the bay areas to make it necessary to remove aquatic plants for boat access to docks. Overall there are enough plants to provide cover, food and spawning locations for fish. While the lake, as a whole, is not clogged with plants that would make boat travel and other recreation activities difficult, this is not true of all areas of the lake.

During the aquatic plant survey conducted in August on West Lake, twenty different species of aquatic plants were identified. The three most dominant plant species found are Chara at forty-six percent occurrence on the lake, Illinois Pondweed at forty-one percent occurrence, and Leafy Pondweed at thirty-seven percent occurrence on West Lake.

No exotic (foreign) species of aquatic plants were found in the aquatic plant survey of the lake.

West Lake supports natural reproduction of a number of pan and game fish species. An electrofishing survey was conducted on the Spread Eagle Chain of Lakes in September of 1994. The results indicate that the Spread Eagle Chain supports a dynamic and diverse fishery.

The fish found in West Lake include Largemouth Bass, Smallmouth Bass, Walleye, Northern, Bluegill, Rockbass, Yellow Perch, and Black Crappie (also known as Calico Bass).

The following fish species use West Lake as a spawning location: Northern, Bass, Walleye, and Bluegill.

The following is a summary of recommendations provided to improve the ecosystem of West Lake:

- The Spread Eagle Lake Association should continue to monitor the water quality of West Lake. Adverse lake trends can thereby be identified and corrected before irreversible damage to the lake has occurred.

- Educate and involve the of property owners in measures that can maintain and improve water quality on West Lake. Maintaining good water quality will help minimize aquatic plant growth and minimize future sedimentation.

- The level of fish stocking in the Spread Eagle Chain of Lakes should be maintained, but not increased. The addition of fish cribs should be continued. The cribs provide habitat for fish to thrive.

- Purchase or rent an aeration system to prevent winterkill of fish in West Lake during winters with deep snow and thick ice conditions

- Consider purchasing or renting an aquatic plant harvester. Selective removal of aquatic plants after the summer growing season is recommended. Removal of dense areas of aquatic plants at this time of year will reduce sedimentation and thereby reduce the amount of nutrients available for future plant growth. Reduced quantities of aquatic plants will also reduce the amount of oxygen required to decompose the plants. This will result in slightly higher oxygen levels in the water during the winter, thereby reducing the likelihood of fish winterkill.

- Carefully weigh the pros and cons of dredging combined with plant harvesting. Be certain to consider all the alternatives and the resulting ecological effects.

- Measures should be taken to protect the shoreline from erosion due to boat traffic. Keep aquatic plants growing near shore and rooted plants on shore to minimize shoreline erosion. In areas of shoreline erosion, obtain a permit to install rock rip-rap near the shoreline.

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1.0. INTRODUCTION

West Lake is one of nine lakes of the Spread Eagle Chain of Lakes located in northeastern Florence County in northeastern Wisconsin. The Spread Eagle Chain of Lakes is located mid-way between Iron Mountain, Michigan and Florence, Wisconsin, near U.S. Highway 2/141. The location of West Lake is shown on Figure No. 1 - Location Map included in Appendix "A."

This section of the report provides a summary of the work to be performed during the study and some historical and general information pertaining to West Lake and the Spread Eagle Chain of Lakes.

1.1. Purpose

The Spread Eagle Chain of Lakes Association, Inc. was formed in 1988, with the objective **"...to provide a forum in which property owners, as members of the Association, can come together to discuss and act upon matters pertaining to the preservation and upkeep of their properties and of the surrounding area. Major interests include water quality, water safety, property improvement, relations with the Town of Florence, and the use of Spread Eagle waters by the general public."** A copy of the Spread Eagle Chain of Lakes Association bylaws is included in Appendix "C."

In 1995, the Spread Eagle Chain of Lakes Association sought financial assistance from the WDNR Lake Management Planning Grant Program for the purpose of conducting a lake planning study on West Lake of the Spread Eagle Chain of Lakes. The Lake Management Planning Grant Program, authorized under Chapter 144.253, Wisconsin Statutes, provides for assistance to eligible sponsors for the collection and analysis of information needed to protect and restore lakes and their watersheds. Lake Planning Grants provide seventy-five percent of the costs incurred. The Spread Eagle Chain of Lakes Association received notice of grant eligibility in October, 1995.

On October 23, 1995, the Spread Eagle Chain of Lakes Association entered into an agreement with MMA, INC. of Green Bay, Wisconsin to provide the following services in conducting the lake planning study:

- Obtain water quality samples and analyze the samples through the State Laboratory of Hygiene for appropriate parameters five (5) times: during winter 1995-96 (ice on), spring 1996 (ice out), June, July and August, 1996.
- Obtain water quality samples from the inlet to West Lake and analyze the samples through the State Laboratory of Hygiene for total and dissolved phosphorus two (2) times during the year.
- Prepare an assessment of the aquatic plant and fish community.
- Address the current usage and resulting impact on the lake.
- Estimate sedimentation along the shoreline of West Lake.

- Assist the Spread Eagle Chain of Lakes Association, through the education of designated members, with the equipment operation and sampling procedures necessary to continue its efforts of monitoring the quality of the Spread Eagle Chain of Lakes.
- Consider all other lake management activities and other local interest groups in the lake study project.
- Tailor the work undertaken to comply, to the greatest extent possible, with the goals, objectives and recommendations of the Upper Green Bay Basin Water Quality Management Plan.
- Conduct a sociological survey consisting of a letter survey of landowners to identify lake management goals and objectives.
- Prepare a news release and attend a public informational meeting to enhance local understanding of the lake's water quality.
- Submit a minimum of two (2) progress reports during the project to the Spread Eagle Lake Association.
- Give recommendations in the areas of water quality, fish management and aquatic plant management.
- Include as part of the final report appropriate physical background information on West Lake.
- Consult with the Lake Study Committee of the Spread Eagle Lake Association near the completion of the project to review material that will be included in the final report. The final report will be written as to be easily understood by the general public.
- Prepare a report summarizing the work to submit to the WDNR.

1.2. History

As with most of northern Wisconsin and the Upper Peninsula of Michigan, prior to the late 1800's the Florence area was a great virgin forest. The Iron Mountain and Florence areas developed in the late 1800's and earlier 1900's as a result of the logging and mining activities in the area.

Logging activities did not occur in the Florence area until the mid to late 1870's, shortly after the government land sales which started in 1866. Most of the logs that were cut in the late 1800's and early 1900's were floated down river to lumber mills. The Menominee River, located just north and east of the Spread Eagle Chain of Lakes, served as a main vehicle for transporting the logs to the lumber mills. By 1898, most of the large stands of virgin pine in Florence County had been cut by the major logging companies, including the virgin Red and White Pine stands in the Spread Eagle Chain of Lakes area. The last of the remaining small stands of virgin pine were harvested from the Spread Eagle Chain of Lakes in winter of 1907 - 1908 (Ref. #1).

Iron ore was discovered by Hiram D. Fisher in the Florence area in 1873 and in Commonwealth in 1876. The Chicago and Northwestern Railway Company extended rail service to Commonwealth and Florence in 1880 to transport the iron ore mined from the

Florence and Commonwealth area. Passenger rail service was provided to Spread Eagle, Commonwealth and Florence in 1881.

Rail service to Spread Eagle opened up the Spread Eagle Chain of Lakes area for recreation and tourism. In 1881, Fred John opened up a resort and an ice house on Bass Island on Bass Lake. It was expanded in 1889 when it was purchased by Emmanuel Chainey to include a popular dance pavilion. In 1894, a resort hotel opened with a saloon and ice house on Eagle Island between Bass Lake and Middle Lake. Each of these resorts had steam powered boats to transport people from the train depot near Railroad Lake to the resorts. Paradise Island on East Lake had a small resort in the 1880's until 1894 (Ref. #2).

In 1882, the first private cottage was built by Mark Dunn on Dunn's Point near the entrance to West Lake. The first major building of cottages on the Spread Eagle Chain of Lakes did not occur until 1904 when the lots on Mosquito Bay of Bass Lake were sold.

Waterfront lots on Spread Eagle Chain of Lakes accessible by roads from the railroad depot sold quickly, while lots which were only accessible by water usually did not sell until the roads were provided shortly after World War 1.

Once roads were built around the Spread Eagle Chain of Lakes making the lots easily accessible, building around the Lakes flourished. Recently, building on vacant lots has given way to the conversion or replacement of summer cottages to year-round homes.

1.3. General Information

West Lake is located in Sections 32 and 33 of Township 40 North, Range 19 East, in the Township of Florence in the northeastern portion of Florence County, Wisconsin. It is the most western lake of the Spread Eagle Chain of Lakes.

The Spread Eagle Chain of Lakes consists of nine lakes totaling approximately 548 acres in size. West Lake is approximately 72 acres in size. The maximum depth of West Lake is approximately 25 feet (Ref. #3). For complete details on the depths of the Spread Eagle Chain of Lakes refer to Figure Nos. 2 & 3 - Lake Survey Maps of the Spread Eagle Chain of Lakes, included in Appendix "A."

It should be noted that Wisconsin Department of Natural Resources (WDNR) publication FM-800-95 Rev - Wisconsin Lakes incorrectly shows an inlet into North Lake which in fact enters into West Lake. These maps include the WDNR Lake Survey Map shown as Figure No. 2 - Lake Survey Map of the Spread Eagle Chain of Lakes, included in Appendix "A," Clarkson map No. 3805 - Spread Eagle Chain and the United States Geological Survey (USGS) topographic map - Florence, East.

The inlet to West Lake supplies much of the water coming into the Spread Eagle Chain of Lakes; springs and precipitation supply the remainder.

The outlet to the Spread Eagle Chain of Lakes is located on the south end of South Lake. A small concrete compensation dam controls the lake level. Once water flows over the dam, it continues south and east as the Spread Eagle Outlet, flowing to the Menominee River.

The soils around West Lake are predominately sandy loams, loamy sands or muck. The primary soil series around West Lake is the Pense sandy loam, followed by the Sayner loamy sand, Markey muck, Sarona - Vilas Complex and Croswell loamy sand (Ref. #4). Descriptions of each of these soil series are located in Glossary of Terms. The sandy soils found around the lake are primarily glacial outwash created after the last stage of glaciation. It appears that the Spread Eagle Chain of Lakes were formed as a result of the glaciers approximately 12,300 years ago (Ref. #5).

These soils are typically well drained with permeabilities ranging from rapid to very rapid. On-site septic system drain fields function satisfactorily, but groundwater pollution is a potential problem because of the rapid to very rapid permeability in the lower soils (Ref. #4).

West Lake bottom soils are a mixture of muck, sand, and gravel. The West Lake bottom soils are dominated by muck (forty percent) followed by sand (thirty percent) and gravel (thirty percent)(Ref. #3). For complete details on the West Lake bottom soils refer to Figure No. 2 - Lake Survey Map of the Spread Eagle Chain of Lakes in Appendix "A."

The annual average precipitation in the Spread Eagle Chain of Lakes area is 29.8 inches. About 18 inches, or sixty percent, usually falls in May through September (Ref. #3).

Prevailing winds are from the west and northwest from late fall through early spring, and from the southwest the remainder of the year. The average wind speed is six miles per hour (Ref. #3).

Public access to the Spread Eagle Chain of Lakes is gained on the southwest side of North Lake. The public access has adequate parking, a boat ramp, a dock, and a latrine.

There are approximately 58 seasonal and permanent residences on West Lake. There are approximately 330 property owners on the entire Spread Eagle Chain of Lakes.

2.0. DISCUSSION OF INFORMATION

The following sections of the report discuss the information generated during the study.

2.1. Property Owner Survey Results

A letter survey was conducted of Spread Eagle Chain of Lakes property owners in July of 1997. The property owners were given an opportunity to express their concerns and offer suggestions regarding the Spread Eagle Chain of Lakes. The Spread Eagle Lake Association will use this information to establish its future goals and objectives. The survey had an excellent return rate: sixty percent of the property owners completed and returned the questionnaire. This response indicates that the Spread Eagle Chain of Lakes property owners want to actively participate in the decisions which affect the future of the Spread Eagle Chain of Lakes.

The following indicates the questions asked by the survey followed by the response by lake:

1. *The West Lake study indicates that the selective removal of aquatic plants in areas of the lake would reduce sedimentation and thereby reduce the amount of nutrients available for future plant growth. It would also result in higher oxygen levels in the winter, thereby reducing the likelihood of fish winterkill.* ***The grant committee should study the feasibility of weed removal and the availability of funding for the same.***

Lake	% AGREE	% DISAGREE	% NO OPINION
Bass	73.9	19.6	6.5
East	77.8	22.2	0.0
Lily	100.0	0.0	0.0
Long	65.2	26.1	8.7
Middle	86.7	13.3	0.0
North	78.6	17.9	3.6
Railroad	68.0	24.0	8.0
South	0.0	50.0	50.0
West	77.5	15.0	7.5
Unknown	40.0	60.0	0.0
All Lakes	**73.3**	**20.5**	**6.2**

The survey results indicate that the grant committee should study the feasibility of weed removal and the availability of funding for the same.

2. *The West Lake study indicates the need to rent or purchase an aeration system to prevent winterkill of fish in West Lake during winters with deep snow and thick ice conditions.* ***The grant committee should study the feasibility of renting/purchasing an aeration system and the availability of funding for the same.***

Lake	% AGREE	% DISAGREE	% NO OPINION
Bass	54.3	34.8	10.9
East	66.7	33.3	0.0
Lily	100.0	0.0	0.0
Long	45.5	45.5	9.1
Middle	60.0	40.0	0.0
North	67.9	28.6	3.6
Railroad	50.0	34.6	15.4
South	0.0	50.0	50.0
West	61.0	29.3	9.8
Unknown	60.0	40.0	0.0
All Lakes	**57.1**	**34.2**	**8.7**

The survey results indicate that the grant committee should study the feasibility of renting/purchasing an aeration system and the availability of funding for the same.

3. *As a preliminary step in pursuing funding for restoration/maintenance of Bacco's Island, it is necessary to complete a lake study. Considering time and cost factors,* ***the grant committee should apply for one study grant for both Bass and Middle Lakes, rather than two separate study grants.***

Lake	% AGREE	% DISAGREE	% NO OPINION
Bass	84.8	8.7	6.5
East	77.8	11.1	11.1
Lily	100.0	0.0	0.0
Long	81.0	14.3	4.8
Middle	66.7	26.7	6.7
North	75.0	21.4	3.6
Railroad	80.8	15.4	3.8
South	100.0	0.0	0.0
West	87.5	7.5	5.0
Unknown	60.0	40.0	0.0
All Lakes	**80.9**	**13.9**	**5.2**

The survey results indicate that the grant committee should apply for one study grant for both Bass and Middle Lakes, rather than two separate study grants.

4. *As part of our on-going grant program, we will soon have available water testing equipment. Carl Sundberg has agreed to be responsible for that equipment and to test and teach others to test water quality. Please indicate your interest in working with Carl in this endeavor.*

Lake	# of People
Bass	8
East	2
Lily	1
Long	1
Middle	2
North	3
Railroad	4
South	0
West	10
All Lakes	**31**

The survey results indicate that the lakes are well represented by property owners who are interested in helping with water quality testing on the Spread Eagle Chain of Lakes.

5. *Lake on which you reside:*

Lake	# of Returned Questionnaires	Approximate # of Property Owners per Lake	% of Response
Bass	46	80	58
East	9	18	50
Lily	2	5	40
Long	21	33	64
Middle	15	47	32
North	28	33	74
Railroad	26	53	49
South	2	2	100
West	40	58	69
Unknown	5		
All Lakes	**194**	**330**	**60**

The survey results indicate that sixty percent of the questionnaires sent out were returned.

6. Please indicate the top three concerns about the Spread Eagle Chain of Lakes.

Lake	Water Quality	Water Safety	Fishing	Noise	Plant Quantity	Boat Landing	Water Levels	Bacco's Island	Other	Shoreline Structure	Wood & Debris	Protect Waterfowl	Plant Species
Bass	27.4	11.1	10.2	11.9	5.8	4.9	2.7	8.0	4.0	3.5	5.3	4.0	1.3
East	40.8	14.3	10.2	12.2	8.2	0.0	2.0	0.0	2.0	4.1	4.1	2.0	0.0
Lily	9.1	0.0	0.0	0.0	27.3	27.3	36.4	0.0	0.0	0.0	0.0	0.0	0.0
Long	34.2	13.2	7.9	13.2	1.8	7.0	2.6	3.5	5.3	3.5	2.6	5.3	0.0
Middle	36.7	22.2	4.4	10.0	1.1	0.0	11.1	2.2	3.3	3.3	3.3	0.0	2.2
North	20.1	9.0	12.5	6.3	13.9	10.4	3.5	5.6	8.3	3.5	1.4	1.4	4.2
Railroad	22.9	24.8	8.3	8.3	1.3	7.0	7.0	4.5	0.0	6.4	7.6	1.3	0.6
South	18.8	25.0	0.0	0.0	0.0	6.3	0.0	0.0	25.0	12.5	0.0	12.5	0.0
West	25.0	9.0	18.0	3.0	18.0	2.5	4.5	4.0	4.0	2.5	1.5	3.5	4.5
Unknown	25.0	0.0	20.8	16.7	12.5	0.0	0.0	0.0	16.7	0.0	0.0	0.0	8.3
All Lakes	**27.1**	**13.7**	**11.0**	**8.6**	**8.1**	**5.2**	**4.8**	**4.6**	**4.6**	**3.8**	**3.6**	**2.8**	**2.2**

The survey results indicate that the top three concerns of Spread Eagle Chain of Lakes Property Owners are: Water Quality, Water Safety, and Fishing.

*7. Please indicate **how many** of each type of watercraft you own.*

Lake	Outboard	Canoe	Rowboat	Pontoon	Paddleboat	I/O	Inboard	PWC	Sailboat	Total
Bass	39	23	9	9	12	19	10	1	2	124
East	7	5	4	2	2	2	2	0	0	24
Lily	1	1	0	1	0	0	2	0	0	5
Long	21	16	4	4	4	6	7	2	1	65
Middle	7	13	5	6	6	3	7	0	2	49
North	23	14	12	8	9	7	7	2	0	82
Railroad	17	7	9	13	7	10	6	0	0	69
South	1	0	1	0	2	0	0	0	0	4
West	30	20	18	17	16	8	3	5	0	117
Unknown	2	4	2	1	0	0	0	0	0	9
All Lakes	**148**	**103**	**64**	**61**	**58**	**55**	**44**	**10**	**5**	**548**

The survey results indicate the type of watercraft most predominant on the Spread Eagle Chain of Lakes. Copies of the returned questionnaires with written responses are found in Appendix "D."

2.2. Water Quality

The purpose of testing a lake's water quality is to document changes in a lake which will help to distinguish between a lake's natural variability and the impacts of human activity. The following information provides a baseline for which future water quality testing of West Lake can be measured.

Water quality samples were taken five times on West Lake during 1996. They were ice on (February), ice out (May), and June, July and August. Two samples were also taken on the inlet to West Lake during June for total and dissolved phosphorus. The location of water quality sampling on West Lake is indicated in Appendix "A," Figure No. 4. The following table shows the analytical parameters for each water sampling event:

Water Sampling Parameter	Month Tested
Total Phosphorus	February, May, June, July, August
Dissolved Phosphorus	February, May, June, July, August
TKN	May
Nitrate/Nitrite	May
Ammonia Nitrogen	May
Color, Turbidity, Sulfate, Chlorides, Alkalinity	May
Magnesium, Sodium, Potassium, Calcium	May
Iron, Manganese, Hardness	May
Chlorophyll a	May, June, July, August
Fecal Coliform	July

2.2.1. Methods of Sample Collection and Testing

Water samples were collected for laboratory analysis with a Wildco®, clear acrylic, one-liter, horizontal style water sampler at specified depths and locations. Samples were immediately transferred to appropriate bottles, preserved (if necessary), labeled, packed in ice and sent via overnight express mail to the laboratory. All laboratory analysis was conducted by the Wisconsin State Laboratory of Hygiene in Madison, Wisconsin, using WDNR specified methods.

Sampling and analysis for total phosphorus and dissolved phosphorus were conducted during all sampling events. Phosphorus is normally the limiting factor in aquatic plant growth.

Sampling and analysis for total phosphorus, dissolved phosphorus, total kjeldahl nitrogen, nitrate/nitrite nitrogen, ammonia nitrogen, color, turbidity, sulfate, chlorides, alkalinity, magnesium, sodium, potassium, calcium, iron, manganese and hardness were all conducted during the May sampling event. The May sampling event took place shortly after spring turnover to take advantage of the natural mixing action that occurs at that time. During spring and fall turnover in a lake, nutrients and sediments stored on the bottom are resuspended. Spring turnover was extremely late this year. The ice was not off West Lake until the first week in May.

Sampling and analysis for chlorophyll a (a measure of algae growth) were conducted during the May, June, July and August sampling events. These are months when algae growth is expected to be the highest in a lake.

Sampling and analysis for fecal coliform (coliform bacteria found in feces) were conducted during the July sampling event. A high fecal coliform count is usually an indication of raw sewage entering the lake. A mid-summer test was conducted because this is the time of highest use of on-site systems by lake residents and visitors.

In addition to the previously described water sampling, physiochemical parameters were measured in the field. These parameters included Secchi depth, dissolved oxygen (DO), specific conductivity, pH, and water temperature.

The Secchi depth is a measure of water clarity. It is determined using a standard secchi disc. The Secchi disk is a black and white circular plastic plate, 20 centimeters (~8 inches) in diameter. The Secchi disc is lowered over the downwind, shaded side of the boat into the water until it just disappears from sight, then raised again until it is visible. The average depth at which the Secchi disk disappears and reappears is the Secchi depth at that location. Water with greater clarity will have a greater Secchi depth. Secchi depth readings were measured on calm sunny days between 10 A.M. and 2 P.M.

Water temperature and DO readings were obtained with a ICM® Model 51601 water analyzer. The probe, located at the end of a 100 foot cable, was lowered into the water to a specified depth. Readings for DO and temperature were recorded at the prescribed elevation.

The measurement of specific conductivity (ability to conduct electricity) of lake water was also done with a ICM® Model 51601 water analyzer. Measurements were taken randomly from a boat traveling along the shoreline. The conductivity measurements were recorded at each location. Distilled water has a conductivity of zero micromhos. As minerals and nutrients are added to the water the specific conductivity goes up. A base reading was taken in the middle of the lake at the beginning and end of each test. The readings obtained along the shoreline were compared to the base readings. If the shoreline readings are considerably higher than the base readings, it can be assumed that minerals or nutrients are coming from a source nearby, i.e., leaking septic drain field system, etc.

The pH (measure of acidity) of surface water in the lake was measured in February, May, June, July and August with an ICM® Model 51601 water analyzer. Readings for pH were taken at the same location as water samples.

2.2.2. Results of Water Quality Analysis

The following sections of the report summarize the water quality sampling and laboratory analysis conducted on West Lake. For complete details of the laboratory results refer to Appendix "E."

Aquatic plants need many elements for growth and survival: Carbon (C), Hydrogen (H), Oxygen (O), Nitrogen (N), Phosphorus (P), Sulfur (S), Calcium (Ca), Magnesium (Mg), Potassium (K), and Iron (Fe). A number of other elements are also necessary, but in

extremely small amounts. Only two of these elements are considered major limiting nutrients when it comes to plant growth in lakes: Nitrogen and Phosphorus (Ref. #6).

2.2.2.1. Phosphorus

Phosphorus is a highly variable nutrient in lakes. Its concentration has probably the greatest effect on aquatic plant growth. The concentration of Phosphorus in West Lake was determined as Total Phosphorus and Dissolved Phosphorus.

Dissolved Phosphorus is, as the name implies, dissolved in the water and readily available for aquatic plant uptake. Its concentration generally varies throughout the year.

Total Phosphorus is a better indicator of the amount of Phosphorus ultimately available in a lake for aquatic plant growth. It is the sum of the dissolved Phosphorus and the Phosphorus contained in suspended plant and animal material in the water.

The following table provides the Total and Dissolved Phosphorus concentrations in water samples collected from West Lake during 1996. The concentrations are presented in micrograms per liter (ug/l) or parts per billion.

Total and Dissolved Phosphorus Concentrations - West Lake

Month	Sample	Total Phosphorus (ug/l)	Dissolved Phosphorus (ug/l)
February	Top	< 7	2
February	Bottom	9	2
May	Top	11	< 2
May	Bottom	11	< 2
June	Top	9	< 2
June	Bottom	35	< 2
July	Top	9	< 2
July	Bottom	9	< 2
August	Top	8	< 2
August	Bottom	23	< 2

*Top samples were obtained within one meter of the surface.
*Bottom samples were obtained within one meter of the bottom.

It should be noted that the 35 ug/l and 23 ug/l results for Total Phosphorus obtained from the June and August bottom samples are higher than normal compared to the rest of the year. During anaerobic (no oxygen) conditions, phosphorus can be driven out of bottom sediment and indicate a temporarily high figure (Ref. #7). This may be a reason for elevated Total Phosphorus results obtained.

Dissolved Phosphorus concentrations should be less then 10 ug/l during spring turnover (May) to prevent summer algae blooms. The results of sampling on West Lake indicate concentrations to be less than the detectable limit of 2 ug/l. This means that a very small amount of phosphorus is readily available for plant uptake.

The following table provides the average Total Phosphorus concentrations for Wisconsin's natural lakes and impoundments.

Total Phosphorus Concentrations for Wisconsin Lakes and Impoundments Compared to West Lake Summer of 1996. (Adapted from Ref. #8 and Ref. #9)

Water Quality Index	Total Phosphorus (ug/l)	State Ave. Total Phosphorus for all Lakes (ug/l)	State Ave. Total Phosphorus for Impoundments (ug/l)	State Ave. Total Phosphorus for Natural Lakes (ug/l)	West Lake Total Phosphorus (ug/l)
Very Poor	> 150				
Poor	55-150		65		
Fair	32-55				
Good	16-32	31		25	
Very Good	2-16				13
Excellent	<2				

The results of Total Phosphorus concentrations are less than those for other natural lakes and much less than that for all lakes (Ref. #9).

2.2.2.2. Nitrogen

Nitrogen is a relatively stable nutrient in most lakes compared to Phosphorus. Nitrogen is a major natural component in decomposing plant and animal matter. It exists in lakes in several forms including: nitrate (NO_3), nitrite (NO_2), ammonia (NH_4) and organic nitrogen. Total Kjeldahl Nitrogen (TKN) is the combined total of ammonia nitrogen and organic nitrogen. Total Nitrogen is the sum of TKN plus nitrate and nitrite nitrogen. The following table provides the results of Nitrogen testing on West Lake conducted during spring turnover. The concentrations are presented in milligrams per liter (mg/l) or parts per million.

Results of Testing for Nitrogen - West Lake, May 1996

Sample	Ammonia Nitrogen (mg/l)	Nitrate/Nitrite (mg/l)	TKN (mg/l)	Total Nitrogen (mg/l)
Bottom	*	0.098	0.4	0.498
Top	0.177	0.067	0.5	0.567

* No laboratory result available

Wisconsin lakes have an average Total Nitrogen concentration of 0.86 mg/l, with seventy-one percent of the lakes falling between 0.30 and 1.0 mg/l (Ref. #9). West Lake falls in the lower half of the range.

The Total Nitrogen to Total Phosphorus ratio (N:P ratio) for West Lake was found to average 41:1 for the year. N:P ratios greater than 15:1 generally indicate Phosphorus is the limiting nutrient for aquatic plant growth.

2.2.2.3. Chlorophyll a

Chlorophyll a is a green pigment necessary for photosynthesis. The amount of chlorophyll a found in lake water is used to estimate algae (phytoplankton biomass) in the lake. The concentration of chlorophyll a found in water samples collected in May, June, July and August (algae season) from West Lake are provided in the following table:

Chlorophyll a - West Lake, 1996

Month	Chlorophyll a (ug/l)
May	3.24
June	1.54*
July	4.64
August	3.64

* Low Absorbance, result approximate

The average concentration of chlorophyll a in Wisconsin lakes was 14.8 ug/l with sixty-five percent of the lakes having a value of less than 10 ug/l (Ref. #9). The results indicate that West Lake is well below the state average for chlorophyll a.

2.2.2.4. Fecal Coliform

Fecal coliform are coliform bacteria originating from animal feces. A high count from a fecal coliform test (greater than 200 colonies per 100 ml sample) usually indicates raw sewage is entering the lake. A mid-summer test was conducted because this is the time of highest use by residents and visitors. The sample taken in July had a count of less than 10 colonies per 100 ml sample.

This indicates that raw sewage was not detected in the sample obtained.

2.2.2.5. Color

The color of a lake is a measure of the amount of material dissolved in the water. Color is mainly aesthetic, but it can affect light penetration and heat absorbance of lakes. Tannic and humic acids originating from decomposing plant material can give a lake a natural brown color. West Lake was sampled in May for color. The following table provides the water color range from low to high as correlated to standard units (SU) of color, and the results of the samples obtained from West Lake.

Water Color (Ref. #8) - West Lake, May 1996

Range	Color	West Lake Top Sample (SU)	West Lake Bottom Sample (SU)
0-40 units	Low	20	25
40-100 units	Medium		
>100 units	High		

The results indicate the color of West Lake is low; this indicates good water clarity.

2.2.2.6. Turbidity

The turbidity of a lake is a measure of the amount of organic and inorganic matter suspended in the water. Levels of turbidity between 0 and 2 Jackson Turbidity Units (JTU) were recorded in forty-four percent of a random data set of Wisconsin lakes according to a 14 year study done by Lillie and Mason. The average Turbidity was listed at 3.1 JTU. Nephelometric Turbidity Units (NTU) are the laboratory units used to measure the turbidity of the West Lake samples. For our purposes, JTU's and NTU's can be assumed to be the same. The May, 1996, sample indicated an average value of 0.9 NTU (0.9 NTU - top, 0.9 NTU - bottom).

The results for West Lake indicate relatively low turbidity.

2.2.2.7. Metals and Salts

The metals and salts found in lake water are primarily related to the types of minerals found in the watershed. The purpose of sampling for these metals and salts is to get a good baseline for future readings to confirm the presence of sources of pollution.

For example, the presence of chloride above its naturally occurring level may be an indicator of a pollution source. Sources of chloride may include septic tank effluent, animal waste, potash fertilizer, and drainage from road salt. The presence of sulfate in lake water can be an indicator of acid rain.

The following is a chart indicating the results of spring testing for metals and salts:

Water Sampling Results for Metals and Salts

Parameter	Bottom Sample (mg/l)	Top Sample (mg/l)
Calcium	24	24
Chloride	5.8	5.8
Hardness	100	100
Iron	0.23	0.22
Magnesium	10	10
Manganese	0.190	0.190
Potassium	1.1	1.5
Sodium	2.0	2.0
Sulfate	10	10

The results of testing for metals and salts in West Lake provide a baseline for future readings. They are all in the low to average range compared to other lakes in Wisconsin.

2.2.3. Secchi Depth

Secchi depth is a measure of water clarity. It measures the combination of color and turbidity and takes into account algae growth as well. Secchi depth is generally a good indicator of a lake's overall water quality. The following table provides a general index of water clarity using Secchi depth:

Water Clarity Index

Water Clarity	Secchi Depth (ft.)
Very Poor	3
Poor	5
Fair	7
Good	10
Very Good	20
Excellent	32

The following table provides the actual Secchi depth measured by MMA, Inc. during the summer months of 1996.

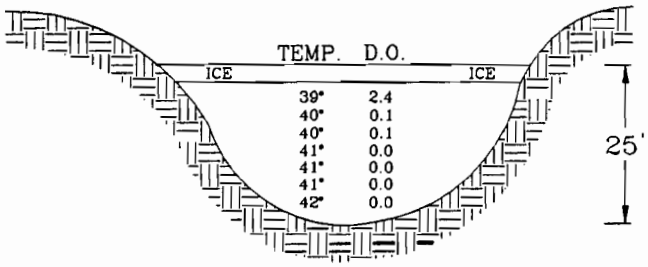
Secchi Depths Measured for West Lake

Month	Secchi Depth (ft.)
May	9.8
June	17.2
July	13.1
August	14.8

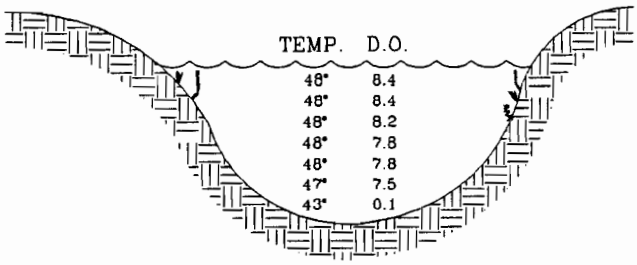
The Secchi depth measured in West Lake in comparison to the water clarity index, indicates West Lake has good water clarity.

2.2.4. Lake Temperature/Dissolved Oxygen

Wave action, mixing of the lake and photosynthesis all add dissolved oxygen (DO) to lake water. Plant and animal respiration and decomposition will decrease the DO supply in a lake. The amount of DO present is also dependent upon water temperature. The lower the temperature of the water, the greater the oxygen solubility and vice versa. For example, the maximum solubility of oxygen in water at 32° F is 15 mg/l; at 68° F the maximum solubility of oxygen in water is 9 mg/l (Ref. #8). The maximum density (weight per unit volume) of water is at 39° F. All these factors interplay when you assess a lakes DO level at any time of the year. The following figures provide the temperature and DO levels for West Lake measured during 1996.



FEBRUARY



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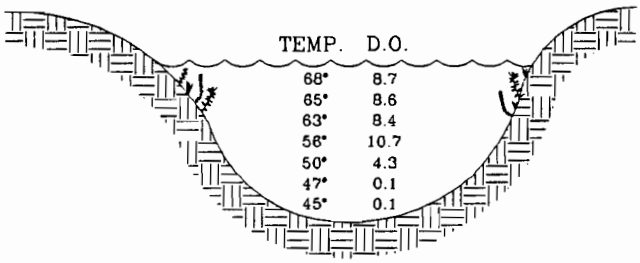

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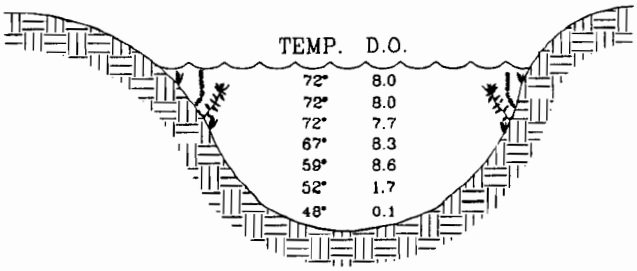

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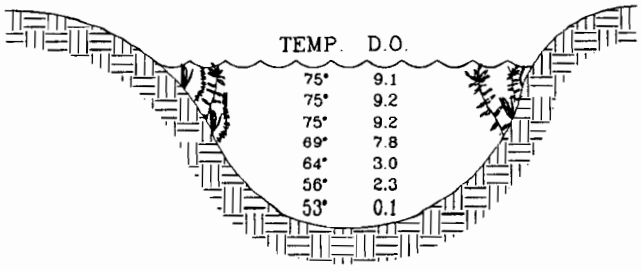

AUGUST

TEMPERATURE (°F)
DISSOLVED OXYGEN (mg/l)
ONE METER INTERVALS SHOWN

TEMPERATURE/DISSOLVED OXYGEN PROFILES – WEST LAKE

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The temperatures and DO levels were measured in West Lake at the sample location in February, May, June, July and August. During February, the temperature at the ice/water interface was the coldest recorded at 33° F and the DO level was the highest at 3.23 mg/l. The DO level dropped rapidly to 0.1 mg/l just two meters from the surface due to the decomposition of plant and animal material and the reduced photosynthesis during the winter. The thickness of the ice and snow reduced the amount of photosynthesis which occurred since it kept the sunlight from reaching aquatic plants.

During May, spring turnover occurred. As the sun warmed the surface water up to 39° F, the 39° F water began to sink to the bottom since the maximum density (weight per unit volume) of water peaks at 39° F. Water that was cooler than 39° F (lighter) began to rise. A great deal of mixing occurred at this time, until the temperature at the top and bottom were the same. During this turnover, some of the decomposed matter and nutrients on the bottom were resuspended. A similar phenomenon occurs in the fall as 39° F water sinks as the surface water is cooled and is replaced by warmer (lighter) water.

During June, July and August, temperatures adjust to the season. The sun maintains the water nearest the surface warm, while the bottom is somewhat cooler. The DO levels remain higher near the surface due to wave action and photosynthesis. Summer stratification does not appear to take place in West Lake. In most lakes greater than 20 feet, a metalimnion layer exists between the warm surface water layer (epilimnion) and the cooler bottom layer (hypolimnion) and prevents complete mixing. Since West Lake is not much deeper than 20 feet at its deepest point, this does not have a chance to occur.

Temperature and DO levels measured in West Lake in February indicate DO readings less than 2 mg/l at depths greater than 1 meter. In shallow lakes, oxygen depletion (winterkill) occurs when plant and animal material decay and use up available oxygen. Winterkill of fish can occur when the DO levels fall much below 1 to 2 mg/l (Ref. #10). Winterkill can be expected during extremely harsh winters in West Lake due to its shallow depth.

2.2.5. Shoreline Specific Conductivity Survey

The specific conductivity (ability to conduct electricity) of the water was measured along the shoreline of West Lake in late summer. The purpose of the specific conductivity survey is to detect higher than normal amounts of nutrients entering West Lake.

Table No. 1, included in Appendix "F," provides the results of the specific conductivity readings. Figure No. 5 - Specific Conductivity Survey Locations, included in Appendix "A," provides the locations of the conductivity readings.

The specific conductivity readings along the shoreline did not show significant variations above the baseline reading.

2.2.6. Water Quality Assessment

Overall water quality of West Lake is "very good" compared to the state averages of Wisconsin lakes.

- Total Phosphorus levels are low (13 ug/l) and Nitrogen to Phosphorus (N:P) ratios are high (41:1), indicating Phosphorus is the limiting nutrient for plant growth. (N:P ratios > 15:1 indicate Phosphorus limits plant growth).
- Samples were taken during spring turnover for total kjeldahl nitrogen, nitrate/nitrite, ammonia nitrogen, salts and metals. Results were all in the low to average range.
- Chlorophyll a results are low (3.3 ug/l), indicating a relatively small amount of algae growth.
- Color, Turbidity and Secchi depths (10 - 17 feet) indicate good water clarity.
- pH levels ranged from 6.8 (February) to 8.5 (August). pH levels over 7.0 indicate non-acidic conditions.

The inlet to West Lake was tested two times in June for Phosphorus content. Total Phosphorus content was also low (11.5 ug/l), indicating the watershed is supplying a low amount of phosphorus to the Spread Eagle Chain of Lakes.

A shoreline specific conductivity survey of West Lake was conducted during July. Specific conductivity indicates the electrical conductivity of the water tested. High amounts of minerals or nutrients would cause increased conductivity of the water and would be indicated by the meter. No abnormal readings were observed.

Based on the total phosphorus, chlorophyll a and water clarity, West Lake is considered a Oligotrophic Lake (a lake with low nutrient levels).

2.3. Aquatic Plant Survey Information

2.3.1. Methods of Testing

The aquatic plant (macrophyte) survey was conducted by boat in August of 1996. Aquatic plants were pulled up with a garden rake in the shallow areas of West Lake. In the deeper areas of West Lake, a device was lowered to the bottom of the lake and dragged along a transect (straight line across the lake) to retrieve the plants. No plants were found to exist below 16' - 20' depth. All plants were found in the littoral zone (zone of light penetration).

2.3.2. Aquatic Plant Density and Abundance Values

From the aquatic plant samples obtained in July, the individual plant species were identified and the *individual plant species* were given a density value as follows:

- (1) Rare
- (2) Occasional
- (3) Common
- (4) Very Common
- (5) Abundant

By area, the *overall aquatic plant abundance* was given a density value as follows:

- (0) Rare
- (1) Occasional
- (2) Moderate
- (3) Abundant
- (4) High
- (5) Very High

Figure No. 6, included in Appendix "A," provides the aquatic plant survey locations of West Lake. Table No. 2, included in Appendix "F," provides a listing of the aquatic plants and their respective locations. Table No. 3, included in Appendix "F," provides the location of aquatic plants with individual plant abundance. Table No. 4, included in Appendix "F," provides the relative plant abundance by area.

2.3.3. Results of the Aquatic Plant Survey

During the aquatic plant survey conducted in August on West Lake, twenty different species of aquatic plants were identified. The three most dominant plant species found are

1) Chara
2) Illinois Pondweed
3) Leafy Pondweed

The three most dominate plant species identified are discussed in detail below. For complete details on aquatic plants refer to "Guide to Wisconsin Aquatic Plants" (Ref. #11), provided in Appendix "G."

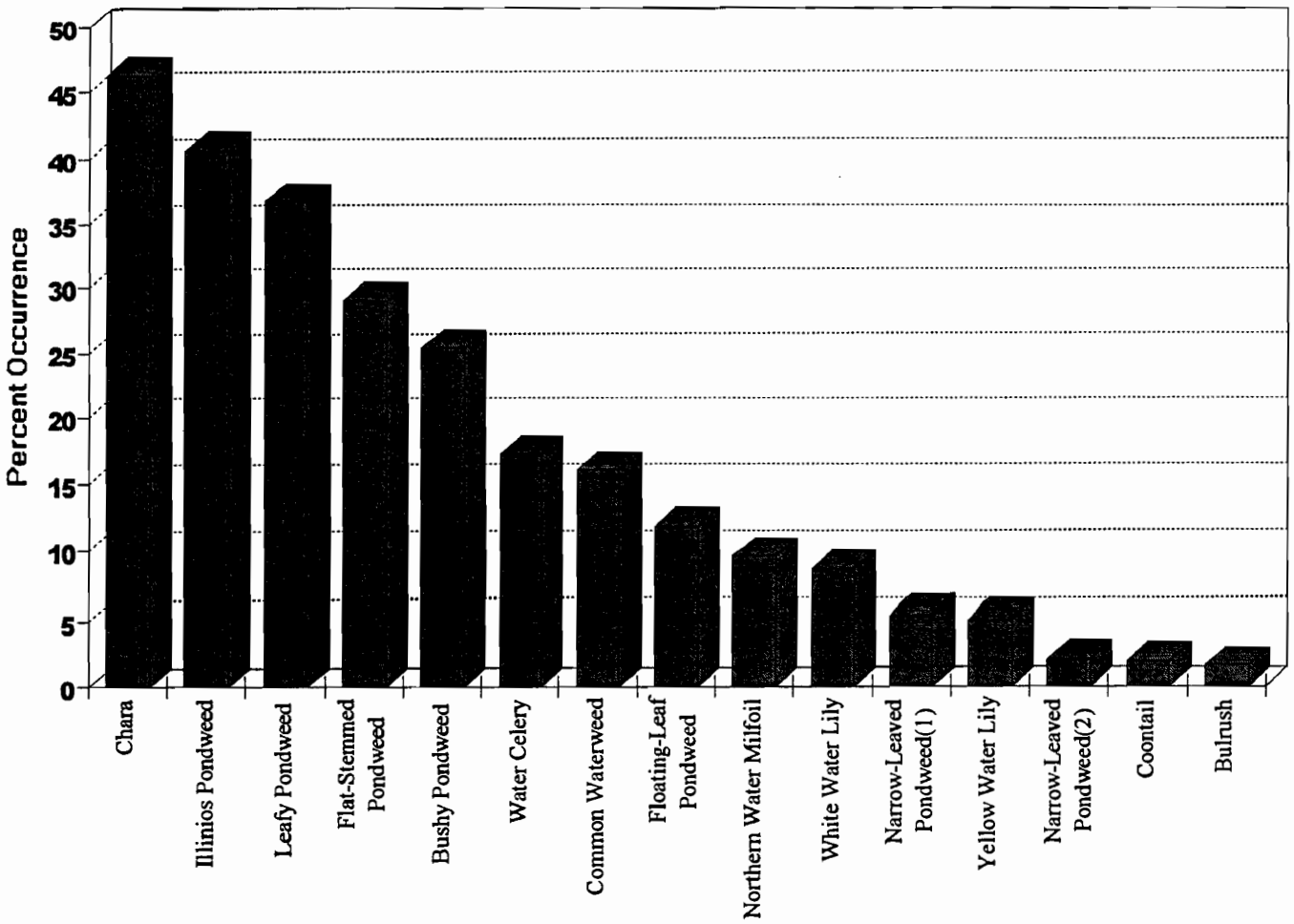
The most prominent aquatic plant found on West Lake is Chara. Chara was found to inhabit approximately 46 percent of West Lake. Even though Chara looks like a plant, it is actually a type of algae. Chara grows entirely below the water surface. It covers a large portion of the lake bottom. Chara has stem-like branches with forked leaves. It has a hollow stem, rough-textured leaves and smells similar to musk when crushed. Chara provides cover for fish and supports insects that provide food for fish and waterfowl (Ref.

#11). See Appendix "G" - Guide to Wisconsin Aquatic Plants for a pictorial representation of Chara.

The second most prominent aquatic plant found at West Lake is Illinois pondweed. Illinois pondweed was found to inhabit approximately 41 percent of West Lake. Illinois pondweed is a broad-leaved aquatic plant that provides an attractive cover for fish, such as panfish, largemouth bass, muskellunge and northern pike. Illinois pondweed also supports insects valuable as food for fish and ducklings (Ref. #11 & 12).

Leafy Pondweed was found to inhabit approximately 37 percent of West Lake. Leafy Pondweed provides good cover for walleye and some cover for bluegill, perch, northern pike and muskellunge. It supports insects valuable as food for fish and waterfowl. (Ref. #11).

All the aquatic plants identified in West Lake inhabiting greater than 1% of the area are provided in the following figure:



Occurrence of Aquatic Plants on West Lake

Plant Identification and Percent Occurrence on West Lake

TAXA Common Name	TAXA (Scientific Name)	% OCCURRENCE
Chara	(Characeae spp.)	46%
Illinois Pondweed	(Potamogeton illoensis)	41%
Leafy Pondweed	(Potamogeton robbinsii)	37%
Flat Stemmed Pondweed	(Potamogeton zosteriformis)	29%
Bushy Pondweed	(Najas flexilis)	25%
Water Celery	(Vallisneria americana)	17%
Common Waterweed	(Elodea canadensis)	16%
Floating-Leaf Pondweed	(Potamogeton natans)	12%
Northern Water Milfoil	(Myriophyllum sibiricum)	10%
White Water Lily	(Nymphaea odorata)	9%
Narrow-Leaved Pondweed (1)	(Potamogeton pusillus)	5%
Yellow Water Lily	(Nuphar variegatum)	5%
Narrow-Leaved Pondweed (2)	(Potamogeton friesii)	2%
Coontail	(Ceratophyllum demersum)	2%
Bulrush	(Scirpus validus)	2%
Narrow-Leaved Pondweed (3)	(Zosterella dubia)	0.8%
Smartweed	(Polygonum amphibium)	0.7%
Sago Pondweed	(Potamogeton pectinatus)	0.6%
Narrow-Leaved Pondweed (4)	(Potamogeton spp.)	0.4%
Narrow-Leaved Pondweed (5)	(Potamogeton strictifolius)	0.2%

The relative density of aquatic plants in West Lake was rated from 0 to 5 (rare to very abundant). The term "very abundant" refers to a relative quantity of aquatic plants that

will inhibit motorized boat travel through these areas because of propeller clogging. West Lake has approximately 2 percent of its area inhabited with a "very abundant" amount of aquatic plants, and approximately 11 percent of its area inhabited with an "abundant" (relative density of 4) amount of aquatic plants in the months of July through September. The areas of West Lake with an "abundant to very abundant" amount of aquatic plants (13%) are shown in Figure No. 7, included in Appendix "A." Approximately 17 percent of West Lake is classified with an aquatic plant density category of rare (relative density of 0).

No exotic (foreign) plant species were found during the aquatic plant survey of West Lake.

It should be noted, that while no aquatic plant survey was conducted in 1995, MMA, Inc. did an informal observation in August of that year. There appeared to be less abundance of aquatic plants in 1996, than was observed in 1995. This could be attributed to late ice-out conditions on the lake in 1996 giving plants a late start. Informal input from some West Lake property owners, however, indicated they did not seem to notice much difference in the quantity of the aquatic plants in 1996 compared to other years.

2.4. Fish Species Information

The Spread Eagle Chain of Lakes has been shown to support the natural reproduction of a number of pan and game fish species. The most recent electrofishing survey was conducted by the WDNR on the Spread Eagle Chain of Lakes in September of 1994. The results indicate that the Spread Eagle Chain supports a dynamic and diverse fishery. West Lake was not included in the electrofishing survey. However, the Spread Eagle Chain of Lakes are fairly consistent throughout, with minor variations.

The dominant predator fish in West Lake is the largemouth bass. Other predator fish include northern, walleye and smallmouth bass. Bluegill dominate the panfish population followed by rockbass, yellow perch, and black crappie (Ref. #13). The crappie population seems to have decreased in recent years and may be undergoing a cyclic low period which is common for crappie (Ref. #13).

In the Spread Eagle Chain of Lakes as a whole, large and smallmouth bass remain the dominant predators with an expanding walleye population. The capture of 22 walleye fingerlings in 1994 without any walleye planting the year before indicates the natural reproduction of walleye is occurring. Northern Pike are also an important component to the game fishery, but they are not sampled efficiently with electrofishing equipment.

Bluegill dominate the panfish population followed by rockbass, yellow perch, and black crappie. All species supported fish over seven inches with some over ten inches (Ref. #13). The results of electrofishing surveys conducted by the WDNR in 1993 and 1994 are included in Appendix "I."

Available information on the fish species identified during the electrofishing survey is included in Appendix "H." The information includes identification, distribution, habits, habitat, life cycles, fishing hints and environmental concerns for each of these species.

The spawning and nursery locations of fish on West Lake are shown on Figure No. 8, located in Appendix "A" (Ref. #14). The following fish species use West Lake as a spawning location:

- Northern
- Bass
- Walleye
- Bluegill

2.5. Watershed

The watershed area of the Spread Eagle Chain of Lakes consists of approximately 3,200 acres located primarily to the northwest of the Spread Eagle Chain of Lakes. Runoff from the watershed of Montgomery Lake flows down Montgomery Creek to West Lake. The watershed consists predominantly of forest and wetlands with a scattering of residential development. Figure No. 9 - Watershed Area of the Spread Eagle Chain of Lakes, included in Appendix "A," shows the watershed area and surface runoff patterns in the watershed.

Approximately 450 acres of wetland make up part of the Spread Eagle Chain of Lake's watershed area. Wetland locations are shown in Figure No. 10, included in Appendix "A." Much of the wetland area is located to the northwest of the Spread Eagle Chain of Lakes along Montgomery Creek and the tributaries to Montgomery Creek.

The estimated Phosphorus loading of the watershed is approximately 250 lb/year for a dry year, 617 lb/year for a normal year, and 1,580 lb/year for a wet year. These results are based on values obtained using the WDNR Wisconsin Lake Model Spreadsheet (WILMS version 1.01) and the input of watershed data for the Spread Eagle Chain of Lakes Watershed (see Appendix "I" for the printout of the WILMS spreadsheet). The results obtained reflect the low nutrient loading from forested watersheds. If the Spread Eagle Chain of Lakes were located in Dane County, for example, where the watershed contains a higher amount of nutrients and the land is primarily agricultural, the phosphorus loading would be of approximately 522 lb/year for a dry year, 2,140 lb/year for a normal year and 6,350 lb/year for a wet year.

The inlet to West Lake was tested two times in June for Phosphorus content. Total Phosphorus content was also low (11.5 ug/l), confirming the watershed is supplying a low amount of phosphorus to the Spread Eagle Chain of Lakes.

The drainage basin/lake area ratio (DB:LA) of the Spread Eagle Chain of Lakes is approximately 5.8:1. This is based on a watershed (drainage basin) area of 3,200 acres

and a lake area of 548 acres. The Spread Eagle Chain of Lakes has a low DB:LA ratio which is generally an indicator of low phosphorus loading.

Figure No.'s 2 & 3 - Lake Survey Maps of the Spread Eagle Chain of Lakes, included in Appendix "A," indicate areas of steep slopes around the lakes.

2.6. Lake Usage Impact

The purpose of this section is to evaluate the current usage of West Lake and its resulting environmental impact on the lake.

2.6.1. Fishing

Fishing on West Lake has had no significant ecological impact. The West Lake fishery is in excellent condition with no appreciable reduction in the fish population due to overfishing. The overall size of some game fish may have been reduced by fishing, but a healthy population exists of significant size.

2.6.2. Motorized Boating

The use of motorized boats on West Lake has had some impact on the lake. The use of motorized boats has shifted sediment in the lake. The sediment shift due to boat traffic is generally only in the shallow areas of the lake. Plants growing in the bays are generally coated with sediment throughout the summer months. It is unknown how much effect this has on aquatic plant growth or fish reproduction in the bay. Increased sediment concentration in the water does decrease the amount of sunlight available for photosynthesis. When boats resuspend sediment, they also resuspend nutrients normally unavailable for use by aquatic plants. Sediment resuspension by boats is generally limited to water depths 10 to 15 feet below the surface. The greater the horsepower, the larger the particles that can be resuspended as well as the greater the depth affected. The frequency of boat traffic also increases the settling time of sediment (Ref. #15).

Boat traffic also increases shoreline erosion. How much shoreline erosion has taken place on West Lake due to boat traffic is unknown since no baseline points have been established along the shore for that purpose. Shoreline which does not have aquatic plants nearby to help dampen the wave action, or shoreline devoid of rooted vegetation or rip-rap are the most vulnerable to erosion.

Personal watercraft (Jet Skis) have had no greater effect on West Lake than other motorized boat traffic. Personal watercraft are more obvious than conventional boats due to the type of noise they produce and their ability to turn tight circles and operate closer to shore. Their affect on the environment, however, is no different than that of a conventional boat. The operation and subsequent safety concerns of personal watercraft is not within the scope of this report.

2.6.3. Shoreline Development

Shoreline development has reduced some areas once available to wildlife. The areas along the shoreline that once provided a source of food, shelter and breeding for a number of birds and mammals have been reduced. Approximately 26% of the area within 100' of the West Lake shoreline is now without tree cover. Leaving a natural buffer area of trees and shrubs near shore provides wildlife habitat and reduces the chances of soil erosion and the addition of nutrients into the lake.

Associated with shoreline development is increased motorized boat traffic. As noted in Section 2.6.2 - Motorized Boating, boats will resuspend sediment near shore causing the addition of nutrients available to plants in the water, increasing plant growth. Conversely, aquatic plants are also removed by boats in the traffic area. The removal of plants reduces the dampening effect they have to wave action, making shoreline erosion a greater possibility when boats enter or leave.

With each house built along shore is a septic system. The affect of the septic systems on the West Lake does not appear to be significant. Water quality data in addition to the shoreline conductivity survey do not indicate excessive levels of nutrients entering the water from septic systems.

2.7. Sedimentation

The sediment found in West Lake is generally located in the bay areas that are protected from wind which allows the sediment to settle. A great deal of sediment was also found near the inlet. This is to be expected since the inlet carries sediment and debris from plants located along the creek. The bottom of West Lake in the deeper sections also contain a great deal of sediment. Because of its inability to support aquatic plants at a depth over 20 feet, only the sediment along shore in the shallow areas were included in this study.

The sediment has come from over 12,000 years of plant and animal decay. The aquatic plants and animals that have lived in the lake combined with the leaves and trees that fall into the lake have become the sediment we now see.

Each spring and fall as the water temperature equalizes, the lake is said to turn over. Since water is heaviest at 39° F, water both warmer and cooler moves toward the surface. In the process, the movement of water resuspends sediment. The spring and fall are also times of high winds which move the sediment around the lake by circulation. The sediment is finally deposited in the quieter areas of the lake where the water is not moving to keep it suspended.

During the summer months, the wind will resuspend some of the sediment in the shallow areas of the lake for redeposition elsewhere.

Areas which were previously immune to the resuspension of sediment because of their location, are now being mixed up by boat traffic, with the sediment redeposited elsewhere in the lake. For this reason, it may appear that there has been a greater amount of sedimentation in recent years, when in fact, it is the redistribution of some of the sediment which was deposited over the last 12,000 years.

Figure No. 4, included in Appendix "A," shows sediment depth along the shoreline of West Lake. As can be seen by the map, the areas of greatest sedimentation near the shore are in the protected bays. These areas are also areas of high aquatic plant density since the sediment provides nutrients for the plants.

3.0. CONCLUSIONS

The following section contains the conclusions drawn from the information collected during the study of West Lake.

3.1. Property Ownership Survey

Based on the results of the survey, the following were indicated:

- The grant committee should study the feasibility of weed removal and the availability of funding for the same.
- The grant committee should study the feasibility of renting/purchasing an aeration system and the availability of funding for the same.
- The grant committee should apply for one study grant for both Bass and Middle Lakes, rather than two separate study grants.
- The top three concerns of Spread Eagle Chain of Lakes property owners are: Water Quality, Water Safety, and Fishing.

3.2. Water Quality

Overall water quality of West Lake is "very good" compared to the state averages of Wisconsin lakes.

- Total Phosphorus levels are low (13 ug/l) and Nitrogen to Phosphorus (N:P) ratios are high (41:1), indicating Phosphorus is the limiting nutrient for plant growth. N:P ratios > 15:1 indicate Phosphorus limits plant growth.
- Samples were taken during spring turnover for total kjeldahl nitrogen, nitrate/nitrite, ammonia nitrogen, salts and metals. Results were all in the low to average range.
- Chlorophyll a results are low (3.3 ug/l), indicating a relatively small amount of algae growth.
- Color, Turbidity and Secchi depths (10 - 17 feet) indicate good water clarity.
- pH levels ranged from 6.8 (February) to 8.5 (August). pH levels over 7.0 indicate non-acidic conditions.

The inlet to West Lake was tested two times in June for Phosphorus content. Total Phosphorus content was also low (11.5 ug/l), indicating the watershed is supplying a low amount of phosphorus to the Spread Eagle Chain of Lakes.

Based on the total phosphorus, chlorophyll a and water clarity, West Lake is considered an Oligotrophic Lake (a lake with low nutrient levels).

3.3. Aquatic Plant Survey

During the aquatic plant survey conducted in August on West Lake, twenty different species of aquatic plants were identified. The three most dominant plant species found are

1) Chara
2) Illinois Pondweed
3) Leafy Pondweed

No exotic species of aquatic plants were found in the aquatic plant survey of the lake.

West Lake has a well balanced population of desirable aquatic plants. There is sufficient plant growth in some of the bay areas to make it necessary to remove aquatic plants for boat access to docks. Overall there are enough plants to provide cover, food and spawning locations for fish. While the lake, as a whole, is not clogged with plants that would make boat travel and other recreation activities difficult, this is not true of all areas of the lake.

3.4. Fish Species

An electrofishing survey was conducted on the Spread Eagle Chain of Lakes in September of 1994. The results indicate that the Spread Eagle Chain supports a dynamic and diverse fishery. While, West Lake was not included in the 1994 electrofishing survey, the Spread Eagle Chain of Lakes are fairly consistent throughout, with minor variations.

West Lake supports natural reproduction of a number of pan and game fish species. The fish found in West Lake include

- Largemouth Bass
- Smallmouth Bass
- Walleye
- Northern
- Bluegill
- Rockbass
- Yellow Perch
- Black Crappie

The following fish species use West Lake as a spawning location:

- Northern
- Bass
- Walleye
- Bluegill

3.5. Watershed

The watershed area of the Spread Eagle chain of Lakes consists of approximately 3,200 acres located primarily to the northwest of the Spread Eagle Chain of Lakes. Runoff from the watershed of Montgomery Lake flows down Montgomery Creek to West Lake. The watershed is predominantly forest and wetland with a scattering of residential development.

Since the watershed is predominantly forest and wetland, its runoff is low in nutrients.

3.6. Lake Usage Impact

There have been no significant impacts on the ecosystem of West Lake due to lake usage. Sediment shifts due to boat traffic and decreased wildlife habitat due to shoreline development are the main impacts related to the usage of West Lake.

3.7. Sedimentation Impact

The sediment has come from over 12,000 years of plant and animal decay. Some of the sediment is resuspended by spring and fall turn over as well as wind and wave action and is redeposited in quieter portions of the lake. In more recent times, high horsepower motorized boats have made major changes in where the sediment is deposited. Areas which were previously immune to the resuspension of sediment because of there location in relation to the wind, are now being mixed up with the sediment being deposited elsewhere.

4.0. RECOMMENDATIONS

The following section contains recommendations on water quality, aquatic plant management, fish management, watershed practices, lake usage, and sedimentation.

4.1. Water Quality Recommendations

The water quality of West Lake is very good as compared to other Wisconsin Lakes. Continued sound ecological practices by residents are necessary to maintain or improve water quality. Education and involvement of property owners should be promoted.

Mailers can be sent to property owners informing them of sound ecological practices which include the following:

- Have your septic system checked by a qualified individual.
- Have your septic tank pumped every three years.
- Keep an undisturbed buffer zone of natural trees and plants between the lake and your dwelling.
- Avoid using chemical fertilizers, if you choose to have a lawn.
- Don't dump leaves or grass clippings in the lake.

It is important that Spread Eagle Association continues to monitor the water quality of West Lake. Adverse lake trends can be identified and corrected before irreversible damage to the lake has occurred.

4.2. Aquatic Plant Management Recommendations

West Lake has a well balanced quantity of aquatic plants necessary for a healthy ecosystem. Aquatic plants which hinder boat access to docks can be removed by small scale cutting or pulling. Large scale removal of aquatic plants or the use of chemicals to kill aquatic plants is not recommended. Large scale removal of native aquatic plants will only provide areas for exotic plants to move in if they are once introduced.

Selective removal of aquatic plants after the summer growing season is recommended, however. Removal of dense areas of aquatic plants at this time of year will reduce sedimentation and thereby reduce the amount of nutrients available for future plant growth. Reduced quantities of aquatic plants will also reduce the amount of oxygen required to decompose the plants. This will result in slightly higher oxygen levels in the water during the winter, thereby reducing the likelihood of fish winterkill.

4.3. Fish Management Recommendations

Currently, the Spread Eagle Chain of Lakes has an excellent fishery. Walleye are being lightly stocked in the Spread Eagle Chain of Lakes with the addition of approximately

2,000 fingerlings every couple of years. It is not recommended at this time to increase fish stocking. If walleye stocking were increased dramatically, they would be in competition with bass and thereby reduce their numbers. Only walleye and northern would be left if this would occur. This may be good for the avid fisherman, but for kids and the average fisherman it would not, since bass are fish everyone can have fun catching.

The addition of fish cribs on the Spread Eagle Chain of Lakes should be continued. The cribs provide a beneficial habitat in which fish can thrive. While there are currently no fish cribs in West Lake, the West Lake fish population has the potential to increase from the cribs installed in other lakes.

If the Spread Eagle Lake Association has any questions on stocking fish, Russ Heiser of the WDNR - Peshtigo office is able to assist them in making fish management decisions.

It is also recommended that the Spread Eagle Chain of Lakes Association look into the purchase or rental of an aeration system to prevent winterkill of fish in West Lake. The dissolved oxygen levels were found to be dangerously low during testing in February of 1996. The DO level dropped to unsupportable conditions just two meters below the surface due to the decomposition of plant and animal material and the reduced photosynthesis during the winter. The thickness of the ice and snow reduces the amount of photosynthesis which occurs since it keeps the sunlight from reaching aquatic plants.

West Lake did have a fish dieoff about 15 years ago, but it has not reoccurred since. However, it is advisable to have an aeration system available to shallow lakes, such as West Lake, to prevent winterkill on years of heavy snowfall and thick ice.

4.4. Watershed Recommendations

The water quality of West Lake is very good. Continued sound ecological practices of residents within the watershed are necessary to maintain or improve water quality. Education and involvement of property owners should be promoted as is recommended in Section 4.1 - Water Quality Recommendations.

4.5. Lake Usage Recommendations

Since the use of boats on the lakes is not going to decrease in the foreseeable future, it is best to protect the shoreline as much as possible. Keep aquatic plants growing near shore and rooted plants on shore to minimize shoreline erosion. In areas where shoreline erosion develops, it is recommended that the owners secure a permit to install rock rip-rap near the shoreline. Leave a natural buffer area of trees and shrubs near shore to provide a wildlife habitat as well as to reduce the chances of soil erosion and filter nutrients that could enter the lake.

To obtain information about a permit to install rip-rap or other shoreline protection, contact Tim Funk, Water Regulation and Zoning Specialist at the WDNR Antigo Office.

4.6. Sedimentation Recommendations

There is very little that can be done to stop the continued addition of sediment to a lake. The continual decay of plants and animals in addition to surface water runoff will continue to add to this process. However, by reducing the amount of nutrients added to a lake, plant life can be minimized and thereby decrease the amount of sediment added. Following the recommendations listed in Section 4.1 - Water Quality Recommendations will help.

The redistribution of sediment due to boat traffic is difficult to control. Short of implementing no-wake zones, sediment from boat traffic will continue to be redistributed.

One way to eliminate the sediment already in place is removal. This is typically done by small floating dredges. However, it has been shown over the years that dredging is only a temporary remedy. Sediment from decaying plants and animals will again fill in dredged areas. Aquatic plant harvesting, in addition to the initial dredging of affected areas may help slow the addition of sedimentation. After the summer growing season, aquatic plants are harvested and placed on land to decompose. This reduces the sediment buildup and nutrient deposition from decomposing aquatic plants, thereby slowing aquatic plant growth. Dissolved oxygen uptake by decomposing aquatic plants in winter months will also be reduced.

There are drawbacks, however. Changing these areas of sedimentation may affect the spawning and nursery locations for some fish. As can be seen in Figure No.'s 4 & 8, located in Appendix "A," the areas of greatest sedimentation are also good areas for the spawning of bass, bluegill and northern. The removal of sediment and aquatic plant harvesting should be weighed carefully against the effect it may have on the fish community.

5.0. SUMMARY OF RECOMMENDATIONS

The following is a summary of recommendations provided to improve the ecosystem of West Lake:

- The Spread Eagle Lake Association should continue to monitor the water quality of West Lake. Adverse lake trends can thereby be identified and corrected before irreversible damage to the lake has occurred.

- Educate and involve the of property owners in measures that can maintain and improve water quality on West Lake. Maintaining good water quality will help minimize aquatic plant growth and minimize future sedimentation.

- The level of fish stocking in the Spread Eagle Chain of Lakes should be maintained, but not increased. The addition of fish cribs should be continued. The cribs provide habitat for fish to thrive.

- Purchase or rent an aeration system to prevent winterkill of fish in West Lake during winters with deep snow and thick ice conditions

- Consider purchasing or renting an aquatic plant harvester. Selective removal of aquatic plants after the summer growing season is recommended. Removal of dense areas of aquatic plants at this time of year will reduce sedimentation and thereby reduce the amount of nutrients available for future plant growth. Reduced quantities of aquatic plants will also reduce the amount of oxygen required to decompose the plants. This will result in slightly higher oxygen levels in the water during the winter, thereby reducing the likelihood of fish winterkill.

- Carefully weigh the pros and cons of dredging combined with plant harvesting. Be certain to consider all the alternatives and the resulting ecological effects.

- Measures should be taken to protect the shoreline from erosion due to boat traffic. Keep aquatic plants growing near shore and rooted plants on shore to minimize shoreline erosion. In areas of shoreline erosion, obtain a permit to install rock rip-rap near the shoreline.

6.0. REPORT LIMITATIONS

This document was developed and prepared as a limited investigation and evaluation subject to the constraints of cost and time. This document is not intended to represent a total, complete, exhaustive or extensive investigation and evaluation.

The report was performed with the degree of care and levels of skill and experience ordinarily used, under like, or similar circumstances, by professional consultants practicing in this general locality and similar areas. No other warranty or guarantee, expressed, or implied, is made with respect to the findings, conclusions and professional advice and opinion included in this document.

The report contained in this document is based upon an observation of site conditions, information provided by the WDNR and investigation of historical and public records.

7.0. USE OF DOCUMENT BY OTHERS

This document has been developed and prepared for a specific application, under specific limitations. This document, therefore, may not be used without the prior written approval of the authors, West Lake Grant Committee and MMA, INC.

References

(Ref. #1) Putnam Robbins. July 22, 1995 conversation and letter to MMA, Inc. dated January 8, 1996. Mr. Robbins, born in 1902, has spent part of every summer at the Spread Eagle Chain of Lakes. Author of *THE EAGLE SPREADS ITS WINGS.*

(Ref. #2) Putnam Robbins. 1988. *THE EAGLE SPREADS ITS WINGS.*

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(Ref. #14) Fred Fox. August 15, 1995 conversation. Fred Fox is a lifetime resident and avid fisherman of the Spread Eagle Chain of Lakes.

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(Ref. #16) Carper, G.L. and R.W. Bachman. 1984. *Wind Resuspension of Sediments in Prairie Lake.*

(Ref. #17) United States Department of Agriculture, Soil Conservation Service. 1987. *Soil Survey of Marinette County, Wisconsin.*

(Ref. #18) United States Department of Agriculture, Soil Conservation Service. 1988. *Soil Survey of Oconto County, Wisconsin.*

Note: The references are noted in the report by insertion of (Ref. #00) at the end of each passage pertaining to the particular reference used.

Glossary of Terms

Algae — One-celled (phytoplankton) or multicellular plants either suspended in water (plankton) or attached to rocks and other substrates (periphton). Their abundance is measured by the amount of chlorophyll a in an open water sample, and is commonly used to classify the tropic state of a lake (Ref. #8).

Alkalinity — A measure of the amount of carbonates, bicarbonates and hydroxide present in water (Ref. #18).

Ammonia Nitrogen — A form of nitrogen found in organic materials and many fertilizers. It is the first form of nitrogen released when organic matter decays. It can be used by most aquatic plants and is therefore an important nutrient (Ref. #8).

Chlorophyll a — A green pigment present in all green plant life and required in photosynthesis. The amount found in lake water is related to the amount of algae and is therefore used as an indicator of water quality.

Color — Measured in color units that relate to a standard. A yellow-brown natural color is associated with lakes or rivers receiving wetland drainage. The average color value for Wisconsin lakes is 39 units, with color of state lakes ranging from zero to 320 units. Color affects light penetration and therefore the depth at which plants can grow (Ref. #8).

Croswell Loamy Sand — Typically, the surface layer is black, very friable, loamy sand about 1 inch thick. The subsurface layer is brown, very friable loamy sand about 2 inches thick. The subsoil is about 27 inches thick. It is dark reddish brown, very friable loamy sand in the upper part; reddish brown, very friable sand in the next part; and yellowish red, mottled, very friable sand in the lower part. The substratum to a depth of about 60 inches is reddish brown and brown , mottled sand (Ref. #17).

Epilimnion — See "Stratification."

Eutrophic — Trophic classification of a lake, indicating very productive and fertile conditions (see Eutrophication).

Eutrophication	The process by which lakes are enriched with nutrients, increasing the production of rooted aquatic plants and algae. The extent to which this process has occurred is reflected in a lake's trophic classification: oligotrophic (nutrient poor), mesotrophic (moderately productive), and eutrophic (very productive and fertile) (Ref. #8).
Fetch	Distance over water that the wind blows (Ref. #16).
Fingerlings	Young fish, 1-4 inches in length.
Friable	Readily crumbled, brittle.
Fry	Newly hatched Fish.
Hypolimnion	See "Stratification."
TKN	Total Kjeldahl Nitrogen, ammonium plus organic nitrogen.
Littoral Zone	The shallow area of a lake from the shore to the depth where light no longer penetrates to the bottom.
Loam	Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.
Macrophyte	Aquatic vascular plants that grow either floating, emergent or submergent in a body of water.
Markey Mucks	Soils which consist of deep, very poorly drained soils on outwash plains. These soils formed in organic material derived primarily from herbaceous plants and are underlain by sandy material. They are moderately permeable in the upper part and rapidly permeable in the lower part (Ref. #18).
Mesotrophic	Trophic classification of a lake, indicating moderately productive conditions (see Eutrophication).
Metalimnion	See "Stratification."
Micromhos	One millionth of a mho. A mho is a unit of conductance reciprocal to the ohm.
Oligotrophic	Trophic classification of a lake, indicating nutrient poor conditions (see Eutrophication).

Pense Sandy Loam

Typically, the surface layer is black sandy loam about 1 inch thick. The subsurface layer is brown sandy loam about 1 inch thick. The subsoil is about 21 inches thick. It is dark brown, friable sandy loam in the upper part; brown, friable sandy loam in the next part; and brown friable loamy sand in the lower part. The substratum to a depth of about 60 inches is strong brown, loose, stratified sand and gravel. In some places the surface layer and subsoil are loamy sand. In other places the stratum is sand (Ref. #18).

Permeability

The rate that water travels through soil.

pH

A measure of acidity or alkalinity, numerically equal to 7 for neutral solutions, increasing in acidity as the number decreases from 7 to zero, increasing in alkalinity as the number increases from 7 to 14.

Photosynthesis

The process by which green plants convert carbon dioxide to sugar plus oxygen using sunlight for energy.

Sarona - Vilas Complex

Moderately steep and steep, well drained soil formed in loamy deposits and in the underlying loamy or sandy glacial till; moderately steep and steep, somewhat excessively drained soil formed primarily in sandy glacial outwash. This map unit is highly erodible (Ref. #4).

Sayner Loamy Sand

Typically, the surface layer is black, very friable loamy sand about 4 inches thick. The subsoil is about 21 inches thick. It is reddish brown, very friable loamy sand in the upper part and strong brown, very friable gravelly sand in the lower part. The substratum to a depth of about 60 inches is strong brown gravelly sand (Ref. #17).

Specific Conductivity

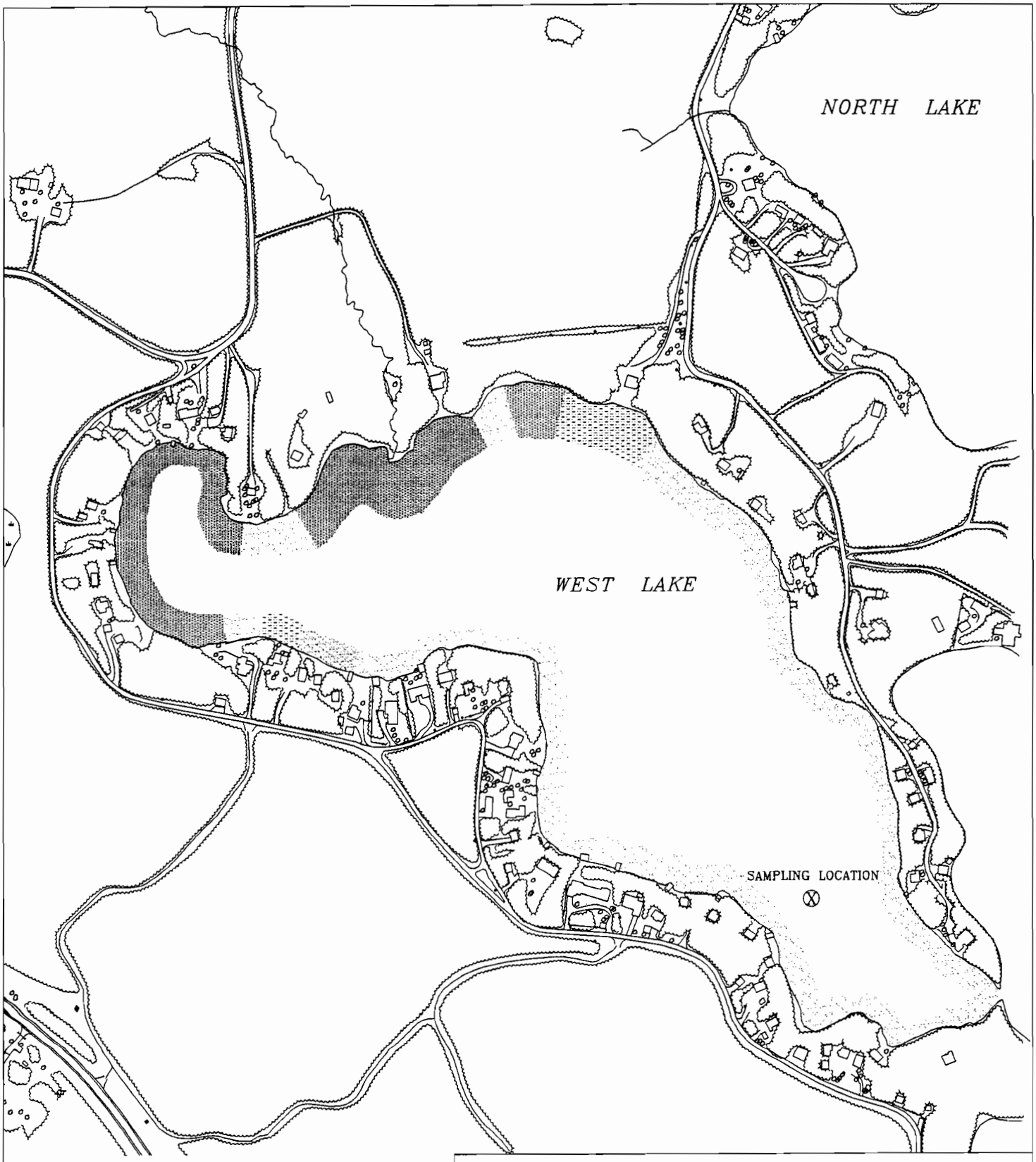
A measure of water's ability to conduct electricity. Conductivity is reported in micromhos per centimeter. and is directly related to the total dissolved inorganic chemicals in the water. Values are commonly two times the water hardness unless the water is receiving high concentrations of contaminants introduced by humans (Ref. #8).

Stratification The layering of water due to differences in density. Water's greatest density occurs at 39°F (4°C). As water warms during the summer, it remains near the surface while colder water remains near the bottom. Wind mixing determines the thickness of the warm surface layer (epilimnion), which usually extends to a depth of about 20 feet. The narrow transition zone between the epilimnion and cold bottom water (hypolimnion) is called the metalimnion or thermocline.

Thermocline See "Stratification."

Trophic State See "Eutrophication."

Turnover Overturn of the water mass of a lake from the surface to the bottom under uniform temperature conditions due to the action of wind energy.



LEGEND

SEDIMENT DEPTH:

- > 3'
- 2' – 3'
- 1' – 2'
- 6" – 12"
- 0" – 6"

NOTE: ONLY SHORELINE SEDIMENTATION WAS MAPPED.
STUDY DOES NOT INCLUDE AREAS > 70' FROM SHORELINE.

SEDIMENT DEPTH

SCALE: 1" =500'	APPROVED BY:	DRAWN BY: SMF
DATE: 1/22/97		REVISED:

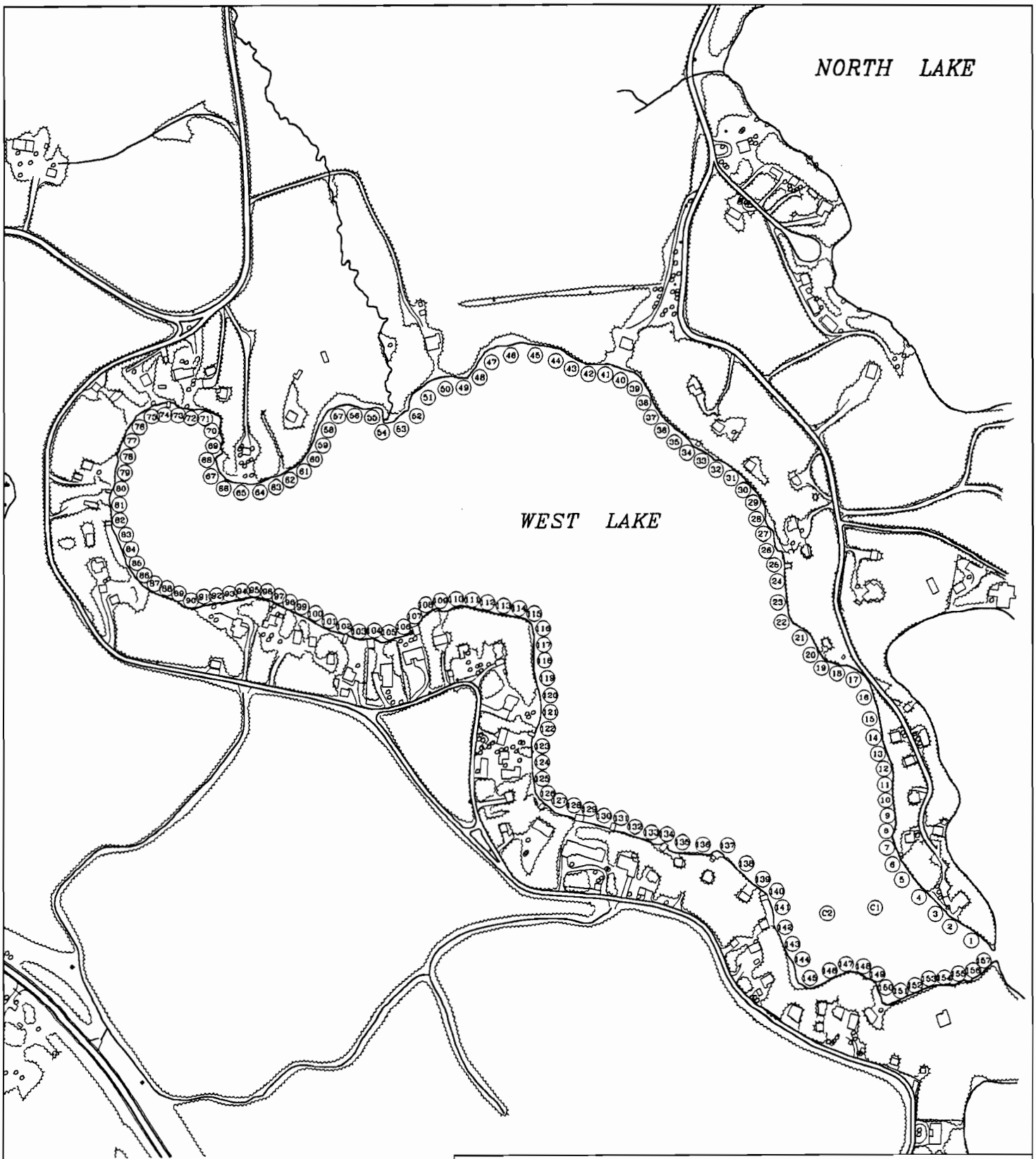
SPREAD EAGLE CHAIN OF LAKES ASSOCIATION
Florence, Wisconsin

MMA, INC. – Florence, WI

FIGURE NUMBER: 4

E:\EAGLE\WEST\WEST.DWG

DIGITAL BASE MAP FILES USED WITH PERMISSION FROM THE FLORENCE UTILITY COMMISSION.



SPECIFIC CONDUCTIVITY SURVEY LOCATIONS

SCALE: 1"=500'	APPROVED BY:	DRAWN BY: SMF
DATE: 12/12/96		REVISED:

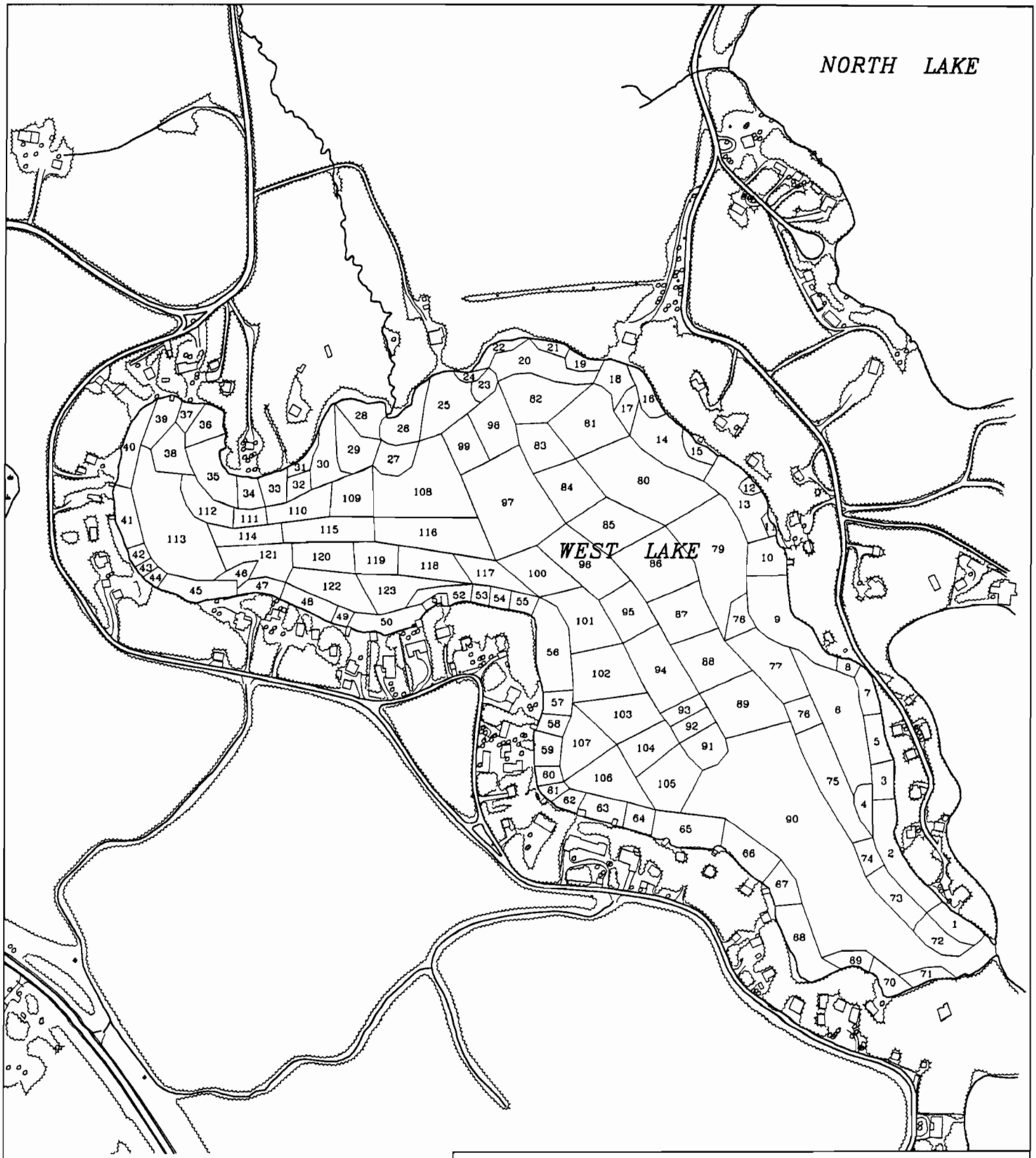
SPREAD EAGLE CHAIN OF LAKES ASSOCIATION
Florence, Wisconsin

MMA, INC. – Florence, WI

FIGURE NUMBER: 5

E:\EAGLE\WEST\WEST.DWG

DIGITAL BASE MAP FILES USED WITH PERMISSION FROM THE FLORENCE UTILITY COMMISSION.



AQUATIC PLANT SURVEY LOCATIONS

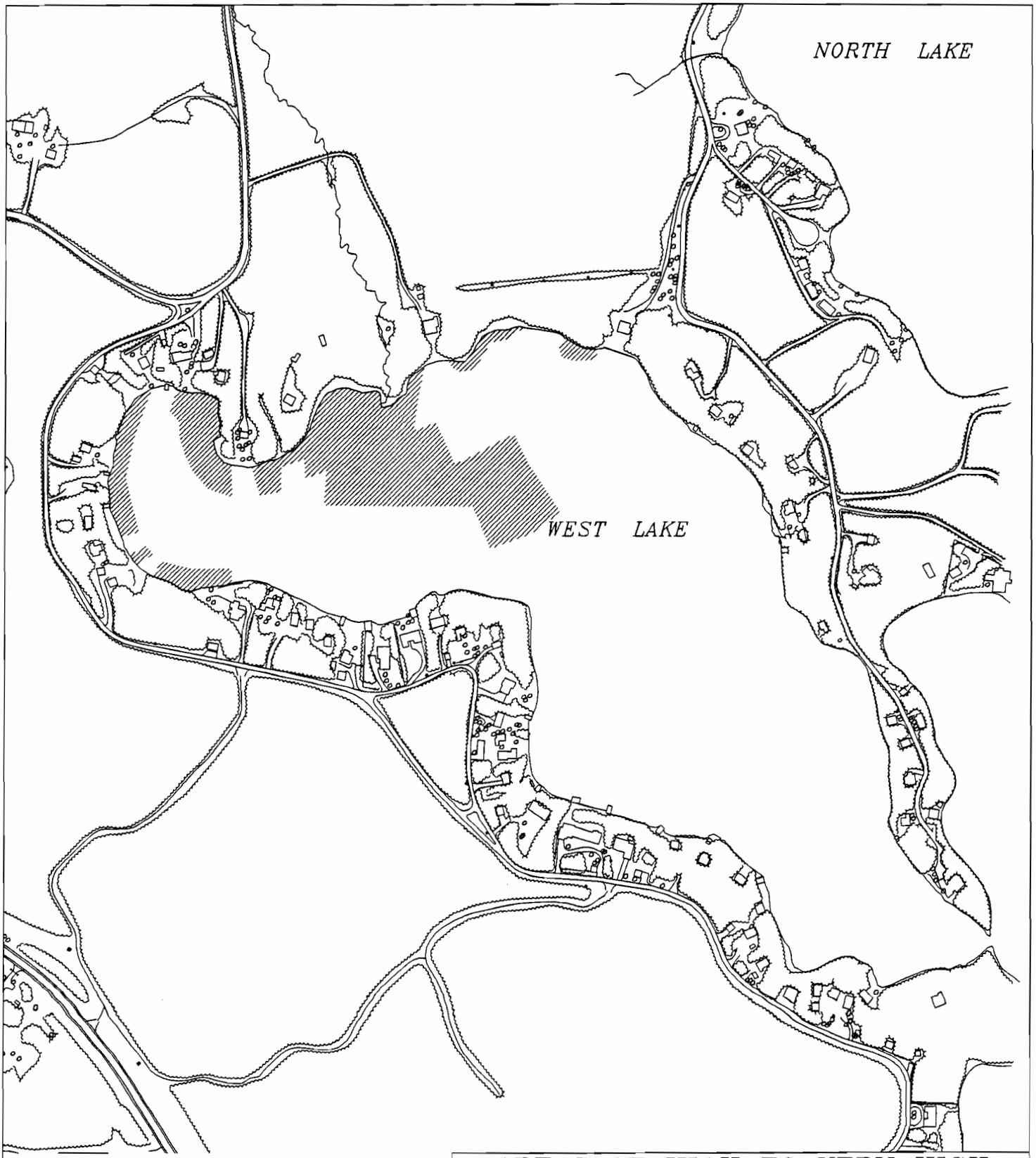
SCALE: 1"=500'	APPROVED BY:	DRAWN BY: SMF
DATE: 1/20/97		REVISED:

SPREAD EAGLE CHAIN OF LAKES ASSOCIATION
Florence, Wisconsin

MMA, INC. – Florence, WI

FIGURE NUMBER: 6

E:\EAGLE\WEST\WEST.DWG



LEGEND

AREA OF AQUATIC PLANT DENSITY FROM HIGH TO VERY HIGH

ABUNDANCE RANGE:

5 – VERY HIGH
4 – HIGH
3 – ABUNDANT
2 – MODERATE
1 – OCCASIONAL
0 – RARE

AREAS OF HIGH TO VERY HIGH AQUATIC PLANT DENSITY

SCALE: 1" =500'	APPROVED BY:	DRAWN BY: SMF
DATE: 1/22/97		REVISED:

SPREAD EAGLE CHAIN OF LAKES ASSOCIATION
Florence, Wisconsin

MMA, INC. – Florence, WI

FIGURE NUMBER: 7

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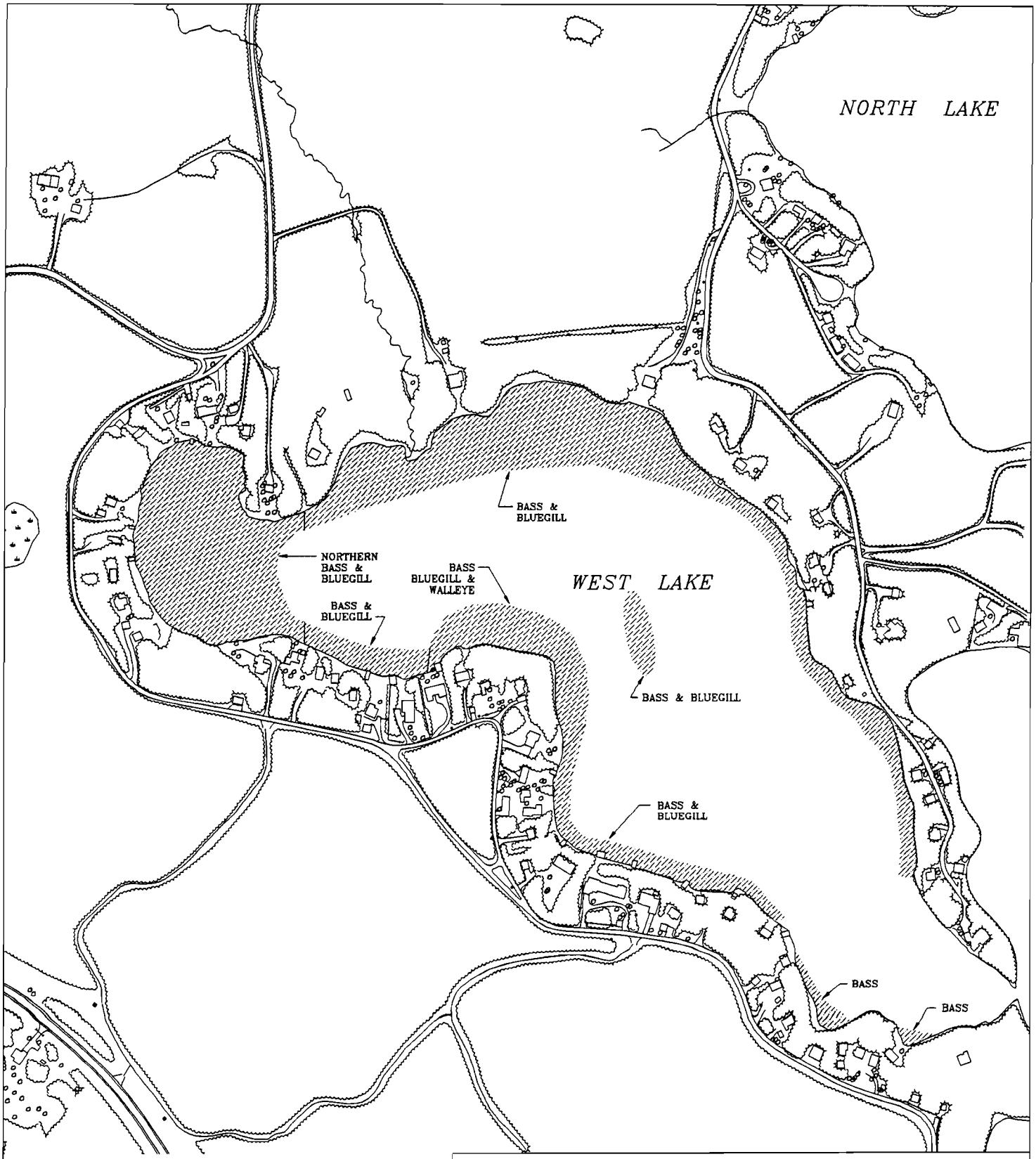


LEGEND

FISH SPAWNING & NURSERY LOCATIONS

SPAWNING & NURSERY LOCATIONS

SCALE: 1" =500'	APPROVED BY:	DRAWN BY: SMF
DATE: 1/22/97		REVISED:

SPREAD EAGLE CHAIN OF LAKES ASSOCIATION
Florence, Wisconsin

MMA, INC. – Florence, WI

FIGURE NUMBER: 8

E:\EAGLE\WEST\WEST.DWG

LEGEND

ARROWS INDICATE SURFACE RUNOFF PATTERNS AND WATER FLOW DIRECTION

WATERSHED AREA OF THE SPREAD EAGLE CHAIN OF LAKES

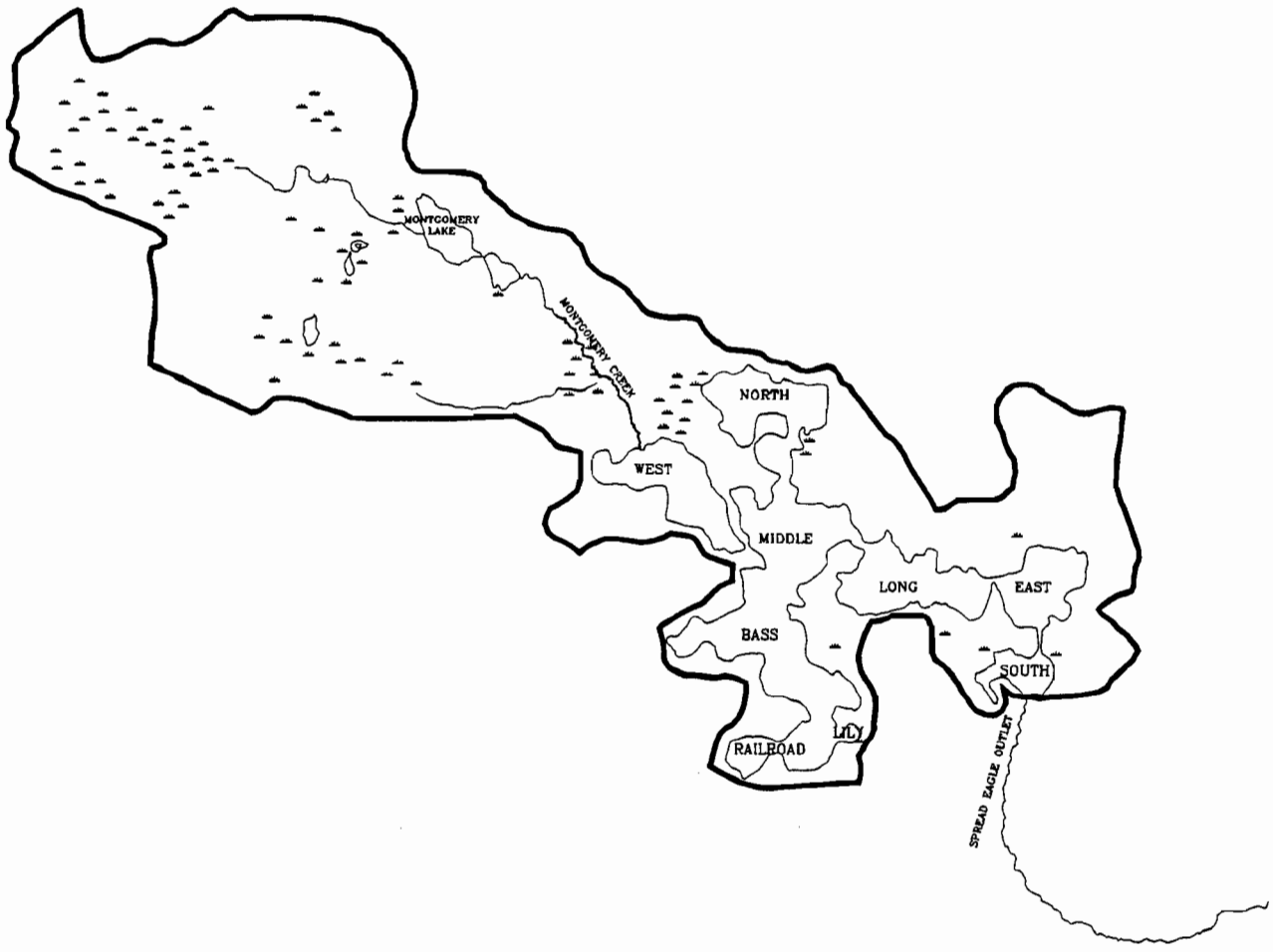
SCALE: 1"=4000'	APPROVED BY:	DRAWN BY: SMF
DATE: 1/20/97		REVISED:

SPREAD EAGLE CHAIN OF LAKES ASSOCIATION
Florence, Wisconsin

MMA, INC. – Florence, WI

FIGURE NUMBER: 9

E:\EAGLE\WEST\WATRSHED.DWG



LEGEND

WETLAND AREA

WETLAND AREAS OF THE SPREAD EAGLE CHAIN WATERSHED

SCALE: 1"=4000'	APPROVED BY:	DRAWN BY: SMF
DATE: 1/20/97		REVISED:

SPREAD EAGLE CHAIN OF LAKES ASSOCIATION
Florence, Wisconsin

MMA, INC. – Florence, WI

FIGURE NUMBER: 10

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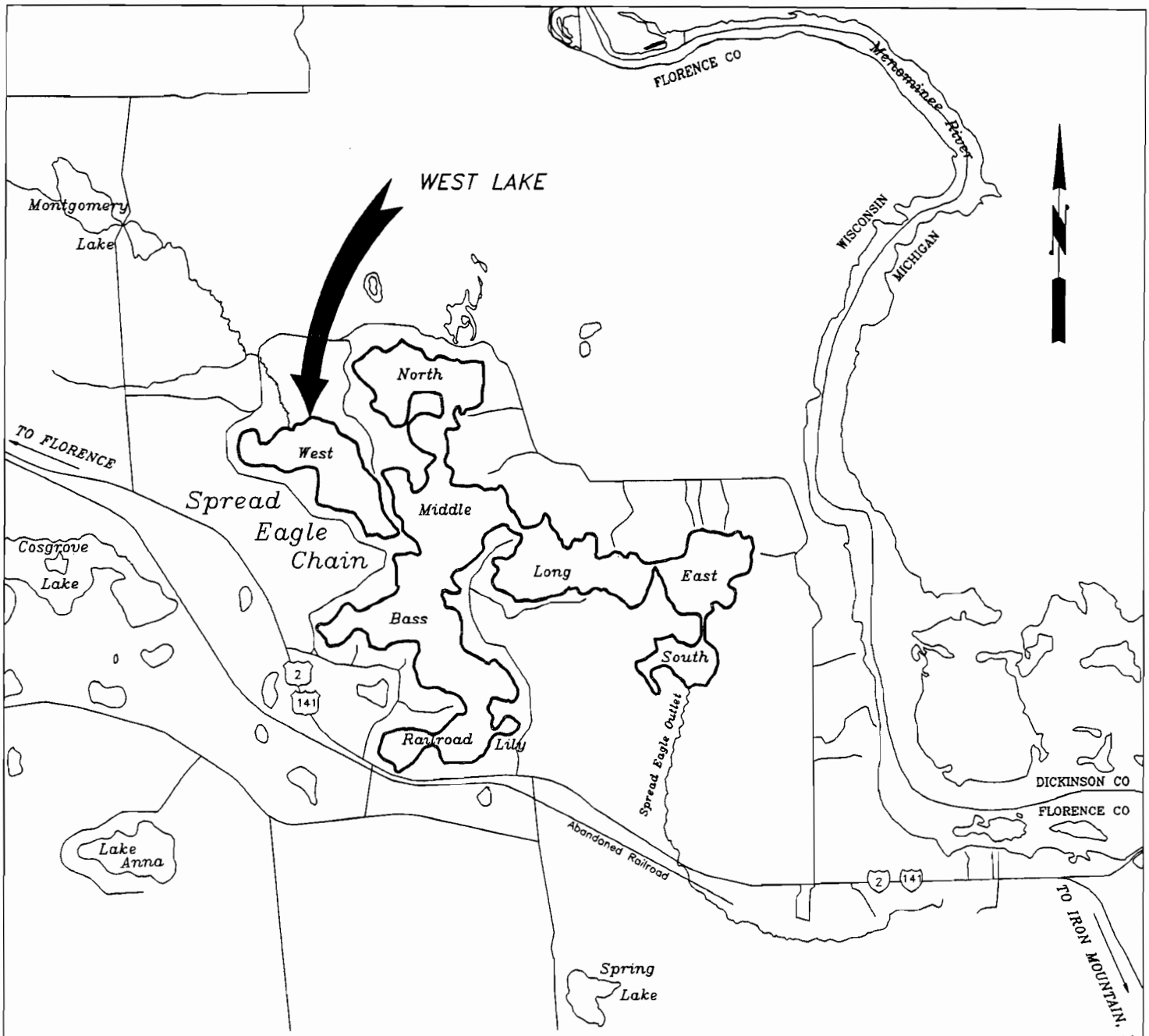
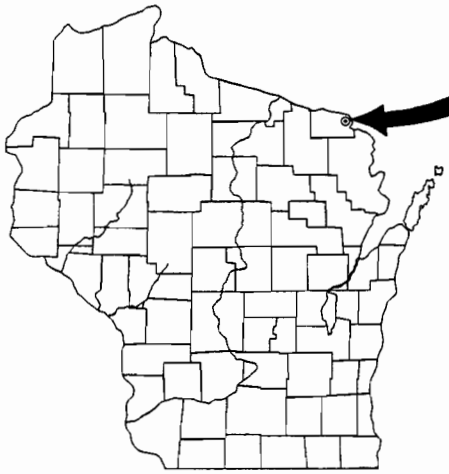




WISCONSIN

WEST LAKE
OF THE SPREAD EAGLE CHAIN OF LAKES
(FLORENCE COUNTY)

LOCATION MAP – WEST LAKE

SCALE: 1" = 3000'	APPROVED BY:	DRAWN BY: SMF
DATE: 3/21/96		REVISED:

SPREAD EAGLE LAKE ASSOCIATION
Florence, Wisconsin

MMA, INC. – Florence, WI

FIGURE NUMBER: 1

E:\EAGLE\WEST\LOCATION.DWG

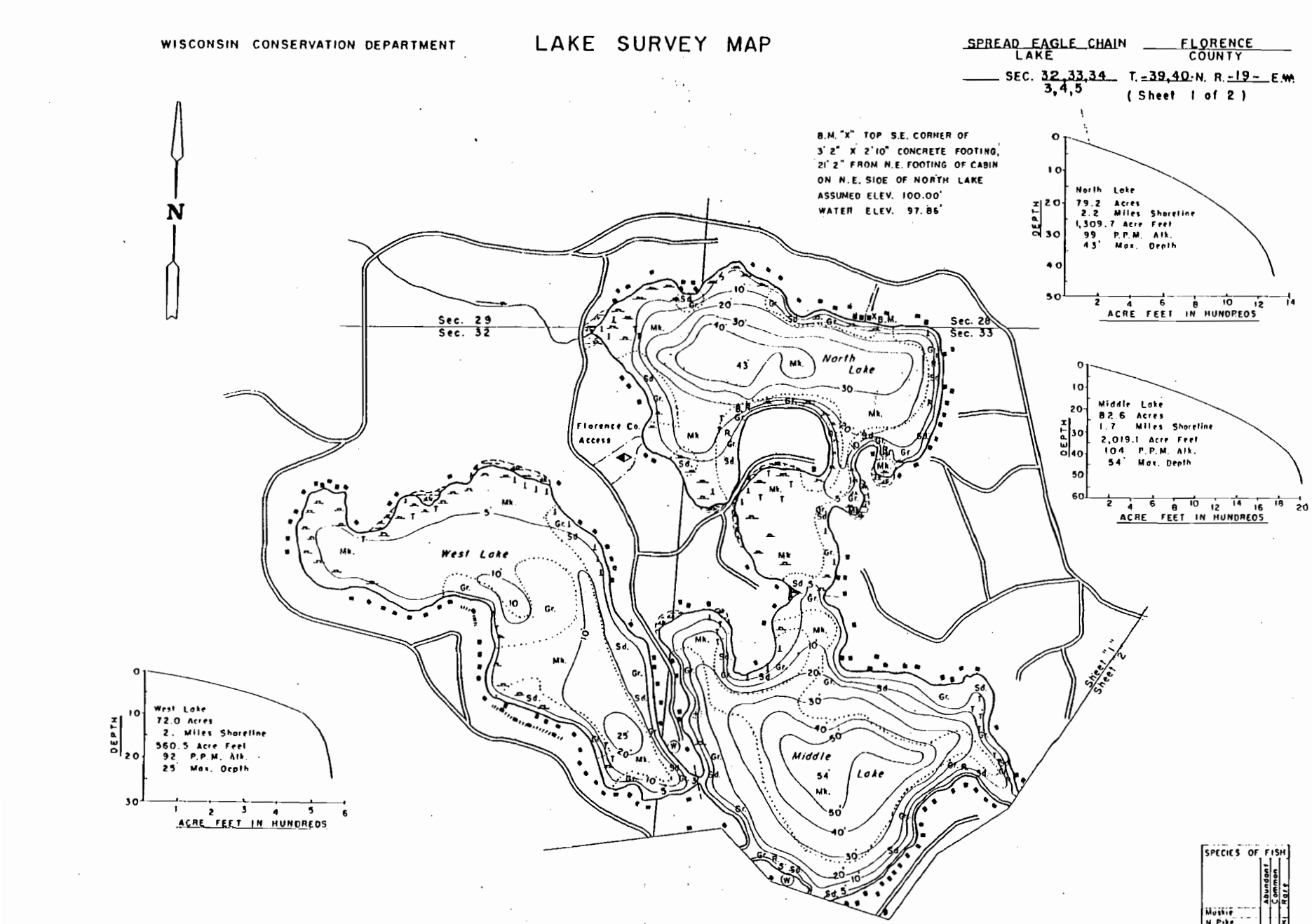
WISCONSIN CONSERVATION DEPARTMENT

LAKE SURVEY MAP

SPREAD EAGLE CHAIN LAKE — FLORENCE COUNTY

SEC. 32,33,34 3,4,5 T. 39,40 N. R. 19 E.W.

(Sheet 1 of 2)



SPECIES OF FISH

	Abundant	Common	Rare
Muskie			X
N. Pike			X
Walleye		X	
L.M. Bass		X	
S.M. Bass		X	
Panfish		X	
Trout			X

EQUIPMENT RECORDING SONAR MAPPED AUGUST (MO.) 1966 (YR.)

TOPOGRAPHIC SYMBOLS

- (B) Brush
- (PW) Partially wooded
- (W) Wooded
- (C) Cleared
- (P) Pastured
- (A) Agricultural
- BM Bench Mark
- # Dwelling
- Steep slope
- Indefinite shoreline
- Marsh
- Spring
- Intermittent stream
- Permanent inlet
- Permanent outlet
- Dam

WATER ELEV. 91.89

LAKE BOTTOM SYMBOLS

- P. Peat
- Mk. Muck
- C. Clay
- M. Marl
- Sd. Sand
- Gr. Gravel
- R. Rubble
- Br. Bedrock
- T Submergent vegetation
- I Emergent vegetation
- Stumps & Snags
- Rock danger to navigation

SCALE 500' 0' 500' 1,000' 1,500' 2,000' 2,500'

◇ Access ◆ Access with Parking ◆ Boat Livery

552.2 WITH ISLANDS

AREA 548.4 ACRES

UNDER 3FT. 11 %

OVER 20FT. 40 %

VOLUME 10,896 ACRE FT.

TOTAL ALK. 92 - 104 P.P.M.

SHORELINE 14.8 MILES

MAX. DEPTH 75 FEET

Figure No. 2 - Lake Survey Map
Sheet 1 of 2

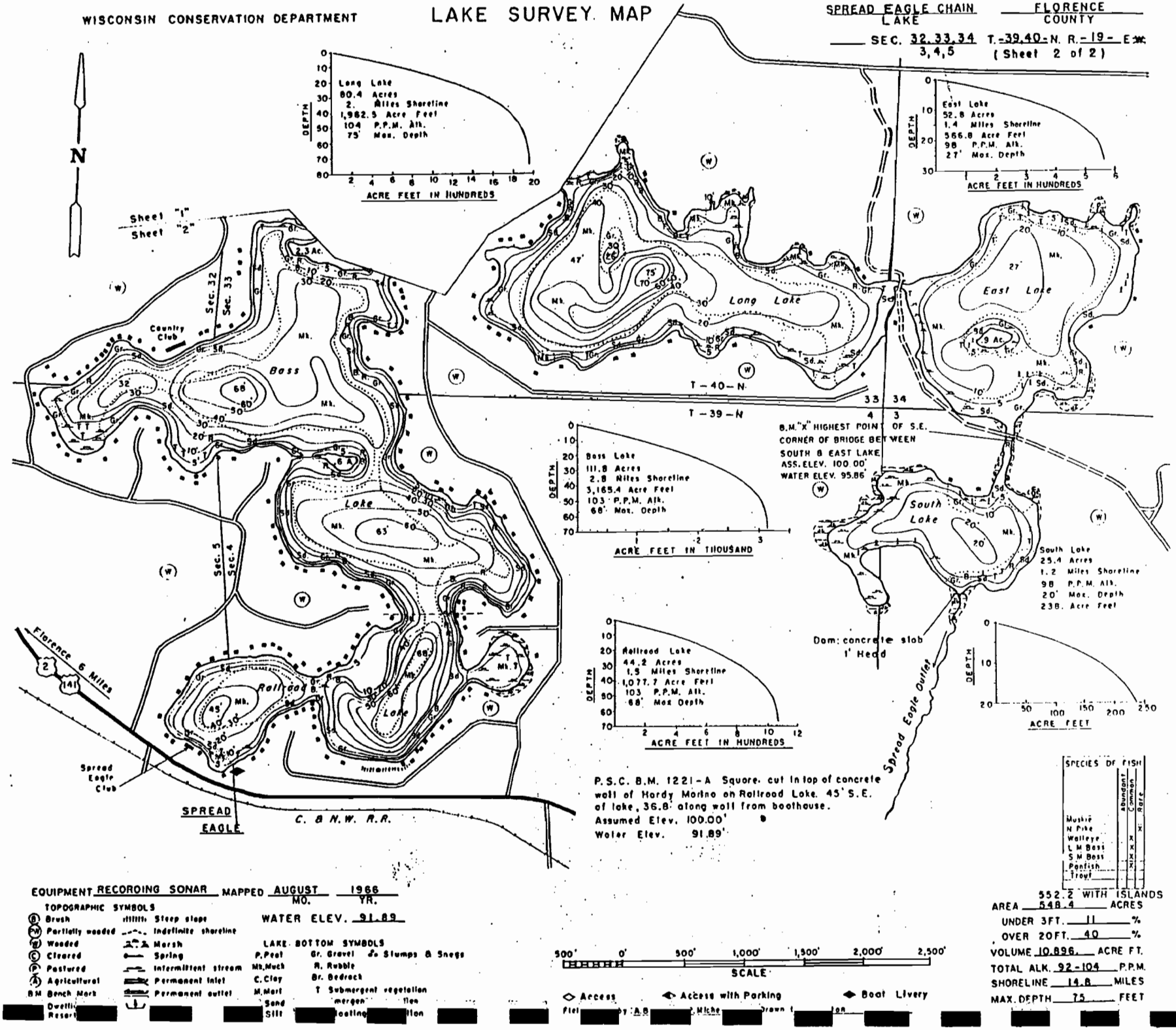


Figure No. 3 - Lake Survey Map
Sheet 2 of 2