IPS ENVIRONMENTAL AND ANALYTICAL SERVICES
Appleton, Wisconsin

PHASE I
PLEASANT LAKE MANAGEMENT PLAN
WAUSHARA COUNTY, WISCONSIN

REPORT TO:
PLEASANT LAKE IMPROVEMENT CORPORATION

August, 1996

TABLE OF CONTENTS

ACKNOWLEDGEMENTS

Assistance provided by the Pleasant Lake Improvement Corporation is much appreciated. Special thanks are extended to Francie Rowe and Bill Vance for their involvement with field activities, informational input and local coordination of the project.

Development of this plan was made possible with funds provided by the Wisconsin Department of Natural Resources Lake Management Planning Grant Program and the Pleasant Lake Improvement Corporation.

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDIXES

GLOSSARY OF TERMS (1, 2, 3)

Best Management Practices (BMP's) Land use practices to control the interactive processes of erosion, runoff and nutrient or pesticide inflows.

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

Conductivity Determined by measuring the conductance, which is the ratio of current to voltage, of a conductivity cell immersed in the solution of interest.

Ecoregion An area delineated in order to make comparisons between and within certain geographic areas of the state. The five lake region boundaries were chosen to group lakes of similar nature, provide sufficient number of lakes and lake types to provide for adequete statistical analysis, and seperate lakes on the basis of regional means.

Eutrophication The process of lake aging or enrichment with nutrients, generally with associated increases in algae or weeds. The extent to which this process has progressed is described by trophic status terms, e.g., oligotrophic, mesotrophic, or eutrophic.

Littoral The shallow area of a lake from the shore to the depth where light no longer penetrates to the bottom.

Macrophyte Commonly referred to as lake "weeds", actually aquatic vascular plants that grow either floating, emergent or submergent in a body of water.

Mesotrophic A lake of intermediate photosynthetic activity and transparency.

N/P Ratio Total nitrogen divided by the total phosphorus found in a water sample. A value greater than 15 indicates phosphorus to be limiting **primary production**.

GLOSSARY OF TERMS
(Continued)

Oligotrophic A lake of low plant productivity and high transparency.

Physicochemical Pertaining to physical and/or chemical characteristics.

Primary production The energy captured by plants in photosynthesis. Gross primary production measures the amount of energy stored as organic materials, as well as that used in respiration by the plant. Net production includes only the amount stored.

Residence Time Commonly called the hydraulic residence time. The amount of time required to completely replace the lake's current volume of water with an equal volume of "new" water.

Riparian A landowner whose land lies on the shore of a particular body of water.

Secchi Depth A measure of optical water clarity as determined by lowering a weighted Secchi disk (20 cm in diameter) into a body of water to a point where it is no longer visible.

Seepage Lake A lake with no permanent inlet or outlet and with adjacent land groundwater and precipitation inputs as major sources of water.

SUMMARY

Pleasant Lake is a small (126 acres) natural **seepage lake**[1] primarily located in Waushara County with a slight southeast portion of the lake located in Marquette County. As a heavily used recreational resource and high aesthetic quality, it is perceived that Pleasant Lake may encounter an acceleration of nutrient (eutrophication) problems.

The majority of Pleasant Lake's watershed can be characterized as forested with more steeply sloped areas being common. Open or agricultural areas of nearly level sandy soils are also present but not as abundant within the watershed.

Water quality, when rated according to Trophic State Index, was **oligotrophic** to **mesotrophic** for total phosphorus and **chlorophyll a**, and oligotrophic for **Secchi depth**. Pleasant Lake, however, has a very narrow **littoral** zone which limits the amount of rooted aquatic plants (**macrophytes**) and allows nutrients to be available for algal growth. Pleasant Lake nutrient levels were low in comparison to most seepage lakes. Event sampling indicated the public boat landing area on the north shore as an area of concern each for phosphorus and nitrogen.

Management objectives should target continued monitoring, better definition and reduction of surface runoff (where possible and practical), riparian education/awareness of land use practice effects on water quality and potential use conflicts:

- Areas of concern should be assessed for nutrient and sediment contributions to surface and groundwaters. **Riparian** landowner education and awareness regarding yard practices should be emphasized and measures implemented where appropriate and practical.

- Water quality monitoring should be continued to track trends and develop an accurate nutrient budget. Secchi depth monitoring should be continued along with lake level readings. Rainfall data should be recorded as practical to supplement this data.

- A DNR fishery survey should be completed in the next five years to determine the status of fish populations.

- An exotic species watch group should be encouraged to monitor or remove exotic species when encountered. Members should coordinate with the WDNR Exotic Species Program and inform the PLIC membership and public on the hazards of exotic species as they relate to Pleasant Lake.

- Areas defined as "sensitive areas" should be designated accordingly to help protect and preserve the resource.

[1] Text terms in bold print defined in glossary (pp. vi-vii)

INTRODUCTION

Pleasant Lake is a small, hard water seepage lake located in southwest Waushara County, Wisconsin, with a small portion of the lake located in Marquette County, Wisconsin. Pleasant Lake is characterized by good water quality with littoral bottom materials comprised of primarily sand and marl. The lake basin is a fairly deep; roughly fifty percent of its area is greater then 20 feet deep. Groundwater from a primarily forested watershed is the major source of inflow to Pleasant Lake.

The Pleasant Lake Improvement Corporation (PLIC) was formed in the early to mid 1940's to provide leadership and coordination of lake preservation and educational activities pertinent to Pleasant Lake. Currently, the PLIC has nine elected board members and about 130 members overall (4). Major concerns of the PLIC in development of a lake management plan included fluctuating water levels, general water quality maintenance and excessive recreational use.

The PLIC, in 1993, decided to pursue development of a long range management plan under the Wisconsin Department of Natural Resources (WDNR) Lake Management Planning Grant Program. The PLIC officers selected IPS Environmental & Analytical Services (IPS) of Appleton, Wisconsin as its consultant to assist with

development of the plan. A grant application, incorporating required or recommended program components and the following objectives, was prepared, submitted, and approved in October 1993:

- assessment of current water quality in Pleasant Lake and implementation of a monitoring strategy to track trends,
- conduct recreational use survey of landowners,
- review of historic information,
- identify environmentally sensitive areas in need of protection.

This report summarizes and presents conclusions based on Phase I management planning efforts for Lake Management Plan, Pleasant Lake, Waushara County, Wisconsin. Specific physical properties of the resource, preliminary methods, and other introductory and technical information are described or discussed in text.

DESCRIPTION OF AREA

Pleasant Lake (T18N R8E S33) is a natural 126 acre seepage lake (i.e., with no permanent inlet or outlet) located primarily in the Town of Coloma (North) and Springfield (South), in Waushara County, Wisconsin (Figure 1). Pleasant Lake has a moderately deep basin with a maximum depth of about 30 feet, a mean depth of 15 feet and a volume of 1890 acre-feet (5). Like other seepage lakes, Pleasant Lake has a long **residence time**, a comparatively small watershed and commonly reflects groundwater level and rainfall patterns.

Physicochemical characteristics of natural lakes tend toward a state of dynamic equilibrium (e.g., seasonally variable but relatively consistent within the framework over the long-term) as defined by basin morphometry and watershed characteristics. Area, soil and cover types, slopes and land uses all directly and indirectly influence the Pleasant Lake resource.

Major soil types near Pleasant Lake are excessively drained Coloma loamy sands on 2-12 percent slopes, Okee loamy sand on 2-12 percent slopes, Boyer loamy sand on 6-12 percent slopes and Plainfield sand on 6-30 percent slopes (6). Permeability is moderate to rapid and the soils are generally unsuited for septic systems because of steep slope (Okee) or inability to filter septate (Boyer, Coloma, Plainfield).

Figure 1. Location Map, Pleasant Lake, Waushara County, WI.

Public lake access is available at two locations. A paved boat ramp, with available parking, is maintained by Waushara County on the north shore, and an unpaved boat ramp in Marquette County on the southwest shore.

Pleasant Lake supports fish species including northern pike (Esox lucius), yellow perch (Perca flavescens), largemouth bass (Micropterus salmoides), rock bass (Ambloplites rupestris), bluegill (Lepomis macrochirus), black crappie (Pomoxis nigromaculatus), pumpkinseed (Lepomis gibbosus), black bullhead (Ictalurus melas), white sucker (Catostomus commersoni) and warmouth bass (Lepomis gulosus) (5). The most recent Wisconsin Department of Natural Resources fish survey (conducted June 13, 1960) indicated a very good fish population but unsuccessful northern pike hatches several years prior (7). Also, there is a significant number of ducks, coots, Canada geese, loons, great blue herons and a number of other waterfowl species that use the lake during annual migration.

METHODS

Watershed Characteristics

Watershed information was entered into the AGNPS (**AG**ricultural **N**on**P**oint **S**ource) computerized modeling program (8). The AGNPS program is commonly used for intense watershed analysis. Because of large informational needs for analysis, the program was used as a mapping tool for the Pleasant Lake project.

Parameters entered into the 192 cell (cell = 10 acres) database included soil type, slope, flow and cover type information. Cover type and flow information was taken from the United States Geological Survey 7.5' quadrangles for the area (9); soils information was taken from the Waushara County Soils Survey (6). A weighted average was assigned for slope and other numeric data while absolute information (cover and soil type) was recorded as the category with the greatest area for the cell.

Water Quality Monitoring

Pleasant Lake water samples were taken from Station 2201 (deepest point) during January, May, June, July, and September, 1994 and March, May, June, July, and August, 1995 (Table 1, Figure 2). Samples were taken from three feet below the surface (designated "S") and three feet above bottom (designated "B").

Table 1. Sampling Station Descriptions, Pleasant Lake, 1994 - 1995.

REGULAR MONITORING

Site	Depth
2201	30 feet

EVENT MONITORING

Site	Description
22E1	Overland flow - near boat landing on north shore of Lake.
22E2	Sample collected near boat landing
22E3	Sample collected near boat landing
22E4	Sample collected near boat landing after 3 hours of rain.

Figure 2. Sample Station Location, Pleasant Lake, Waushara

Secchi depth, water temperature, pH, dissolved oxygen (DO), and **conductivity** were measured in the field. Field measurements were taken using a standard Secchi disk and a Hyrolab Surveyor II; Hydrolab data were adjusted for meter drift based on calibration prior to and subsequent to daily use (manufacturers recommended procedure).

Water samples were taken for laboratory analyses with a Kemmerer water bottle. Samples were labeled, preserved if necessary, and packed on ice in the field; samples were delivered via overnight carrier to the State Laboratory of Hygiene (Madison, WI) for analysis using WDNR or APHA (10) methods. Spring parameters determined by the laboratory included laboratory pH, total alkalinity, total Kjeldahl nitrogen, ammonia nitrogen, nitrate/nitrite nitrogen, total phosphorus and dissolved phosphorus, total solids and chlorophyll a. Summer and late Summer laboratory analyses included total phosphorus, dissolved phosphorus and chlorophyll a.

Event Monitoring

In addition to regular monitoring sites, an event sampling site was established (Figure 2) to help assess the extent of nutrient inflow. The event sample site was located at the public boat access. Samples were collected by members of the PLIC (with IPS instruction) on June 5, June 28, July 4, August 3, and August 18, 1994.

Staff Gage

Measurement of changes in lake level, and determination of water flow into and out of a lake, can help assess the annual nutrient, organic matter, and sediment loads to a lake. A staff gage was constructed and positioned in the lake to record water levels associated to groundwater inflow and seasonal variations in the local water table. The enamel staff gage was purchased with funds provided by the PLIC and positioned in the lake by IPS on June 15, 1995.

Recreational Use

A recreational use survey of the PLIC membership was conducted to obtain property and lake use, water use opinions and demographics information. About 100 questionnaires were distributed (one per household) by PLIC neighborhood volunteers. A sample survey questionnaire is included in Appendix I.

Public Involvement Program

Public involvement activities were coordinated to inform and educate the PLIC about lake management and specifics regarding the Pleasant Lake resource. Activities included news releases, IPS newsletters, meeting attendance and presentations to the PLIC. A summary of public involvement activities is outlined in Appendix II.

Land Use Information

Details of zoning and specific land uses were obtained from the United States Soil Conservation Services soil maps (6), aerial photographs, United States Geological Survey quadrangle maps and the Waushara County Land Conservation Department. This information, when considered questionable or out-dated, was confirmed by field reconnaissance.

Exotic Species

Visual observation [including a full shoreline cruise and in-lake observations (raking)] were made throughout the Phase I period to document the occurrence of exotic species. Target species included Eurasian Water Milfoil *(Myriophyllum spicatum)*, Purple Loosestrife *(Lythrum salicaria)* and Zebra Mussels *(Dreissena polymorpha)*.

FIELD DATA DISCUSSION

Watershed Characteristics

Water quality in Pleasant Lake is influenced by watershed characteristics. Watershed area, soil and cover types, slopes and land uses all directly and indirectly influence the Pleasant Lake resource.

AGNPS program results for the Pleasant Lake watershed:

- Slopes - 0-5% (770 acres, 43%), 5.1-10% (710 acres, 39%), 10.1-15% (240 acres, 13%), 15.1-17% (90 acres, 5%) (Figure 3).
- Cover types - forested (1180 acres, 65%), open/ agricultural (630 acres, 35%) (Figure 4).

Areas of concern include sand soils with nearly level slope (0 - 5%) which are prone to rapid infiltration with greater potential for groundwater contamination (Figure 5).

Water Quality Monitoring

Phosphorus is often the limiting major nutrient in algal and plant production in lakes. Pleasant Lake surface total phosphorus levels (ave. = 0.009, median = 0.008, σ = 0.004 mg/l)

(Table 2, Figure 6) were well below expected levels for seepage lakes (ave. = 0.021, median = 0.015, σ = 0.028 mg/l), drainage lakes (ave. = 0.040, median = 0.025, σ = 0.064) and lakes in the central region of Wisconsin (ave. = 0.020, median = 0.012, σ = 0.021) (11). NOTE: Some total phosphorus data are indicated to have exceeded the recommended holding time before analysis. A study has shown, however, that phosphorus data remains accurate for samples analyzed well after the 28 day holding time (12).

Surface total nitrogen levels were lower (ave. = 0.370, median = 0.380, σ = 0.035) (Table 2, Figure 7) than expected levels for seepage lakes (ave. = 0.760, median = 0.640, σ = 0.570), drainage lakes (ave. = 0.950, median = 0.830, σ = 0.550), and lakes in the central region of Wisconsin (ave. = 0.720, median 0.690, σ = 0.310) (11). Surface **N/P ratios** greater than 15 indicated Pleasant Lake to be phosphorus limited during 1994 - 1995 Phase I activities.

Figure 3. Watershed Land Slopes, Pleasant Lake, Waushara County,

WI.

Figure 4. Watershed Cover Types, Pleasant Lake, Waushara County, WI.

Figure 5. Open/Agricultural Areas on Sand Soils with less than

5% Land Slope, Pleasant Lake, Waushara County, WI.

Table 2. Water Quality Parameters, Station 2201, Pleasant Lake, January, 1994 - August, 1995.

PARAMETER	SAMPLE[1]	DATE 01/31/94	05/09/94	06/28/94	07/27/94	09/07/94	03/01/95	05/15/95	06/15/95	07/25/95	08/22/95
Secchi (feet)		NR[2]	21.2	8.3	20.7	10.8	NR	16.5	19.4	11.6	12.3
Cloud Cover (percent)		0	0	70	50	30	0	0	0	5	0
Temperature (degrees Celsius)	S	4.13	13.22	24.91	23.33	20.19	5.28	12.96	21.09	25.82	25.43
	B	4.71	13.08	19.52	22.77	19.95	4.99	11.41	17.62	22.82	23.98
pH (surface units)	S	7.18	8.29	8.18	8.03	7.69	NR	8.83	8.43	9.08	8.18
	B	6.57	7.93	8.10	7.73	7.67	8.31	8.43	7.92	8.42	7.16
D.O. (mg/l)	S	12.68	11.34	9.06	7.75	7.05	NR	11.37	10.02	8.42	7.31
	B	7.72	11.43	NR	5.11	6.83	NR	11.21	7.91	7.71	2.47
Conductivity (umhos/cm)	S	257	248	224	232	215	255	243	237	236	238
	B	269	248	235	246	215	259	245	252	270	286
Laboratory pH (surface units)	S	NR	8.40	NR	NR	NR	NR	8.66	NR	NR	NR
	B	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Total Alkalinity (mg/l)	S	NR	134	NR	NR	NR	NR	125	NR	NR	NR
	B	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Total Solids (mg/l)	S	NR	162	NR	NR	NR	NR	156	NR	NR	NR
	B	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Tot. Kjeld. Nitrogen (mg/l)	S	NR	0.2	NR	NR	NR	NR	0.3	0.4	NR	0.4
	B	NR	0.4	NR	NR	NR	NR	0.6	0.4	NR	NR
Ammonia Nitrogen (mg/l)	S	NR	0.061	NR	NR	NR	NR	ND[3]	ND	NR	ND
	B	NR	0.054	NR	NR	NR	NR	ND	0.042	NR	NR
NO_2 + NO_3 Nit. (mg/l)	S	NR	0.129	NR	NR	NR	NR	0.053	ND	NR	ND
	B	NR	0.068	NR	NR	NR	NR	0.038	ND	NR	NR
Total Nitrogen (mg/l)	S	NR	0.329	NR	NR	NR	NR	0.353	0.4	NR	0.4
	B	NR	0.454	NR	NR	NR	NR	0.638	0.4	NR	NR
Total Phosphorus (mg/l)	S	<0.004	0.009	0.010	0.007[4]	0.017[4]	0.007	0.008	ND	0.008	0.009
	B	0.006	0.009	0.012	0.007[4]	0.011[4]	0.010	0.035	ND	0.011	0.015
Dissolved Phos. (mg/l)	S	ND	ND	0.002	0.003	ND	NR	ND	ND	ND	0.004
	B	ND	ND	ND	ND	ND	NR	ND	0.002	ND	0.005
Nit./Phos Ratio	S	--	36.6	--	--	--	--	44.12	--	--	44.4
	B	--	50.4	--	--	--	--	18.23	--	--	--
Chlorophyll a (ug/l)	S	NR	3.94	3.16	2.37	4.01	NR	4.5	2.3	0.35	3.2

[1] S = surface, B = bottom; [2] NR = no reading; [3] ND = not detectable; [4] holding time exceeded by SLOH

__Figure 6. Total Phosphorus Trends for Pleasant Lake, 1994 - 1995.

__Figure 7. Total Nitrogen Trends for Pleasant Lake, 1994 - 1995.

Event Monitoring

Event monitoring (near public boat landing) indicated significantly higher total phosphorus levels compared with the in-lake site (Table 3). The average event total phosphorus level was 0.387 mg/l (median 0.066, σ = 0.033); highest total phosphorus was observed August 3, 1994.

Higher than expected total nitrogen levels were also observed during event monitoring (Table 3). Total nitrogen levels ranged from 0.407 to 1.698 mg/l with an average of 0.888 mg/l for all in-lake samples collected. The extreme level (12.306 mg/l) of total nitrogen was collected on August 3, 1994, as surface runoff prior to entering lake.

Other indicators of lake **eutrophication** status include light penetration and algal production. Numerous summarative indicies have been developed, based on combination of these and other parameters, to assess or monitor lake eutrophication or aging. The Trophic State Index (TSI) developed by Carlson (13) utilizes Secchi transparency, chlorophyll a, and total phosphorus. As with most indicies, application is generally most appropriate on a relative and trend monitoring basis. This particular index does not account for natural, regional variability in total phosphorus levels nor in Secchi transparency reduction unrelated to algal growth (e.g. that associated with color).

Table 3. Event Nitrogen and Phosphorus Parameters (in milligrams per liter), Pleasant Lake, Waushara County, 1994 - 1995.

DATE / PARAMETER	
06-05-94 22E1	
TKN	0.4
NH_4-N	0.018
NO_2+NO_3-N	0.007
Tot. N	0.407
Tot. P	0.007
Diss. P	ND
06-28-94 22E2	
TKN	0.9
NH_4-N	0.036
NO_2+NO_3-N	0.029
Tot. N	0.929
Tot. P	0.050
Diss. P	ND[1]
07-04-94 22E3	
TKN	0.5
NH_4-N	0.043
NO_2+NO_3-N	0.019
Tot. N	0.519
Tot. P	0.066
Diss. P	0.007
08-03-94 22E1[2]	
TKN	11.47[3]
NH_4-N	0.621
NO_2+NO_3-N	0.836
Tot. N	12.306
Tot. P	1.71[3]
Diss. P	0.075
08-18-94 22E4	
TKN	1.26[3]
NH_4-N	0.853
NO_2+NO_3-N	0.438
Tot. N	1.698
Tot. P	0.103[3]
Diss. P	0.015

[1] ND = not detectable; [2] lake access runoff; not a lake sample; [3] holding time exceeded by SLOH

Low total phosphorus and chlorophyll a TSI values for Pleasant Lake were typical of oligotrophic to mesotrophic conditions with early indications of eutrophic conditions. Low Secchi depth TSI values were typical of a oligotrophic classification (Figure 8).

Figure 8. Trophic State Index for Secchi Depth, Total Phosphorus and Chlorophyll a, Pleasant Lake, Waushara County, WI, 1994 - 1995.

Recreational Use

About 12% of all Pleasant Lake respondents indicated they were permanent residents. Average occupancy for all respondents was 5.7 weeks (Table 4); seasonal residents averaged 7.3 months.

Occupancy was greatest during summer (Figure 9).

Table 4. Comparison of Recreational Use Parameters, Pleasant Lake, Waushara County, WI.

Parameter	
Average weekly occupancy	5.7
Average number of watercraft (per response)	2.5
Average number of adults (per respondent household)	2.4
Average number of children 12 - 18 years old (per respondent household)	0.2
Average number of children less than 12 years old (per respondent household)	0.6
Percent of respondents leaving comments	46

Figure 9. Seasonal Use for Pleasant Lake, Waushara County, WI.

Respondents indicated a total of 262 watercraft with an average of 2.5 per household. Most common watercraft types (in order) were row/paddle boats, boats with greater than 25 horsepower motors , boats with less than 25 horsepower motors and canoes or kayaks (Figure 10).

Figure 10. Most Commonly Reported Watercraft Types, Pleasant Lake, Waushara County, WI, 1995.

Pleasant Lake resident respondents agreed (71% "strongly agree" or "agree" responses) there are too many watercraft [primarily on weekends and holidays (Appendix II] and that the number of watercraft cause safety problems (71%) [primary cause identified as non-resident watercraft (68%] and diminish user enjoyment

(Table 5).

Table 5. Percentage of "Strongly Agree" and "Agree" Responses, Pleasant Lake, Waushara County, WI.

Opinion		
There are too many watercraft on Pleasant Lake	71	
The current number of watercraft causes safety problems		71
There is adequate water safety enforcement:		
weekdays		67
weekends		32
holidays	29	
The current number of watercraft diminishes aesthetics:		
weekdays		24
weekends		57
holidays	67	
The causes of water safety problems:		
private residential watercraft		22
non-residential watercraft	68	
other		10
Additional water use regulations need to be enacted and enforced		45
There should be limits set on the number of watercraft	52	
There is adequate public boater access to Pleasant Lake	96	
There should be a public swimming beach on Pleasant Lake	35	

They agreed there was adequate water safety enforcement on weekdays (67%); considerably fewer agreed for weekends (32%) and holidays (29%). Overall consensus was somewhat against the enactment of more ordinances (55% "strongly disagree" or "disagree" responses) and nearly evenly split on the need for limiting boat numbers (52% "strongly agree" or "agree" responses).

Respondents agreed (96% "strongly agree" or "agree" responses) there is adequate public boater access to Pleasant Lake and generally disagreed (65%) there should be a public swimming beach. They also agreed that during peak use (holidays) the current number of water craft diminish the ability to enjoy Pleasant Lake aesthetics (67%); fewer agreed for weekends (57%) and weekdays (24%) (Appendix II).

Exotic Species

Eurasian Water Milfoil was not observed in Pleasant Lake (aquatic plant observations, 1994 - 1995). There were also no observations of Zebra Mussels or Purple Loosestrife plants.

Eurasian Milfoil plants possess leaves with 12-15 pairs of leaflets and red tinged stems and shoots (characteristics normally associated with Eurasian Milfoil). Eurasian Milfoil, when present, can spread quickly, and is known to occur at

nuisance levels (14) and often displaces more desirable native vegetation and can alter plant and animal assemblages within a lake. Milfoils are able to reproduce by seeds, winter buds, and by fragmentation (15). If Eurasian milfoil becomes established, care must be taken to remove all cut plants when harvesting to avoid introduction of the plant to previously unpopulated areas.

Purple loosestrife is an exotic plant with a bright purple flower, originally propagated in the United States by the horticulture industry for flower gardens. It blooms late June to July and produces seeds soon after. The plant is able to outcompete native wetland vegetation and modify entire plant (and thus animal) assemblages.

Zebra mussels look like small clams with a yellowish and/or brownish "D"-shaped shell, usually with alternating dark and light bands of color. Most are under an inch long and usually grow in clusters containing numerous individuals and are generally found in shallow (6 to 30 feet deep), algae-rich water. They are the only freshwater mollusk that firmly attaches itself to solid objects, including rocks, boat hulls, etc.

BASELINE CONCLUSIONS

Watershed Characteristics

Areas of concern for the watershed include a combination of steep shorelines, sandy soils with low slopes and particular areas which provide ecological importance in preserving the resource.

As part of the Phase I elements ecologically sensitive areas were identified. "Sensitive areas" designation is described in Chapter NR 107 of the Wisconsin Administrative Code. In Section 107.05 (3(i)) it is stated that "Sensitive areas are areas of aquatic vegetation identified by the department as offering critical or unique fish and wildlife habitat, including seasonal or lifestage requirements, or offering water quality or erosion control benefits to the body of water". The southwest bay (Turtle Bay) and south shoreline provide important spawning and feeding grounds for the lake's fishery. The sand and gravel bar which extends from the north shore also provides an important panfish nesting area.

Water Quality

Regular water quality monitoring in Pleasant Lake during Phase I indicated good to very good water quality. Surface total phosphorus levels generally exhibited weak and variable seasonal trends. Total nitrogen levels tended to be slightly higher, as a

whole, and the limited amount of data did not suggest seasonal trends. Good water quality appears to be related to a combination of substantial groundwater inflow and a primarily wooded watershed. In-lake phosphorus levels were near or below levels expected for stratified lakes, lakes in the central region of Wisconsin and lakes in the **ecoregion** in which Pleasant Lake is located.

Nutrient inputs (and probably sediment) from the immediate watershed appear significant as higher levels of nitrogen and phosphorus were observed entering the lake via the public access area on the north shore of the lake.

Recreational Use

Pleasant Lake respondents generally agreed watercraft use is high and that the current number of watercraft cause safety problems. They also indicated that water safety enforcement was adequate during weekdays, but considerably fewer agreed during weekend or holiday periods of heavy recreational use. Respondents were evenly split as to limiting the number of watercraft and slightly less agreeable to additional use regulations being enacted and enforced. Respondents also tended to agree the current number of watercraft diminishes the ability to enjoy aesthetics from the water or shore during holidays. There was relatively low interest in establishment of a public swimming beach on Pleasant Lake.

Water quality protection and recreational use conflict minimization appear to be of most concern in future management objectives for Pleasant Lake.

Exotic Species

There were no observations of, Eurasian Water Milfoil, Purple Loosestrife or Zebra Mussels in Pleasant Lake. Purple Loosestrife and Eurasian Water Milfoil have become widely distributed in Wisconsin and are agents of habitat alteration and degradation.

MANAGEMENT RECOMMENDATIONS

Watershed: Management of Pleasant Lake should concentrate on better definition and reduction of nutrient inputs, via runoff to the lake. Nutrient input may be controlled to an extent by riparian land owners, but measured levels entering the lake from the extended watershed are somewhat excessive (on an event basis).

Pleasant Lake is significantly influenced by groundwater and receives surface water inflow from the watershed. Residential landowners should be made aware of the potential effects of watershed uses on their resource and can also use **Best Management Practices (BMP's)** to control nutrients and sediment entering Pleasant Lake. Buffer stripping, composting yard wastes, fertilizer management and slope contouring are just a few practices that can be adopted to slow and absorb overland runoff. Also, "clear-cutting" on steep slopes should be avoided. A number of informational sources regarding land management are outlined in Appendix III.

It is recommended that the Pleasant Lake Association request that the "sensitive areas" be designated accordingly, as defined by Chapter NR 107 of the Wisconsin Administrative Code. It is important that these areas (i.e., Turtle Bay, Sunset Point) be protected to help preserve the Pleasant Lake resource.

Water Quality: Water quality in Pleasant Lake is currently very good but routine sampling to monitor trends and further event sampling should be continued. More extensive monitoring of the public boat access (north shore) should better define the magnitude and timing of nutrient inputs to the lake. Re-routing surface runoff to a vegetative area would help filter out nutrients and sediment prior to entering the lake and should be pursued with county assistance. Self-help secchi monitoring should be continued; rainfall monitoring should be initiated.

The Pleasant Lake fishery should be assessed in the next five years to determine the status of the fishery. An aquatic plant survey should also be implemented in order to correctly identify macrophyte communities and their densities.

Agricultural/open land owners could then implement a number of Best Management Practices (BMP's) through development of a soil and nutrient conservation plan. BMP's are sometimes costly but are often common sense approaches based on awareness of land usage. Adoption of BMP's is especially important on open, sloping, tiled, tilled and fertilized lands. Some pertinent BMP's are outlined in Appendix IV.

Recreational Use: Pleasant Lake recreational use survey results suggest that use, during summer weekends and holidays, is at or near saturation levels and that most perceive the problems

related to non-resident and private watercraft. There does not appear, however, to be a clear concensus that additional regulations are desirable to address the situation. The PLIC, then, should form a committee, or enlist some outside assistance, to address direct education or prevention measures to attempt minimization of use conflicts; these may include

- Brochures, for visitors at access points, emphasizing "water use ethics" along with information on, access points and applicable regulations and ordinances,

- Development of waste disposal facilities for boaters,

- Initiation of a reasonable ramp fee at boat landing (north shore) with the money collected directed toward access maintenance or lake management/protection activities, and

- Riparian landowners education about pertinent ordinances (dock design/size, boat numbers per pier, building near lakeshores, near-lake improvements, etc.).

Exotic Species: The three exotic species of most concern are currently not established in Pleasant Lake.

- An exotic species watch group should be organized to monitor exotic species (i.e., Purple Loosestrife, Zebra Mussels and

Eurasian Water Milfoil) within the resource. Members should coordinate with the WDNR Exotic Species Program and inform the PLIC membership and public on the hazards of exotic species as they relate to Pleasant Lake.

Public Involvement: Informational and educational programs for the PLIC membership and public should be continued. Meetings, presentations and/or newsletters should continue to include information on groundwater and surface water quality, recreational use issues and the spread or control of exotic species.

Local townships, Waushara County and the State of Wisconsin, should take a cooperative effort in protection of the Pleasant Lake resource by the regulation of land uses and land use practices. Counties should communicate to the PLIC any variances that are granted in order for the PLIC to be more aware of changes within the watershed and the possible long-term effect to water quality. Efforts should continue to pursue cost-share funding (Lake Protection Grant) to implement long term conservation practices and preserve/protect important ecological areas.

Waushara County ordinances and plans possibly pertinent to Pleasant Lake are summarized in Appendix V. Potential sources of funding are listed in Appendix VI.

LIST OF REFERENCES

1. North American Lake Management Society. 1988. The Lake and Reservoir Restoration Guidance Manual (First Edition.). EPA 440/5-88/002.

2. Shaw, Byron, and Chris Mechenich. 1987. A guide to Interpreting Water Quality Data. Unpublished.

3. Wisconsin Department of Natural Resources, Bereau of Water Resource Management. 1983. Inland Lake Feasibility Studies. Unpublished.

4. Personal communication with the Pleasant Lake Improvement Corporation.

5. Wisconsin Department of Natural Resources. 1991. Wisconsin Lakes. PUBL-FM-800 91. 174 p.

6. United States Department of Agriculture, Soil Conservation Service. 1989. Soil Survey of Waushara County Wisconsin. 158 p.

7. Wisconsin Department of Natural Resources, Fish Management Division. 1960. Lake Survey Worksheet. Pleasant Lake. Unpublished.

8. Young, R. A., C. A. Onstad, D. D. Bosch, and W.P. Anderson. 1987. AGNPS, Agricultural Non-Point-Source Pollution Model. A Watershed Analysis Tool. U.S. Department of Agriculture, Conservation Research Report 35, 80 p.

9. United States Department of the Interior, Geological Survey. 1979. Coloma and Westfield West 7.5 Minute Quadrangles.

10. APHA. 1989. Standard Methods for the Examination of Water and Wastewater (17th ED.). American Public Health Association. American Public Health Association Washington, DC 20005.

11. Lillie, R. A. and J. W. Mason. 1983. Limnological Characteristics of Wisconsin Lakes. WDNR Technical Bulletin No. 138. 117 pp.

12. Bowman, G. and Shuknecht, B. 1991. Memo regarding stability of total phosphorus and total kjeldahl nitrogen samples exceeding holding times. Unpublished.

13. Carlson, R.E. 1977. "A Trophic State Index for Lakes." Limnol. Oceanogr. 22(2): 361-9.

LIST OF REFERENCES
(continued)

14. Nichols, Stanley A., and James G. Vennie. 1991. Attributes of Wisconsin Lake Plants. University of Wisconsin-

15. Whitley, James R., B. Basset, J. G. Dillard, R. A. Haefner. 1990. Water Plants for Missouri Ponds. 151 p.

APPENDIX I
SAMPLE RECREATIONAL USE SURVEY
Pleasant Lake Management Plan

APPENDIX I
(continued)

APPENDIX I
(continued)

APPENDIX I
(continued)

APPENDIX I
(continued)

APPENDIX I
(continued)

APPENDIX I
(continued)

APPENDIX I
(continued)

APPENDIX I
(continued)

APPENDIX I
(continued)

APPENDIX II

SUMMARY OF PUBLIC INVOLVEMENT ACTIVITIES

Pleasant Lake Management Plan

The Pleasant Lake Improvement Corporation (PLIC) initiated steps to develop a comprehensive lake management plan under the Wisconsin Department of Natural Resources (WDNR) Lake Management Planning Grant Program in the Spring of 1993. A public involvement program was immediately initiated as part of the planning process. The following is a summary of Phase I and major public involvement efforts.

Planning Advisory Committee

A working group comprised of PLIC Commissioners, WDNR and IPS representatives was established at the start of the program. The group provided planning direction and served as main reviewer of the draft plan document.

Brochures

A plan summary brochure will be produced upon conclusion of Phase I activities. It will be made available for PLIC use and distribution when the plan document is approved by the WDNR. The brochure will describe the main features of plan development, plan recommendations and other pertinent information.

Meetings

The PLIC conducted meetings for its board, its members and interested parties. IPS presented progress reports, provided information about the resource and interpretations of these results.

Print Media

A quarterly IPS newsletter entitled "Lake Management News" was developed and distributed to the PLIC for the Board's use and distribution among the membership.

Surveys

Recreational use surveys were distributed to the membership to solicit input from members.

APPENDIX III
SOURCES OF INFORMATION AND ASSISTANCE
Pleasant Lake, Waushara County, WI

Coloma Town Board

Mark Kerschner, Chairman
Rt. 1, Box 50
Coloma, WI 54930

Can answer questions regarding ordinances, zoning and permitting.

Department of Natural Resources:

Wautoma Ranger Station
Curt Wilson
Wautoma, WI 54982
414-787-4686

Lake Michigan District Office
Tim Rasman, Lakes Coordinator
1125 N. Military Road, Box 10448
Green Bay, WI 54307-0448
414-492-5903

Can answer questions on lake management, groundwater, water quality, fisheries, regulations, zoning and wildlife or direct you to someone that can be of help.

Environmental Task Force:

Environmental Task Force
College of Natural Resources
UW-Stevens Point
Stevens Point, WI 54481

Will test soils, lake water or well water.

IPS Environmental and Analytical Services

IPS Environmental and Analytical Services
ATTN: Lake Management Program
101 West Edison Avenue, Suit #250
Appleton, WI 54912
414-749-3040

Has specific information on the Pleasant Lake Management Plan and development of other management plans in the area.

APPENDIX III
(continued)

State Laboratory of Hygiene:

University of Wisconsin
Center of Health Sciences
465 Henry Mall
Madison, WI 53706
608-263-7384

Can give information on costs for testing of water and soils.

Waushara County Soil Conservation Service (USDA):

Steve Prissel, Soil Conservationist
P.O. Box 458
Wautoma, WI 54982
414-787-3828

Can provide information on soil types and limitations, depths to groundwater and bedrock and related information.

Waushara County Zoning Administration:

Mark Schumacher
Zoning Administrator
Wautoma Courthouse
Wautoma, WI 54982
414-787-4631

May have information on development, land use, floodplain and regulations regarding land parcels in your area.

Waushara County University of Wisconsin Extension:

Dennis Dornfield
UW-Extension
Wautoma Courthouse
P.O. Box 487
Wautoma, WI 54982
414-787-4631

Has information of agricultural practices, waste disposal and conservation practices.

APPENDIX III
(continued)

Wisconsin Geological and Natural History Survey:

Ron Hennings
3817 Mineral Point Road
Madison, WI 53705
608-263-7384

Can give information on groundwater and mineral exploration.

APPENDIX IV
Review of Best Management Practices (BMP's) (1)

Conservation Tillage: A farming practice that leaves stalks or stems and roots intact in the field after harvest. Its purpose is to reduce water runoff and soil erosion compared to conventional tillage where the topsoil is mixed and turned over by a plow. Conservation tillage is an umbrella term that includes any farming practice that reduces the number of times the topsoil is mixed. Other terms that are used instead of conservation tillage are (1) minimum tillage where one or more operations that mixed the topsoil are eliminated; and (2) no-till where the topsoil is left essentially undisturbed.

CRITERIA		REMARKS
1.	Effectiveness	
	a) Sediment	Fair to excellent, decreases sediment input to streams and lakes. (40-90% reduced tillage, 50-95% no tillage).
	b) Nitrogen (N)	Poor, no effect on nitrogen input to streams and lakes.
	c) Phosphorus (P)	Fair to excellent, can reduce the amount of phosphorus input to streams and lakes. (40-90% reduced tillage, 50-95% no tillage).
	d) Runoff	Fair to excellent, decreases amount of water running off fields carrying sediment and phosphorus.
2.	Capital Costs	High, because requires purchase of new equipment by farmer.
3.	Operation and Maintenance	Less expensive than conventional tillage. Potential increase in herbicide costs. Potential increase in net farm income.
4.	Longevity	Good, approximately every five years the soil has to be turned over.
5.	Confidence	Fair to excellent.
6.	Adaptability	Good, but may be limited in northern areas that experience late cool springs, or in heavy, poorly drained soils.
7.	Potential Treatment Side Effects	Potential increase in herbicide effects and insecticide contamination of surface and groundwater. Nitrogen contamination of groundwater.
8.	Concurrent Land Management Practices	Consider fertilizer management and integrated pest management.

Integrated Pest Management: Pests are any organisms that are harmful to desired plants, and they are controlled with chemical agents called pesticides. Integrated pest management considers factors such as how much pesticide is enough to control a problem, the best method of applying the pesticides, the appropriate time for application and the safe handling, storage and disposal of pesticides and their containers. Other considerations include using resistant crop varieties, optimizing crop planting time, optimizing time of day application, rotating crops and biological controls.

CRITERIA		REMARKS
1.	Effectiveness	
	a) Sediment	No effect, but pesticides attached to soil particles can be carried to streams and lakes.
	b) Nitrogen (N)	No effect.
	c) Phosphorus (P)	No effect.
	d) Runoff	No effect, but water is the primary route for transporting pesticides to lakes and streams.
2.	Capital Costs	No effect.
3.	Operation and Maintenance	Farming cost, potential reduction in pesticide costs and an increase in net farm income.
4.	Longevity	Poor, as pesticides are applied one or more times per year to address different pests and different crops.
5.	Confidence	Fair to excellent, reported pollutant reductions range from 20-90%.
6.	Adaptability	Methods are generally applicable wherever pesticides are used: forest, farms, homes.
7.	Potential Treatment Side Effects	Potential for ground and surface water contamination. Toxic components may be available to aquatic plants and animals.
8.	Concurrent Land Management Practices	See crop rotation, conservation tillage.

APPENDIX IV
Review of Best Management Practices (BMP's)
(continued)

Street Cleaning: Streets and parking lots can be cleaned by sweeping which removes large dust and dirt particles or by flushing which removes finer particles. Sweeping actually removes solids so pollutants do not reach receiving waters. Flushing just moves the pollutants to the drainage system unless the drainage system is part of the sewer system. When the drainage system is part of the sewer system, the pollutants will be treated as wastes in the sewer treatment plant.

CRITERIA		REMARKS
1.	Effectiveness	
	a) Sediment	Poor, not proven to be effective.
	b) Nitrogen (N)	Poor, not proven to be effective.
	c) Phosphorus (P)	Poor, not proven to be effective.
	d) Runoff	No effect.
2.	Capital Costs	High, because it requires the purchase of equipment by community.
3.	Operation and Maintenance	Unknown but reasonable vehicular maintenance would be expected.
4.	Longevity	Poor, have to sweep frequently throughout the year.
5.	Confidence	Poor.
6.	Adaptability	To paved roads, might not be considered a worthwhile expenditure of funds in communities less than 10,000.
7.	Potential Treatment Side Effects	Unknown.
8.	Concurrent Land Management Practices	Detention/Sedimentation basins.

Streamside Management Zones (Buffer strips): Considerations in streamside management include maintaining the natural vegetation along a stream, limiting livestock access to the stream, and where vegetation has been removed, planting buffer strips. Buffer strips are strips of plants (grass, trees, shrubs) between a stream and an area being disturbed by man's activities that protects the stream from erosion and nutrient impacts.

CRITERIA		REMARKS
1.	Effectiveness	
	a) Sediment	Good to excellent, reported to reduce sediment from feedlots on 4% slope by 79%.
	b) Nitrogen (N)	Good to excellent, reported to reduce nitrogen from feedlots on 4% slope by 84%.
	c) Phosphorus (P)	Good to excellent, reported to reduce phosphorus from feedlots on 4% slope by 67%.
	d) Runoff	Good to excellent, reported to reduce runoff from feedlots on 4% slope by 67%.
2.	Capital Costs	Good, moderate costs for fencing material to keep out livestock and for seeds for plants.
3.	Operation and Maintenance	Excellent, minimal upkeep.
4.	Longevity	Excellent, maintains itself indefinitely.
5.	Confidence	Fair, because of the lack of intensive scientific research.
6.	Adaptability	May be used anywhere. Limitations on types of plants that may be used between geographic areas.
7.	Potential Treatment Side Effects	With trees, shading may increase the diversity and number of organisms in the stream with the possible reduction of algae.
8.	Concurrent Land Management Practices	Conservation tillage, animal waste management, livestock exclusion, fertilizer management, pesticide management, ground cover maintenance, proper construction, use, maintenance of haul roads and skid trails.

APPENDIX IV
Review of Best Management Practices (BMP's)
(continued)

Contour Farming: A practice where the farmer plows across the slope of the land. This practice is applicable on farm land with a 2-8 percent slope.

CRITERIA		REMARKS
1.	Effectiveness	
	a) Sediment	Good on moderate slopes (2 to 8 percent slopes), fair on steep slopes (50 percent reduction).
	b) Nitrogen (N)	Unknown.
	c) Phosphorus (P)	Fair.
	d) Runoff	Fair to good, depends on storm intensity.
2.	Capital Costs	No special effect.
3.	Operation and Maintenance	No special effect.
4.	Longevity	Poor, it must be practiced every time the field is plowed.
5.	Confidence	Poor, not enough information.
6.	Adaptability	Good, limited by soil, climate, and slope of land. May not work with large farming equipment on steep slopes.
7.	Potential Treatment Side Effects	Side effects not identified.
8.	Concurrent Land Management Practices	Fertilizer management, integrated pesticide management, possibly streamside management.

Contour Stripcropping: This practice is similar to contour farming where the farmer plows across the slope of the land. The difference is that strips of close growing crops or meadow grasses are planted between strips of row crops like corn or soybeans. Whereas contour farming can be used on 2-8 percent slopes, contour stripcropping can be used on 8-15 percent slopes.

CRITERIA		REMARKS
1.	Effectiveness	
	a) Sediment	Good, 8 to 15 percent slopes, provides the benefits of contour plowing plus buffer strips.
	b) Nitrogen (N)	Unknown, assumed to be fair to good.
	c) Phosphorus (P)	Unknown, assumed to be fair to good.
	d) Runoff	Good to excellent.
2.	Capital Costs	No special effect unless farmer cannot use the two crops.
3.	Operation and Maintenance	No special effect.
4.	Longevity	Poor, must be practiced year after year.
5.	Confidence	Poor, not enough information.
6.	Adaptability	Fair to good, may not work with large farming equipment on steep slopes.
7.	Potential Treatment Side Effects	Side effects not identified.
8.	Concurrent Land Management Practices	Fertilizer management, integrated pesticide management.

APPENDIX IV
Review of Best Management Practices (BMP's)
(continued)

Range and Pasture Management: The objective of range and pasture management is to prevent overgrazing because of too many animals in a given area. Management practices include spreading water supplies, rotating animals between pastures, spreading mineral and feed supplements or allowing animals to graze only when a particular plant food is growing rapidly.

CRITERIA		REMARKS
1.	Effectiveness	
	a) Sediment	Good, prevents soil compaction which reduces infiltration rates.
	b) Nitrogen (N)	Unknown.
	c) Phosphorus (P)	Unknown.
	d) Runoff	Good, maintains some cover which reduces runoff rates.
2.	Capital Costs	Low, but may have to develop additional water sources.
3.	Operation and Maintenance	Low.
4.	Longevity	Excellent.
5.	Confidence	Good to excellent. Farmer must have a knowledge of stocking rates, vegetation types, and vegetative conditions.
6.	Adaptability	Excellent.
7.	Potential Treatment Side Effects	None identified.
8.	Concurrent Land Management Practices	Livestock exclusion, riparian zone management and crop rotation.

Crop Rotation: Where a planned sequence of crops are planted in the same area of land. For example, plow based crops are followed by pasture crops such as grass or legumes in two to four year rotations.

CRITERIA		REMARKS
1.	Effectiveness	
	a) Sediment	Good when field is in grasses or legumes.
	b) Nitrogen (N)	Fair to good.
	c) Phosphorus (P)	Fair to good.
	d) Runoff	Good when field is in grasses or legumes.
2.	Capital Costs	High if farm economy reduced. Less of a problem with livestock which can use plants as food.
3.	Operation and Maintenance	Moderate, increased labor requirements. May be offset by lower nitrogen additions to the soil when corn is planted after legumes, and reduction in pesticide application.
4.	Longevity	Good.
5.	Confidence	Fair to good.
6.	Adaptability	Good, but some climatic restrictions.
7.	Potential Treatment Side Effects	Reduction in possibility of groundwater contamination.
8.	Concurrent Land Management Practices	Range and pasture management.

APPENDIX IV
Review of Best Management Practices (BMP's)
(continued)

Terraces: Terraces are used where contouring, contour strip cropping, or conservation tillage do not offer sufficient soil protection. Used in long slopes and slopes up to 12 percent; terraces are small dams or a combination of small dams and ditches that reduce the slope by breaking it into lesser or near horizontal slopes.

CRITERIA		REMARKS
1.	Effectiveness	
	a) Sediment	Fair to good.
	b) Nitrogen (N)	Unknown.
	c) Phosphorus (P)	Unknown.
	d) Runoff	Fair, more effective in reducing erosion than total runoff volume.
2.	Capital Costs	High initial costs.
3.	Operation and Maintenance	Periodic maintenance cost, but generally offset by increased income.
4.	Longevity	Good with proper maintenance.
5.	Confidence	Good to excellent.
6.	Adaptability	Fair, limited to long slopes and slopes up to 12 percent.
7.	Potential Treatment Side Effects	If improperly designed or used with poor cultural and management practices, they may increase soil erosion.
8.	Concurrent Land Management Practices	Fertilizer and pesticide management.

Animal Waste Management: A practice where animal wastes are temporarily held in waste storage structures until they can be utilized or safely disposed. Storage units can be constructed or reinforced concrete or coated steel. Wastes are also stored in earthen ponds.

CRITERIA		REMARKS
1.	Effectiveness	
	a) Sediment	Not applicable.
	b) Nitrogen (N)	Good to excellent.
	c) Phosphorus (P)	Good to excellent.
	d) Runoff	Not applicable.
2.	Capital Costs	High because of the necessity of construction and disposal equipment.
3.	Operation and Maintenance	Unknown.
4.	Longevity	Unknown.
5.	Confidence	Fair to excellent if properly managed.
6.	Adaptability	Good.
7.	Potential Treatment Side Effects	The use of earthen ponds can possibly lead to groundwater contamination.
8.	Concurrent Land Management Practices	Fertilizer management.

APPENDIX IV
Review of Best Management Practices (BMP's)
(continued)

Nonvegetative Soil Stabilization: Examples of temporary soil stabilizers include mulches, nettings, chemical binders, crushed stone, and blankets or mats from textile material. Permanent soil stabilizers include coarse rock, concrete, and asphalt. The purpose of soil stabilizers is to reduce erosion from construction sites.

CRITERIA		REMARKS
1.	Effectiveness	
	a) Sediment	Excellent.
	b) Nitrogen (N)	Poor.
	c) Phosphorus (P)	Poor.
	d) Runoff	Poor on steep slopes with straw mulch, otherwise good.
2.	Capital Costs	Low to high, depending on technique applied.
3.	Operation and Maintenance	Moderate.
4.	Longevity	Generally a temporary solution until a more permanent cover is developed. Excellent for permanent soil stabilizer.
5.	Confidence	Good.
6.	Adaptability	Excellent.
7.	Potential Treatment Side Effects	No effect on soluble pollutants.
8.	Concurrent Land Management Practices	Runoff detention/retention.

Porous Pavement: Porous pavement is asphalt without fine filling particles on a gravel.

CRITERIA		REMARKS
1.	Effectiveness	
	a) Sediment	Good.
	b) Nitrogen (N)	Good.
	c) Phosphorus (P)	Good.
	d) Runoff	Good to excellent.
2.	Capital Costs	Moderate, slightly more expensive than conventional surfaces.
3.	Operation and Maintenance	Potentially expensive, requires regular street maintenance program and can be destroyed in freezing climates.
4.	Longevity	Good, with regular maintenance (i.e., street cleaning), in southern climates. In cold climates, freezing and expansion can destroy.
5.	Confidence	Unknown.
6.	Adaptability	Excellent.
7.	Potential Treatment Side Effects	Groundwater contamination from infiltration of soluble pollutants.
8.	Concurrent Land Management Practices	Runoff detention/retention.

APPENDIX IV
Review of Best Management Practices (BMP's)
(continued)

Flood Storage (Runoff Detention/Retention): Detention facilities treat or filter out pollutants or hold water until treated. Retention facilities provide no treatment. Examples of detention/retention facilities include ponds, surface basins, underground tunnels, excess sewer storage and underwater flexible or collapsible holding tanks.

CRITERIA		REMARKS
1.	Effectiveness	
	a) Sediment	Poor to excellent, design dependent.
	b) Nitrogen (N)	Very poor to excellent, design dependent.
	c) Phosphorus (P)	Very poor to excellent, design dependent.
	d) Runoff	Poor to excellent, design dependent.
2.	Capital Costs	Dependent on type and size. Range from $100 to $1,000, per acre served, depending on site. These costs include capital costs and operational costs.
3.	Operation and Maintenance	Annual cost per acre of urban area served has ranged from $10 to $125 depending on site.
4.	Longevity	Good to excellent, should last several years.
5.	Confidence	Good, if properly designed.
6.	Adaptability	Excellent.
7.	Potential Treatment Side Effects	Groundwater contamination with retention basins.
8.	Concurrent Land Management Practices	Porous pavements.

Sediment Traps: Sediment traps are temporary structures made of sandbags, straw bales, or stone. Their purpose is to detain runoff for short periods of time so heavy sediment particles will drop out. Typically, they are applied within and at the periphery of disturbed areas.

CRITERIA		REMARKS
1.	Effectiveness	
	a) Sediment	Good, coarse particles.
	b) Nitrogen (N)	Poor.
	c) Phosphorus (P)	Poor.
	d) Runoff	Fair.
2.	Capital Costs	Low.
3.	Operation and Maintenance	Low, require occasional inspection and prompt maintenance.
4.	Longevity	Poor to good.
5.	Confidence	Poor.
6.	Adaptability	Excellent.
7.	Potential Treatment Side Effects	None identified.
8.	Concurrent Land Management Practices	Agricultural, silviculture or other construction best management practices could be incorporated depending on situation.

APPENDIX IV
Review of Best Management Practices (BMP's)
(continued)

Surface Roughening: On construction sites, the surface of the exposed soil can be roughened with conventional construction equipment to decrease water runoff and slow the downhill movement of water. Grooves are cut along the contour of a slope to spread runoff horizontally and increase the water infiltration rate.

CRITERIA		REMARKS
1.	Effectiveness	
	a) Sediment	Good.
	b) Nitrogen (N)	Unknown.
	c) Phosphorus (P)	Unknown.
	d) Runoff	Good.
2.	Capital Costs	Low, but requires timing and coordination.
3.	Operation and Maintenance	Low, temporary protective measure.
4.	Longevity	Short-term.
5.	Confidence	Unknown.
6.	Adaptability	Excellent.
7.	Potential Treatment Side Effects	None identified.
8.	Concurrent Land Management Practices	Nonvegetative soil stabilization.

Riprap: A layer or loose rock or aggregate placed over a soil surface susceptible to erosion.

CRITERIA		REMARKS
1.	Effectiveness	
	a) Sediment	Good, based on visual observations.
	b) Nitrogen (N)	Unknown.
	c) Phosphorus (P)	Unknown.
	d) Runoff	Poor.
2.	Capital Costs	Low to high, varies greatly.
3.	Operation and Maintenance	Low.
4.	Longevity	Good, with proper rock size.
5.	Confidence	Poor to good.
6.	Adaptability	Excellent.
7.	Potential Treatment Side Effects	In streams, erosion may start in a new, unprotected place.
8.	Concurrent Land Management Practices	Streamside (lake) management zone.

APPENDIX IV
Review of Best Management Practices (BMP's)
(continued)

Interception or Diversion Practices: Designed to protect bottom land from hillside runoff, divert water from areal sources of pollution such as barnyards or to protect structures from runoff. Diversion structures are represented by any modification of the surface that intercepts or diverts runoff so that the distance of flow to a channel system is increased.

CRITERIA		REMARKS
1.	Effectiveness	
	a) Sediment	Fair to good (30 to 60 percent reduction).
	b) Nitrogen (N)	Fair to good (30 to 60 percent reduction).
	c) Phosphorus (P)	Fair to good (30 to 60 percent reduction).
	d) Runoff	Poor, not designed to reduce runoff but divert runoff.
2.	Capital Costs	Moderate to high, may entail engineering design and structures.
3.	Operation and Maintenance	Fair to good.
4.	Longevity	Good.
5.	Confidence	Poor to good, largely unknown.
6.	Adaptability	Excellent.
7.	Potential Treatment Side Effects	None identified.
8.	Concurrent Land Management Practices	Since the technique can be applied under multiple situations (i.e., agriculture, silviculture, construction) appropriate best management practices associated with individual situations should also be applied.

Grassed Waterways: A practice where broad and shallow drainage channels (natural or constructed) are planted with erosion-resistant grasses.

CRITERIA		REMARKS
1.	Effectiveness	
	a) Sediment	Good to excellent (60 to 80 percent reduction).
	b) Nitrogen (N)	Unknown.
	c) Phosphorus (P)	Unknown.
	d) Runoff	Moderate to good.
2.	Capital Costs	Moderate.
3.	Operation and Maintenance	Low, but may interfere with the use of large equipment.
4.	Longevity	Excellent.
5.	Confidence	Good.
6.	Adaptability	Excellent.
7.	Potential Treatment Side Effects	None identified.
8.	Concurrent Land Management Practices	Conservative tillage, integrated pest management, fertilizer management, animal waste management.

APPENDIX IV
Review of Best Management Practices (BMP's)
(continued)

Maintain Natural Waterways: This practice disposes of tree tops and slash in areas away from waterways. Prevents the buildup of damming debris. Stream crossings are constructed to minimize impacts on flow characteristics.

CRITERIA		REMARKS
1.	Effectiveness	
	a) Sediment	Fair to good, prevents acceleration of bank and channel erosion.
	b) Nitrogen (N)	Unknown, contribution would be from decaying debris.
	c) Phosphorus (P)	Unknown, contribution would be from decaying debris.
	d) Runoff	Fair to good, prevents deflections or constrictions of stream water flow which may accelerate bank and channel erosion.
2.	Capital Costs	Low, supervision required to ensure proper disposal of debris.
3.	Operation and Maintenance	Low, if proper supervision during logging is maintained, otherwise $160-$800 per 100 ft stream.
4.	Longevity	Good.
5.	Confidence	Good.
6.	Adaptability	Excellent.
7.	Potential Treatment Side Effects	None identified.
8.	Concurrent Land Management Practices	Proper design and location of haul and skid trails; Streamside management zones.

Haul Roads and Skid Trails: This practice is implemented prior to logging operations. It involves the appropriate site selection and design of haul road and skid trails. Haul roads and skid trails should be located away from streams and lakes. Recommended guidelines for gradient, drainage, soil stabilization, and filter strips should be followed. Routes should be situated across slopes rather than up or down slopes. If the natural drainage is disrupted, then artificial drainage should be provided. Logging operations should be restricted during adverse weather periods. Other good practices include ground covers (rock or grass) closing roads when not in use, closing roadways during wet periods, and returning main haul roads to prelogging conditions when logging ceases.

CRITERIA		REMARKS
.1.	Effectiveness	
	a) Sediment	Good if grass cover is used on haul roads (45 percent reduction); Excellent if crushed rock is used as ground cover (92 percent reduction).
	b) Nitrogen (N)	Unknown.
	c) Phosphorus (P)	Unknown.
	d) Runoff	Unknown.
2.	Capital Costs	High, grass cover plus fertilizer $5.37/100 ft roadbed, crushed rock (6 in) $179.01/100ft roadbed.
3.	Operation and Maintenance	High, particularly with grass which may have to be replenished routinely and may not be effective on highly traveled roads.
4.	Longevity	Unknown.
5.	Confidence	Good for ground cover, poor for nutrients.
6.	Adaptability	Good.
7.	Potential Treatment Side Effects	Potential increase in nutrients to water course if excess fertilizers are applied.
8.	Concurrent Land Management Practices	Maintain natural waterways.

APPENDIX V

SUMMARY OF PERTINENT WAUSHARA COUNTY ORDINANCES AND PLANS

Waushara County Zoning Ordinance

Included in this ordinance are regulations for shoreland/ floodplain zoning, land subdivisions private sewage systems and water setback.

- Shoreland/Floodplain Zoning: Section 87.30 Wis. Stats. requires all counties to adopt floodplain zoning as part of their local zoning ordinance. This type of zoning is used to minimize flood damage in areas subject to flooding. The purposes of the county's ordinance include: aid in the prevention and control of water pollution; protect spawning beds, fish and aquatic life; minimize erosion sedimentation; preserve shore cover and natural beauty; protect stream channels from encroachment; and provide for the movement and storage of flood waters.

  Waushara County's ordinance covers all shorelands, floodplains, shoreland-wetlands of navigable waters and designated conservancy areas in the unincorporated areas of the county. The ordinance regulates all lands that would be inundated by a "regional flood" or a flood the magnitude of which could be expected on the average of once every hundred years. Floodplain districts include a floodway and flood fringe area. The floodway is the channel of a stream and that portion of the floodplain adjoining the channel that would carry and discharge the floodwaters of the stream. Only open space uses that have a low flood damage potential and will not obstruct flood flows are permitted within the floodway.

  The flood fringe is that portion of the floodplain between the outer limits of the general floodplain and the floodway that would be covered by flood waters during a regional flood. The flood fringe is generally associated with standing water rather than rapidly flowing water. A number of structural land uses are permitted in the flood fringe, provided they meet certain floodproofing standards.

  Shoreland Zoning: As required under Section 59.971 Wis. Stats., Waushara County has adopted shoreland zoning. This type of zoning provides the means to protect valuable natural resources that are common along lakes and rivers. The ordinance can prevent

APPENDIX V
(Continued)

development of land and certain land use activities from adversely affecting the waterbody. Several districts have been delineated and defined under the county's shoreland zoning, including; Floodway District, Flood Fringe District, General Floodplain District, Shoreland District, Shoreland-Wetland District and Conservancy District.

Subdivision Ordinance: The Subdivision Ordinance regulates any division of land that creates two or more parcels. No land can be subdivided which is determined by the county planning and zoning committee to be unsuitable for development because of potential flooding, inadequate drainage, or severe erosion potential.

Private Sewage System Ordinance: The Private Sewage System Ordinance provides measures to preclude the installation of private on-site waste disposal systems in areas not suited for such systems. Such areas are frequently located near rivers and lakes where high groundwater tables can prevent adequate percolation and thereby contribute to surface runoff of septate or groundwater contamination.

Water Setback Ordinance: The Water Setback Ordinance requires all buildings and structures to be set back at least 75 feet from the ordinary high water mark of navigable waters, except Class I, II, and III trout streams, in which case the required setback from the ordinary high water mark shall be at least 100 feet: patios must seventy five feet from the OHWM (100 feet from the OHWM if Class I, II, and III trout streams).

Stairways, walkways, piers, and landings should be elevated above the ground surface rather than excavated.

Erosion Control Plan

Waushara County has adopted an Erosion Control Plan that requests subdividers to submit an erosion control plan that specifies measures that will be taken to assure the minimization of erosion problems.

Specifically, the subdivider shall cause all gradings, excavations, open cuts, side slopes, and other land surface disturbances to be mulched, seeded, sodded or otherwise protected

APPENDIX V
(Continued)

so that erosion, siltation, sedimentation, and washings are prevented. Although the plan looks at soil loss in relation to construction activities, it can also have a significant impact in reducing nutrient loadings to rivers and lakes. Finally, the plan states that the Land Conservation Committee (LCC) shall review the erosion control plan to determine the adequacy of the proposed measures.

APPENDIX VI

POTENTIAL FUNDING SOURCES FOR PLAN IMPLEMENTATION

Potential sources of funds to assist plan implementation include:

County:

- Conservation funds from the state to be used for natural resources projects (old Predator Fund). Erosion control cost share funds through Land Conservation Committee.

State:

- WDNR Priority Watershed Program. This program has been modified to include priority lakes. The program provides 50-80% cost share for installing "best management practices" to combat nonpoint source water pollutants. Projects are selected by the WDNR and administered by the County Land Conservation Committee.

- WDNR Lake Management Grants. Funding is available to local governments and lake management organizations for the collection and analysis of information needed to manage lakes. The state may pay for 75% of the cost and up to $10,000 for any one project. The remaining 25% must be provided by the local organization or cash contributions from other sources. Projects may include: gathering and analysis of physical, chemical and biological information, describing present and potential land uses within lake watersheds, reviewing jurisdictional boundaries and evaluating ordinances that relate to zoning, sanitation or pollution control, gathering and analyzing information from lake property owners, community residents and lake users, developing alternative courses of action and recommendations.

- WDNR Lake Protection Grants. Another 75% cost share program which allows lake management organizations to obtain funds to protect or restore lakes and their ecosystems. Activities eligible for funding include: the purchase of property which will contribute to the protection or improvement of the natural ecosystem and water quality of a lake, the restoration of wetlands, the development of regulations and ordinances, and any lake improvement projects recommended in a DNR approved plan including lake restoration, watershed management, pollution prevention and

control projects.

APPENDIX VI
(continued)

- WDNR's Recreational Boating Facilities Program (NR 7). This program is administered by the WDNR and supervised by the Wisconsin Waterways Commission. Forty per cent of funds are allocated to the Great Lakes, 40% to inland lakes and 20% is discretionary. Financial assistance is available for safe recreational boating projects including: "...dredging of channels of waterways for recreational boating purposes, acquisition of capital equipment necessary to cut and remove aquatic plants, and acquisition of aids to navigate and regulatory markers." A 50% cost share is provided.

- DATCP Farmers' Fund (AG 165). Assists farmers with construction of animal waste management installations (county sets design standards).

- Soil Erosion Control (AG 160) funds targeted to areas that counties have identified as priorities in the County Erosion Control Plan.

- Stewardship Program. Ten year program to protect environmentally sensitive areas and acquire or maintain recreational areas. The funds are raised by state sale of bonds. Potential lake applications include:

  Habitat Restoration Areas - $1.5M annually to encourage private landowners and non-profit organizations to adopt management practices favorable to wildlife.

  Urban Green Space - $750,000 annually for 50% grants to municipalities to protect scenic or ecological sites from development.

  Streambank Protection - $1M annually to WDNR to purchase streambank easements of at least 66 feet and to provide fencing.

Federal:

- Environmental Protection Agency (EPA) Clean Lakes Program (appropriations pending). Limited amount of cost share funding for planning and

implementing public lake protection and restoration projects. WDNR must apply for the

APPENDIX VI
(continued)

funds on behalf of lake organization. Requires EPA feasibility study.

- Army Corps of Engineers. Can provide limited cost share funds to states to support selected aquatic plant management projects. Must be identified by WDNR as high priority and have an in-depth aquatic plant management plan.

- Department of Agriculture (USDA) 1985 Federal Farm Bill. Program to take land out of agricultural production. While these funds go to individual farmers, lake leaders may want to encourage farmers to use these programs. Conservation Reserve Program is purchasing the right to keep some Wisconsin farmland out of cultivation for 10 years. County office administers the program.

- Farmers' Home Administration (FmHA) Loan program to farmers in exchange for Conservation Easements. Long-term easements take land adjacent to wetlands, lakes and streams out of production. Annual multi-year set-aside programs.

- Soil Conservation Service (SCS). Beginning in 1983, SCS has provided large grants to selected areas to enhance water quality.

- Agricultural Conservation Program (ACP). Provides financial assistance for agricultural conservation practices the USDA-ASCS.

Miscellaneous:

Programs that might be useful in certain situations include: Trout Stamp land purchase program (WDNR), Water Bank Program (ASCS), water safety patrol aids (WDNR), Land and Water Conservation Fund (US Dept. of Interior and WDNR), Forest Incentive Program (ASCS), Mining Investment and Local Impact Fund (Wis. Dept. of Revenue) and Septic Tank Replacement Program (WDNR).

PHASE I
LAKE MANAGEMENT PLAN
PLEASANT LAKE
WAUSHARA COUNTY, WISCONSIN

Prepared for

Pleasant Lake Improvement Corporation

by

August, 1996