IPS ENVIRONMENTAL AND ANALYTICAL SERVICES
Appleton, Wisconsin

LAKE MANAGEMENT PLAN
PINE LAKE
SHAWANO COUNTY, WISCONSIN

REPORT TO:
CLOVERLEAF LAKES PROTECTIVE ASSOCIATION

June, 1992

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ACKNOWLEDGEMENTS

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GLOSSARY OF TERMS (1, 2, 3)

Anoxic	Water that has extremely low or no dissolved oxygen.
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.
Drainage Lake	Generally referred to as those natural lakes having inflowing and outflowing streams.
Edge	A biologically diverse area located at the interface of differing habitat types.
Eutrophic	From Greek for "well nourished", describes a lake of high photosynthetic activity and low transparency.
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.
Fetch	The longest distance over which the wind can sweep unobstructed.
Hypolimnion	Lower, cooler layer of a lake during summertime thermal stratification.
Immediately Adjacent Watershed	Here defined as the drainage area immediately around a lake, i.e. within 1,000 feet of shore and any inlet(s).
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.

GLOSSARY OF TERMS
(Continued)

N/P Ratio	Total nitrogen divided by the total phosphorus found in a water sample. A value greater than 15 indicates that phosphorus is limiting for primary production.
Physicochemical	Pertaining to physical and/or chemical characteristics.
Oligotrophic	A lake of low plant productivity and high transparency.
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.
Secchi Depth	A measure of optical water clarity as determined by lowering a weighted Secchi disk (20 cm in diameter) into the water body to a point where it is no longer visible.
Stratification	Layering of water caused by differences in water density. Thermal stratification is typical of most deep lakes during the Summer. Chemical stratification can also occur.

SUMMARY

Pine Lake, Shawano County, is the lower, largest, and shallowest lake of a three lake "chain" known as the Cloverleaf Lakes. Groundwater is a primary source of inflow to the chain. This, combined with a primarily wooded watershed, results in a relatively low potential for sediment and nutrient input.

Water quality was fair to good for all parameters measured; transparency, nutrients and **chlorophyll a**[1] indicated a **mesotrophic** status. Pine Lake stratified during summer and exhibited high nutrient levels and near-**anoxic** conditions near bottom in deeper portions of the basin.

Macrophyte growth in Pine Lake, in general contrast to the upper lakes in the chain, occurred across a rather extensive **littoral** zone. Bushy pondweed (*Najas* sp.), a plant known to reach nuisance levels, and water celery (*Vallisneria americana*), a relatively desireable plant from the viewpoint of habitat provision, were most common. Water milfoil, which may include Eurasian Milfoil, an exotic species was also relatively common. Macrophyte compositional differences from that observed in adjacent Grass Lake may be related to substrate differences, e.g., generally harder substrate in Pine Lake.

Overall management objectives for Pine Lake should emphasize protection and improvement/enhancement of this already high quality resource.

- Regular water quality monitoring should be continued to track water quality trends. Event monitoring should target sources of overland drainage (parking areas, roads). Self-Help Secchi monitoring should be continued.

- Riparian land owner education and diligence with respect to runoff control, yard waste and fertilizer management should be encouraged to minimize sediment and nutrient input to the lake. Runoff or erosion prone areas should be identified and protective measures implemented where possible.

- Macrophyte management in near shore areas should be limited to manual harvest (if necessary or desired) to improve aesthetics and minimize build-up of organic sediments. Water milfoil species should be determined; Eurasian Milfoil, if present, should be selectively removed. Macrophyte management should be limited to localized nuisance species control and should emphasize creation of **edge** and protection of desireable species assemblages.

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

INTRODUCTION

Pine Lake is located in the Town of Belle Plaine in south-central Shawano County, Wisconsin. Pine Lake is the lower lake of a three lake "chain" also consisting of Round (upper) and Grass (middle) Lakes. This chain of primarily groundwater fed natural lakes is collectively referred to as the Cloverleaf Lakes.

The Cloverleaf Lakes Protective Association (CLPA) was formed in 1930 to provide leadership and coordination of lake preservation and educational activities pertinent to the Cloverleaf Lakes. Overall objectives of the CLPA, and their major concerns in development of a lake management plan included weed growth, redistribution of sediment, the problem of swimmer's itch and general water quality upkeep. Currently, the CLPA has seven elected officers and about 220 members.

The CLPA, in late-1990, decided to pursue the development of a long range management plan under the Wisconsin Department of Natural Resources (WDNR) Lake Management Planning Grant Program. The CLPA officers selected IPS Environmental & Analytical Services (IPS) of Appleton, Wisconsin as its consultant to develop the plan. A grant application, incorporating required or recommended program components and the following objectives, was prepared, submitted, and approved in April, 1991:

- establishment of a monitoring study designed to track long-term lake quality trends,
- acquisition of existing historic data and analysis, along with current data, to assess the present status of the resource,
- location, identification and quantification of aquatic macrophyte concentrations,
- development of the awareness of the lake property owners and establishment of a base of support for lake management efforts.

A Planning Advisory Committee, comprised of representatives from CLPA, IPS, WDNR and the Town of Belle Plaine was formed and met initially in May, 1991 to provide program guidance and direction.

DESCRIPTION OF AREA

Pine Lake (T26N R15E S34) is a **drainage lake** located in Shawano County northeast of Clintonville, Wisconsin (Figure 1). The general topography of Shawano County is related to glacial activity. The Cloverleaf Lakes' watershed is predominantly forested with agricultural areas. Topography adjacent to the lakes is level to gently sloping. The major soil types in the Cloverleaf Lakes area are somewhat poorly drained Au Gres loamy sands on 0-3 percent slopes, excessively drained Menahga loamy sands on 2 to 6 percent slopes and moderately well drained Croswell loamy sands on 0 to 3 percent slopes (4). Soil permeability is rapid in all soils.

Pine Lake has a surface area of 209 acres, an average depth of about 8 feet, and a maximum depth of 35 feet (5). The **fetch** is 0.8 miles and lies in a southwest-northeast orientation and the width is 0.7 miles in a northwest-southeast orientation. The Pine Lake watershed to lake ratio is about 6 to 1 which means that 6 times more land than lake surface area drains to the lake. Lake volume is approximately 1,700 acre feet with a **residence time** of about one year (6).

The **immediately adjacent watershed** of Pine Lake is about 305 acres and is predominantly wooded residential, wetland and

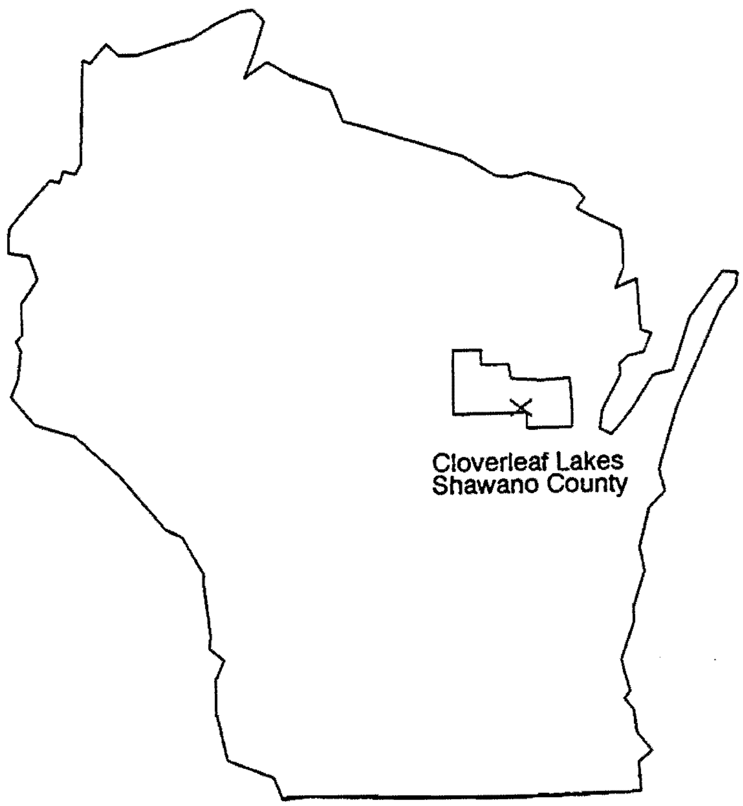

Figure 1. Location Map, Cloverleaf Lakes, Shawano County, WI.

forested; that of the Cloverleaf Lakes chain, overall, is wooded residential (45%), forested (35%), wetlands (17%) and agricultural (2%) areas. Woodlands are comprised mainly of hardwood forests (maples and oaks) with areas of conifers and pine plantations.

Littoral substrates are primarily sand and muck; some gravel was observed and rock is reportedly present (Personal Communication WDNR). Pine Lake has more hard (gravel and sand) substrate and more littoral area overall than the other Cloverleaf Lakes (6).

Pine Lake supports fish species including largemouth bass (Micropterus salmoides), smallmouth bass (Micropterus dolomieui), rock bass (Ambloplites rupestris), walleye (Stizostedion vitreum), yellow perch (Perca flavescens), black crappie (Pomoxis nigromaculatus), sunfish (Lepomis sp.), northern pike (Esox lucius), muskellunge (Esox masquinongy), black bullhead (Ictalurus melas), longnose gar (Lepisosteus osseus), bowfin (Amia calva), burbot (Lota lota), carp (Cyprinus carpio), white sucker (Catostomus commersoni), buffalo (Ictiobus sp.) and golden shiner (Notemigonus crysoleucas) (6). One or more species of fish have been sampled containing mercury and currently there is a consumption advisory for fish taken from the chain (7). Fish have been stocked in Grass, Round and Pine Lakes by the WDNR or the CLPA (Pers. Comm. CLPA, Table 1).

Table 1. Stocking Effort, Cloverleaf Lakes.

YEAR	SPECIES (NUMBER:SIZE)					
	WALLEYE	MUSKELLUNGE	LARGEMOUTH BASS	NORTHERN PIKE	YELLOW PERCH	SUNFISH
1939						3,800:Ad./fing.
1940	500,000:fry					
1941	500,000:fry					
1943			300:fingerlings			
1956				2,010:Adult		
1961	16,200					
1962		160:yearlings				
1963		50:yearlings				
1964		1,600:fingerlings				
1965		1,280:fingerlings				
1966		200:fingerlings				
1970		400:fingerlings				
1973		1,300:fingerlings				
1974		1,300:fingerlings				
1976		625:12"				
1977		630:8"				
1978		630:9"				
1979		630:8"				
1980		630:8"				
1982	10,000:fry	315:10"				
1983	17,085:1-5"	455:10"				
1984	1,500					
1985	15,100:2-3"	840:12"				
1986	1,297:2-3"					
1987	11,050:5"	640:10"				
1988	400:4"		1,364:4-5"			
1989	4,500:5"	640:8"		828:9-24"	198:4-6"	
1991	15,000:fingerlings	640:7-9"				

Waterfowl observed nesting in the Cloverleaf Lakes include mallards, black ducks and blue-winged teal. Migratory waterfowl that use the Cloverleaf Lakes include other puddle and diving ducks, coots and Canada geese (6).

CLPA has previously tried copper sulfate slow release pellets and other chemicals to control nuisance macrophytes and swimmer's itch in areas adjacent (3500 foot arc) to the north, east, and south shores (Pers. Comm. WDNR). Treatment was stopped so as not to affect monitoring results and because of stricter regulation.

A public swimming beach (owned by the Town of Belle Plaine) is located on the northeast shore of Pine Lake. Public boat access to Pine Lake is available indirectly via the navigable channel to the boat ramp (with parking) on Grass Lake.

METHODS

FIELD PROGRAM

Water sampling was conducted in late-Spring (May 21, 1991), mid-Summer (August 1, 1991), late-Summer (August 27, 1991) and Winter (January 27, 1992) at Station 0601, the deepest point in Pine Lake (Table 2, Figure 2). This site was sampled near surface (designated "S") and near bottom (designated "B").

Physicochemical parameters measured in the field were **Secchi depth**, water temperature, pH, dissolved oxygen (DO), and conductivity. Field measurements were taken using a standard Secchi disk and either a Hydrolab Surveyor II or 4041 multiparameter meter; Hydrolab units were calibrated prior to and subsequent to daily use.

Samples were taken for laboratory analyses with a Kemmerer water bottle. Samples were labelled, preserved if necessary, and packed on ice in the field; samples were delivered by overnight carrier to the laboratory. All laboratory analyses were conducted at the State Laboratory of Hygiene (Madison, WI) using WDNR or APHA (8) methods. Spring parameters determined by the laboratory included laboratory pH, total alkalinity, total Kjeldahl nitrogen, ammonia nitrogen, nitrate/nitrite nitrogen,

Table 2. Sampling Station Locations, Pine Lake, 1991 - 1992.

WATER QUALITY

Site	Latitude/Longitude	Depth
0601	44° 41.50' 88° 39.00'	35.0 ft.

MACROPHYTE TRANSECTS

Transect	Latitude/Longitude Origin	End	Transect Length(m)	Bearing (Degrees)	Depth Range[1]
A	44° 41.41' 88° 39.77'	44° 41.16' 88° 39.52'	150	145	1/2/3
B	44° 41.51' 88° 40.09'	44° 41.16' 88° 39.52'	30	204	1/2/3
C	44° 41.10' 88° 39.52'	44° 41.16' 88° 39.52'	230	272	1/2/3
D	44° 40.81' 88° 39.52'	44° 41.16' 88° 39.52'	320	15	1/2/3
E	44° 40.72' 88° 39.52'	44° 41.16' 88° 39.52'	270	133	1/2/3

[1] 1 = 0.0 - 0.5m (0.0 - 1.7ft)
2 = 0.5 - 1.5m (1.7 - 5.0ft)
3 = 1.5 - 3.0m (5.0 - 10.0ft)

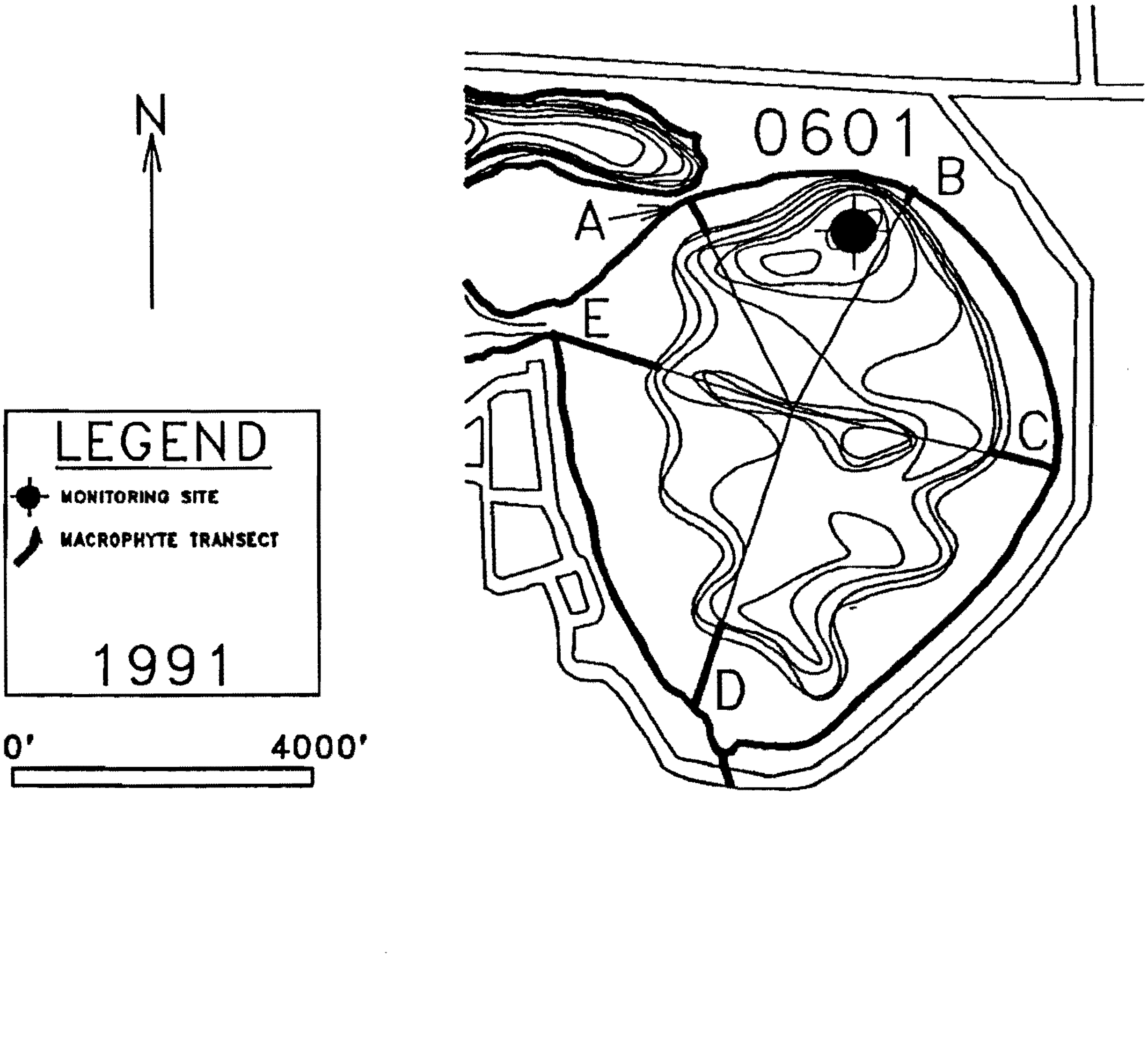

Figure 2. Sampling Sites, Pine Lake, Shawano County, WI, 1991 - 1992.

total phosphorus and dissolved phosphorus, total solids, color and chlorophyll a. Summer and late Summer laboratory analyses included total Kjeldahl nitrogen, ammonia nitrogen, nitrate/nitrite nitrogen, total phosphorus, dissolved phosphorus, and chlorophyll a. Winter water quality parameters included total Kjeldahl nitrogen, ammonia nitrogen, nitrate/nitrite nitrogen, total phosphorus and dissolved phosphorus.

Macrophyte surveys were conducted in early Summer (July 19) and again later in the season (September 6) using a method developed by Sorge et al and modified by the WDNR-Lake Michigan District (WDNR-LMD) for use in the Long Term Trend Lake Monitoring Program (9). Transect endpoints were established on and off shore for use as reference from one sampling period to the next. These points were determined using a Loran Voyager Sportnav latitude/longitude locator and recorded with bearing and distance of the transect (line of collection) for future surveys. Five transects sampled in 1991 were chosen to provide information from various habitats and areas of interest.

Data were recorded from three depth ranges, i.e., 0 to 0.5 meters (1.7 feet), 0.5 to 1.5 meters (5.0 feet), and 1.5 to 3.0 meters (10.0 feet), as appropriate along each transect. Plants were identified (collected for verification as appropriate), density ratings assigned (see below), and substrate type recorded along a six foot wide path on the transect using a garden rake, snorkel gear or SCUBA where necessary. Macrophyte density ratings, assigned by species, were: 1 = Rare, 2 = Occasional, 3 = Common, 4 = Very Common, and 5 = Abundant. These ratings were treated as numeric data points for the purpose of simple descriptive statistics in the Field Data Discussion section of this report.

OTHER

Water Quality Information

Additional lake information was retrieved from the WDNR Surface Water Inventory (6), CLPA water quality data, Wisconsin Self Help Monitoring Program (10) and from the WDNR Wisconsin Lakes publication (5). Historic water quality monitoring was conducted by the University of Wisconsin - Stevens Point Environmental Task Force Laboratory.

Land Use Information

Details of zoning and specific land uses were obtained from the UW-Extension, Shawano County zoning maps, United States Soil Conservation Service soil maps (4), aerial photographs, and United States Geological Survey quadrangle maps. This information, when considered questionable or out-dated, was confirmed by field reconnaissance.

Ordinance information was taken from Shawano County Zoning Ordinance, Shawano County Floodplain Zoning Ordinance, and Shawano County Erosion Control and Animal Waste Management Plans which were acquired from the Shawano County Land Conservation Department.

Swimmer's Itch Literature Search

A literature search was conducted through the Dialog network, various environmental computerized bulletin board systems and the Universities of Wisconsin - Madison and Milwaukee library card catalogs. Information gathered and results obtained are outlined in the Field Data Discussion section of this report.

Public Involvement Program

A summary of public involvement activities coordinated with the lake management planning process is outlined in Appendix I.

FIELD DATA DISCUSSION

A precise or universally applicable definition of "lake" is rather difficult given the wide size range and differences of origin of basins with standing water. The term is further complicated by the common usage of "lake" in reference to dammed reaches of flowing water (riverine) systems.

Pine Lake is a natural lake, as opposed to an artificial lake, i.e., dammed riverine system. Physicochemical characteristics of natural lakes tend toward a state of dynamic equilibrium (e.g., seasonally variable but relatively consistent within that framework over the long-term) as defined by basin morphometry and watershed characteristics.

Pine Lake is, by definition, a drainage lake because it has a definite inlet and outlet stream; Pine Lake and the Cloverleaf Lakes overall, receive major inflow from groundwater. Lake level is controlled by a splash-board weir (owned by the Town of Belle Plaine and operated by the CLPA) on the outlet stream. Pine Lake is larger (about 209 acres) and shallower (35 ft max. depth) than the upper lakes in the chain and has a water residence time of about one year. Land use in the immediately adjacent Pine Lake watershed is primarily wooded residential, forested and wetland (Figure 3).

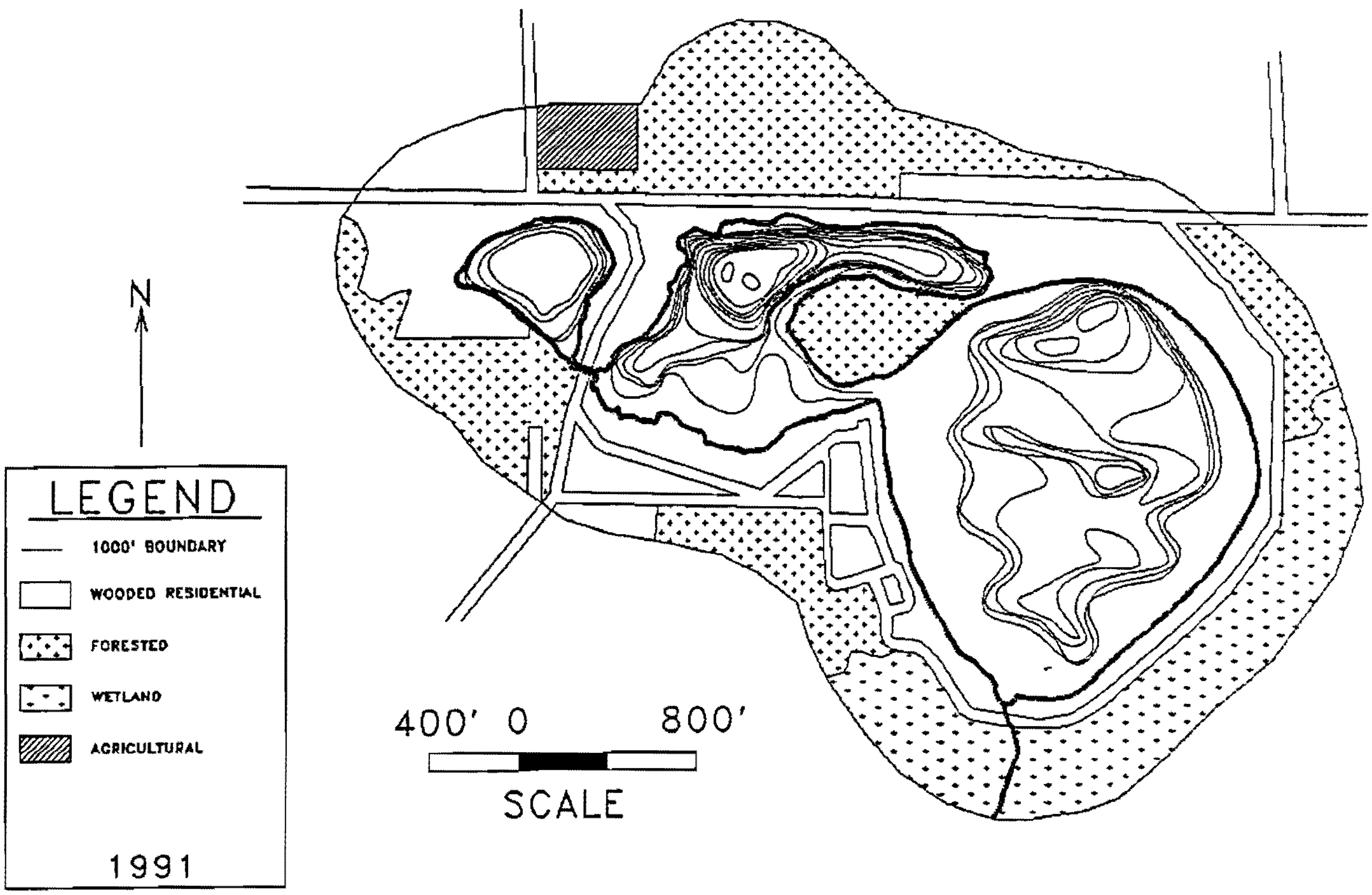

Figure 3. Land Uses in the Immediately Adjacent Watershed, Cloverleaf Lakes, 1991 - 1992.

Phosphorus is often the limiting major nutrient in algal and plant production in lakes. Surface total phosphorus during 1991 monitoring ranged from .007 to .015 mg/l (parts per million) with a mean value of .011 mg/l (Table 3). During past monitoring (1975-1990), in-lake surface total phosphorus ranged from .002 to .13 mg/l, but with two exceptions was $\leq$ .03 mg/l; all values recorded since 1986 were $\leq$ .024 mg/l (Appendix II). Nitrogen to phosphorus ratios (**N/P ratio**) generally greater than 15 indicated Pine Lake to be phosphorus limited most of the time.

Summer surface phosphorus levels in 1991 (.010 and .015 mg/l) were, according to a recent compilation of summer total phosphorus levels in upper midwestern lakes (11), much lower than typical (.030 to .050 mg/l) for the transitional region in which Pine Lake is located. Much higher values for total phosphorous and other nutrient parameters were observed near bottom and suggested release from the sediments under anoxic or near-anoxic conditions in the **hypolimnion** during summer **stratification** at this relatively deep point (Figure 4).

Total surface nitrogen for the 1991-1992 monitoring dates ranged from about 0.415 mg/L to 0.551 mg/l. Bottom samples, particularly during Summer, showed significantly higher levels and reflected relatively high ammonia nitrogen present in this dissolved oxygen limited strata.

Table 3. Water Quality Parameters, Station 0601, Pine Lake, 1991 - 1992.

PARAMETER	SAMPLE[1]	05/21	08/01	08/27	01/27
Secchi (feet)		11.9	12.0	NR[2]	NR
Temperature (°C)	S	23.53	22.98	24.58	2.27
	B	11.02	11.15	11.63	4.62
pH (S.U.)	S	8.38	8.63	8.68	8.04
	B	7.73	7.17	7.39	7.36
D.O. (mg/l)	S	8.43	8.62	8.70	12.45
	B	4.46	0.17	0.28	2.70
Conductivity (μmhos/cm)	S	323	294	284	312
	B	344	337	352	334
Laboratory pH (S.U.)	S	8.5	NR	NR	NR
	B	7.8	NR	NR	NR
Total Alkalinity (mg/l)	S	142	NR	NR	NR
	B	147	NR	NR	NR
Color (Pt-Co Units)	S	5	NR	NR	NR
	B	5	NR	NR	NR
Total Solids (mg/l)	S	208	NR	NR	NR
	B	212	NR	NR	NR
Total Kjeldahl N (mg/l)	S	0.4	0.5	0.5	0.5
	B	0.6	1.3	1.8	0.7
Ammonia Nitrogen (mg/l)	S	0.015	0.008	0.018	0.071
	B	0.266	0.664	1.07	0.255
NO_2+NO_3 Nitrogen (mg/l)	S	<0.015	<0.007	<0.007	0.051
	B	0.017	0.027	0.032	0.089
Total Nitrogen (mg/l)	S	<0.415	<0.507	<0.507	0.551
	B	0.617	1.327	1.832	0.789
Total Phosphorus (mg/l)	S	0.007	0.010	0.015	0.011
	B	0.015	0.061	0.086	0.007
Diss. Phosphorus (mg/l)	S	0.006	0.005	<0.002	<0.002
	B	0.005	0.005	<0.002	0.002
N/P Ratio	S	<59.3	<50.7	<33.8	50.1
	B	41.1	21.8	21.3	112.7
Chlorophyll a (μg/l)	S	5	4	5	NR

[1] S = Near Surface; B = Near Bottom
[2] NR = No Reading

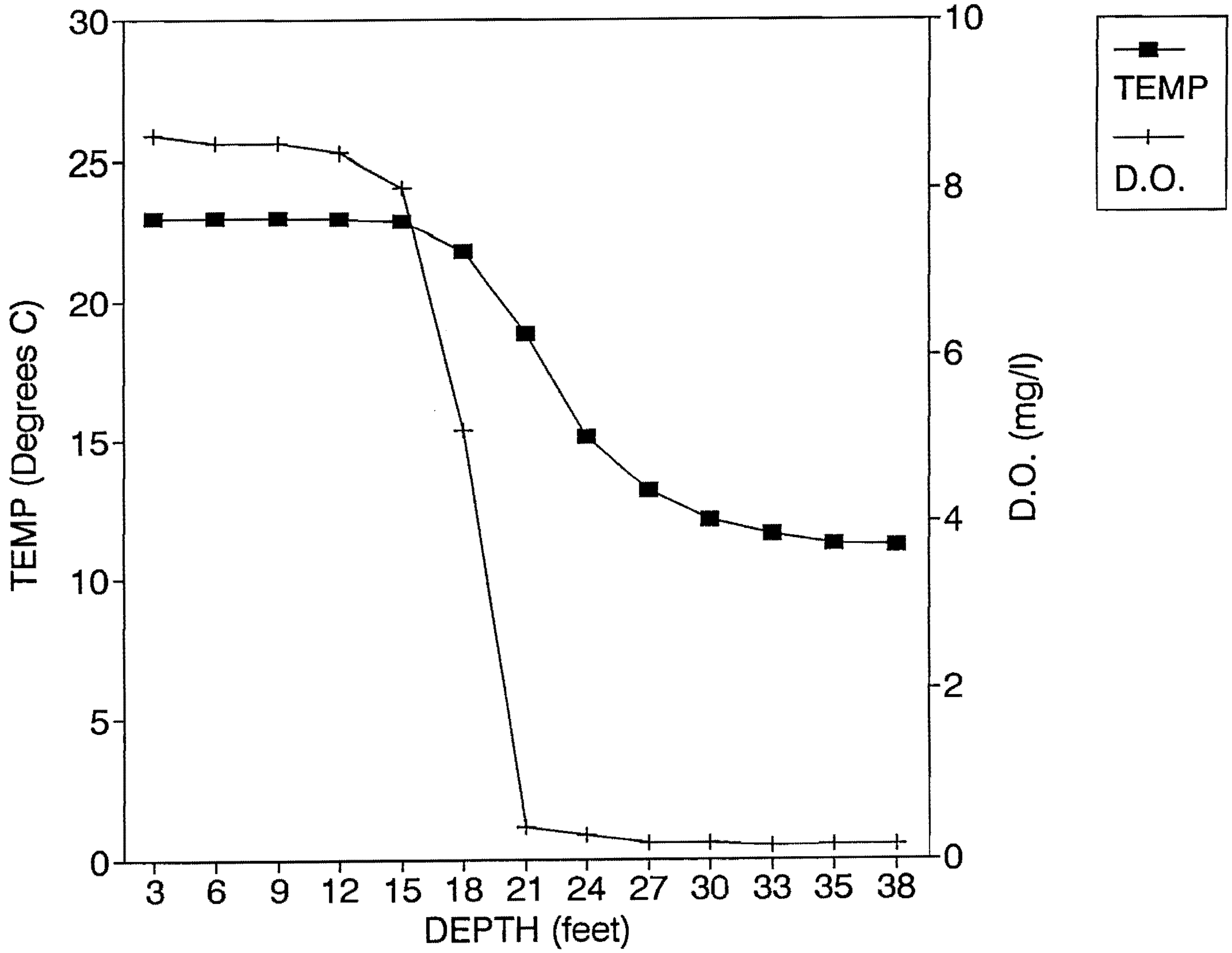

Figure 4. Temperature/DO Profile, Pine Lake, August 1, 1991.

Other indicators of lake **eutrophication** status include light penetration and algal production. Numerous summarative indices have been developed, based on a combination of these and other parameters, to assess or monitor lake eutrophication or aging. The Trophic State Index (TSI) developed by Carlson (12) utilizes Secchi transparency, chlorophyll a, and total phosphorus. As with most indices, 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). TSI numbers for Pine Lake, in general, indicated a mesotrophic classification; values for total phosphorus (TSI for historical data recorded as < not shown) were most variable and ranged from those indicative of **oligotrophic** to **eutrophic** classifications (Figures 5-7).

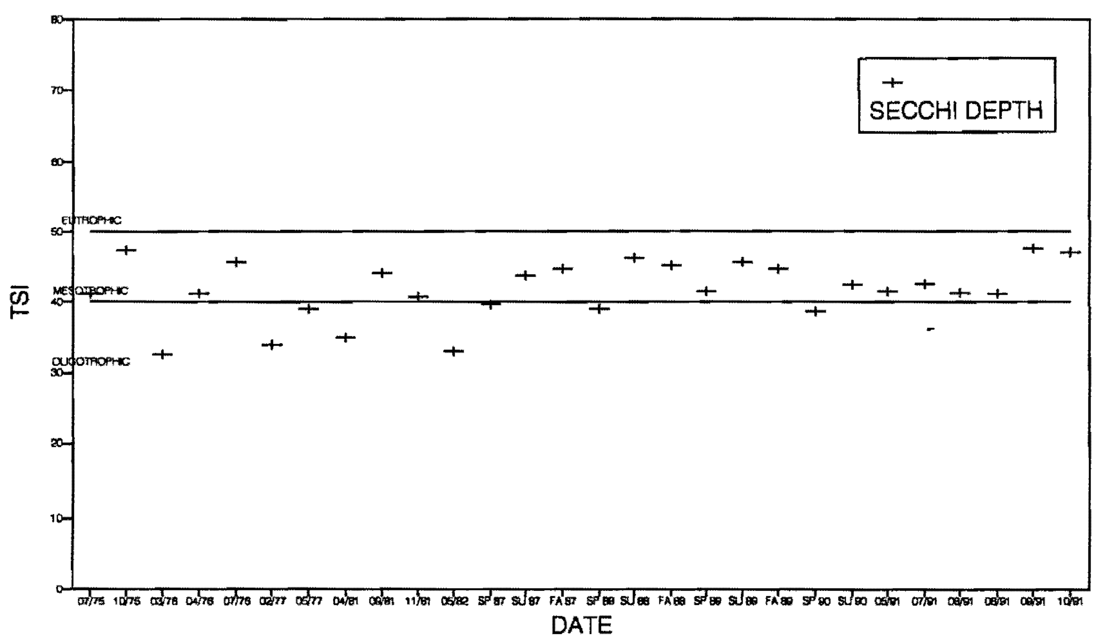

Figure 5. Trophic State Index for Secchi Depth, Pine Lake.

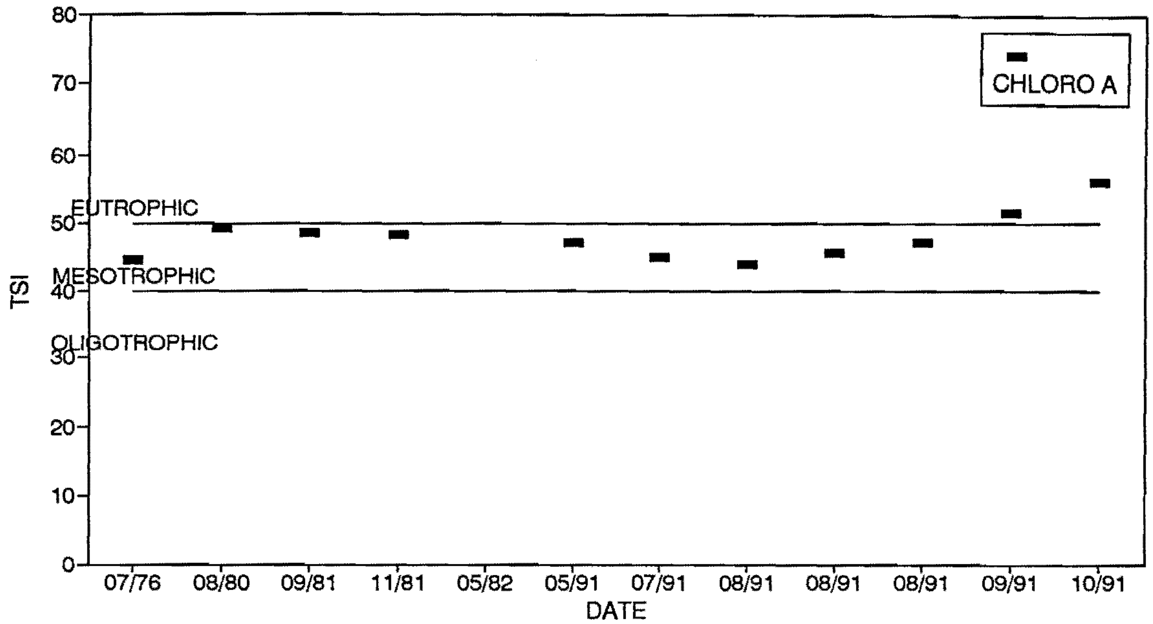

Figure 6. Trophic State Index for Chlorophyll a, Pine Lake.

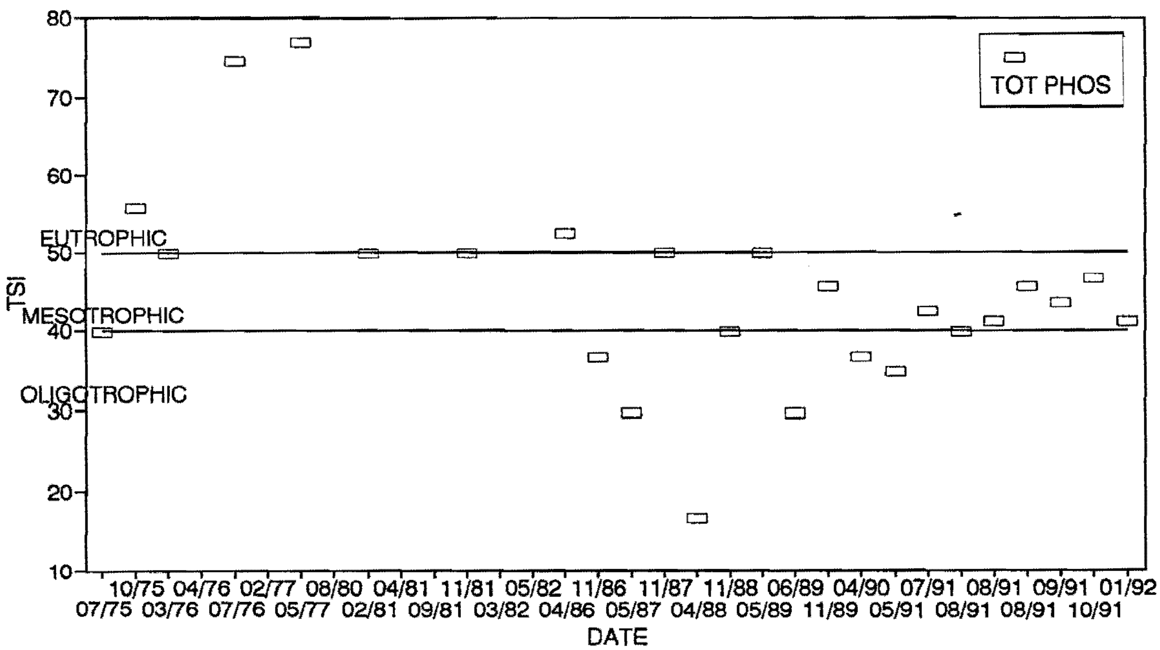

Figure 7. Trophic State Index for Total Phosphorus, Pine Lake.

During recent macrophyte surveys (Appendix III), macrophytes (Table 4) were found at 29 of 30 sample sites (sample sites = number of depth ranges sampled). Bushy pondweed (Najas sp.) was widely distributed (at 21 of 30 sites) and overall the most abundant aquatic plant (Tables 5-8). Bushy pondweed is most commonly found completely submerged, on hard substrates and in water with low turbidity (13). Bushy pondweed flowers July to October and flowers are only visible with the use of a hand lens (14). Seeds and stems are a source of waterfowl food and the plants provide fish with forage food and cover. Bushy pondweed is known to reach nuisance levels.

Water celery (Vallisneria americana), an abundant Wisconsin macrophyte, was found more frequently (at 24 of 30 sites), and was only slightly less abundant overall than bushy pondweed. Water celery (also known as eel grass), has long tape-like leaves, grows completely submerged and is typically found on hard substrates; growth can increase with turbidity. It is rated as excellent waterfowl food and provides fish with forage, cover and spawning habitat but has been known to reach nuisance levels (13). Water celery produces seeds, but spreads mainly from rhizome growth and reproduces mainly by tubers from one year to the next (14).

Table 4. Macrophyte Species Observed, Pine Lake, 1991 (13).

Taxa	Code
Coontail (*Ceratophyllum demersum*)	CERDE
Muskgrass (*Chara* sp.)	CHASP
Common waterweed (*Elodea canadensis*)	ELOCA
Filamentous algae	FILAL
Water milfoil (*Myriophyllum* sp.)	MYRSPE
Bushy pondweed (*Najas* sp.)	NAJSP
Nitella (*Nitella* sp.)	NITSP
No plants found	NOPLT
Yellow pond lily (*Nuphar* sp.)	NUPSP
White pond lily (*Nymphaea* sp.)	NYMSP
Large-leaf pondweed (*Potamogeton amplifolious*)	POTAM
Curly-leaf pondweed (*Potamogeton crispus*)	POTCR
Leafy pondweed (*Potamogeton foliosus*)	POTFO
Illinois pondweed (*Potamogeton illinoensis*)	POTIL
Sago pondweed (*Potamogeton pectinatus*)	POTPE
White-stem pondweed (*Potamogeton praelongus*)	POTPR
Small pondweed (*Potamogeton pusillus*)	POTPU
Clasping-leaf pondweed (*Potamogeton richardsonii*)	POTRI
Flat-stem pondweed (*Potamogeton zosteriformis*)	POTZO
Eel grass (water celery) (*Vallisneria americana*)	VALAM

Table 5. Occurrence and Abundance of Macrophytes by Depth, Pine Lake, July, 1991.

CODE	Depth Ranges 1 (N=5) % of Sites	1 (N=5) Σ Abundance (range)	2 (N=5) % of Sites	2 (N=5) Σ Abundance (range)	3 (N=5) % of Sites	3 (N=5) Σ Abundance (range)
CERDE	0	0	0	0	60	7(2-3)
CHASP	0	0	0	0	20	2(2)
ELOCA	0	0	0	0	20	1(1)
FILAL	40	2(1)	0	0	20	1(1)
MYRSPE	0	0	80	5(1-2)	60	6(1-3)
NAJSP	80	5(1-2)	80	13(2-4)	60	11(3-4)
NITSP	20	2(2)	100	15(2-3)	20	3(3)
NOPLT	0	0	0	0	20	0
NUPSP	20	3(3)	40	6(3)	0	0
NYMSP	0	0	20	2(2)	0	0
POTAM	0	0	0	0	0	0
POTCR	20	1(1)	20	1(1)	0	0
POTFO	20	1(1)	20	1(1)	0	0
POTIL	0	0	80	6(1-2)	20	2(2)
POTPE	80	6(1-2)	20	1(1)	0	0
POTPR	0	0	20	1(1)	0	0
POTPU	0	0	40	2(1)	20	3(3)
POTRI	0	0	60	7(2-3)	60	6(2)
POTZO	0	0	0	0	0	0
VALAM	60	6(1-4)	80	10(2-3)	80	8(1-3)

Nitella sp. and clasping-leaf pondweed (Potamogeton richardsonii) were also widespread and relatively abundant in Pine Lake. Both plants grow completely submerged, with Nitella (an algae) growing along the bottom and clasping-leaf pondweed extending up from the bottom. Neither plant shows preference to substrate or turbidity. Clasping-leaf pondweed is rated as a good source of waterfowl food and provides fish with forage food and cover.

Table 6. Occurrence and Abundance of Macrophytes by Depth, Pine Lake, September, 1991.

CODE	Depth Ranges 1 (N=5) % of Sites	Σ Abundance (range)	2 (N=5) % of Sites	Σ Abundance (range)	3 (N=5) % of Sites	Σ Abundance (range)
CERDE	0	0	20	1(1)	0	0
CHASP	0	0	0	0	0	0
ELOCA	0	0	0	0	0	0
FILAL	0	0	0	0	0	0
MYRSPE	0	0	80	6(1-2)	60	4(1-2)
NAJSP	20	1(1)	100	10(1-4)	80	11(2-3)
NITSP	40	3(1-2)	60	7(2-3)	20	3(3)
NOPLT	0	0	0	0	0	0
NUPSP	20	2(2)	20	1(1)	0	0
NYMSP	0	0	0	0	0	0
POTAM	0	0	60	7(2-3)	20	1(1)
POTCR	0	0	0	0	0	0
POTFO	0	0	40	3(1-2)	20	1(1)
POTIL	0	0	80	6(1-2)	20	1(1)
POTPE	100	5(1)	20	1(1)	0	0
POTPR	0	0	0	0	20	2(2)
POTPU	0	0	0	0	0	0
POTRI	0	0	60	7(2-3)	80	11(2-3)
POTZO	0	0	20	1(1)	0	0
VALAM	60	4(1-2)	100	11(2-3)	100	10(1-3)

Species for water milfoil (Myriophyllum sp.), common and relatively abundant, was not determinable because of lack of distinguishing flower parts (bracts) during the time of the surveys, but Eurasian Milfoil (Myriophyllum spicatum) may be present in Pine Lake. This species is an exotic (not native to Wisconsin) and has shown the capability to outcompete native vegetation and reach nuisance levels quickly.

Table 7. Comparison of Occurrence as Percent of Total Abundance for Selected Macrophytes by Depth, Pine Lake, 1991.

Species Code	Depth Range 1		Depth Range 2		Depth Range 3	
	JULY	SEPT	JULY	SEPT	JULY	SEPT
NAJSP	19	7	19	16	22	25
VALAM	23	26	14	18	16	23
NITSP	8	20	21	11	6	7
POTRI	0	0	10	11	12	25
MYRSPE	0	0	7	10	12	9
POTIL	0	0	9	10	4	2
POTPE	23	33	1	2	0	0
NUPSP	12	13	9	2	0	0
CERDE	0	0	0	2	14	0
POTAM	0	0	0	11	0	2

Swimmer's itch (schistosome dermatitis) has been a recurrent problem in the Cloverleaf Lakes (primarily Pine Lake). It is caused by penetration of the skin by an intermediate life cycle stage of the flatworm known as cercaria larvae. The cercaria die shortly after penetration (in humans) but swelling and redness can persist for several days (usually less than one week) and can increase (especially when scratched).

Adult flatworms are carried by birds and rodents in blood vessels where the females lay eggs which travel to the intestine and are expelled in feces. The eggs hatch into miracidia larvae that are taken up in snails where they develop into cercaria; cercaria then penetrate rodents and birds to complete the cycle.

Table 8. Abundance Distribution and Substrate Relations for Selected Macrophytes, Pine Lake, 1991.

Transect	Substrate	Species Code									
		NAJSP	VALAM	NITSP	POTRI	MYRSPE	POTIL	POTPE	NUPSP	CERDE	POTAM
		J[1] S[1]	J S	J S	J S	J S	J S	J S	J S	J S	J S
A1	SAND/GRAV	1 1	1 0	0 2	0 0	0 0	0 0	0 1	0 0	0 0	0 0
A2	SAND	2 2	2 2	3 0	2 3	2 2	2 1	1 0	3 0	0 0	0 0
A3	SILT	3 3	3 3	0 0	0 3	1 2	0 0	0 0	0 0	3 0	0 0
B1	SAND	0 0	4 1	0 1	0 0	0 0	0 0	2 1	0 0	0 0	0 0
B2	SAND	3 2	2 2	4 3	0 0	1 1	2 0	0 0	0 0	0 0	0 3
B3	SAND	0 3	2 2	3 0	2 2	2 1	2 0	0 0	0 0	0 0	0 0
C1	SAND	1 0	0 1	2 0	0 0	0 0	0 0	1 1	0 0	0 0	0 0
C2	SAND	4 1	3 2	3 2	2 0	1 1	0 1	0 0	0 0	0 1	0 0
C3	SILT/SAND	4 2	2 1	0 3	2 0	3 1	0 1	0 0	0 0	2 0	0 1
D1	SAND	1 0	0 0	0 0	0 0	0 0	0 0	1 1	0 0	0 0	0 0
D2	SAND	4 4	3 3	2 0	3 2	1 2	1 2	0 1	0 0	0 0	0 2
D3	SILT/SAND	4 0	1 3	0 0	2 3	0 0	0 0	0 0	0 0	2 0	0 0
E1	SAND	2 0	1 2	0 0	0 0	0 0	0 0	2 1	3 2	0 0	0 0
E2	SAND	0 1	0 2	3 2	0 2	0 0	1 2	0 0	3 1	0 0	0 2
E3	SAND/SILT	0 3	0 1	0 0	0 3	0 0	0 0	0 0	0 0	0 0	0 0

[1] J = July survey, S = September survey

Attempts to control swimmer's itch have largely been through snail or cercaria control. Biological and chemical controls have met only with limited success and introduction of exotic snail species (resistant to larvae) can lead to displacement of native populations and change animal and plant assemblages. Chemical controls (usually copper sulfate or copper carbonate) are often undesirable because they cannot ensure eradication of cercaria and snails and can cause native mollusk and vegetation die-off, reduced DO levels and fishkills (15). Infestation of snails is most common during dry and hot Summer months (16) and the swimmer's itch problem can persist longer than a month.

Suggestions to prevent swimmer's itch are designed to minimize contact with cercaria (17). These include avoid swimming when an onshore wind is present and swim away from shore [cercaria move in the top 1 mm of water and often near shores (18)], towel down or shower immediately after swimming to prevent penetration of the cercaria, discourage birds from staying near swimming areas, and avoid swimming in areas with large accumulations of snails.

BASELINE CONCLUSIONS

- Pine Lake water quality is fair to good with respect to all parameters measured and has not exhibited any readily discernible trends since the mid 1970's. Summer total phosphorus was variable but much lower than that typically found in lakes in this region. Overall good water quality and a mesotrophic status appears related to substantial groundwater inflow (low surface runoff) and a primarily wooded/wetland watershed. Higher phosphorus levels near bottom, at the stratified deepest point, appear related to sediment release under near-anoxic conditions. Surface runoff from the immediate watershed was not directly assessed in this program, but appears (based on adjacent watershed characteristics) to be relatively minimal with respect to nutrient and sediment input. Water chemistry parameters were similar to those observed in the other Cloverleaf Lakes.

- Pine Lake macrophyte growth is more extensive than in the upper lakes and appears related to a more extensive littoral zone; compositional differences from that in Grass Lake (i.e., much less abundant flatstem pondweed) appear related to generally harder substrates.

MANAGEMENT ALTERNATIVES DISCUSSION

WATER QUALITY

Pine Lake is a natural lake which benefits from high groundwater inflow and relatively low surface runoff from a predominantly forested/wetland watershed. Water quality relative to transparency, productivity and nutrients is fair to good.

While no event samples were taken by the CLPA and the potential for nutrient or sediment input from the immediately adjacent watershed appears minimal, significant input may occur during major storm or other (e.g., snow-melt) surface runoff events. Efforts should be made to identify runoff or erosion prone areas and control (to the extent practical) nutrient and sediment inflows.

Riparian land use practices can, cumulatively, have a significant influence on water quality and land owner diligence should be strongly emphasized and encouraged. Common sense approaches are relatively easy and can be very effective in minimizing inputs.

Yard practices can minimize both nutrient and sediment inputs. Lawn fertilizers should be used sparingly, if at all. If used, the land owner should use phosphate-free fertilizers and apply small amounts more often instead of large amounts at one or two times. Composting lawn clippings and leaves away from the lake can reduce nutrient inputs to the lake. If leaves are burned, it should be done in an area where the ash cannot wash directly into the lake (19), or indirectly to the lake via roadside ditches.

Creation of a buffer strip with diverse plants at least 20 feet wide immediately adjacent to the lake can control wave erosion, trap soil eroded from the land above, increase infiltration (to filter nutrients and soil particles), and shade areas of the lake to reduce macrophyte growth (especially on south shores) and provide fish cover. Placement of a low berm in this area can enhance effectiveness of the buffer strip by further retarding runoff during rainfalls. A buffer zone protects lake water quality, creates habitat for wildlife, and provides privacy (19).

There are a number of informational sources for land owners with questions regarding land management practices. Some sources are outlined in Appendix IV.

MACROPHYTES

Management of macrophyte populations may be an objective on Pine Lake where littoral areas are relatively extensive. Macrophytic growth appears to positively affect the resource in some places through forage fish production, shoreline stabilization and negatively in others (reduced access, sediment build-up, aesthetics). A macrophyte management plan should be carefully thought out by prioritizing differing use areas in the lake. Numerous methods of macrophyte control and management are available ranging from radical habitat alteration to more subtle habitat manipulation and are discussed below relative to Pine Lake applicability.

Dredging is a drastic form of habitat alteration. Dredging could entail massive lake-wide sediment removal (to a depth at which macrophyte growth would be retarded due to reduced sunlight) or spot dredging of limited (high priority) areas. Large scale sediment removal is very costly. Spot dredging, because of lower cost may be a reasonable alternative in some cases. Spot dredging may be an alternative in Pine Lake in the near future since there is a low potential for sediment transport into the lake; if considered, the potential for wind-driven or power boat related sediment redistribution/resuspension from adjacent areas should be carefully assessed.

Chemical treatment has been shown to eradicate some undesirable species and leave others intact. The WDNR strongly discourages the use of chemicals because of nutrient release, oxygen depletion, sediment accumulation, bioaccumulation and other unknown environmental hazards including invasion potential from nuisance exotics. Chemical effects are nondiscriminate and may harm desireable or beneficial plant populations; chemical treatment should not be considered for Pine Lake at this time.

Aquatic plant screens have been shown to reduce plant densities in other lakes and may be applicable here. A fiberglass screen or plastic sheet is placed and anchored on the sediment to prevent plants from growing. This may also make some sediment nutrients unavailable for algal growth. Screens should be removed each fall and cleaned in order to last a number of years.

A newer technique of rototilling sediments to destroy plant roots appears to be effective in controlling plant growth for a relatively longer period than harvesting. The process is about the same cost per hour as a contracted macrophyte harvester (20). A potential problem is disturbance of the sediments and resuspension of nutrients or toxics.

Installation of floating platforms (black plastic attached to wooden frames) just after ice-out can shade the sediments, restrict plant growth and help to open corridors for swimming or boat navigation. Shading is usually required for three weeks to two months to impact nuisance plant growth (21). A drawback is that the area cannot be used while the platform is in place.

Remaining control methods consist, in one form or another, of macrophyte harvest. It is a commonly used technique which can be applied on a widespread or localized basis. Its efficiency, based on method of cut/harvest, can vary substantially with depth.

Several conditions should be considered with respect to macrophyte harvest. Some macrophyte growth on Pine Lake is beneficial to the resource and manipulation methods should be species selective and localized (where considered nuisance) in application. Eurasian Milfoil, an exotic which spreads easily by fragmentation, may be present in Pine Lake; strong consideration should also be given to the potential of this species to invade areas where competing macrophytes have been removed.

Macrophyte harvesting is typically conducted with a mechanical harvester which cuts the vegetation and removes (harvests) it onto a platform for out-lake disposal. Given the precautions regarding potential Eurasian Milfoil dispersal and the ability of some plants to survive and spread when detached from the substrate, harvest practices may even enhance the nuisance macrophyte problem through seed dispersal, fragmentation or incomplete removal. Indiscriminate power boat usage, through formation of "prop cut" floating weed masses, may also contribute to this problem.

Selective SCUBA assisted harvest has been shown to selectively manage macrophytes. It can be used in deeper areas and to target only desired species (e.g., Eurasian milfoil) or nuisance growth areas. This method is labor intensive, but has proved to effectively reduce nuisance plant levels for up to two years (20). With the limited areas of potential macrophyte management in Pine Lake, SCUBA assisted harvest may be a viable option.

Raking weeds (using an ordinary garden rake) in the frontage area can be a very effective localized plant control method when done on a regular basis. Such concentration on the problem shallow water areas would reduce efforts expended on other control methods. Harvested plants should be removed from the lakeshore area to prevent nutrients from re-entering the lake.

MANAGEMENT RECOMMENDATIONS

CLPA management objectives for Pine Lake should include continued regular water quality monitoring and expanded event monitoring to target maintenance and protection of existing high water quality. Localized macrophyte management may help to protect or improve aesthetics/recreational use of the resource. The CLPA should consider conducting a user or landowner survey to better define desired uses of, and minimize potential user conflicts in, the Cloverleaf Lakes chain. CLPA should also strongly encourage riparian land owner education and diligence with respect to nutrient input and erosion control.

- Water quality monitoring should be continued to track long-term water quality trends. Self-Help Monitoring as well as regular monitoring by a similar protocol should be continued. Event monitoring may be undertaken to provide additional information in areas of concern (i.e., roadside and agricultural areas).
- There is the potential of nutrient runoff or infiltration to surface or groundwater because soils in the immediate Pine Lake watershed may not filter runoff adequately. Residential input, cumulatively, can have a large impact. Yard and frontage practices, including fertilizer management, nuisance macrophyte raking and

buffer stripping can all have positive effects, especially in near-shore areas.

- Nutrient/sediment input from the immediate watershed appears minimal but efforts should be made to identify runoff/erosion prone localized areas. Riparian owners should be encouraged to implement protective measures.
- Localized and selective macrophyte manipulation may be implemented to improve desireable plant diversity and to reduce numbers of nuisance species. This form of selective management should emphasize creation of habitat (edge) or access improvement across extensive littoral areas, control of nuisance species and protection of beneficial species, near shore raking to improve aesthetics and minimize build-up of in-lake organic sediments. Eurasian Milfoil beds (if present) should be identified and selective SCUBA aided removal implemented.

IMPLEMENTATION

The success of any lake management plan relates directly to the ability of the association/district to obtain funds and regulatory approval necessary to implement the plan. The CLPA is a voluntary association that does not have a lake district's specific legal or financial powers (to adopt ordinances or levy taxes or special assessments) to meet plan objectives.

The Pine Lake watershed is located within the political jurisdictions of the Town of Belle Plaine, County of Shawano and the State of Wisconsin. These units have the power to regulate land uses and land use practices. Shawano County ordinances and plans possibly pertinent to the Pine Lake plan are summarized in Appendix V.

Potential sources of funding are listed in Appendix VI.

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APPENDIX I

SUMMARY OF PUBLIC INVOLVEMENT ACTIVITIES

Pine Lake Management Plan

The Cloverleaf Lakes Protective Association (CLPA) initiated steps to develop a comprehensive lake management plan under the Wisconsin Department of Natural Resources (WDNR) Lake Management Planning Grant Program in the fall of 1990. The grant was received on December 20, 1990. A public involvement program was immediately initiated as part of the planning process. The following is a summary of major public involvement efforts.

Planning Advisory Committee

A Planning Advisory Committee comprised of representatives from WDNR, CLPA, IPS, the Town of Belle Plaine, the Shawano County UW-Extension, the Shawano County Land Conservation Department and the Shawano County Board was established at the start of the program. The committee provided direction during the planning program and served as main reviewer of the draft plan document.

Meetings

The CLPA conducted meetings for its board, its members and interested parties. IPS presented progress reports, provided information about the resource and interpretations of these results at board meetings and at the 1991 and 1992 CLPA annual meetings.

Print Media

The Clintonville newspaper, "Tribune Gazette" was present at the initial meeting of the Planning Advisory Committee and published articles throughout the course of the program.

An IPS newsletter entitled "Lake Management News" was developed and distributed to the CLPA for the Board's use and distribution among the membership. A special "Clover Lakes Edition" was also developed to notify the CLPA of any late developments in the planning program.

APPENDIX II
HISTORIC WATER QUALITY DATA
Pine Lake, Shawano County, WI
Water Chemistry: 04/86 - 04/90
Lake Center - Surface
(Source: WDNR and UW-Stevens Point Environmental Task Force)

Parameter (Units)	Date									
	04/86	11/86	05/87	11/87	04/88	11/88	05/89	06/89	11/89	04/90
Water Temperature (°F)	NR	NR	16	5	11	4	NR	22	HR	50
Air Temperature (°F)	NR	36	NR	NR	NR	NR	NR	NR	NR	NR
Secchi Depth (feet)	NR	NR	15.4	8.8	22.0	9.1	18.0	8.0	NR	8.5
pH (SU)	8.08	8.11	8.42	8.02	8.15	8.12	8.20	8.35	7.97	8.10
Conductivity (umhos/cm)	299	297	293	293	315	297	311	284	289	298
Alkalinity (mg/l $CaCO_3$)	138	132	136	132	138	136	144	134	136	144
Magnesium (mg./l)	66.0	69.9	72.0	36.0	76.0	56.0	56.0	86.0	80.0	76.0
Calcium (mg/l)	33	25.4	80.0	96.0	80.0	92.0	100.0	64.0	68.0	72.0
Color (Pt/Co Units)	1.2	2.5	5.0	18.0	5.0	1.5	9.5	10.0	<1.0	8.0
Turbidity (NTU's)	1.5	0.7	0.6	0.9	0.7	0.5	0.5	<1.0	0.7	2.0
Total Hardness (mg/l $CaCO_3$)	148	133	152.0	132.0	156.0	148.0	156.0	150.0	148.0	148.0
Reactive Phosphorous (mg/l)	0.002	0.005	<0.005	<0.002	<0.002	0.005	0.005	<0.002	0.005	0.002
Total Phosphorous (mg/l)	0.024	0.008	0.005	0.020	0.002	0.010	0.020	0.005	0.015	0.008
NH_4-Nitrogen (mg/l)	0.04	0.01	0.05	0.08	<0.01	0.02	0.05	0.05	0.10	0.05
NO_2/NO_3-Nitrogen (mg/l)	0.30	0.01	<0.05	0.02	0.01	0.03	<0.20	<0.20	0.02	<0.02
Total Keljdahl-Nitrogen (mg/l)	0.40	0.35	0.48	0.66	0.16	0.62	0.35	0.50	0.60	0.42
Total Nitrogen	0.70	0.36	0.48	0.68	0.17	0.65	0.35	0.50	0.62	0.42
N/P Ratio	NR	NR	96.0	34.0	85.0	65.0	17.5	100.0	41.3	52.5
Chloride (mg/l)	13.9	13	13.0	15.0	23.0	15.0	14.0	15.0	13.0	15.0
Sulfate (mg/l)	11	7.5	7.4	6.5	6.5	8.0	8.0	8.0	6.5	6.0
Sodium (mg/l)	7.4	6.5	6.4	6.8	7.4	7.5	7.6	6.9	7.2	1.1
Potassium (mg/l)	2.1	1.5	1.2	1.4	1.5	1.4	1.5	1.3	1.3	1.5

NR denotes no reading given

APPENDIX II
HISTORIC WATER QUALITY DATA
Pine Lake, Shawano County, WI
Water Chemistry: 07/75 - 02/77
Lake Center
(Source: WDNR)

Parameter (Units)	Date													
	07/75	07/75	07/75	10/75	10/75	03/76	03/76	04/76	04/76	07/76	07/76	07/76	02/77	02/77
Depth (feet)	0	20	31	0	36	0	34	0	34	0	25	40	0	36
Water Temperature (°F)	68	64	NR	53.5	49	33	41	62	44.5	77	58	60	1	5.5
Air Temperature (°F)	90	–	–	60	–	32	–	55	–	75	–	–	18	–
Cloud Cover (%)	0	–	–	90	–	0	–	0	–	100	–	–	90	–
Dissolved Oxygen (mg/L)	8.0	3.2	0.2	10.1	6.7	9.5	0.8	10.5	3.7	8.0	0.7	0.0	11.7	0.8
Secchi Depth (feet)	12	–	–	8	–	22	–	12	–	9	–	–	20	–
pH (SU)	8.1	8.0	7.8	8.1	7.8	7.7	7.9	7.9	7.7	NR	NR	NR	8.1	7.8
Conductivity (umhos/cm)	260	262	281	328	278	246	317	273	289	NR	NR	NR	318	348
Alkalinity (mg/l $CaCO_3$)	122	136	138	128	134	116	162	132	132	62	138	142	147	151
Magnesium (mg/l)	19	19	18	22	23	17	20	20	20	NR	NR	NR	21	21
Calcium (mg/l)	29	29	30	28	30	29	37	32	32	NR	NR	NR	36	39
Turbidity (NTU's)	2.1	2.7	3.6	1.8	3.1	0.4	1.2	0.8	0.7	0.7	1.3	1.5	0.4	1.8
Reactive Phosphorous (mg/l)	<0.005	<0.005	<0.006	<0.006	<0.006	<0.008	<0.008	0.006	0.008	0.014	0.016	0.010	0.006	0.007
Total Phosphorous (mg/l)	0.01	0.02	0.02	0.03	0.01	0.02	0.03	<0.01	<0.01	0.11	0.10	0.09	<0.01	0.03
NO_3-Nitrogen (mg/L)	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.03	0.03	0.35	NR	NR
NH_4-Nitrogen (mg/l)	<0.03	<0.03	0.72	<0.03	0.37	<0.03	0.11	<0.03	0.04	NR	NR	NR	0.30	1.08
NO_2/NO_3-Nitrogen (mg/l)	<0.043	<0.043	0.011	0.043	0.066	0.183	0.536	0.126	0.251	NR	NR	NR	<0.032	0.029
Organic Nitrogen (mg/l)	0.30	0.46	0.62	0.26	0.24	0.13	0.24	0.76	0.74	0.37	0.68	0.74	0.70	0.72
Total Nitrogen (mg/L)	0.30	0.46	1.31	0.26	0.67	0.34	0.89	0.88	1.02	0.40	0.81	1.09	1.03	1.83
N/P Ratio	30.0	23.0	65.8	8.7	67.0	17.0	29.7	>88.0	>102.0	3.6	8.1	12.1	>103.0	61.0
Chloride (mg/l)	10	9	10	8	8	8	8	9	9	NR	NR	NR	10	11
Sulfate (mg/l)	12	8	12	8	9	7	8	8	13	NR	NR	NR	NR	NR
Sodium (mg/l)	9	8	7	4	6	<1	<1	3	3	NR	NR	NR	9	9
Potassium (mg/l)	6.7	4.5	2.9	0.7	1.7	<0.5	<0.5	1.8	<0.5	NR	NR	NR	1.2	1.8
Iron (mg/L)	1.03	0.13	0.63	0.10	0.39	0.17	0.17	0.21	0.24	NR	NR	NR	0.14	0.11
Manganese (mg/L)	0.06	0.23	0.23	0.09	0.97	<0.03	0.43	<0.03	0.09	NR	NR	NR	<0.03	1.25
Chlorophyll "a" (g/L)	NR	NR	NR	NR	NR	NR	NR	NR	NR	3.4	NR	NR	NR	NR

NR denotes no reading given

APPENDIX II
HISTORIC WATER QUALITY DATA
Pine Lake, Shawano County, WI
Water Chemistry: 05/77 - 11/81
Lake Center
(Source: WDNR)

Parameter (Units)	Date												
	05/77	05/77	05/77	08/80	08/80	02/81	02/81	04/81	04/81	09/81	09/81	11/81	11/81
Depth (feet)	0	30	40	3	18	3	20	3	20	3	23	3	30
Water Temperature (°F)	17	8	7	NR	NR	41	43	46	46	77	66	49	47
Air Temperature (°F)	70	–	–	NR	–	60	–	45	–	60	–	60	–
Cloud Cover (%)	80	–	–	NR	–	10	–	100	–	85	–	0	–
Dissolved Oxygen (mg/L)	10.2	0.8	0.4	NR	NR	9.8	2.0	9.8	8.9	7.9	6.7	11.3	9.1
Secchi Depth (feet)	14	–	–	NR	–	NR	–	18.8	–	9.9	–	12.6	–
pH (SU)	7.6	7.7	7.7	8.5	8.6	7.3	7.8	7.8	7.6	8.2	8.3	8.1	7.9
Conductivity (umhos/cm)	292	325	334	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Alkalinity (mg/l $CaCO_3$)	125	144	149	128	127	66	150	140	140	118	116	126	126
Magnesium (mg/l)	19	20	22	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Calcium (mg/l)	30	31	36	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Turbidity (NTU's)	1.0	1.0	2.0	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Reactive Phosphorous (mg/l)	<0.004	0.026	<0.004	<0.004	<0.004	0.013	0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Total Phosphorous (mg/l)	0.13	0.05	0.03	<0.02	0.02	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	0.02
NO_3-Nitrogen (mg/L)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
NH_3-Nitrogen (mg/l)	0.04	<0.04	<0.04	<0.02	<0.02	0.63	0.02	0.03	0.03	<0.02	<0.02	<0.02	<0.02
NO_2/NO_3-Nitrogen (mg/l)	0.022	0.333	0.216	<0.02	<0.02	0.76	0.16	0.05	0.06	<0.02	<0.02	<0.02	<0.02
Organic Nitrogen (mg/l)	0.26	0.40	0.44	0.5	0.5	0.3	0.5	0.37	0.37	>0.58	>0.58	0.4	0.4
Total Nitrogen (mg/L)	0.29	0.71	0.63	<0.64	<0.64	1.61	0.67	0.48	0.48	<0.64	<0.64	<0.44	<0.44
N/P Ratio	2.2	14.2	21.0	NR	<32.0	80.5	>33.5	>24.0	>24.0	NR	NR	<22.0	<22.0
Chloride (mg/l)	9	9	10	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Sulfate (mg/l)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Sodium (mg/l)	5	4	6	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Potassium (mg/l)	1.5	1.7	1.8	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Iron (mg/L)	0.16	0.22	0.35	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Manganese (mg/L)	<0.03	<0.03	0.26	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Chlorophyll "a" (g/L)	NR	NR	NR	7	NR	NR	NR	NR	NR	6.2	NR	5.0	NR

* NR denotes no reading given

APPENDIX II
HISTORIC WATER QUALITY DATA
Pine Lake, Shawano County, WI
Water Chemistry: 03/82 - 05/82
Lake Center
(Source: WDNR)

Parameter (Units)	Date			
	03/82	03/82	05/82	05/82
Depth (feet)	3	13	0	23
Water Temperature (°F)	NR[1]	–	60	48
Air Temperature (°F)	NR	–	75	–
Cloud Cover (%)	NR	–	40	–
Dissolved Oxygen (mg/L)	NR	NR	11.2	8.3
Secchi Depth (feet)	NR	–	21.4	–
pH (SU)	NR	NR	8.2	7.7
Conductivity (umhos/cm)	NR	NR	NR	NR
Alkalinity (mg/l $CaCO_3$)	148	144	138	140
Magnesium (mg./l)	NR	NR	NR	NR
Calcium (mg/l)	NR	NR	NR	NR
Turbidity (NTU's)	NR	NR	NR	NR
Reactive Phosphorous (mg/l)	<0.004	<0.004	<0.004	<0.004
Total Phosphorous (mg/l)	<0.02	<0.02	<0.02	0.07
NO_3 -Nitrogen (mg/L)	NR	NR	NR	NR
NH_4-Nitrogen (mg/l)	<0.02	<0.02	0.02	2.1
NO_2/NO_3-Nitrogen (mg/l)	0.16	0.16	0.03	0.02
Organic Nitrogen (mg/l)	>0.38	>0.38	NR	NR
Total Nitrogen (mg/L)	>0.38	>0.38	0.48	0.1
N/P Ratio	NR	NR	>24.0	1.4
Chloride (mg/l)	NR	NR	NR	NR
Sulfate (mg/l)	NR	NR	NR	NR
Sodium (mg/l)	NR	NR	NR	NR
Potassium (mg/l)	NR	NR	NR	NR
Iron (mg/L)	NR	NR	NR	NR
Manganese (mg/L)	NR	NR	NR	NR
Chlorophyll a (g/L)	NR	NR	<5	NR

[1] NR denotes no reading given

APPENDIX II

HISTORIC WATER QUALITY DATA

Pine Lake, Shawano County, WI

Expanded Self-Help Data: 07/18/91 - 10/14/91

Lake Center (Surface)

PARAMETER	DATE			
	07/18/91	08/16/91	09/27/91	10/14/91
Time (24 hour clock)	9:05	8:50	8:55	9:15
Secchi (feet)	11.00	12.00	7.75	8.00
Chlorophyll a (g/l)	3.09	3.60	9.70	19.31
Rainfall (inches) (between samples)	NA	4.5	1.9	0.6
pH (SU)	8.0	8.5	8.3	NR
Diss. Oxygen (mg/l)	9.0	9.2	8.8	10.0
Total Phos. (g/l)	12	11	13	16

APPENDIX II

HISTORIC WATER QUALITY DATA

Pine Lake, Shawano County, WI

Secchi Readings: 05/87 - 07/90

Lake Center

(Source: CLPA Water Quality Files)

DATE	SECCHI DEPTH (ft)	DATE	SECCHI DEPTH (ft)
05-10-87	15.4	10-11-88	8.8
05-25-87	13.5	10-22-88	8.6
06-07-87	11.3	11-16-88	9.8
06-27-87	14.0	05-14-89	18.0
07-12-87	9.5	06-03-89	12.0
07-25-87	9.7	06-11-89	9.7
08-09-87	10.4	06-17-89	7.5
08-22-87	7.4	06-25-89	8.3
09-07-87	12.0	07-09-89	9.8
09-19-87	8.7	07-30-89	7.6
09-26-87	10.0	08-20-89	7.2
10-24-87	10.0	09-02-89	10.8
11-14-87	8.8	09-17-89	9.0
04-17-88	15.2	10-08-89	8.3
04-30-88	22.0	10-22-89	10.0
05-14-88	19.0	11-11-89	9.8
05-30-88	9.2	04-21-90	13.7
06-12-88	10.0	05-13-90	15.8
06-19-88	9.0	05-28-90	15.0
06-26-88	9.0	06-09-90	12.8
07-09-88	10.0	06-29-90	12.7
07-24-88	8.5	07-09-90	9.8
08-07-88	10.0	07-20-90	11.0
08-20-88	8.0		
09-05-88	6.7		
09-18-88	8.0		

APPENDIX III
MACROPHYTE SURVEY DATA
Pine Lake, 1991

Transect	Substrate	NAJSP		VALAM		NITSP		POTRI		MYRSPE		POTIL		POTPE		NUPSP		CERDE		POTAM	
		J[1]	S[1]	J	S	J	S	J	S	J	S	J	S	J	S	J	S	J	S	J	S
A1	SAND/GRAV	1	1	1	0	0	2	0	0	0	0	0	0	0	1	0	0	0	0	0	0
A2	SAND	2	2	2	2	3	0	2	3	2	2	2	1	1	0	3	0	0	0	0	0
A3	SILT	3	3	3	3	0	0	0	3	1	2	0	0	0	0	0	0	3	0	0	0
B1	SAND	0	0	4	1	0	1	0	0	0	0	0	0	2	1	0	0	0	0	0	0
B2	SAND	3	2	2	2	4	3	0	0	1	1	2	0	0	0	0	0	0	0	0	3
B3	SAND	0	3	2	2	3	0	2	2	2	1	2	0	0	0	0	0	0	0	0	0
C1	SAND	1	0	0	1	2	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0
C2	SAND	4	1	3	2	3	2	2	0	1	1	0	1	0	0	0	0	0	1	0	0
C3	SILT/SAND	4	2	2	1	0	3	2	0	3	1	0	1	0	0	0	0	2	0	0	1
D1	SAND	1	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0
D2	SAND	4	4	3	3	2	0	3	2	1	2	1	2	0	1	0	0	0	0	0	2
D3	SILT/SAND	4	0	1	3	0	0	2	3	0	0	0	0	0	0	0	0	2	0	0	0
E1	SAND	2	0	1	2	0	0	0	0	0	0	0	0	2	1	3	2	0	0	0	0
E2	SAND	0	1	0	2	3	2	0	2	0	0	1	2	0	0	3	1	0	0	0	2
E3	SAND/SILT	0	3	0	1	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0

Species Code

Transect	Substrate	POTFO		POTPU		FILAL		POTPR		CHASP		NYMSP		POTCR		ELOCA		NOPLT		POTZO	
		J	S	J	S	J	S	J	S	J	S	J	S	J	S	J	S	J	S	J	S
A1	SAND/GRAV	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	0	0
A2	SAND	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	0	0
A3	SILT	0	1	0	0	0	0	0	0	2	0	0	0	0	0	1	0	-	-	0	0
B1	SAND	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	-	-	0	0
B2	SAND	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	0	1
B3	SAND	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	0	0
C1	SAND	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	0	0
C2	SAND	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	-	-	0	0
C3	SILT/SAND	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	-	-	0	0
D1	SAND	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	0	0
D2	SAND	0	2	0	0	0	0	0	0	0	0	0	0	1	0	0	0	-	-	0	0
D3	SILT/SAND	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	-	-	0	0
E1	SAND	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	0	0
E2	SAND	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	-	-	0	0
E3	SAND/SILT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	0	0

[1] J = July survey, S = September survey

APPENDIX IV

SOURCES OF INFORMATION AND ASSISTANCE (22)

Pine Lake, Shawano County, WI

Bell Plaine Town Board

Jerry C. Eckers, Supervisor
B-617 Rustic Drive
Route 4, Box 870
Clintonville, WI 54929

Can answer questions regarding ordinances, zoning and permitting.

Department of Natural Resources:

Shawano Area Office
647 Lakeland Road
Shawano, WI 54116

Lake Michigan District Office
Tim Rasman
Lakes-LMD
1125 N. Military Road, Box 10448
Green Bay, WI 54307-0448
414-497-6034

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

East Central Wisconsin Regional Planning Commission:

Ken Theine
RP, ECWRPC
132 N. Main Street
Menasha, WI 54952
414-729-4770

Has information regarding zoning and building planning information as well as information on land use.

APPENDIX IV
(Continued)

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
P.O. Box 446
Appleton, WI 54912-0446
(414) 749-3040 (Business Phone)
(414) 749-3046 (FAX)

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

Shawano County Land Conservation Department:

Ronald Ostrowski
Courthouse
311 N. Main Street
Shawano, WI 54166

Can provide soil erosion prevention measures and water quality problems related to your area.

Shawano County Land Conservation Service (USDA):

Steve Persteiner
Courthouse
311 Main Street
Shawano, WI 54116

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

APPENDIX IV
(Continued)

Shawano County University of Wisconsin Extension:

Jim Resick
UWEX, Courthouse
311 N. Main Street
Shawano, WI 54116
715-526-6136

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

Shawano County Zoning Administration:

Roger Mathison
ZA, Courthouse
311 N. Main Street
Shawano, WI 54116
715-526-6766

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

State Laboratory of Hygiene:

University of Wisconsin
Center for Health Sciences
465 Henry Mall
Madison, WI 53706
608-262-3458

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

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 V
SUMMARY OF PERTINENT SHAWANO COUNTY ORDINANCES AND PLANS

Shawano County Zoning Ordinance

Included in this ordinance are regulations for floodplain zoning, general shoreland provisions, and land subdivisions.

- 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.

  Shawano County's floodplain ordinance regulates all lands that would be inundated by a "regional flood" or a flood the magnitude that could be expected on the average of once per 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., Shawano County was required to adopt 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 development of land and certain land use activities from adversely affecting the waterbody.

  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

APPENDIX V
(Continued)

to be unsuitable for development because of potential flooding, inadequate drainage, ... (or) severe erosion potential...." (Shawano County, 1982)

Sanitary Ordinance. The Sanitary 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.

Soil Erosion Control Plan

In 1987, Shawano County adopted a Soil Erosion Control Plan based on guidelines contained in Chapter AG 160 of the Wisconsin Administrative Code. The purpose of the plan is to "... determine where the most serious erosion is occurring and to establish a strategy to address the problem." (Shawano County, 1987). Specifically, the plan provides educational programs, technical assistance, and seeks cost sharing funds to reduce soil erosion to acceptable limits and reduce the amount of sediment being carried to surface waters. Based on maintaining a tolerable soil loss level (expressed as "T"), the plan delineates areas in the county that should receive priority assistance in reducing soil loss. Although the plan looks at soil loss in relation to maintaining agricultural productivity, it can also have a significant impact in reducing nutrient loadings to rivers and lakes. (The Cloverleaf Lakes watershed, in the Belle Plaine Township is currently not identified as a priority area.)

Animal Waste Water Pollution Control Plan

In 1985, Shawano County adopted an Animal Waste Management Plan. The purpose of this plan is to "...identify those areas within the county that have the greatest potential for water pollution caused by animal waste." As with the Soil Erosion Control Plan, these priority areas will be eligible to receive technical and cost share assistance, as available. (The Cloverleaf Lakes watershed is currently not a priority area for assistance at this time.)

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. This program is still in draft stage. When finalized, it is intended to be funded by a $1M appropriation from an expanded motorboat gas tax formula. Up to 50% cost share for projects would be available. Projects may include: conservation or purchase of land, construction or restoration of a wetland, development of local regulations/ordinances to protect lake ecology or the water quality tributary to a lake, activities identified in a WDNR approved lake management plan (may include harvesting, biomanipulation, installation of BMPs, aeration, dilution, sediment treatment, drawdown and habitat improvement). The program will <u>not</u> include: dredging, dam maintenance/repair and chemical treatment of aquatic nuisances.

- WDNR's Recreational Boating Facilities Program (NR 7). Program has been expanded to include qualified lake associations as applicants. 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

APPENDIX VI
(Continued)

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 (the watershed including the Clover Lakes is not currently identified as a priority soil erosion area).

- 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:

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

- US 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.

- USDA (1985 Federal Farm Bill). Program to take

APPENDIX VI
(Continued)

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.

- 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.

- SCS. Beginning in 1983, SCS has provided large grants to selected areas to enhance water quality.

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).