PHASE 2

LAKE MANAGEMENT PLAN

RIB LAKE

TAYLOR COUNTY, WISCONSIN

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Prepared for

Rib Lake Protection and Rehabilitation District

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SUMMARY

Rib Lake is a 324 acre, drainage lake that is located within the village limits of Rib Lake, Taylor County, Wisconsin. It is a natural lake of glacial origin which formed 10,000 to 15,000 years ago. Past industrial and limited agricultural activities have degraded the water quality and biological integrity of the lake ecosystem.

Major impacts to Rib Lake's water quality date back to the village's development in 1882 when the Rib Lake Saw Mill and Tannery Lane Company were established. After industrial activities along the lake shore closed in 1948, the aesthetic and natural values of Rib Lake began to be appreciated. However, years of neglect and pollution had contributed to excess weed growth and fish kills.

In response, the Rib Lake Protection and Rehabilitation District was formed in 1976 to improve the water quality and fishery of the lake. In cooperation with the Wisconsin Department of Natural Resources, the district took action to control and correct some of the problems. As a result, the water quality and fishery have improved, but the district wanted to further improve the lake ecosystem.

The objectives of this study are part of an on-going lake management program developed by the Rib Lake District and the Village of Rib Lake. The project centers on identifying potential pollutants that may be discharging to Rib Lake and determining pollutant concentrations that are currently in the lake. Surveys were also done to determine if the water quality is degrading the biological communities. A lake management plan will report the results of the study.

Investigations included analysis of water chemistry, bottom sediment, benthic macroinvertebrate and fishery surveys, plankton analysis, aquatic plant (macrophyte) surveys, and a watershed appraisal. The lake management plan will analyze the data and make recommendations for strategies to improve the water quality and biological communities of Rib Lake.

The Phase 1 report includes an introduction to the project, information on the materials and methods that were used to conduct the study, and the results of the study in table form. The Phase 2 study will include analysis of the data and recommended strategies and alternatives for best management practices that will improve the biological integrity of Rib Lake.

INTRODUCTION

Rib Lake is a 324 acre lake located totally within the village limits of Rib Lake, Taylor County, Wisconsin. It is a natural lake of glacial origin that was formed 10,000 to 15,000 years ago. The lake has been subjected to significant deterioration in water quality since the early days of the village's development in 1882 when it was used for industrial purposes for the Rib Lake Saw Mill and Tannery Lane Company. After the sawmill closed (1948) the lake began to be used and appreciated for its aesthetic and natural value.

This appreciation came after 60 years of saw dust, bark, slabs and tannery sludge were deposited in the lake in addition to large quantities of nutrients and sediments eroding from the cleared forest land. The lake experienced significant algal blooms, weed growth and fish kills in the 1960's and 1970's promoting the community to form the Rib Lake Public Inland Lake and Protection and Rehabilitation District in 1976 and a conservation club to improve the lake quality and its fishery.

A comprehensive lake study was conducted in 1977-80 by the Wisconsin Department of Natural Resources (WDNR) indicating:

- The 3.7 square mile watershed includes the Village of Rib Lake, a small amount of agricultural land and extensive marsh and woodland areas.
- The soils of the watershed originate from acid drift from granite source materials. The drainage basin is mainly hilly loams formed from sandy loams, acid glacial till and sand and gravel outwash.
- The major drainage to the lake occurs through two tributary streams. Land use in the watershed consists of approximately 10% urban residential, 60% forested and wetland, and 30% abandoned agricultural.
- Surface runoff, groundwater, and atmospheric fallout contribute approximately 1070 pounds of phosphorus per year. The acid soils and high background phosphorus levels in the soil are the most likely cause of this higher than expected nutrient loading.
- The lake's present volume is 1,977 acre-feet. The lake's original volume was 7,600 acre-feet.

- In certain areas the soft sediment is over 40 feet deep. The organic content of the sediment is 40%-to-50% and the water content is 85%-to-95% indicating that internal production of algae and macrophytes is the major cause of lake infilling.

The 1979 lake study indicated that the water quality of the two tributaries and their appropriate watersheds were minimally affected by human activities and development. At that time their were three active farming operations in the watershed. Agricultural land use is currently limited to two hobby farms. The study suggests that Rib Lake was recycling its nutrients in a cyclical fashion with the excessive weed growth that resulted in seasonal fish kills.

The Rib Lake District took recommended action to control and correct some of the problems. Under supervision and direction of the WDNR the outlet dike was reconstructed elevating the water level approximately two feet. A weed harvesting program was implemented but later abandoned when weeds appeared to be under control. A fish stocking program was developed under WDNR supervision and is expanding. A bullhead/rough fish removal effort has been implemented. A rock reef was also constructed and the Lake District is into it's 13th year of aeration.

All of the above practices have improved the lake and its fishery, but citizens want to do more. In 1995, the village conducted a long range planning program. Through it, residents identified the lake as a major asset to their culture and economy. Also, citizens want to further improve the water quality, fishery, aesthetics, and provide better public access (i.e. swimming beach, fishing peer, improved boat landings).

Watershed management and man induced phosphorus control does not appear to be the key issue affecting Rib Lake's current water quality. Controlling non-point pollution by implementing best management practices in the watershed will not rehabilitate the lake. This is a unique opportunity to restore a local and state resource that was degraded by activities 100 years ago. This investment will allow the current stewards of Rib Lake to correct the errors of a past generation and enact practices that will protect this resource for future generations.

The objectives for this study are part of an on-going program of lake management activities by the Rib Lake District and the Village of Rib Lake. A comprehensive lake management and rehabilitation plan will provide data and suggest recommendations for best management practices that will improve the water quality and biological integrity of Rib Lake.

MATERIALS AND METHODS

Field Analysis

To determine the current health of the Rib Lake's ecosystem, numerous categories of the lake were reviewed and analyzed. These included reviewing the history of Rib Lake and its land use; reviewing and interpreting past sampling data; water quality and sediment analysis; phytoplankton and zooplankton analysis; benthic macroinvertebrate and macrophyte surveys; analysis of WDNR fishery surveys; and a current watershed and land use appraisal.

Watershed Appraisal

A visual survey of the existing conditions of the drainage basin for Rib Lake was done to determine potential sources of point source and nonpoint source pollution. Point sources of pollution are those that have discrete discharges, usually from a pipe or outfall. Nonpoint source pollution is that which cannot be traced to a single point such as a municipal or industrial wastewater treatment plant discharge pipe. Nonpoint sources include eroding farmland and construction sites, urban streets, and barnyards. Pollutants from these sources reach water bodies in runoff, which can best be controlled by proper land management.

Water Chemistry

Water chemistry samples were collected at three strategic locations that best represented the lake's morphology and drainage patterns. These three locations are the deepest area of the lake, the littoral zone near the major inlet on the northwest side of the lake, and the outlet on the south end of the lake.

One sample was collected at each site, one meter below the surface. Samples were collected at different times throughout 1996 and 1997. The samples were collected with a ALPHA water sampling bottle, and WDNR quality assurance procedures. Samples were placed on ice and mailed to the State Laboratory of Hygiene in Madison, Wisconsin for chemical analysis.

Chemical analysis included biochemical oxygen demand (5-day), chloride, conductivity, acidity, alkalinity, hardness, calcium, magnesium, ammonia nitrogen, nitrate and nitrite nitrogen, total kjeldahl nitrogen, total phosphorus and dissolved ortho phosphorus. These parameters were only analyzed in June of 1996 and 1997. The remaining samples were only tested for total phosphorus and dissolved ortho phosphorus. All analyses were done using U.S. Environmental Protection Agency (EPA) approved methods.

Bottom Sediment

Two sediment samples were collected in July, 1996 using an Ekman Bottom Grab sampler that was six inches in length and six inches wide. Samples were collected at an approximate depth of four-to-six inches at the northwest and southern ends of the lake. Samples were placed on ice and delivered to the University of Wisconsin - Stevens Point Environmental Task Force Laboratory for chemical analysis.

Analysis included total cadmium, chromium, copper, lead, mercury, and zinc; oil and grease; total phosphorus; total organic carbon; alpha-BHC; beta-BHC; gamma-BHC; delta-BHC; heptachlor; aldrin; heptachlor epoxide; endosulfan I; p,p'-DDE; dieldrin; endrin; endosulfan II; p,p'-DDD; endrin aldehyde; endosulfan sulfate; p,p'-DDT; endrin ketone; and methoxychlor. All analyses were done using U.S. EPA approved methods.

Benthic Macroinvertebrate Surveys

Three replicate sediment samples were collected in May and September of 1996 and 1997, adjacent to the two bottom sediment sites, for a total of 24 benthic macroinvertebrate samples. Samples were collected with an Ekman Bottom Grab sampler at an approximate depth of four-to-six inches. Invertebrates were separated from the sediment using a WILDCO Wash Bucket with a #30 (600 um) sieve bottom.

Invertebrate samples were preserved with 70 percent ethanol and identified to family level using a dissecting microscope. Data was tabulated and compared to sediment chemistry to determine if chemical concentrations were affecting the benthic macroinvertebrate populations.

Fish Community Surveys

WDNR staff has monitored the fish community surveys of Rib Lake on an annual basis since 1984. Surveys have been conducted using electroshocking equipment and fyke nets. This data was reviewed and compiled to determine the current health and status of the fishery.

Phytoplankton and Zooplankton Analysis

Three phytoplankton and zooplankton samples were collected in June and August of 1996 and 1997. A total of 12 phytoplankton and 12 zooplankton samples were collected. Samples locations were the same as the three water chemistry sites. Phytoplankton samples were collected at a depth of one meter, placed in 120 ml, glass, amber, bottles, and were preserved with 1 mL of iodine.

The zooplankton samples were collected by a vertical net haul (lake bottom to surface), using a 'Wisconsin Plankton Net', and placed in clear, 120mL, glass bottles. Samples were preserved with 10 mL of ethanol. Phytoplankton and zooplankton samples were identified to species level, when possible, using the standard inverted microscope analysis method (American Public Health Association et al., 1995).

Aquatic Plant Surveys

Macrophyte surveys were conducted using a modification of the grid sampling method of Jessen and Lound (1962) in August of 1996 and 1997. Permanent reference points were established along shore using Capree Scout Loran C receiver. Six transacts were established from shore to the open water along a straight line. Four stations were recorded in each transact according to water depth for a total of 24 sample stations. Direction was maintained using a compass.

Observations of abundance and diversity of aquatic vegetation was made using a 14 inch wide, double-sided, thatch rack head attached to a rope. Rake teeth are spaced 3/4 inch apart. Observations were made at precise depths along the transacts and reported. The width and distance across each station where observations were made along the transacts were six feet or 1.8 meters.

Sediment Criteria

The use of one standardized set of sediment criteria is not a luxury that is available at this time. Several sediment pollutant concentration guidelines or criteria are commonly used when assessing sediment quality. Criteria is typically derived using information from background concentrations, toxicity tests, bioassessments, and chemical and physical properties.

Sediment guidelines that are commonly used, but are not limited to, include criteria developed by the Wisconsin Department of Natural Resources (WDNR) for maximum allowable concentrations in Great Lakes sediments for beach nourishment and in-water disposal; U.S. EPA 1977 guidelines for the pollutional classification of Great Lakes Harbor sediments; National Oceanic and Atmospheric Administration guidelines for biological effects; Ontario Ministry of the Environmental Provincial sediment quality guidelines based on biological effects; and an Equilibrium Partitioning Approach to develop sediment quality assessment values for nonpolar hydrophobic organic compounds.

For the purposes of this report the U.S. EPA and WDNR sediment guidelines will be used to interpret the chemical data. This is because both sets of criteria address dredging, beach nourishment, and in-water disposal of sediment (Tables 31 & 32). The other standards are primarily applied to potential biological impacts from contaminated sediment (Tables 33 & 34).

RESULTS AND DISCUSSION

Site Description

Rib Lake is located in Taylor County, Wisconsin, adjacent to the village of Rib Lake (Figure 1). The Rib Lake Protection and Rehabilitation District, which was formed on September 28, 1976, encompasses the entire lake and includes the village of Rib Lake.

Rib Lake is a natural lake of glacial origin, being formed some 10,000 to 15,000 years ago. The 3.7 square mile watershed (Figure 2) includes the village of Rib Lake, a small amount of agricultural land, and extensive wetland and woodland areas. A sawmill was established at Rib lake in 1882, harvesting and processing large quantities of timber. The mill, once the largest in Wisconsin, finally closed in the mid-nineteen hundreds after most of the desirable timber was harvested. Following the lumber period, much of the cleared land was converted to dairy farming, bypassing the wheat stage. A large tannery operation also contributed to the Rib Lake economy in the early 1900s. The tannery closed its doors in the early 1920s.

Rib Lake was extensively used, and misused, by industry during these times. The clearing of the forest resulted in the loss of ground cover and runoff to the lake carried large quantities of nutrients and sediments. The tannery also discharged large quantities of untreated wastewater into the lake.

The lake was first manipulated during the early 1900s when the lumber companies constructed small dams on the Rib River to slightly raise the natural level of the lake, allowing it to more easily float large numbers of logs. The lake appears to have remained in an impounded condition since those early days.

In 1966 an extensive dike was constructed to more permanently stabilize the water level of the lake. Unfortunately the dike has not functioned as intended, being plagued with breaks and leaks. The potential exists for the dam to fail in quite a catastrophic fashion, releasing large quantities of stored water downstream and lowering the lake level by as much as two feet or more.

Geology and Soils

The geological formation of the Rib lake area is primarily glacial drift, composed of a heterogeneous mixture of clay, sand, and gravel. Near the lake the thickness of this drift varies between 100 and 200 feet. Underlying this drift is a bedrock formation of igneous granite rock. The present landscape and soils of the area are the result of glacial advances during the Pleistocene glacial period. The Chippewa lobe of the Lake Superior glacier was the last advance of the Wisconsin stage. When this lobe receded it left behind a large block that then melted, forming the original basin of Rib Lake.

The soils of the watershed area originate from acid drift derived from granite source materials. In the drainage basin they are principally hilly loams formed from sandy loams, acid glacial till, and sand and gravel outwash. These soils are primarily devoted to forestry and pasture lands with only a few cultivated fields being present.

Surface and Groundwater Drainage

The watershed of Rib Lake is 3.7 square miles, with the major drainage to the lake occurring through two tributary streams. The northwest tributary drainage area is comprised of 1.26 square miles and the northeast tributary system drains 2.40 square miles. Land use in the watershed consists of 10 percent urban, 60 percent forest and wetland, and 30 percent agricultural activities. The northwest tributary includes runoff from the village of Rib Lake and exhibits the greatest variation in the quantity of flow. The northeast tributary exhibited much more uniform flow during the period of the study; likely the result of the large percentage of wetlands it drains.

Long-term runoff from the region is approximately 0.8 cubic feet/second (cfs) per square mile. In addition to surface runoff, direct rainfall upon the lake contributes and average input of 1.1 cfs on an annual basis, approximately balancing evaporation loss of 1.0 cfs. Groundwater has been estimated to contribute 0.5 cfs to the lake on an annual average. Water loss form the lake is occurring as seepage through the dike and runoff into the Rib River.

Nutrient Loading

Unless environmental conditions such as light or temperature are limiting, aquatic plants and algae respond to the quantities of nutrients made available to them. The major nutrients that are often limiting but essential to plant growth are nitrogen and phosphorus. Nutrient control schemes have thus far been directed primarily at the one element most easily controlled — phosphorus. Phosphorus concentrations, when combined with the quantity of flow, define the nutrient load a lake receives.

The greatest loads to Rib lake occurred via the two inlet streams. Although it appears that the watershed exists primarily in a natural state, phosphorus loss and movement is more in the range one would expect from an intensively farmed agricultural area. the acid soils and likely high background phosphorus levels in them are the most likely cause of this higher than expected loading. Lake sediment analysis also confirm this theory.

Watershed Land Use and Potential Pollution Sources

The Rib Lake Watershed has an area of 3.7 square miles. The dominant land cover is a mix of woodland and wetland. Agricultural land use is limited to two hobby farms on the east side of the watershed. Agricultural land use was more widespread in the past. The village of Rib Lake is also located within the watershed. The current population for the village is 945 people.

A sawmill operated from 1882 to 1948. Sawdust, bark chips, slabwood, horse manure, and possibly wood ash were disposed of in the lake. This waste material filled in certain areas of the lake contributing to the current shallow depths. Also the bark chips and woody debris have undergone very little decomposition.

The lengthy breakdown of this material can release nutrient concentrations into the water column contributing to the excess algae and weed growth. Bacterial decomposition of the organic matter also requires oxygen. Therefore, dissolved oxygen levels in the lake are at a higher risk of falling to levels that may cause fish kills.

A tannery operated in the village of Rib Lake from the early 1900s to the early 1920s. The tannery reportedly used the vegetative tanning process. The tannery reportedly used tannins (tannic acid) derived from hemlock bark for tanning and never used chromium as a tanning agent. Other chemical usage by the tannery is unknown. Hair removed from hides by the tannery were discharged to Rib Lake via Tannery Creek and can still be found in the sediment.

There was also a shoe and glove factory in Rib Lake which closed in the early 1980s. However, drainage from the site of the shoe factory was directed to Sheep Ranch Creek and did not enter Rib Lake.

The village of Rib Lake is an urbanized area that can also act as a potential source of pollution in the watershed.

There are two reasons why urbanization increases pollutant loads in runoff to Rib Lake:

1. The volume and rate of runoff typically increase as an area is developed thereby providing a larger capacity for transporting pollutants.

2. Pollutants may be more prevalent given the development or more available for loss in runoff as the intensity of the land use increases.

Although pollutants impact the quality of surface water, ground water quality can also be adversely affected. The greatest potential for groundwater pollution comes from pollutants that are soluble in water and not trapped or treated by the soil during percolation.

Hydrologic Changes

When an undeveloped area changes to support urban land use, drastic changes in the local hydrology result. As land is covered with roads, buildings, and parking lots, the amount of rainfall that can infiltrate into the soil is reduced. This increases the volume of runoff from the watershed.

When an urban area is developed, natural drainage patterns are modified as runoff is channeled into road gutters, storm sewers, and paved channels. These modifications increase the velocity of runoff, which decreases the time required to convey it to the mouth of the watershed. This results in higher peak discharges and shorter times to peak discharges. Also water that once seeped through the upper layers of soil now runs off the surface. The loss of this shallow groundwater is significant because it supplies much of the baseflow in streams that discharge to Rib Lake between storms.

Those who are conscious of the effects of urbanization on water quality have a much greater chance of cost effectively minimizing those effects. Best Management Practices that slow runoff and increase infiltration are recommended as opposed to intercepting all runoff in storm sewers and directing it to the nearest waterway.

Pollutants Affecting Water Quality

Although urban areas cover only a small part of the land use in the Rib Lake watershed, they can be responsible for significant water quality problems, flooding, and habitat destruction. The major urban pollutants include:

1. Sediment
2. Nutrients
3. Oxygen demanding material
4. Bacteria
5. Heavy metals
6. Pesticides
7. Toxic chemicals such as Hydrocarbons and PCB
8. Chloride
9. Temperature

Each of the pollutants is discussed below.

Sediment

Sediment is considered one of the most damaging pollutants, and is the major pollutant by volume in Wisconsin surface waters. Urban runoff produces a unique mix of sediment that contains flakes of metal from rusting vehicles, particles from vehicle exhaust, bits of tires and brake linings, chunks of pavement and soot from residential chimneys and industrial smokestacks.

Generally, the concentration of sediment in urban runoff is lower than rural runoff, but because more water runs off impervious surfaces in cities, the total load of sediment for urban areas is comparable to rural areas. Land uses that produce the highest sediment loads in existing urban areas are industrial sites, commercial development, and highways. Parking lots are the predominant source in industrial areas. In residential and commercial areas, street surfaces are the primary source of sediment. Although existing urban areas are important sources of sediment, the highest loads of sediment come from construction sites.

Nutrients

Runoff from urban and rural areas contains nutrients such as phosphorus and nitrogen. Phosphorus is of greatest concern in storm water runoff because it usually promotes weed and algae growth in freshwater lakes and streams. Because phosphorus compounds attach themselves to sediment particles, land uses that produce high sediment loads also tend to produce high phosphorus loads. The phosphorus in runoff from existing urban areas come from lawn fertilizer, leaves and grass left on paved areas, and from pet waste.

Nitrogen is usually so abundant in Wisconsin lakes and streams that nitrogen in runoff does not usually increase weed and algae growth. Nitrogen can occur in several forms in the aquatic environment. These include nitrate, nitrite, organic nitrogen, kjeldahl nitrogen, and ammonia. High concentrations of ammonia in the lake can be toxic to fish and other organisms.

Nitrate forms of nitrogen also become a problem when they contaminate drinking water. Unlike phosphates, nitrates are easily soluble and do not attach to soil particles. This allows nitrates to readily leach into the groundwater when nitrogen fertilizer application rates exceed plant needs. Septic systems are another source of nitrate contamination in groundwater. Nitrates are found naturally at low levels in water. However, drinking water contaminated with high levels of nitrate is a health hazard.

Oxygen Demanding Material

Urban runoff carries organic material such as pet waste, leaves, grass clippings, and litter. As these materials undergo bacterial decay, the bacteria use oxygen needed by fish and other aquatic life. The sudden increase of oxygen demand after a storm can totally deplete oxygen in an urban lake or stream. Shallow, slow-moving waterways are especially vulnerable to fish kills caused by the oxygen demands of urban runoff.

Bacteria

The levels of bacteria found in urban runoff usually exceed public health standards for water contact recreation such as swimming and wading. Generally, fecal coliform bacteria counts in urban runoff are 20 to 40 times higher than the health standard for swimming. Sources of bacteria in urban runoff include sanitary sewer overflows, pets and urban wildlife such as pigeons, raccoons, geese, and deer.

Heavy Metals

The greatest challenge in urban storm water pollution control is toxic pollution, particularly heavy metals. Metals are the most understood toxic pollutants in urban runoff because they were excessively monitored as part of the National Urban Runoff Program (NURP) in the early 1980s. Data recently collected in Wisconsin cities verify that heavy metals such as lead, zinc, and copper contaminate storm water runoff from small and large cities.

Lead is an indicator for other toxic pollutants because it is relatively easy to monitor. Lead is toxic to all living organisms and has no beneficial significance. According to recent monitoring, about 40 percent of the runoff samples from a residential area, and 70 percent of the samples from a commercial area have lead levels that exceed acute (short-term) toxicity standards for aquatic life. However, lead levels in urban runoff are much lower today than they were before the move to unleaded gasoline.

Zinc is another heavy metal found in urban runoff that commonly violates water quality standards. While zinc does not create human health problems, it can be toxic to aquatic life. Zinc levels in urban runoff are more likely than lead to violate acute toxicity standards for aquatic life.

Copper concentrations in urban runoff frequently violate water quality standards. Like lead, copper can be toxic to both humans and aquatic life at elevated concentrations.

Cadmium is another heavy metal commonly found in urban runoff. Unlike zinc and copper, cadmium concentrations usually do not exceed acute toxicity standards. However, cadmium has a low standard value for chronic (long-term) toxicity frequently exceeded by urban runoff. This means cadmium concentrations are seldom high enough to kill aquatic life, but are likely to risk long-term health problems for people, such as cancer and kidney damage.

Chromium is frequently detected in urban runoff but usually does not violate acute toxicity standards. Organisms can excrete chromium very quickly and keep it from accumulating in body tissues. One form of chromium (chromium IV) is considered highly toxic to humans.

These metals originate from galvanized metal, chrome plating, and other metal sources in urban areas. Lead and zinc have also been associated with the application of deicing materials such as road salt. Another significant source of heavy metals is runoff from rooftops. Many roofs have galvanized sheet metal, gutters, and downspouts that contaminate storm water with zinc.

In industrial areas galvanized roofs and gutters are the leading source of zinc (60%). In residential areas, roofs are a less significant source of zinc (7%). This dramatic difference happens because most residential downspouts discharge onto lawns that filter out zinc while most industrial downspouts discharge directly into storm sewers. Another source of heavy metals on some roofs is copper flashing. Runoff from these roofs carries high concentrations of copper and lead.

In some cities, a significant source of heavy metals is uncovered, outdoor, storage piles of scrap metal, coal, and salt. According to United States Geological Survey analysis, scrap metal piles are the primary source of mercury in the area surrounding the Milwaukee harbor. Scrap metal piles are also a source of arsenic. Coal piles are also a source of arsenic, while salt piles are a source of chromium and lead.

The list of other sources of heavy metals is long and can range from combustion to deteriorating metal and paint. For example, paints and plated metals commonly contain cadmium or chromium. Fishing weights, shot gun shells, and paint sold before 1977 may contain lead. Air-borne emissions from burning coal, oil, or municipal waste may carry cadmium, copper, lead, or mercury. Wood used in outdoor construction may contain arsenic, chromium, copper, or zinc to prevent rotting.

Pesticides

Monitoring data from Wisconsin shows urban runoff contains numerous pesticides. Common lawn and garden insecticides like diazinon and malathion may not persist in the environment, but they are toxic to bees, fish, aquatic insects, and other wildlife. Diazinon is toxic to birds and is banned on golf courses and sod farms because of waterfowl deaths in diazinon treated feeding areas.

Finding agricultural herbicides like alachlor, atrazine, and cyanazine in urban storm water may seem surprising since these herbicides are not used in lawn and garden compounds. However, studies in Minnesota suggest that concentrations of atrazine observed in urban storm water are consistent with concentrations observed in rainfall. These herbicides apparently evapotranspirate from farm fields and are redeposited during a storm.

Pesticides in Urban Runoff		
Regulated Insecticides	Lawn & Garden Insecticides	Agricultural Herbicides
Aldrin	Diazinon	Alachlor
Chlordane	Malathion	Atrazine
DDT	Cyanazine	
Endrin		
Heptachlor		
Lindane		
Toxaphene		

Other Toxic Chemicals

The other toxic chemicals found in urban runoff are organic compounds. Some of these are health hazards even in small doses and therefore have water quality standards set in the parts per billion (ppb). Data suggests that polycyclic aromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs) are the two groups of chemicals present in large enough concentrations in urban runoff to be of concern.

Hydrocarbons

Polycyclic aromatic hydrocarbons (also called polynuclear aromatic hydrocarbons) are a large group of about 10,000 compounds. They are common byproducts of incomplete combustion from vehicles, wood and oil burning furnaces, and incinerators. PAHs are used in ingredients in gasoline, asphalt, and wood preservatives. The best known PAH is benzene, which is used both as a solvent and as an antiknock additive in gasoline. While benzene levels in Wisconsin storm water do not exceed surface or ground water standards, several other PAHs do exceed standards.

Petroleum-derived hydrocarbons are commonly found in urban runoff. These materials initially float on water and create the familiar rainbow-colored film. Hydrocarbons have a strong affinity for sediment and quickly become absorbed in it. The hydrocarbons are then transported with sediment and settle out with it where they are stored for potential re-release into the water column.

Common sources of hydrocarbons are spillage at oil storage and fueling facilities, leakage from crankcases, and improper disposal of drain oil. PAHs affect human health in a variety of ways but they are of particular concern because several of the most toxic carcinogens are found in PAHs. According to monitoring from Wisconsin cities, a significant percent of urban storm water samples violate human cancer criteria.

Polychlorinated biphenyls are a group of over 200 compounds. They are very stable compounds that do not easily degrade, burn, or dissolve in water. PCBs have been used for many purposes that include insulation in transformers and electrical capacitors for fluorescent light fixtures and appliances. They have also been used as coolants or lubricants.

PCBs are of special concern because they remain in the environment for a long time. They can build up in the food chain, accumulating in the fatty tissues of animals and humans, and may eventually cause health problems. PCB production stopped in 1977.

Chloride

In Wisconsin a tremendous amount of salt is used each year to melt ice from roads, parking lots, and sidewalks. Because it is extremely soluble, almost all salt applied ends up in surface or ground water. If the concentration of chloride becomes too high, it can be toxic to freshwater organisms. Normal application of salt to roads for de-icing is unlikely to create toxic conditions due to elevated chloride levels. However, there have been numerous documented cases of surface and ground water contamination caused by runoff from inadequately protected stockpiles of salt and sand-salt mixtures.

Temperature

Besides changes in water chemistry, urbanization changes the quality of waterways by raising their temperature. Reasons for increased temperatures in urban lakes and streams include:

- Pavement and roofs that store the sun's head, warming storm water running over them.

- Shallow ponds and impoundments that head up between storms and release a pulse of warm water during a storm.
- Fewer trees along streams decrease shading, resulting in warmer water.

Temperature is a critical factor in determining what species can live in a lake or stream since increases in temperature affect waterways in several ways. At higher temperature, water holds less oxygen and many processes that consume oxygen speed up. Therefore, as water temperatures rise, the demand for oxygen increases while the supply decreases.

Levels of Pollutants

The water chemistry analysis for Rib Lake indicates poor water quality when comparing nutrient levels (Tables 1 & 2). Phosphorus analysis includes both dissolved ortho phosphorus and total phosphorus. The dissolved ortho phosphorus is dissolved in water and is readily available for plant growth. Total phosphorus concentrations greater than 50 ug/L suggest poor water quality and dissolved ortho phosphorus concentrations should be 10 ug/L or less in the spring to prevent summer algal blooms. Water chemistry analysis suggests that the phosphorus concentrations in the lake are contributing to the excess algae and weed growth that occurs during the summer. Other parameters did not indicate abnormal conditions.

Sediment analysis showed elevated concentrations of several heavy metals (Table 6). Certain metals were found at levels of concern. Mercury concentrations appear to be the most significant. Mercury concentrations were about 1.5 mg/kg. This concentration of mercury would be expected to be toxic to 95 percent of benthic macroinvertebrates, based on Ontario sediment quality guidelines (Table 33). Copper, cadmium, lead, and zinc were present at concentrations in the sediment expected to be toxic to 30-to-70 percent of benthic organisms based on Ontario sediment quality guidelines. Pesticides were not detected in the two samples.

Biological Conditions

Benthic macroinvertebrate surveys that were done showed only populations of chironomid larvae (chironomidae) and tubificid worms (tubificidae). There were more tubificidae than chironomidae (Table 7). The elevated metal concentrations in the sediment samples may be responsible for the low abundance and diversity of invertebrates, but very low dissolved oxygen levels that occur at the sediment/water interface may also contribute to the degraded populations.

Fisheries data collected from 1984 to 1997 by the WDNR shows that Rib Lake has one of the best walleye fisheries in Taylor County and provides some trophy muskellunge and northern pike fishing. An abundant bullhead population can make panfish fishing difficult but good crappie and perch are present. A mid-lake rock bar attracts spring walleyes as does the area around Copper Creek.

The local sportsmen's club and the WDNR stock the lake annually with walleye and muskellunge. A permanent aeration system prevents overwinter oxygen depletion and maintains a healthy fishery. Major fish species include walleye, muskellunge, northern pike, crappie, and perch. Less abundant fish species include bluegill, pumpkinseed, bullhead, and largemouth bass (Table 8).

Annual fish shocking data, from 1984 to 1997, during the spring spawning period for targeted walleyes shows that populations continue to increase in number. The aeration system, annual stocking activities, and protecting the spawning areas help make this possible.

Phytoplankton data indicate that Rib Lake is a eutrophic lake dominated by blue-green algae species common to eutrophic lakes within this region. Zooplankton data indicate the community is comprised of small bodied individuals (Tables 9 through 16). The lack of large bodied forms is suggestive of predation by planktivorous fish.

Such predation generally occurs when a lake lacks a zooplankton refuge, due to anoxic conditions associated with eutrophication. The small-bodied zooplankton can graze only small algal cells and are therefore unable to exert a significant grazing pressure on the algal community. This is a possible reason why algae blooms are excessive during the summer. Therefore, the data suggest the lake's algal community is determined by the lake's epilimnetic phosphorus concentration, with no significant biological control occurring.

Macrophyte surveys show that certain areas of Rib Lake have excess weed growth. Transacts 3, 4, 5 & 6 had the highest abundance of aquatic plant growth. Populations were high enough at times to hinder boat traffic. Thirteen different macrophyte species were identified during the 1996 and 1997 surveys. Dominant species included *Elodea canadensis, Typha latifolia, Ceratophyllum demersum,* and *Nuphar variegata* (Tables 17 through 30). *Elodea canadensis* is by far the most abundant and should be targeted for management to control and reduce populations.

ALTERNATIVE CONTROL METHODS

Several methods are available which provide temporary relief from aquatic weed and algae problems. Selecting a successful program depends upon objectives, weed types, environmental impacts, site characteristics and economics. The control measures described will help users select a program which suits their individual or group needs.

To obtain successful results and maintain quality of the surface waters for everyone, specific control measures should be selected carefully. many of the recommended control techniques require a permit from the WDNR. **Before using any control measure, check with your local WDNR representative concerning permit requirements.**

1. **Watershed Management** - Limiting or controlling the amount and kind of plant nutrients that enter surface waters is an essential step in waterweed control. Some Wisconsin lakes are so overfertilized that nutrient control must be supplemented with other methods. Discharging sewage effluent, industrial or agricultural wastes into water adds enormous quantities of plant nutrients. So also does soil erosion and urban runoff. It is easy to limit runoff into well constructed ponds but more difficult in lakes. Nutrient limitation should, nevertheless, supplement all other control measures.

2. **Harvesting** - mechanical harvesting is an ideal method of controlling waterweeds. It reduces excessive growth and at the same time removes growth-producing nutrients from the aquatic system. Mowers cut to depths over 4 feet. Cut weeds are automatically lifted to the barge and moved to shore where they are transferred to a truck and hauled to a disposal site. Equipment required to a good job is large and expensive, and a sound maintenance program is required to insure successful operation. Smaller and less expensive equipment will do creditable work in small lakes and in shallow-water areas.

   Hand harvesting is hard work, but is sometimes practical in limited areas along shore lines.

3. **Light Elimination** - This method is adapted to beaches, shorelines and for creating spots in fish ponds. One technique is to fasten black plastic to a Styrofoam barge (Leave it in one spot for three to four weeks). The barge can be easily moved from place to place for spot treatment. Spreading black plastic on the pond bottom and weighting it is another effective technique. Spreading plastic over the ice in winter is easy. Properly weighted, the plastic sinks to the bottom during spring thaw.

4. **Dredging and Dragging** - These can be effective in removing shallow-rooted weeds from small impoundments. Drag heavy log chains or other heavy metal objects (e.g., old bed springs) across pond bottom. Dragging rips out shallow rooted weeds which can be raked or forked to shore. Tractors or trucks are best for pulling the drag. Dredging which removes earth is expensive but sometimes warranted.

5. **Chemical** - Control of aquatic weeds and algae can be achieved with chemicals. The chemicals approved by the WDNR for use in Wisconsin waters are safe to fish when applied correctly, and the water can be used for recreational purposes a short time after application. Only specific chemicals are approved: For aquatic weed control, Diquat (dibromide), Aquathol® or endothall (saltor acid) and 2-4D. For algae control, copper sulfate and complexes of copper.

   Proper plant species identification is important because the recommended chemicals vary in effectiveness on different weeds. Only copper compounds are recommended for algae control in Wisconsin.

   Chemicals are usually available in either liquid or granular form. For large areas, uniform and effective application is made with power-spraying or broad-casting equipment. Small areas can be treated with hand sprayers or by uniform hand broadcasting of the granules.

   Application rates will vary with the type of weed and chemical used. Usually chemical application is restricted to areas less than 5 feet in depth. The application rates (pounds or gallons/surface areas) for weed species are provided on the label of the container.

   In areas where heavy weed infestation occurs, care must be taken to prevent complete depletion of dissolved oxygen which results from decomposition of the treated plants. Stay on the safe side by treating only a portion of the area at a time. Treatment is recommended early in the growing season (May-June) when plants are small. At this time the plants are in a rapid stage of growth and most susceptible to chemicals.

   Treatment should start from the shoreline (parallel) to deeper water. This allows the fish an avenue of escape. Chemicals should be applied on calm, sunny days. Done in this manner, less chemical is required and only the treatment area is affected.

6. **Biological** - Utilizing the natural predators of aquatic weeds and algae represents another method of control. Plant diseases, fish, insects or other animals which limit the growth of specific aquatic plants could provide the desired control. Unfortunately biological controls are still in the early stages of development. In most instances they still require considerable investment in time and research. The present condition of Wisconsin lakes and the public's desire to use these lakes dictates the need for using other control techniques which offer temporary relief until biological control methods can be developed.

7. **Water Fluctuation** - Raising and/or lowering water levels rapidly often has a cleansing effect upon small water impoundments. Drawdown for longer periods (especially over winter) can also be a very effective weed control technique.