LPL-532

Development of Management Strategies To Address Algae Problems

For

LAKE ROAD & BRIGHTON DRIVE CHANNELS

In The

CITY OF MENASHA

Winnebago County, Wisconsin

PRELIMINARY

May 26, 1998
McM No. 1301-97599
AJV:lml

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I. BACKGROUND

In 1997, an extremely heavy bloom of blue-green algae developed on Lake Winnebago. Large floating mats of the algae migrated into several access channels in the City of Menasha. The Brighton Drive intake for the Menasha Water Plant also became clogged with heavy algae growth. This situation occurs to different degrees on an annual basis.

The City of Menasha applied for and received a Lake Management Planning Project Grant from the Wisconsin Department of Natural Resources (DNR) to study this problem. The City of Menasha, Menasha Utilities, Menasha Marina and the Lake Road Homeowners Association, combined, contributed local matching funds to the management planning project. The purpose of this project is to develop management strategies necessary to identity appropriate lake protection or improvement projects that will prevent or reduce the re-occurrence of the algae mat problems. Viable options for addressing the problem are evaluated in detail and presented in this report.

II. DESCRIPTION OF STUDY AREA

A. General

The study area includes two separate channel systems located in the City of Menasha, at the northwest end of Lake Winnebago. The location of the study area is shown on Figure 1. The Lake Road channels are on the south side of the Menasha Fox River channel. The Brighton Drive channel is located on the north side of the Menasha channel. A brief overview of the Lake Winnebago System is provided.

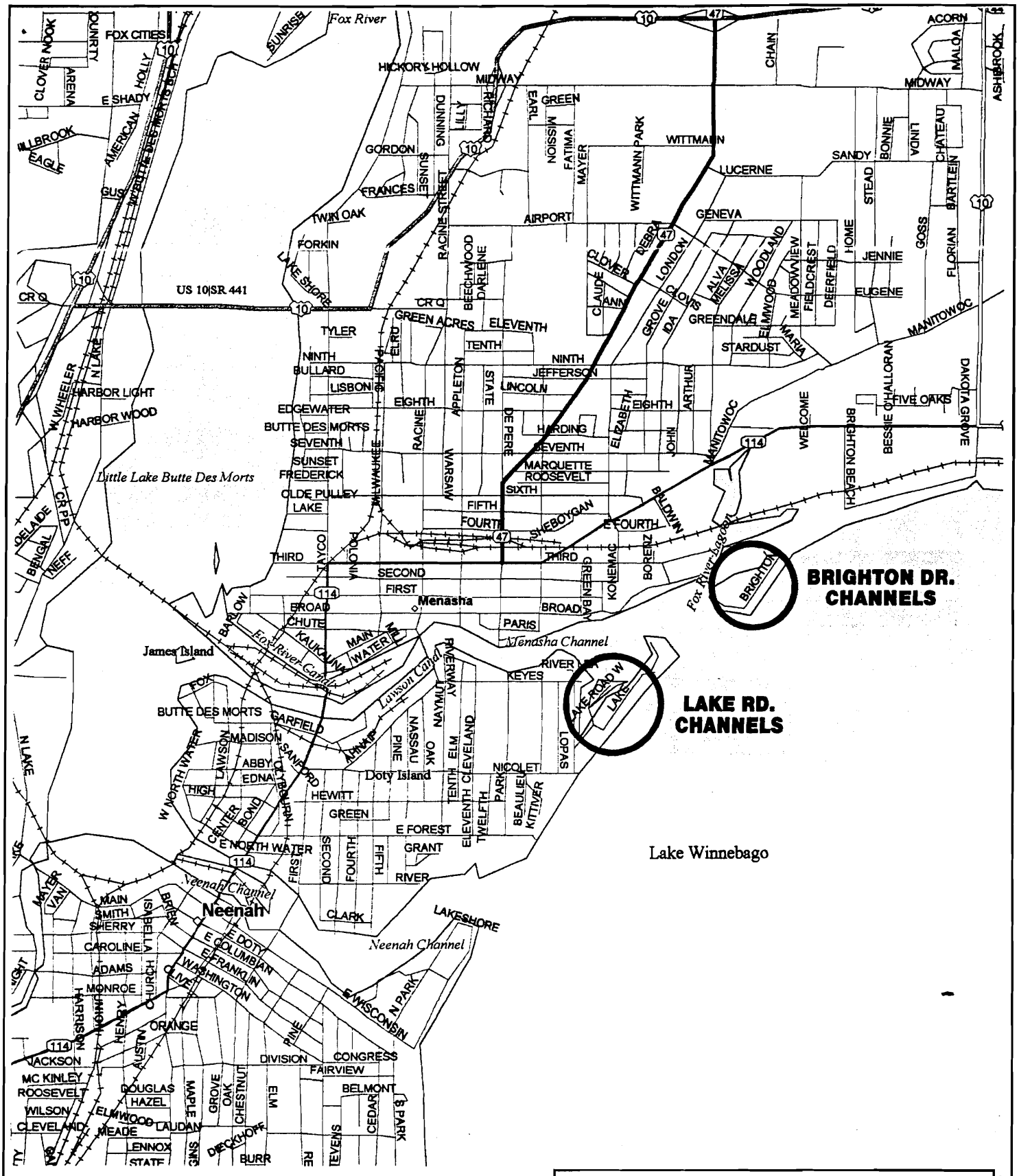

FIGURE 1

STUDY AREA

MANAGEMENT STRATEGY
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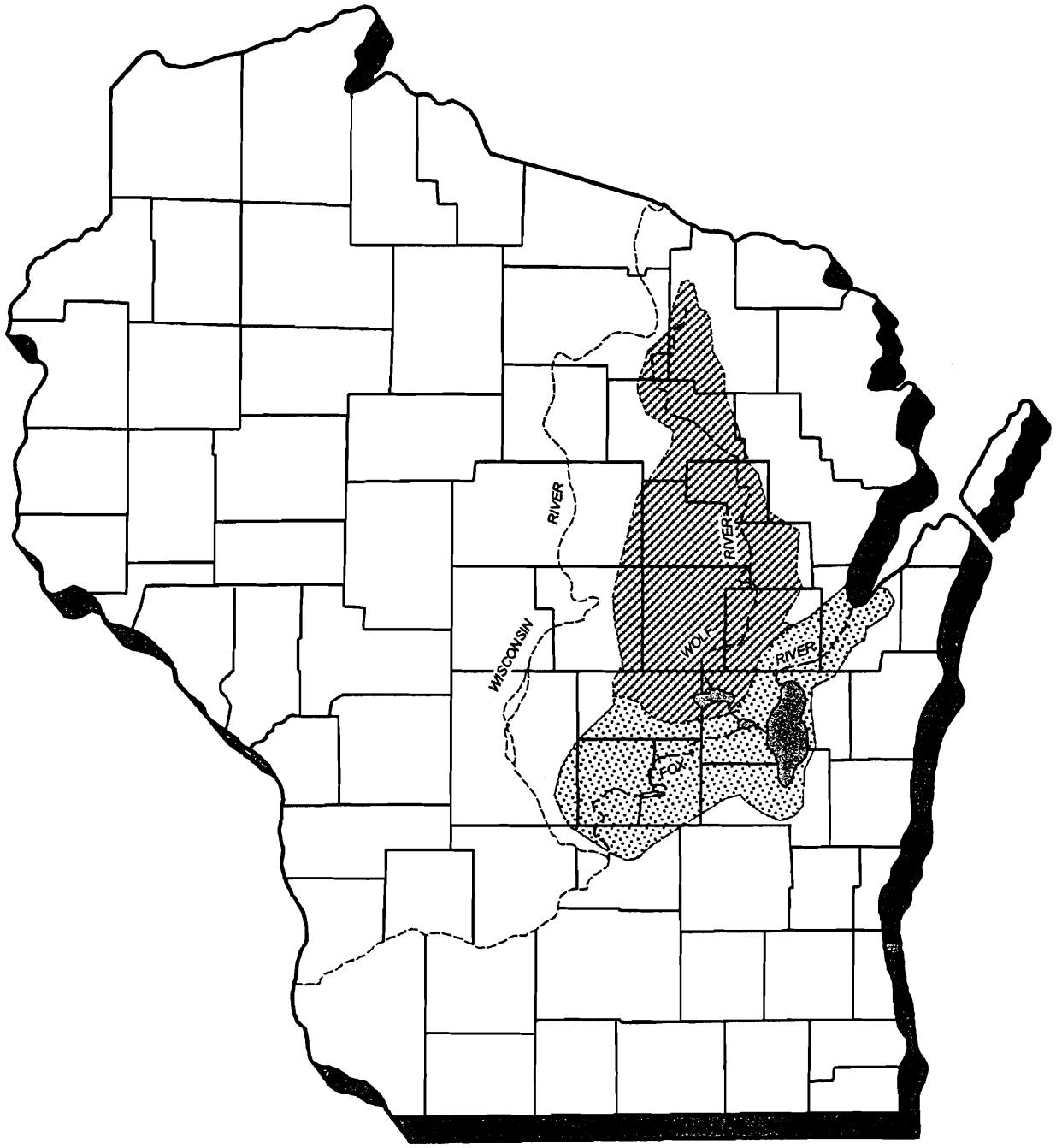
B. Lake Winnebago System

1. System Description

The following is an excerpt from the Winnebago Comprehensive Management Plan, Wisconsin Department of Natural Resources, December 1989.

"The Lake Winnebago System (Figure 2) is one of Wisconsin's most significant water resources. Composed of Lakes Winnebago, Butte des Morts, Winneconne and Poygan, plus their main tributary waters of the upper Fox and Wolf Rivers, the system comprises 17% of the state's surface water acreage. The lakes average 7-feet in depth, and receive water from 6000 square miles of watershed. These factors combine to result in a highly productive warm water system that is difficult to manage in the face of abundant conflicting uses. At 137,700 acres, Lake Winnebago is the state's largest inland lake. The system located in east central Wisconsin, is within 75 miles of over 2 million people and receives heavy recreational use by boaters, anglers, swimmers, hunters and trappers. The waters of the system are also heavily used for industrial and domestic water supply, waste assimilation and disposal, and hydropower. In addition, aquatic plants such as wild celery and sago pondweed tubers are harvested commercially, and there is an active commercial set-line fishery for catfish.

Water levels of the lakes are controlled by dams located at each of the two outlets of Lake Winnebago at Neenah and Menasha. These dams date back to the 1850's, and raised the water levels of the lakes 2.5-3.0-feet to form what is known as the Winnebago Pool. The dams were originally constructed to manage water levels for commercial navigation, as the system was an important trade and exploration route for early settlers. Based on historical accounts and records, the system once supported extensive growths of emergent and submergent rooted aquatic plants. The Upriver Lakes (Butte des Mort, Winneconne and Poygan) were described as river marshes rather than lakes, and Lake Winnebago was bordered by vast shallow bays and marshes. In the 1700's, the entire system supported lush stands of wild rice (Titus, 1930). Increases in water levels and subsequent management of the levels for navigation and commerce, water pollution, and other factors resulted in the loss of tens of thousands of acres of wetland habitat. Without the buffering effect of the shoreline marshes, shorelines have been eroded by wind, wave, and ice action.



NORTH

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FIGURE 2

LAKE WINNEBAGO SYSTEM

MANAGEMENT STRATEGY
CITY OF MENASHA, WISCONSIN

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Waters of the Winnebago System have probably always been fertile, but they are now described as highly eutrophic primarily due to poor agricultural practices in the watershed. Over time, the poor land use practices have accelerated loadings of nonpoint pollution to the system in the form of excess nutrient and sediment runoff. Approximately 1.5 million pounds of phosphorus is entering the Winnebago lakes annually. With large areas of rooted aquatic plants no longer available to trap the excess nutrients, they are channeled into nuisance algae blooms. The excess algae further shade the water and impair rooted vegetation growth. Excess sediments no longer trapped and stabilized by vegetation, fill in boating channels, cover fish spawning areas, and further cloud the water."

2. Water Level Regulation Plan

The U.S. Army Corps of Engineers is responsible for regulating the water levels of Lake Winnebago. The Linde Plan, developed by Arlyn Linde, a DNR research biologist, is used as a guide to regulate the water levels. This plan has been used since the early 1980's. The plan attempts to address the needs of the system users. Of course, the implementation of the plan is impacted by weather conditions, including amounts of rainfall and wind action. Primarily the plan is intended to provide adequate water for hydropower and navigation, while preserving or enhancing fish, wildlife, wetland habitat, and water quality in the lower Fox River and the Lake Winnebago Pool.

Water levels are regulated in response to seasonal variations. The Linde Plan recommends that levels be maintained at a constant depth during navigation season and when ice is forming or breaking up. Once a solid layer of ice has formed water levels are drawn down to provide storage capacity for spring snow melt and precipitation. After the ice cover melts in the spring the Lake is refilled in anticipation of the navigation season. During the navigation season, the water level is held as closely as possible to the target stage. During the fall, after the navigation season, the water level is drawn down gradually. (Source: Lake Winnebago Fox-Wolf River Basin, U.S. Army Corps of Engineers, December 1994.)

Environmental groups and sportsman's groups have established programs to promote development of wetland or marsh areas within the Lake Winnebago system. There has been considerable discussion regarding the lake levels established by the Linde Plan. The primary concern of these groups is that the summer lake levels are too high and do not allow wetland and aquatic plants to become established. The U.S. Army Corps

of Engineers has modified the implementation of the Linde Plan to address these concerns and it is possible that the plan may be modified further.

The characteristics of the Lake Winnebago System clearly impact the Study Area channels. Algae laden waters from the Lake enter the channels and are concentrated and become stagnant. Improved water quality in the total system would reduce the severity of algae blooms. Maintenance of the Linde Plan may reduce the flow through the channels when dam gates are kept closed to maintain high water levels. Therefore, it is not practical to focus just on the channels with regard to developing a long-term solution to the algae problem.

C. Lake Road Channels

The Lake Road area is a private residential development of approximately 30 homes. A detail map of the area is provided on Figure 3. Originally the area was primarily low land that was very wet or submerged during parts of the year. There was a higher ridge of relatively dry land directly adjacent to Lake Winnebago. Residential development of the area started in the 1920's. Prior to that time the higher lands were used as cattle pastures. The channels were dredged and the dredge material was used as fill material adjacent to the channels. Additional fill material was brought in to raise the elevation of the island area adjacent to Lake Road West. In addition to the homes on Lake Road and Lake Road West there are eight homes on Willow Lane adjacent to the west channel.

The channels run between Lake Winnebago and the Fox River. Water generally flows from the Lake to the River. However, there are times when strong winds cause water to flow from the River to the Lake. The majority of the channel is approximately 3 feet deep and ranges from approximately 40 feet wide to 200 feet wide. The channel openings at the Lake and the River are relatively narrow, which impedes flow. In the northern portions of the Lake Road development there is a shallow rock or hard pan shelf. This rock layer limits the depth of the channels.

The channels are primarily used for boating recreation by the residents. A number of residents have boat docks on the channels. Smaller boats and especially canoes and kayaks can use the channels to travel between the River and the Lake. Use of the channels allows small boats to avoid the sometimes treacherous area where the main River channel joins the Lake.

Fish life is not significant in the channels. During the spring season there may be some pan fish, catfish, and crappies in the channels. There may be some spawning activity. Bullhead and large mouth bass may be found in the channels

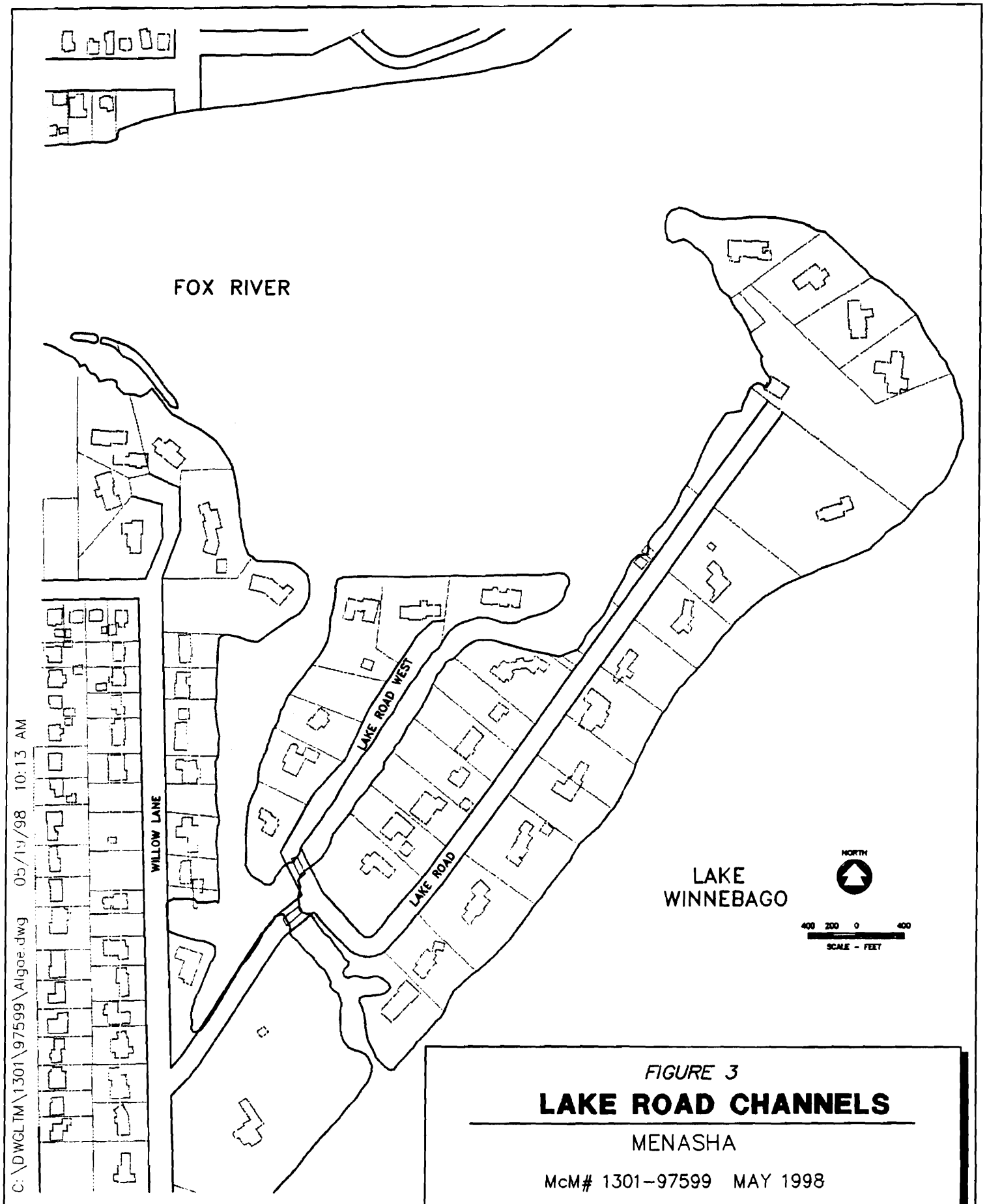

FIGURE 3

LAKE ROAD CHANNELS

MENASHA

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during other seasons. Forage fish may be found in overgrowth along the channel banks.

In general, the banks of the channels are natural. There are areas where the banks have eroded and caved into the channels. This is especially a problem along Lake Road West where the road is being undermined. In the fall of 1997, the Lake Road residents made an effort to remove fallen trees and overgrowth from the channels. There were plans to have additional trees removed during the winter, however, mild weather and poor ice conditions did not allow access to the banks from the ice covered channels. Residents also plan to protect the bank from erosion by developing rip rap walls. This work could not be completed during the winter of 1997/98 due to mild weather conditions.

Surface water drainage from the yard areas adjacent to the channels drains to the channels. Only one catch basin discharges to the channels. This catch basin is located on Willow Lane near the south end of the channels. Only a small street area drains to this catch basin. Therefore, large quantities of storm water runoff are not directed to the channels.

The south end of the channels become stagnant. There is no natural flow into this area. This is where the worst algae conditions occur. At the north end of Lake Road West the channel turns and bends around a section of land. This also impedes flow through the channel. Therefore, there are a number of permanent features within the channels that impeded flow through the channels. These include:

- Minimum gradient
- Relatively small openings at Lake and River
- Southern area with no natural flow
- Bend at north end of east channel

There are other forces related to the Lake and River characteristics that also impact the flow through the channel. These larger basin-wide issues will be addressed in a later section of this report.

D. Brighton Drive Channels

Brighton Drive is a public street with approximately 40 homes. The area was originally owned by a single family. The channel was probably originally a slough area which was dredged to allow boat access. The dredge material was built up on the northwest bank of the channel. At one time there was an opening to the Lake from the channel at the north end of the channel. This opening was

filled in and a residential lot was formed. The channel is used for boating recreation by the residents.

The Menasha Utilities Water Plant raw water intake is located at the north end of this channel. Pretreatment lagoons were constructed north of the Brighton Road channel in the 1950's. Approximately 4 million gallons per day (gpd) is drawn through the channels into the lagoons. Therefore, the only flow through this channel is induced by the flow into the water treatment plant. Chemical treatment is provided to kill the algae and control the taste and odor of the water. The lagoons are baffled to increase the detention time and to allow solids to settle. The area where the lagoons were constructed was also originally part of the slough. The area was dredged to create the lagoons.

Menasha Utilities plans to abandon this raw water intake in the near future. The lagoon system will still be utilized, but raw water will be taken directly from the Lake. The Utility is currently evaluating new intake options and a final decision has not been made. It is likely that either a separate intake line will be extended from the north end of the lagoons out into the Lake or Menasha will utilize the existing Appleton raw water intake which is located at the end of Oneida Street.

Once the Utility is no longer drawing water through the channel the characteristics of the channel will change significantly. The channel will become a dead end water body with no mechanism for flow in the channel.

III. CAUSE OF SEVERE ALGAE BLOOMS IN CHANNELS

A. Algae Development

Lake Winnebago is a very euthrophic lake with high nutrient levels. Phosphorus concentrations are normally 150 micrograms per liter (ug/l). Algae is a primitive plant that requires light and nutrients to develop. Phosphorus is the nutrient controlling algae growth in most lakes. The Lake Winnebago System experiences large algae blooms almost every year. The DNR Comprehensive Management Plan, (December, 1989) identified a phosphorus concentration of 35 ug/l as the target to reduce algae productivity.

Land use practices within the Lake Winnebago watershed contribute to the high phosphorus loads discharged to the system each year. Agricultural practices and urban development discharge excess nutrients to the surface water via surface water runoff, including snow melt. Recycling of phosphorus from lake bottom sediments was also confirmed as a major phosphorus source. Phosphorus recirculated through algae blooms and subsequent dieoffs also adds to the overall

phosphorus loading of the lake water. Poor water clarity due to suspended sediments and algae is a significant factor to limiting vegetation growth. By limiting vegetation growth, the algae is reducing the beneficial impact that may be realized from the development of wetlands that would improve water quality.

Lake Winnebago is relatively shallow. The water in the lake mixes entirely and is not stratified in layers. Because the lake is shallow the wind causes the water to constantly circulate and mix throughout the water column. Therefore, although algae concentrations would be greater close to the surface of the lake, algae is disbursed throughout the water column. Algae is phototrophic which would cause it to develop better near the water surface where the light levels are greater.

B. 1997 Algae Bloom

The conditions of the algae bloom that occurred in 1997 along the northern shores of Lake Winnebago are considered as the worse known occurrence in this area. There was a significant nutrient loading to the lake system from spring runoff and rains. When the algae bloom reached it's peak, the bloom was pushed into the study area channels by the wind. The algae accumulated in areas where there was no outlet or a minimum amount of flow. During the summer of 1997 there was a lack of water supply to the Lake Winnebago system, which reduced the flow velocities through the Lake Road channels.

The degree or level of algae problems in the channels are weather dependent and will vary depending on the weather conditions. Since there is algae present in the channels each summer, especially at the south end of the Lake Road channels where there is no outlet, it is not practical to implement a costly, complicated system to reduce the algae concentrations in the source water, especially when conditions such as those experienced in 1997 are not common.

IV. PRELIMINARY SCREENING OF MANAGEMENT STRATEGIES

A. General Approaches

The best solution to problems related to lake euthrophication is to try to prevent it from happening in the first place. Solutions to treat the products of over-fertilization of the water body must be implemented once the euthrophication process has reached the state it has in Lake Winnebago. Management strategies for addressing the algae problems in the Study Area Channels are divided into two categories: Pro-Active Strategies and Re-Active Strategies. These approaches and specific strategies are explained and evaluated in the following paragraphs.

B. Pro-Active Strategies

1. Lake Winnebago System

The main focus of pro-active strategies is to limit the fertility of the water body. Due to the fact that the water in the study area channels comes from Lake Winnebago, the fertility of the entire Lake Winnebago system would have to be reduced to improve the conditions in the channels. Programs to improve the water quality of the Lake Winnebago system may include the following:

- In-Lake Schemes
  - Dredging of bottom sediments
  - Nutrient inactivation with chemicals
  - Harvesting of fish and plants
  - Increase Flow Rates and Dilution
- Restricting Nutrient Input
  - Land-Use Regulation
  - Education

While these system-wide programs would improve water quality in the Lake Road and Brighton Drive channels, it is beyond the focus of this study to develop area wide management strategies. Therefore, Lake Winnebago system-wide management strategies will not be presented in detail in this report. However, residents of the study area should be aware of, participate in, and promote these programs. Information regarding system- wide improvement programs are presented in the Potential Management Strategies section of this report.

2. Study Area Channels

The characteristics of the two channel areas, Lake Road and Brighton Drive, are significantly different. Therefore, the management strategies will be presented separately.

a. Lake Road Channels

1) Limiting Fertility

The same strategies identified limiting fertility throughout the Lake Winnebago System will be evaluated for effectiveness within the Lake Road Channels.

a) *Dredging* - Dredging is the removal of sediments from the bottom of the channels. The sediments are a significant source of nutrients. Dredging is a relatively expensive process. When large quantities of sediment are removed they must be hauled to a disposal site. This is not only costly, but the increased truck traffic is disruptive in residential areas, and it may be difficult to find an appropriate disposal site.

Dredging of the sediments within the channels to reduce nutrients would not provide a significant improvement, because nutrient rich waters would continue to flow into the channels from the Lake. Therefore, this management strategy will not be evaluated further. Dredging to improve flow conditions in the channels will be evaluated in a later paragraph.

b) *Nutrient Inactivation with Chemicals* - Chemicals are available to control phosphorus in lakes and ponds. In Wisconsin, chemical use permits must be obtained from the Department of Natural Resources (DNR) for all chemical applications. Phosphorous control chemicals would not be effective for the Lake Road Channels, because the water flow would simply carry the chemicals out of the channels. The DNR has indicated that a chemical application permit would not be approved for the Lake Road Channels because chemical treatment would not be effective. Use of chemicals to control or inactivate phosphorus will not be evaluated further.

c) *Harvesting of Fish and Plants* - Harvesting of fish and plants removes some nutrients. Harvesting of rough fish, such as sheep head, may also reduce turbidity. This strategy does not remove sufficient amounts of nutrients to be effective. It would especially not be effective for a small area such as the Lake Road channels, because more fish and plants would move in from the Lake.

d) *Increase Flow Rates and Dilution* - Increasing the flow rate through the channels would decrease the concentration of algae in the channels by introducing larger volumes of water having a lower algae count. Increasing the flows would also reduce the potential for the area to become stagnant and for the algae to form thick mats. Methods for increasing flow rates will be considered in detail in the Potential Management Strategies section of this report.

Dilution, by adding low-nutrient water, is also a method of lake restoration. Using Lake Winnebago water for dilution water may provide limited improvement. This is because the Lake water is high in nutrients throughout the depth of the water column.

e) *Other Measures* - Other measures for reducing or limiting fertility of lakes continue to be evaluated. Plastic sheeting and sand blankets have been used successfully to seal off nutrient rich bottom sediments. Research is currently being done on the effects of straw bales placed in the water body. Apparently the rotting straw produces a chemical that stops algae growth. However, this could promote eutrophication because of organic loading to the lake. Information on this method is provided in Appendix A. This information is provided to demonstrate that improvement methods are always being investigated. Investigations should continue to stay inform of possible solutions.

Due to the continuous influence of the Lake on the Lake Road Channels it is not likely that these other measures would have significant impact on the growth of algae in the channels. Therefore, these measures will not be evaluated further. However, it is important to continue to follow the development of other measures which may address the algae problem in the Lake Road Channels.

2) Restricting Nutrient Input

Nutrients carried by surface water drainage to the Lake are the major source of phosphorus in the Lake Winnebago System. Restricting nutrient input just in the Lake Road Channels would probably not provide significant water quality improvement. However, residents should take steps to reduce the amount of pollutants from entering the channels and Lake. This would include minimizing the use of lawn fertilizers that may run off into the lake, not dumping anything into the water, including grass clippings and yard waste, maintaining healthy ground vegetation to reduce erosion, protecting channel banks from erosion. Residents must also take proper measures to not pollute the Lake when they are boating on the water. These are the types of practices that need to be implemented through out the entire Lake Winnebago System, not just within the study area.

b. Brighton Drive Channel

The characteristics of the Brighton Drive channel are significantly different from the Lake Road channels. The Brighton Drive channel is a dead end channel that opens into the Fox River. Currently, Menasha Utilities draws water through the channel into the pretreatment lagoons for the City's water supply. This operation will be abandoned in the near future, possibly as early as the summer of 2000. When that operation is abandoned, there will be no natural flow through this channel. The same management strategies presented for the Lake Road channels will be evaluated for the Brighton Drive channel. The strategies will be evaluated under the condition where the Utility has stopped using the channel as the raw water intake for the City of Menasha water supply, although the Utility will maintain a system that would allow for water intake through the channel for emergency conditions.

1) Limiting Fertility

Although Lake water does not flow freely through the Brighton Drive channel, the water in the channel comes from the Lake. Therefore, management strategies applied only in the channel that do not limit the fertility of the Lake water would not have a significant impact on fertility in the channel. These strategies include dredging, harvesting of

fish and plants, and other measures such as covering or sealing the bottom sediments. These strategies will not be evaluated further for the Brighton Drive channel.

a) *Nutrient Inactivation with Chemicals* - As described previously chemicals can be utilized to control phosphorus in surface waters. Metal salts inactivate phosphorus by precipitating it as a metal phosphate. The reactions occur at the pH values normally found in surface waters and are dependent on water temperature and alkalinity as well as metal salt concentration. The predominant chemicals used are aluminum sulfate, polyaluminum chloride (PACI), ferric chloride and sulfate and ferrous chloride and sulfate. Calcium chloride and lime are also used to lesser degrees.

Chemical treatment may provide short-term relief, but the risks may outweigh the benefits. Chemical treatments are not recommended by the DNR or biologists except in cases where public health may be impacted. Chemicals can accumulate in the bottom sediments and adversely impact the fish and aquatic life. Weather conditions can impact the effectiveness of chemical treatments. Rain, wind or changes in temperatures can dissipate the chemicals. Another issue to consider is that the Menasha Utilities will continue to utilize the channel as an emergency public drinking water supply. Therefore, the impact of any chemical treatment would have to be thoroughly evaluated.

This management strategy will not be considered in further detail.

b) *Increase Flow Rates and Dilution* - Increasing flow rates through the channel would keep the nutrient rich waters moving through the channel rather than allowing the water to become stagnate. Methods for increasing flow rates and dilution will be evaluated further in the Potential Management Strategies section of this report.

C. Re-Active Strategies

Re-active management strategies are actions taken to treat the products of over-fertilization of the Lake. In this case the significant nuisance product is blue-green algae. Because the focus of this study is the specific Menasha channels, re-active strategies for the Lake Winnebago System will not be evaluated.

1. Lake Road Channels

a. Aeration

Aeration systems could be utilized to prevent severe build-up or matting of the algae, to induce flow in the channels and to keep algae mats from collecting in the dead end pool area at the south end of the channels. There are a wide variety of systems that can be utilized ranging from floating, portable aerators to permanent piping systems.

An aeration system was installed in the Menasha Marina in the fall of 1997. This system consists of pipes placed along the Marina walls approximately 2 to 3 feet below the water surface. Air is forced into the water through the pipes. The intent is to cause mixing in the water column, to reduce the potential for mats of algae to form, and to induce some current in the Marina to move algae out of the Marina. The effectiveness of this system should be evaluated and may be effective for the Lake Road Channels.

Aeration may be a viable system for eliminating or reducing the severe matting of algae. Aeration systems must be placed in operation before the algae builds up. Depending on the complexity and scope of the system, aeration systems can be relatively inexpensive. A proposal to use portable aerators to form a barrier at the channel openings and to induce flow through the channels will be presented in the potential management strategies section.

b. Harvesting or Other Algae Removal Strategies

Mechanical harvesting of weeds has been utilized effectively to remove plant growth from water bodies. Methods for harvesting algae have not been effective, however. Companies involved in the wastewater industry have investigated the development of a system to harvest algae. The primary drawback is that as soon as the algae is removed, it comes back. By harvesting the algae,

conditions are improved to promote more growth. Handling and disposal of harvested plants, which are primarily water, is also a major problem with mechanical harvesting.

A system to move the algae out of the channels may be effective. A pumping system to suck up the algae and pump it out to the Fox River would remove the algae mats from the channels. This type of system would require developing a system to direct the algae to be pumped towards the pumps. A piping system would then be laid from the pumping station to the Fox River. Pumping may be required at several locations in the channel, depending on the build up of the algae. Certainly pumping would be required in the dead end pool area at the south end of the channels. This option will be evaluated further in the Potential Management Strategies section of this report.

Pumping the algae to the sanitary sewer, could cause problems with the operation of the sewer system and the wastewater treatment plant operation. This option should only be considered in the event of severe public health nuisance.

A pontoon boat equipped with a blade or plow could be used to push the algae out of the channel. This option will be presented in detail in the Potential Management Strategies section of this report.

In 1997, during the severe algae bloom, fire hoses were used to flush out the channels. Apparently, this operation was not very efficient or effective. The Menasha City Council has indicated they would not support a channel flushing program. Therefore, this option will not be evaluated in further detail.

c. Physical Controls

Physicals controls are barrier systems that are intended to keep the algae out of the channels. Physical systems include baffles or actually closing off the Lake Road channels at the Lake opening.

During the severe bloom in 1997, baffles in the form of logs were placed at the Lake Road bridge. This system was effective in keeping the algae mats out of the lower section of the channels. These logs do restrict boating on the channels, however. This type

of simple system will be analyzed further in the Potential Management Strategies section of this report.

1) Baffling System

A baffling system could be constructed at the Lake side opening to the channels. Floating baffles (or booms) that do not extend down into the water very deep would only be effective in keeping surface algae and mats out of the channels. As previously described, algae is found throughout the water column in the Lake. Baffles could be extended deeper into the water in an attempt to keep significant quantities of algae out to the channel. Nutrient rich or algae laden waters can easily circumvent baffle systems during high winds and or storms. For baffles to be effective it is likely that baffles would also be required at the River side of the channels. A baffle system would also restrict navigation through the channels. Complex baffle systems will not be evaluated further, because the effectiveness of the systems can easily be lost due to collapse of the system.

2) Block off Channels

Other physical controls would consist of blocking off the channels at the Lake opening or completely filling in the channels. Blocking off the channel at the Lake opening may eliminate the thick mats from entering the channels, but algae laden water would still enter the channels from the River opening. It is not likely that the DNR would approve permanent blockage of a navigable waterway. Also the Lake Road residents have expended considerable funds and efforts to open up the Lake side opening. The impact of these improvements should be evaluated before consideration is given to blocking off the channel. This option will not be evaluated in further detail.

Filling in the channels would certainly eliminate the problem, but would not be an acceptable solution, both to the homeowner or the DNR. This option will, therefore, not be considered in further detail.

d. Chemical Controls

Algaecides are chemicals used to kill algae. Use of chemicals only serves as a short-term solution. Information regarding chemical applications is provided in Appendix B. Mr. Bradley A. Johnson, DNR - Aquatic Biologist, toured the Lake Road channels. He commented that he would not recommend approval of a chemical treatment permit for the Lake Road channels because the treatment may not be effective. The chemical treatment would be flushed out of the channels with the current. The effectiveness of chemical treatment was also discussed with other biologists at the University of Wisconsin - Oshkosh and University of Wisconsin - Green Bay. They agree that chemical treatment would not be effective. Therefore, chemical treatment will not be evaluated in further detail.

e. Biological Controls

Biological controls are systems that would reduce the algae content of the water by planting fish or other animal species that would consume the algae. The introduction of plant species that alter the conditions in the channels so that it is not conducive to algae development is also a biological control system. Due to the fact that the Lake Road channels are not an isolated system, biological controls would have limited impact on the algae problem. Therefore, these systems will not be analyzed in further detail.

2. Brighton Drive Channel

The operation of the Brighton Drive channel will change significantly when the channel is not used as the raw water intake for the City of Menasha drinking water supply system. The channel will become a dead end channel unless an opening is created out to the Lake at the north end of the channel. Re-active strategies that may be effective for the Brighton Drive channel are presented in the following paragraphs.

a. Aeration

Aeration within the channel would probably not be effective because it would simply provide mixing of the water column. A very large aeration system would be required to move algae out of the channel. A line of aerators across the opening of the channel at the River may help keep the algae mats out of the channel. This

option, which is actually a proposal to form a barrier, not aerate the water, will be presented in detail in the Potential Management Strategies section of this report.

b. Harvesting or Other Algae Removal Strategies

The options presented in the Lake Road discussion, which were determined to have potential benefit, will be presented in detail in the Potential Management Strategies section:

- Use pontoon boat with plow to push algae out of channel
- Develop pumping system for pumping algae out of channel

c. Chemical Systems

Although chemical systems could be more effective in the Brighton Drive channel because there would be no flow through the channel, this option will not be considered further. Based on conversations with DNR staff and biology professors, chemical treatment would not provide significant benefit. There is also the concern that the chemicals would accumulate in the sediments and adversely impact water quality. This may impact fish and other aquatic wildlife. There is also the potential that water may be taken out of the channel for public drinking water in case of emergency. Therefore, chemical systems will not be evaluated in detail.

d. Biological Systems

Even through there may be no direct flow through the Brighton Drive channel, there would be a direct influence from the River on any biological system in the channel. Therefore, this option will not be considered further.

V. POTENTIAL MANAGEMENT STRATEGIES

A. General

The following strategies will be presented in detail, including projected costs where appropriate, in the following paragraphs:

- Pro-Active Strategies:

- Promote Lake Winnebago System water quality improvement programs.
- Increase flow rate through channels.

- Re-Active Strategies:
  - Aeration.
  - System of booms to keep algae out of channels.
  - Move algae out of channels using:
    - Pontoon boat with plow
    - Algae pumping removal system

These potential strategies may provide the greatest benefit if utilized in combination. Certainly every effort should be made to improve the overall water quality of the Lake Winnebago System. A combination of algae removal systems may be needed depending on the location of the algae bloom and the severity.

Funding sources for potential strategies have not been identified in detail in this report. The company that installed the aeration system in the Menasha Marina in the fall of 1997, intends to use the operation as a demonstration project. Therefore, the cost to install that system was very reasonable. There may be opportunities for similar cost sharing projects for the channel improvement projects. Once a management strategy has been selected interested firms should be contacted.

Funding is available from the DNR for lake improvement projects through the Lake Management Program. Information regarding the Lake Management Grant Program is provided in Appendix C. This program provides cost sharing assistance for eligible lake protection and restoration projects which benefit the quality of water in lakes.

The City of Menasha and study area residents should investigate the possibility of obtaining funding for the management strategies identified in this report. The contact person for this program is Mark Sessing, DNR – Horicon, (920) 387-7860.

The Lake Road area is a private development. Both of the channel systems are used by a relatively small number of City residents. Therefore, the City may not be able to contribute significant funds to improvement projects. Especially in the Lake Road area, projects may have to be funded by the residents.

B. Proactive Strategies

1. Improvement of Water Quality of Lake Winnebago System

Residents of the channel areas should promote programs that improve the water quality of the Lake Winnebago System. This would include lobbying State Legislators and County and City elected officials to support and fund lake system improvement programs and projects. Water quality improvement programs will encompass a large area and require significant funding. The City of Menasha and the Lake Road residents were successful in attracting public attention during the severe algae bloom in 1997. That same process must be maintained and used to focus broader attention on the water quality of the Lake Winnebago System. Studies indicate that the water in Lake Winnebago turns over in 210 days, therefore, there is good potential that when the water quality improves, the benefits would be realized in a relatively short amount of time.

The Wisconsin Department of Natural Resources expends a considerable amount of resources on the protection of the Lake Winnebago System. Current and future DNR programs are described in a letter from DNR Secretary George E. Meyer to local state legislators. A copy of the letter is provided in Appendix D. DNR programs aimed at improving water quality include the Priority Watershed Program and implementation of the steps identified in the Lake Winnebago Comprehensive Management Plan, dated 1989.

The Priority Watershed Program identifies significant sources of non-point pollution. Funding, on a cost sharing basis, is available for property owners to implement pollution reduction systems. The Lake Winnebago Comprehensive Management Plan identified goals and action steps in three areas - Water Quality, Habitat Restoration and Public Education. Approximately 70% of the action steps identified in the Plan have been implemented. Art Techlow, Winnebago System Biologist, Oshkosh, 920-424-3001, is the primary DNR contact for the Lake Winnebago System.

Winnebago County is working to develop and implement a water quality improvement plan. The issues to be addressed include:

- Pollution abatement and preventative practices
- Shoreline and stream bank protection
- Methods to keep soil on land and nutrients out of surface waters
- Focus on the source of the problem

The plan initially recommended that the County establish a revolving loan program to fund projects primarily in rural agricultural areas that would improve water quality. Peter Van Airsdale, Director, Winnebago County Land and Water Conservation Department, 920-232-1951 is the person responsible for the development and implementation of the Winnebago County Water Quality Improvement Plan.

Channel area residents should encourage elected officials to promote programs that improve the water quality throughout the Lake Winnebago System.

Channel area residents should also practice good shoreline land use measures. This would include reducing the potential for shore line erosion, maintain healthy ground vegetation to reduce erosion. Remove fallen trees and brush from the channel, minimize the potential for lawn and garden fertilizers to runoff into the water, do not dispose of any lawn waste, pet waste or other trash in the water. Residents should also take care when boating on the Lake to not add to the pollution problem.

There are a number of local non-profit organizations that promote programs that will improve water quality. Again, channel area residents should promote and participate these organizations. Two primary organizations are Fox-Wolf Basin 2000 and the Lake Winnebago Citizens Alliance. The Mission Statement of Fox-Wolf Basin 2000 is as follows:

> "Fox-Wolf Basin 2000 is a broadly based, independent, not-for-profit organization dedicated to ensuring cost-effective public policy and private action to achieve and maintain high-quality surface waters in Wisconsin's Fox-Wolf River Basin."

A copy of the 1998 Work Plan Summary is provided in Appendix E. Additional information may be obtained from Bruce Johnson, Executive Director, P.O. Box 1861, Appleton, WI 54913, 920-738-7025.

The goal of the Lake Winnebago Citizens Alliance is to educate the public about Lake Winnebago water quality issues. The Alliance prepares a newsletter that is mailed to all lake shore residents. Additional information may be obtained from Lee Macrander, W5517 Fire Lane 12, Menasha, WI 54952, 920-749-1442.

2. Increase Flow Rate Through Channels

Residents of Lake Road have already taken steps to increase the flow rate through the channels. In the fall of 1997 the opening at the Lake was cleared out and dredged to a depth of approximately 6 feet. That opening had become restricted to a width of approximately 10 feet. The opening is now approximately 30 feet wide. Riprap was placed along the channel banks for a length of approximately 75 feet. Residents also cleared fallen trees and debris from the channel. There are plans to remove additional fallen trees and debris when conditions permit. Property owners have also been encouraged to install riprap along the channel banks. This is being done primarily to reduce erosion, but should also improve flow through the channel. The cost to construct riprap walls ranges from $40 to $60 per foot. The cost to line the channels with rip rap, including a 10% contingency, is summarized below:

Lake Road - $280,000 to $420,000
Brighton Drive - $170,000 to $250,000

In areas where the channel bank is severely eroded, property owners should be encouraged to install rip rap or take other steps to reduce erosion. Shoreline plantings may be used to control bank erosion, if it is not severe. Water iris plants work well in shady conditions.

A pumping system could be installed to take water from the Lake to induce flow through the channels. Such a system would be very expensive to install and would require regular maintenance. This type of system would consist of the construction of a flushing pump system, including a small structure to house the pumps and 2-50,000 gpm pumps. Jet aspirating aerators could also be provided to deliver oxygen and to provide greater movement of the water.

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The projected capital cost for this type of system for the Lake Road channels is as follows:

Item	*Projected Cost*
Flushing Pump System	
Structure	$100,000
Pumps (2 @ 50,000 gpm ea.)	150,000
Piping	50,000
Electrical	75,000
Jet Aspirating Aerators	
Equipment	$600,000
Piping and Valves	100,000
Installation	100,000
Subtotal	$1,175,000
Engineering & Contingencies – 25%	300,000
TOTAL PROJECTED COST	**$1,475,000**

It is obvious that this type of system is cost prohibitive. Even if just the pumping system was installed the cost would be approximately $475,000. Therefore, this type of system could not be justified.

a. Brighton Drive Channel

It may be necessary to provide flow through the Brighton Drive channel by installing a culvert at the north end of the channel. An easement would have to be acquired by the City to install and maintain the culvert. If a culvert is installed it is recommended that a slide gate be installed. The gate could be closed during times when it would be beneficial to keep algae laden Lake water out of the channel. The gate could also be closed when the wind would push the algae into the channel.

The cost for the installation of approximately 250 feet of 36-inch CMP culvert and a slide gate is projected to be $25,000. This does not include any legal fees or easement acquisition costs.

b. Lake Winnebago Water Level Management

As previously described, the water level of Lake Winnebago is controlled by two dams on the Fox River downstream of the channel area. The water level management system attempts to

keep water levels constant during the summer. A certain amount of water must flow through the system to maintain power generation systems downstream. In 1997, the flows through the lake system were maintained at a relatively low rate. This may have caused the flow rate to be reduced through the Lake Road channels. The management of the water levels is dependent on rain fall and weather conditions and must meet the needs of a diverse group of system users. Therefore, the Army Corps of Engineers may not be able to improve specific conditions, but they should be made aware of the impact of water levels and flow rates on the algae build up in the channels.

C. Re-Active Strategies

Implementation of the potential pro-active strategies for addressing the algae problem in Lake Winnebago will take many years and requires the cooperation of a widely diverse group. Therefore, it may be many years before the nutrient content of the Lake is reduced enough to decrease the severity of algae blooms. The study area channels are well suited for the concentration of algae blooms. Therefore, even if significant water quality improvements are realized, algae blooms may still occur in the channels. Therefore, the residents of the channel areas should be prepared to implement re-active strategies to reduce the severity of the blooms. Depending on the location and the severity of the bloom it may be necessary to implement a combination of strategies.

1. Algae Monitoring Program

It is recommended that the residents of the channel area implement a voluntary program to monitor the development of algae in the Lake each year. Then as the concentration of algae increases, strategies can be implemented to reduce the potential for algae build up in the channels.

The monitoring program could be as simple as taking note of the clarity of the Lake water as residents boat on the water. A secchi disc could be used to measure water clarity and to observe the algae development in the water. A more sophisticated program would require taking water samples and conducting laboratory analysis, including algae counts of the water samples. The important thing is that changes be noted and steps taken before problems become severe.

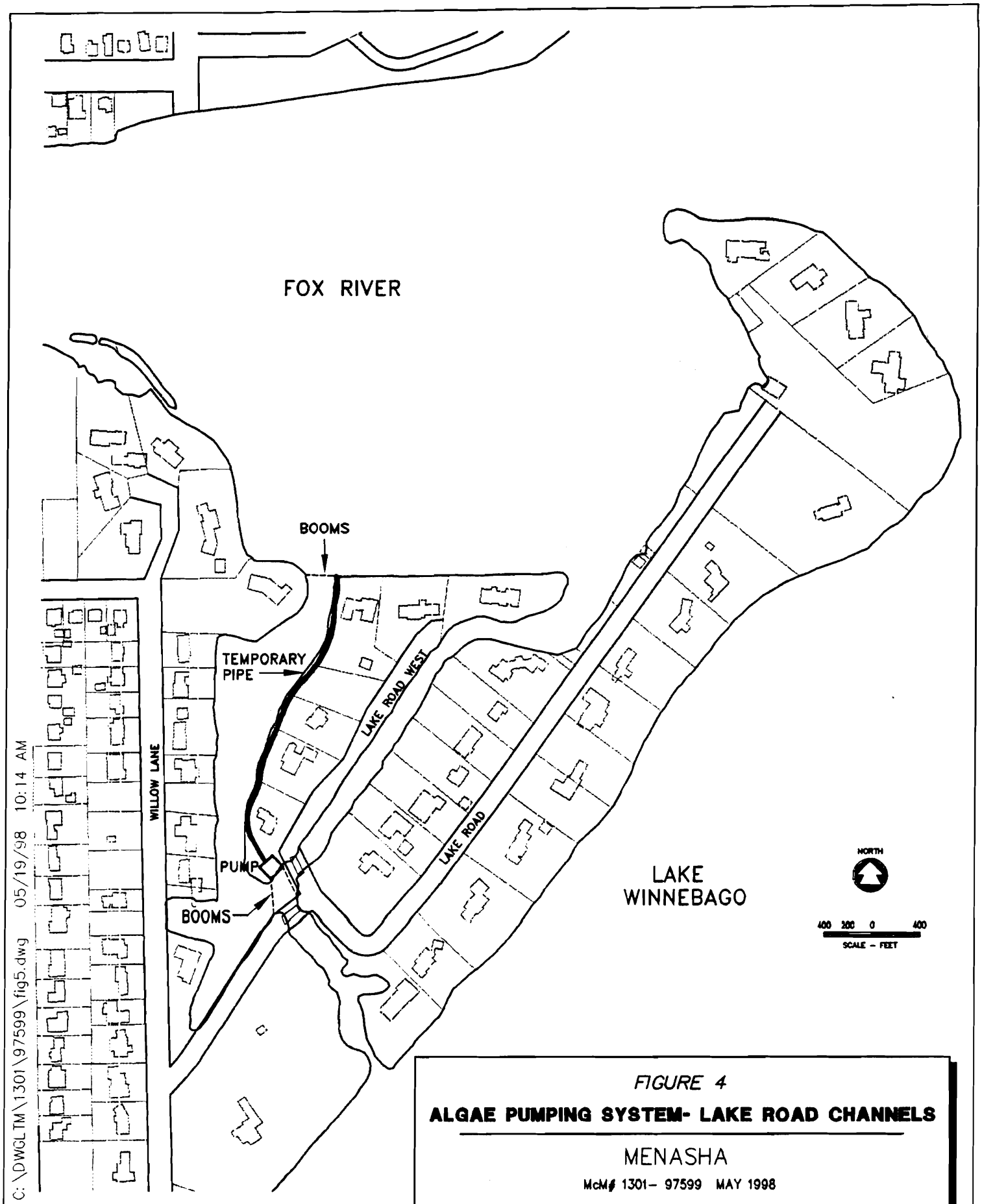

FIGURE 4

ALGAE PUMPING SYSTEM- LAKE ROAD CHANNELS

MENASHA

McM# 1301- 97599 MAY 1998

2. Aeration Systems to Form Barriers or to Induce Flow

If aerators are used before thick algae mats developed they may help reduce the potential for severe problems. Care must be taken to watch that aerators do not stir up nutrient rich sediments in shallow areas. Aerators may be most effective if used to form a barrier to keep algae laden waters either out of the channels or out of stagnant areas, such as the south end of the Lake Road channels. Aerators could either be placed in a line across the Lake side opening of the Lake Road channels or in a line across the wide area at the south end of the Lake Road channels. Aerators may also form an effective barrier if placed along the River opening of the Brighton Drive channel. The installation of an aeration system may impede navigation. However, the aerators would only be placed across the channel opening when needed, not for an extended period of time.

The City has eleven aerators that would be available to the residents. The aerators are manufactured by Aire-O_2, 2 Hp, 115/208-230 volts, 23/12-11.5 amps. The cost of new aerators is approximately $750. There would be labor costs associated with installing the aerators and checking them daily to ensure that they are placed properly and operating properly. There would also be operational costs for electricity to run the aerators and capital costs to install an electrical system for the aerators. In 1997, extension cords were used from the sewer lift station to power the aerators. An additional electrical service would be required near the lake opening to power those aerators. The projected cost is $10,000 to install two permanent electrical services and to hook up the aerators at the Lake Road channels. One service would be at the lake opening and the second service would be near the bridges. The electrical power costs for a 2 Hp aerator are approximately $2.10 for 24 hours of operation.

To form a barrier across the channel openings with the aerators, it is recommended that four aerators be placed at the lake side opening of the Lake Road Channels and six aerators at the south end of the channels. This system of ten aerators would only be used on an as-needed basis, at an electrical cost of approximately $21 per day.

Four aerators could be used at the river opening of the Brighton Drive channels. The electrical cost would be approximately $8.40 per day. An electrical service would be needed at the river opening to the channel. The cost to extend electrical service and hook up the aerators would be approximately $6,000.

If the aeration system installed in the Menasha Marina in the fall of 1997 is found to be effective, a similar process could be installed in the Lake Road and Brighton Drive channels. The supplier of the Marina system suggested a system that would include placement of an aeration pipe across the channel openings. The pipe would be placed under water and would form a barrier of air to keep the algae out of the channels.

Additional aeration systems could be installed along the length of the Lake Road channels to encourage flow. This process is basically the same as the system suggested for the portable arerators. This system would be more complex, requiring pumps, air injectors, piping and power systems.

It is recommended that the City monitor the effectiveness of the Marina system, including operation and maintenance requirements before considering this system for the channel areas.

3. Boom Systems

The simple boom system used in the Lake Road channel last year was effective in keeping algae mats out of the channels. Large logs were chained together and placed in the channel at the Lake Road bridge. This system could be used again when conditions are right for algae mats to float into the channels.

Algae mats may also be kept out of the Lake Road and Brighton Drive channels by placing floating booms across the openings of the channels. This would only be done when conditions warrant. Algae would still enter the channels by flowing under the booms, but the amount of matting may be reduced. Navigation on the channels would be impeded, but again it would only be when the booms are needed to prevent algae mats from entering the channels. The booms would have to be inspected periodically to ensure that they remain in place and are effective.

The approximate cost for booms is $20 per foot. For the Lake Road channel, booms would be required at the lake opening and both river openings. Approximately 340-feet of booms would be required. The projected cost, including anchoring hardware is $7,000. A boom approximately 120-feet would be required to block the river opening of the Brighton Drive channel. The cost would be approximately $2,500.

4. Algae Removal

a. Algae Pumping System

In 1997, the Menasha Utilities used a temporary pumping system to pump the algae mats out of the Brighton Drive channel. The efficiency of this system could be improved with the addition of a structure or a series of booms to direct the algae mat towards a more effective pumping system. The structure should be placed in the channel current to assist in the collecting of algae. The capital cost of this type of system for the Lake Road channels would be approximately $30,000. This would include booms around the pump and at the River opening, so that the algae doesn't drift back into the channel. Approximately 900 feet of pipe would be placed on the ground along the east edge of the west channel as illustrated on Figure 4.

It would be necessary to observe the operation of the pump and the discharge of the algae into the River when this system was in operation. This system would certainly impede navigation through the channels when the system was in operation. There may also be some concerns about discharging the algae into the River. It is recommended that this system only be considered in the event of a severe algae bloom.

The Menasha Utilities maintains a temporary pumping system which is used to pump algae mats out of the Brighton Drive channel. They may allow the City to continue to use that system after a new water supply intake is developed. However, there will be no current through the channel to carry the algae to the pump. Therefore, it may be necessary to direct the algae to the pump with boats and/or booms.

b. Push Algae Mats Out of Channels

A scoop, similar to a snow plow, could be placed on the front of a pontoon boat and used to push algae mats out of the channel. The operation of the pontoon boat motor must be monitored to ensure that it does not become clogged with algae and over heat. The algae must be pushed far enough out into the River, such that it does not drift back into the channels.

The cost of this operation would include the purchase of a pontoon boat. A used pontoon boat would cost approximately $2,000 and a new boat would be approximately $12,000. A lightweight stainless steel scoop would cost approximately $2,000. The labor cost and fuel cost to operate the boat must also be considered. This boat could be used in both the Lake Road and Brighton Drive channels. The effectiveness of such a system would need to be given further investigation.

VI. CONCLUSIONS & RECOMMENDATIONS

The Lake Road and Brighton Drive channels have often experienced problems with algae blooms. The problem was much worse than normal in 1997. This was primarily due to a combination of weather conditions that caused algae mats and nutrient rich waters to be forced into the channels. The amount of flow through the channels was minimal, causing the algae to stagnate and die in the channels. The channels became clogged and impassible.

The algae problem that has developed on Lake Winnebago and which directly impacts the channels has increased over a long period of time. The factors which cause the problem can not be eliminated in a short period of time. The primary source of nutrients to the surface waters are non-point sources of pollution from surface water runoff from agricultural and urban land use. Far reaching programs are needed to properly manage the land use in the Lake Winnebago water shed. These programs are beyond the scope of this study or the ability of one community to address or implement. However, it is recommended that residents of the channel areas promote and support programs that are directed at improving the water quality of Lake Winnebago.

There are a number of strategies that can be implemented to reduce the potential of severe algae problems in the channels. There are also measures that can be taken to move the algae out of the channels when severe matting occurs. Viable strategies evaluated in this report are summarized on Table 1. Cost projections are also provided.

Funding sources for the viable strategies need to be investigated. Funding sources may include cost sharing assistance for eligible projects from the Department of Natural Resources Lake Management Grant Program. Detailed information about this program is included in Appendix C.

It is recommended that a combination of measures be used to reduce algae problems in the channels areas. This includes promotion of watershed-wide water quality improvement programs. Organizations involved in improvement programs are listed in Appendix F. Development of a volunteering monitoring program to evaluate when algae

blooms may occur. Use of boom system to keep algae mats out of channels. Use of floating aerators to keep algae mats out of the channels and to keep algae mats out of low flow areas of the channels. Use of a pontoon boat with a scoop to move the algae out of the channels. Other strategies presented in this report could be implemented when the recommended efforts are not sufficient to control the algae problem.

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