Chapter III

ALTERNATIVE AND RECOMMENDED LAKE WATER QUALITY MANAGEMENT MEASURES

INTRODUCTION

Based upon a review of the inventories and analyses set forth in Chapters II through VI of Volume One of this report, two major groups of issues were identified requiring consideration in the formulation of alternative and recommended lake management measures. These issue groups are related to: 1) water quantity management primarily associated with the operations of the Elizabeth Lake dam, and 2) watershed and water quality management, including aquatic plant and fisheries management elements. The management measures associated with each of these major issue groups are enumerated and evaluated in Chapters II and III of Volume Two. In this Chapter, alternative measures to manage water quality in Lake Mary and Elizabeth Lake are presented. A watershed-based approach to water quality management forms the basis for the alternatives assessed. The water quality issues addressed include: 1) land use, runoff management, and pollution control, including stormwater and wastewater management measures; 2) in-lake water quality management; 3) management of aquatic biota; and, 4) management of human water uses, including recreational use management and informational programming measures. The management measures considered herein are focused primarily on those measures which are applicable to the Twin Lakes Protection and Rehabilitation District (TLPRD) and to the Village of Twin Lakes.

LAND USE MANAGEMENT AND ZONING

A basic element of any water quality management effort for a lake is the promotion of sound land use development and management strategies in the tributary area. The type and location of future urban and rural land uses in the area tributary to the Twin Lakes will determine, to a large degree, the character, magnitude, and distribution of nonpoint sources of pollution; the location and nature of wastewater treatment facilities; the practicality of, as well as the need for, stormwater management practices; and, consequently, to some degree, the water quality of the waterbodies.

Development in the Tributary Area

Alternatives

The level of development envisioned in the regional land use plan for the area tributary to the Twin Lakes includes continuing urban development, generally on large, suburban-density lots. Careful review of applicable zoning ordinances to incorporate levels and patterns of development consistent with the plan within the tributary area is considered a viable option for the management plan. Changes in the zoning ordinances could be considered to better reflect the land use patterns recommended in the regional land use plan. One feasible option would be giving consideration to minimizing the areal extent of development by providing specific provisions and incentives to cluster residential development on smaller lots, while preserving portions of the open space on each

property or group of properties considered for development, utilizing the principles of conservation development.[1] In addition, periodic review of building codes and subdivision requirements to ensure best practices and review of development plans for consistency with applicable stormwater and wastewater management practices, as described below, are considered viable options.

Recommended Measures

It is recommended that the impact of future land use development on the Twin Lakes be minimized through review and modification of the applicable zoning ordinance regulations and zoning district maps to address the control of shoreland redevelopment, and the related intensification of use, if not specifically addressed in the existing zoning codes. Changes in zoning ordinances are recommended to minimize the areal extent of development by providing specific provisions and incentives for the clustering of residential development on smaller lots within conservation subdivisions, thus, preserving significant portions of the open space within each property or group of properties considered for development.

In addition, periodic review of county and local government ordinances by Kenosha and Walworth Counties, the Villages of Twin Lakes and Genoa City, and the Towns of Randall and Bloomfield is recommended. Such review should be undertaken to ensure consistency with current nonpoint source pollution abatement practices, including stormwater management practices. Similar reviews by McHenry County, the Villages of Richmond and Spring Grove, and the Town of Burton in Illinois are to be encouraged, especially with respect to those lands that drain to Elizabeth Lake.

Development in the Shoreland Zone

Alternatives

Existing 2000 and planned 2035 land use patterns, and existing zoning regulations in the area tributary to the Twin Lakes, have been described in Chapter II in Volume One of this report. If the recommendations set forth in the adopted regional land use plan are followed,[2] under year 2035 conditions, some additional urban residential development within the area tributary to the Twin Lakes would occur. Much of this residential development is likely to occur on agricultural lands. Infilling of existing platted lots and some backlot development, as well as the redevelopment and reconstruction of existing single-family homes and commercial structures on lakefront properties, also may be expected to occur. Recent surveillance indicates that this type of development is currently occurring. Accordingly, given the potential impact of lakeshore development on the lake resources, land use development or redevelopment proposals around the shorelines of the Twin Lakes and within the area tributary to the waterbodies should be evaluated for potential impacts on the waterbodies, as such proposals are advanced.

Recommended Measures

Maintenance of the historic low- and medium-density residential character of the shorelines of the Twin Lakes to the maximum extent practical is recommended. It is further recommended that lakefront developments, as well as setback and landscaping provisions, be carefully reviewed by the Village of Twin Lakes. Such review would address specific shoreland zoning requirements, and could consider the stormwater and urban nonpoint source pollution abatement practices proposed to be included in shoreland development activities. Provision for shoreland buffers—such as those required pursuant to the Village of Twin Lakes Ordinance No. 2005-8-1, creating Chapter 17.38 of the *Twin Lakes Code of Ordinances*, that establishes shoreline setbacks and provides for vegetated shoreline buffer strips—along with use of appropriate and environmentally friendly landscaping practices and inclusion of stormwater management measures that provide water quality benefits, are practices to be encouraged.

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[1]*See SEWRPC Planning Guide No. 7,* Rural Cluster Development Guide*, December 1996.*

[2]*SEWRPC Planning Report No. 48,* A Regional Land Use Plan for Southeastern Wisconsin: 2035*, June 2006.*

Stormwater Management on Development Sites

Alternatives

With respect to stormwater management on development sites, Kenosha County does not have specific erosion control and stormwater management ordinances, although such ordinances have been adopted by the Village of Twin Lakes. These ordinances reflect current best practices insofar as the determination of stormwater flows, mitigation of flooding potentials, and control of contaminants from land use activities are concerned. Periodic review of these ordinances and their provisions for consistency with best management practices, and to ensure their currency with the state-of-the-art, undertaken on a regular basis to facilitate control of urban-source contaminants that would likely be delivered to the Lakes, is considered a viable option. Where onsite detention/retention of stormwater is considered as a management practice, adoption of good shorescaping and shoreland management practices is considered a viable option.[3] Any such practices should conform to the requirements of the NR 151 suite of stormwater management requirements, both for pre-development and post-development conditions; the Village of Twin Lakes stormwater management ordinance should be examined for consistency with the model ordinance set forth a Chapter NR 152 of the *Wisconsin Administrative Code*.

It is recommended that Kenosha and Walworth Counties, the Towns of Randall and Bloomfield, and the Villages of Twin Lakes and Genoa City take an active role in promoting urban nonpoint source pollution abatement. Actions to promote urban nonpoint source pollution abatement would include the conduct of specific stormwater management planning within specific portions of the tributary area located within each municipality where further urban development or redevelopment is anticipated. Such a planning program should include a review of the stormwater management ordinances, to ensure that the ordinance provisions reflect state-of-the-art runoff and water quality management requirements, and to ensure that there is harmony between the ordinances governing urban-density development in each of the municipalities draining to the Twin Lakes. Adoption by all riparian municipalities of common stormwater management ordinance provisions is strongly recommended.

Recommended Measures

The Village of Twin Lakes currently holds an MS4 General Stormwater Permit issued by the Wisconsin Department of Natural Resources (WDNR)—Permit No. WI-S050075-1—in terms of which the Village undertakes an ongoing program of outreach and public involvement, discharge detection and elimination, and pollution prevention and control activities. Currently, this program is executed principally by the Village building inspector and Village engineer, in accordance with the provisions of the Village stormwater management plan.[4] Projects impacting the Twin Lakes have been, and continue to be, supported in part by the Twin Lakes Protection and Rehabilitation District (TLPRD). These projects address specific stormwater conveyances discharging to the Lakes, amongst which the management of agricultural runoff and implementation of water quality improvement practices in the vicinity of Esch Road, draining to Elizabeth Lake, is a recent example. Periodic review of this plan and its accomplishments is recommended; annual reporting is required pursuant to the general permit requirements as set forth in Chapter NR 216 of the *Wisconsin Administrative Code*.

Protection of Environmentally Significant Lands

Alternatives

Environmentally significant lands within the area tributary to Lake Mary and Elizabeth Lake include wetlands, woodlands, and wildlife habitat areas. Nearly all of these areas within the Twin Lakes tributary area are included in the environmental corridors and isolated natural resource features delineated by the Southeastern Wisconsin Regional Planning Commission (SEWRPC). Upland areas, woodlands, and wildlife habitat areas, currently, are protected primarily through local land use regulation, while wetlands enjoy a wider range of protections set forth in State and Federal legislation.

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[3]*See University of Wisconsin-Extension, Publication No. GWQ045,* Storm Water Basins: Using Natural Landscaping for Water Quality and Esthetics, *2005.*

[4]*Earth Tech, Inc*., Stormwater Management Plan prepared for the Village of Twin Lakes, Wisconsin*, January 2004.*

Wetland protection can be accomplished through land use regulation and, in cases where land use regulations may not offer an adequate degree of protection, through public acquisition of sensitive sites. These wetland areas are currently protected to a degree by current zoning and regulatory programs administered by the U.S. Army Corps of Engineers, Wisconsin Department of Natural Resources (WDNR), and county and municipal authorities under one or more of the Federal, State, county, and local regulations.

Some of the wetland, woodland, and wildlife habitat areas within the area tributary to the Twin Lakes have been recommended specifically for public acquisition in the adopted regional natural areas and critical species habitat management and protection plan.[5] These lands include the 48 acres of the privately owned Elizabeth Lake Lowlands and the 18 acres of Hamilton Woods.[6] Public acquisition of these lands by the WDNR in the case of Elizabeth Lake Lowlands, and by the Village of Twin Lakes in the case of Hamilton Woods, as recommended in the adopted regional natural areas and critical species habitat protection and management plan, is considered a viable option.

Wetlands adjacent to lakes and streams help enhance water quality conditions, while preserving desirable open space characteristics for residents of the area to participate in a wide range of resource-oriented recreational activities, and to avoid the creation of new environmental and developmental problems as urbanization proceeds within the watershed. In parallel with such protection and preservation, the use of natural and native vegetation as shoreline protection is required pursuant to Chapter NR 328 of the *Wisconsin Administrative Code* as best practice along lake shorelines where such measures are feasible. Consequently, protection and enhancement of shoreland wetlands is recommended.

Recommended Measures

Nearly all wetland areas in the Twin Lakes tributary area are included in the environmental corridors delineated by the SEWRPC and protected under one or more of the existing Federal, State, county, and local regulations. Consistent and effective application of the provisions of these regulations is recommended. In addition, the implementation of the recommendations set forth in the adopted park and open space plan for Kenosha County,[7] and adopted regional natural areas and critical species habuitat protection and management plan,[8] would complement the protection and preservation of these environmentally sensitive lands.

POLLUTION ABATEMENT

All human activities upon the land surface result in some degree of mobilization of contaminants and modification of surface runoff patterns that can affect lakes and streams, their quality, and biotic conditions. Many human activities can be mitigated, to a large extent, by undertaking sound land use planning, appropriate nonpoint source pollution abatement measures, and individual action by an informed public. In the first instance, sound land use development and management in the tributary area, and protection of environmentally sensitive lands, are the fundamental building blocks for protecting lake and stream water quality and habitat, and preserving human use opportunities that will support a broadly based recreational and residential community. In addition, specific nonpoint source pollution control and abatement measures should be integrated into land use regulations and promoted by a far-reaching informational and educational program within the area tributary to individual lakes and streams.

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[5]*SEWRPC Planning Report No. 42,* A Regional Natural Areas and Critical Species Habitat Protection and Management Plan for Southeastern Wisconsin*, September 1997.*

[6]Ibid.

[7]*SEWRPC Community Assistance Planning Report No. 131,* A Park and Open Space Plan for Kenosha County, Wisconsin*, November 1987.*

[8]*SEWRPC Planning Report No. 42,* op. cit.

Nonpoint Source Pollution Abatement

Alternatives

Recent studies of the potential impact of riparian landscaping activities on nutrient loadings to lakes in southeastern Wisconsin have suggested that urban residential lands can contribute up to twice the mass of phosphorus to a lake when subjected to an active program of urban lawn care than similar lands managed in a more natural fashion.[9] The application of agrochemicals to such lands, in excess of the plant requirements, therefore, results in enhanced nutrient loading directly to the adjacent waterbodies. To address these concerns, some communities, such as the portion of the Town of West Bend served by the Big Cedar Lake Protection and Rehabilitation District, have purchased bulk lots of phosphorus-free lawn and garden fertilizers for resale to riparian landowners. Alternatively, a number of communities have enacted turf management or fertilizer control ordinances. To this end, the State of Wisconsin has promulgated guidance for turf nutrient management targeted at residential lands, parks, and high use areas, such as golf courses and parks.[10] Other communities have relied on informational programs to encourage landowners to reduce the use of phosphorus fertilizers in southeastern Wisconsin.

In the case of the Twin Lakes, the Village of Twin Lakes has enacted a ban on the use of phosphate-containing fertilizers in residential areas. Further, the Village of Twin Lakes, like other communities within the Region, has adopted shoreline management guidelines and ordinances that encourage or require the use of vegetative shoreland buffers to intercept runoff and associated contaminant loads generated in the immediate lakeshore area. Such actions limit the mass of nutrients entering waterways from the land surface, and mitigate the negative consequences of excessive nutrient inputs to aquatic ecosystems, including consequences, such as excessive aquatic plant and algal growths.

In addition to urban residential areas, recreational lands, such as golf courses, are major sources of phosphorus-rich runoff due to their extensive use of agrochemicals. To address concerns over the impacts of such runoff on natural waters and waterways, several national programs to encourage owners and operators of recreational areas to reduce nutrient applications have been proposed. Among these, the Audubon [International] Cooperative Sanctuary Program for Golf Courses (ACSP) is an education and certification program that helps golf courses protect the environment by helping participants in the program enhance the valuable natural areas and wildlife habitats that golf courses provide, while improving efficiency and minimizing the potentially harmful impacts of golf operations. In southeastern Wisconsin, the Lauderdale Lakes Lake Management District, owner of the Lauderdale Lakes Country Club, is one lake organization that has subscribed to this program with no loss of quality in the recreational activities but a significant cost savings to the organization and its contractor-operator in terms of course maintenance and concomitant benefits to the Lakes. Consequently, the use of this type of integrated nutrient and pest management best practices should be considered by the Nippersink Country Club and Twin Lakes Country Club, where maintenance of these facilities may promote control of nutrient runoff to the Lakes. While the State turf management guidance recognizes the need for use of fertilizers in high-traffic areas, such as public parks and golf courses, the guidance recommends that such applications be targeted to the high-traffic areas and not generally applied throughout the recreational sites.[11]

Within the area tributary to the Twin Lakes, agricultural lands remain an important land use. As a consequence of nutrient export in the form of agricultural produce, agricultural operations need to replace these nutrients and engage in other agrochemical-based practices to ensure crop quality and production levels. This need underlies the fact that agriculture remains the single largest source of nutrients to the Lakes. Nevertheless, the widespread

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[9] *U.S. Geological Survey Water-Resources Investigations Report No. 02-4130,* Effects of Lawn Fertilizer on Nutrient Concentration in Runoff from Lakeshore Lawns, Lauderdale Lakes, Wisconsin*, July 2002.*

[10] *Wisconsin Department of Natural Resources, Technical Standard No. 1100,* Turf Nutrient Management, *2006.*

[11] *Wisconsin Department of Natural Resources, Technical Standard No. 1100,* op. cit.

adoption of integrated nutrient and pest management practices within the industry as a consequence of nonpoint source pollution abatement programs implemented by the U.S. Department of Agriculture (USDA) and Wisconsin Department of Agriculture, Trade and Consumer Protection (WDATCP), among others, has contributed to improved agrochemical management within the agricultural industry. In the Fox River watershed, these practices have been promoted by WDATCP, the WDNR, county land and water conservation departments, and University of Wisconsin-Extension (UWEX).

Tributary area management measures may be used to minimize nonpoint source pollutant loadings from the watershed by locating development within a tributary basin in accordance with sound planning principles and practices. Beyond such actions, specific interventions may be required to control the mass of contaminants, generated by various types of land use activity, which are transported to the Lakes. Rural sources of contaminants arise as pollutants transported by runoff from cropland and pastureland; urban sources include contaminants transported by runoff from residential, commercial, industrial, transportation, and recreational land uses, and from construction activities. Alternative, tributary area-based nonpoint source pollution control measures considered in this report are based upon the recommendations set forth in the regional water quality management plan[12] and in the Kenosha County land and water resource management plan.[13]

The regional water quality management plan recommended that the nonpoint source pollutant loadings from the areas tributary to the Twin Lakes be reduced by up to 25 percent in urban areas and by up to 25 percent in rural areas, in addition to implementation of urban construction erosion controls and streambank erosion controls. Onsite sewage disposal system management practices also are recommended where appropriate and applicable. In this regard, it is noted that the Village of Twin Lakes is served by a public sanitary sewerage system.

As set forth in Chapter IV in Volume One of this report, the most readily controllable loadings are associated primarily with runoff from urban lands within the area tributary to the Lakes and from urbanizing lands throughout the tributary area that are linked to the Lakes by way of streams and stormwater drainage systems. These loadings constituted about 40 percent of the total phosphorus and about 10 percent of the sediment loadings to Lake Mary, about 26 percent of the total phosphorus and about 3 percent of the sediment loadings to Elizabeth Lake, and 100 percent of the heavy metals loadings to both of the Twin Lakes, based upon 2000 land uses. Phosphorus loadings from the remainder of the tributary area, and from direct deposition onto the lake surfaces, contributed the balance of the total loadings. The contributions of phosphorus, sediment, and heavy metals from urban lands are expected to increase as agricultural lands are progressively converted to urban uses. In the case of the annual phosphorus loads to the Lakes, urban land uses are forecast to contribute more than one-half of the total annual loads under year 2035 land use conditions. Urban lands will remain the source of the annual heavy metal loadings to the Lakes.

While some proportion of these contaminant loads may be attenuated as a consequence of the extensive wetland areas, the ability of these wetlands to assimilate pollutants is wholly dependent upon the maintenance of their structure and function within their ecosystems. These features can be overwhelmed by inappropriate land uses that result in the degradation of the wetlands, diminishing their ability to capture contaminants, or creating contaminant loads of such magnitude that the wetlands are overloaded. Thus, the control of nonpoint sources of water pollution at their sources is an important consideration. Properly applied, such controls can reduce the pollutant loadings to a lake by about 25 percent or more.

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[12]*SEWRPC Planning Report No. 30,* A Regional Water Quality Management Plan for Southeastern Wisconsin: 2000*, Volume One,* Inventory Findings*, September 1978; Volume Two,* Alternative Plans*, February 1979; and Volume Three,* Recommended Plan*, June 1979; SEWRPC Memorandum Report No. 93,* A Regional Water Quality Management Plan for Southeastern Wisconsin: An Update and Status Report*, March 1995.*

[13]*SEWRPC Community Assistance Planning Report No. 255,* A Land and Water Resource Management Plan for Kenosha County: 2000-2004, *September 2000.*

Appendix G presents a list of alternative nonpoint source pollution management measures that could be considered for use in the Twin Lakes area to reduce loadings from nonpoint sources of pollution. Information on the cost and effectiveness of the measures is also presented in Appendix G. It should be noted that appropriate public informational programming, described below, provides a means of disseminating information on various nonpoint source control measures that can be targeted to specific sectors of the community. Many of the measures are low-cost or no-cost measures that can be implemented by individual landowners. Selected measures are discussed below.

Recommended Measures

Nonpoint source pollution abatement controls in the tributary area are recommended to be achieved through a combination of rural agricultural nonpoint controls, urban stormwater management, and construction erosion controls. The implementation of the land management practices described below may be expected to result in a reduction in nonpoint source pollutants that is considered to be the maximum practicable given the findings of the inventories and analyses compiled during the planning effort. These measures are consistent with the recommended measures set forth in the Kenosha County land and water resource management plan.[14]

Rural Nonpoint Source Controls

Upland erosion from agricultural and other rural lands is a contributor of sediment to streams and lakes. Estimated phosphorus and sediment loadings from croplands, woodlots, pastures, and grasslands in the area tributary to the Twin Lakes were presented in Chapter IV in Volume One of this report. These data were utilized in determining the pollutant load reduction that could be achieved, the types of practices needed, and the extent of the areas to which the practices need to be applied within the area tributary to the Twin Lakes.

Based upon the pollutant loading analysis set forth in Chapter IV in Volume One of this report, a total annual phosphorus load of 315 pounds is estimated to be contributed to Lake Mary and 816 pounds to Elizabeth Lake. Of the mass of phosphorus entering Lake Mary, it is estimated that 172 pounds per year, or about 55 percent of the total loading, were contributed by runoff from rural land. In addition, it is estimated that about 138 tons of sediment, or about 74 percent of the total annual sediment load to Lake Mary, were contributed by agricultural lands in the tributary area. As of 2000, such lands comprised about 614 acres, or about 40 percent of the area tributary to Lake Mary. By 2035, these areas are expected to diminish to about 170 acres, or about 10 percent, of the area tributary to the Lake.

Of the mass of phosphorus entering Elizabeth Lake, it is estimated that 543 pounds per year, or about 66 percent of the total loading, were contributed by runoff from rural land. In addition, it is estimated that 427 tons of sediment, or about 85 percent of the total annual sediment load to Elizabeth Lake, were contributed by agricultural lands in the tributary area. As of 2000, such lands comprised about 1,900 acres, or about 50 percent of the area tributary to Lake Elizabeth. By 2035, these areas are expected to diminish to about 1,150 acres, or about 30 percent, of the area tributary to the Lake.

While agricultural land uses are anticipated to be a declining form of land use within the area tributary to the Twin Lakes, the agricultural operations that remain within the tributary area will continue to contribute a significant proportion of the sediment load to the waterbody. Tables 14 through 17 in Volume One, Chapter IV, of this report suggests that, based upon estimated contaminant loadings, agricultural land uses will continue to contribute 40 percent of the total sediment load, or about 40 tons of sediment annually, to Lake Mary, and 60 percent of the total sediment load, or about 260 tons of sediment annually, to Elizabeth Lake. Thus, detailed farm conservation plans are likely to continue to be required to adapt and refine erosion control and nutrient and pest management practices for individual farm units. Generally prepared with the assistance of staff from the USDA Natural Resources Conservation Service (NRCS) or County Land Conservation Departments, such plans identify

[14] *SEWRPC Community Assistance Planning Report No. 255,* op. cit.

desirable tillage practices, cropping patterns, and rotation cycles. The plans also consider the specific topography, hydrology, and soil characteristics of the farm; identify the specific resources of the farm operator; and articulate the operator objectives of the owners and managers of the land.

It is recommended that the Towns of Bloomfield and Randall, in coordination with the WDNR and Kenosha and Walworth Counties, develop a strategy to address nonpoint source pollution primarily from agricultural activities within the drainage area in Wisconsin. In addition, it is recommended consideration be given to cropping patterns and crop rotation cycles, with attention to the specific topography, hydrology, and soil characteristics for each farm. A reduction of about 25 percent in the nonpoint source loading from rural lands could provide up to about a 20 percent reduction in total phosphorus loading to Lake Mary and up to about a 22 percent reduction in total phosphorus loading to Elizabeth Lake under current land use conditions. Implementation of the recommendations and work planning activities set forth in the Kenosha County land and water resource management plan would constitute a major step toward implementation of these lake management recommendations. In Wisconsin, the cost of the needed measures will vary depending upon the details of the recommended farm conservation plans, for which efforts, as promulgated in Chapters NR 153 and NR 154 of the *Wisconsin Administrative Code*, cost-share funding may be available to encourage installation of appropriate land management measures.

In Illinois, it is recommended that the Illinois Department of Natural Resources (IDNR), Illinois Environmental Protection Agency (IEPA), McHenry County, and the Town of Burton develop a parallel strategy to address nonpoint source pollution primarily from agricultural activities within the drainage area tributary to Elizabeth Lake.

Urban Nonpoint Source Controls

As of 2000, established urban land uses comprised about 1,145 acres, or about 20 percent, of the area tributary to the Twin Lakes. The annual phosphorus loading from these urban lands was estimated to be 334 pounds, or about 20 percent of the total load of phosphorus to the Lakes. This is anticipated to increase to about 705 pounds of phosphorus, or about 60 percent of the total load of phosphorus under planned year 2035 land use conditions. Those urban source pollutant loadings that are most controllable include runoff from the residential lands adjacent to the Lakes and urban runoff from areas with a high proportion of impervious surface. The potential also exists within the Twin Lakes tributary area for significant construction site erosion impacts if development continues in the tributary area as has been the recent trend.

Potentially applicable urban nonpoint source control measures include stormwater management measures, such as wet detention basins, grassed swales, and good urban "housekeeping" practices. Generally, the application of low-cost urban housekeeping practices may be expected to reduce nonpoint source loadings from urban lands by about 25 percent. Public informational programs can be developed to encourage good urban housekeeping practices, to promote the selection of building and construction materials which reduce the runoff contribution of metals and other toxic pollutants, and to promote the acceptance and understanding of the proposed pollution abatement measures and the importance of lake water quality protection. Urban housekeeping practices and source controls include restricted use of fertilizers and pesticides, improved pet waste and litter control, the substitution of plastic for galvanized steel and copper roofing materials and gutters, proper disposal of motor vehicle fluids, increased leaf collection, and continued use of reduced quantities of street deicing salt.

Particular attention also should be given to reducing pollutant loadings from high-pollutant loading areas, such as commercial sites, parking lots, and material storage areas. To the extent practicable, parking lot stormwater runoff should be diverted to areas covered by pervious soils and appropriate vegetation, rather than being directly discharged to surface waters. Material storage areas may be enclosed or periodically cleaned, and diversion of stormwater away from these sites may further reduce pollutant loadings. Street sweeping, increased catch basin cleaning, stream protection, leaf litter and vegetation debris collection, and stormwater storage and infiltration measures can enhance the control of nonpoint source pollutants from urban and urbanizing areas, and reduce urban nonpoint source pollution loads by up to about 50 percent.

As has been noted in Volume One, Kenosha County does not have specific erosion control and stormwater management ordinances; rather, these concerns are managed through local government ordinances. As of 2006, the Village of Twin Lakes in Kenosha County, Walworth County, and the Village of Genoa City in Walworth County all had specific ordinances governing construction site erosion control; the Town of Bloomfield in Walworth County used the county ordinance. While these measures limit the potential impacts of new development, they do not address impacts from existing land uses nor do they address the cumulative impacts of past development. Therefore, additional measures to reduce nonpoint source pollution from existing development would appear to be warranted. Proper design and application of structural urban nonpoint source control measures, such as grassed swales and detention basins, requires the preparation of a detailed stormwater management system plan that addresses stormwater drainage problems and recommends controls on nonpoint sources of pollution. These measures should be supported by appropriate ordinances at all levels that are consistent with the current *Wisconsin Administrative Code* provisions governing stormwater management, and, to the extent practicable, with the best practices adopted within the profession.

In addition to the adoption of stormwater management ordinances, the most viable measures to control urban nonpoint sources of pollution appear to be good urban land management and urban housekeeping practices. Such practices consist of fertilizer and pesticide use management, litter and pet waste controls, and management of leaf litter and yard waste. The Village of Twin Lakes has adopted a phosphorus fertilizer control ordinance that prohibits the use of fertilizers containing phosphorus within the urban areas of the Village. The promotion of this ordinance requires an ongoing public informational program. It is recommended that the TLPRD, in cooperation with the Village, take the lead in sponsoring such programming for the Twin Lakes community through regular public informational meetings and mailings. The district should also ensure that relevant literature, available through the University of Wisconsin–Extension (UWEX) and the WDNR, is made available at these meetings, and at the local public library and government offices.

As an initial step in carrying out the recommended urban practices, it is recommended that a fact sheet identifying specific residential land management measures beneficial to the water quality of the Twin Lakes be prepared and distributed to property owners. This fact sheet could be distributed by the Village of Twin Lakes, with the assistance of the UWEX and Kenosha County Park Division of the Department of Public Works office. The recommended measures may be expected to provide about a 25 percent reduction in urban nonpoint source pollution runoff and up to about a 5 percent reduction in total phosphorus loadings to Lake Mary and up to about a 3 percent reduction in total phosphorus loadings to Elizabeth Lake. Cost-share funding for stormwater management actions may be available under NR 153 targeted runoff management grant program, NR 155 urban nonpoint source water pollution abatement and storm water management grant program, and the Chapter NR 120 nonpoint source pollution abatement program.

Development Area Nonpoint Source Controls

Development areas can generate significantly higher pollutant loadings than established areas of similar size. Development areas include a wide array of activities, including urban renewal projects, individual site development within the existing urban area, and new land subdivision development. The regional land use plan envisions only limited new urban development within the tributary area. However, as previously noted, some large-lot, suburban-density development is currently taking place in the area tributary to the Twin Lakes, together with the redevelopment of existing, platted lakefront lots.

During this process of land conversion and redevelopment, construction sites generally produce suspended solids and phosphorus loads at rates several times higher than those of established urban land uses. Control of sediment loss from construction sites can be provided by measures set forth by the WDNR in their construction erosion control handbook and in stormwater management and construction erosion control standards prepared by the WDNR in cooperation with the State of Wisconsin Standards Oversight Council.[15] These controls are temporary

[15]*Wisconsin Department of Natural Resources,* Wisconsin Construction Site Best Management Practices Handbook*, April 1994, and http://www.dnr.state.wi.us/org/water/wm/nps/stormwater/techstds.htm.*

measures taken to reduce pollutant loadings from construction sites during stormwater runoff events. Construction erosion controls may be expected to reduce pollutant loadings from construction sites by about 75 percent. While such practices are expected to have only a minimal impact on the total pollutant loading to the Lakes, due to the relatively small amount of land proposed to be developed, such controls are important pollution control measures that can abate localized short-term loadings of phosphorus and sediment from the tributary area and upstream watershed. Control measures include such revegetation practices as temporary seeding, mulching, and sodding; and such runoff control measures as filter fabric fences, straw bale barriers, storm sewer inlet protection devices, diversion swales, sediment traps, and sedimentation basins.

It is recommended that the counties and local units of government continue efforts to control soil erosion attendant to construction activities in accordance with existing ordinances. As noted in Chapter III of Volume One, construction site erosion control ordinances have been adopted throughout the tributary area of the Twin Lakes, either as stand-alone ordinances or as part of the building and zoning codes. Enforcement of the ordinances is generally considered effective. Construction site erosion controls may include the use of silt fences, sedimentation basins, rapid revegetation of disturbed areas; the control of "tracking" from the site; and careful planning of the construction sequence to minimize the areas disturbed. Construction site erosion control is particularly important in minimizing the more severe localized short-term nutrient and sediment loadings to the Twin Lakes that can result from uncontrolled construction sites. Consideration should be given to incorporating construction site erosion control measures into a formal stormwater management system serving larger developments following construction.

Construction site erosion control measures may be expected to reduce the phosphorus loading from that source by about 75 percent. Because of the potential for development in the tributary area to the Twin Lakes, it is important that adequate construction erosion control programs be in place. The costs for construction site erosion control will vary depending upon the amount of land under construction at any given time. Typical costs are $250 to $500 per acre under development.

Public Sanitary Sewerage System Management

At the present time, the lands directly tributary to the Lake Mary and Elizabeth Lake are served by public sanitary sewerage services operated by the Village of Twin Lakes.[16] Even so, the regional water quality management plan recommends that the sewerage needs in such areas be periodically reevaluated in light of changing conditions. The sewer service area plan for the Village of Twin Lakes has been periodically refined, with the current refinement dating from June 2007.

Recommended Measures

For those portions of the area tributary to the Twin Lakes served by a public sanitary sewerage system, it is recommended that the local units of government assume the lead in providing public informational and educational programs to encourage affected property owners to use their sewerage systems appropriately and wisely. In an analogous recommendation, stenciling of storm drains and related informational programming encourages residents to dispose of waste products safely, avoiding discharge directly to the surface waters or indirectly through the wastewater treatment works to the environment.

Onsite Sewage Disposal System Management

Portions of the area tributary to the Twin Lakes continue to utilize onsite wastewater treatment systems for the treatment of sanitary and household wastewaters. As reported in Chapter IV in Volume One of this report, total phosphorus loadings from onsite sewage disposal systems are estimated to contribute only a minor proportion of the total phosphorus load to the Lakes, which proportion is anticipated to continue to decline as public sanitary sewerage services are extended within the tributary area, as recommended in the adopted regional water quality

[16] *SEWRPC Community Assistance Planning Report No. 149, Sanitary Sewer Service Area for the Village of Twin Lakes, Kenosha County, Wisconsin, May 1987, as amended.*

management plan[17] and sewer service area plans.[18] In addition to lake water quality considerations, sewage disposal options in the area have implications for groundwater quality and property values. Thus, onsite sewage disposal is an important consideration in the portions of the tributary area not within the planned public sanitary sewer service area. Two basic alternatives are available for the abatement of pollution from onsite sewage disposal systems: continued reliance on, and management of, the onsite sewage disposal systems, and, alternatively, the expansion of the existing public sanitary sewer system.

Recommended Measures

Where onsite sewage disposal systems are anticipated to remain the primary wastewater treatment method, it is recommended that an onsite sewage disposal system management program be carried out, including the conduct of an ongoing informational and educational effort and periodic inspections of the systems to ensure their effective operation. Homeowners in areas served by onsite systems should be advised of the rules, regulations, and system limitations governing onsite sewage disposal systems, and should be encouraged to undertake preventive maintenance programs. Typical costs for a basic inspection and maintenance service range from about $100 to $200 per year, although more extensive programs could be more expensive. The costs of the informational programming typically have been included within the operating budget of the Counties. It should be noted that, as of 2008, consideration was being given by the Wisconsin Legislature to extending this inspection program to all onsite sewage disposal systems.

WATER QUALITY MONITORING

The reduction of external nutrient loadings to the Twin Lakes by the measures described above should help to prevent further deterioration of lake water quality conditions. These measures, however, may not completely eliminate existing water quality and lake-use problems. In mesotrophic lakes, the nutrients previously delivered to, and retained in, such lakes can result in excessive aquatic macrophyte growth and/or occasional algae blooms, which can result in restricted water use potentials, even after the implementation of tributary area-based management measures. Given that the Twin Lakes fall within the mesotrophic range, the awareness of in-lake rehabilitation techniques is of value.

The applicability of specific in-lake rehabilitation techniques is highly dependent on lake-specific characteristics. The success of any lake rehabilitation technique can seldom be guaranteed, and because of the relatively high cost of applying most techniques, a cautious approach to implementing in-lake rehabilitation techniques is generally recommended. Certain in-lake rehabilitation techniques should be applied only to lakes in which: 1) nutrient inputs have been reduced below the critical level; 2) there is a high probability of success in applications of the particular technology to lakes of similar size, shape, and quality; and, 3) the possibility of adverse environmental impacts is minimal. Finally, it should be noted that most in-lake rehabilitation techniques require the issuance of permits from appropriate State and Federal agencies prior to implementation.

As discussed in Chapter IV in Volume One of this report, water quality information for the Twin Lakes has been compiled during the current study period through efforts involving the USGS and WDNR/UWEX. The continued acquisition and analysis of relevant water quality data is the foundation for the implementation of an informed program of in-lake management. The data acquired provide an ongoing record of the short-term effects and long-term benefits of the lake management measures implemented in and around the Twin Lakes. These data, also, permit modification of the management measures as required to address changing conditions in the Lakes and their watersheds, and support the process of adjustment of the measures being implemented known as "adaptive management."

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[17] *SEWRPC Memorandum Report No. 93,* op. cit.

[18] *See SEWRPC Amendment to Community Assistance Planning Report No. 30,* op. cit.*; Amendment to SEWRPC Community Assistance Planning Report No. 149,* op. cit.

Alternatives

The WDNR has supported Self-Help Monitoring Program volunteers who have acquired water clarity data on the Twin Lakes over a period of several years, as summarized in Chapter IV of Volume One. This program currently is supported by the UWEX as the Citizen Lake Monitoring Network (CLMN), and citizen monitoring of the Twin Lakes is ongoing. Because pollution tends to reduce water clarity, Secchi-disk transparency measurements are generally considered one of the key parameters in determining the overall quality of a lake's water, as well as a lake's trophic status. Secchi-disk measurement data are added to the WDNR-sponsored data base containing lake water quality information for those lakes in Wisconsin that participate in the CLMN. These data are accessible on-line through the WDNR and UWEX websites.

The UWEX also offers an expanded monitoring program that involves collecting data on several key physical and chemical parameters in addition to the Secchi-disk measurements. Under the expanded program, samples of lake water are collected by volunteers at regular intervals and analyzed for total phosphorus and chlorophyll-*a* concentrations by the State Laboratory of Hygiene (SLOH). Data collection also is more extensive, including temperature and dissolved oxygen concentrations, which, consequently, places more of a burden on the volunteers. However, the additional data provide significantly more insight into the functioning of the sampled lakes.

The USGS offers an extensive water quality monitoring program, within which Federal field personnel conduct a series of approximately five monthly samplings beginning with the spring turnover. Samples are analyzed by the SLOH for an extensive array of physical and chemical parameters. These data have been summarized in Chapter IV in Volume One of this report. The USGS also offers an array of other specialist services, including groundwater modeling and monitoring. An alternative to the USGS program is the analytical services provided by the Water and Environmental Analysis Laboratory (WEAL) of the University of Wisconsin-Stevens Point (UWSP). However, this program requires volunteers to obtain and transmit the water quality samples to the laboratory. In both cases, the WDNR offers Chapter NR 190 Small Grant funding that can be applied for to defray the costs for laboratory analysis and sampling equipment.

Recommended Measures

Ongoing water quality monitoring by volunteer monitors, supplemented by periodic more-detailed water quality monitoring, is recommended for the Twin Lakes.

WATER QUALITY IMPROVEMENT MEASURES

This group of in-lake management practices includes a variety of measures designed to directly modify the magnitude of either a water quality determinant or biological response. Specific measures aimed at managing aquatic plants and the fisheries are separately considered below.

Alternatives

Phosphorus Precipitation and Inactivation

Nutrient inactivation is a restoration measure that is designed to limit the biological availability of phosphorus by chemically binding the element in the lake sediments using a variety of divalent or trivalent cations, highly positively charged elements. Aluminum sulfate (alum), ferric chloride, and ferric sulfate are commonly used cation sources. The use of these techniques to remove phosphorus from nutrient-rich lake waters is an extension of common water supply and wastewater treatment processes. Costs depend on the lake volume and type and dosage of chemical used. Approximately 100 tons of alum, costing about $150 per ton, can treat a lake area of about 40 acres. Effectiveness depends, in part, on the ability of the alum flocculent to form a stable "blanket" on the lakebed; to wit, on flushing time, turbulence, lake water acidity (pH), and rate of continued sedimentation. Impacts can include the release of toxic quantities of free aluminum into the water. The resulting improved water clarity can also encourage the spread of rooted aquatic plants. In the case of the Twin Lakes, nutrient inactivation is not considered a viable option for the Twin Lakes due to the paucity of soft sediments, low level of internal loading, and relatively low overall pollutant loading rates, all of which mediate against the effective use of nutrient inactivation.

Nutrient Load Reduction

Nutrient diversion is a restoration measure which is designed to reduce the trophic state or degree of over-feeding of a waterbody and thereby control the growth response of the aquatic plants in the system. Control of nutrients in surface water runoff in the tributary area, as described in the tributary area management section above, is generally preferable to attempting such control within a lake. In-lake control of nutrients generally involves removal of contaminated sediments or encapsulation of nutrients by chemical binding. Costs are generally high, involving an engineered design and usually some form of pumping or excavation. Effectiveness is variable, and impacts include the rerelease of nutrients into the environment. While some limited deepening of specific areas within the Lakes may be warranted for navigational purposes, especially in the constructed channels and small embayments adjacent to the main lake basins, the widespread use of in-lake nutrient load reduction measures is not warranted in the Twin Lakes, especially given that internal loading from the lake sediments is not an important nutrient source to the water column. As noted in Chapter IV in Volume One of this report, the good agreement between predicted and observed phosphorus concentrations in the Lakes strongly suggests that the external nutrient load to the Lakes accounts for the entire phosphorus concentration in the Lakes' water columns.

Hydraulic and Hydrologic Management for Water Quality and Habitat Improvement

This group of in-lake management measures consists of actions designed to modify the depth of water in the waterbody to create, enhance, or modify water quality and habitat. The presence of the two small outlet control structures—one located in the connecting channel between Lake Mary and Elizabeth Lake, the other located in the outflow stream that carries water from the south end of Elizabeth Lake to the Elizabeth Lake Drain—provide an opportunity to manipulate surface water levels within the Lakes; however, it should be noted that the lake level-water quantity management elements of these actions have been discussed and evaluated in Chapter II of this report. Consequently, the objectives of water quantity manipulation as discussed in this Chapter are to enhance a particular class of recreational uses, or to control the types and densities of organisms within a waterbody, through drawdown, water level stabilization, and/or dredging.

Drawdown

Drawdown refers to a the manipulation of lake water levels, especially in impounded lakes, in order to change or create specific types of habitat and thereby manage species composition within a waterbody. Drawdown may be used to control aquatic plant growth and to manage fisheries. With regard to aquatic plant management, periodic drawdowns can reduce the growth of some shoreland plants by exposing the plants to climatic extremes, while the growth of others is unaffected or enhanced. Both desirable and undesirable plants are affected by such actions. Costs are primarily associated with loss of use of the waterbody surface area during drawdown, provided there is a means of controlling water level in place, such as a dam or other outlet control structure. Effectiveness is variable with the most significant side-effect being the potential for increased plant growth.

Drawdown can also affect the lake fisheries both indirectly, by reducing the numbers of food organisms, and directly, by reducing available habitat and desiccating (drying out) eggs and spawning habitat. In contrast, increasing water levels, especially during spring, can provide enhanced fish breeding habitat for some species, such as pike and muskellunge, and increase the food supply for opportunistic feeders, such as bass, by providing access to terrestrial insects, for example. Costs are primarily associated with loss of use. Effectiveness is better than for aquatic plant control, but the potential for side-effects remains high given that undesirable fish species may also benefit from water level changes.

Sediment exposure and desiccation by means of lake drawdown has been used as a means of stabilizing bottom sediments, retarding nutrient release, reducing macrophyte growth, and reducing the volume of bottom sediments. During the period of drawdown, the exposed sediments are allowed to oxidize and consolidate. It is believed that by reducing the sediment oxygen demand and increasing the oxidation state of the surface layer of the sediments, drawdown may retard the subsequent movement of phosphorus from the sediments. Sediment exposure may also curb sediment nutrient release by physically stabilizing the upper flocculent, sediment-water interface zone of the sediments which plays an important role in the exchange reaction and mixing of the sediments with the overlying water. Drawdown may, thus, deepen the lake by dewatering and compacting the bottom sediments. The amount of

compaction depends upon the organic content of the sediment, the thickness of sediment exposed above the water table, and the timing and duration of the drawdown.

Possible improvements resulting from a lake drawdown include reduced turbidity from wind action, improved gamefishing, an opportunity to collect fish more effectively in fish removal programs, an opportunity to improve docks and dams, and an opportunity to clean and repair shorelines and deepen areas using conventional earth-moving equipment. Limited, over-winter drawdowns sometimes are considered in order to limit shoreland damage by ice and ice movements during the winter months.

In contrast, depending on the timing and duration of the drawdown, drawbacks include loss of fish breeding habitat, loss of benthic food organisms, and disruption of waterfowl feeding and roosting patterns. Increased turbidity and unpleasant odors from rotting organic matter may occur during the period of the drawdown. Other adverse impacts of lake drawdown include algal blooms after reflooding, loss of use of the lake during the drawdown, changes in species composition, and a reduction in the density of benthic organisms following drawdown and reflooding. In some drawdown projects, it has been found that several years after reflooding, flocculent sediments began to reappear because of algae and macrophyte sedimentation. Therefore, to maintain the benefits of a drawdown project, a lake may have to be drawn down every five to 10 years to recompact any new sediments.

Because of the unpredictability of the results, the impairment of recreational uses, and the temporary nature of the beneficial effects of a drawdown, drawdown is not considered a viable option for the Twin Lakes. Specifically, the low elevations of the outlet structures serving Lake Mary and Elizabeth Lake make any significant drawdown impracticable. Further, there is some anecdotal evidence from Elizabeth Lake that an overwinter drawdown, that drops the lake surface water elevation below the toe of the shoreline protection structures, leading to the failure of these structures and/or ice damage to the structures caused by ice heaves.

Water Level Stabilization

Water level fluctuations are a significant concern of the Twin Lakes users. While water level management in a lake is a common technique for managing fish and aquatic macrophytes, the consequences of manipulating lake water levels can be both beneficial and deleterious. The major impacts from the standpoint of riparian owners are that the fluctuating water levels affect shoreline erosion and interfere with proper pier height and placement and the correct placement of shoreline protection structures.

Periodic changes in precipitation and weather patterns between years often result in fluctuation of water loads to a lake. These fluctuations in turn can affect lake levels. Most plant and animal species can cope with this level of water surface fluctuation without experiencing the consequences, both positive and negative, noted above. Heavy snowfall and record rainfall within the Twin Lakes drainage area during 2008, as noted in Chapter III of Volume One, have led to significant concerns regarding shoreland erosion and property flooding damage amongst the owners of low-lying properties. Nevertheless, while artificial stabilization of the water surface is not considered a viable option for the Twin Lakes, as noted above, it is desirable from the point of view of aquatic habitat that water level fluctuations be maintained within natural limits.

Dredging

Sediment removal is a restoration measure that is carried out using a variety of techniques, both land-based and water-based, depending on the extent and nature of the sediment removal to be carried out. For larger-scale applications, a barge-mounted hydraulic or cutter-head dredge is generally used. For smaller-scale operations a shore-based drag-line system is typically employed. Both methods are expensive, especially if a suitable disposal site is not located close to the dredge site. Costs for removal and disposal begin at between $10 and $15 per cubic yard, with the cost of sediment removal alone beginning at between $3.00 and $5.00 per cubic yard. Effectiveness of dredging varies with the effectiveness of tributary area controls in reducing or minimizing the sediment sources. Federal and State permits are required for use of this option.

Dredging in the Twin Lakes could be accomplished using several different types of equipment, including a hydraulic cutterhead dredge mounted on a floating barge in deeper water areas; a bulldozer and backhoe equipment in the shoreland area, especially if the Lakes were drawn down; and a clamshell, or bucket, dragline dredge from the shoreline. While the use of conventional earth-moving equipment and shore-based draglines has some advantages over hydraulic dredging, particularly since these methods would not require large disposal and dewatering sites in close proximity to the project area, these methods would be dependent, to some extent, on the drawdown of the Lakes. Reducing the water level in the Lakes would be especially advantageous for dragline dredging, because it would not require the removal of shoreland trees, resulting in less disturbance of the shoreline to provide access for trucks and equipment. Likewise, reduced water levels would allow conventional construction equipment access to the littoral portions of the Lakes. Given the potential recreational use impacts of a drawdown during the summer and winter recreational seasons, use of these methods is not considered feasible.

Hydraulic cutterhead dredging is the most commonly employed method in the United States. The dredge is typically a rotating auger or cutterhead on the end of an arm that is lowered to the sediment-water interface. Sediment excavated by the cutterhead is pumped as a slurry of 10 to 20 percent solids by a centrifugal pump to the disposal site. This pumping usually limits the distance between the lake and disposal site to less than a mile, even using intermediate booster pumps. Because of the large volume of slurry produced, a relatively large disposal site is typically required. Water returned from the disposal site, whether returned to the lake or a stream, would have to meet effluent water quality standards of the State and would be subject to State permitting.

Dredging is the only restoration technique that directly removes the accumulated products of degradation and sediment from a lake system and can return a lake to a younger "age." If carried to the extreme, dredging can be used, in effect, to construct a new lake with a size and depth to suit the management objectives. Dredging has been used in other lakes to increase water depth; remove toxic materials; decrease sediment oxygen demand, prevent fish winterkills and nutrient recycling; restore fish breeding habitat; and decrease macrophyte growth. The objective of a dredging program at the Twin Lakes would be to increase water depth to maintain recreational boating access and increased public safety.

Even so, dredging may have serious, though generally short-term, adverse effects on the Lakes. These adverse effects could include increased turbidity caused by sediment resuspension, toxicity from dissolved constituents released by the dredging, oxygen depletion as organic sediments mix with the overlying water, water temperature alterations, removal of native plant seeds, and destruction of benthic and fisheries habitats. There may also be impacts at upland spoil disposal sites, such as odor problems, restricted use of the site, and disturbances associated with heavy truck traffic. In the longer term, disruption of the lake ecosystem by dredging can encourage the colonization of disturbed portions of the lakebed by less desirable species of aquatic plants and animals, including Eurasian water milfoil, which is present in the Twin Lakes.

In addition, while dredging can result in an immediate increase in lake depth, such increases may be short-lived if the sources of sediment being deposited in the lake are not controlled within the area tributary to the lake. The sediment load reaching the Twin Lakes comes from both urban and agricultural lands within the area tributary to the Lakes. Sediment also may be generated from streambank and shoreland erosion. Many of these sources can be effectively controlled through the adoption, implementation, and maintenance of recommended control measures within the tributary area. Such practices should be implemented in the area tributary to the Lakes, as noted above, regardless of the likely conduct of any dredging project.

Dredging of lakebed material from the navigable waters of the State requires a Chapter 30 permit to be issued by the WDNR and a Federal Chapter 404 permit to be issued by the U.S. Army Corps of Engineers. In addition, current solid waste disposal regulations define dredged material as a solid waste. Chapter NR 180 of the *Wisconsin Administrative Code* requires that any dredging project of over 3,000 cubic yards submit preliminary disposal plans to the WDNR for review and potential solid waste licensing of the disposal site. Because sodium arsenite was applied to the Twin Lakes during the 1950s and 1960s, as noted in Chapter V in Volume One of this report, sediment samples may need to be analyzed to determine the extent and severity of any residual arsenic contamination.

Recommended Measures
It is recommended that the dams be regularly inspected for proper operation and that the lake levels be monitored and controlled by the Village of Twin Lakes. Staff gauges are currently in place for this purpose, but they should be inspected annually to ensure that the elevations remain accurate. It is further recommended that, as noted in Chapter II of the Volume, consideration be given to the reconstruction of the Elizabeth Lake water level control structure to minimize the need for human interventions in the management of lake water surface elevations. Lake levels are recommended to be maintained between the elevations of 793.5 feet and 794.5 feet above NGVD-29.

Because of the considerations noted above, extensive widespread dredging of the Twin Lakes is not considered a viable alternative at this time, although limited dredging may be a viable option for the maintenance of public recreational boating access in specific targeted areas, such as constructed channels and shallow embayments.

FISHERIES MANAGEMENT

The Twin Lakes, like most mesotrophic waterbodies, provide an environment that is capable of producing productive, warmwater fisheries. Currently, adequate water quality, dissolved oxygen levels, and diverse plant communities exist for the maintenance of a sportfish population in the Lakes. Winterkill is currently not a problem. As described in Chapter V in Volume One of this report, WDNR fisheries surveys conducted in the Twin Lakes have indicated that the waterbodies support relatively large and diverse fish communities, with bluegill being the most abundant fish reported in the most recent survey of Lake Mary, completed in 2004.[19] Given the intensity of recreational use of these waterbodies, fisheries management measures are indicated. Applicable management measures are reviewed below, focusing on habitat management and shoreland protection.

Alternatives
Monitoring
A baseline fishery survey in Lake Mary was recently conducted in 2004 by the WDNR, and a similar survey of Elizabeth Lake was proposed to be conducted in Elizabeth Lake during 2008. Future surveys should have the following objectives:

1. To identify changes in fish species composition that may have taken place in the Lakes since the previous surveys;

2. To permit any changes in fish populations, species composition and condition factors to be related to such known interventions as stocking programs, water pollution control activities, and aquatic plant management programs;

3. To refine and update information on fish spawning areas, breeding success, and survival rates;

4. To confirm the lack of disturbance by roughfish populations; and,

5. To determine the need for, and inform the timing of, any additional stocking of northern pike, smallmouth bass, walleyed pike, and/or other gamefish species, as appropriate, by the WDNR, in order to maintain a continuing, viable sportfishery.

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[19] *WDNR enhancement services have not been available to Elizabeth Lake due to a lack of adequate public recreational boating access, as defined in Chapter NR 1 of the* Wisconsin Administrative Code*, although, with the provision of additional public recreational boating access by the Village of Twin Lakes at a recently acquired site, a fisheries survey is proposed to be conducted in Elizabeth Lake during 2008.*

This action could provide a sound basis for the TLPRD and the WDNR to continue the stocking program and to revise, as may be found necessary, the current fishing regulations regarding the size and number of fish to be taken seasonally. Should roughfish population increases be shown to warrant intervention, conduct of "carp out" events is recommended.

Habitat Protection

Habitat protection refers to a range of conservation measures designed to maintain existing fish spawning habitat, including measures, such as restricting recreational use and other intrusions into gravel-bottomed shoreline areas during the spawning season. For bass this is mid-April to mid-June. Use of natural vegetation in shoreland management zones and other "soft" shoreline protection options aids in habitat protection. Costs are generally low, unless the habitat is already degraded. Modification of aquatic plant management operations, if utilized, may be considered to support restoration and protection of native aquatic plant beds, and maintenance of fish breeding habitat during the early summer period. Effectiveness is variable depending in part on community acceptance and enforcement. Generally, it is more effective to maintain a good habitat than to restore a habitat after it is degraded.

Protection and provision of habitat should be a primary focus of any fisheries management program. The environmentally valuable areas identified within the Lakes and its tributary area, as described in Chapter V in Volume One of this report, are the most important areas to be protected. In addition, limiting or restricting certain activities in these areas of the Lakes will prevent significant disturbance of fish nests and aquatic plant beds. There currently are no areas officially designated by the WDNR pursuant to Chapter NR 107 of the *Wisconsin Administrative Code* as Environmentally Sensitive Areas within the Twin Lakes. However, as noted in Chapter V of Volume One of this report, there were several littoral zone areas in the Twin Lakes considered to be ecologically significant. Within such areas, aquatic plant management measures may be restricted, and dredging, filling, and the construction of piers and docks are commonly discouraged. Outside of the designated areas, these activities may be expedited with respect to required permitting. It also should be noted that water level fluctuations other than those consequent to natural climatic variability and water quality conditions can affect fish habitat and the breeding success of fishes. In this regard, the maintenance of Lake water levels within natural limits, and the maintenance of good water quality, cannot be overemphasized as fish habitat protection measures.

Shoreline Protection

Shoreline protection refers to a group of measures designed to reduce and minimize shoreline loss due to erosion by waves, ice, or related actions of the water. Much of the shoreline of the Twin Lakes is protected by some type of structural measure. Four shoreline erosion control techniques were in use in 2008: vegetative buffer strips, rock revetments, wooden and concrete bulkheads, and beaches.

Maintenance of a vegetated buffer strip immediately adjacent to the Lake is the simplest, least costly, and most natural method of reducing shoreline erosion. This technique employs 1) natural vegetation, rather than maintained lawns, within five to 10 feet of the lakeshore and 2) the establishment of emergent aquatic vegetation from two to six feet lakeward of the shoreline. Desirable plant species that may be expected and encouraged to invade a buffer strip, or which could be planted, include arrowhead (*Sagittaria latifolia*), cattail (*Typha* spp.), common reed (*Phragmites communis*), water plantain (*Alisma plantago-aquatica*), bur-reed (*Sparganium eurycarpum*), and blue flag (*Iris versicolor*) in the wetter areas; and jewelweed (*Impatiens biflora*), elderberry (*Sambucus canadensis*), giant goldenrod (*Solidago gigantea*), marsh aster (*Aster simplex*), red-stem aster (*Aster puniceus*), and white cedar (*Thuja occidentalis*) in the drier areas. In addition, trees and shrubs, such as silver maple (*Acer saccharinum*), American elm (*Ulmus americana*), black willow (*Salix nigra*), and red-osier dogwood (*Cornus stolonifera*) could become established in the shoreland area. These plants will develop a more extensive root system than turf grass and the aboveground portion of the plants will protect the soil against the erosive forces of rainfall and wave action. On individual properties, a narrow, 10- to 30-foot-wide path to the Lakes could be maintained as lake access for boating, swimming, fishing, scenic viewing, and other activities. A vegetative buffer strip would also serve to trap nutrients and sediments washing into the Lakes via direct overland flow. This alternative can be undertaken by individual landowners and would involve only minimal cost as it is incorporated into the property landscaping scheme. In August of 2005, the Village of Twin Lakes adopted ordinance provisions to establish setback requirements for shoreline structures and encourage the development of natural vegetative

buffer strips along the shorelines. Such laws, and the enforcement of them, are considered an essential element to the establishment of measures to provide for long-term protection of the Lakes and ensure continuation of the Lakes as a valuable resource element in the area.

Rock revetments, or riprap, are a highly effective method of shoreline erosion control applicable to many types of erosion problems, especially in areas of low banks and shallow water. Many of these structures are already in place along the shores of the Twin Lakes. The technique involves the shaping of the shoreline slope; the placement of a porous filter material, such as sand, gravel, pebbles, or geosynthetic fabric on the slope; and, the placement of rocks on top of the filter material to protect the slope from the actions of waves and ice. The advantages of rock revetments are that they are highly flexible and not readily weakened by movements caused by settling or ice expansion, they can be constructed in stages, and they require little or no maintenance. The disadvantages of rock revetments are that they limit some uses of the immediate shoreline. The rough, irregular rock surfaces are unsuitable for walking; require a relatively large amount of filter material and rocks to be transported to the lakeshore; and can cause temporary disruptions and contribute sediment to the lake. If improperly constructed, revetments may fail because of washout of the filter material. As noted above, anecdotal evidence from Elizabeth Lake also suggests that low water levels can exacerbate the effect of ice heaves on such shoreline protection structures. A rock revetment is estimated to cost $25 to $35 per linear foot.

Modification of Species Composition

Species composition management refers to a group of conservation and restoration measures that include selective harvesting of undesirable fish species and stocking of desirable species designed to enhance the angling resource value of a lake. These measures also include water level manipulation, both to aid in the breeding of desirable species, for example, increasing water levels in spring to provide additional breeding habitat for pike, and to disadvantage undesirable species, for example, drawing a lake down to concentrate forage fish and increase predation success and also to strand juveniles and desiccate the eggs of undesirable species. Costs, as with water level management above, are primarily associated with loss of use; effectiveness is good, but by no means certain; and side effects include collateral damage to desirable fish populations.

More extreme measures include organized fishing events and selective cropping of certain fish species, poisoning, and enhancement of predation by stocking. In lakes with an unbalanced fishery, dominated by carp and other roughfish, chemical eradication has been used to manage the fishery. Lake drawdown is often used along with chemical treatments to expose spawning areas and eggs and concentrate fish in shallow pools, thereby increasing their availability to anglers, commercial harvesters, or chemical eradication treatments. Fish barriers are usually used to prevent reintroduction of undesirable species from upstream or downstream, and the habitat thus created will benefit the desired gamefish populations. Chemical eradication is a drastic, costly measure and the end result may be highly unpredictable. Although effectiveness is generally good, such extreme measures are not considered viable for the Twin Lakes.

Recommended Measures

Ongoing fisheries monitoring by the WDNR is recommended for the Twin Lakes as the basis for the conduct of fisheries management interventions and assessment of their effectivity.

Habitat Protection

The habitat protection measures recommended for the Twin Lakes are designed to avoid disturbances in fish breeding areas during spring and autumn by appropriately managing nuisance aquatic plants and maintaining stands of native aquatic plants. In particular, this recommendation extends to, and includes, any Chapter NR 107 sensitive areas that may be identified by the WDNR and located in the Lakes, although at the time of the printing of this document there were no such State designated sensitive areas in either of the Twin Lakes. Nevertheless, it is recommended that environmentally sensitive lands, including wetlands along the lakeshore and in the tributary area, be preserved. To this end, note is made of the McHenry County conservancy lands at the southern extreme of Elizabeth Lake, which have established a high level of protection of the riparian wetland areas upstream of the dam. Similarly, the Village of Twin Lakes has adopted shoreland wetland zoning ordinance requirements that have established a high level of protection of the extensive wetland system on the northwestern shores of

Elizabeth Lake. Additional shoreland wetlands, known as the Elizabeth Lake Lowlands and located on the southwestern shore of Elizabeth Lake, are recommended in the regional natural areas and critical; species habitat protection and management plan for protection as a natural area of countywide or regional importance. These areas contribute to the available aquatic and terrestrial habitat in and around the Twin Lakes.

Shoreline Protection

The use of vegetated buffer strips and riprap, as shown in Figure 1, is recommended, especially in those areas subject to significant wind-wave, boat-wake, and ice-scour erosion. In those portions of the Lakes subject to direct action of wind waves and ice scour, the use of riprap would provide a more robust means of stabilizing shorelines, while elsewhere along the lakeshore creation of vegetated buffer strips would provide, not only shoreline erosion protection, but also enhanced shoreland habitat for fish and wildlife. In this regard, it should be noted that the selection of appropriate shoreland protection structures is subject to the provisions of Chapter NR 328 of the *Wisconsin Administrative Code*. Where recreational boating traffic is a concern, use of the long-form worksheet, included in Chapter NR 328, is recommended, as this form takes into account boat wakes, as well as wind waves, in determining the shoreline erosion intensity index, which, in turn, determines the type of shoreline protection that can be permitted.

Adoption of the vegetated buffer strip method is recommended to be used in lakeshore areas and on tributary waterways wherever practical in order to maintain habitat value and the natural ambience of the lakeshore. Continued maintenance of existing revetments and other protection structures also is recommended. Conversion of vertical bulkheads to sloping revetments or to natural vegetated shoreline or combinations is recommended to be considered where potentially viable at such time as major repairs are found necessary. Revetments and natural shorelands provide habitat for shoreland dwelling organisms and allow passage of amphibians to and from the Lakes. Natural vegetated buffer strips should be considered for shorelines wherever practical. Guidance provided in the proposed Chapter NR 328 of the *Wisconsin Administrative Code* sets forth a methodology for determining appropriate shoreline protection structures for inland lakes based upon wind-wave action, wind fetch, substrate type, and boat-wake action.[20]

In addition to the foregoing measures, it also is recommended that the Village of Twin Lakes continue to enforce existing shoreland setback requirements, and construction site erosion control and stormwater management provisions, set forth in the Village *Code of Ordinances*. Provision of informational materials to shoreland property owners to encourage protection, restoration and/or maintenance of shoreland vegetation is recommended, as set forth in the informational and educational programming element of this plan. To the extent that the Town of Randall and Kenosha County have jurisdiction in portions of the drainage area to the Lakes outside of the Village of Twin Lakes, enforcement of setback, construction site erosion control, and stormwater management requirements within the drainage area also is recommended. Periodic review of these requirements for currency and consistency with the requirements of the *Wisconsin Administrative Code* is strongly recommended.

Species Modification

As noted in Chapter V in Volume One of this report, the Twin Lakes are currently managed for warmwater sportfish; selective stocking has been undertaken historically by the WDNR, with northern pike, smallmouth bass and walleye being stocked. Continued fish stocking by the WDNR is recommended, subject to monitoring and creel surveying data collected from the Lakes by the WDNR. Supplemental stocking by other interested parties may be warranted, subject to WDNR permitting. Additional fish population control measures do not appear to be warranted at this time, although monitoring of roughfish populations should continue.

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[20] *It should be noted that a short form worksheet for determining the appropriate shoreland protection structure for a specific site is available on the WDNR website. This form, however, does not allow consideration of boat-wake impacts; hence, use of the long-form worksheet set forth in Chapter NR 328 of the* Wisconsin Administrative Code *is recommended.*

Regulations and Public Information
To reduce the risk of overharvest, the WDNR has placed restrictions on the number and size of certain fish species caught by anglers. The open season, size limits, and bag limits for the fish species of the Twin Lakes are given in Table 27 in Volume One of this report. Enforcement of these regulations is critical to the success of any sound fish management program. Special note should be taken of measures established under Section NR 19.05 of the *Wisconsin Administrative Code* for the control of viral hemorrhagic septicemia (VHS) within the State of Wisconsin. Amongst other provisions, the VHS control regulations created by Emergency Rule during 2007 and amended during 2008 limit the transportation of live aquatic organisms between lakes and their use as bait organisms within the waters of the State without appropriate permits from the WDNR, applicable to anglers and bait dealers, among others.

AQUATIC PLANT MANAGEMENT

Aquatic plant management refers to a group of management and restoration measures aimed at both removal of nuisance vegetation and manipulation of species composition in order to enhance and provide for recreational water use. Generally, aquatic plant management measures are classified into four groups: physical measures, which include lake bottom coverings and water level management; mechanical removal measures, which include harvesting and manual removal; chemical measures, which include using aquatic herbicides; and biological control measures, which in turn include the use of various organisms, such as insects. All of these measures are stringently regulated and require State permits available through the WDNR pursuant to Chapters NR 107 and NR 109 of the *Wisconsin Administrative Code*.

Costs of aquatic plant management measures range from minimal—for manual removal of plants using rakes and hand-pulling—to upwards of $100,000—for the purchase of a mechanical plant harvester and ancillary equipment, the operational costs for which can approach $10,000 to $20,000 per year, depending on staffing and operating policies. Harvesting is likely to be the measure most applicable to larger, deeper areas while chemical controls may be best suited to use in confined areas and for initial control of invasive plants. Planting of native plant species is largely experimental in lakes, but can be considered as a specialized technique, especially in the shoreland management zone at the water's edge. Physical controls and mechanical harvesting may have side effects in the expansion of plant habitat and the spread of reproductive vegetative fragments.

Periodic reconnaissance surveys of aquatic plant communities and periodic updates of in-place aquatic plant management plans are valuable data gathering tools in the determination of any aquatic plant management actions and, as such, are considered viable options.[21]

Alternatives
Aquatic Herbicides
Chemical treatment with aquatic herbicides is a short-term method of controlling heavy growths of aquatic macrophytes and algae. Chemicals are applied to the growing plants in either liquid or granular form. The advantages of using chemical herbicides to control aquatic macrophyte growth are the relative ease, speed, and convenience of application. Herbicides also offer a degree of selectivity, targeting specific types of aquatic plants. However, the disadvantages associated with chemical control include the following:

1. The short-term, lethal effects of chemicals are relatively well known. However, properly applied, chemical applications should not result in such effects. Potential long-term, sublethal effects, especially on fish, fish-food organisms, and humans, are relatively unknown.

[21]*See, for example, Aron and Associates,* Twin Lakes Aquatic Plant Management Plan Reassessment, *2005.*

2. The elimination of macrophytes eliminates their competition with algae for light and nutrients. Algal blooms may then develop unless steps are taken simultaneously to control the sources of nutrient input.

3. Since much of the dead plant materials are left to decay in the lake, nutrients contained in them are rapidly released into the water and fuel the growth of algae. The decomposition of the dead plant material also consumes dissolved oxygen and increases the potential for fishkills. Accretion of additional organic matter in the sediments as a result of decomposition also increases the organic content of the soils and predisposes the sediments toward reintroduction of other (or the same) nuisance plant species. Long-term deposition of plant material may result in the need for other management measures, such as dredging.

4. The elimination of macrophyte beds destroys important cover, food sources, and spawning areas for desirable fish species.

5. Adverse impacts on other aquatic organisms may be expected. At the concentrations used for macrophyte control, Diquat has been known to kill the zooplankton *Daphnia* and *Hyalella*, both important fish foods. *Daphnia* is the primary food for the young of nearly all fish species found in the Region's lakes.[22]

6. Areas generally must be treated again in the following season and weedbeds may need to be treated more than once in a summer, although certain herbicides may give relief over a period of up to three years in some lakes.

7. Many of the chemicals available often affect nontarget, desirable species, such as water lilies, as well as the target "weeds," such as Eurasian water milfoil, as both species are dicotyledons which share similar biological characteristics.

The advantages and disadvantages of chemical macrophyte control also apply to the chemical control of algae. Copper, the active ingredient in most algicides, may accumulate in the bottom sediments, where excessive amounts are toxic to fish and benthic animals. Fortunately, copper is rapidly eliminated from human systems and few cases of copper sensitivity among humans are known.[23]

Costs of chemical treatments vary widely. Large, organized treatments are more efficient and tend to decrease unit costs for commercial applications compared to individual treatments. Other factors, such as the type of chemical used and the number of treatments needed, are also important. Estimated costs for lakes in southeastern Wisconsin range from $240 to $480 per acre. Chemical treatments must be permitted by the State under Chapter NR 107 of the *Wisconsin Administrative Code*.

Because there is a demonstrated need to control aquatic plants in selected areas of the Twin Lakes, chemical treatment is considered to be a viable management option best suited for nearshore areas of the Lakes, around piers and structures. Widespread use of chemical herbicides is not considered a viable option.

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[22] *P.A. Gilderhus, "Effects of Diquat on Bluegills and Their Food Organisms,"* The Progressive Fish-Culturist*, Vol. 2, No. 9, 1967, pp. 67-74.*

[23] *J.A. Thornton, and W. Rast, "The Use of Copper and Copper Compounds as an Algicide,"* Copper Compounds Applications Handbook*, H.W. Richardson, ed., Marcel Dekker, New York, 1997.*

Aquatic Plant Harvesting

Aquatic macrophytes are mechanically harvested with specialized equipment consisting of a cutting apparatus which cuts up to five feet below the water surface and a conveyor system that picks up the cut plants and hauls them to shore. Advantages of macrophyte harvesting include the following:

1. Harvesting removes the plants from the lake. The removal of this plant biomass decreases the rate of accumulation of organic sediment. A typical harvest of submerged macrophytes from eutrophic lakes in southeastern Wisconsin can yield between 140 and 1,100 pounds of biomass per acre per year.[24]

2. Harvesting removes plant nutrients, including nitrogen and phosphorus, which would otherwise "refertilize" the lake as the plants decay. A typical harvest of submerged macrophytes from eutrophic lakes in southeastern Wisconsin can remove between four and 34 pounds of nitrogen and 0.4 to 3.4 pounds of phosphorus per acre per year. In addition to the physical removal of nutrients, plant harvesting may reduce internal nutrient recycling.[25]

3. Repeated macrophyte harvesting may reduce the regrowth of certain aquatic macrophytes. The regrowth of Eurasian water milfoil has been reported to have decreased as harvesting frequency was increased.

4. Where dense growths of filamentous algae are closely associated with macrophyte stands, they may be harvested simultaneously.

5. The macrophyte stalks remaining after harvesting provide cover for fish and fish-food organisms, and stabilize the bottom sediment against wind erosion.

6. Selective macrophyte harvesting may reduce stunted populations of panfish in lakes where excessive cover has adversely influenced predator-prey relationships. By allowing an increase in predation on young panfish, both gamefish and the remaining panfish may show increased growth.[26]

7. The cut plant material can be used as mulch.

The disadvantages of macrophyte harvesting include the following:

1. Harvesting is most effective in water depths greater than two feet. Large harvesters cannot operate in shallow water or around docks and buoys. Operation of harvesting equipment in shallow waters can result in significant increases in turbidity and disruption of the lake bottom and lake bottom-dwelling fauna.

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[24]*James E. Breck, Richard T. Prentki, and Orie L. Loucks, editors,* Aquatic Plants, Lake Management, and Ecosystem Consequences of Lake Harvesting*, Proceedings of Conference at Madison, Wisconsin, February 14-16, 1979.*

[25]*Several studies have shown that aquatic macrophytes can act as nutrient pumps, recycling nutrients from the bottom sediments into the water column. Ecosystem modeling results have indicated that a harvest of 50 percent of the macrophytes in Lake Wingra, Wisconsin, could reduce instantaneous phosphorus availability by about 30 percent, with a maximum reduction of 40 to 60 percent, depending on the season.*

[26]*James E. Breck, and J.F. Kitchell, "Effects of Macrophyte Harvesting on Simulated Predator-Prey Interactions," edited by Breck et al., 1979, pp. 211-228.*

2. The reduction in aquatic macrophytes by harvesting reduces their competition with algae for light and nutrients. Thus, algal blooms may develop.

3. Fish, especially young-of-the-year bluegills and largemouth bass, as well as fish-food organisms, are frequently caught in the harvester. As much as 5 percent of the juvenile fish population can be removed by harvesting. A WDNR study found that four pounds of fish were removed per ton of plants harvested.[27]

4. The reduction in aquatic macrophyte biomass by harvesting or chemical control can reduce the diversity and productivity of macroinvertebrate fish-food organisms feeding on the epibiota. Bluegills generally move into the shoreline area after sunset, where they consume these macroinvertebrates. After sunrise they migrate to open water, where they graze, primarily on zooplankton. If harvesting or chemical control shifts the dominance of the littoral macroinvertebrate fauna to sediment dwellers, the macroinvertebrate component of the bluegill diet could be restricted.[28] This would increase predation pressure on zooplankton and reduce the growth rate of the panfish; it could eventually lead to undesirable ramifications throughout the food web in a lake.

5. Macrophyte harvesting may influence the community structure of macrophytes by favoring such plants as milfoil (*Myriophyllum* spp.) that propagate from cut fractions. This may allow these plants to spread into new areas through the rerooting of the cut fractions.

6. Certain species of plants, such as coontail, are difficult to harvest due to lack of root system.

7. The efficiency of macrophyte harvesting is greatly reduced around piers, rafts, and buoys because of the difficulty in maneuvering the harvesting equipment in those restricted areas. Manual methods have to be used in these areas.

8. High capital and labor costs may be associated with harvesting programs. Macrophyte harvesting on the Twin Lakes could be conducted through cooperative agreements among various municipalities or be contracted to a private company. These costs are largely staff costs and operating costs such as fuel, oil, and maintenance. The cost of new harvesting equipment, including the harvester, transporter, conveyor, and vehicle, would be about $282,500.

Harvesting programs should be designed to provide optimal benefits and minimal adverse impacts. Small fish are common in dense macrophyte beds, but larger fish, such as largemouth bass, do not utilize these dense beds.[29] Narrow channels may be harvested to provide navigational access and "cruising lanes" for predator fish to migrate into the macrophyte beds to feed on smaller fish. "Shared access" lanes may also be cut, allowing several residents to use the same lane. Increased use of these lanes should keep them open for longer periods than would be the case if a less directed harvesting program was followed. "Clear cutting" of aquatic plants and denuding the lake bottom of flora should be avoided. However, top cutting of plans such as Eurasian water milfoil, as shown in Figure 2, is suggested, as this technique allows native aquatic plants to successfully compete with the Eurasian water milfoil by providing access to sunlight below the Eurasian water milfoil canopy.

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[27] *Wisconsin Department of Natural Resources,* Environmental Assessment Aquatic Nuisance Control (NR 107) Program*, 3rd Edition, 1990, 213 pp.*

[28] *James E. Breck, et. al.,* op. cit.

[29] *S. Nichols, Wisconsin Department of Natural Resources Technical Bulletin No. 77,* Mechanical and Habitat Manipulation for Aquatic Plant Management: A Review of Techniques*, 1974.*

Water depth, numbers and arrangement of docks and moored boats, and nature of bottom substrate are important factors when considering mechanical harvesting. Most harvesting equipment is large and not well-suited to close operation around docks and moored boats where precise control of movement is needed. Areas of shallow depth—two to three feet or less containing muck or other soft, loose bottom materials—are generally not considered to be well suited to harvesting, as the equipment tends to churn up these bottom materials, creating turbid water conditions, affecting established benthic communities and fragmenting rooted aquatic macrophytes. Additionally, plants, such as Eurasian water milfoil, which propagate through the spread of plant fragments, may actually be given a reproductive advantage as a result of the chopping action of harvesting equipment. Mechanical harvesting is best suited to areas free of docks and moored watercraft or recreational equipment, where lake bottom materials are firm and water is of sufficient depth to offer a degree of protection against potential lake bottom disruption by harvester equipment. The harvest of water lilies and emergent native plants should be avoided.

Protecting native aquatic plant communities from disturbances can help prevent Eurasian water milfoil from spreading within a lake. Recent studies show that native plants can effectively compete with Eurasian water milfoil. However, the nonnative invasive species tends to outcompete native plants when the lake's ecosystem is stressed.[30] Stress can be brought on by tributary area pollution, shoreline development, changing water levels, boating activity, carp, and aquatic nuisance controls. This maintenance of a healthy aquatic plant community has been found to be the most efficient way of managing aquatic plants, as opposed to other means of managing problems once they occur. Furthermore, native aquatic plant communities contribute most effectively to the maintenance of good water quality by providing suitable habitat for desirable fish and other aquatic organisms which promote stable or increased property values and quality of life.[31]

Because of the demonstrated need for control of aquatic plants, harvesting is considered a viable option in areas of the Twin Lakes that are conducive to this method of management. Mechanical harvesting of aquatic plants must be permitted by the WDNR pursuant to authorities set forth in Chapter NR 109 of the *Wisconsin Administrative Code*.

Manual Harvesting

Due to water depth limitations imposed by the size and maneuverability of the harvesters, it is not always possible for harvesters to reach the shoreline of every property. Likewise, because of the cost and other concerns relating to the use of chemical herbicides, alternative measures for the control of aquatic plant growth in specific areas of the Lakes should be considered. A number of specially designed rakes are available from commercial outlets to assist lakefront homeowners in manually removing aquatic plants from the shoreline area. The TLPRD could acquire a number of these rakes, which could be made available to lakefront property owners upon request. The advantages of these rakes are that they are easy and quick to use, and result in an immediate result, in contrast to chemical treatments that involve a waiting period. This method also removes the plants from the lake avoiding the accumulation of organic matter on the lake bottom.

Manual harvesting is feasible in only very limited areas and is not practical for large-scale use. Nevertheless, manual harvesting does offer a reasonable level of aquatic plant control in the vicinity of docks and piers, and is therefore considered a viable option. Manual harvesting beyond a 30-foot-wide recreational corridor, or within a WDNR-delineated environmentally sensitive area, must be permitted by the WDNR pursuant to authorities set forth in Chapter NR 109 of the *Wisconsin Administrative Code*. Pursuant to the provision of this Chapter, piers and other recreational areas must be placed within the 30-foot-wide recreational corridor.

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[30] *Wisconsin Department of Natural Resources,* Eurasian Water Milfoil in Wisconsin: A Report to the Legislature*, 1992.*

[31] *Roy Bouchard, Kevin J. Boyle, and Holly J. Michael,* Water Quality Affects Property Prices: A Case Study of Selected Maine Lakes*, Miscellaneous Report 398, February 1996.*

Biological Controls

Another alternative approach to controlling nuisance weed conditions, in this particular case Eurasian water milfoil, is biological control. Classical biological control has been successfully used to control both weeds and herbivorous insects.[32] Recent documentation states that *Eurhychiopsis lecontei*, an aquatic weevil species, has the potential as a biological control agent for Eurasian water milfoil. In 1989, the weevil was discovered during a study investigating a decline of Eurasian water milfoil growth in a Vermont pond. *Eurhychiopsis* proved to have significant negative effects on Eurasian water milfoil in the field and in the lab. The adult weevil feeds on the milfoil causing lesions which make the plant more susceptible to pathogens, such as bacteria or fungi, while the weevil larvae burrows in the stem of the plant causing enough tissue damage for the plant to lose buoyancy and collapse.[33] The few studies that have been done since that time have indicated the following potential advantages to use of this weevil as a means of Eurasian water milfoil control:

1. *Eurhychiopsis lecontei* is known to cause fatal damage to the Eurasian water milfoil plant and over a period of time has the potential to cause a decrease in the milfoil population.

2. *Eurhychiopsis lecontei* larvae are easy to produce.

3. *Eurhychiopsis lecontei* are not known to cause damage to existing native aquatic plants.

The potential disadvantages of using *Eurhychiopsis lecontei* include:

1. Relatively little experience in southeastern Wisconsin in the use of biological control agents for the management of Eurasian water milfoil. The studies done on *Eurhychiopsis* suggest that, while the weevil is usually present in lakes infested with Eurasian water milfoil, it is only effective periodically when its populations grow to a level sufficient to cause significant damage to the milfoil plant stems.[34]

2. Since the upper portion of the Eurasian water milfoil plant is preferred by the weevil, harvesting would have to be extremely limited or not used at all in conjunction with this type of aquatic plant management control. The studies done on *Eurhychiopsis* also suggest that the organism is susceptible to wash-off from the plant stem by boat wakes and wind waves, and that the organisms are subject to predation by bluegill and other fishes.

3. Adequate overwintering habitat, consisting of natural shoreland areas, must be present to ensure continuity of the Eurasian water milfoil weevil. Extensive lengths of shoreland protection structure may limit the ability of the organisms to survive from year-to-year.

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[32]*C.B. Huffacker, D.L. Dahlsen, D.H. Janzen, and G.G. Kennedy,* Insect Influences in the Regulation of Plant Population and Communities*, 1984, pp. 659-696; C.B. Huffacker and R.L. Rabb, editors,* Ecological Entomology*, John Wiley, New York, New York, USA.*

[33]*Sally P. Sheldon, "*The Potential for Biological Control of Eurasian Water Milfoil (*Myriophyllum spicatum*) 1990-1995 Final Report*," Department of Biology, Middlebury College, February 1995.*

[34]*The use of* Eurhychiopsis *sp. on an experimental basis to control Eurasian water milfoil was monitored in selected Wisconsin lakes by the WDNR and the UWSP from 1995 through 1998. These results indicated mixed success, suggesting that this organism has specific habitat requirements that limit its utility as a Eurasian water milfoil control agent within Wisconsin.*

Relatively few studies concerning the use of *Eurhychiopsis lecontei* as a means of aquatic plant management control have been completed. Such cases have resulted in variable levels of control, and, although priced competitively with aquatic herbicides, the use of *Eurhychiopsis lecontei* is not considered a viable option for the Twin Lakes at this time. Use of biological control agents must be permitted by the State under Chapter NR 109 of the *Wisconsin Administrative Code*.

In contrast, the use of biological control agents, such as the purple loosestrife beetles, *Hylobius transversovittatus*, *Galerucella pusilla*, *Galerucella calmariensis*, *Nanophyes brevis*, and *Nanophyes marmoratus,* is recommended to control infestations of purple loosestrife (*Lythrum salicaria*) in wetlands and along shorelands. These biological control agents have been shown to be beneficial in a variety of circumstances throughout the Southeastern Wisconsin Region.

The use of other biological control agents is prohibited in Wisconsin; the use of the grass carp, *Ctenopharyngodon idella*, for aquatic plant control is expressly prohibited.

A variation of the biological control philosophy is the introduction of aquatic plants into potentially suitable areas of habitat in order to restore or create competition or fill vacant ecological niches in lake ecosystems. Within lakes, this planting approach has been used rarely and generally in an experimental manner.[35] The planting of wetland plant species along shorelines and within the littoral zones of lakes is an established management measure for shoreland protection. This latter measure is recommended for consideration in the Twin Lakes, as has been noted in terms of fisheries habitat creation and enhancement, above.

Lake Bottom Covering

Lake bottom covers and light screens provide limited control of rooted plants by creating a physical barrier which reduces or eliminates the sunlight available to the plants. They have been used to create swimming beaches on muddy shores, to improve the appearance of lakefront property, and to open channels for motorboats. Sand and gravel are usually readily available and relatively inexpensive to use as cover materials, but plants readily recolonize areas so covered in about a year. Synthetic materials, such as polyethylene, polypropylene, fiberglass, and nylon, can provide relief from rooted plants for several years. The screens are flexible and can be anchored to the lakebed in spring or draped over plants in summer.

The advantages of bottom covers and screens are that control can be confined to specific areas, the covers and screens are usually unobtrusive and create no disturbance on shore, and the covers are relatively easy to install over small areas. The disadvantages of bottom covers and screens are that they do not reduce eutrophication of the lake, they are expensive, they are difficult to spread and anchor over large areas or obstructions, they can slip on steep grades or float to the surface after trapping gases beneath them, and they may be difficult to remove or relocate.

Screens and covers should not be used in areas of strong surf, heavy angling, or shallow water where there is motorboat traffic. They also should not be used where aquatic vegetation is desired for fish and wildlife habitat. To minimize interference with fish spawning, screens should be placed before or after spawning. A permit from the WDNR is required for use of sediment covers and light screens. Permits require inspection by the WDNR

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[35]*See, for example, Donald H. Les and Glenn Guntenpergen, "Laboratory Growth Experiments for Selected Aquatic Plants, Final Report, July 1989 – June 1990 (Year 1)," Report to the Wisconsin Department of Natural Resources, June 1990; and,Wisconsin Department of Natural Resources, "Environmental Assessment: Improvement of the Water Quality and Fisheries Habitat of LacLaBelle [sic] and the Lower Oconomowoc River," s.d., for documentation of the attempt to "seed" various pondweed species into Lac La Belle. This experience is documented in SEWRPC Community Assistance Planning Report No. 47, 2nd Edition,* A Water Quality Management Plan for Lac La Belle, Waukesha County, Wisconsin*, May 2007.*

staff during the first two years, with subsequent permits issued for three-year periods. Annual removal of such barriers is generally required as a permit condition.

The estimated cost of lake bottom covers that would control plant growth along a typical shoreline property, an area of about 700 square feet, ranges from $100 for burlap to $300 for Aquascreen®. Placement of lake bottom screens requires a WDNR permit pursuant to Chapter 30 of the *Wisconsin Statutes*. Because of the limitations involved, placement of lake bottom covers as a method to control aquatic plant growth is not a viable option for the Twin Lakes.

Use of sand blankets and pea gravel deposits has also been proposed as a physical barrier to aquatic plant growth in certain situations. Placement of materials on the bed of a navigable lake or waterway also requires a WDNR permit pursuant to Chapter 30 of the *Wisconsin Statutes*, and the use of these materials is generally confined to the creation and augmentation of swimming beaches. Use of these materials for aquatic plant management purposes is not a viable option as deposition of sediments above the sand or gravel layer limits the longer-term viability of this technique.

Public Informational Programming

Aquatic plant management usually centers on the eradication of nuisance aquatic plants for the improvement of recreational lake use. The majority of the public views all aquatic plants as "weeds" and residents often spend considerable time and money removing desirable plant species from a lake without considering their environmental impacts. As shown in Table 20 in Chapter V in Volume One of this report, many aquatic plants have positive ecological value within the lake ecosystem, and most native aquatic plants rarely interfere with human water uses. Thus, public information is an important component of an aquatic plant management program and should include informational programming on:

1. The types of aquatic plants in the Twin Lakes and their value to water quality, fish, and wildlife.

2. The preservation of existing stands of desirable plant species.

3. The identification of nuisance species and the methods of preventing their spread.

4. Alternative methods for controlling existing nuisance plants, including the positive and negative aspects of each method.

An organized aquatic plant identification/education day is one method of providing hands-on education to lake residents. Other sources of information and technical assistance include the WDNR and the UWEX. The aquatic plant species lists provided in Tables 21 and 22 of Chapter V in Volume One of this report, and the illustrations of common aquatic plants present in the Twin Lakes, appended to Volume One of this report as Appendix A, may serve as a checklist for individuals interested in identifying the plants near their residences. Residents can observe and record changes in the abundance and types of plants in their part of a lake on an annual basis.

Of the submerged floating and free-floating aquatic plant species found in the Twin Lakes, Eurasian water milfoil is one of the few species likely to cause lake-use problems. Eurasian water milfoil, unlike most aquatic plants, can reproduce from fragments and often forms dense, monotypic beds with little habitat value for fish or waterfowl. Lakeshore residents should be encouraged to collect fragments that wash ashore after storms and, especially, from weekend boat traffic. The plant fragments can be used as mulch on flower gardens or ornamental planting areas. Likewise, lake users should be encouraged to inspect boats and trailers both prior to launch and following recover as Eurasian water milfoil and other aquatic plants can be transported between lakes as fragments on boats and boat trailers. This effort also limits the likelihood of transporting zebra mussel, *Dreissena polymorpha*, between lakes and into new areas of the Lakes.

To prevent unwanted introductions of plants and invasive aquatic animals into lakes, boaters should remove all plant fragments from their boats and trailers when exiting a lake, and allow wet wells, engine water jackets, and

bilges to dry thoroughly for up to one week. Alternatively, boaters can run their vessels through a car wash, where high-pressure, high-temperature water sprays can remove and destroy organisms, such as the zebra mussel juveniles (veligers).[36] Providing the opportunity for the removal of plant fragments at the boat landings on the Twin Lakes, and provision of signage at the boat landing, including provision of disposal containers at the boat landing, may help motivate boaters to utilize this practice. Posters and pamphlets are available from the WDNR and UWEX that provide information and illustrations of milfoil, zebra mussel, and other nonnative aquatic species; discuss the importance of removing plant fragments from boats; and, remind boaters of their duty in this regard. Removal of bait organisms from live wells, and the aforementioned precautions to prevent the transportation of nuisance aquatic plants between lakes, also can limit the transportation of other organisms such as the VHS virus, as noted above. Such actions would be consistent with the legal requirements set forth in Chapters NR 19 and NR 109 of the *Wisconsin Administrative Code*.

Recommended Measures

It is recommended that aquatic macrophyte surveys be conducted at about five-year intervals, depending upon the observed degree of change in the aquatic plant communities. This interval is consistent with the requirements of Chapters NR 107 and NR 109 of the *Wisconsin Administrative Code*, which govern permitting for various types of aquatic plant management measures. In addition, information on the aquatic plant control program should be recorded and should include descriptions of major areas of nuisance plant growth; areas chemically treated and/or harvested; and, in areas where harvesting is conducted, species harvested and amounts of plant material removed from the Lakes. Note also should be taken of the species and approximate numbers of fish and invertebrates, if any, caught in the harvest. It is further recommended that a daily harvester log, containing this information, be maintained. This information, in conjunction with the conduct of the recommended aquatic macrophyte surveys, will allow evaluation of the effectiveness of the aquatic plant control program over time and allow adjustments to be made in the program to maximize its benefit.

To enhance the use of the Twin Lakes while maintaining the quality and diversity of the biological communities, the following recommendations are made:

1. Reconnaissance surveys of the aquatic plant communities in the Twin Lakes are recommended to be conducted periodically and the approved aquatic plant management plan should be updated every three to five years.

2. Mechanical harvesting is recommended as a possible future management method should the need arise. As indicated in Chapter V of Volume One, this will, in the long-term, help to maintain good water quality conditions by removing plant materials which are currently contributing to an accumulation of decomposing vegetation and associated nutrient recycling.

3. In areas where harvesting occurs, it is recommended that shared-access channels be harvested to minimize the potential detrimental effects on the fish and invertebrate communities. Directing boat traffic through these common channels would help to delay the regrowth of vegetation in these areas. Additionally, surface harvesting is recommended, cutting to a depth to remove the surface canopy of nonnative aquatic plants, such as the Eurasian water milfoil. This should provide a competitive advantage to the low-growing native plants present in the Lakes. By not disturbing the low-growing species which generally grow within one to two feet of the lake bottom and in relatively low densities, leaving the root stocks and stems of all cut plants in place, the resuspension of sediments in the Twin Lakes will be minimized, and some degree of cover will continue to be provided for panfish

[36]*See Wisconsin Department of Natural Resources Publication No. PUBL-WR-383 95-REV.,* Zebra Mussel Boater's Guide*, 1995; Wisconsin Department of Natural Resources Publication No. PUBL-WR-463 96-REV.,* The Facts...On Eurasian Water Milfoil*, February 1996.*

populations which support the gamefish populations in the Lakes. Further, cutting should not be broad-based, but focused on boating channels and selected navigation areas.

4. It is recommended that the use of chemical herbicides be limited to controlling nuisance growths of nonnative species in shallow water around docks and piers. It is recommended that chemical applications, if required, be made by licensed applicators in early spring, subject to State Chapter NR 107 permitting requirements, to maximize their effectiveness on nonnative plant species, while minimizing impacts on native plant species and acting as a preventative measure to reduce the development of nuisance conditions. Such use should be evaluated annually and the herbicide applied only on an as-needed basis. Only herbicides that selectively control milfoil, such as 2,4-D and fluridone, should be used. Algicides, such as Cutrine Plus, are not recommended because there are few significant, recurring filamentous algal or planktonic algal problems in the Twin Lakes and valuable macroscopic algae, such as *Chara* and *Nitella* are killed by this product.

5. The control of rooted vegetation between adjacent piers and docks is recommended to be left to the riparian owners concerned. The TLPRD and the Village of Twin Lakes may wish to obtain informational brochures regarding shoreline maintenance, such as information on hand-held specialty rakes made for this specific purpose, to inform residents of the control options available.

6. The ongoing collection of aquatic plant fragments and other debris along shoreline areas is recommended.

7. It is recommended that ecologically valuable areas be excluded from aquatic plant management activities, especially during fish spawning seasons in early summer and autumn. Aquatic plant management limitations that may be set forth within any future WDNR-designated, Chapter NR 107 sensitive area determinations are incorporated herein by reference.

8. It is further recommended that the TLPRD and the Village of Twin Lakes conduct public informational programming on the types of aquatic plants in the Twin Lakes; on the value of, and the impacts of, these plants on water quality, fish, and on wildlife; and on alternative methods for controlling existing nuisance plants, including the positive and negative aspects of each method. This program can be incorporated into the comprehensive informational and educational programs that also would include information on related topics, such as water quality, recreational use, fisheries, and onsite sewage disposal systems.

The recommended aquatic plant management measures represent a continuation of the current aquatic plant management program conducted by the TLPRD and the Village of Twin Lakes.

RECREATIONAL USE MANAGEMENT

Regulatory measures provide a basis for controlling lake use and use of the shorelands around a waterbody. On land, shoreland zoning, requiring setbacks and shoreland buffers can protect and preserve views both from the water and from the land, controls development around a lake to minimize its environmental impacts and manages public and private access to a waterbody. On water, recreational use zoning can provide for safe and multiple-purpose use of lakes by various groups of lake users and protect environmentally sensitive areas of a lake. Use zoning can take the form of allocating times of use, such as the annual fishing season established by the State, or areas of use, wherein the types or rate of use is controlled, as in the case of shallow water, slow-no-wake speed limits. A key issue in zoning a waterbody for use is equity; the same rules must apply to both riparian owners/residents and off-lake users. This condition is usually met in situations where use zoning is motivated by the protection of fish habitat, for example, as both on- and off-lake users would appreciate an enhanced fishery. Costs are relatively low, associated with creating and posting the ordinance, and effectiveness can be good with regular/consistent enforcement. Costs increase for measures requiring buoyage.

Alternatives
Currently, watercraft are restricted to slow-no-wake speeds within 100 feet of pierheads; personal watercraft or jetskis® are restricted to slow-no-wake speeds within 200 feet of shore and 100 feet of other watercraft.[37] The 100 foot to 200 foot nearshore zone typically coincides with water depths of less than five feet. Demarcation of Eurasian water milfoil control areas, and similar environmentally valuable or sensitive areas of the Lakes is recommended. It is also recommended that the Village of Twin Lakes continues to enforce the recreational boating ordinance appended hereto as Appendix B in Volume One of this report.

Recreational use management measures applicable to the Twin Lakes also include the implementation of slow-no-wake regulations during periods of high water. These regulations are designed to protect human lives and property, the latter especially being the focus in the low-lying areas of the lake shores. As discussed in Chapter II of this Volume, the Village of Twin Lakes had periodically implemented such slow-no-wake regulations through a Village ordinance, most recently during June and July of 2008.

Recommended Measures
With respect to boating ordinances applicable to the Twin Lakes, it is recommended that current levels of enforcement be maintained. In addition, recreational boating access users should be made aware of the presence of the exotic invasive species Eurasian water milfoil within the Twin Lakes. Appropriate signage should be placed at the public recreational boating sites, and supplemental materials on the control of invasive species should be made available to the public. These materials could be provided to riparian householders by means of mail drops or distribution of informational materials at public buildings, such as municipal buildings and the public library, and to nonriparian users by means of informational materials provided at the entrance to all municipal public recreational boating access sites. In addition, it is recommended that disposal bins be made available at the public recreational boating access sites for disposal of plant materials and other refuse removed from watercraft using the public recreational boating access sites.

PUBLIC INFORMATIONAL AND EDUCATIONAL PROGRAMMING

Alternatives
Educational and informational brochures and pamphlets, of interest to homeowners and supportive of the recreational use and shoreland zoning regulations, are available from UWEX and the WDNR for distribution by both local governments and nongovernmental organizations to interested parties. These cover topics, such as beneficial lawn care practices and household chemical use guidelines. These brochures could be provided to homeowners through local media, direct distribution, or targeted school or public library displays. Many of these ideas can be integrated into ongoing, larger-scale municipal activities, such as anti-littering campaigns, recycling drives, and similar pro-environment activities. The TLPRD publishes a periodic newsletter and both the Village and lake management district maintain internet websites to inform electors, property owners, and other interest individuals of the District's activities.

In addition to public informational programming, or informal educational programming, discussed above, there are a number of school-based educational opportunities that the community can utilize at the middle school level and at the high school level. Such programming as Project WET are available from and supported by the UWEX and provide youth the opportunity to experience "hands on" the aquatic environment and become better informed about current and future lake issues and concerns. Such programs are considered a viable option.

Finally, reporting of water quality sampling results to the public should be continued and participation in the UWEX CLMN should be continued. Volunteer monitoring under the auspices of the CLMN involves citizens in taking Secchi-disk transparency readings in the Lakes at regular intervals. The Lake Coordinator of the WDNR-

[37] *Wisconsin Department of Natural Resources Publication No. PUBL-LE-301 2006,* Wisconsin Boating Regulations*, 2006.*

Southeast Region can assist in enlisting volunteers in this program. The information gained at first hand by the public during participation in this program increases the credibility of the proposed changes in the nature and intensity of use to which the Lakes are subjected.

Recommended Measures
It is recommended that the TLPRD and the Village of Twin Lakes assume the lead in the development of a public informational and educational program. Participation by the Town of Randall should be encouraged. This program should deal with various lake management-related topics, including onsite sewage disposal system management, water quality management, land management, groundwater protection, aquatic plant management, fishery management, invasive species, and recreational use. Educational and informational brochures and pamphlets, of interest to homeowners and supportive of the recreational use and shoreland zoning regulations, are available from the WDNR and the UWEX. These cover topics, such as beneficial lawn care practices and household chemical use. Such brochures should be provided to homeowners through local media, direct distribution, or targeted library and civic center displays. Such distributions can also be integrated into ongoing, larger-scale activities, such as lakeside litter collections, which can reinforce anti-littering campaigns, recycling drives, and similar environmental protection activities.

Given the extent of public interest in the Twin Lakes, it is recommended that the Village of Twin Lakes consider offering regular informational programs on the Lakes and issues related thereto. Such programming can provide a mechanism to raise awareness of the lake issues, and provide a focal point from which to distribute the informational materials referred to above. The Village of Twin Lakes and the municipalities are also encouraged to take an active role in encouraging the local school districts to adopt and utilize lake-related educational programs, such as a Pontoon Classroom or Project WET, as means of more closely linking students to the lake environment. The cost for conducting this informational and educational program is estimated to be $1,200 per year.

INSTITUTIONAL DEVELOPMENT

While lake management activities fall under the general powers of municipalities, in the case of the Village of Twin Lakes pursuant to Section 61.34(1), *Wisconsin Statutes*, other public and private organizational alternatives exist for the management of lakes in the State of Wisconsin.[38] Private lake organizations have the option to be incorporated, generally as nonstock, not-for-profit corporations under Chapter 181, *Wisconsin Statutes*. Public lake organizations include special-purpose units of government that are created as public inland lake protection and rehabilitation districts under Subchapter IV of Chapter 33, *Wisconsin Statutes*, and utility districts created pursuant to Subchapter VIII of Chapter 66, *Wisconsin Statutes*. The specific type (or types) of organization created is based upon the decision of the community.

Current Lake Management Structure
In the case of the Twin Lakes, general oversight of lake management activities is provided by the TLPRD, whose governing board, pursuant to Section33.23(1), *Wisconsin Statutes*, is the Village Board of the Village of Twin Lakes. A citizen-based steering council oversees the activities of several citizen-based committees which perform numerous lake-oriented activities and functions, and provides a liaison function between the TLPRD and community. A citizen-based nongovernmental organization, the Lakes and Recreation Association of Twin Lakes, Inc., (LARA), also serves the Twin Lakes community. LARA is incorporated in the State of Wisconsin as a Chapter 181, nonstock, not-for-profit corporation.

Twin Lakes Protection and Rehabilitation District
Currently, there is no formal procedural mechanism through which the citizen-based steering council, noted above, can interact directly with the TLPRD Board of Commissioners. To improve communication and create a more productive relationship between the TLPRD Board of Commissioners and the electors and property owners

[38]*See University of Wisconsin-Extension Publication No. G3216,* The Lake in Your Community*, 1986.*

of the District, as well as to develop a greater sense of community involvement and support for District policies, the following alternatives may be considered; namely, 1) the granting of self-governance to the TLPRD through the petitioning process provided in Sections 33.23(3) and 33.28, *Wisconsin Statutes*, or 2) the development and adoption of a formal reporting procedure to enable the citizen steering council to interact with the TLPRD Board of Commissioners during their regularly scheduled meetings. This latter alternative has been adopted by several public inland lake protection and rehabilitation districts within the Southeastern Wisconsin Region, including the Big Muskego Lake Management District formed by the City of Muskego in Waukesha County and the Paddock Lake Management District formed by the Village of Paddock Lake in Kenosha County. Creation of such an interactive liaison mechanism validates the existence of the citizen steering council and improves the likelihood of success of District-sponsored events, activities and policies by encouraging a sense of community and partnership between the citizenry and the Lake District Board of Commissioners. This alternative also enables the municipality to focus on the broader range of concerns facing the community, while simultaneously focusing on lake protection and rehabilitation issues in an effective and meaningful way. Both of these options are considered feasible.

Lakes and Recreation Association of Twin Lakes, Inc.

The LARA is incorporated in the State of Wisconsin as a Chapter 181, nonstock, not-for-profit corporation. This nongovernmental organization has, as its mission, the following: "to protect the lakes located in the Village of Twin Lakes and lake rights of all the property owners through information, communication and publication of an email newsletter and maintaining a web site on current issues while providing continuing support to the Lake District Committees." It is intended that LARA supplement the work of the Lake Management District by promoting: understanding and awareness of the "facts behind lake issues;" sound, practical governance and support on lake issues; common lake goals for the betterment of the entire watershed through "common sense solutions and social awareness;" policies based on preserving and protecting the lakes while maintaining high levels of safety for the residents and visitors who come to use the lakes; and, balanced decision making by the community. Issues of concern are identified by the members of the Association at their annual meeting, which generally is held immediately prior to that of the Lake Management District, and shared through periodic newsletters published by the Association. LARA encourages it membership to participate in the annual meeting of the District, and to become involved in the various advisory committees established by the District. LARA has been a positive force in encouraging the citizens of the Twin Lakes community to become involved with lake issues. Continuing the ongoing partnership between LARA and the Twin Lakes Protection and Rehabilitation District, including the citizen-based Steering Council and its committees, is recommended.

Recommended Measures

In order to create a more productive relationship between the TLPRD board and the citizens of the District, and to improve communication between the property owners and electors of the District and the Board of Commissioners, it is recommended that a formal reporting mechanism be developed between the TLPRD and the citizen-based steering council. As of 2008, this recommendation had been implemented through the appointment of Lake District Commissioners to each of the Committees and to the Steering Council, so as to facilitate communication between the Board of Commissioners and the citizen advisory committees. Additionally, during the 2008 annual meeting of the District, the citizen chairperson of the Steering Council actively participated in the conduct of the annual meeting of the TLPRD. This formal relationship between the committees, Steering Council, and Lake District Board of Commissioners should be maintained. In this regard, it is suggested that the quarterly Commissioner meetings required pursuant to Section 33.28(6) of the *Wisconsin Statutes* be held in conjunction with the monthly meetings of the Steering Council, and that both meetings allow an exchange of views. It should be noted, however, that during the quarterly Lake District Board of Commissioner meetings only the Lake District Commissioners would be able to vote on motions or resolutions, even if the discussion includes the views of the Lake Steering Council members.

Chapter III

ALTERNATIVE AND RECOMMENDED LAKE WATER QUALITY MANAGEMENT MEASURES

FIGURES

#141044 V1 - CAPR-302 V2 CH-3 FIGURES DRAFT
300-1060
MGH/JAT/pk
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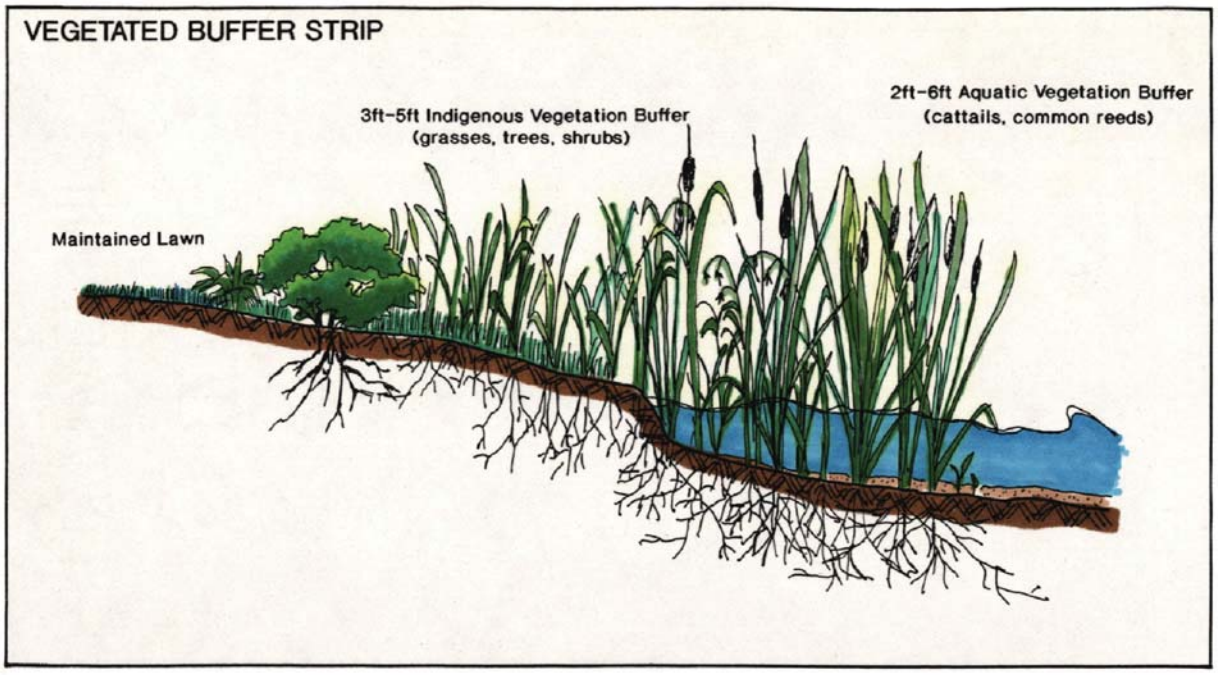
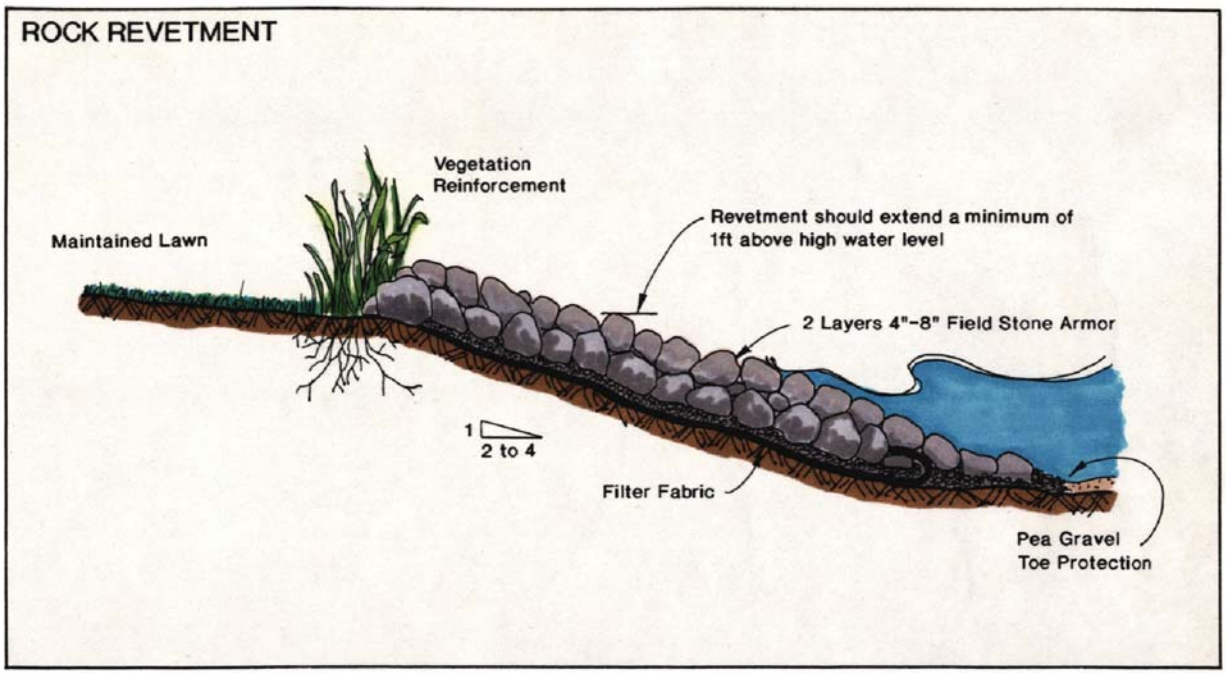
Figure 1

RECOMMENDED ALTERNATIVES FOR SHORELINE EROSION CONTROL



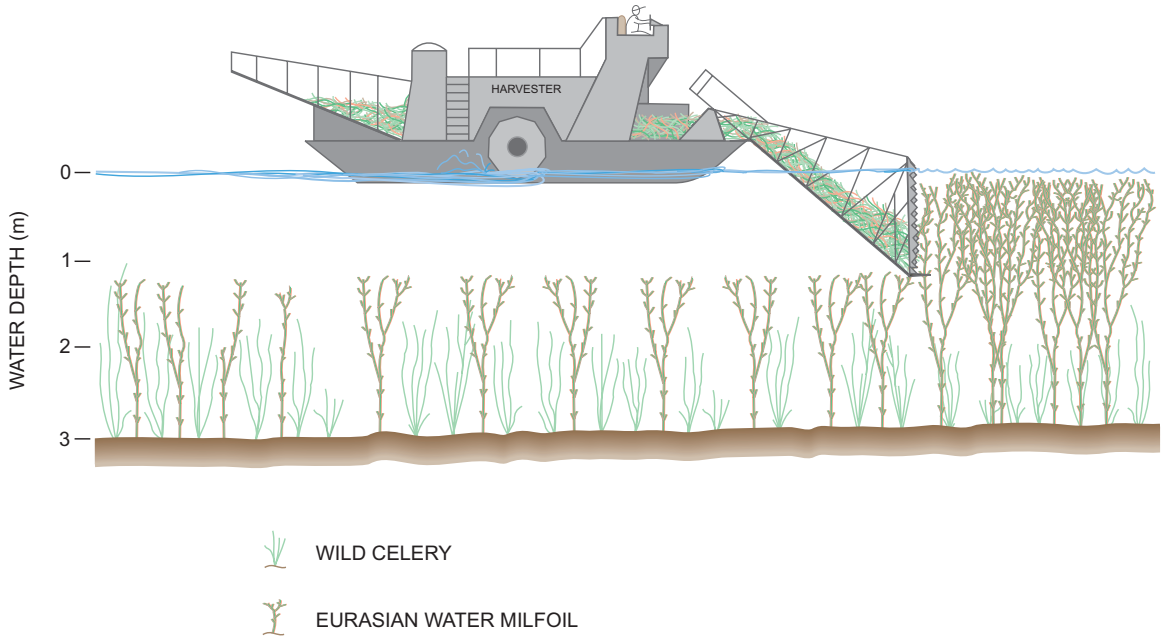


NOTE: Design specifications shown herein are for typical structures. The detailed design of shoreline protection structures must be based upon analysis of local conditions.

Source: SEWRPC.

Figure 2

PLANT CANOPY REMOVAL WITH AN AQUATIC PLANT HARVESTER



NOTE: Selective cutting or seasonal harvesting can be done by aquatic plant harvesters. Removing the canopy of Eurasian water milfoil may allow native species to reemerge.

Source: Wisconsin Department of Natural Resources and SEWRPC.