## Protecting in partnership: the Mukwonago River Basin Protection Plan

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#### Abstract

The Wisconsin (USA) Lakes Partnership is a coalition of academic, advocacy and regulatory entities focused on ensuring effective conservation of the State's natural and water resources. This report summarizes a successful application of the Partnership concept through a case study describing the process that led to the development and implementation of a River Protection Plan for the Mukwonago River Watershed. In addition to the actions of individual landowners, a planning programme sponsored by special purpose units of government, funded in part by the State of Wisconsin and in part by non-governmental organizations, and conducted by a regional planning authority in partnership with local universities and governmental agencies led to the development of the Mukwonago River Watershed Protection Plan, the contents of which were validated and guided by stakeholders through a Watershed Team and *ad hoc* Advisory Group. The Watershed Team secured and provided in part the necessary financial support for the conduct of the planning programme, while the Advisory Group identified concerns and validated recommended responses to address the shared issues of concern. The resulting watershed protection plan sets forth a strategy for the maintenance and protection of the high-quality water resources of the Mukwonago River Basin.

#### Key words

basin plans, citizens, collective actions, government, non-governmental organizations, stakeholders.

#### BACKGROUND

The Mukwonago River and its major tributaries are a unique water resource located in south-eastern Wisconsin, USA. The river and its watershed include portions of various governmental jurisdictions, including the Villages of Eagle, East Troy, Mukwonago and North Prairie, and the Towns of Eagle, East Troy, Genesee, LaGrange, Mukwonago, Ottawa, Palmyra, Troy and Vernon, all located primarily within Walworth and Waukesha Counties with a small portion within Jefferson County (Figure 1).

The Mukwonago River system includes seven major lakes (i.e. lakes with a surface area of >0.25 square kilometres (km<sup>2</sup>)), seven minor lakes and numerous tributary streams. The system supports a variety of fishes, mussels and other aquatic organisms, including nearly 80 State-listed threatened and endangered species and species of special concern. The water budget for this river system includes groundwater recharge, seepage from wetlands and glacial moraines, direct precipitation and run-off from a 192 km<sup>2</sup> watershed. The Mukwonago River discharges into the Fox (Illinois) River, a tributary stream to the Mississippi River drainage system, within the Village of Mukwonago.

The Mukwonago River has unique recreational values. The majority of the stream and adjacent riparian corridors exhibits a rural character, which provides recreational opportunities within and adjacent to the river system. Utilized for fishing, hunting, boating, water skiing, wading, canoeing, wildlife watching and scenic viewing, it provides ecological and recreational benefits for adjacent landowners and other users. Public recreational access opportunities are provided through boating access sites on the major lakes and public parks and other facilities adjacent to the lakes and river system.

The Mukwonago River system also has unique aesthetic and ecological values. Lulu Lake is designated as an Outstanding Resource Water (ORW) under Chapter

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Fig. 1. Mukwonago river watershed and subwatershed divisions within South-Eastern Wisconsin (USA; SEWRPC 2010).

NR 102, 'Water Quality Standards for Wisconsin Surface Waters', of the Wisconsin Administrative Code, and, as noted above, the Mukwonago River downstream of Eagle Spring Lake to its confluence with Upper Phantom Lake, is designated as an Exceptional Resource Water (ERW) under Chapter NR 102 (State of Wisconsin 2011a). The Mukwonago River also is designated under Chapter NR 104 (State of Wisconsin 2011a) as a potential Class II brown trout (Salmo trutta) fishery, with limited natural reproduction, extending from Phantom Lake upstream to Eagle Spring Lake, and as a Class I, self-sustaining brown trout fishery upstream from Lulu Lake. Jericho Creek is designated as a Class III brown trout fishery, requiring annual stocking, for its entire length. Despite these classifications, only brook trout (Salvelinus fontinalis) have been stocked, becoming an important element of the overall fishery since 2002.

In contrast, recent introductions of non-native species such as Eurasian water milfoil (*Myriophyllum spicatum* L.), zebra mussels (*Dreissena polymorpha*), Asian clams (*Cor*-

and phragmites (Phragmites australis) threaten the biological integrity of this system. Additionally, the Mukwonago River watershed is threatened by increasing urbanization (Figure 2), particularly in recent years. Figure 2 also shows that urban development pressures among subwatersheds are not the same and were primarily focused in the headwater Jericho subwatershed and lowest reaches of the Phantom subwatershed. The very attributes that make the Mukwonago River and its watershed so unique within the south-eastern Wisconsin region are the same attributes that attract new residents, businesses and supporting infrastructure to the watershed. Increasing urban development in recent years has led to conversion of agricultural and open lands to residential lands with increased impervious area and volumes of stormwater run-off, increased demands for groundwater and increased demands on the recreational opportunities throughout the river system. Based upon the year 2000 land use analysis, Figure 3 shows that the Mukwonago River watershed continues to

bicula fluminea), purple loosestrife (Lythrum salicaria L.)



**Fig. 2.** Historical urban growth among subwatersheds within Mukwonago river watershed (SEWRPC 2010).

be dominated by rural lands that are mostly agricultural. These increased demands could affect the hydrological and ecological integrity of this outstanding and exceptional resource water system.

#### PURPOSE OF THE PLAN

Research shows that the health of a lake or stream is usually a direct reflection of the use and management of the land surface within its watershed (see ILEC 2005). The Mukwonago River, its tributaries and associated wetlands, with their unique blend of cold- and warm-water resources within a biologically diverse watershed, can be considered to be in very good health. Actions by both individual landowners and by the communities within which they live have served to maintain the river system in an exceptional condition, a fact recognized by the State of Wisconsin (2011a) through its designation as an Exceptional Resources Water of the State, pursuant to



**Fig. 3.** Per cent urban versus rural land use among subwatersheds within Mukwonago river watershed in 2000 (SEWRPC 2010).

Chapter NR 102 of the *Wisconsin Administrative Code*. Section NR 102.11 defines such waters as 'surface waters which provide valuable fisheries, hydrologically or geologically unique features, outstanding recreational opportunities, unique environmental settings and which are not significantly impacted by human activities....'.

Consequently, the Mukwonago River Watershed Protection Plan (SEWRPC 2010) was designed to provide a framework to enable the communities within the drainage area to work together with a common goal, namely that of protecting and improving the water resources of the Mukwonago River through the management of its watershed. While the watershed protection plan focused on what could be carried out to prevent future water pollution or resource degradation from occurring while continuing to protect the existing high-quality resources from human impacts, this paper focuses on the process of stakeholder participation and involvement that formed the hallmark of this planning and protection effort.

These recent concerns, combined with the need to protect and preserve the ecology and water quality of Eagle Spring Lake and Upper and Lower Phantom Lakes, led to the development of comprehensive lake management plans that set forth priority actions to protect and preserve the ecology and water quality of these waterbodies (SEWRPC 1997a, 2006a,b, 2011a). Nevertheless, shared ongoing concerns over the state of the river linking the lakes remained.

The Mukwonago River Protection Plan was designed to complement the existing programmes, and ongoing management actions being implemented within the Mukwonago River watershed. The planning and implementation process embodied the ongoing commitments of governmental agencies, municipalities and citizens to diligent land use planning and natural resource protection. To this end, the plan presented new and refined recommendations for the implementation of appropriate and feasible watershed management measures specifically for enhancing and preserving the water quality of the Mukwonago River and for providing the public with opportunities for safe and enjoyable recreation within the Mukwonago River watershed.

## THE STAKEHOLDERS Antecedents

The Mukwonago River Protection Plan planning process arose from a general undercurrent of concern within the basin community. Town residents in the Towns of Eagle and Mukwonago initiated a buzz of concern about the type and rate of development occurring within their communities, and the increasingly urbanized character of that development. This concern was initially focused on the Lakes: Eagle Spring Lake in the Town of Eagle and Upper and Lower Phantom Lakes in the Town (and Village) of Mukwonago. This concern coincided with more vocal concerns being expressed by the Lake Beulah community in the Town of East Troy over the (then) plans of the Village of East Troy to site a municipal high capacity well adjacent to Lake Beulah, and with the statewide initiative of the State of Wisconsin to promote comprehensive planning across communities in the State (a programme known as 'Smart Growth').

This planning need (for integrated water resources planning) and requirement (for comprehensive planning), coupled with the acknowledgement of the high quality of the Mukwonago River ecosystem (SEWRPC 1997b), resulted in the request to Southeastern Wisconsin Regional Planning Commission (SEWRPC) by the Eagle Spring Lake Management District and Phantom Lakes Management District for planning assistance in developing an overall river and watershed protection plan for the Mukwonago River system. This paper analyses the roles, actions and outcomes of the stakeholder process employed by SEWRPC and its partners in the resultant planning process.

## The cast (in alphabetical order)

#### Eagle Spring Lake Management District

A special purpose governmental organization created under Section 33.21 of the *Wisconsin Statutes* (State of Wisconsin 2011b) for the purpose of undertaking a programme of lake protection and rehabilitation of Eagle Spring Lake. SEWRPC assisted the District with the preparation of both the first and second editions of a comprehensive lake management plan (SEWRPC 1997a, 2011a). The Eagle Spring Lake Management District was the grant applicant for a River Protection Grant that supported, in part, the inventory and planning process associated with the Upper portion of the Mukwonago River Watershed.

#### Friends of the Mukwonago River, Inc

A private, non-profit, non-governmental conservation organization dedicated to protecting the Mukwonago River and its associated watershed ecosystems by way of education, advocacy and promotion of sound land use throughout the watershed.

## Lake Beulah Management District

A special purpose governmental organization created under Section 33.21 of the *Wisconsin Statutes* (State of Wisconsin 2011b) for the purpose of undertaking a programme of lake protection and rehabilitation of Lake Beulah.

## Phantom Lakes Management District

A special purpose governmental organization created under Section 33.21 of the *Wisconsin Statutes* (State of Wisconsin 2011b) for the purpose of undertaking a programme of lake protection and rehabilitation of Upper and Lower Phantom Lakes. SEWRPC assisted the District with the preparation of a comprehensive lake management plan (SEWRPC 2006a,b). The Phantom Lakes Management District was the grant applicant for a River Protection Grant that supported, in part, the inventory and planning process associated with the Lower portion of the Mukwonago River Watershed.

## Southeastern Wisconsin Regional Planning Commission

A statutory agency created under Section 66.0309 of the Wisconsin Statutes (State of Wisconsin 2011b) for the purposes of conducting all necessary studies for the accomplishment of its other duties; making plans for the physical, social and economic development of the region; publicizing its purposes, objectives and findings, and distributing reports concerning these items; and providing advisory services on regional planning problems to the local government units and other public and private agencies in matters relative to its functions and objectives, acting as a coordinating agency for programmes and activities of local units and agencies as they relate to its objectives. Included within this mandate is the preparation of regional water quality management plans pursuant to authorities granted under the Federal Water Pollution Control Act (Government of the United States 2011).

#### The Nature Conservancy

A private, non-profit, non-governmental conservation organization dedicated to preserving the plants, animals and natural communities that represent the diversity of life on Earth by protecting the lands and waters they need to survive. Beginning in 1983, The Nature Conservancy (TNC) initiated the protection of the Mukwonago River Basin by purchasing the former Milwaukee Boys Club Camp. By 2010, TNC owned 1274 acres (5.2 km<sup>2</sup>) within the watershed and has helped to protect an additional 360 acres (1.5 km<sup>2</sup>) through its work with individual landowners and partner organizations.

#### Town of Eagle

A general purpose unit of government within which Eagle Spring Lake and its associated Lake Management District are located.

## Town of East Troy

A general purpose unit of government within which Lake Beulah and its associated Lake Management District are located. Towns are bodies corporate and politic, having those powers granted by Chapter 60 of the *Wisconsin Statutes* (State of Wisconsin 2011b).

#### Town of Mukwonago

A general purpose unit of government within which Upper Phantom Lake and a portion of Lower Phantom Lake and their associated Lake Management District are located.

#### University of Wisconsin–Extension

The community outreach branch of the University of Wisconsin system. The University of Wisconsin system is established as a system of institutions of learning within the State of Wisconsin pursuant to Chapter 36 of the Wisconsin Statutes (State of Wisconsin 2011b). The Extension programme is undertaken by the University system in cooperation with the Counties, within the limits of funds provided by the University system and cooperating state and federal agencies, to make available necessary facilities and conduct programmes in the areas of professional and liberal education, human resource development, economic and environmental development, and any other extension work provided for in an Act of the United States Congress. For the purposes of the Mukwonago River Protection planning project, the University of Wisconsin-Extension (UWEX) Basin Educator for the Fox River Basin provided community informational programming in support of the project.

## Village of Mukwonago

A general purpose unit of government within which a portion of Lower Phantom Lake and its associated Lake Management District are located. Villages, whose powers are granted pursuant to Chapter 61 of the *Wisconsin Statutes* (State of Wisconsin 2011b), have power to manage and control village property, finances, highways, streets, navigable waters and public services; act for the government and good order of the village, for its commercial benefit and for the health, safety, welfare and convenience of the public; and carry its powers into effect by license, regulation, suppression, borrowing, taxation, special assessment, appropriation, fine, imprisonment and other necessary or convenient means.

#### Walworth and Waukesha counties

General purpose units of government, created pursuant to Chapter 2 of the Wisconsin Statutes (State of Wisconsin 2011b), within which the Mukwonago River and its watershed are located. Counties, whose powers are granted pursuant to Chapter 59 of the Wisconsin Statutes (State of Wisconsin 2011b), have power to sue and be sued; acquire and hold, lease or rent real and personal estate for public uses or purposes, including the authority to enter into leases or contracts with the State; and make such contracts and to do such other acts as are necessary and proper to the exercise of the powers and privileges granted and the performance of the legal duties charged upon it. Every county might exercise any organizational or administrative power subject only to the Constitution (State of Wisconsin 2011c) and enactments of the Legislature which are of statewide concern and which uniformly affect every county.

#### Wisconsin Department of Natural Resources

The governmental agency tasked with the conservation, preservation and management of the natural resources of the State of Wisconsin. As part of its mandate, the Wisconsin Department of Natural Resources (WDNR) administers various grant programmes on behalf of the State. The lake management planning grant programme (Chapter NR 190 of the *Wisconsin Administrative Code*) and lake protection grant programme (Chapter NR 191 of the *Wisconsin Administrative Code*) both funded through revenues generated by the State's tax of gasoline; the river protection grant programme (Chapter NR 195 of the *Wisconsin Administrative Code*); the recreational boating facilities grant programme (Chapter NR 7 of the *Wisconsin Administrative Code*); and the aquatic invasive species control grant programme (Chapter NR 198 of the

*Wisconsin Administrative Code*). The Mukwonago River Protection Plan was developed with financial assistance provided through the River Protection Grant programme, local funds provided by the Eagle Spring Lake Management District and Phantom Lakes Management District, and in-kind contributions from the TNC and Friends of the Mukwonago River.

## STAKEHOLDER PARTICIPATION Initiating the participatory process

Early in the process of initiating the Mukwonago River Watershed Protection planning programme, a Watershed Team' was established as an informal watershed coalition for the purpose of focusing attention on the entire hydrological system of the Mukwonago River Basin. This Watershed Team was spearheaded by the Phantom Lakes Management District and the Eagle Spring Lake Management District, special purpose units of government who applied for and received a grant awarded under Chapter NR 195 of the Wisconsin Administrative Code for River Planning and Management (State of Wisconsin 2011a). In addition, the Watershed Team was completed by representatives of the TNC, Friends of the Mukwonago River, Waukesha County, WDNR, UWEX and SEWRPC. SEWRPC prepared the plan on behalf of the Watershed Team. Representatives of the Lake Beulah Management District, Walworth County, and the Towns and Villages within the basin also participated as their interests intersected with the scope of the project.

As the Mukwonago River Watershed Protection planning programme got underway, SEWRPC was assisted in the planning process by representatives from the ad hoc Mukwonago River Watershed Protection Advisory Group (the 'Advisory Group'), comprised of self-nominated individuals representing a range of stakeholders with interests in the Mukwonago River watershed. These stakeholders represented the diversity of interests and perspectives that affect the watershed, and included farmers, land developers, residents and environmental groups; county and local governments; the Southeastern Wisconsin Fox River Commission (SEWFRC; see SEWRPC 2011b); lake and property owners associations; and others who volunteered their time to review all or portions of the plan as it was formulated. During 2009, the participants in the Advisory Group either attended one or more of the several meetings or provided electronic mail correspondence to define issues, develop goals and establish recommendations that would help manage local community growth while protecting the natural resources in the Mukwonago River watershed. It is important to note that the Advisory Group devoted much time and thought to the development of the plan goals, which formed the foundation for generating and evaluating the alternative and recommended plans, and for establishing a sound framework within which to implement the recommendations.

#### Conducting the participatory process

The Watershed Team and Advisory Group developed the following general goals for the development of the protection plan:

 protect and improve wildlife, land, surface water and groundwater resources;

• minimize impacts of land development by controlling agriculture and urban run-off pollution and flooding;

• build partnerships and inform public to promote protection and use of natural resources.

In formulating the protection plan, as embodied within these goals, public involvement and participation was viewed as an integral element of the process. Through such involvement, the resultant plan would reflect the consensus of the citizens and communities within the watershed. Upon completion of the protection plan, this consensus was viewed as critical to the adoption and implementation of the plan recommendations, as any implementation would be reliant upon the actions of the general purpose units of government, and support of the special purpose units of government, within which the watershed is located. In particular, actions to protect the resources of the basin are largely dependent upon regulating land uses. Such regulation is the shared responsibility of the Counties, Villages, and Towns. In addition, because of the mandate of the lake management districts, aspects of the control of water quality through in-lake management and stormwater management, for example, would involve the actions of the lake management districts and WDNR.

## Implementing the planning process

The WDNR awarded the River Protection grant funding in two tranches, initially in 2008 to the Eagle Spring Lake Management District for the upper portion of the watershed and subsequently in 2009 to the Phantom Lakes Management District for the lower portion of the watershed. Both lake management districts requested the assistance of SEWRPC in the conduct of the planning studies. SEWRPC, in turn, solicited data and information from various agencies, including WDNR and local universities.

The WDNR staff had conducted numerous studies of the river during the past and shared their information on fisheries and benthic invertebrates (mussels) as a contribution to the planning process. Similarly, the Wisconsin Lutheran College, University of Wisconsin-Madison, University of Wisconsin-Milwaukee and Carroll University had all conducted investigations of parts of the river system and shared their information on fishes and water quality. The investigations undertaken by students of the University of Wisconsin-Madison Department of Geoscience were especially helpful in providing an understanding of the groundwater system and its interactions with the Mukwonago River. River flow data were compiled by the US Geological Survey (USGS) from a gauging station located at the outlet to the Mukwonago River from Lower Phantom Lake. The ability to show this connection between the stream channel and groundwater was a vital component of the stakeholder participation process (Figure 4), which served as the foundation for the protection of groundwater recharge areas as an important dimension of protecting water quality and quantity in the Mukwonago River system.

In addition to information provided by cooperators in the project, SEWRPC staff collected site-specific information from the river system (Figure 5), including data on river morphology based on numerous transects compiled from upstream to downstream; additional fisheries data collected in cooperation with the universities; and temperature data from various points within the basin. This information helped the stakeholders develop an understanding of the longitudinal connections (channel to channel) from upstream to downstream within the watershed as critical linkages between the lakes in this system, which led to incorporation of this important dimension into the final recommendations of the plan.



(USGS monitoring well WK05/19E/31-1301 is located outside of the Mukwonago River watershed about five miles south of the City of Waukesha, Wisconsin; water level records in feet are referenced to 1929 National Geodetic Vertical Datum.)

Fig. 4. Mukwonago river daily discharge compared with shallow aquifer groundwater levels and total precipitation in Waukesha County, Wisconsin: 1972–2009 (SEWRPC 2010).



Fig. 5. Mean water depth, sediment depth and dominant substrate composition among transects within Mukwonago 2 stream reach (SEWRPC 2010).

Southeastern Wisconsin Regional Planning Commission staff also utilized data collected for use in other planning programmes, including data acquired for use in the regional natural areas and critical species habitat protection and management plan (SEWRPC 1997b). Land use and planned land use, major drivers of water quality and water quantity change within the system, data were acquired from the regional land use plans prepared by the Commission (see, for example, SEWRPC 1997c, 2006c). In addition, recognition also was given to the potential risks associated with climatic variability as identified by the State of Wisconsin (University of Wisconsin Board of Regents 2011). These issues were specifically considered in terms of extreme departures from normal and longer-term changes from colder-drier to warmerwetter conditions (see National Oceanic Atmospheric Association 2012).

Compilation of these data into a single source document (SEWRPC 2010) was an important element of the planning programme and formed a major outcome of the planning project. These data, presented in the plan, form a baseline from which future studies can evaluate changes within the drainage system.

As data were collected and analysed, the SEWRPC team in partnership with the UWEX basin educator and WDNR staff shared the information with the Watershed Team and Advisory Group in a series of public meetings. These meetings provided citizens and decision-makers with the opportunity to comment in advance of plan formulation and share their local knowledge and experiences with the planning team. In many cases, this local knowledge enhanced the understanding of the project team and added to the knowledge base used in the planning process. Additionally, these meetings resulted in the determination of consensus about the nature and severity of concerns identified within the watershed, and contributed to a prioritization of concerns necessary to the formulation of corrective and remedial actions.

## Developing the plan

As noted above, the Watershed Team and Advisory Group developed three general goals for the development of the protection plan, focusing on land and water management, land development and building of partnerships. Each of these elements is reviewed *ad seriatim* below.

#### Land and water management

It is a testimony to the landowners within the Mukwonago River watershed that substantial portions of the watershed have been maintained in, or returned to, a largely natural condition. Land disturbances have been minimized within the stream corridor for more than 50 years, allowing regrowth of the native woodland and prairie. While the watershed continues to be subjected to increasing human demands for urban density development, the impacts of such demands have been moderated by good stewardship practices of both individual land owners and targeted land acquisitions by the WDNR and TNC.

Three objectives were associated with land and water resource management in the Mukwonago River watershed:

1 Preservation and protection of environmentally sensitive areas, including stream buffers, wetlands, fish and wildlife habitat, and environmental corridors. Wetlands, stream banks and lake shores provide a range of ecosystem services for the diverse populations of wildlife in the watershed and contribute to the protection and enhancement of human investments in the watershed – contributing not only to the scenic beauty of the watershed but also to the interception of run-off and associated contaminants. Because of the width of the natural lands surrounding the Mukwonago River, these buffers provide habitat for wildlife as well as travel corridors for migratory species.

2 Maintenance of habitat and water quality to support high-quality warm-water and cold-water communities of fishes and other aquatic life. The natural geography and topography of the Mukwonago River watershed have helped to protect the landscape from human intrusion. These areas have been included into the Environmental Corridors mapped by SEWRPC (see SEWRPC 2006c) and incorporated into Town zoning ordinances. These corridors are at least 1.6 km<sup>2</sup> in area, 3.2 km or more in length and at least 61 m wide. As of 2000, these areas of woodland, wetland and wildlife habitat encompassed about 30% of the Mukwonago River watershed.

3 Preservation and protection of groundwater recharge areas and groundwater quality. One of the major elements contributing to the high-quality habitat in the Mukwonago River watershed is the groundwater inflow into the lakes and streams making up the river system. Both the groundwater recharge and discharge areas have implications for the lake levels, for the stream flows and for the cold-water habitat. Paving over recharge areas will limit groundwater recharge, while groundwater pumping might impact the maintenance of cold-water conditions in the streams downstream of the groundwater discharge areas.

#### Land development control

Complementing the land and water resource management measures are land development controls. There are four objectives associated with land and water resource management in the Mukwonago River watershed:

1 develop policies and install practices to minimize urban non-point sources of pollution;

2 develop policies and install practices to minimize agricultural non-point sources of pollution, protect and preserve riparian buffers and environmental corridors;

3 preserve floodwater storage areas and control the quality of run-off from urban development; and

4 promote agricultural practices that meet or exceed standards.

Achieving these objectives requires action both by landowners and other stakeholders. Landowners are to be encouraged to maintain the setbacks and buffer strips around the lakes and stream course. Where lands are considered for development, it is recommended that conservation or cluster development techniques be adopted, siting homes and infrastructure away from the riverbanks while maintaining the shorelines in a natural state (SEW-RPC 2006d). As lands become available for sale, it is recommended that they be acquired by governmental and/ or non-governmental organizations and placed into conservancy; where fee simple purchase might not be possible, acquisition of conservation easements by these entities should be considered, the objective of such actions being the preservation of the riparian corridor lands (see SEWRPC 1997b).

Prioritization of purchase and/or easement acquisition should be predicated upon three factors, namely (i) the lands being within the 1% annual probability of occurrence floodplain, the so-called 100-year recurrence interval floodplain boundary; (ii) their proximity to other protected lands currently in public or private ownership; and (iii) their status as lands with a high groundwater recharge potential. As a guide, the minimum goals for protecting the Mukwonago River would be the 'Goals of 75', namely a minimum 75 feet (23 m) setback from the water's edge, to achieve a 75% reduction in contaminant loads from the surrounding land surface, with 75% of the riparian corridor being maintained in natural vegetative cover. Beyond these areas are the 122-m riparian buffers that approximately correspond to the 1% recurrence interval floodplain, and beyond this is the 305-m shoreland zone. This latter zone corresponds in many cases to the extent of the primary environmental corridors within the Mukwonago River watershed. In point of fact, the existing setbacks and status of the Mukwonago River watershed corridor are largely consistent with these goals except for a few isolated pockets. It is these pockets that should be considered to be priority areas for protection.

#### Partnership development

The third goal involves the building of partnerships to promote the protection of the natural resources of the Mukwonago River watershed. There are four objectives within this goal:

1 development and expansion of land use and water quality monitoring programmes;

2 implementation of public informational programming as required under the Municipal Separate Storm Sewer System (MS4) permitting requirements;

3 continuation of the cooperation among communities and community organizations and the ongoing development of public participation opportunities; and

4 promotion and expansion of safe recreation opportunities.

Achieving these objectives requires the participation and active involvement of many sectors within the Mukwonago River communities, including governmental entities, not-for-profit organizations, and individual citizens and landowners. It is through the collective action of all of these stakeholders that the efforts of previous generations can be maintained, protected and expanded.

The Mukwonago River watershed protection plan planning programme encouraged community involvement and was supported in many ways by government, nongovernmental organizations and citizens. The Eagle Spring, Phantom Lakes and Lake Beulah Management Districts; TNC; the Friends of the Mukwonago River; the riparian municipalities (the Villages of Eagle, East Troy, North Prairie and Mukwonago, and the Towns of Eagle, East Troy, Genesee, Mukwonago, Ottawa, Palmyra, Troy and Vernon); Jefferson, Walworth and Waukesha Counties; WDNR; the schools and libraries; and the individual landowners within the watershed all form constituencies that benefit from the high-quality natural resource that is the Mukwonago River watershed. These various entities also are the principal stakeholders to be tasked with maintaining this resource base and implementing the watershed protection measures. To this end, through the collective efforts of all of the stakeholders, the necessary balance between the human community and the aquatic and terrestrial communities that comprise the watershed can be maintained and enhanced, to the benefit of all.

The protection strategy in the plan therefore is based on preserving existing resources through a combination of regulatory measures, restoration project measures, and continued informational and outreach programming. These elements are necessary to help balance the needs of the resource and maintain the high-quality aquatic and terrestrial communities within this system, as well as to accommodate the expected increases in development pressures in the future. Regulations alone will not be adequate to protect this valuable resource. Rather, the future protection of the Mukwonago River watershed will depend upon the continued vigilance, cooperation and partnership of all stakeholders.

# Implementing the plan through stakeholder action

The recommended plan is based upon a three-tiered framework approach, summarized in Figure 6, focused on the reconnection of the main waterways with their tributary systems and associated lands that collectively form the Mukwonago River system. This framework is specifically designed to protect and restore the integrity of four essential dimensions within a stream system that include (FISRWG 1998; Frissell et al. 1986; Stanford et al. 1996; McDonough et al. 2011) (i) channel to channel, or the longitudinal connection; (ii) groundwater to channel, or the vertical connection; (iii) channel to land or the lateral connection and (iv) time. These connections also are related to position within the watershed and to scale, as well as associated with sensitivity to disturbance, expected time to recovery and time for implementation measures. The three components of this framework strategy are as follows:

• Tier 1 – Restoring connectivity and habitat quality between the mainstem of the Mukwonago River and the Fox River, the mainstem of the Mukwonago River upstream of Lower Phantom Lake, the mainstem of the Mukwonago River flowing into Eagle Spring-Lulu Lakes, and the unnamed tributary stream upstream of Lake Beulah and Lake Beulah;

• Tier 2 – Restoring connectivity and habitat quality between the tributary streams and the mainstem of the Mukwonago River; and

• Tier 3 – Expanding the connection of highest-quality fish, mussels and other invertebrates, and habitat sites within subwatersheds.

The Tier 1 prioritization is based upon the understanding that the Fox River and major lakes including Eagle Spring-Lulu, Phantom and Beulah Lakes are the most



Fig. 6. Graphical representation of three-tier river protection strategy set forth in Mukwonago river watershed protection plan (SEWRPC 2010).

diverse resources and greatest assets in the watershed for the maintenance of high-quality recreation as well as a sustainable fishery. This prioritization is also based upon the understanding that within river systems, the widest and deepest downstream areas are generally associated with a greater abundance and diversity of fishes compared to narrower and shallower upstream areas.

The Tier 2 prioritization is based upon the understanding that, through their connection with the mainstem of the Mukwonago River, the tributaries are the next most diverse resources and greatest assets that have the potential to restore and maintain a sustainable fishery. Tributary streams that are connected to the associated mainstem of stream systems have a greater potential for increased fish abundance and diversity via access to feeding, rearing and spawning, as well as refuge from thermal stress or low-water periods.

The Tier 3 approach is a 'catch-all' approach that enables stakeholders to link the goals of habitat restoration and improvement of recreational options with ongoing activities throughout the watershed. This strategic element provides the flexibility for communities and stakeholders to take advantage of opportunities throughout the watershed that might arise independently of the primary strategy of restoring linkages with the Fox River and major lakes within the Mukwonago River system.

Since the publication of the Watershed Protection Plan (SEWRPC 2010), under the auspices of the Friends of the Mukwonago River, the Friends, TNC and the lake management districts have used the plan to focus their efforts in informing their members and constituents and in conveying the basic principles of the plan to the local governments within the watershed. Local governments, such as the Town of Mukwonago and Town of Eagle, have adopted the principles set forth in the plan and have mandated their plan commissions to utilize the guidelines of the plan in making land use decisions within the portions of their jurisdictions in the watershed. For example, the Town of Eagle has utilized the plan to inform a local land use decision relating to a proposed residential and light industrial development at the headwaters of the Jericho Creek tributary to the Mukwonago River. Jericho Creek receives sufficient groundwater discharge to meet the cold-water quality standard designation of the State of Wisconsin (2011a). Brook trout were found in both the upper and lower portions of the Creek, which also was found to contain several species of fishes that are intolerant to pollution, including a species of special concern in

the State of Wisconsin. The extensive riparian buffers along the majority of the Creek help to maintain this high-quality resource, while the lack of disturbance by channelization has preserved much of the instream aquatic habitat; in addition, a limited number of crossings along Jericho Creek has helped to maintain the continuity of the riparian buffers and protect the Creek from land-sourced pollutants. Recognition of the fact that Jericho Creek is a high-quality cold-water brook trout stream has led the Town to protect the stream from being encroached upon by the proposed additional urban density development.

From the perspective of an ongoing assessment of ecosystem health, the Fish Committee created under the auspices of the TNC Mukwonago River Initiative brings both the WDNR regulatory staff and research staff to the table together with staff from the local universities, including private universities such as the Wisconsin Lutheran College and Carroll University, and public institutions such as the University of Wisconsin, the lake districts and SEWRPC staff. Included on this Committee are not only fisheries staff but also individuals versed in water quality assessments and macroinvertebrate studies. The Committee meets approximately quarterly to share data and coordinate field work. This Committee provides a forum for ongoing 'real-time' evaluation of the state of the watershed. Inclusion of the universities allows the development of a new generation of water resources professionals versed in the issues and concerns associated with a 'real-world' case study, while the participation of the lake districts ensures that the information is transferred back to the community in a timely manner, making the management of the Mukwonago River Watershed a living process.

## LESSONS LEARNED

The conduct and successful conclusion of the Mukwonago River Watershed Protection Plan planning programme, in part, was the culmination of a 'perfect storm' of increasing citizen/stakeholder concerns, organizational interest and involvement, and legislative mandate. In great part, however, the opportunities to complete the Mukwonago River Watershed Protection Plan were created long before the execution of the planning programme. These opportunities arose from the decision of landowners, subsequent to the Second World War, to allow the riparian corridor of the Mukwonago River in large part to revert to a natural woodland–prairie condition. The reasons for this are not clear, but, based upon aerial photographic evidence, the riparian owners ceased cultivating these lands after 1942, when the aerial photographs show extensive cultivation in the riparian zone. Thus, engaging the individual landowners/stakeholders is a key element in providing the opportunities for future generations to protect and preserve portions of the shared natural resource base.

Early recognition of critical environmental assets also is critical for successful land management. Such early recognition, in addition to the actions of the individual landowners, is evidenced by the activities of the TNC and WDNR in acquiring key portions of the headwaters of the Mukwonago River and implementing work programmes aimed at controlling non-native species and restoring natural structure and function to these portions of the watershed. Many of these actions took place beginning in the 1980s. To this end, the emergence of a 'champion' is a key element in providing the opportunities for future generations to protect and preserve portions of the shared natural resource base.

Complementary to the actions of the TNC and WDNR in recent years have been the actions of the public inland lake protection and rehabilitation, or lake management. districts in the watershed. As these are voluntary units of government, the creation and continuity of these special purpose organizations demonstrate an ongoing commitment by the people of the watershed to the protection and rehabilitation of the basin's water resources. Through the respective planning programmes executed by the districts, the electors and property owners of the districts have gained knowledge of the watershed draining to the lakes. This knowledge is essential to creating a watershed perspective among stakeholders and is the foundation for basin-wide actions such as purchase of conservancy lands, promulgation of appropriate land use regulations and acceptance of limitations on individual property rights for the benefit of the environment. Consequently, dissemination of knowledge is foundational both to individual action and to community action.

While stakeholder action is critical to the protection and preservation of such exceptional and outstanding natural resources as the Mukwonago River, the assistance provided to these stakeholders by government agencies, educators and non-governmental organizations forms an important element in ensuring a successful outcome. In a society that is increasingly specialized and, hence, compartmentalized, access to specialized talents and knowledge is necessary to ensuring the availability and application of a wide range of skills to resolving issues of shared concern. To this end, appropriate and complete documentation of the state of the basin will provide a common platform for future action, and the baseline metric against which success can be determined. In this regard, the role of the Mukwonago River Watershed Protection Plan can be viewed not only as a catalyst to present actions but also as a basis for future actions within specific watersheds. The Mukwonago River Watershed Protection Plan not only captures a 'current' condition within the River Basin but also embodies the consensus of opinion and resolve that will enable effective contracting associated with plan implementation as well as efficient conservation of resources, whether these be human, financial or ecosystem based.

## CONCLUSION AND SUMMARY

The stakeholders of the Mukwonago River Basin in south-eastern Wisconsin (USA) include a wide variety of interested parties, including State, county and local governments, special purpose units of government, non-governmental organizations and individuals. It is the collective actions of this entire group of stakeholders that has created the conditions within the watershed that have led to its classification by the State of Wisconsin as an exceptional and outstanding resource water of the State. While key actions to protect and preserve the watershed predate the Mukwonago River Watershed Protection Plan planning programme in many cases, the planning programme provides a formalized and coordinated basis for current and future actions, documenting the state of the basin in early 2010 (SEWRPC 2010). The plan not only summarized the state of the basin but also set forth a three-part strategy for the future: Tier 1 – Restoring the connectivity and habitat quality between the mainstem of the Mukwonago River and the Fox River, the mainstem of the Mukwonago River upstream of Lower Phantom Lake, the mainstem of the Mukwonago River flowing into Eagle Spring-Lulu Lakes, and the unnamed tributary stream upstream of Lake Beulah and Lake Beulah; Tier 2 - Restoring the connectivity and habitat quality between the tributary streams and the mainstem of the Mukwonago River; and Tier 3 - Expanding the connectivity between the highest-quality fish, mussels and other invertebrates populations and habitat sites within subwatersheds. Since its publication, the plan has guided land use decisions in several basin communities and has provided a focus for citizen actions as individuals, through civil associations, and by government.

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