A CLEAN Future for the Yahara Lakes: Solutions for Tomorrow, Starting Today

Submitted to Yahara CLEAN Memorandum of Understanding Signatories:
County Executive Kathleen Falk, Mayor David Cieslewicz, Secretary Matthew Frank, and Secretary Randy Romanski

And to the Dane County Lakes and Watershed Commission

By Lead Staff for Each MOU Signatory Agency:
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In addition, the Dane County Lakes and Watershed Commission played a key role in offering overall guidance to this effort. The Commission's Visioning, Partnerships and Planning Committee convened the early meetings that led to establishment of the Yahara Lakes Legacy Partnership and its mission of supporting Yahara CLEAN (Capital Area Environmental Assessment and Needs) and developing a framework for a long-term community-wide visionary plan for protecting and improving the quality of the Yahara chain of lakes. Yahara CLEAN has been a top priority for the Commission, and the Commission has been instrumental in obtaining funding for work accomplished to date, and supporting county staff in carrying out this work. Individual Commission members served on the committees as noted above.

Key contributors and support were provided by several individuals who did not formally serve on the advisory committees noted above. They are:

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The Nelson Institute's conference and forums built on two earlier conferences that engaged area residents with the history of the Yahara lakes improvement and generated momentum for next steps. The first was the 2005 North American Lake Management Society's international symposium held in Madison, especially its day-long "Madison Lakes and Nearby Waters" session and subsequent special *LakeLines* publication. The second was the Yahara Lakes conference in May 2007 co-sponsored by the Yahara Lakes Association (a riparian owners' association) and the Nelson Institute.

Finally, we would like to acknowledge the people who attended any of the several public meetings and provided their comments on our work. Hundreds of people attended public information sessions, or came in contact with this project in many ways.

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1. EXECUTIVE SUMMARY

1.1 Overview

The Yahara River runs through us, our community, and our lakes, and its watershed needs our help.

Two and one-half years ago, concern about the quality of lakes and waters in Madison and Dane County catalyzed a new wave of responsive action. A partnership called **Yahara CLEAN** (Capital Lakes Environmental Assessment and Needs) was forged between the City of Madison, Dane County, and the State Departments of Natural Resources (DNR) and Agriculture, Trade and Consumer Protection (DATCP). This effort was bolstered by funding from the agency partners to engage the community and establish "clear and achievable goals and an implementation plan for cleaning the lakes," and a grant from the Madison Community Foundation to partner in developing a community vision to guide long-term strategies. The result of this combined effort was broad collaboration and involvement from scientific and technical experts, agency staff, and many local lake organizations, farmers, business leaders, policymakers and concerned individuals.

The **Yahara Lakes Legacy Partnership** was formed to coordinate the agency partners and other groups working on environmental improvements in the watershed. It was also charged to lay the groundwork for a new permanent public-private partnership to clean up and restore our treasured lakes.

The Yahara CLEAN parties agreed to the following:

- Develop a shared vision for lake quality.
- Design models that could assess the sources of nutrients and sediments flowing into the lakes.
- Assess causes of bacterial outbreaks at beaches.

With this information in hand, they could then:

- Develop achievable goals.
- Identify needs and priorities for action.
- Advise the community and regulatory agencies on which actions would be most effective to address lake conditions, and finally.
- Communicate progress on lake restoration.

1.2 Vision

Participants in the vision process developed this statement:

> *The Yahara River watershed is a beloved asset to our communities. We are proud of the chain of beautiful, clean, and healthy lakes. There is widespread*

recognition of the lakes' contributions to our region's economy and quality of life. The lakes provide benefits that outweigh the investment required to keep them clean and healthy. Creative partnerships among urban and rural dwellers, farmers and other business people, and the private and public sectors generate lasting results as we tackle shared challenges across the watershed.

1.3 Assessment and Diagnosis

Models and several assessment tools have distilled extensive research and targeted the problems. Several state-of-the art models were used to assess nutrient and sediment loadings. One was a watershed-wide Soil and Water Assessment Tool (SWAT) that identified where phosphorus and sediment loads are coming from, and how much is flowing into the lakes. A second tool looked at specific influences on phosphorus loadings from various farm field uses and livestock management practices, shedding light on the impact of crop rotation, manure and fertilizer applications, and tillage in control strategies. Another model, designed to learn how phosphorus behaves in each lake (in-lake modeling), is still under development, but will be in place within the next year. In combination, these models are providing a sophisticated picture of the sources of the problem, concentrations, and locations. These are shaping strategies for intervention, providing insights into project costs, and have set the stage for taking action.

For example, we now know that the highest concentrations of the phosphorus in the watershed is coming from specific drainages northwest of Lakes Mendota, and in the upper Waubesa and Kegonsa watersheds. This tells us where to target the reduction efforts for biggest impacts. We also know that the benefits of reducing inputs into Lake Mendota will "cascade" throughout the full chain of lakes downstream. Thus, improving Lake Mendota's source-water quality is one of the linchpins in cleaning up the whole system.

For beaches, analyses included water testing and site analysis, including slope, sand characteristics, proximity to storm drains, visitor facilities, presence of geese and other wildlife, and other factors. This revealed the need for a multi-pronged approach, customized to the particular beach.

1.4 Goals

The broad goals of this effort are cleaner, clearer water throughout the watershed, and safe and healthy beaches. There is strong evidence that these goals can be achieved in ways that support the overall economic viability and quality of life in Dane County, including a viable and sustainable agricultural industry and business sector. When examining the vision of cleaner, clearer water throughout the watershed and safe and healthy beaches, one group identified six criteria for measuring progress on the lakes, and they projected what might be achieved in ten and twenty years if steps were taken to reduce phosphorus, sediments and bacteria. Highlights of their "ten-year" projections illustrate practical benchmarks toward the goals. The 20-year projections are even more encouraging. (See Appendix A, Attachment A8.) If we take action now, in ten years…

Water clarity: Algae blooms will be less dense, and less frequent. Near the shore algae is fading and being replaced by native lake plants.

Shore areas: All of the public shoreline will have natural plants, shrubs and trees (as appropriate to uses such as beaches, boat access points, etc.), and up to one in five private shoreline properties have natural plants. The community will see these plantings as increasingly desirable. Odor from decaying lake weeds will be greatly reduced.

Water safety and accessibility for recreation: There will be half as many (or less) beach closures, illness from contact with algal toxins is very rare, and the full range of lake users are able to access and enjoy the lakes year-round while respecting other users and activities.

Fishery health and fish consumption: While mercury levels are likely to remain high from global sources, we are maintaining a good overall fishery and rough fish populations are held steady or reduced.

Litter and debris: Less debris, trash and litter are getting into lakes, although there will still be some after large storms. Natural woody habitat for fish, birds, and land animals has increased, especially along publicly owned shorelines.

1.5 Needs and Priorities for Intervention

- Aggressive reductions in phosphorus and sediment loadings from all sources including farm fields and streets.
- Full-spectrum and customized beach strategies to curtail bacteria at impaired beaches.
- Apply the best science in models, pilot projects, measuring progress, and adaptive management.
- Engage the community in awareness, involvement, and solutions.

1.6 Responsive Actions and Tactics

Two timelines for action have emerged from the work of the last two and one-half years. The first is the set of immediate and near-term steps that could provide significant gains in lake quality and beach health within the next five years by targeting major sources of phosphorus and bacteria. Today's conditions are, however, the result of more than a century's worth of cumulative impacts on the watershed and lakes. Restoring full quality and public benefits will require a long-term commitment and particular vigilance in the next few decades ahead. We need to address both the near-term opportunities and the long-term challenges to achieve lasting and long-term gains.

The experts also cautioned that lake and watershed restoration strategies need to consider the likely influences of climate change and weather, including the projected increase in intense storms, and more extreme fluctuations between drought years and very wet years, and consider the effects of aquatic invasive species. Intense rains are a major influence on the amount of nutrients and sediments that are flushed into the lakes and in bacteria concentrations as well.

Weather and its impact on the speed of lake recovery will be a variable we won't be able to control. The effects of zebra mussels, spiny water flea, and other invasive species will have impacts, but those impacts are not considered in this report.

The CLEAN partners identified 70 specific actions that will reduce phosphorus, sediment loadings, and beach bacteria, many of which address more than one of the main targets. In order to be included, these options for action needed to be scientifically sound, cost effective, practical, high impact, and have measurable results. The full list appears in Section 3.5 of this report. Implementation will depend on which actions are selected as priorities by the Yahara CLEAN signatories (DNR, DATCP, Dane County and City of Madison) and available resources. Here are some highlights of options by category.

1. **Rural areas and farmlands: target the phosphorus hotspots and major sources, especially in the Mendota watershed.**
   - Maintain and expand farming practices that reduce phosphorus loads and runoff, including regular soil testing, nutrient management planning, alternative crop rotations, and perennial crops near streams and in highly erodible areas.
   - Remove concentrated manure loadings from the watershed, using a range of strategies that include building manure digesters and associated equipment to capture and convert concentrated manure sources to energy and to allow nutrients to be exported from the watershed, discouraging winter spreading, changing to low phosphorus animal feeds.
   - Test and assess specific methods, where appropriate using SNAP-Plus and nutrient management planning, in pilot watersheds; learn, adapt and apply to wider areas.
   - Restore and expand wetlands and natural buffers to capture sediments and filter runoff, especially along inlet streams and creeks.

2. **Urban areas: expand the scope and intensity of runoff control programs**
   - Maintain and expand practices to reduce polluted stormwater runoff, including street sweeping, better enforcement of construction site management and storm water management facility maintenance, road salt management, restrictions on lawn and garden fertilizers, leaf collection, and community education to keep pet waste and other contaminants out of the lakes.
   - Test and assess specific methods in a pilot watershed; learn, adapt and apply to wider areas.

3. **Beaches: control the common sources of *E. coli*; customize approaches by beach**
   - Re-locate or re-direct stormwater pipes that discharge close to affected beaches.
   - Conduct regular testing of water quality; annual analysis of beach conditions and characteristics to continually assess strategies and effectiveness.
   - Educate and encourage good beach hygiene (frequent diaper changes, using restroom facilities, etc.).
   - Consider a range of options, including landscaping choices, to discourage geese and other waterfowl from congregating at or near beaches.
   - Use physical barriers (grates, etc.) to prevent raccoons from nesting in storm drainage systems.

1.7 Communicating Progress

Over the course of this project, the Yahara CLEAN partners, YLLP, and the Dane County Lakes and Watershed Commission have shared information through public participation sessions, the www.yaharawatershed.org and partner organization web sites, feature stories and other coverage in local media, and through participation in various conferences and public meetings.

1.8 Moving Forward

- We now have a specific set of options for action that, if implemented, will dramatically improve water quality in the Yahara lakes and restore recreational and economic values to our region.
- Plans are actively in development to establish a permanent public-private umbrella organization in the next six months to coordinate strategies, share resources, and build community involvement to clean and care for our watershed and the lakes we love.

2. INTRODUCTION

The Yahara River's chain of five beautiful lakes defines our community and region and is integral to everything we are and do. The Yahara River watershed, to the Lake Kegonsa outlet, comprises 246,117 acres (384 square miles) in Columbia and Dane Counties.

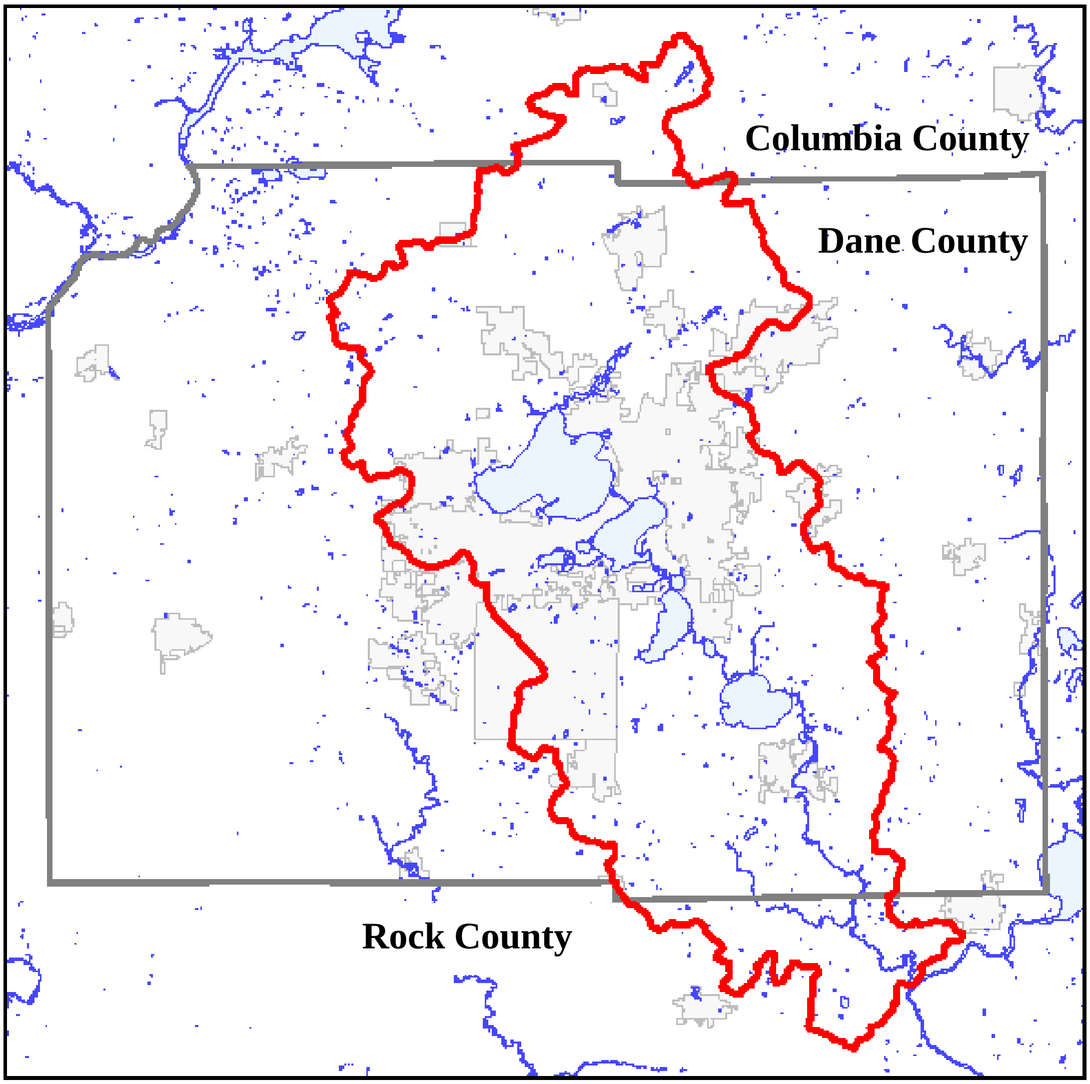


Figure 1: Watershed Map

The map above (Figure 1) shows the entire Yahara River watershed to its confluence with the Rock River. Badfish Creek flows into the Yahara River in Rock County, which is located directly south of Dane County. The Badfish Creek watershed was not part of our study area.

The quality of the Yahara lakes deteriorated significantly since European settlement as population and use increased. Many public and private organizations have dedicated time and resources over decades and have solved many Yahara Lakes problems. We are at a critical moment in the health of the lakes, and have an unprecedented opportunity to bring together key stakeholders from all sectors.

The Yahara CLEAN (Capital Area Environmental Assessment and Needs) Memorandum of Understanding (MOU), signed in February 2008, committed Dane County, the City of Madison, the Wisconsin Department of Natural Resources (DNR), and the Wisconsin Department of Agriculture, Trade and Consumer Protection (DATCP) to develop an action plan to reduce nutrient and sediment loadings to the Yahara River chain of lakes, and to reduce beach bacteria. (Yahara CLEAN MOU, See Appendix G). This recent action follows a long history of efforts to reverse degradation of our lakes.

2.1 Historical Context[1]

First-time visitor accounts of the Yahara Lakes in the early 1800s portrayed lakes Mendota and Monona as having remarkable water clarity. Almost immediately after Wisconsin became a state in 1848 lake conditions in the Yahara chain of lakes changed. In 1849 the outlet to Lake Mendota was dammed, raising the water level about five feet, flooding the shoreline, and submerging a large wetland complex at the inflow. These changes would have increased sediment and nutrients in the lake, and since Lake Mendota is the single largest source for the lower lakes – Monona, Waubesa, and Kegonsa – would have changed water quality in those lakes as well. In addition to the dam, agricultural land was being fully developed, and while the crops raised – wheat, oats and hay – have less potential for soil erosion than corn, they would have still contributed sediment and nutrients to the lakes. Blue-green algae blooms were first noted in 1882 in Lake Mendota.

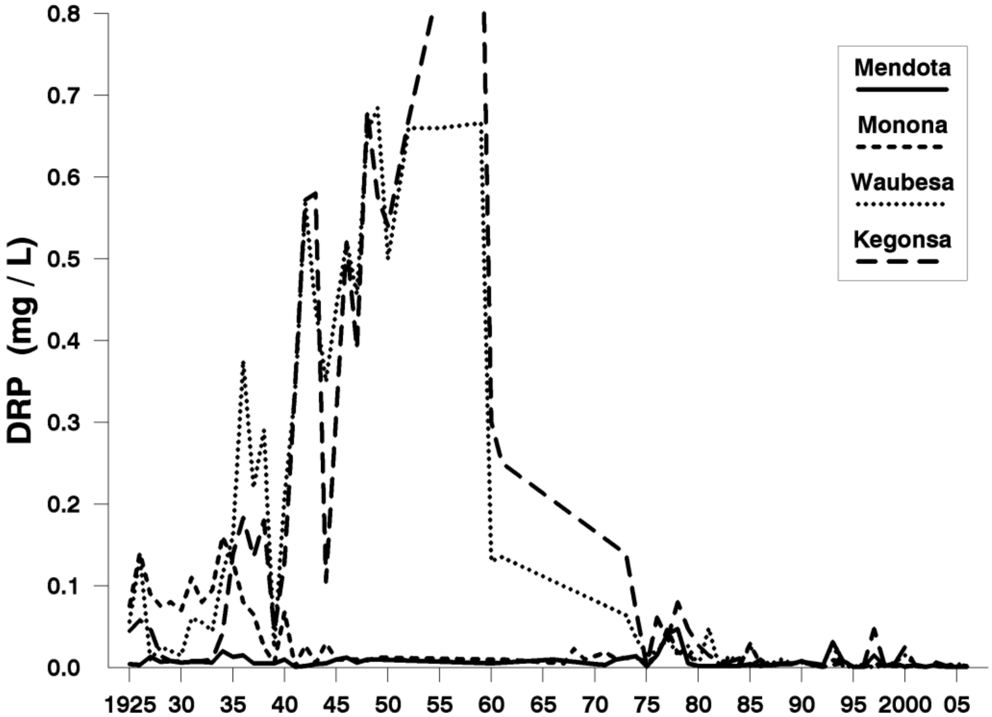
The most pronounced deterioration in water quality in the Yahara chain of lakes first occurred in Lake Monona, which was receiving most of Madison's untreated sewage by 1890. Civic leaders knew in the 1880s that discharging untreated sewage to the lake was wrong, but it would be almost 80 years before the lower lakes were no longer a receptacle for Madison's wastewater. Appendix H, Attachment H1 is a timeline of conditions and actions related to the Yahara lakes from 1836 to 2010.

Figure 2 below shows how the levels of dissolved reactive phosphorus (DRP) in the Yahara lakes during July and August peaked in the 1950s, and have remained at significantly lower levels since the 1970s.

Over the years, the issues facing the lakes have changed and the cumulative effects of many pollutant sources now are the greatest challenge. Sources include rural and urban runoff containing nutrients and sediment, over-application of phosphorus fertilizer and manure to soils already high in that nutrient, urbanizing landscapes, and uncontrolled storm sewer outfalls.
The Yahara watershed has been the focus of many past and ongoing projects. As part of its work the YLLP Coordinating Committee has documented 70 plans, studies and reports (See Appendix H, Attachment H2) with goals related to water quality of the Yahara lakes and their watersheds

[1] Most of this section has been taken from: Lathrop, Richard, 2007. Perspectives on the eutrophication of the Yahara Lakes. Lake and Reservoir Management 23:345-365
http://dnr.wi.gov/lakes/publications/documents/Lathrop2007LakeandReservManageVol23p345-365.pdf

(in the last 10-15 years alone, not to mention earlier work). Many Yahara lakes problems have been solved, yet new challenges have emerged.



Lathrop, 2007

Figure 2: Dissolved Reactive Phosphorus in the Yahara Lakes, 1925 - 2005

To date, Dane County, watershed municipalities, and state and federal agencies have invested millions of dollars for urban and agricultural practices to improve water quality. Private individuals and businesses have also invested in water quality improvement practices on their own, or as required.

- Wastewater treatment and diversion has done much to improve lake water quality, and while the cost has been large, no one seriously advocates abandoning these activities.

- Stormwater treatment is an essential strategy. Municipalities have begun implementing stormwater treatment on some storm sewer outfalls. Some effective efforts, such as enhanced street sweeping, leaf removal, general public education (i.e., don't pour used motor oil down the sewer, don't rake leaves into the street, pick up after your pet), have been going on for years. Others, such as retrofitting storm sewer outfalls and using less deicing salt in the winter, are more recent activities.

- Similarly, farmers have been learning cropping and livestock production practices that reduce soil erosion and negative water quality impacts since the 1930s; average soil loss in townships that drain to the Yahara lakes meets the state standard for soil erosion.[2]

[2] Dane County Land and Water Resources Department, 2008. Dane County Land and Water Resource Management Plan, 2009-2014. http://www.countyofdane.com/lwrd/landconservation/lwrm.aspx

The most recent large-scale study of Lake Mendota took place in preparation for the Yahara Mendota Priority Watershed Project, funded by the DNR's Priority Watershed Program (now called the Targeted Runoff Management Program), and created in 1978. The Priority Watershed Program used federal, state and local (county) funds to address water quality issues targeted to a watershed, making millions of dollars available to provide technical assistance staff and funds to address both urban and rural nonpoint sources. Lake Mendota was selected as a priority watershed in October 1993; the plan (The *Nonpoint Source Pollution Control Plan for the Lake Mendota Priority Watershed*) prepared by the DNR, DATCP, Dane County Land Conservation Department (LCD) and Columbia County LCD) was approved in 1997; project implementation began in June 1997; and funding ended in 2008. The four partners contributed over $9 million for practices – barnyard runoff systems, grass waterways, stream buffers, etc. – and the staff needed to contact landowners, design structures or practices, monitor compliance after installation, purchase land and easements, and conduct information and education activities.

As a result of the Lake Mendota project, significant phosphorus and sediment reductions were achieved. Municipalities adopted and enforced stricter erosion control and stormwater practices. Farming practices for water quality protection improved. For specifics see the Lake Mendota Priority Watershed and Priority Lake Program Final Report at www.yaharawatershed.org.

Area municipalities and organizations have continued to invest in Yahara Lakes improvements since the end of the Mendota watershed project. Among the CLEAN partners, for example, Dane County, through its Land and Water Legacy Fund, has invested $3.6 million since 2007 to complete a wide range of lake and stream improvements, including Yahara watershed-wide and field-specific modeling, land purchases, a feasibility study and preliminary design of the community manure digester, navigational improvements, and streambank and wetland restorations. Groundbreaking for the first manure digester occurred in early August 2010. The City of Madison has used its stormwater utility to fund streambank improvements and stormwater runoff quality improvements in the watershed. DATCP has supported preparation of the Land and Water Resource Management Plan for Dane County and provided partial staffing and cost-sharing for its implementation. DNR has invested significant grant funds for agricultural and urban runoff controls through several programs as well as being instrumental in the ‘clean water’ portion of the community manure handling facilities. DATCP and DNR also continue to support the SNAP-Plus development.

Despite these and many other investments and involvement of many other partners, lake water quality still does not satisfy area residents’ expectations or meet healthy ecological conditions. As one indication of how dissatisfied Madison residents are with lake water quality, consider a quality of services survey prepared for the City of Madison and presented to city department heads at a January 2009 meeting[3]. The survey measured the level of satisfaction and sense of importance of a selection of 15 city services, from police and fire protection to lake water

[3] The 2008 presentation can be found at:
https://www.cityofmadison.com/mayor/Documents/2008QualSvcSurveySumm.pdf
The 2009 survey data can be found at:
http://www.cityofmadison.com/mayor/Documents/2009QualSvcSurveySumm.pdf
The graph above is from slide 14 of the 2008 presentation.

quality, garbage collection, traffic enforcement, libraries, and land use/planning services. The results are shown in Figure 3. Only 24% of respondents were "satisfied" or better with lake water quality, the lowest level of satisfaction of any of the 15 services; yet it was considered more important than over half of the services assessed. And new challenges have emerged, including invasive species prevention and control, and lake water level management.

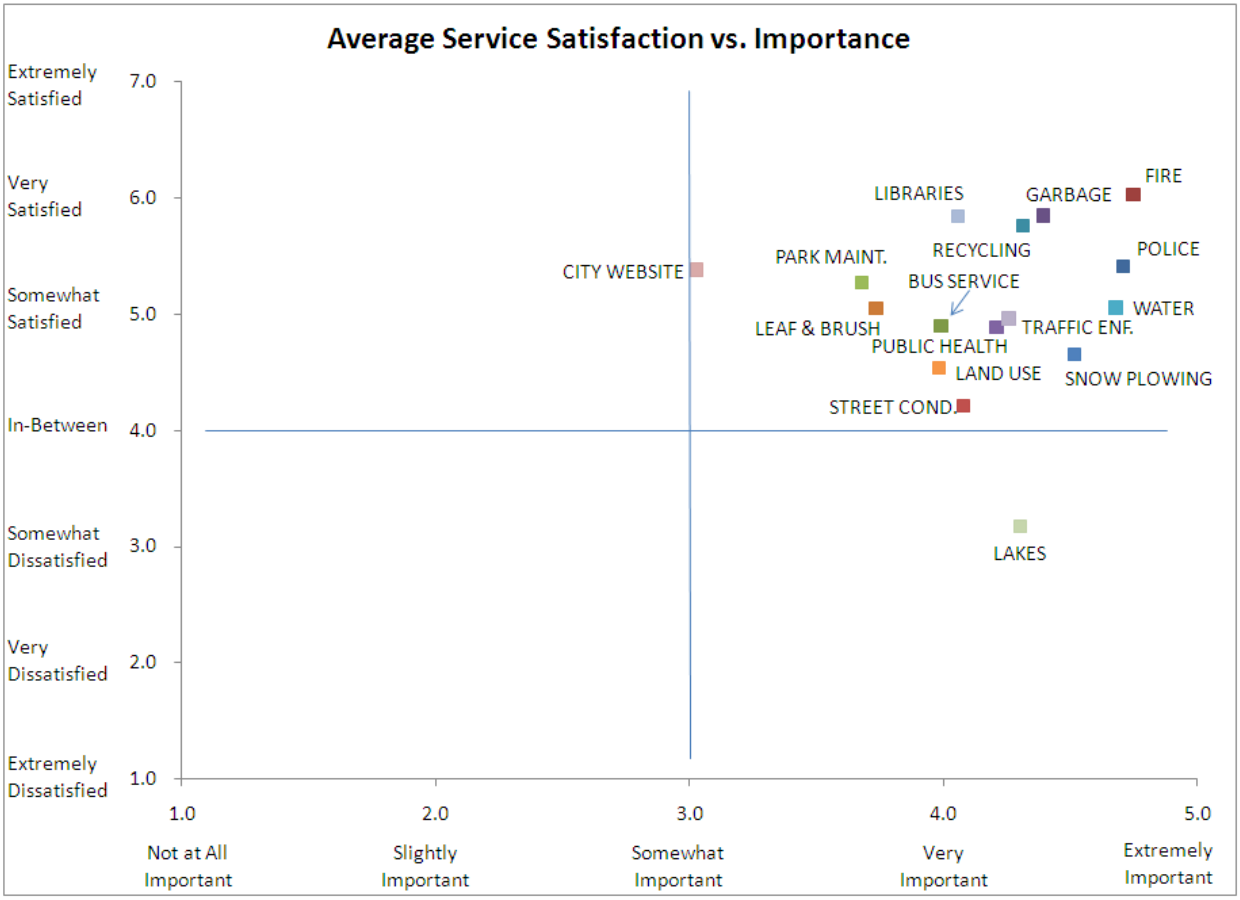


Figure 3: Quality of Services Survey, 2009 Results

To make more progress towards restoring the Yahara chain of lakes, we must continue current efforts, and based on the most current science and technology, embark on a new era of strategies. Doing more will cost money. Continuing current efforts also will cost money. Given the way people feel about the Yahara lakes, simply continuing current efforts while still dealing with blue-green algae blooms, fish kills, unswimable beaches, and poor water quality overall, is less and less acceptable to more and more Dane County residents.

We are at a critical moment in the health of the lakes, and have an unprecedented opportunity to bring together key stakeholders from all sectors. The Yahara CLEAN/Yahara Lakes Legacy Partnership has brought together many key stakeholders to reach this point, and continued and expanded stakeholder and public engagement will be necessary to select priority actions to develop a *specific* implementation plan with identified leads and funders, to implement the actions, and to assess the impact.

In response, this report sets forth a community vision of the lakes, explains what the best available science has to say about how clean we can really expect the lakes to be, describes the options and costs for achieving these goals, and identifies next steps for selecting actions and funding implementation.

2.2 Yahara Lakes Legacy Partnership

Three initiatives emerged independently in the fall of 2007, each responding to identified needs for visioning and planning for the Yahara lakes. The Yahara Lakes Legacy Partnership was created to coordinate, support, and provide for communication among the initiatives, and to formulate a plan for continued, long-term, broader partnerships aimed at protecting and enhancing Yahara lakes and watersheds. The three initiatives were:

- Yahara CLEAN (Capitol Lakes Environmental Assessment and Needs), a Memorandum of Understanding between Dane County, DNR, DATCP and the City of Madison with the purpose of assessing existing nutrient and sediment loading to the Yahara Lakes and determining actions required to decrease the loading and address bacterial outbreaks at beaches to improve water quality. Dane County provided funding to support work on this MOU.

- A City of Madison budget amendment that provided “funding to initiate a planning process to pull together stakeholders and community members to establish clear and achievable goals and an implementation plan for cleaning the lakes.”

- The Yahara Lakes Legacy Project in which Gathering Waters and Clean Wisconsin, two nonprofit organizations with funding from the Madison Community Foundation, documented historical lake rehabilitation efforts and developed ideas for “a common vision for restoring and maintaining a healthy, sustainable [Yahara lakes] watershed.”

Representatives of these three initiatives were brought together under the auspices of the Dane County Lakes and Watershed Commission through its Visioning, Partnerships, and Planning Committee. All parties agreed the different initiatives would ultimately be more successful if they cooperated with one another.

The partners share the belief that lakes and watershed planning needs to be “practical,” including specific implementation objectives and timelines that produce achievable results. At the same time, the partners agree that planning needs to be “visionary” in the sense that it inspires the community to develop goals that may sometimes be viewed as unachievable due to constraints of resources and political will at the time. Thus, the partnership committed itself to: 1) supporting the goals of the Yahara CLEAN MOU, and 2) working toward a more comprehensive and long-term “visionary plan” for the Yahara Lakes (and associated aquifers and wetlands) to provide:

- Community ownership in a common vision for the lakes and their watershed, resulting from a well thought-out process of public participation.
- A single over-arching plan for the management of the Yahara Lakes that builds on the results of Yahara CLEAN, that is based on principles of adaptive management, and that

includes specific measureable goals and timelines for issues that extend beyond the present focus on lake nutrients, sediments, and beach bacteria.

- Detailed outline of implementation steps (or "road map") that spells out how and when each action will be taken, who is responsible, and how it can be funded, as well as what results can be expected.
- Collaboration among all the political jurisdictions involved.
- Coordination with citizen watershed groups, neighborhood organizations, etc., in order to take advantage of their ongoing initiatives and their grassroots energy and creativity.

3. YAHARA CLEAN PLAN OF ACTION

In the Yahara CLEAN MOU, signed in February 2008, Dane County, the City of Madison, DNR, DATCP agreed to a variety of activities to assess the existing nutrient and sediment loading to the Yahara Chain of Lakes and determine needs or activities to decrease the loading to improve water quality. (See Appendix G)

The purpose of the Yahara CLEAN MOU was to establish a process for assessing water quality conditions in the Yahara River Watershed in Dane County. The italicized text in this section indicates the MOU requirement.

> *The MOU will identify possible future actions that can be taken to improve the water quality and thus the users' enjoyment of the Yahara Lakes. Dane County, the City of Madison and the Wisconsin Departments of Natural Resources (DNR) and Agriculture, Trade and Consumer Protection (DATCP) enter into the MOU to participate in Yahara CLEAN (Capital Lakes Environmental Assessment and Needs)*[4].

MOU signatories agreed to:

A. Develop a community vision for the Yahara lakes, reflecting extensive input from scientists, residents, agencies, elected officials, businesses, and other stakeholders. This vision statement was intended to guide the goal setting for nutrient limits.
B. Model existing nutrient and sediment loadings to the lakes.
C. Assess causes of bacterial outbreaks at beaches.
D. Determine the necessary nutrient, sediment and bacteria levels to reach the community vision for the lakes, and determine if the needed reductions can be achieved if reduction activities are taken.
E. Identify the activities necessary to meet the loading and bacterial reductions and estimate the costs of these activities.
F. Provide regular updates to Dane County residents.

This report follows the outline of the Yahara CLEAN MOU, with supporting materials in separate appendices. Work on the various parts of the MOU was done simultaneously, in that the visioning process was done while nutrients, sediments and bacterial issues were being

[4] Yahara CLEAN MOU, signed February 2008

discussed and addressed with other experts and stakeholders. One of the first meetings – in July 2008 – brought members of the visioning committee together with technical experts to clarify what is achievable in this watershed, on these lakes, so the vision would be achievable.

3.1 Develop a Vision

The MOU required:

> *During 2008, a community vision statement for the Yahara Chain of Lakes will be developed, reflecting extensive input from scientists, residents, agencies, elected officials, businesses, and other stakeholders. This vision statement will guide the goal setting for nutrient limits.*

A fortuitous grant from the Madison Community Foundation funded Gathering Waters Conservancy and Clean Wisconsin to document historical lake cleanup efforts and participate in the development of a vision for restoring the Yahara Lakes watershed. The representatives from these two organizations, Mike Carlson from Gathering Waters and Will Hoyer (until April 2008) and Ezra Meyer (April 2008 and after) from Clean Wisconsin, focused on the visioning process, and their final report to the Madison Community Foundation is included as Appendix A, Attachment A1 to this report.

Dane County hired consultants Anne Carroll and Pat Van Gorp (Beacon Associates) to assist in development of a visioning process and communication plan ("Yahara Lakes Kickoff Consultant Report: Results, Scoping, and Initial Recommendations," included as Appendix F, Attachment F1, since it deals more with communicating progress than the visioning process itself). The consultants took an active role in the visioning process and developed a communication plan to help address the "communicate progress" component of the Yahara CLEAN MOU. They also helped facilitate a meeting of technical experts to determine what goals would be feasible for the Yahara Lakes. Obviously, as southern eutrophic lakes in an urban/agricultural landscape, none of the lakes will ever be an idealized sandy-beached lake with excellent visibility throughout its depth. The experts advised what improvements are possible in the Yahara Lakes, given the lakes' characteristics and properties and surrounding land uses.

Early in the process a "Visioning Advisory Committee" was organized and solicited comments from a wide range of interested parties, and the YLLP Coordinating Committee and Visioning Advisory Committee hosted a number of focus group meetings in mid-June, 2008, including:

- A meeting with David Mollenhoff and Michael Gerner; David is a local historian and is seen as the sparkplug for these most recent lake cleanup efforts, due to an inspiring address before the North American Lakes Management Society Conference at Monona Terrace in November 2005. His address appeared as an article in local media, and he repeated his address at a May 2007 conference sponsored by the Yahara Lakes Association, a 600-member lakeshore property owners' group, and the University of Wisconsin's Gaylord Nelson Institute of Environmental Studies. Michael is the managing partner for Grant-Thornton LLP, a national accounting firm, and is on the Board of Directors of the Greater Madison Chamber of Commerce and Yahara Lakes Association. The success of our efforts will depend on our ability to demonstrate their value to the business community in and around Madison and Dane County. Meeting notes are in Appendix A, Attachment A2.

- Lakes and Watershed Commission focus group; participants were: Howard Teal, Melissa Malott, Patrick Miles, Brett Hulsey, Doug Bach, Lyle Updike, John Magnuson, Jerry Jensen, Kirsti Sorsa, and Chuck Erickson. Meeting notes are in Appendix A, Attachment A3.
- City and county elected officials and staff focus group; participants were: Sue Jones, Ray Harmon, Larry Nelson, Patrick Miles, Jim Lorman, Genesis Steinhorst, Topf Wells, Brett Hulsey and Satya Rhodes-Conway. Meeting notes are in Appendix A, Attachment A4.
- Agricultural interests focus group; participants were: Jerry Jenson, David Fischer, Pat Sutter, Joe Connors, and Richard Keller. Meeting notes are in Appendix A, Attachment A5.
- Environmental interests focus group; participants were: Don Hammes, Jon Becker, Peter McKeever, and John Hendrick. Meeting notes are in Appendix A, Attachment A6.
- YLLP Coordinating, Visioning and Technical Committees focus group: Meeting notes are in Appendix A, Attachment A7.

Soon after these focus group meetings were concluded, the Visioning Advisory Committee hosted a meeting with members of the Nutrient and Sediment Technical Advisory Committee and the Beaches Technical Advisory Committee to determine what kind of water quality improvements are possible. Everyone agreed that the Yahara chain of lakes are not and will never be "quintessential" sandy-beached northern Wisconsin lakes. However, the group concluded there are six categories of lake improvements that citizens can expect, given stable or increased funding:

Water clarity
Vegetation at or near shore
Water safety and accessibility for recreation
Water level and variation
Fishery health and fish consumption
Litter and debris

The group discussed what the community could expect given stable (current) funding levels in ten years, and what the community could expect given increased funding in ten years and twenty years. For example, "water safety and accessibility for recreation" is shown in Table 1.

Table 1: Example of Achievable Goals for One of Six Lake Improvement Categories

Water safety, accessibility		
What the lakes will look like if we don't accelerate investment	**With accelerated investment, what the lakes will look like in 10 years**	**With accelerated investment, what the lakes will look like in 20 years**
Frequent or near-constant beach closures due to elevated bacteria (not every beach every day, but people don't make that distinction)	50% reduction in beach closure frequency, number, and duration	90% reduction in beach closure frequency, number, and duration; only following extreme storm events

Illness from algal toxins and other sources	Reduced incidence of illness from algal toxins	
Increased conflicts among types of lake users around activities and access, especially on weekends and in heavy traffic areas	The full range of lake users are able to access and enjoy the lakes year round while respecting other users and activities	

Similar achievable goals were developed for each of the other five categories of lake improvements. Complete results are at Appendix A, Attachment A8.

The University of Wisconsin – Madison provided outstanding assistance to this whole effort, from faculty, staff and student research and expertise to the Gaylord Nelson Institute for Environmental Studies hosting a conference that focused on lakes issues in 2008, and Community Environmental Forums in the spring of 2009 and 2010. Over 300 people attended the Yahara Lakes Conference on October 10, 2008, and provided feedback about the draft mission and vision statements.

In November 2008 a “Goals, Strategies and Tactics” (GST) workshop was held to further develop the goals, strategies and tactics that would help us achieve the vision that was developed. The Goals, Strategies and Tactics workshop summary is at Appendix A, Attachment A9.

For example, if one goal is:
Agricultural practices and systems are economically and ecologically sustainable
The strategies to achieve that goal might include:

- Create formal agricultural/urban linkages for communications and feedback.
- Change the "us" vs. "them" rural-urban mentality to one of shared responsibility for the lakes.
- Prevent soil runoff into waterways.

Note that two strategies deal with increased communication and fostering a shared identity, and one could potentially lead to additional regulation, but also addresses a shared concern, namely retaining soil fertility on agricultural land.

If we consider the strategy “prevent soil runoff into waterways” potential tactics include:

- Develop incentives for farmers to install buffers and tillage setbacks.
- Develop incentives to improve land management practices.
- Promote use of grassy biofuels over corn ethanol.
- Stop tilling soil in sensitive areas near tributary streams.
- Develop PDR/TDR (purchase or transfer of development rights) programs with a watershed protection priority.
- Improve manure management with digesters and daily haul reduction.

- Ensure all farmers create and follow nutrient management plans.
- Identify/create priorities about best locations for conservation practices.

This GST workshop was very challenging given the wide range of interests and viewpoints. One example of this was the diversity of opinion expressed regarding agricultural operations. Some expressed the view that because of state and local laws and ordinances, agricultural producers “get away” with sending sediment and nutrients into our lakes at a level that other sectors of our economy would not be permitted. Others observed that the vast majority of agricultural producers in Dane County do the right thing for the land and the environment.

The workshop was also very productive in showing that the range of potential options -- in strategy and in tactics -- is very broad in achieving our goals and the vision, and in voicing the commitment from all sectors to Yahara lakes improvement.

By December 2008 a “final” draft vision statement was provided to the Yahara CLEAN MOU signatories. It has remained basically unchanged since:

> *“The Yahara River watershed is a beloved asset to our communities. We are proud of the chain of beautiful, clean, and healthy lakes. There is widespread recognition of the lakes’ contributions to our region’s economy and quality of life. The lakes provide benefits that outweigh the investment required to keep them clean and healthy. Creative partnerships among urban and rural dwellers, farmers and other business people, and the private and public sectors generate lasting results as we tackle shared challenges across the watershed.”*

3.2 Model Existing Nutrient and Sediment Loadings

Concurrent with the visioning work above, the Partnership tackled another MOU section. The MOU required:

> *The University of WI- Madison, under the guidance of a technical advisory board, will engage in the assessment of existing lake-loading conditions. The UW-Madison will complete this assessment by 9/2009 but release relevant parts of the data as available.*

Within a few months of the first meeting of the YLLP Coordinating Committee, scientists and engineers from various departments at the UW-Madison, the US Geological Survey, DNR, Dane County, and the City of Madison, met to discuss the technical feasibility of efforts to address water quality issues in the Yahara lakes; as mentioned, those results are at Appendix A, Attachment A8.

The Yahara lakes in general, and Lake Mendota in particular, are among the most studied lakes in the world, thanks to the UW-Madison’s Center for Limnology, a world-class institution located adjacent to Lake Mendota, and DNR researchers. The UW-Madison Gaylord Nelson Institute for Environmental Studies requires most masters candidates in the Water Resources Management Program to complete an applied experience practicum, and frequently students study some aspect of lake management on one of the Yahara Lakes. Other programs at the UW provide similar local support, including the School of Engineering, Business School, Department of Urban and Regional Planning, and other campus entities. For examples, see the Recommendations of various reports in Appendix H, Attachment H2. However, even with the amount of research that takes place on our lakes, large gaps remain regarding problems and solutions to water quality issues such as agricultural runoff, urban stormwater impacts, and other impairments.

The following sections provide a context for and a description of modeling done for Yahara CLEAN.

As part of Yahara CLEAN, Dane County contracted with MARS to use the watershed-wide model, SWAT, to indicate relative sources and amounts of sediment and phosphorus loading to the Yahara lakes. The outcome of the SWAT modeling is a comprehensive, science-based assessment that identifies the highest loading areas, and allows us to target load reduction efforts in those areas.

Key findings from the SWAT analysis show that some subwatersheds contribute disproportionate P loads; variations in P loading in lakes depends on rain events, snowmelts, and climatic conditions; and changes in land management practices will result in initial reduction in P loading in 5-10 years. This model underestimated the P delivered to lakes from winter spread manure runoff, does not address changes in manure management practices and impacts at the farm field scale, and does not include site-specific inventories of sediment P stored within the ditches and streams leading to the lakes.

In order to rectify an underestimation of P loads, the SWAT results have been combined with Source Loading and Management Model (SLAMM) modeling results conducted by the City of Madison. A final P loading database for Lake Mendota was completed in early June 2010, but the lake response analyses using these updated data have not been completed. Progress has been made in compiling the P loading database for Lake Monona once the approach of combining the SWAT and SLAMM modeling results for urban drainage basins was resolved. While this in-lake modeling is still in the works, tentative conclusions include:

- Lake Mendota's water quality will improve relatively soon after major reductions in P loads delivered to the lake.
- P load reductions will take a long time to occur without significant control measures because of high P concentration in watershed soils and in the stream bottom sediments of the lakes' tributaries.
- P load reductions to Lake Mendota will produce measurable water quality improvements in downstream lakes.

In order to work at the appropriate scale to design runoff control practices, Dane County contracted for field-scale analysis of two subwatersheds. Both the UW-Madison Water Resources Management Practicum and a UW-Madison grad student used the SNAP-Plus nutrient management software developed by the UW-Madison Soil Science Department, on Door Creek (in the Lake Kegonsa watershed) and the North Fork Pheasant Branch (in the Lake Mendota watershed). SNAP-Plus includes the NRCS RUSLE2 erosion estimate model and the Wisconsin Phosphorus Index and can thus be used to evaluate the impact of field topography, management (crop rotation, tillage, manure and fertilizer) and existing soil conditions (soil type and P concentrations) on potential field-level erosion and P delivered via runoff to the nearest surface water.

Key findings from SNAP-Plus and PI index also show that there are variations in P loading across the watershed. Modifications of agricultural practices in high risk areas, reduction of P in dairy cattle diets resulting in reduced manure P, modification of rotations to reduce erosion and runoff, and discontinuation of manure application on soils with higher P concentrations and high erosion or runoff potential, would all yield reductions in P loads in the watershed.

The flow chart below (Figure 4) illustrates how various types and scales of models have been used together thus far in the Yahara CLEAN process.

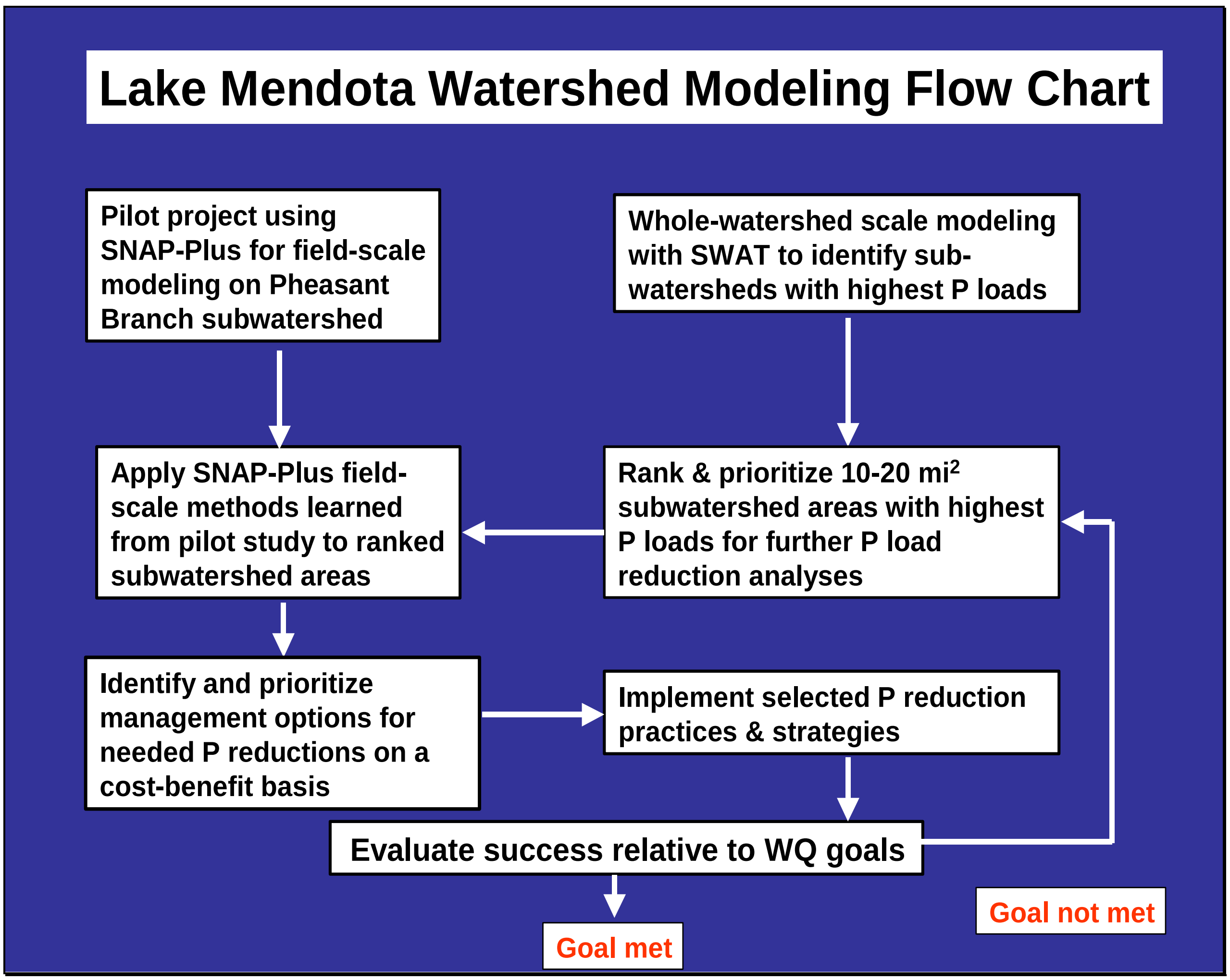


Figure 4: Lake Mendota Watershed Modeling Flow Chart

3.2.1 Overview of Cascading Effects of Phosphorus Loading on Downstream Lakes

Early in the MOU and prior to subsequent soil and water assessment tool (SWAT) watershed-wide modeling by Montgomery Associates: Resource Solutions, LLC (MARS) described later in this section, Richard Lathrop and DNR modeler Kevin Kirsch prepared the following graphic (Figure 5) to describe the downstream benefits of reducing nutrient loading from Lake Mendota, and how each upstream lake in the Yahara chain influences the water quality of the lower lakes.

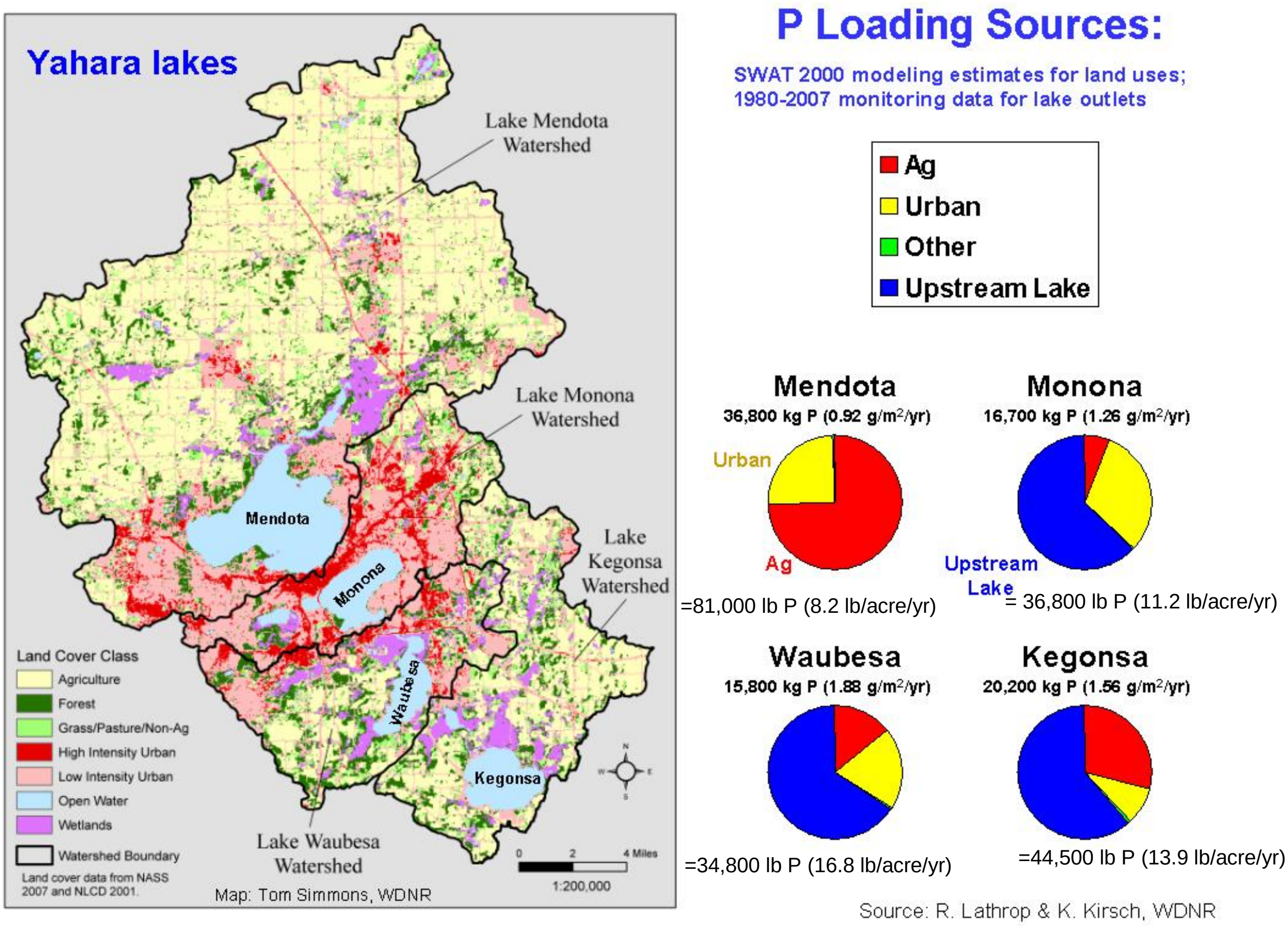


Figure 5: Phosphorus Loading Sources

The points Lathrop and Kirsch emphasized from this analysis:

- ¾ of Mendota's phosphorus (P) load comes from agricultural sources.
- ⅔ of P load to lower Yahara lakes comes from upstream lakes.
- ½ of Monona's P load is linked to urban sources (some of Monona's urban load is from Mendota's urban load flowing into Monona).
- Major P loading reductions from Mendota's large watershed will cascade water quality benefits downstream.

3.2.2 Watershed-wide Modeling

The CLEAN MOU required the signatories to address both nutrients and sediments. Nutrients, especially phosphorus in these lakes, are a concern because they feed the growth of algae that interferes with residents' ability to enjoy recreational uses of the water, and can lead to health impacts as well. Sediment loading is a major source of algae-producing phosphorus in our lakes. However, sediment loading can also have a deleterious effect on the number and variety of aquatic plants, turbidity, water temperature, and fish habitat including cover, reproductive substrate, food, and oxygen levels.

As part of Yahara CLEAN, Dane County contracted with MARS to use the watershed-wide SWAT model with up-to-date information, to show us origins and quantities of the sediment and P loading to the Yahara lakes. A significant problem in the Lake Mendota basin is winter runoff. The SWAT model didn't adequately address the winter-spread manure. Phosphorus modeling experts at UW calculated a correction, which is added to the SWAT results to account for winter runoff. (See Appendix B, Attachment B1 for information on accessing the full report)

3.2.2.1 SWAT Model Analysis

The Soil and Water Assessment Tool (SWAT) is a watershed scale, GIS-based model developed to quantify the impact of land management practices in large, complex watersheds. It was designed to predict the effect of management decisions on water, sediment, and nutrients with reasonable accuracy on large, ungaged river basins.

Model limitations

- SWAT is a watershed-scale, not field-scale model. The model will not target specific fields, but the small subwatershed size—2-5 square miles—will help locate potential "hot spots."
- SWAT does not route phosphorus beyond the subwatershed level and does not predict the effects of in-stream aggradation or degradation on sediment and phosphorus loads.
- SWAT, like all models, contains a degree of uncertainty, but uncertainty in the input parameters was reduced due to the involvement of Dane County Land and Water Resources Department. Some of the sources of this uncertainty include:
    - Intermediate features (i.e., slope, percent residue, etc.)
    - Processing techniques (i.e., crop growth model, ET calculations, etc.)
    - Temporal difference (i.e., use of current land use with historical climate and monitoring data)
    - Numerical limitations

Dane and Columbia Counties provided topographic data for the project. A digital elevation model (DEM) and four-foot contour from Dane County's FlyDane 2000 program provided an X, Y and Z value located at the center of each 10-foot x 10-foot cell with a two-foot vertical accuracy. Columbia County provided a 2003 DEM.

Dane County also provided MARS with digital hydrologic layers for both Dane and Columbia Counties based on the Wisconsin DNR's 1:24,000 scale hydrography layer created in 2005. Soils data was taken from the Soil Survey Geographic Database (SSURGO) rather than the more generalized State Soil Geographic Database (STATSGO). Soils data are in a 7.5 minute quadrangle format obtained from the USDA Natural Resources Conservation Service (NRCS). Land use data was developed by updating Dane County's 2005 land use GIS Shapefile based on interpretation of 2008 USDA National AIP, and the 2008 National Agricultural Statistics Service Wisconsin Cropland Data Layer for the portions of the watershed in Columbia County. The Wisconsin DNR's Wisconsin Wetland Inventory layer was used to develop wetland areas.

Four of 18 historical water quality and quantity U.S. Geological Survey (USGS) gage datasets were analyzed, with datasets beginning between 1973 and 1976, and collecting continuously (except for Yahara at Windsor (no data 1982 to October 1989) and Willow Creek (sediment data are intermittent from October 1973 to October 1974 and from October 1980 to January 1984). Data sets analyzed were:

- Yahara at Windsor (Agricultural)
- Pheasant Branch at Middleton (Mixed agricultural & urban)
- Willow Creek (Primarily urban)
- Spring Harbor (Urban sewershed)

Climatological data were obtained from three weather stations, in Madison, Arlington and Stoughton, and missing data from Arlington and Stoughton records were replaced with the Madison record. Each subwatershed was assigned the nearest climate monitoring station.

The Madison Metropolitan Sewerage District (MMSD) inputs were not modeled in SWAT because MMSD discharges into Badfish Creek, which flows into the Yahara River downstream from the limits of this study.

MMSD also produces highly treated effluent as well as biosolids, referred to as Metrogro. Metrogro has been applied to agricultural land as a fertilizer for over 20 years. Farmers use Metrogro to replace chemical fertilizer. MMSD uses the most recent soil test data to determine application rates. The amount of Metrogro phosphorus is small compared to the total amount of phosphorus applied through manure or commercial fertilizer (see Table 2) and may only be significant in the Waubesa watershed, and therefore MARS chose not to include it in the SWAT model.

Table 2: Total Phosphorus and Metrogro Phosphorus Applied by Lake Watershed (1000 lb. and Metrogro as % of the Total)

Mendota			Monona			Waubesa			Kegonsa		
Average Annual P Applied	Metrogro P Applied		Average Annual P Applied	Metrogro P Applied		Average Annual P Applied	Metrogro P Applied		Average Annual P Applied	Metrogro P Applied	
	Lb.	%		Lb.	%		Lb.	%		Lb.	%
4,074	14	0.3%	81	11	13%	262	85	32%	760	46	6%

SWAT modeled crop rotations, tillage management practices and nutrient or manure applications. Dane County staff provided MARS crop rotations and other management practices in each subwatershed. Generally the Yahara watershed is dominated by dairy (forage) and cash-grain rotations. Several different crop rotation scenarios were developed:

- Continuous corn (four management scenarios)
- One year corn – one year soybeans (8 management scenarios)
- Two year corn – one year soybeans (12 management scenarios)
- Dairy rotation (six years total, with three years corn silage followed by three years alfalfa; 16 management scenarios)

Corn as grain and corn as silage were treated differently due to the small amount of residue left after corn silage is harvested.

SWAT tillage management included conventional tillage (<15% residue), other till (15-30% residue), mulch till (>30% residue), no till (60-70% residue). Most operations in the watershed use conservation tillage (>30% residue). Mixing depth and mixing efficiency were also considered. Chisel, disk, and moldboard plow, and field cultivator tillage were considered. Specific parameters were modified in SWAT to account for certain management practices, including contour farming, parallel terraces, residue management, filter strips, and nutrient management.

Five classifications were developed for different levels of manure application, but as the analysis developed, a sixth (higher) classification was developed. Dane County provided MARS with a Shapefile showing farm location, animal unit (AU) numbers, AU type, manure system (daily haul versus storage), and approximate haul distance. The planned expansion of the UW Arlington Research Station was also included. Five assumptions were carried through the manure application rate determination:

- All manure generated in the watershed stayed in the watershed.
- All manure was converted to dairy manure based on phosphorus content.
- Columbia County haul distances and application rates are similar to northern Dane County.
- Manure was only applied to lands with crop rotations.
- Farms with similar ratios of manure produced to available lands were appropriate for clustering for analysis.

Each of 251 farms in the Mendota watershed was considered in a preliminary analysis. Manure calculations were based on Wisconsin DNR's "Animal Units Calculation Worksheet Form 3400-25A" and Wisconsin DATCP's "Wisconsin Manure Quantity Estimation" found in the Wisconsin NRCS "Standard 590, Nutrient Management."

Commercial fertilizer application was also modeled. Starter fertilizer was applied to all corn crops in fields that received manure; starter fertilizer (9-23-30) was applied at a rate of 100 pounds/acre, or 9 pounds/acre of nitrogen and 10 pounds/acre of phosphorus. All starter fertilizer was assumed to be injected. Commercial nitrogen and phosphorus were applied to crop removal rates based on UW-Extension recommendations, with 10% surface applied.

Watershed-Wide Model Results

The outcome of the watershed-wide modeling is a comprehensive, science-based assessment that identifies those areas producing the greatest relative loadings. It gives us the best information possible for targeting the greater loading areas with practices to reduce that loading. Two maps that follow visually summarize the results of the watershed-wide modeling.

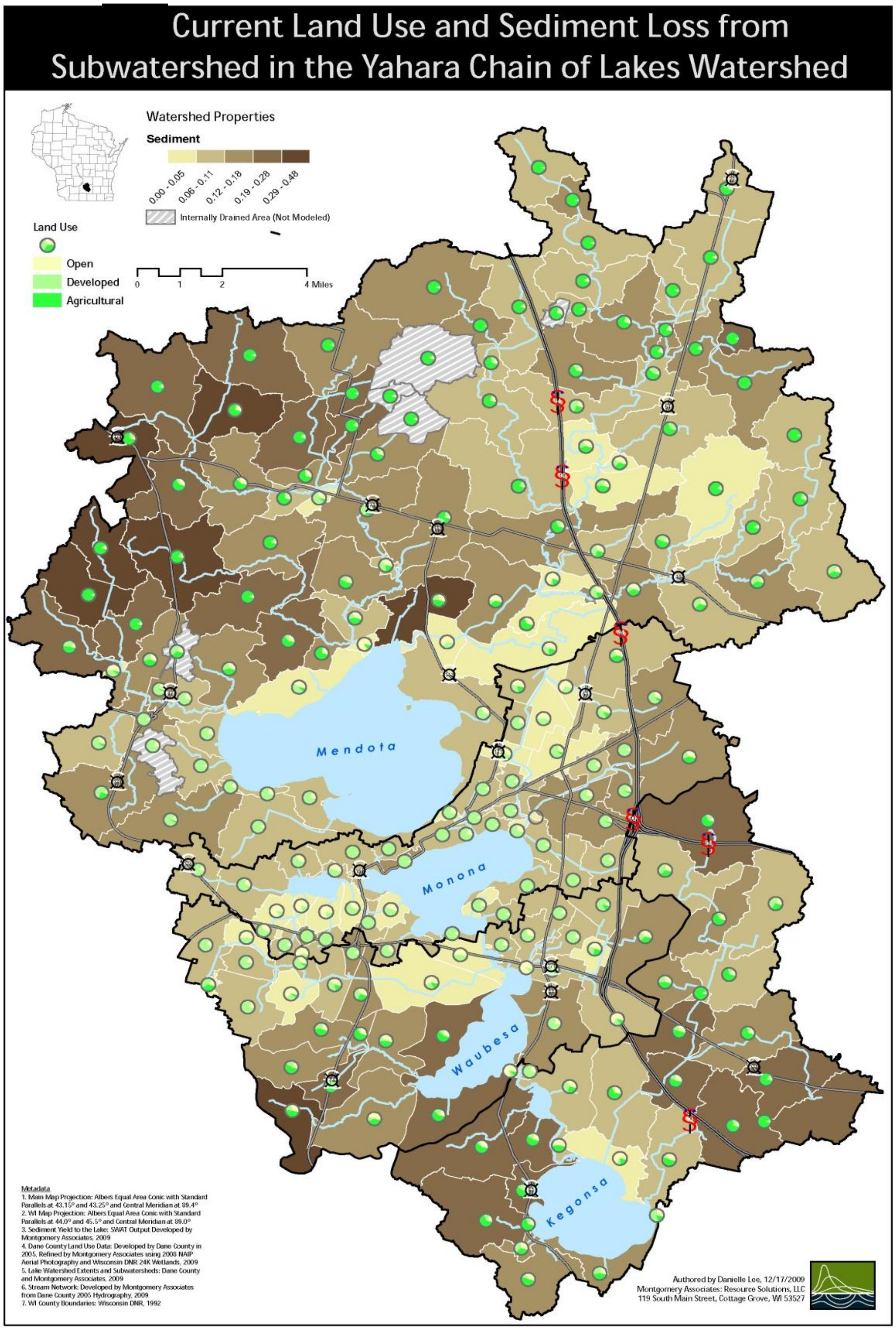


Figure 6: Current Lake Use and Sediment Loss from Subwatershed in the Yahara Chain of Lakes Watershed

This map (Figure 6) shows the results for sediment. Darker areas have highest sediment loading to the lakes, ranging from 0.29-0.48 tons/acre/year.

The map shows that all areas of the watershed contribute sediment. Sediment loss is variable by location and related to land use, soils, and topography.

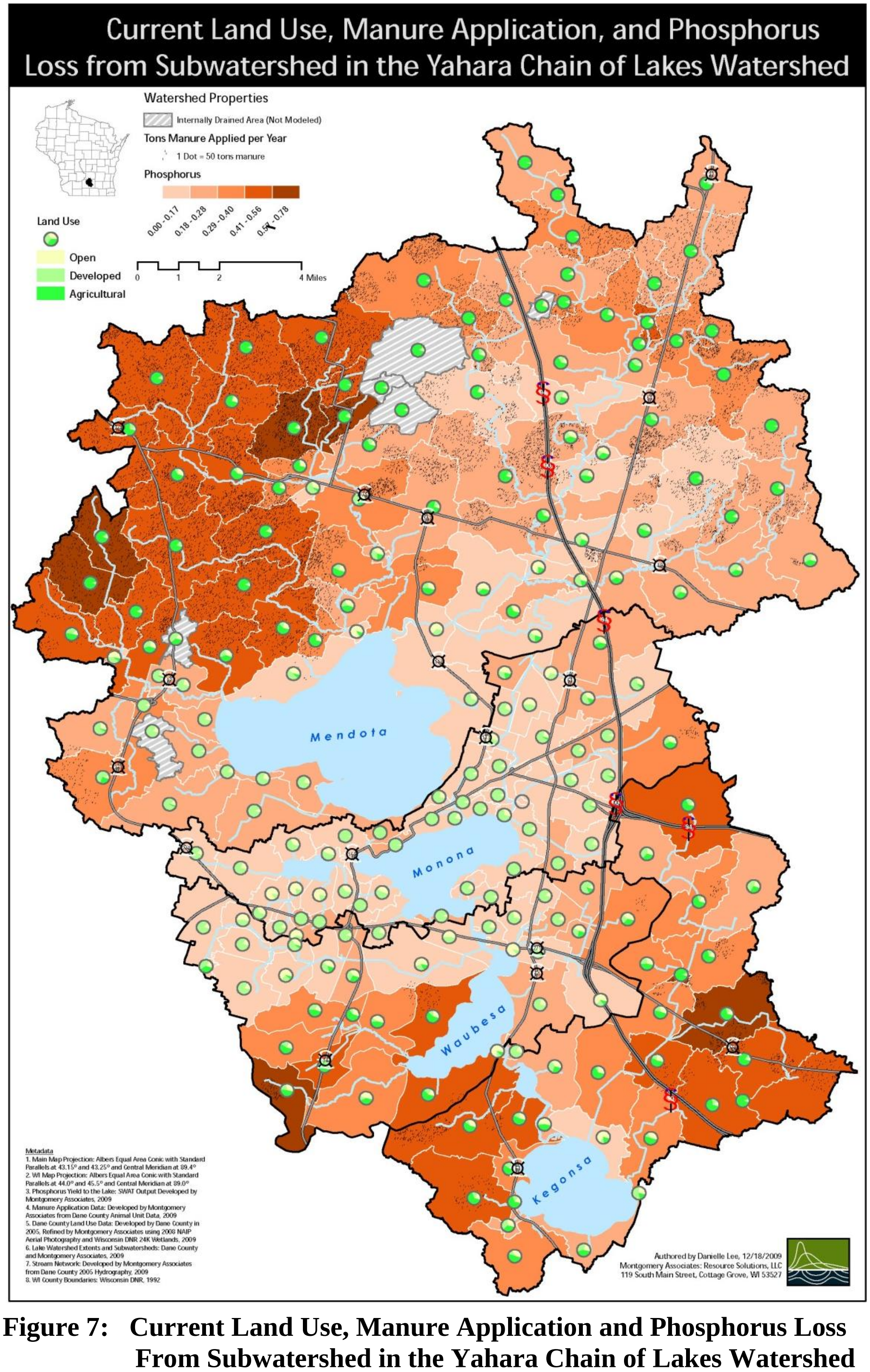


Figure 7: Current Land Use, Manure Application and Phosphorus Loss From Subwatershed in the Yahara Chain of Lakes Watershed

Similarly, Figure 7 shows the results for phosphorus. The darkest areas deliver the highest phosphorus loads to the lakes (.57 to .78 lbs/acre/year). Each small black dot (often seen in clusters on the map) represents 50 tons of manure applied per year.

Note the correlation between animal operations and high P loss areas.

This map shows that existing land use phosphorus delivery is extremely variable by location. It is dependent on soils, manure application, topography, and tillage practices. The highest loadings are in the Mendota subwatershed, but there are also substantial loadings to Lakes Waubesa and Kegonsa.

Also note that the darkest phosphorus loading area northwest of Lake Mendota is where Dane County chose to locate the first of two community manure handling facilities, with additional treatment funded by the state, to export phosphorus from the watershed.

The Nutrient and Sediment Technical Advisory Committee has agreed on the following summary of what these modeling results tell us, and do not tell us.

3.2.2.2 What Does SWAT Tell Us?

- SWAT provides the relative distribution of pollutant (phosphorus (P) and sediment) loading from the watershed to each lake (an MOU condition) using physical and land management conditions across the entire watershed, thus providing the basis for a science-based priority driven remediation strategy.
- The SWAT analysis shows that some subwatersheds contribute a disproportionately greater P load than others. However it shows that the aggregate P loading is widely distributed throughout the watersheds. Based on SNAP-Plus modeling done in the North Fork Pheasant Branch (see next section) probably about 50% of the P loading comes from about 25% of the land surface area.
- The SWAT analysis and monitoring data show us that, even if all land practices remain constant, a five-fold variation in the amount of P loading to the lakes persists in any year, depending on that year's rain events, snowmelt, and other climatic events.
- The SWAT analysis gives an estimate of the likely bounds on what P loading reductions might accomplish on a whole-watershed scale for areas draining to the Yahara lakes. That is, "bookend" scenarios of extreme management actions across the entire watershed can reasonably demonstrate the expected percentage average annual reduction of P loading to each lake for that scenario.
- For any land management scenario, the SWAT model can give an estimate of the likely percent reduction in average annual P and sediment loading to each Yahara lake. Later in 2010, when in-lake response models are available, we will be able to use a percent reduction in average annual P loading to each lake to show the resulting in-lake water quality based on Carlson's Trophic State Index (TSI) (TSI for a mesotrophic lake = 50 or better, Secchi = 2 m or better, or P = 24 µg/l or better).
- The SWAT analysis estimates that taking major steps now to reduce sediment and nutrient runoff will result in a relatively quick initial reduction in P loading to the lakes (5 to 10 years) with further reduction coming over time from the depletion of soil P.
- Because SWAT shows up to a five-fold variation in annual P loading depending on climatic events, the potential exists that reductions in P loading from land management changes could be totally masked by a stretch of rainy summers, significantly large snow melts or climate change.
- The data set developed via the SWAT modeling process is a detailed comprehensive inventory of watershed physical conditions and managements for the entire Yahara chain of lakes system.

3.2.2.3 What Does SWAT Not Tell Us?

- SWAT is based on the most recent and cutting-edge science available. It is the best and most sophisticated soil and water computer model available. However SWAT does consistently underestimate the P delivered to lakes due to winter runoff modeling issues.
- SWAT doesn't directly or comprehensively address manure management practices.

- SWAT does not identify loading from individual farm fields and cannot evaluate the impacts of management changes made on individual farm fields. The SNAP-Plus model does this.
- SWAT does not identify a comprehensive site-specific inventory of sediment P stored within ditches and streams draining to the lakes.

Dane County also asked MARS, using SWAT, to develop a series of "scenarios" to show probable impacts to the Yahara lakes. The scenarios included:

1. Existing condition
2. 25% increase in manure application rates
3. 60% reduction in manure application rates
4. 80% reduction in manure application rates
5. No manure
6. No manure and perennial crops

The second and sixth scenarios provided both a set of bookends to the modeling results and a conclusion that the watershed and lakes really would respond to efforts to reduce agricultural and urban runoff impacts. No one is remotely proposing an end to animal agriculture or farming in the watershed. Farming is an integral, vital component to the local economy and to our cultural heritage.

3.2.3 Field-Specific Modeling

Another tool that we are using to design practices to reduce P runoff from farms is the field-scale SNAP-Plus model developed at UW. The Phosphorus Index (PI) is part of the model. Together, SNAP-Plus and the PI can evaluate the impact of crop rotation and tillage on P losses, and the impact of manure and application method on P losses. SNAP-Plus modeling runs were conducted in two subwatersheds: one on the North Fork Pheasant Branch (Lake Mendota), the other in Door Creek (Lake Kegonsa).

3.2.3.1 North Fork Pheasant Branch Watershed

Field-specific modeling of the North Fork Pheasant Branch watershed was conducted by Cory Anderson, a graduate student funded by Dane County and guided by Ken Potter of the UW Civil and Environmental Engineering Department. (See Appendix B, Attachment B2 for Anderson's report. Note that some information collected is confidential and cannot be made available)

Professor Potter provided the following summary of Anderson's findings regarding the North Fork Pheasant Branch subwatershed to the Nutrient and Sediment Technical Advisory Committee.

- The unit-area phosphorus loading from fields in the subwatershed varies greatly across the subwatershed. For example, 25% of the field area contributes 53% of the phosphorus.

- Bennett et al. (1999) estimated that 18% of the P input to the Lake Mendota watershed has been due to feed supplements for dairy cattle. According to Satter and Wu (1999) the average dairy diet in U.S. is supplemented to 4.8 g/kg P, although the nutritional requirement is only 3.8 g/kg P. Sharpley, Kleinmann and Weld (2004) estimate that such a dietary reduction would result in a 30-35% reduction in manure P.
- For a typical crop rotation in the subwatershed, this dietary change would reduce Bray 1 soil P values by 4-12%.
- In a 5-year corn grain and corn silage rotation, this change would reduce Bray 1 P values by 9-19%.
- Discontinuing manure application on those farms contributing to a manure digester, plus two farms with similar characteristics (total of 5 farms decreasing in manure application of 31,000 pounds per year) would result in 3% average annual reduction of P loading from the subwatershed.
- Removal of all manure application in the subwatershed would result in 13% reduction of subwatershed load.
- Changing from corn silage to corn grain would yield significant reductions in PI.
- Continuous corn silage with inter-seeded rye would also yield significant reductions.
- Inclusion of oatlage in alfalfa seeding year would yield modest benefits.
- Change in timing of corn silage (moving corn silage to the year immediately before an alfalfa year) would yield slight benefit.

3.2.3.2 Door Creek Watershed

Additional SNAP-Plus field-scale modeling was completed as part of the UW's study of Door Creek, a tributary to Lake Kegonsa. Dane County obtained a DNR Lake Management Planning Grant and contracted with the 2009 UW-Madison Water Resources Management (WRM) Practicum to support the mission of the Yahara Lakes Legacy Partnership via an in-depth study of the Door Creek watershed. The WRM study used Door Creek as a model subwatershed within the Yahara Lakes watershed for recognizing and addressing potential sources of nutrient loading to the Creek and Lake Kegonsa, and identify management techniques and wetland conservation opportunities that could potentially be applied to the larger Yahara Lakes chain.

The report's key recommendations are listed below. The full final report "Door Creek Watershed Assessment: A Sub Watershed Approach to Nutrient Management for the Yahara Lakes," is available online. (See Appendix B, Attachment B3.)

Key recommendations the students identified for agricultural producers are:

1. Perform regular soil tests on cropped fields.
2. Apply nutrients according to crop needs.
3. Avoid application of fertilizer or manure when soil is wet.
4. If receiving biosolids, be aware of application rates and nutrient content.

Key recommendations the students identified for Dane County, DNR and others are:

1. Protect existing wetlands.
2. Restore wetlands.
3. Have MMSD use up-to-date soil tests prior to application of biosolids.
4. Support techniques to reduce P loading, including:
    a. No till farming (except on drain tiled fields).
    b. Minimize farming on >12% slope.
    c. Incorporate some type of non-row crop in rotations on slopes greater than 6%.
5. Monitor fertilizer applications after storm events.
6. Focus on P control management after storm events.
7. Test soil P levels prior to construction and reduce allowable soil loss accordingly.
8. Promote improved consistency between NRCS 590 (nutrient management standards) and NR 204 (domestic sewerage sludge management standards).

3.3 Assess Causes of Bacterial Outbreaks at Beaches

Concurrent with the Visioning, and Sediment and Nutrient Assessment, the Beaches Technical Advisory Committee conducted their work. The MOU required:

Assess Causes of Bacterial Outbreaks at Beaches.

Beach bacteria outbreaks routinely cause the closing of City of Madison beaches during summers, resulting in the loss of recreational opportunities as well as economic and social value to residents. In 2008, review of the beach bacteria data led to the listing of 9 of 13 City of Madison beaches[5] on the 303(d) list of impaired waters due to exceedances of the EPA *E. coli* standard (geometric mean >235 cfu/100 mL, (235 colony forming units/100 milliliters)) (See Appendix C, Attachment C1). Subsequently in 2010 as a result of additional testing, three of the nine beaches were removed from the 303(d) list. As part of the Yahara CLEAN MOU, the signatories agreed to assess the causes of bacterial outbreaks at beaches in order to reduce the occurrence of beach closures. The six beaches in the City of Madison that are included on the EPA 303(d) impaired waters list are the focus of Yahara CLEAN analysis. A summary description of Madison beaches is included as Appendix C, Attachment C2, and a briefer summary is found below in Table 3.

The Public Health-Madison and Dane County (PHMDC) collects samples from knee deep water and uses a higher single sample beach closure threshold (*E. coli* > 1000 MPN/100mL (1000 Most Probable Number/100 milliliters)) for bacterial beach water quality at Madison beaches. This level is based on several decades of experiences in beach monitoring, knowledge of the depth distribution with significant bacterial decline with depth and the general contaminant sources as well as lack of evidence of occurrence of swimming related illness below that level. Furthermore, Madison beaches do not receive point-source contamination.

[5] Three beaches located on Lake Mendota – James Madison, Marshall, and Spring Harbor Beaches – were considered in a tentative 303 (d) listing but were removed after additional data assessment.

Table 3: Descriptions of the Six Impaired Beaches

Vilas Beach *Lake Wingra*	• popular regional city beach adjacent to the Henry Vilas Park and Zoo • most heavily-used beach in the city • approximately 250 feet long and 65 feet wide, with a 7% slope • nearest storm outfall from the direction of the prevailing winds is approximately 1800 feet away (to the west) • large goose population frequently located near the beach, which almost certainly have caused the beach to close on numerous occasions due to high bacteria levels
Olbrich Beach *Lake Monona*	• frequently used regional city beach located at one of the city's first parks • approximately 180 feet long and 78 feet wide, with an 8.3% slope • located approximately 300 feet northwest of the nearest storm water outfall and 1300 feet southeast from the outlet of Starkweather Creek (which may transport contaminants to the beach) and a popular boat launch
Olin Beach *Lake Monona*	• neighborhood beach located on land purchased in 1912 for use as a park • located approximately 400 feet southeast of the Wingra Creek outfall (which may transport contaminants to the beach) and 250 feet southeast of a popular boat landing and parking lot • about 100 feet long and 12 feet wide, with an 8.8% slope • frequent goose problem • issue with stormwater runoff from the surrounding mowed turf areas
Esther Beach *Lake Monona*	• located along the southeastern shore of Turville Bay in Lake Monona • small neighborhood beach prone to problems with weeds due to its orientation to Turville Bay, and prevailing winds • about 70 feet long by 50 feet wide, with a 7.5% average slope • geese frequently an issue
Bernie's Beach *Lake Monona*	• small neighborhood beach situated in the southeast corner of Monona Bay • not a large goose population, but regular evidence of their presence • approximately 68 feet long and 40 feet wide, with an average slope of 8.8% • storm sewer outfall located directly adjacent to the beach
Brittingham Beach *Lake Monona*	• located along the north shore of Monona Bay, in Brittingham Park • approximately 80 feet long and 32 feet wide, with an average slope of 9.3% • storm outfalls sit on either side of the beach, both about 340 feet away • frequent evidence of a sizable goose population

Progress toward assessing causes of bacterial outbreaks at beaches has focused on two areas. First, representatives of the MOU signatories and their partners assembled and organized a technical group with the expertise to assess the situation and possible solutions to the problem. Second, progress was made in performing the technical analyses to assess the sources and develop a plan to begin reducing bacterial loading at the beaches.

In May 2008, YLLP organized the Beaches Technical Advisory Group designated for the assessment of bacterial outbreaks at Madison beaches as specified in the Yahara CLEAN MOU. The advisory group was composed of representatives of the relevant signatory agencies and experts in the field of environmental microbiology, stormwater, and beach bacteria issues. The technical advisory team members are listed at the Acknowledgement section at the beginning of this report.

In October 2008, the UW Nelson Institute for Environmental Studies hosted the Yahara Lakes Conference ("A Clean Future for the Yahara Lakes: Solutions for Tomorrow, Starting Today") to present and discuss issues affecting the Yahara Lakes. Approximately 350 individuals attended the event. Morning and afternoon presentations were broken up into concurrent sessions, including sessions dealing with beach bacteria issues. Morning sessions on this topic summarized what is known about the situation at City of Madison beaches and afternoon sessions discussed case studies from other areas and methods of identifying sources. After afternoon presentations concluded, the group in this session discussed recommendations to begin addressing bacterial loading in Madison. The following recommendations were presented at the closing plenary session:

- Comprehensively evaluate potential pollution sources at beaches (the EPA-developed Beach Sanitary Survey is an excellent tool) and develop a beach master plan. Reducing impacts from urban geese is a key component of implementation.
- Create a beach group involving all stakeholders and jurisdictions to foster political will and funding resources to achieve goals. Recognize the importance of education in informing and advancing public and political will.
- Recognize that healthy, sustainable beaches have social, political, and economic value.

In September and October 2008, WDNR conducted surveys of the 303(d)-listed beaches using the EPA Great Lakes Annual Sanitary Survey protocol. The EPA developed the Beach Sanitary Survey as a method to identify sources of bacterial pollution using field investigations of the beaches, assessments of the potential for pollution from different sources, and statistical analyses of collected data. All surveys were conducted after beaches had been closed for the season. The results of these surveys were presented to the Beaches Technical Advisory Committee in December 2008.

As part of the EPA Beach Sanitary Survey process, correlation and regression analyses were conducted to identify potential sources of bacterial contamination. All analyses used bacterial concentrations and associated data collected by PHMDC. The associated parameters can generally be separated into categories related to weather, water quality, and bather and wildlife use. Correlation analyses were performed primarily to identify the sources of variation in *E. coli* concentrations at each individual beach. However, some parameters such as bather and wildlife counts can vary widely within a given day so data was averaged at each beach to identify sources of variation in average *E. coli* concentrations between the beaches. Multi-variable regression analyses were also conducted for each beach, using parameters chosen based on the results of the correlation analyses. Multi-variable regression allows for the analysis of multiple relationships simultaneously, which is not possible using correlation analyses.

A University of Wisconsin-Madison statistics class (Stat 998, Statistical Consulting) performed a separate statistical analysis with the goal of developing models to predict beach closures. The analysis of bacterial samples takes 24 hours to complete, causing beach managers to always be a day behind in decision-making. This means that often beaches stay open on the first day of a bacterial outbreak or may be closed on days after bacterial counts have decreased. The student models attempted to identify causes of bacterial loading and provide guidance on when to close a beach using field ratings that can be made at the time of decision-making. PHMDC and USGS presented the data to the students and answered student questions. Each student then developed models for two of the thirteen beaches and wrote up their results in a report. Student approaches varied though most students relied on linear and logistic regression analyses to develop the models. Reports were presented to the Beaches Technical Advisory Committee in November 2008. A summary is included as Appendix C, Attachment C3.

3.3.1 EPA Beach Annual Sanitary Surveys

Beach Sanitary Surveys using US Environmental Protection Agency protocols were completed in fall 2008 for the 303(d) listed beaches, and repeated in fall 2009. Information on how to access copies of the 2008 completed forms is included in Appendix D. The field visits and desktop reviews associated with the surveys identified a common set of potential sources for bacterial loading that were present at all or most beaches:

- Storm sewer outfalls are located directly next to or in the near vicinity of nearly all of the beaches. Storm sewers have the potential to collect fecal matter from watershed runoff and carry it directly to the lakes. Additionally, bacteria can persist in sediment or standing water held within the storm sewer system and is flushed into the lake during rain events.
- Waterfowl have been observed at many of the city beaches with geese being the primary culprit. Waterfowl and wildlife have been identified as the primary source of bacterial loading at beaches in various studies. The feces from waterfowl and wildlife can enter the lake through direct runoff or through the storm sewer system. Since geese and ducks are often observed on or very near the beaches, waterfowl may be affecting the beach through direct runoff.
- Starkweather Creek and Wingra Creek enter the lake near Olbrich Beach and Olin Beach, respectively. Streams can transport bacteria in the same manner as storm sewers. Additionally, bacteria can persist in the sediment within the stream and be carried into the lake during storm events. Multiple storm sewers drain into these creeks and may act as a conduit from the watershed to the streams.

Other potential sources observed during annual sanitary surveys include restroom facilities, which were present near all beaches. However, there is no data indicating whether any of the facilities are contributing to bacteria levels at any of the beaches. Since all facilities are connected to the sanitary sewer, the facilities would only be contributing to bacterial loading during overflows or if the sanitary sewer system needs repair. Dye tests may be performed to assess whether sanitary contamination is occurring.

While not directly a source of bacteria, the layout of the beaches and their surrounding areas may facilitate the movement of fecal matter from the watershed to the beach. Municipal parks with mowed lawn landscaping surround all surveyed beaches. At most of these beaches, the lawn is mowed to the shoreline. This kind of landscape offers little resistance to runoff, allowing higher volumes and velocities of runoff that can carry feces or other material with it. Additionally, lawn grass provides favorable habitat to geese and ducks, since it allows wide fields of view for the waterfowl to see potential predators. The combination of these factors creates a beach landscape with an abundant source for fecal matter in an area where it is likely to run off into the water.

While the field surveys identified these factors as the general sources affecting multiple beaches, each individual beach has its own potential sources and challenges. Potential sources identified for individual beaches are summarized in Table 4.

3.3.2 Correlation/Regression Analyses

Correlation and regression analyses were performed for all beaches, including the six 303(d) list for impaired waters. Results of the correlation analyses for the 303(d) listed beaches can be found in Tables 5 and 6. The results of the multivariable regression analyses are found in Tables 7 and 8. Statistical relationships were generally weak but some significant relationships were observed.

- Rainfall exhibited a correlation with *E. coli* concentrations at most of the beaches. This relationship tended to be weaker or not statistically significant at beaches not listed on the 303(d) list for impaired waters. Regression analyses supported this work with statistically significant relationships at most beaches and higher coefficients at beaches listed on the 303(d) list for impaired waters. Coefficients associated with rainfall were the highest coefficient estimates for all beaches, suggesting that rainfall has the largest effect on bacteria levels. This relationship reinforces the observations made during the annual sanitary surveys that bacteria tend to be introduced to the beaches through stormwater, either by storm sewers or direct runoff.
- Wave intensity exhibited a statistically significant correlation with *E. coli* concentrations at all beaches except those in Monona Bay or Lake Wingra, where beaches are relatively protected from wind and waves. This relationship was less consistent in the regression analyses with wave intensity being statistically significant at only five of the six 303(d) listed beaches. It is possible that the relationship between waves and bacteria is based on a mutual relationship with weather, since one would expect higher wave intensity associated with storms. However, the absence of this relationship between waves and bacteria at "protected" beaches suggests that waves may play a role independent of rainfall. This role may be by pushing debris (human debris and aquatic plant matter) toward a beach and also causing resuspension of bacteria-laden sediment to the beach water. Plant and human debris has been shown to harbor bacteria and allow bacterial growth in some studies. The City of Madison Parks Department currently cleans most beaches and collects debris from the beach. Alternatively, waves may increase bacteria counts by wetting and flushing the shoreline. Studies have shown that bacteria can persist in beach sand and be washed into the water by wave action.
- Turbidity exhibited a statistically significant correlation at all beaches and was statistically significant in regression analyses for all listed beaches. Turbidity can be caused by either sediment in the water or by algal growth. PHMDC workers record the coloration of the water during sampling. While far from definitive, turbidity tended to be

associated more with brown coloration than green coloration, suggesting that turbidity was due more to sediment loading than by algal growth. The relationship between bacteria and turbidity may be due to either an increase in both a shared source or a causative relationship. Since turbidity can be caused by sediment additions through stormwater, this relationship may arise from stormwater loading both bacteria and sediment into the lake. Alternatively, wave/wind action and lake currents that stir up the lake bottom could cause turbidity. Some studies have shown that bacteria can persist and grow in lake sediment. Additionally, turbid waters decrease the mortality rate of bacteria by shielding the bacteria from ultraviolet light.

- Goose counts had a statistically significant correlation with average *E. coli* concentrations at the beaches. Beaches with higher average goose counts also had higher mean *E. coli* concentrations. As discussed above, geese and other wildlife can contribute to higher bacteria levels through the runoff of their feces into the water. The relationship between goose counts and *E. coli* suggests that beaches visited more frequently have a higher pool of bacteria that can be carried by runoff into the water. The total number of animals was also statistically significant, indicating that other wildlife may also contribute to bacterial loading.

Other parameters exhibited statistically significant relationships at individual beaches but no widespread trends were observed.

Table 4: Potential sources identified and the recommended next steps to reduce bacterial loading at each individual beach. See Table 9 for general recommendations for addressing bacterial loading for each potential source.

Beach	**Lake**	**303(d) Listed**	**Potential Sources**				**Next Steps**	**Challenges**
			Stormwater Outfall(s)	**Stream**	**Geese**	**Restroom Facilities**		
Bernie's Beach	Monona	Yes	X			X	• Implement pilot project • Divert water from nearest storm sewer outfall to retention pond • Determine if farther storm sewer outfalls influence the beach	• Several storm sewer outfalls may affect beach • Wind patterns cause plant accumulation near beach
Brittingham Beach	Monona	Yes			X	X	• Divert water from major storm sewer outfall west of beach to retention pond • Geese management	• Low depth to groundwater makes infiltration BMPs difficult to implement
Esther Beach	Monona	Yes	X		X	X	• Install stormwater infrastructure to prevent runoff from landscape	• Little stormwater infrastructure in area so outfall diversion not likely to have a large impact

							• Divert storm sewer outfall next to beach to retention pond • Geese management	• Surrounding land relatively steep
Olbrich Beach	Monona	Yes	X	X	X	X	• Address bacterial loading to Starkweather Creek • Geese management.	• Very big project since lots of loading from Starkweather Creek • Wind patterns and beach configuration cause plant accumulation near beach
Olin Beach	Monona	Yes		X	X	X couple minute walk and not as visible as at other beaches	• Address bacterial loading to Wingra Creek • Geese management	• Drainage of hillside • Very big project since lots of loading from Wingra Creek • Beach configuration cause plant accumulation near beach
Vilas Beach	Wingra	Yes			X	X	• Implement pilot project • Geese management	• Carp population impacts turbidity • Abundance of geese habitat

Table 5: Results of correlation analyses for weather and water quality parameters: S = relatively strong correlation (r of 0.4 or more), M = relatively moderate correlation (r between 0.3 and 0.4), L = relatively weak correlation (r of 0.3 or less). Boxes highlighted in color were statistically significant. Darker colors indicate stronger correlations.

	Rainfall	Air Temp	Water Temp	Wave Intensity	Turbidity	Weed Growth	Weed Accumulation	Algal Growth	Green Coloration	Brown Coloration
Bernie's	**S**	N	N	N	**S**	N	N	N	N	**M**
Brittingham	**M**	N	N	N	**M**	**L**	N	**L**	N	**L**
Esther	**S**	N	N	**M**	**L**	**L**	N	**L**	**L**	N
Olbrich	**L**	N	N	**M**	**M**	N	N	N	N	**M**
Olin	**S**	N	N	**M**	**L**	N	**L**	N	N	**M**
Vilas	**L**	N	N	N	**L**	**L**	N	N	N	N

Table 6: Results of correlation analyses for bather use and wildlife count parameters. Parameters in blue were statistically significant.

	PopInWater	PopOnBeach	TotalPop	Ducks	Gulls	Geese	Feces	Critters	Total Animals
r	0.134511	0.013095	0.058178	0.139648	0.336295	**0.778171**	0.395926	-0.02517	**0.696214**
t	0.450212	0.043436	0.193281	0.467745	1.184345	**4.109369**	1.429993	-0.08351	**3.216729**
p (2-tailed)	0.661301	0.966132	0.850261	0.649097	0.261236	**0.001732**	0.180503	0.934948	**0.008207**

Tables 7 and 8: Results of multi-variable regression analyses for individual 303(d) listed beaches. Parameters highlighted in green were statistically significant at the 95% level. Parameters highlighted in yellow were statistically significant at the 90% level.

Table 7

	r^2	Precipitation		Turbidity	Weeds	Algae Amount	Waves	Green	Brown
		Data Source	Coefficient						
Bernie's	**0.38**	Arboretum	2.389826438	0.605957428	-0.10370868	-0.422572948	-0.20877724	0.364741253	0.810619059
Brittingham	0.33	**Rainfall**	2.799468179	0.471038566	0.156832375	-0.284527248	0.019431578	0.068183566	0.394781375
Esther	0.38	Arboretum	2.541250321	0.452880238	0.132678912	-0.049719012	0.324267544	-1.437052691	-0.75621703
Olbrich	0.26	Arboretum	1.024472472	0.378041102	-0.22425327	-0.078758632	0.282100174	0.73611828	0.89984213
Olin	0.39	Arboretum	2.131506912	0.265298065	-0.28215221	-0.154418574	0.464945608	-0.56781801	0.661294324
Vilas	0.12	Arboretum	1.019181364	0.212818763	0.298114777	-0.00195055	-0.14570953	-0.001268401	0.141980771

Table 8

	Other 1		Other 2		Other 3	
	Parameter	Coefficient	Parameter	Coefficient	Parameter	Coefficient
Bernie's	Condition	-0.098721718	Feces	0.549616149	Water Temp	-0.028392453
Brittingham	Accum	0.156023818	TotalPop	-0.132495635		
Esther	Accum	0.030085052	TotalPop	-0.11970613		
Olbrich						
Olin	Feces	0.266883675	Total Animals	0.014650295		
Vilas	Condition	0.067214916				

3.3.3 Student Analyses

UW-Madison graduate students in the Stat 998 class analyzed data for 13 beaches including the six 303(d) listed beaches using a range of techniques, including linear regression, logistic regression, and decision trees. Since some but not all beaches were analyzed by multiple students and not all students used the same procedures, the results are not directly comparable to each other. However, some general conclusions can be gathered from the results.

Overall, the parameters with the most consistent relationship with high *E. coli* levels were rainfall, turbidity, and wave intensity. Other parameters were locally significant but did not have general predictive power. These results correspond well with the results from correlation analyses conducted under the annual sanitary surveys.

3.3.4 Beach-Specific Considerations

While stormwater and geese were identified as general sources that potentially affect many of the city beaches, the relative impact of each source varies from beach to beach. Additionally, each beach has particular site-specific sources and challenges that need to be addressed. Based on discussions of the Beaches Technical Advisory Committee, Table 4 lists the recommended next steps and challenges associated with individual beaches.

The Beaches Technical Advisory Committee began work on a pair of pilot projects to begin addressing these problems at two city beaches. PHMDC applied for two DNR small-scale lake planning grants to fund conceptual plans to address bacterial levels at two beaches. The DNR approved both applications for funding in March 2009. After approval, the Beaches Technical Advisory Committee met to select the two beaches at which to pursue pilot projects. The group selected the beaches based on the scope of the problem and the feasibility of addressing that problem at each beach. Additionally, since stormwater and geese were identified as the predominant sources of bacteria, it was decided that the two pilot projects should each address one of those sources. Bernie’s Beach was selected as a beach at which to pursue stormwater improvements. Vilas Beach was selected as a beach at which to pursue geese management strategies.

All beaches will need long-term management to reduce and eliminate bacteria. Some bacterial sources can be eliminated with a specific activity such as redirecting roof drainage through the beach. However, most of the activities needed to reduce bacteria at our beaches will require activities on a daily basis like removing plant matter from the shoreline, seasonally like geese management, and yearly basis like replenishing sand with adequate grain size. The long-term commitment from the City of Madison and PHMDC will improve the beach bacteria problems at the six 303(d) listed beaches.

Table 9: Recommendations for addressing bacterial loading from identified sources

Source	Potential Actions
Stormwater Outfall(s)	• Identify the outfalls affecting the beach using dyes, bacterial sampling, etc. • Install infiltration BMPs where feasible and divert water from storm sewer to BMP • Educate residents on pet waste disposal • Relocate outfalls to locations that will not impact beaches • Install filters at storm sewer inlets
Stream	• Perform dye tests or sampling studies to determine if and when stream is affecting beach • Address storm sewer contributions to the stream (see above) • Install vegetated buffers
Geese and Other Wildlife	• See Appendix E, Attachment E1 for full list of Goose Management Options
Restroom Facilities	• Perform dye test to determine if facility is affecting beach • Repair existing infrastructure to eliminate overflows and leaks

3.4 Determine Necessary Nutrient, Sediment and Bacteria Levels to Reach the Community Vision

The MOU required:

> *During the first year, the parties, consulting with our partners, will determine the necessary nutrient, sediment and bacteria levels to reach the Vision and determine if the needed reductions can be achieved if reduction activities are taken.*

Dr. Richard Lathrop (DNR lake researcher) and Dr. Steve Carpenter (Director, UW Center for Limnology) agreed to complete in-lake modeling of the Yahara lakes system in order to establish phosphorus (P) loading limits to the Yahara lakes, and provide tools with which the Coordinating Committee could assess the lake response to nutrient and sediment reductions. Lathrop and Carpenter's initial work focused on Lake Mendota and its watershed, and their summary is provided in section 3.4.1 below. Appendix D, Attachment D1 provides information on lake trophic state and phosphorus that is useful background to the material that follows.

3.4.1 In-Lake Modeling and Establishment of Phosphorus Loading Recommendations

Background and Methods

These analyses build on the previous modeling work that was included in the Lake Mendota Priority Watershed Plan approved for funding in 1997. The modeling results for that plan included an analysis of lake and watershed data for 1976-1996 (21 years); results were published in the peer-reviewed aquatic sciences literature. Using the natural variability in annual P loadings over the 21-year record, a model was developed that predicted in-lake P concentrations during mid-April, which in turn predicted the probability on any given summer day (July-August) of having blue-green algae with a density greater than 2 mg/L (measured in the center of the lake). Ultimately, the model predicted how the daily bloom probability would be affected by a change in annual P loading. For example, a 50% P load reduction predicted the bloom threshold would be exceeded on average only 2 out of 10 days compared to 6 out of 10 days under current P loading conditions. For the Mendota watershed plan, a 50% P load reduction was recommended.

The updated lake response modeling work being conducted for Yahara CLEAN included in-lake water quality data and watershed P loading data for 1976-2008 (33 years). While the earlier analyses completed for the Lake Mendota Priority Watershed Project used mid-April as the annual time step in loadings to predict summer algal bloom conditions, the newer analyses use an annual loading time step of November 1 and the lake's P status (mixed water column P concentration or mass) on that date as a hindcast predictor of that summer's water quality. Also, lake water quality is measured as two response variates: Secchi disc transparency and surface water P concentration. Both measures have values that correspond to Carlson's (1977) Trophic State Index (TSI) threshold of 50 separating "mesotrophic" (moderately fertile) and "eutrophic" (fertile) lake conditions. A TSI value of 50 corresponds to a Secchi disc of 2 m and surface water total phosphorus (TP) concentration of 0.024 mg/L. Thus, the lake response modeling predicts the probability of a summer day when the lake is "mesotrophic" – i.e., with a Secchi disc reading >2.0 m or surface water TP concentration <0.024 mg/L. Both Secchi and TP are relatively easy to measure compared to blue-green algae concentrations, and the Trophic State Indices are more widely interpretable by lake managers and informed citizens. The water quality goal of "mesotrophy" for Lake Mendota is also a laudable target.

An additional lake modeling variate used to predict summer water quality conditions is the zooplankton grazing (or "biomanipulation") state of the lake. This refers to whether the lake was dominated by large-bodied *Daphnia pulicaria* during spring and early summer, or whether the lake only had small-bodied zooplankton grazers. Research has shown that when large *Daphnia* are present, then water clarity is significantly increased during spring and even summer when blue-green algae normally occur. In the past, large *Daphnia* only have occurred in Lake Mendota when zooplankton-eating fish populations were low. Since 1988, predator fish (walleye and northern pike) have been regularly stocked to reduce and then maintain low densities of zooplankton-eating fish such that Lake Mendota has been in the "good" biomanipulation state through 2008. The discovery of the invasive spiny water flea in the Yahara lakes in 2009 may have some impact on future densities of large *Daphnia* in Lake Mendota, as spiny water fleas are invertebrate predators of *Daphnia* and other zooplankton. The effect of spiny water fleas on summer water clarity is not modeled for the Yahara CLEAN report given the invasion is so recent.

Another new aspect of the watershed P loading and lake response analyses was the hope that the SWAT watershed modeling results would provide updated annual P loading data that could be linked to specific watershed areas of high P loading. First, the SWAT results were not completed until late December 2009, which has delayed the lake response modeling analyses. Another problem is that the SWAT modeled P loadings from agricultural subwatersheds are significantly underestimated and hence biased. This conclusion is based on a comparison of monthly SWAT P loadings with two monitored subwatersheds in the Mendota basin: the Yahara River and Pheasant Branch. In both cases, SWAT severely underestimated late winter runoff P loadings, which represented well over 40% of the long-term annual P loadings for those two subwatersheds. The reason is that SWAT predicts sediment in runoff as a response to precipitation with the heaviest rainstorm events producing significant sediment loads with associated high P loads. However, late winter runoff events are produced by snowmelt and/or relatively minor amounts of rain on frozen ground. And because dissolved P concentrations are typically high during these late winter runoff events in agricultural watersheds with winter manure spreading, SWAT cannot accurately predict P loads at this time of the year. SWAT did identify where subwatershed loading sources would likely be high as well as determined internally drained land areas that would not contribute surface runoff to Lake Mendota.

Thus, the annual P loading data used to predict lake water quality responses are derived from the monitored subwatershed P loading data for Pheasant Branch and Yahara River and loading relationships develop in earlier analyses for other rural subwatersheds coupled with newer information on watershed drainage areas determined by SWAT. For urban storm sewer drainage basins draining directly to Lake Mendota, SWAT did seem to predict runoff volumes fairly well although P loads appeared to be underestimated based on a comparison with monitoring data. To rectify this problem, SLAMM modeling results recently conducted by the City of Madison using

1981 as the “typical” runoff year were then used in conjunction with SWAT annual urban runoff volumes to predict annual P loads for each urban subbasin draining directly to Lake Mendota for 1976-2008. (Urban loads from outlying communities in the Mendota watershed were included in the rural P loading estimates.) The final P loading database for Lake Mendota was completed in June 2010 and the lake response modeling work was completed in July. Results are presented below including a brief description of the Lake Mendota response model. Modeling results for Lake Monona and the other lower lakes will be completed in ensuing months after the P loading databases are assembled.

The model used for assessing the response of Lake Mendota to watershed P loading reductions is structured from submodels that produce a large sample (or probability distribution) of P loads, November P masses, and P export masses (outlet P) that are used to drive a water quality model. The water quality model produces a probability distribution of in-lake water quality (i.e., P concentrations or Secchi readings) that represent “mesotrophic” conditions for the lake. This process is conducted for “current” P loads as described by the past 33 years of data representing a wide range of loading conditions. The process is then repeated for different P load changes expressed as a percent of the current loads. A key assumption is that the 33 years of history of the lake represent future conditions where relationships (e.g., food web or algal grazing) are stable. As mentioned before, spiny water fleas could decrease algal grazing (as spiny water fleas eat *Daphnia* and other zooplankton, thereby reducing algal grazing from *Daphnia*). Conversely, the invasion of zebra mussels (found in lakes of adjacent counties) could increase algal grazing and produce greater mid-lake water clarity (zebra mussels filter water and eat algae), but available nutrients could then fuel algae blooms that float and pile-up as shoreline scums.

Mesotrophic is a term used to describe lakes with a moderate amount of dissolved nutrients. Figure 8 illustrates the good water clarity associated with mesotrophy. Figure 9 is an example of the shoreline scums that would be absent in mesotrophy.

	
Figure 8: This Secchi disk is visible in several feet of water. A Secchi disk visible in two meters of water indicates mesotrophy.	**Figure 9**: Algal scums like this eutrophic lake situation would be absent at the shoreline in mesotrophy.

Lake Response Modeling Results

Lake response modeling results for the probability of July-August days with TP concentrations <0.024 mg/L (mesotrophic) are shown in Figure 10. Probability of summer days of Lake Mendota being mesotrophic are represented on the Y (vertical) axis with watershed P loads

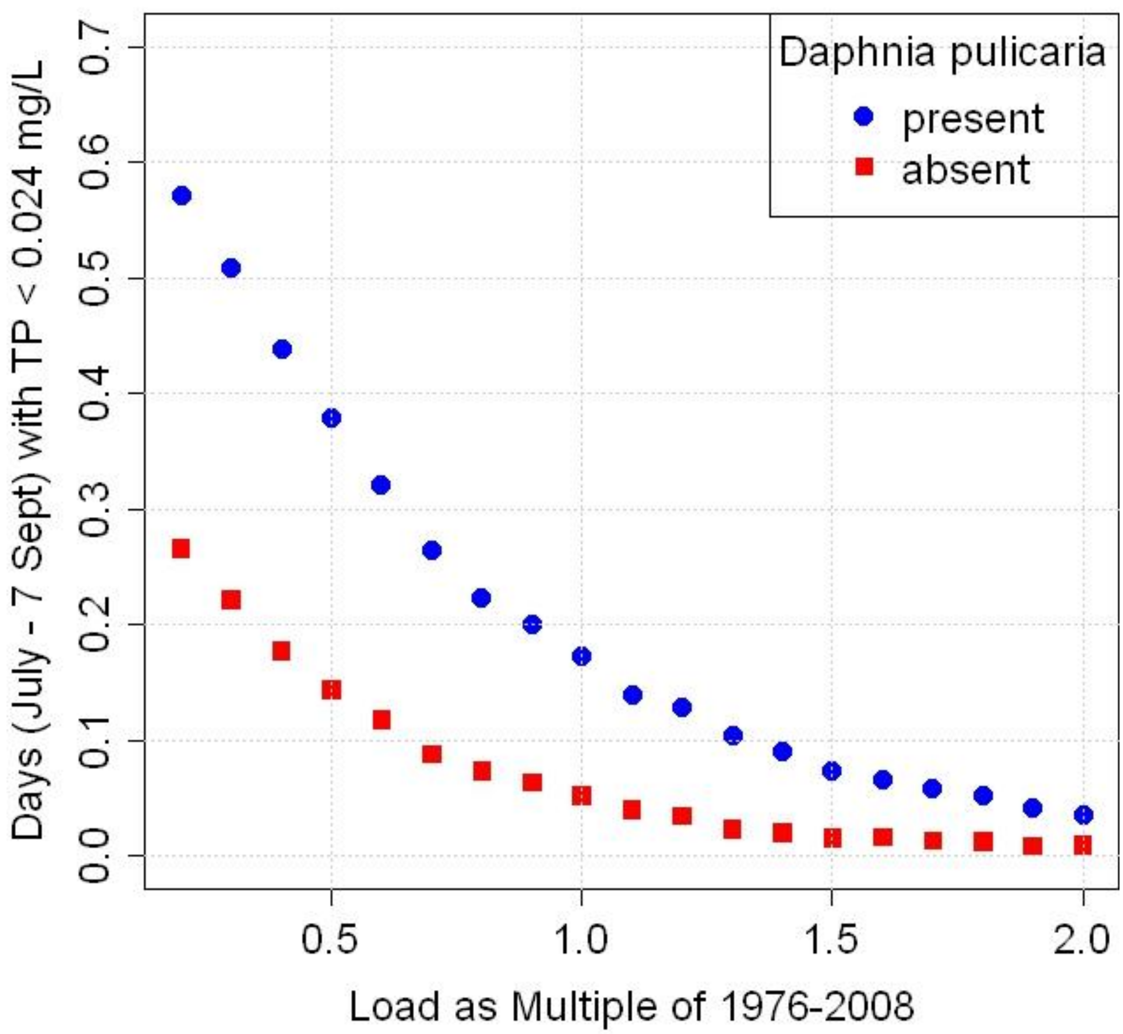


Figure 10: *P loads representing the distribution of annual loads to Lake Mendota over a 33-year period (1976-2008) are plotted on the X-axis. The probability of days with mesotrophic lake conditions during the summer (July-August) are plotted on the Y-axis. Mesotrophic conditions are represented by lake surface water TP concentrations <0.024 mg/L based on the corresponding Carlson Trophic State Index value of 50 being the separation between mesotrophic and eutrophic lake conditions. Current P load conditions are 1.0; a 50% P load reduction of the 33-year history of loads is plotted as 0.5. The two curves represent the lake's different food web or biomanipulation states – i.e. whether* Daphnia pulicaria *are present or not during spring and early summer, a condition that has generally occurred since 1988.*

plotted on the X (horizontal) axis as multiples of the past 33 years of loading history (1976-2008). Two separate curves are plotted representing the two different zooplankton grazing or biomanipulation states of the lake, one with and one without *Daphnia pulicaria* being present. (Given that the lake has been in the "good biomanipulation" state [*D. pulicaria* present] since 1988, discussion of the modeling results are based on those conditions.) For current P load conditions, the probability of lake TP being in the mesotrophic state is slightly less than 2 out of 10 days. If P loads are reduced by 50%, then the probability of mesotrophy increases to about 4 out of 10 days. The modeling results also indicate that if P loads increase, then the probability of mesotrophy declines somewhat.

Similar analyses were produced for Secchi, but food web issues complicate the analyses (results not shown here). For example, middle-of-the-lake Secchi readings can be slightly better than 2 m, but algal blooms can develop and pile-up as scums on downwind shorelines, a condition that could worsen if zebra mussels become established. Thus, for the purposes of this report, the summer (July-August) TP index for mesotrophy is considered the best response variate for managers to use.

Similar to the P loading results utilized in the earlier Mendota Priority Watershed Project, the in-lake modeling results indicate a sliding scale of lake water quality improvements with P load reductions, with ever increasing probability of mesotrophy as P loads progressively decrease. Thus, the decision as to how much P load is needed to improve lake quality is a cost-benefit decision as to how much P load reduction can be achieved. The more P loading is reduced, the greater the water quality improvement.

3.4.2 EPA Standards for Beaches

US EPA established standards for *E. coli* and enterococci on the Nation's beaches in 1986. The standards are designed to protect swimmers from illness due to exposure to pathogens in recreational waters. The "Advisory" standards were adopted based upon data from US EPA studies conducted in the late 1970's. The 1986 US EPA guidelines recommended a single sample maximum of 235 cfu/100mL (235 colony forming units/100 milliliters) for *E. coli* and a maximum of 61 cfu/100mL for enterococci as the levels where beach notification should be considered. The US EPA bacterial water quality standards for fresh water are based on epidemiological studies on samples collected from chest deep water in areas that receive point-source contamination. The US EPA is currently developing new criteria that are expected to be promulgated in 2012.

3.5 Activities Necessary to Meet Loading and Bacterial Reductions

The MOU next required that:

> *The parties will identify the activities necessary to meet the loading and bacterial reductions and estimate the costs of these activities. The needs assessment and cost estimates will be completed by fall, 2009.*

Following the analysis of modeling and other findings, staff members to signatories have prepared, working with the technical advisory committees, "Nutrient and Sediment Action Opportunities," which represents the top priority listing of action opportunities for reducing nutrient and sediment loading, and "Beach Action Opportunities," a listing of action opportunities for reducing beach bacteria. These action opportunities are found in Tables 10 and 11. As required by the MOU, these tables identify possible actions and an estimate of their costs, where available. These tables have undergone extensive discussion with technical committees, and have been strengthened and clarified by stakeholder input.

The intent of this part of the report is to lay out options for reaching the goals described in Section 3.4. The goal is for cost-effective sediment, nutrient and bacteria reductions, selected in a consensus-based manner. Consensus may not be achievable, given competing interests and probable entrenched positions, but it is something to work for.

3.5.1 Discussion of Nutrient and Sediment Action Opportunities

The Yahara CLEAN Nutrient and Sediment Technical Advisory Committee, with input from interested individuals, groups and the general public, has identified more than 30 possible "action opportunities" to reduce the flow of phosphorus (P) and sediment into our lakes. For each action opportunity, we show an estimated cost and an estimate of high, medium or low direct reduction of P flowing into our lakes (P loading) that would result from taking the action. The high, medium and low classifications are based on professionals' estimates of P reductions leaving the site where the action was taken.

The advisory group did not identify a specific number of pounds of P per year by which loading would be reduced for any of the possible action opportunities. Group members found that the variability and complexity of the watershed systems, in particular the spatial variability of the source of P runoff and the wide variety of conveyance systems (ditches, channels, steams, marshes and rivers) leading to the lakes, made it impossible for them to identify with any confidence the pounds of phosphorus loading annually that would be reduced by taking any of the action opportunities. The technical advisory group didn't want one action opportunity to be picked for wholesale implementation over another action opportunity based on numerical estimates of loading which are highly variable from site to site and have not been validated. The amount of P loading reduction for any action depends on where that action is located in the watershed.

An underlying theme of this report is the desirability of a targeted approach to reducing the P and sediment flowing into our lakes. Models identify the relative difference in P and sediment loading between large subwatersheds (modeled in SWAT) and between individual farm fields within subwatersheds (modeled in SNAP-Plus). Clean-up efforts will be most effective and most cost efficient when we begin by targeting our efforts in areas that have relatively high loading to the lakes, and when we focus on site-specific action opportunities that will most reduce loading to the lakes in those sub-watersheds.

Ideally, a completed in-lake response model used in combination with the tables of action opportunities will provide even more detailed guidance on what needs to be done, what it will cost, what the outcome will be for the lakes, how long it will take, staff confidence that specific actions are do-able and will achieve the results the community desires, and the time it will take in order to see those results. Community leaders have told staff that this comprehensive package is needed in order to build public support and funding to implement the practices needed to clean up the lakes. Unfortunately the in-lake modeling is not complete and therefore the comprehensive package is not yet ready. We do expect this work to be completed in stages over the course of 2010-2011. This should not however, stand in the way of moving forward with responsive action. It will simply let us fine-tune this work as we move forward.

However, even though Richard Lathrop and Steve Carpenter are not done with their in-lake modeling, they have provided these tentative conclusions regarding P runoff reductions to Lake Mendota:

- Lake Mendota's water quality will improve relatively soon after the amount of P flowing into the lake is significantly reduced.
- Reducing the P flowing into the lakes will take a long time to occur without significant control measures because of high P concentration in watershed soils and sediment accumulated in tributaries.
- P load reductions to Lake Mendota will produce measurable water quality improvements in downstream lakes.

The next step is for wide review of this report and the identified action opportunities, and a process by which policy makers working with the advisory committee and others identify opportunities for implementation.

3.5.1.1 Reducing the flow of P into our lakes -How will we know when we have reduced enough?

The University of Wisconsin Center for Limnology is developing in-lake models that will predict how changes in the average annual loading of P to our lakes will affect lake quality. A preliminary in-lake response model for Lake Mendota was completed in August 2010. Using this model in conjunction with estimates of P loading to Lake Mendota show how we might answer the question of "how much is enough?"

The Nutrient and Sediment Technical Advisory Committee used two methods to estimate the annual P loading to Lake Mendota, and each arrived at a very similar estimate. In one method, loading estimates using the SWAT model were adjusted by applying the SNAP-Plus model's algorithm for spring-melt manure run off to estimates of animal waste spreading in the watershed. In the second method, historic monitored loading data for Pheasant Branch and Yahara River subwatersheds were projected over the entire Lake Mendota watershed using identified loading relationships between those subwatersheds. In each case, the annual P loading to Lake Mendota varied greatly from year to year (up to 25-fold variation) and averaged on the order of 70,000 pounds of P per year.

The in-lake model for Lake Mendota shows how, as the annual amount of P flowing into the lake changes, the probability of summer days with clear lake water changes. For example, in a year where the annual loading of P is 70,000 the expected probability of any July-August day having a total phosphorus concentration less than 0.024 mg/L (this corresponds to water clarity of a Secchi disk reading of 2 meters or more) would be just under 20%. If we take actions that result in a net reduction in annual P loading of 50% to Lake Mendota (an average annual net reduction of about 35,000 pounds of P), the model predicts that (barring disruptions caused by invasive species) the probability of any day in July and August having water P concentrations less than 0.024 mg/L increases to just under 40%.

As we identify site-specific action opportunities to implement, we will be able to estimate the average annual reduction to P loading that will result from those actions. When in-lake response models are complete, we will be able to gauge the likely impact of P reductions on lake quality. Thus, as site specific action opportunities are implemented, policy makers and the general public will be able to look at these investments of money and/or regulations being made for clean, clear lakes; be able to identify the probability of lake response to those investments; and will be able to decide how much investment is enough.

Two important facts bear repeating:

1) The high temporal variation of annual P loading means that we could implement action opportunities that will greatly reduce the average annual P loading, but if we have a year with a big snow-melt, or large rainfall events, the flushing of P and sediment into our lakes caused by those climactic events could temporarily mask the long-term positive effects of what we have done.

2) The in-lake models use the net change to annual P loading to predict lake response. If we implement action opportunities that greatly reduce the average annual P loading to our lakes, but other actions elsewhere in the watershed increase annual P loading, we will not get the results we hope for. Actions to reduce P loading to our lakes will always be positive steps for improved lake quality, but it is the net effect of all actions in the watershed that determine the lake water quality.

3.5.2 Discussion of Beach Action Opportunities

The action opportunities address bacterial reductions, as directed by the MOU. Clearly many beach closures are linked not only to bacteria, but also to blue-green algae blooms and other conditions. Practices to reduce nutrient input to the lakes will help reduce the frequency of the algae blooms, and therefore beach closure frequency related to those blooms. Other practices for mitigation of blooms are already being tested, and additional focus on these could come with the successor organization and the additional issues and actions it addresses.

Table 10: Yahara CLEAN Nutrient and Sediment Action Opportunities

Action Opportunities to Reduce Sediment and Nutrient Runoff	FTE	LTE	Cost Share $	Other Costs	Total $	Estimated Direct P Red.
Establish and lead a successor organization to the Yahara Lakes Legacy Partnership.	1				$100,000	0
Rural Opportunities						
Policy Development						
Establish an agriculture producers' advisory group to help shape our water quality policies including review of liquid manure spreading ordinance and improvements to solid manure application practices	0	0	$0	$1,800	$1,800	0
Talk with farmers in the lake Mendota watershed to see how farming practices have changed since 1996, and identify changing needs and opportunities to reduce nutrients and sediment flowing to the lakes. This update to the 1996 Farming Practices Inventory (FPI) is currently underway. (grant funded)				$13,500	$13,500	0
Stay abreast of science developments and adjust our strategy for protecting our lakes accordingly.					0	0
Maintain existing, and establish additional stream monitoring to measure nutrients and sediment going into our lakes.				$137,000	$137,000	0
Existing Ag Production						
The following 4 possible action opportunities involve the systematic implementation of the requirements of Wisconsin Administrative Rule NR 151 Agricultural Performance Standards and Prohibitions for Runoff Management, targeting the use of public funds to help pay for best management practices in high-loading farm fields. In order to do this, it is necessary to: conduct a soil test of each farm field, run a SNAP-Plus analysis of each farm field, develop a multi-year nutrient management plan for each farm field, conduct a whole-farm performance standard inventory, cost share in the necessary management practices needed to reach compliance, and then monitor and ensure continued compliance with all requirements. This work would be rolled out over a period of years as funding is available, beginning with those subwatersheds and farm fields that load the most phosphorus to the lakes.					See the 4 recommendations below	See Below

Table 10: Yahara CLEAN Nutrient and Sediment Action Opportunities

Action Opportunities to Reduce Sediment and Nutrient Runoff	FTE	LTE	Cost Share $	Other Costs	Total $	Estimated Direct P Red.
1) In a small (59 square miles) area with high runoff (Waunakee Marsh/Six Mile Creek and Pheasant Branch subwatersheds), identify nutrient and sediment runoff from individual farm fields. Pay farmers part of the cost of installing farming practices that will reduce nutrient and sediment flowing into the lakes from the high runoff fields. Evaluate the effectiveness of this effort at reducing P loading to the lakes and reassess and adjust PI value used to identify high loading fields targeted for management changes if necessary. This is currently under way in the 5 year Mississippi River Basin Initiative (MRBI). (grant funded)	$325,000 (1) 5 yr project position	$167,500 10 LTE for 2 yrs	$2,000,000		$2,492,500	High
2) Develop a simpler, quicker, cheaper way to identify individual farm fields with high nutrient and sediment runoff without running the SNAP-Plus model on each field. This could be done using data collected in the Smith/Conley, Pleasant Valley, Pheasant Branch, and Waunakee Marsh/Six Mile Creek sub-watersheds. That new method would be used in #3 below.	$210,000 1(3 yr project)				$210,000	0
3) Based on the evaluation done in #1 above, expand what was done in the 59-square-mile area (MRBI project) to all farms in the Yahara lakes watershed, starting with subwatersheds that send the most nutrients and sediment to the lakes.					$14,250,000	High
4) If farmers refuse to install (after being offered grant money), or fail to maintain farming practices designed to reduce runoff, use Dane County's stepped enforcement policy, provisions of the Farmland Preservation Tax Credit Program, or enforcement options under state administrative codes to achieve compliance with state and county rules. Stepped enforcement policy suggests that when implementing any actions to reduce agricultural sediment and nutrient loading to the Yahara lakes, if any non-compliance with agricultural performance standards is found, enforcement is taken only after all other avenues to compliance are unsuccessful.	$75,000 (1)				$75,000	0
Run soil tests on all cropland and pastureland in the Yahara lakes watersheds. Soil phosphorus (P) levels for each farm field are often unavailable, and are a major factor in identifying how P is entering our lakes.			$310,000		$310,000	0

Table 10: Yahara CLEAN Nutrient and Sediment Action Opportunities

Action Opportunities to Reduce Sediment and Nutrient Runoff	FTE	LTE	Cost Share $	Other Costs	Total $	Estimated Direct P Red.
Work with farmers and crop consultants (provide training) to develop multi-year, Phosphorus Index-based, nutrient management plans that detail crop rotations, tillage practices, manure and commercial fertilizer application (NRCS 590 plans). Review and ensure the plans are followed, including review of nutrient management plan updates, farm visits and records inspection.	$75,000 (1)		$2,850,000		$2,925,000	0
Prohibit the application of manure and any other P-containing fertilizer to farm fields with a soil P level of 200 ppm or more. An exception would be necessary starter fertilizer. *Note: This could be done by County ordinance.*					Low	High
Dredge sediment from selected drainage ditches, and incorporate that sediment back on the farm fields. Do this only after nutrient and sediment runoff from the fields have been controlled. Test dredge spoils where possibility of unwanted contaminants exists. Install 2-stage ditches where warranted.				$1,500,000	$1,500,000	High
Build the community manure handling facility (manure digester) planned for the Waunakee area. After it is evaluated, if evaluation shows the facility to be a cost-effective method of transferring phosphorus out of the watershed and reducing P loading to the lakes, build more facilities to meet needs in other watersheds.					$3,300,000	High
Establish an easement purchase/relocation program for a limited number of livestock operations in locations that send large amounts of nutrients and sediment into the lakes.			$2,500,000		$2,500,000	High
Devote staff time to help farmers get necessary federal, state and local permits for projects that reduce nutrients and sediment flowing into the lakes.					$0	0
Information and Education						
Inform and educate the agricultural community and the general public about sediment and nutrients flowing into the lakes from ag. sources and what can be done about it. Build support for cleanup actions.	$75,000 (1)			$26,000	$101,000	0
Alternative Markets or Funding Sources						
Identify farm-specific opportunities for reducing P flowing into our lakes to take advantage of pollution trading opportunities.					Low	High

Table 10: Yahara CLEAN Nutrient and Sediment Action Opportunities

Action Opportunities to Reduce Sediment and Nutrient Runoff	FTE	LTE	Cost Share $	Other Costs	Total $	Estimated Direct P Red.
Identify or hire an aggregator who would buy switch grass or other biofuels from Yahara basin farmers and sell it to the University Charter Street power plant. Provide a cost incentive to Yahara basin farmers growing biofuels.					$3,632,000	High
Develop a conservation standard to pay farmers for growing harvestable perennial crops on stream-edge buffer strips and other land with high runoff to the lakes. Harvesting perennial crops would reduce soil P level. Crop could be used as food for livestock, biofuel, landscaping mulch, animal bedding, etc.					$0	High
Restoration/Stabilization						
Identify, purchase and restore critical wetlands in the watersheds. Harvest plants from wetlands to "mine down" soil P (estimated cost based on purchase and management of 200 acres)					$2,100,000	High
Stabilize rural waterway banks. (Cost estimate is for 5,000 linear feet.)					$155,000	High
Urban Opportunities						
New Development						
Require all new development to maintain 90% of the pre-development infiltration volume for all land uses. Include a provision for the option of off-site remediation when cost of meeting 90% infiltration on-site is prohibitive.		$30,000 (1)			$30,000	High
Continue to achieve an 80% reduction in sediment runoff from new development as required in current NR-151. This standard has been implemented for several years.					$0	High
Increase enforcement of existing rules for construction site erosion control.	$60,000 (1)				$60,000	Unknown
Require increased protection of topsoil piles created during construction of new development. Topsoil on a construction site contains the majority of the P.					Minimal	Unknown
Existing Development						
Achieve a 40% reduction in sediment from runoff in existing urban areas as required in current NR-151. Currently underway, municipalities are funding this effort.					$0	High

Table 10: Yahara CLEAN Nutrient and Sediment Action Opportunities

Action Opportunities to Reduce Sediment and Nutrient Runoff	FTE	LTE	Cost Share $	Other Costs	Total $	Estimated Direct P Red.
Expand the County's Urban water Quality Grant Program to help more municipalities pay for upgrades to their stormwater management structures. Cost estimate based on 160 retrofit projects over 10 years.			$450,000		$450,000	High
Implement a large number of practices to reduce urban nutrient and sediment runoff in a small area as a pilot to demonstrate success.					$200,000	High
Maintenance						
Implement a county-wide inspection and maintenance program to ensure all permitted stormwater facilities are maintained and are operating as planned.	$75,000 (1)	$25,000 (1)			$100,000	High
Prevent erosion from urban waterway banks. (cost estimate based on 5,000 linear feet of stabilization)					$155,000	High
Harvest plants growing in existing urban wetlands to "mine down" soil P levels.					Variable but low	Medium
Information and Education						
Inform the public of how urban runoff containing nutrients and sediment affects our lakes and what can be done about it. Build support for cleanup actions. Specifics found in the YLLP Communications Plan and the MAMSWP Information and Education Plan.	$75,000 (1)			$36,000	$111,000	0
Increase information and education efforts to encourage and support voluntary actions to increase infiltration in existing urban areas. Provide more focused Information and Education where rural developments or municipalities contribute disproportionately to nutrient or sediment pollution.	1	1			$112,500	0
Setting Priorities						
Target the available funding for Information and Education efforts and for urban nutrient and sediment runoff management practices to target those runoff sources and geographical areas with highest loading per acre.					$0	low (mostly doing that now)

Table 10: Yahara CLEAN Nutrient and Sediment Action Opportunities

Action Opportunities to Reduce Sediment and Nutrient Runoff	FTE	LTE	Cost Share $	Other Costs	Total $	Estimated Direct P Red.
Monitor urban stormwater volume and pollution level in two small geographic areas; one with extensive stormwater pollution reduction practices and one untreated control area. (Cost estimate based on two acoustic gauges, three years of gauge operation and twenty private urban practices installed.)	0	0	$0	$0	$374,000	0

Table 11: Yahara CLEAN Beach Action Opportunities

Activity	**Vilas**	**Bernie's**	**Brittingham**	**Olbrich**	**Esther**	**Olin**	**Cost**
Reduce sediment and nutrient runoff to lakes	X	X	X	X	X	X	
Continue to conduct annual Sanitary Surveys including precipitation, beach closures, etc.	X	X	X	X	X	X	$480/beach/yr
Conduct beach-specific monitoring plans - in addition to existing Public Health testing Sand transects Lake transects Stormwater (pipe, surface runoff, during dry and wet periods) Adjacent tributary flow Human bacteriodes testing Project-specific monitoring	X	X	X	UNDERWAY	X	X	Widely variable - $100,000
Interceptor/Diverter research project		UNDERWAY					$18,000/ 3 demo projects

Table 11: Yahara CLEAN Beach Action Opportunities

Activity	Vilas	Bernie’s	Brittingham	Olbrich	Esther	Olin	Cost
Beach-user and sewershed education using these messages: Change diapers regularly Don't feed waterfowl or raccoons Take restroom breaks Keep out of storm sewer what you don't want in the lake Install rain gardens and rain barrels to reduce runoff Don't swim when you have diarrhea Keep leaves out of gutter Pick-up pet wastes	X	X	X	X	X	X	variable
Retrofit storm sewers in the vicinity of beaches Longer pipe - deeper water mixing Store and treat - deep tunnel Underground treatment-under parks/parking lots Large outlet split into smaller Smaller pipe retrofits higher in sewershed UV treatment Filtration - plant, fungus w/ additional monitoring Floating myco-filter island	X X X	UNDERWAY	X	X	X	X	$25,000 - $1 mil/ outlet
Direct site drainage away from beach				X	X	X	$10,000/beach
Control site erosion	UNDERWAY					X	$15,000
Control beach house roof drainage - add gutters/rain garden	X			X			$15,000
Change beach alignment/configuration to encourage water circulation (beach 'coves' become stagnant)				X	X	X	site specific
Reduce and manage geese populations. Activities may include: Stop Feeding Public Education No feeding Ordinance and Enforcement Signs Habitat Modification	PLANNING GRANT	X	X	X	X	X	$400-$6,600/ beach/yr

Table 11: Yahara CLEAN Beach Action Opportunities

Activity	Vilas	Bernie's	Brittingham	Olbrich	Esther	Olin	Cost
Fencing Shoreline Vegetation Less mowed turf Chemical Repellent Reproduction Controls Egg Oiling Contraceptives Removal Relocation Harvesting							
Investigate bacteria impacts of raccoons in storm sewers	X	X	X	X	X	X	
Sand – Activities include: Replace with large grain Regrading Deep tilling/Raking daily	X	X	X	X	X	X	
Provide adequate trash receptacles	X	X	X	X	X	X	$200/beach
Daily maintenance by lifeguards or others even when beach is closed during the season (remove plant matter, dead fish, etc. that accumulated in water at beach)	X	X	X	X	X	X	$1,200/beach w/o lifeguard, $300/beach w/ lifeguard
Provide toilet facilities						X	$172,000
Periodic carp removal at Lake Wingra	X						$9,000/10 yr = $900/yr.
Permanent beach closure			??				$15,000

3.6 Advise and Communicate Progress

Throughout this process the YLLP Coordinating Committee made sure Yahara CLEAN signatories and other key stakeholders were advised about progress towards meeting MOU goals. A “First Year Status Report” presentation was provided to the City of Madison Mayor and department heads, Dane County management, the Dane County Lakes and Watershed Commission (members of which have taken a very active role throughout this process), and DNR and DATCP management in early 2009, and a final report was provided to the Madison Community Foundation by Clean Wisconsin and Gathering Waters Conservancy in January 2009 as part of their contract agreement (see Appendix A, Attachment A1). Additional informal discussions took place on an ongoing basis.

The various methods of public engagement have informed and gathered input from hundreds of area residents. Several of the most important public updates, forums, and public input sessions have been:

- Creating a web presence – first hosted on the Office of Lakes and Watersheds site (www.danewaters.com), and later moved to www.yaharawatershed.org to a page initially designed by City of Madison staff.
- UW-Madison Nelson Institute for Environmental Studies Community Environmental Forums in the spring of 2009 and 2010 and the one-day conference in October, 2008.
- Update and solicitation of public input on conceptual action opportunities spring 2010 – at least a dozen stakeholder meetings with groups like the Dane County Towns Association, Yahara Lakes Association, Four Lakes Yacht Club, Greater Madison Chamber of Commerce, Dane County Farm Bureau, Capital Area Regional Planning Commission, Dane County Agriculture Advisory Council, Dane County Board’s Environment, Agriculture and Natural Resources Committee, Madison Area Builders’ Association, Realtors Association of South Central Wisconsin, Spring Harbor Neighborhood Association, Dane County Environmental Smart Growth and CRANES (local conservation groups).
- Public informational sessions hosted by the Dane County Lakes and Watershed Commission and the YLLP Coordinating Committee were held on April 29, 2010 at the Alliant Energy Center and on July 21, 2010 at Warner Park Community Recreation Center on the action opportunities included in this report.

Among the public comments provided to date:

- Strong support for many of the proposed actions to reduce nutrient and sediment loading, and reduce beach bacteria.
- The action opportunities listed are “tried and true,” but without funding and staffing to implement them on a broad scale, there will be no additional progress toward lake and watershed improvement.
- Soon there must be a priority-setting and implementation planning process that will also identify the parties to lead each agreed-upon action, and secure funding to ensure implementation.

- Closing beaches is unacceptable. Public access to the Yahara lakes is a community priority.
- Educational events, conferences, interpretive signs, and outreach programs such as Take a Stake in the Lakes should be continued and expanded. Staffing and funding to expand educational programs will be necessary to build the community support required to support and fund action implementation.
- Another important leverage point for implementation will be a multi-jurisdictional, public-private partnership, and neighbors working with neighbors.
- Better enforcement of current laws is needed.

4. CONCLUSIONS

4.1 Implementation is Underway

Section 3 above identified that selection of priority actions and extensive implementation lies ahead. However, MOU signatory agencies and others have already been actively engaged in implementing actions that we know will move us closer to MOU goals. Several examples are described below, and this is by no means a comprehensive tally of work already underway.

4.1.1 Learning From Past Projects

An update to the 1996 farming practices inventory for the Lake Mendota watershed (funded with a grant from Wisconsin DNR) will help identify practice changes over time and the most effective methods for promoting producer behavior changes for water quality improvement.

4.1.2 Reducing Bacterial Contamination of Impaired Beaches

Current or recently completed projects include:

- Installation of stormwater treatment structure at Bernie's Beach (funded by City of Madison).
- Vilas Park beach rain garden, shoreline restoration, and community based planning for control of goose population (funded by grants from Wisconsin DNR and matched by City of Madison and Friends of Lake Wingra).
- Three pilot projects to study the use of floating curtains to divert algae scum (funded by Wisconsin DNR, City of Madison and Dane County).
- Comprehensive identification of sources of bacterial contamination at Olbrich Park (funded as part of a federal grant administered by Dr. Julie Kinzelman, Racine, WI).

4.1.3 Reducing Nutrient and Sediment Runoff from High-loading Agricultural Subwatersheds

Dane County is already using the SWAT model results to locate nutrient management practices in high-loading subwatersheds northwest of Lake Mendota. Support provided by the Madison Community Foundation, the Sand County Foundation, and the US Department of Agriculture's NRCS (through its 4-year Mississippi River Basin Initiative (MRBI)), is funding Dane County's intensive work in two high-loading subwatersheds: the Waunakee Marsh/Six Mile Creek and Pheasant Branch. This funding provides for: soil testing, use of the most up-to-date model developed by UW-Madison, the Soil Nutrient Application Planner (SNAP-Plus) to identify nutrient and sediment runoff from individual farm fields, completion of whole-farm performance standard compliance inventories, partial cost share for eligible best management practices that will reduce nutrient and sediment runoff, and development of a more comprehensive review process to ensure nutrient management plan implementation. This initiative is off to a strong start, with 21 applicants signing agreements to install $465,000 of best management practices as of the end of August 2010. (This is $100,000 more than was planned for this time period.)

The first community manure digester in Dane County is now under construction, located in one of the highest-loading phosphorus areas.

Since it was established in 2007, Dane County's Land & Water Legacy Fund has: 1) purchased more than 120 acres of land that will be restored to a high-quality wetland complex and will reduce sediment and nutrient loading to Six Mile Creek and Lake Mendota; and 2) identified projects that will invest approximately $225,000 to ensure compliance with the requirements of the County's manure management and erosion control ordinances and the State of Wisconsin's runoff management rules.

4.1.4 Reducing Nutrient and Sediment Runoff from Urban Subwatersheds

Ongoing compliance with state runoff requirements for urban areas is another method of reducing nutrient and sediment loading to the Yahara lakes. To meet the Clean Water Act, DNR's Administrative Code NR 216 entitled "Storm Water Discharge Permits" requires municipal areas with populations over 10,000 to hold a stormwater discharge permit. The goal of the Municipal Separate Storm Sewer System permit (MS4) is to reduce adverse impacts to water quality in our lakes and streams. The MS4 permit regulates the total suspended solids (TSS) discharged from the storm drainage network.

Rather than comply separately with MS4 regulations, 21 municipalities, 20 of which are in the Yahara watershed, are working together as the Madison Area Municipal Storm Water Partnership or MAMSWP. The 20 municipalities in the watershed are:

Cities	Villages	Towns	Other
Fitchburg	Cottage Grove	Blooming Grove	Dane County
Madison	DeForest	Burke	UW-Madison
Middleton	Maple Bluff	Madison	
Monona	McFarland	Middleton	
Stoughton	Shorewood Hills	Westport	
Sun Prairie	Waunakee	Windsor	

The regulations required each municipality to reduce its TSS loading by 20% by 2008 and to meet a total 40% reduction by 2013. Most MAMSWP communities are making significant progress towards the final goal. Each municipality can achieve its reduction goal using a variety of activities. Some of the reduction activities include: street-sweeping to collect the particles before they enter the storm sewer; retrofitting storm sewer systems with devices to help settle out the particles within the pipe network; discharging to a human-made pond to settle the particles prior to discharging to our lakes and streams; and discharging to constructed rain gardens and filtration areas.

Many municipalities working to meet required TSS reductions have taken advantage of Dane County's Urban Water Quality Grant Program, funded by the Dane County Land and Water Legacy Fund. Within the Yahara watershed, Dane County partnered with the cities of Middleton, Monona, Madison, Sun Prairie, and Fitchburg, the villages of McFarland, Shorewood Hills, DeForest, Maple Bluff, and Mount Horeb, and the Town of Middleton to construct 20 stormwater pollution control structures that reduce sediment and nutrient loading to the Yahara lakes.

4.1.5 Rock River Basin Nutrient and Sediment Reductions Through the TMDL Process

The Rock River Basin, which includes the Yahara watershed, is the focus of a Total Maximum Daily Load (TMDL) planning process that will ultimately establish sediment and phosphorus reductions for impaired waterways in the Yahara watershed. When DNR, and others monitoring our waterways, find a waterway that is so adversely affected by pollutants, such as sediment and phosphorus, that the resulting waterway's uses are impacted, the water body is reported to the Environmental Protection Agency (EPA) for inclusion on the impaired water bodies (303(d)) list.

A Total Maximum Daily Load (TMDL) report is required for each impaired water body. The TMDL is the amount of the pollutant that the water body can tolerate before it exceeds water quality standards and impacts its use. The TMDL report is based on scientific methods to identify water quality impacts, their pollutant sources and the needed pollutant reductions to eliminate the waterway's impairment. The result is a TMDL pollutant allocation for each water body. The pollutant reduction that is needed to meet the load allocation is distributed among the urban and rural point and nonpoint pollutant sources.

The Yahara River watershed is part of the larger Rock River Watershed. Like waterways within the Yahara watershed, about 40 other waterways of the Rock River watershed are also impaired by sediment and phosphorus. The sediment and phosphorus come from urban and rural point and nonpoint sources. Through a federal grant, a draft Rock River TMDL has been developed to address the sediment and phosphorus pollution and resulting impairments.

The Rock River TMDL will set sediment and/or phosphorus allocations for the impaired waterways in the Yahara watershed. The impaired waterways in the Yahara River Watershed are Pheasant Branch Creek, Spring (Dorn) Creek (tributaries to Lake Mendota), Starkweather Creek (tributary to Lake Monona), Nine Springs Creek, (tributary to Lake Waubesa) and the Yahara River below Lake Kegonsa.

The Rock River TMDL draft report is due out in September 2010. There will be a public meeting and comment period in late September. After the TMDL report containing the allocations is finalized and approved by the EPA, the implementation planning will begin. Implementation of point source controls will be through DNR pollutant discharge permit program. The allocation will become the pollutant load limit in municipal stormwater and wastewater permits.

There are no wastewater point sources that discharge into the Yahara lakes. The Stoughton wastewater treatment plant is the upstream-most point source and it is located below the Stoughton Dam, downstream of the lakes. The City of Middleton has a point source permit to pump water from Stricker and Tiedeman Ponds to decrease water levels due to the increased development in the area. The MS4 communities are issued a permit for their stormwater sewer discharges.

The TMDL will likely affect the MS4 municipal permits. (See discussion in Section 4.1.4 above.) Some municipalities may be required to reduce their TSS loads beyond the required 40%.

Agricultural reductions to meet the TMDL allocation will be handled through the existing state and federal regulations and require a 70% cost-share.

4.1.6 Complying With State Runoff Management Rules (NR 151)

Wisconsin's runoff pollution performance standards for both agricultural and non-agricultural practices are in Administrative Rule, NR 151 entitled "Runoff Management". Continuing to implement the existing standards will help address the sediment and nutrient issues in the Yahara watershed. The existing standards have applied since October 1, 2002. Rule changes are proposed to revise and expand the performance standards.

Existing standards that apply to agriculture:

- Meet the tolerable soil loss (T) on cropped fields.
- Prevent direct runoff from feedlots or manure storage - this includes overflows from manure storage.
- Repair or update any manure storage structure that poses an imminent health threat.
- Don't stack manure in unconfined piles within 500 feet of a stream, 1000 feet of lake or in areas susceptible to groundwater contamination.
- Limit livestock access to state waters.
- Divert clean water away from feedlots, manure storage and barnyards within 500 feet of a stream, 1000 feet of lake or in areas susceptible to groundwater contamination.
- Follow a nutrient management plan for manure or fertilizer application.

A significant factor in implementing the agricultural standards is the requirement that a minimum of 70% cost-sharing be offered in most instances.

Proposed Agricultural Standards

There are several proposed changes to the NR 151 agricultural standards. They include:

- Use of Phosphorus Index (PI). The PI is a relatively new land use management tool for assessing the potential of cropland, pasture, and winter grazing areas to contribute phosphorus to nearby water bodies. PI limits are proposed for any individual year and as an average over the crop rotation. In areas that have a TMDL, NR 151 will allow lower PI values.

- A required tillage setback from a waterway. The draft rule proposes that no tillage be allowed within 5 feet of the top of the channel bank. Harvesting of self-sustaining vegetation in the tillage setback would be allowed.
- More stringent soil loss rates in TMDL areas.
- A performance standard for process water handling. Process water includes overflow of animal watering, animal or operation cleaning water and water that comes in contact with bedding, silage, manure, mortalities, etc. that can add high pollutant concentrations to our waterways.
- Clarification of circumstances when enforcement of the standards can occur.

Non-Agricultural Existing Standards (for land-disturbing construction activity affecting one or more acres)

- Implement an erosion and sediment control plan for construction sites using Best Management Practices (BMPs) that, by design, reduce to the maximum extent practicable 80 percent of the sediment load on an average annual basis.
- For post-construction sites, develop and implement a storm water management plan that incorporates performance standards for TSS, peak discharge rates, infiltration, protective areas, and fueling and maintenance areas.

Non-Agricultural Proposed Standards

- Construction site erosion performance standard changes from the current 80% sediment reduction to a maximum of 5 tons/acre/year for all construction sites. Compliance would be determined by modeling results.
- Remove the current exemption for meeting all performance standards for parking lot and road construction that remained within the current footprint. The proposed new standard would 50% total suspended solids reduction from the proposed lots and roads.
- Require that the 1-year and 2-year 24-hour design storm match for the pre- and post-construction.
- Increase the protective area from 50 feet to 75 feet for certain high quality wetlands.
- Provide options for municipalities that may have difficulty meeting the 40% TSS reduction requirement, and flexibility for accounting for practices that aren't included in calculating models. Also significant is defining "maximum extent practicable" as it applies to developed areas TSS reduction which includes a cap on municipal expenditures.

4.1.7 Planning And Implementation Funding To Date

Yahara CLEAN has successfully reached this point due to funding provided from the MOU signatories and external sources. It has provided a solid foundation for seeking the funds necessary for implementing CLEAN action opportunities, guided by the successor organization discussed in Section 4.3. Table 12 focuses on funding provided for planning, assessment and analysis phases of Yahara CLEAN, with some examples of funding for early action implementation. It is not a comprehensive listing of funding provided to date, but does give a sense of the serious commitment made by MOU signatories and staff.

Table 12: Partial Listing of Yahara Lakes Water Quality Improvement Expenditures Since the Inception of Yahara CLEAN

	State of Wisconsin	Dane County	City of Madison	Others
Visioning, Education and Outreach				
Visioning and Stakeholder Engagement - Madison Community Foundation grant to Gathering Waters Conservancy and Clean Wisconsin				$50,000 grant
Visioning and Public Input consultant (Beacon)		$23,000		
Website Development - DNR grant to Gathering Waters Conservancy	$10,000 grant		staff time match	
Vilas Beach Party - DNR grant to Public Health Madison and Dane County	$3,000 grant			staff time match
Planning, Coordination and Administration				
Planning Consultant (Beacon)		$23,000		
Project management		$11,520	$25,000	
LTE staff time – funded by Madison Community Foundation and Dane County		$10,000		$2,000 grant
Project Management/Yahara CLEAN Report - DNR grant to Dane County with match provided by Clean Lakes Alliance	$10,000 grant			$5,000 match
Project Consultant - Report and Implementation planning - EPA grant to DNR				$27,100 grant
Studies and Engineering				
Pheasant Branch Assessment/SNAP-Plus - UW graduate student		$40,000		
Door Creek Assessment - UW Water Resource Management Practicum - DNR grant to Dane County	$10,000 grant	$3,350 match		
LTE staff time - Beach assessment	$11,500			
Farm Practices Inventory - DNR grant to Dane County	$10,000 grant	$3,350 match		
Basin-wide model (SWAT)		$110,000		
Vilas Beach goose management plan - DNR grant to Public Health Madison and Dane County	$3,000 grant			$1,000 match
Bernie's Beach stormwater plan - DNR grant to Public Health-Madison and Dane County	$3,000 grant			$1,000 match
Beach Diverter/Interceptor study - DNR	$3,000	$8,000		

	State of Wisconsin	Dane County	City of Madison	Others
grant to Dane County	grant	match		
Implementation				
Dane County Manure Handling Facilities - Dane County contracted feasibility studies, State of WI and private funding for 2 facilities	$6,600,000 grant	$208,327 feasibility studies		
Mississippi River Basin Initiative - Grant from Natural Resources Conservation Service grant to Dane County for agricultural practices to improve water quality				$2,000,000 grant
DATCP staffing grants to Dane County (2008-10)	$576,562			
DATCP cost share funding for conservation practices (2008-2009)	$117,692			
Madison Community Foundation grant to Dane County for staffing assistance to implement the Mississippi River Basin Initiative agricultural practices in Dane County				$75,000
Madison Community Foundation grant to Friends of Lake Wingra/City of Madison for Vilas Beach improvement project to address stormwater practices		$1,667	$5,168	$21,500 grant $2,000 Friends of Lake Wingra education
TOTALS	**$7,357,754**	**$442,214**	**$30,168**	**$2,184,600**

4.2 Next Steps

While much has been accomplished in meeting MOU objectives, some work remains before implementation can begin:

- MOU signatories and other policy makers review final staff report and select action opportunities for implementation.
- With YLLP and the Lakes and Watershed Commission - establish a work plan, an implementation team, lead entity, budget, and prioritize actions.
- Revisit the Communications Plan and improve if needed; begin to enact.
- YLLP, consultant and Lakes and Watershed Commission work to engage municipalities, friends groups and many others in order to create successor organization.
- Complete website improvements.
- Seek public and private funds to assist with implementation.

- Implement highest priorities as funding is available.
- UW-Madison and DNR - Complete remaining in-lake response models (lower lakes). Amend the report and adjust recommendations as appropriate.
- Evaluate Yahara CLEAN and the Rock River TMDL relationship and identify how implementation of each can be coordinated.
- Provide the Lakes and Watershed Commission, signatories and partners the first in a series of 6-month updates - first due 3/30/11.

4.3 Successor Organization, Other Issues, Other Stakeholders

Over the course of the last 2.5 years, stakeholders have repeatedly recognized the importance of developing a successor partnership that will continue the work of the Yahara Lakes Legacy Partnership, expanded beyond the current focus on nutrients, sediments, and beach bacteria to include other issues and other stakeholders. A successor partnership would be instrumental in garnering public support and a broad range of funding for implementing the chosen action opportunities, and for addressing other issues such as invasive species prevention and control, and water level management.

Over the course of this effort, some area residents have asked "Why are we ignoring other important waterways in Dane County?" The Yahara Lakes Legacy Partnership is solely focused on the Yahara River watershed, and a successor organization would keep that sole focus. That does not mean that other waterways are not important or are undeserving of protection and improvement. In fact, having a successor organization that focuses on the Yahara River watershed would allow the Lakes and Watershed Commission and others to devote more attention to the other waterways in the county.

At its May 14, 2009 meeting, the Dane County Lakes and Watershed Commission approved a document (available at www.yaharawatershed.org) summarizing the benefits of having a coalition of existing stakeholders (each with own perspective, area of expertise, authority, accountability, etc.) that focuses together on areas of agreement, and that leverages the existing resources toward realizing shared goals for protecting and improving the Yahara Lakes over the long term. YLLP's work with Beacon Associates Intl also resulted in a list of necessary criteria for an effective successor organization. This list can also be found at www.yaharawatershed.org.

The Commission's document approved an overall framework for a successor organization, created under the auspices of the Commission, and identified key questions for additional discussion and thinking that should be taken in order to flesh out the details of a long-term partnership organization.

A graphical representation (Figure 11) of the framework is below.

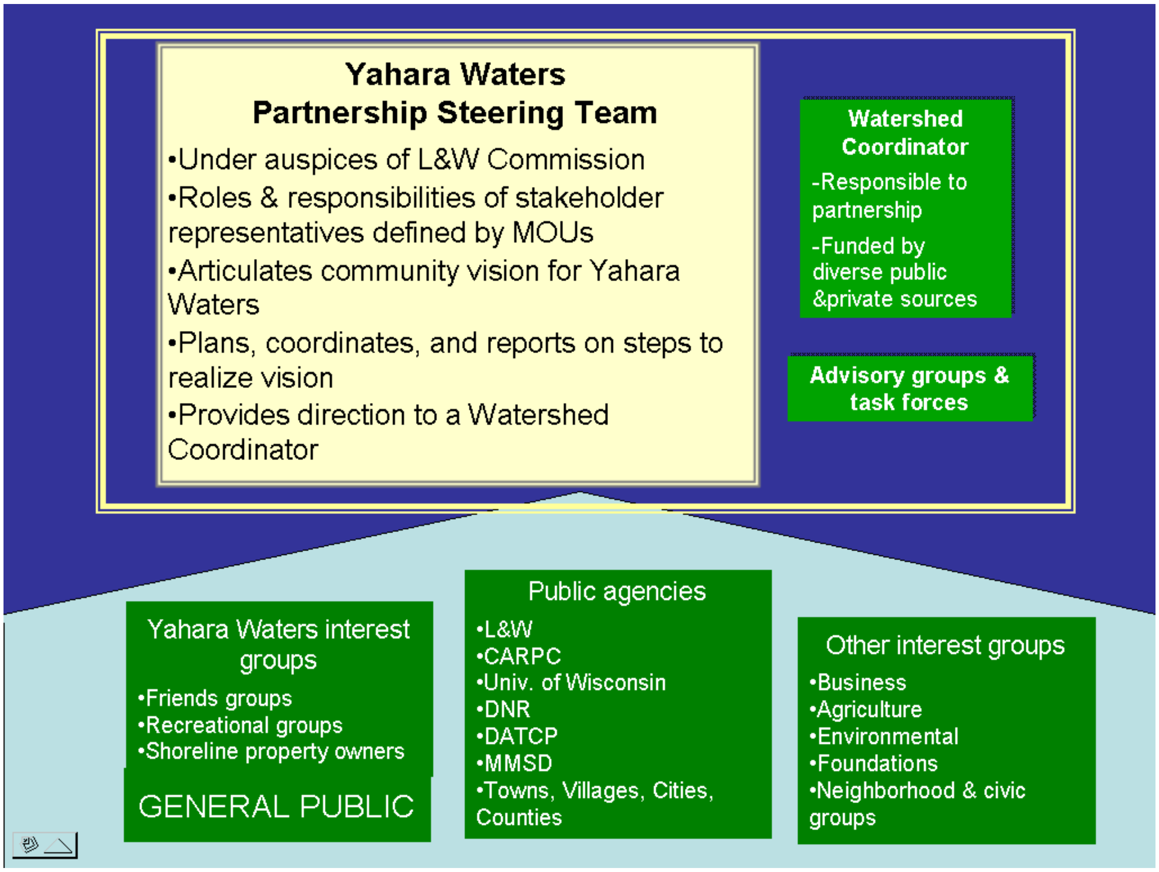


Figure 11: Conceptual Plan for a Successor Organization Approved by Dane County Lakes and Watershed Commission as a Starting Point for Future Discussion

One important function of a successor organization will be to raise public and private funds to support implementation of priority CLEAN actions. One newly-formed nonprofit organization, the Clean Lakes Alliance, already has an effective four-year track record in raising funds through its Clean Lakes Festival to support implementation of Yahara lakes improvement projects. We anticipate that this organization will be an important component of the successor organization.

4.4 Final Remarks

A case study of the history of the Yahara chain of lakes would be a microcosm of US environmental history. From early efforts to remove sewage from the land by channeling or piping it to the lakes—which led to their degradation—and the following near-century story of addressing that degradation by gradually removing and treating those wastes, this all happened around the country during the same timeframe. From unsustainable farming practices that resulted in huge quantities of some of the best topsoil on earth to end up in downstream lakes and drainages, to the post-Dust Bowl conservation programs that taught farmers how to grow crops with minimal environmental impacts and helped pay for conservation practices that kept soil on the land, this also happened around the country during the same timeframe.

An enormous amount of work and money has gone into making sure the Yahara chain of lakes and surrounding watershed remain “a beloved asset to our communities.” The collaborative work and public engagement that reacted to date from the Yahara CLEAN MOU are an indication that local residents really do value these lakes, and that local officials are acting on the knowledge that these lakes are important to our sense of place and the local economy.

The scale of the Yahara watershed and its social and ecological complexity makes precision in predictions and outcomes difficult. In undertaking the next steps identified in Section 4.2, staff will build on the best thinking of the many experts involved in this work, incorporate new findings, plan to be adaptive, and learn as they go.

One of the significant challenges of this work has been that despite requests from area residents, business leaders, etc, for a clear statement of conditions, actions, costs and benefits, current knowledge does not allow more definite statements about what will happen if a certain course of action is undertaken.

These systems are so complex, and there is so much natural variability in conditions, which despite the community’s best efforts to change land uses, install practices, follow conservation plans, and change behaviors, other factors outside the community’s control can override community work and the expected benefits.

For example, according to the Intergovernmental Panel on Climate Change, water-borne diseases and degraded water quality are very likely to increase with heavier precipitation due to global warming. Another example is that the invasive spiny water flea, discovered in the Yahara lakes in September 2009, may reduce densities of *Daphnia* and other zooplankton. Decreased zooplankton could lead to decreasing water clarity regardless of phosphorus loading reductions that would be expected to increase water clarity.

However, if we anticipate the influences of these factors, we can design restoration strategies that will have the best opportunity to reach our goals for Yahara lakes water quality, even in the face of other uncertainties and environmental influences.

The staff team’s hope and belief is that Yahara CLEAN implementation has the potential to take our community far beyond prior accomplishments in this watershed. We have identified points of intervention, using the best watershed models we have available, to improve the health of our lakes, we’ve identified the costs of some of these actions, and we have ideas about how to create organizational structures to implement these actions.

We invite all stakeholders and the public to join with us as we move ahead.

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5. GLOSSARY

Acronym, Term, or Phrase	Description
303 (d) Impaired Waters list	The US Environmental Protection Agency inventory of water bodies and the pollutants that degrade their uses.
Animal Units (AU)	An estimate of equivalent 1,000 lb. animals. A mature dairy cow is considered to be 1.4 animal units.
Bacteriodes	Indicators of bacteria or bacterial activities. Bacteriodes can be used to differentiate bacteria in a lake from different sources.
Biomanipulation	Changing (introducing, increasing, decreasing or eliminating) living organisms in a water body to create a desired result. Examples include improving water clarity by removing carp that stir up lakebed sediments or increasing the algae-grazing zooplankton (mainly *Daphnia*) population by removing plankton-eating fish.
Bray 1 Soil Test	A standard method to determine the amount of phosphorus in soil.
Capital Area Regional Planning Commission (CARPC)	An agency responsible for water quality planning in Dane County.
Capital Lakes Environmental Assessment and Needs	Yahara CLEAN is a Memorandum of Understanding among Dane County, City of Madison, DNR and DATCP to improve the Yahara Lakes - Mendota, Monona, Waubesa, Kegonsa and Wingra. The MOU has six activities that include: identifying sediment and nutrient loading reduction goals, identifying recommendations and costs to meet the reductions.
Dane County Lakes and Watershed Commission	Appointed coordinating and advising board responsible for protecting and improving water quality, as well as the scenic, economic, recreational, and environmental value of Dane County's water resources. The Commission has 10

	members, representing urban and rural areas and a variety of stakeholder interests.
Daphnia	A large zooplankton that feeds on algae.
Department of Agriculture, Trade and Consumer Protection (DATCP)	State agency that is a signatory to the Yahara CLEAN MOU.
Department of Natural Resources (DNR)	State agency that is a signatory to the Yahara CLEAN MOU.
Environmental Protection Agency (EPA)	Federal agency assigned to protect the environment.
Eutrophic	Term to describe a water body with a high level of available nutrients. Eutrophic conditions are often an indicator of poor water quality; poorer than a mesotrophic water body.
Farm Practices Inventory (FPI)	In the early 1990's a farm practices inventory survey was completed in the Lake Mendota watershed. The survey collected data on how ag producers in that basin worked their farm (e.g. tillage practices, manure handling, crop rotations). The survey is again underway in the same area to determine how these activities have changed. It will help Dane County, DNR and DATCP better understand how staff can work with ag producers to reduce sediment and phosphorus runoff. The survey is being conducted by UW-Extension, funded with a grant from DNR to Dane County.
Information and Education (I &E)	Brochures, signs, articles, lectures, demonstrations, discussions, etc. to share concepts and influence behavior.
Land Conservation Division (LCD)	A division of the Dane County Land and Water Resources Department that provides conservation implementation services to private landowners and land users in order to protect and enhance Dane County soil and water resources.
Madison Area Municipal Stormwater Partnership (MAMSWP)	Twenty-one municipalities in the Madison area and the University of WI, regulated under the same WI stormwater permit, have joined forces to address similar needs.

Mesotrophic	Term used to describe a water body with an intermediate level of available nutrients. Mesotrophic water bodies often have better water quality than eutrophic water body.
Mine down P	Removing phosphorus from soil by planting and harvesting plants without adding phosphorus fertilizer or manure. The plants take up the existing phosphorus from the soil while they are growing. The plants are harvested and removed from the site, taking with them the phosphorus that was once in the soil.
Madison Metropolitan Sewerage District (MMSD)	The governmental entity that collects and treats the wastewater for the greater Madison area - from DeForest and Waunakee on the north, to Middleton on the west, to Verona on the south and to Madison and McFarland on the east.
Memorandum of Understanding (MOU)	An agreement among signatories. The Yahara CLEAN MOU is an agreement between Dane County, Madison, DNR and DATCP. See "CLEAN" definition above.
Mississippi River Basin Initiative (MRBI)	The Mississippi River Basin Initiative is a federal (NRCS) program to fund agricultural practices to address phosphorus runoff over the next four years. Dane County has received a grant for $2 million to install practices in the Pheasant Branch and Six Mile subwatersheds. The program is voluntary and will pay for 50-70% of the ag practice cost.
MPN (Most Probable Number)	Term describing the quality of total coliform bacteria in a waterway determined by using a standardized EPA water quality test.
Nutrient Management Plan (NMP)	A written document to guide the application of fertilizer and other nutrients to be added to a farm field to assure adequate nutrients for the crops. The calculations for the NMP are based on soil phosphorus and the crops that will be planted in the rotation (planned crops for the following seasons).
Non-point source pollution	Pollutants that run off the land including farm fields, neighborhoods, streets, discharged from storm sewers, etc.

NR 151	The State's administrative code that sets standards for runoff management. It includes standards for urban and agricultural runoff.
Natural Resource Conservation Service (NRCS)	Federal agency that is part of the US Department of Agriculture.
Phosphorus (P)	A nutrient needed for plant growth that is found in abundance in the Yahara Lakes. Lake sources include past wastewater treatment plant discharges, nutrient rich soil, manure, fertilizer, etc.
Phosphorus Bank (P-bank)	A P-bank is a concept that is part of a phosphorus trading program. The bank would be an inventory of the known practices that could be installed and the amount of phosphorus runoff that would be eliminated. The inventory would be used by others that would rather buy the phosphorus reduction activities (including an extra percentage to be removed) somewhere else than to do the reduction activity at their own location. Reasons for a trade may be that it is significantly more expensive to reduce at a site than it is to reduce the same amount and more at another site.
Phosphorus Index (PI)	A calculation to determine the average phosphorus amount in pounds per acre per year delivered to the nearest surface water from an agricultural field given that field's soil and management conditions and assuming average weather. Factors include type of soil, slope, soil P, tillage method, crop rotation, fertilizer or manure application, etc.
Pollutant trading program	A trading program is a concept that would allow the pollutant reduction activities needed for a site to meet the TMDL to be implemented at another site. Traders buy activities that achieve phosphorus reductions (including an extra percentage to be removed) somewhere else instead of installing practices at their own location. One reason for a trade may be that it is significantly more expensive to reduce at a site than it is to reduce the same amount and more at another site.

Point source pollution	Pollutants discharged from a pipe originating at an industry, wastewater treatment plant, etc.
Sanitary Survey	An evaluation originally developed for the US Environmental Protection Agency to evaluate beach health on the Great Lakes.
Secchi	An instrument used to measure lake clarity. It is a circular disk with quadrants painted black and white. The disk is lowered into the water to the depth that it is no longer visible. The greater the depth, the better the water clarity.
Source Loading and Management Model (SLAMM)	A computer program to evaluate sediment and phosphorus runoff from urban watersheds.
SNAP-Plus	A computer program that calculates a Wisconsin P Index to evaluate phosphorus runoff delivery to the nearest surface water from a given farm field given that field's soil and management conditions. It also includes the USDA-NRCS RUSLE2 erosion estimate model. This software is available for free download at www.snapplus.net and is developed and maintained by the UW-Madison Soil Science Department in collaboration with DATCP, DNR, NRCS-WI, and UW-extension.
Stepped enforcement policy	A multiple-stage process for gaining compliance with regulations. First stage is to ask for voluntary compliance. Stages vary depending on the standard(s) to be met but the final stage is often proceedings in court with fines, costs and other forfeitures.
Soil and Water Assessment Tool (SWAT)	A watershed computer model to evaluate sediment and nutrient runoff.
Total Maximum Daily Load (TMDL)	The maximum amount of a pollutant that a water body can handle without its use being impaired. A TMDL is set by EPA and establishes the reductions needed for point and non-point pollutant sources to meet the TMDL.
Trophic State Index (TSI)	A measurement of the fertility of a lake. More fertile lakes have more available nutrients

	(phosphorus and nitrogen) and therefore more plants and algae.
Watershed	The area of land where all of the water that is under it or drains off of it goes into the same place. John Wesley Powell, a scientist/geographer said that a watershed is: "that area of land, a bounded hydrologic system, with which all living things are inextricably linked by their common water course and where, as humans settled, simple logic demanded that they become part of a community."
Yahara Lakes Legacy Partnership (YLLP)	The adopted name of Dane County, City of Madison, DNR, DATCP, Clean Wisconsin and Gathering Waters Conservancy joint efforts to coordinate Yahara CLEAN planning activities.
Zooplankton	Small, often microscopic aquatic animals important to the food chain.

6. APPENDICES

Appendix A: Visioning process

Attachment A1: Gathering Waters Conservancy/Clean Wisconsin report to Madison Community Foundation (Executive Summary)

Submitted January 30, 2009

A. Organizational and Grant Information ***(deleted from this attachment)***

B. Project Summary:
The purpose of this project was for Gathering Waters Conservancy and Clean Wisconsin to lay the groundwork for a long-term, collaborative clean-up effort involving the many parties concerned about the health of the Yahara lakes and the watershed area that drains into them. With the Madison Community Foundation's support, we reached that goal. We accomplished most of our intended objectives and reached some milestones we did not expect to reach in the project's first year.

To accomplish our objectives and generate the deliverables promised in our proposal, we engaged in the following areas of activity:

- Engaged several key partners in the Yahara Lakes Legacy Partnership, involved numerous stakeholders, and lead a broad community visioning process. That process included several forums, culminating in a conference in October hosting nearly 400 community members.
- Assessed the lay of the land and documented our conclusions in a report that:
    - Catalogs past efforts and maps areas covered by watershed interest groups.
    - Identifies key stakeholders and evaluates existing capacity and resources, as well as needed resources (financial, organizational, and human) to make a clean lakes vision a reality.
    - Describes and prioritizes necessary projects to improve watershed water quality.

Attachment A[6] is our February 2008 modified grant proposal. Attachment B[6] is a detailed list of key activities we undertook as part of this project over the course of the past year. As a result of those activities and the efforts of the many partners who joined with us this past year, we can be proud of all we accomplished. For details on our major accomplishments see Section C below.

Summarizing the net effect of what our partners and we have accomplished, we can now say that all of the foundational elements for success in this endeavor have materialized:

- Key stakeholders who must be partners in this effort if it is to succeed have engaged fully, both in the short-term, through the Yahara C.L.E.A.N. Memorandum of Understanding process, and for the long-term, as active members in the Yahara Lakes Legacy Partnership.
- Through our organizing and public involvement efforts and those of our partners, both the public and the political will behind clean Yahara lakes have expanded. There is now

[6]This attachment was to the source document and is not included in this Yahara CLEAN report.

no question that all stakeholders are committed to the clean lakes vision they helped to create.

- There is consensus among experts on the sources of the problem and on the target levels we must achieve in order to make the vision a reality.
- The radical improvement of water quality in these lakes is entirely feasible on technical grounds. Necessary technologies and best practices exist and have been identified.
- The gaps separating the status quo and a vision of a clean-lakes future can be overcome.

In broad terms, four major areas now demand the attention of those of us directing this process:

1. **Implementation of the organizational structure necessary for long-term success.** We and our partners in the Yahara Lakes Legacy Partnership (hereafter YLLP) spent significant time in 2008 considering the question of what organizational structure is best suited to carrying this effort to a successful outcome. Our accompanying project report offers some of our ideas on the answer to that question. Making a final decision and implementing the agreed-upon structure are key immediate next steps for the partnership.
2. **The completion of a strategic conservation plan for the entire watershed.** Significant progress was made in 2008 toward this end, and the YLLP's plan of action calls for continued focus in this area in 2009 and a completed plan by the end of December 2009.
3. **Continued implementation of the targeted practices, infrastructure, policies and programs that will bring about the community's clean-lakes vision.** Dane County, the City of Madison and other watershed municipalities, farmers, lakefront property owners, local citizen groups, and others whose efforts directly bring about the improvement of lake water quality will both continue their ongoing activities and add additional targeted actions identified through the collaboration we have now generated.
4. **Capacity building with the goal of sustainable levels of financial, organizational, and human resources necessary for the long-term nature of this overall effort.** All of the above will require additional resources building on what is currently available. Thus, cultivating sustainable long-term funding for this effort is a critical next step.

These four broad areas will demand the focus and attention of all of those involved in this effort in the phase we have now entered. As the evidence we provide in this and the accompanying report attests, we accomplished the original purposes of this project. And, by working in partnership with key stakeholders, who we successfully engaged with the help of this grant, we made significantly more progress toward our ultimate goals in the project's first year than we hoped.

Clean Wisconsin and Gathering Waters Conservancy look forward to working with the Madison Community Foundation and all of our partners in this effort to find ways of continuing the progress made in 2008 into the foreseeable future.

C. Outcomes:
1. List the intended outcomes of the program.
The two general aims of our February 19, 2008 updated final proposal were as follows:

- Lead a broad community visioning process, with assistance from Dane County, to bolster support for ongoing and future efforts to rehabilitate the lakes. The visioning process will likely include several local and regional forums, culminating in a larger community-wide event.
- Provide the Madison Community Foundation with a report detailing the historical context for the Yahara C.L.E.A.N. partnership (i.e. how this project fits in with other efforts in the Yahara watershed) and identifying long-term needs and potential solutions.

Our original proposal, dated August 2007, also mentioned the following intended outcomes:

- Identification of key stakeholders and an assessment of their current and future capacity
- A catalog and map of past and ongoing activities in the watershed
- Description of projects that need to occur to improve water quality
- A report (the same report as above) including:
    - A description of current problems
    - Identification of resources for watershed conservation and restoration
    - A clearly articulated vision
    - Actions necessary for the long-term health of the lakes
    - Elements of a business plan for a multi-year initiative

2. Provide evidence from the data collected to support whether outcomes were achieved.
Over the past year, Clean Wisconsin and Gathering Waters Conservancy have successfully laid the groundwork for a multi-year initiative to clean up the Yahara lakes. We accomplished most of the intended outcomes from both our initial and updated grant proposals. In many ways, the progress made this past year—thanks largely to our success in engaging our partners in the Yahara C.L.E.A.N. and YLLP efforts, as well as the UW's Nelson Institute and others—brought us closer to the ultimate goals of the project sooner than we would have imagined one year ago.

As a result of our activities and the efforts of the many partners who joined with us this past year, we can proudly note these **major accomplishments**:

- On December 13, 2007, the Dane County Lakes and Watershed Commission resolved formally to collaborate with us on our efforts under this grant (see Attachment C[7]).
- In February 2008, several key stakeholders critical to the success of this effort came together under the Yahara C.L.E.A.N. Memorandum of Understanding (see Attachment D[7]) with goals that complement ours. Those entities are Dane County, the City of Madison, the Wisconsin Department of Natural Resources, and the Wisconsin Department of Agriculture, Trade, and Consumer Protection.
- Shortly thereafter, the working partnership we had already formed with those entities was formalized under the banner Yahara Lakes Legacy Partnership (YLLP). Staff members from Gathering Waters Conservancy and Clean Wisconsin were part of YLLP's Coordinating Committee from its inception. Please refer to Attachment E[7] for a brochure on YLLP and Attachment F[9] for the Partnership's organizational chart.
- The Yahara Lakes Legacy Partnership engaged several dozen professional experts in advisory committees where they could lend their expertise and experience in the areas of

[7] This attachment was to the source document and is not included in this Yahara CLEAN report.

1. Visioning and stakeholder engagement, 2. Nutrients and sediment, and 3. Beach bacteria.
    - Gathering Waters staff was named chair of the Visioning Advisory Committee, and Clean Wisconsin staff joined the technical advisory committee on nutrients and sediment. Attachment G[8] lists the regular participants in each YLLP committee.
- We generated a catalog of plans and reports resulting from past efforts to deal with various parts of the overall lake water quality problems we now face (see Attachment H[8]). Through our conversations with individuals who were involved in those past efforts, we came to understand which remain most relevant and gleaned some lessons learned.
- In addition to the key partners we worked closely with this year, we also successfully engaged a wide array of important stakeholders in this process, including:
    - **Watershed "friends" groups**: We met personally with representatives of five of the most active and engaged watershed "friends" groups to apprise them of our ongoing project and encourage their active participation in it. We sent information to all twelve of the groups, and representatives from ten attended the October conference. Please refer to Attachment I[8] for a map of watershed "friends" group coverage.
    - **Environmental groups**: We met personally with representatives of nine local and/or state environmental groups about the Yahara lakes clean-up effort, and representatives from twelve of those organizations attended the October conference.
    - **Agricultural groups and farmers**: We and our YLLP partners met with around ten agricultural representatives in June. Three farmers attended the October conference, including the President of the Dane County Farm Bureau, who presented and participated on a panel. We and our partners took him up on his offer, made at the conference, to meet with a larger number of farmers in January. We worked with the Nelson Institute to help organize and sponsor the January 21, 2009 Dane County Farm Bureau meeting that over fifty watershed farmers attended.
    - **Lakefront property owners**: Several current or immediate past leaders of the Yahara Lakes Association were active participants in YLLP and the planning for the October conference. The Yahara Lakes Association represents the interests of lakefront property owners on the Yahara lakes and counts nearly half of the lakefront property owners in the watershed as members.
    - **Rural Dane County municipalities**: The president of the Dane County Towns Association spoke and sat on a panel at the October conference. We also invited him to join our Goals, Strategies, and Tactics Workshop in November and he played an active role in generating ideas there.
    - **Urban Dane County municipalities**: YLLP members briefed the Madison Area Municipal Storm Water Partnership team, which includes representatives of all of the urban watershed municipalities, on the project several times. A leader of the Dane County Cities and Villages Association and a handful of representatives of communities that are members of that organization attended the October conference. Another representative of that organization attended our Goals,

[8] This attachment was to the source document and is not included in this Yahara CLEAN report.

Strategies, and Tactics Workshop in November and played an active role in generating ideas there.

  - **The business community:** We joined YLLP Coordinating Committee colleagues in meeting on several occasions with Mike Gerner, a Madison businessman and Board member of the Greater Madison Chamber of Commerce. Mr. Gerner was a speaker and panelist at the October conference. He corresponded on our behalf with the president of the Chamber, Jennifer Alexander—who also serves as President of the regional economic development enterprise, Thrive—keeping her in the loop on project developments. Ms. Alexander sent staff to attend the October conference. We also joined Jim Lorman at a January 2009 meeting with Thrive staff, where we discussed the project's status and potential opportunities for Thrive's involvement.
  - **The general public:** We successfully engaged significant numbers of members of the general public not necessarily associated with the groups listed above. As mentioned previously, nearly 400 people attended the October conference, including a student group and their teacher/advisor from a local middle school. Thanks in part to proactive efforts by us and our partners, media coverage of the Yahara lakes and our partnership's efforts were numerous in 2008. Please see Attachment J[9] for a listing of local print media coverage the lakes and our effort received this past year.

- We worked with technical experts from relevant disciplines to ensure that the vision for the future of the lakes is technically feasible and grounded in sound science. The work product that resulted from our capstone meeting on technical feasibility is Attachment K[9].
- We now have a community-generated vision statement for the future of the lakes that was shaped through stakeholder input opportunities we and our partners convened this past year. That vision is bold, yet practical…exciting but realistic. Please see Attachment L[9] for one representation of the vision statement that we used to garner community input.
- Nearly 400 people passionate about the improvement of the Yahara lakes attended the all-day Gaylord Nelson Institute for Environmental Studies conference that we and our partners, including the Madison Community Foundation, helped organize and support in October 2008. At this landmark event, big ideas were shared, input was solicited, and the shared will to make our clean lakes vision a reality was witnessed as clearly as ever before.
- Our work with technical experts ahead of the conference encouraged them to generate target levels for reduced phosphorus concentrations in the lakes that they feel will allow for water quality consistent with the vision. These targets are a key part of the strategic clean-up plan.
- With our partners and other key stakeholders, we made significant progress toward an organizational structure for the long-term partnership required for success in this endeavor.
- We made significant progress toward the completion of an overarching strategic conservation plan for the lakes and their watershed. Many of the results documented herein, combined with the outcomes of modeling and monitoring efforts initiated in 2008, will form this plan, which is due at the end of 2009 per the Yahara C.L.E.A.N. MOU

[9] This attachment was to the source document and is not included in this Yahara CLEAN report.

process. We took a major step forward in this effort with the Goals, Strategies, and Tactics workshop in early November, where over 30 key stakeholders participated.

- Under the direction of the YLLP Nutrient and Sediment Technical Advisory Committee, and with funding support from Dane County, UW-Madison's Civil and Environmental Engineering Department launched a pilot implementation modeling project in the upper Pheasant Branch watershed, a Lake Mendota drainage known to be one of the biggest contributors of nutrients and sediment.
- Dane County passed a 2009 budget that included $13.3 million in Land and Water Resources funding, the vast majority of which will help improve water quality in the Yahara watershed, and the City of Madison earmarked $25,000 in its 2009 budget to assist the Yahara C.L.E.A.N. and YLLP processes. In addition to working with our YLLP partners to provide detailed recommendations to leaders at the Dane County Lakes and Watershed Commission that eventually made up the aforementioned budget package, we also engaged members of our organizations and others at the grassroots level to participate in the public input aspects of Dane County's 2009 budget-setting process and ensure that elected officials knew the importance of and level of support for these expenditures. Dane County Executive Kathleen Falk and Lakes and Watershed Commission Chair, Brett Hulsey, deserve credit for their leadership on the County's budget. The City's inclusion of funding for this effort in its budget is thanks to the leadership of Engineering Department director Larry Nelson and three City Council members with whom YLLP worked closely (Satya Rhodes-Conway, Brian Solomon, and Michael Schumacher).
- We documented what we learned through our experiences of the past year in the accompanying Yahara Lakes Legacy Project Report, which further details the history leading up to the present situation, the present context around this effort, our ideas on where the Yahara Lakes Legacy Partnership (YLLP) and the broader lakes clean-up effort are headed, and our analysis of what is needed to achieve desired water quality improvements.

3. If any intended outcomes were not achieved, indicate the reasons.
Given that some of the critical parts of the business plan for this endeavor were underway but not yet complete as our 1-year planning grant period came to a close, we do not yet have a complete multi-year business plan for the initiative. We do, however, have certain key elements of a business plan developed and an outline for next steps, which are detailed in our accompanying project report. It has become obvious that generating all of the pieces necessary for a complete business plan will take longer than one year, particularly given that some key elements require partnership consensus. The partnership is well on its way to generating a complete business plan for the long-term dimensions of the project and intends to finish that task in 2009.

4. Indicate any unintended outcomes that were achieved.
The unintended outcomes we achieved this past year are entirely positive. That we saw the kind of partnership spirit embodied in the Yahara C.L.E.A.N. MOU and the Yahara Lakes Legacy Partnership emerge so quickly was a delightful surprise. The overwhelming public and political support for this project that we witnessed this past year, particularly the community support for the long-term collaborative approach we have felt from the outset would be necessary here, was also welcome as it materialized more quickly and with less groundwork on our parts than we would have expected when our project began. And, the progress we experienced as a group of

partners toward consensus on the specifics of the needed future organizational structure was a welcome outcome we might not have predicted.

D. Conclusions:

1. Describe how the program could be altered to improve its results.

It is the consensus of the partners in YLLP that the forward progress of the overall effort would be expedited by additional project management / coordinator capacity. This capacity will be especially important to support the new organizational framework that is to be implemented in 2009, and will help increase the efficiency and effectiveness of this program. Clean Wisconsin and Gathering Waters Conservancy could potentially fill these needed roles and will consider that possibility with partners as we craft proposals for continued funding of our involvement in this effort in early 2009.

This program could also be improved with the support of a more diverse and sustainable sources of funding. Given the challenging economic times, this program will only be successful if funding can be secured from a variety of sources. The Madison Community Foundation's support will continue to be critical and could help to catalyze future fundraising around this effort.

2. Describe any future plans for the program.

Clean Wisconsin and Gathering Waters Conservancy, along with our partners in the Yahara Lakes Legacy Partnership, are ready to move from a planning phase to an implementation phase in 2009.

This implementation phase will focus on establishing a new organizational framework for the Yahara Lakes watershed clean-up effort. The new organizational framework will play a unique role in the watershed and will augment, but not replicate, ongoing efforts. Given all of the progress and accomplishments of 2008, Clean Wisconsin, Gathering Waters Conservancy, and the members of the Yahara Lakes Legacy Partnership are well positioned to accomplish this important step in the next year. A more in-depth discussion of our ideas regarding the governance of the future organizational structure can be found in our accompanying project report.

Reflective of the ongoing shifting of emphasis toward implementation, the immediate future of this effort will also focus on on-the-ground implementation efforts to be funded by Dane County's 2009 budget and other hoped-for sources of funding, including State and Federal funding and private philanthropy. One specific area of focus will be increased marketing of the effort and successful priority implementation projects, part of the grand scheme of maintaining and expanding public and political support for the overall effort.

Additionally, the Yahara Lakes Legacy Partnership will continue to work with its Technical Advisory Committees on identifying priority solutions throughout the watershed. The guidance provided by these Advisory Committees will have a direct impact on future expenditures of partner resources and will help steer the action steps of the new umbrella organization.

Finally, the future plans for this program also include securing sustainable funding from diverse sources, including government agencies, the business community, foundations, and private individuals. This year, YLLP partners will write applications for additional grant funding from government agencies and private foundations. As of the January 2009 writing of this report, Clean Wisconsin and Gathering Waters Conservancy are deeply involved in the State biennial budget setting process, where both organizations are encouraging state leaders to consider potential funding applicable to elements of this effort. Gathering Waters Conservancy's ongoing work with the Secretary of the Department of Agriculture, Trade, and Consumer Protection could end up yielding beneficial results for this effort. And, Clean Wisconsin's work with Governor Jim Doyle's office and the State Legislature in support of potential State biennial budget solutions for water quality and clean energy challenges facing the state (including Dane County, the Madison area, and the Yahara watershed) may also yield additional resources for this watershed effort. Lastly, we are hopeful that the Madison Community Foundation will continue to play a keystone role in support of this effort, both through direct financial support and continued promotion of community philanthropy toward this effort. We look forward to the opportunity to submit a renewal proposal early in 2009.

Attachment A2: Focus group notes from meeting with David Mollenhoff and Michael Gerner

6/12/08

Overview: The purpose of this focus group meeting was to examine strategic issues and get process guidance to help move lake clean-up efforts forward.

Participants:

- David Mollenhoff, Historian
- Michael Gerner, Grant-Thornton LLP, Board of Directors member of the Madison Chamber of Commerce, and Board member of the Yahara Lakes Association
- Members of the YLLP

Key issues, challenges, barriers

- There is no defined crisis – too diffuse. Short- and long-term aspects of this are confusing; we have to find a way to take the fog out of that equation so short-term leads clearly to long-term. Need a practical and compelling vision and clear goals in front of people around which they can feel excited and capable
- A lot of other problems in people's perspectives trump that of the lakes. Out of sight, out of mind. In 1880 most people lived within a few blocks of the lakes, but now most people measure proximity in miles. Lakes have in some ways become part of the landscape – we don't notice them so much; we need to help people understand how what the lakes really mean to the community and the importance of the lakes' health to the community's health. This will take decades to fix and people have limited interest – must find a way to keep community engaged in the long term.
- Farming practices have changed so significantly, as has scale.
- Farmers today can tell you the cost of manure disposal on a per-head basis; they're not going to pay for it all but will pay for their part of it; plus there will be tax dollars;
- One problem is that no one knows what can be done, that we can do it, and that we can cost it…if we do that, we can wrap the passion around moving in a direction and making the investments
- The leadership is diffuse; there's no one place with the possible exception of the Commission where everything comes together in one place. Everyone says, "they" need to fix the lakes. Qualified leadership is absolutely essential; who is qualified and has experience and credibility to lead this?
- This is expensive and will require serious money that hasn't yet been identified, nor have costs been calculated. Must address cost-effectiveness of specific actions – will pull especially the private sector in (see other points also on his list). Government, private sector, general public all value improving the lakes, but the public must drive government with an outcry to drive the expenditures
- Skepticism is rampant; no more studies; we must be expedient and demonstrate movement forward.
- We must generate the political will…
- What about the science piece of it? Peoples' technical priorities and solutions may not be based on good science

- One problem is that the real solutions may not solve some of people's most pressing priorities...algae and weeds.
- Timing issue; Chamber not going to want to bring this to the top of their pile until they see the potential for opportunity for them.

Strategies for success; champions; key stakeholders

- Need private sector's interest, support, money, and power; George Nelson, George Austin; Nelson is a process genius (Monona Terrace) he put together a tight process flowchart showing all the steps to being successful.
- Conference was intended to build momentum and focus on these issues; where Michael can contribute in the future is to make the connection with the Chamber and help bring along the business community
- Michael is on Chamber Board and they will be critical but it's way on the edge of their list right now; Chamber is taking a regional approach to the business interests; getting out of the traditional chamber role of getting any businesses in and looking at what's best for Madison and who it is and how to improve the quality of life in Madison (including helping ensure the quality of K-12 education); Chamber's role is broadening and they're getting more politically active re: City Council, County Board, etc., around what we want the community to be from a business perspective – strategic approach looking at opportunities for the community and the underlying public infrastructure (transit) and natural environment with the tremendous beauty of the lakes – the business community can rally around the lakes.
- THRIVE is the regional entity; Greater Madison Chamber of Commerce helped create THRIVE to look at the regional perspective; Jennifer Alexander is the president of both organizations and there is some shared staff; boards are completely separate; easier to start with Chamber and then going to THRIVE and then to the individual communities.
- Mike Gerner doesn't believe there's a consensus-building problem here; certainly a majority of individuals and businesses want to see improved water quality; difficulty is how to engage them, what it will cost, and how to pay for it; that's where we get the business and community leaders who must say, "We can't afford not to do this" As in the lakes conference last year, we need to clarify the scale of investment required.
- David Mollenhoff provided a handout reflecting his views of "success criteria" for this initiative. (this document is available www.yaharawatershed.org)
- Persuade people that this is possible – we have this drum roll every summer, newspaper articles, algal blooms, slimy water…this is the lakes' natural state so can't do anything about it.
- Need to get best strategic thinkers into this and figure out why and how to do this; need to get that more wrapped up before going out and building consensus around anything; that's how you get everybody on the same page.
- See Yahara Lakes Association May 2007 "Agenda for Action." NOTE: This document, available at www.yaharawatershed.org, laid out this riparian owners' organization's goals for improving water quality, managing invasive species, and preventing flooding.
- How close is community to having a shared vision and agreeing on the priorities? People need to be brought up to speed on the YLA vision (which is something they can rally around) and it won't take people long to rally around that – but they don' t sit around thinking about it – they think about it when they see the problems.

- Some aspects of the problem will take decades and some can't ever be fixed, so perhaps we should use rehabilitate vs. restore to "original" pristine status – must define expectations and create hope around specific items with timelines and costs.
- It will be easy to tap into people who will really care about the lakes when they understand why they should; massive education required to help them understand what steps to take in what order and that we can measure – instrument panel format.
- (Yahara Lakes curriculum; county watershed curriculum – watersheds)
- Education issues about lake nutrients and warm environment that creates algae and weeds…the clearer the water the more weeds; Lake Wingra has amazing diversity of water plants (no mowing or herbicides); can use that to teach about the notion of underwater garden with 35 vs. 10 plants – seeing the value of the weeds; see diagram about science vs. vision or expectations – half managing lakes and half managing people – lake by lake as well as a whole.
- David describes himself as an impresario without portfolio; provocateur without portfolio; passionate but with a limited amount of time;
- One of the smartest things that could happen right now is to get the two Georges [George Nelson, George Austin] together as well as Mark Bugher [Chairman of the Board, Greater Madison Chamber of Commerce and director of University Research Park, Inc.], and current Chamber president Jennifer Alexander. Getting the value of their strategic thinking is the best value for your time; if we could get those guys in a room, maybe 4 hours, with 30-40 min overview, they will run with the ball; superb problem solvers and among the best strategic thinkers in town; show them your ideas and goal you hope to achieve, if you were going to write a strategy or game plan, what would it be – each would feed on the other and be very rich food; I have talked with both Georges but not with Mark.
- Business people can help us with figuring this out and implementing, as well as marketing.
- For Monona Terrace, a labor organizer went all over town one-on-one to find out how to get to the interests of real people, and clearly deciding who to put up front as the messenger.
- Strategic thinkers: offer their best thinking on the rollout of issue.

Attachment A3: Lakes and Watershed Commission focus group meeting notes

06/12/2008

Overview: The purpose of this focus group was to identify key issues and concerns, as well as barriers to progress, among Lakes and Watershed Commission members.

Participants:

- Howard Teal, Lakes and Watershed Commission, representing villages and cities outside of Madison
- Melissa Malott, current chair, Lakes and Watershed Commission, County Executive's designee; attorney with Clean Wisconsin
- Patrick Miles, Lakes and Watershed Commission, County Board supervisor outside Madison
- Brett Hulsey, Past chair, Lakes and Watershed Commission, County Board Supervisor within Madison
- Doug Bach, Lakes and Watershed Commission, representing Yahara Lakes Association
- Lyle Updike, Lakes and Watershed Commission, citizen representing towns
- John Magnuson, Lakes and Watershed Commission, citizen representing Madison
- Jerry Jensen, Lakes and Watershed Commission, County Board supervisor outside Madison
- Chuck Erickson, Lakes and Watershed Commission, County Board supervisor within Madison
- Kirsti Sorsa, PhD, Public Health- Madison and Dane County

Key Issues

- "You farmers have to keep manure out of trout streams" – tension and blame between farmers and environmentalists.
    - Manure runoff and filtration.
    - Perverse incentives, stormwater runoff: not setting maximum number of parking spaces increases impermeable surfaces and thus increases runoff.
- Economics of farming.
- Conflict between units of government: federal-state, county-city, urban-rural, state-local, and other government units.
- Lack of cooperation; not all pulling together in the same direction.
- Varied uses of lakes: power-boaters, fishers, kayakers, shoreline users/owners, etc., with varied interests, priorities, and uses both within and between groups.
- Disjunction between what we know and what we're able to do – lip service and efforts but no long-term, sustained changes.
- Disconnect between ways of living, building/maintaining infrastructure and what we're trying to do.
- Assessments based on curb linear feet vs. how lot is managed.
- Diverse opinions on actions to fix lakes – what, when, why.
- Lakes are not at the top of everyone's priority list.

- We look linearly at such problems vs. the entire context of the issue including climate change and increase in storm frequency and intensity—need systems approach.
- Need a watershed approach at minimum vs. individual lakes, individual problems.
- Commission has lots of balls in air and priorities change; a systems approach must be implemented through bureaucracies with linear process, budget cycles; solutions must "work" for people and be realistic/feasible.

Barriers to progress

- Long, long-term payoff; progress takes too long.
- Special unit groups that motivate large numbers and may divert attention from long-term goals.
- Short-term crises that divert from long-term goals.
- Take care not to overreach.
- "Negative" power base may be focused on special interests or around dollars to stakeholder groups.
- Sense of resignation.
- Acceptance of lower standards.
- Landmine of the usual suspects…groupthink.
- Shared contributions to success/solutions.
- Engage public in appreciating benchmarks.
- Capitalize on hope and energy and impatience.
- Have tech community put timeline to changes, short-term and long-term.
- Tailor methods and messages to community priorities, capacity, key local stakeholders

Attachment A4: City and County elected officials and staff focus group

06/12/2008

Overview: The purpose of this focus group was to identify key issues and concerns, barriers and indicators of success, and get general input from city and county elected official and staff.

Participants:

- Genesis Steinhorst, City of Madison Engineering
- Ray Harmon, Staff to Madison Mayor Dave Cieslewicz
- Brett Hulsey, immediate past Chair, Lakes and Watershed Commission, Dane County Board supervisor
- Sue Jones, Watershed Management Coordinator, Lakes and Watershed Commission
- Jim Lorman, Professor, Edgewood College, Chair, Yahara CLEAN/YLLP Coordinating Committee, Lakes and Watershed Commission, Madison Mayor's designee
- Patrick Miles, Dane County Board supervisor and member of the Lakes and Watershed Commission
- Larry Nelson, recently retired long–time Madison City Engineer
- Satya Rhodes-Conway, City of Madison Common Council
- Topf Wells, Chief of Staff in Dane County Executive Kathleen Falk's office

Key issues

- The goals are clean water, beaches, shorelines, and no litter.
- No algal blooms; algae results from phosphorus; people don't understand what causes algal blooms; can't have clean lakes without reducing phosphorus – the rest is much less relevant.
- Must deal with phosphorus, sediment, and beaches.
- Everyone contributing to a solution; each jurisdiction doing our part toward solutions.
- Communities most affecting lake are most distant/ have other priorities

Key tasks to clean up lakes

- Community process that everyone can be a part of – vs. finger-pointing – to get moving in the same direction.
- Time for action… but balanced, distributed, shared responsibility and tasks.
- City actions like street sweeping can be put forth early.
- Check state level policy solutions to help chain and other waters.
- Possible cost-sharing with farmers, municipalities that will benefit water quality.
- Innovative approaches (pilot digesters) may help bridge geographical separation.
- Need solutions that benefit payers/users while benefitting lakes (for example, different types of digesters for farmers); government may need to invest if the latter costs more.
- Rain gardens.
- Surface permeability, green roofs, etc., expanded so more people can do these

Barriers

- Money is a big barrier; technical /financial barriers to implement solutions are huge Knowledge/technology gap about how complex this is – not just water, also shoreland, habitat protection, etc.
- Unsure where to target resources.
- Geographical separation between those who cause problems and those who are hurt; different government units and constituents.
- If you limit impervious surfaces, this changes building envelope (thus affects property rights); may affect density standards.
- Can't see immediate results.
- Hard to keep focused with so many "solutions".
- Good example of public-private partnerships (and critical to deal with as people, as some of the solution to water quality may tie to energy production).
- Priority watershed project.
- Madison Gas and Electric/ City/ County demonstration projects.

Key Players

- The University: research/knowledge, landowner, runoff-causer.
    - Nelson Institute
    - Dean of College of Agriculture
- Government/neighborhood partnerships – need to build relationships in order for behavior change.
- Government/ philanthropic/nonprofit partnerships

Desired results

- Specific items for annual budgets
- Clean water throughout lake; fish that are safe to eat.
- Include successes and efforts already underway.
- Stinky weeds, wrappers, and bottles out.
- Swim-able beaches

Attachment A5: Agricultural interests focus group

06/13/2008

Overview: The purpose of this focus group was to identify key issues, challenges, additional stakeholders, and outreach opportunities within the agricultural community.

Participants:

- Jerry Jenson, Dane County Board, and farmer
- David Fischer, UWEX-Dane County Agricultural Educator
- Pat Sutter, Dane County Conservationist
- Joe Connors, Frontier FS Cooperative
- Richard Keller, Wisconsin Farmers' Union

Key issues, challenges

- Angle/language problems: creating impression that it's all ag's fault
- The conversation is perceived as more regulation or leading to more regulation
- Need to present as solution vs. problem; we are all looking for solutions to problems like manure storage and disposal – bring us answers
- Identify/present issues through a balanced approach
- Ask farm community what their issues and challenges are, such as water quality – what is *their* perspective?
- Farmers are feeling threatened by lots of things
- Unless there's a real appreciation of dairies, all will "go on wheels" and be replaced by cash crops, housing
- Stay positive
- Seek a rich combination of urban and rural
- Blend economic survival with clean lakes
- Look toward sustainable farming
- Explore a vision of the county in 20 years; if the community vision is to have both an agricultural community and clean lakes it must build common ground – and figure out how to get from here to there especially because the next generation of farmers often isn't there
- Look at land use within towns; as farmers transition to the next generation, town plans are trying to control housing development with acreage limitations (minimum lot size) as well as construction, runoff controls
- Purchase of development rights
- Focusing on land use issues will not help find common ground with agricultural community on water quality issues; sprawl, TDR, PDR…controversial issues that will tear things apart
- No more rules and regulations are necessary if current ones are enforced – this is already done with livestock
- County faces a huge challenge to enforce rules without driving farmers out
- What would it take to change practices to improve water quality?

- If phosphorus is issue, target that; if soil erosion, target that; if nitrates, target that; the science is moving forward right now to do that
- Convince farm community that it is an issue and there are solutions
- Convince public to support ag to implement solutions
- If rural and urban people want better water quality, everyone has to help pay for it
- Better management practices will help
- Solutions may be less about management practices and more about newer ideas and community-based solutions
- Urban community needs to know how much farm community is already doing to make a difference with water quality
- Stakeholders, players
- Farmer list provided by Extension at previous meeting: Don Hoffman (dairy), Jeff Endres (dairy), Dale Olson (cash grain), Dennis Lund (cash grain), Randy Langer (dairy), Brian Meinholz (large dairy)
- Farmer’s Union (board includes key producers)
- Farmer’s Bureau
- NFO: National Farmers Organization
- Co-ops: Frontier FS, United, Landmark, Premier, Badgerland, Farm Credit
- Professional Dairy Producers of WI- PDPW
- WI Association of Professional Agricultural Consultants and their members; Chris Allen, Dave Cole, Paul Haigh, Eric Birschbach
- Dave Buss, formerly with Landmark; expert in nutrient management
- Crave Brothers Farms
- Custom manure handlers: Curt? or Ted Bay, Grant Co.; Kevin Erb in Green Bay would know contacts of people who do this
- Tile and drainage businesses: Ask Pat Sutter
- Pam Jahnke: Community media person who is trusted by farm community
- Large, progressive dairy producers: Brian Meinholz, second generation; Bluestar; Durfer Bros (Dick) (doing the right thing but doesn’t necessarily want to be involved with these things because they’re just outside of watershed)
- Town Chairs
- Dane County Towns Association
- Small CSAs growing a variety of vegetable crops
- Manager of Dane County Farmers Market
- Duck operations near county line; 75,000+ ducks; issues with dry manure discharge; Dave Cole is a resource
- Check opportunities in watershed in Columbia County
- Arlington Res. Station- UW-Dick Straub
- Columbia County conservationist: Kent Calkins
- Don Tierney, Sun Prairie farmer and developer; using innovative runoff handling and cooling water before discharging to stream.
- Financial Services
- M&I Bank; Sam Miller
- Badgerland Credit; Mary Elvekrog

- Middleton Bank
- Union Bank, Evansville, Dave Faith, Belleville
- Amcore
- Bank of Cottage Grove
- Dane Co. Drainage Board
- Land conservation committee members/supervisors
- Keith Ripp; President of soybean markets board -- Bob Derr- Soybean Association
- FFA groups can get word out

Outreach Opportunities

- For Farmer's Union, education, legislation, cooperation is new motto; significant education opportunities; opportunity for someone to speak on this topic as well as at quarterly meetings
- Farmers Union has active youth group; also reach out to Willy St. Co-op; State education director Cathy Statz, FU President Sue Beitlich
- Town Assn (Jerry Derr, President), NFO, and Farmers Bureau have monthly meetings = opportunity to talk with people
- Farmers Union newsletter 10x/year
- FSA newsletter
- LCC board member Steve Haak (representative FSA) and Upper Sugar River Watershed Association executive director Becky Olson
- 4-H/Dane Co Fair; both have newsletters; ask Lee Cunningham
- Magazines: AgriView, Country Today
- ABS facility off highway
- Brenda Banke, Agriculture Review

Attachment A6: Environmental interests focus group

6/13/08

Overview: The purpose of this focus group was to identify key issues, concerns, and stakeholders within the environmental community.

Participants:

- Don Hammes, Wisconsin Wildlife Federation Board of Directors, past President, Dane County Conservation League
- Jon Becker, President, Friends of Cherokee Marsh
- Peter McKeever, attorney, past President of the Wisconsin Chapter of The Nature Conservancy, past councilman, Monona City Council
- John Hendrick, Dane County Board, attorney

Who's not at the table; key stakeholders

Local watershed groups, all the competing jurisdictions in the watershed; they are competing for development, growth, tax dollars, and there is deep mistrust among some of them.

Trend until now is to look at the surrounding counties; not sure how that will hold up as land values drop and fuel increases; fear that growth will leapfrog past the county if we don't pay attention; Dane County leadership is under the impression that the other counties don't want to engage.

Madison Environmental Justice Organization.

People who fish at the locks.

Swimmers

Anglers

Local land use groups

Tourism interest groups; talk with people who have a business interest in people who come here for tourism/the lakes.

Dane County Drainage Board: they have taxing and regulatory authority within an individual drainage district; funding based on prorated benefits received by parcel; members appointed by Circuit Court.

Key publics that, if they weren't included, would render any decisions we make invalid; these may include: Government sector: cities, county, state, feds; University of Wisconsin, Edgewood College, MATC – educational public especially at the post-secondary level including faculty and students studying environmental issues and the lakes; particular state agencies such as DNR, DOT; riparian property owners on all five lakes and the rivers, some of whom are members of the lakes and other associations; anglers; boat owners/users; business community, both retail and manufacturing.

Need to bring in new people; people who are traditionally underrepresented at the table.

Key Issues, players

Key issues are political, strategic, funding

Madison and Dane County often don't "play well together" or trust each other.

Downstream issues; polluters, both urban and rural: The key is what's going to happen north of Lake Mendota, because it affects both that lake and every other in the chain; county now in the process of determining whether there's a north beltline highway that would catalyze development there; already Middleton and Waunakee are growing rapidly; Prof Ken Potter from UW did a modeling project that determined that a 60% buildout north of Lake Mendota will cause the Madison isthmus to flood; if nothing is done regionally, that buildout will be reached very soon – and affect the entire chain of lakes; this area north of Mendota requires the most attention.

Three major sources of water for Mendota are Yahara River, Six Mile Creek, Pheasant Branch springs; if they are compromised by pollution or loss of base flow/recharge, which will impact Mendota and the whole chain of lakes – so look at the water and look north of Lake Mendota.

A significant villain in the whole process is the faith we place in engineering; they design detention basins based on old assumptions, with very little work done to go back and see if they work – no one pays for that; as you have more development and more rain, you must have a different mindset about stormwater management; we pay undue homage to engineering guidelines – see too many engineering projects that don't work or harm the environment.

Leadership – people who can pick up this work over time.

Future funders/donors, public and private (notion of "river keepers" as part of a nationwide network).

Climate change issues and groups must be higher on the radar screen. All county planning must look at precipitation projections and key future planning to what's anticipated *now* with new data.

There's never been a municipality-based process, which might be an interesting strategy; the Towns Association could help with this.

Really matters who asks the stakeholders; the right person has to talk with the town leaders and other key players; personal relationships, natural partners necessary to engage people in authentic solutions. To engage effectively, visualizations of buildouts are tremendously powerful to convey impacts; public service announcements that show implications of certain decisions or actions help mobilize grassroots efforts.

Catch-22 after this long, snowy winter: areas like the marsh where you have to look carefully at the balance of water from various sources and the impacts of changing that balance.

Two intractable problems: 1) when you talk about vision you'll get a wide consensus plus commitment to education…but when you talk about regulation it will all blow up – "regulate them but not me"; 2) recharge areas are a huge issue; they are necessary to affect base flow into streams and recharge groundwater; people think you can do development with engineering that will improve infiltration; engineering not based on reality of long-term maintenance or climate change.

How to move through regulatory issues

Two scenarios: 1) choose the regulation that's the most important and drive that through; 2) a number of things that have to happen and we're not going to do anything for X years but at that point we're going to do a bunch of things that affect lots of different constituencies.

The group needs experts on regulation in order to get through the "regulatory jungle" – in most cases it starts at the federal level and then state and locals fall in line – especially regarding lakes and streams. In fact we have good regulations right now but we need enforcement; no one has the staff in place to do that; we have a Lakes and Watershed Commission responsible for all the lakes but only one employee.

State and federal regulations need to be the floor, not the ceiling, with local governments adopting more strict regulations; need to challenge developers who say it will cost more money and thus will harm their business – but that's usually not correct. Need political courage to make that happen; as long as political administrations are beholden to business interests, regulations won't be enforced.

Municipality-based task forces can come up with long-term goals and then work their way through finding out how to get there; involves different types of groups dealing with regulatory, political, technical, institutional partners, etc. A comparable approach for YLLP would be to establish the goals then engage community members at the municipal level – not *leading* with the regulatory approach but allowing people to reach common agreement on how they're going to achieve the goals, with everyone offering what they can to help reach the goals – shared goals, shared responsibility for meeting them.

Lakes and Watershed Commission has much more authority than it has ever exercised; before this group or anyone else forms some other group, the Commission has to grow up and become stronger (both staff and otherwise) and use its powers. Commission members are volunteers meeting only monthly plus committee meetings; the enormous issues and challenges of this entire watershed absolutely cannot be resolved at that scale; you need 5-10 full-time people meeting with all the local people on a regular basis to find out what's going on and to move common agendas forward.

Attachment A7: YLLP Coordinating, Visioning and Technical Committees focus group notes

6/13/08

Overview: The purpose of this focus group was to review overarching issues and identify communication strategies to the public.

Participants:

- Members of YLLP
- Members of the Visioning Advisory Committee
- Members of the technical committees

How to communicate to the public about these issues

- Fine to have goals, but how do we get there? What's going to happen?
- Important to know history; the general public doesn't need to know history in detail.
- Unprecedented opportunity to raise the bar on what we can expect from our lakes and how we can improve them. We all need to contribute to helping them get there.
- Perception out there that community will always do good things, but people won't work together to get there – so be more transparent about the value and importance of the MOU being the first time the city, county, and state have agreed to work together to clean up our lakes; different, smaller efforts in past but those were one-legged efforts.
- Our lakes are dirty; we've done some work in the past; we need to do more.
- Need to articulate to the majority of people who don't know the lakes at all how they are contributing to the problems in the lakes – they don't know there's a problem and don't know what's causing the problems. Graphic, imagistic, meaningful descriptors of problems, especially for people who aren't active lake users. People need inspiration; they need to be moved either in negative or positive ways; words, symbols, music, pictures; everyone needs to have feelings about the subject before they think about it.
- What we're trying to get at…example: brand new car salesman and boss wants to see how he sells the car…customer comes in, fantastic car, technical specs up the yin-yang…do you want to buy it -- no. Boss says, bad speech because you talked about the features, not the benefits. Need to talk about what those specs give the buyer that will improve buyer's quality of life and meet her/his needs.
- Can't talk only about features – beautiful, great sunsets, people like to live here – must talk about benefits in two categories 1) economic benefits: spend as much time with a marketing analysis as with an engineering analysis to look at the economic impacts of the Yahara Lakes; 2) noneconomic benefits of living in Dane County/Madison area: people living here have a value system apart from the economic benefits – they value living in a city with water and lakes; it is integral to who we are and the benefits of living here; it's part of our value system. Need to dig into the psychology of what people living here value about their/our community.
- People don't make link between their own actions and the results, and say it in a friendly way so as not to offend them.
- Look for a motto, a tag line…in Dane County we all live near the water…
- The messenger is important and when it's right people can do great things

Urban and rural/farming issues

- Must also look at costs; not only focus on benefits to urban residents; in the outer portions of the watershed where people live 20 miles away; the agricultural community may not have the chance to experience the kinds of lake-related benefits people nearby see every day; many farmers may be living on the margin and focused on their economic and family needs.
- People may be willing to spend tax money but not change their personal habits – at least without some reason.
- To engage with farmers, must have sufficient credibility and do so objectively.
- We really need to be spending more time listening than talking; need to learn from other perspectives and find common ground; every generation of farmers has a "benchmark" about the contribution they're making to their operation – that's temporal, their benchmark, their plateau; we get them to that point but then the next message is, but it's not enough.
- Need to move to the concept of continuous improvement – what we can really influence, not what we just say.
- Need to each have a personal benchmarks – we've done XYZ, now what else can I do? These will vary by age group, economic class, where they're going as an individual/farmer/business person.
- Farmers want to know how they partake of the benefits, not just the costs. Social benefits of making a difference may not be enough; farmers could take pride in helping clean up a lake, but not necessarily bear all the costs.
- Perception that if we want something we have to pay someone to do that (guided by state law); in many cases people will make the change without being paid to do it – on their terms and timescale, but it has to help support their family, benefit them personally, and meet their long-term goals.
- Why not have a campaign to have the urban community to help the farmers install digesters? May be a good idea but part of the farming background is a sense of personal pride; we haven't totally migrated to a sense of this being a business – it's still a "way of life" for many people.
- Easy to categorize rural vs. urban; important to find ways to connect urban kids with their natural environment, as well as not making assumptions about what farmers do or don't do in the rest of their lives and the extent to which they are involved with the lakes.
- Would be valuable to find out who Dane County farmers really are.
- Dane County Fair showcased county as a whole, the ag community, the ag businesses – while giving urban people the chance to mingle with farmers; over the years has become less popular so less chance for that interface.
- Need to develop sense that Dane County is a wonderful place to live – not just Madison – and as a farmer you're contributing to what makes the county great.
- Need to get technical information to farmers about the impact of fertilizers on our lakes, and at the same time information on alternative farming methods or how fertile their land might be without fertilizers.
- Actively engage real family farmers in this work.
- Farmers worry that this will lead to unfair regulation and costs.

Bigger picture

- Look at both economic and ethical sides; economic, we should all share in costs; ethical, we're where the Aldo Leopold land ethic developed, around good land stewardship along with good economic use of the land; *Sand County Almanac* doesn't pick on any particular land user but emphasizes the care of the land no matter who you are; can we capitalize on our history to seek shared costs and a common ethic; look at what the costs really are and how they could be distributed – may not be as dramatic as we think.
- Look for what's important to different people at different times, and find those common points.
- That desire to know people's stories is critical, along with putting that story into the larger context of your story of water…that iterative process of carrying people's stories forward to create shared beliefs, common values and priorities, and coming together to find common solutions.
- In talking with farmers…look at the Toyota Prius…all over Madison; look at marketing strategies around the appeal and attractiveness of nonpolluting operations.
- Need to move fairly quickly to what solutions are possible.
- Some farmers are struggling, some making good money – huge array; they all have a value system around protecting water and soils; need to find a way to help people in both urban and rural areas believe that there are actions they can take and they will make a difference – they don't know the degree to which their actions are really causing harm, and what they can do to tangibly improve water quality; people must have confidence that the plan will work, and if so they will pay and do what they need to do.
- Local multi-stakeholder task forces in partnership with towns/cities can provide opportunities to communicate more effectively; lots of relationship-building and understanding can come from such gatherings

Technical issues

- The Madison community believes these problems are too far gone – the problems can't be solved (the lakes have gotten better over the decades and we know that in drought years the water quality really does improve; the lakes are very responsive to putting less stuff in them – they really do get better very quickly; in just a few years you can make really big improvements).
- We do know where the phosphorus comes from and have ways to contain it; we have also done some good marketing studies – the economic benefits of Lake Mendota are 13x the entire farming profits of the entire watershed, so there's an enormous economic imbalance, so if some of those benefits could be turned around to benefit farmers…creating incentives for farmers to change practices.
- Key issues…economic, quality of life, stewardship; what needs to be added is how we can work together to deal with unexpected events; assumption that the drivers/players will stay the same over time, but that's not so; we're now seeing 500-year storm events every decade, major hydrological changes, changes in both urban and farming economics – maybe there are some ways to work together to hedge our bets for an uncertain future; if you change some of the assumptions about the future, you may take very different actions.

- We now that both stormwater and manure release issues can cause illness; it may be possible to leverage the economic benefits from some of the solutions – like nitrogen production from manure digesters.
- Part of convincing people they should care is getting them to understand and believe that there are practical solutions.
- Many of us are ready to move to solutions; how do we bridge between the technical and vision pieces? Need to look at what kinds of technical information people need to make that bridge.
- Richard Lathrop talks in his speeches about what happens in drought years; if we remove the runoff and soil erosion phosphorus, the lakes will be clear.
- Consistent, well researched, synthesized answer to the technical questions; the newspapers present incomplete and often inaccurate stories.
- We need to have all our messages both correct and clear, and start making that message clear to people – no more mixed messages (about technical issues).
- One of the technical committees is currently working on developing a statement on what we know and agree on about the lakes; our main task is coming up with viable solutions, tangible strategies, costs, and tradeoffs <those priorities must be consistent with the P2 process>.
- Truth is important; all this work needs to be put within the larger context of global warming, population growth, etc. For example, need to illustrate various scenarios and the implications of each, and what they can do to shape different futures.

Next (process) steps

- Key messages about values, technical information about problems, solution options, stories, scenarios…; integrated approach to communication, how and what information is released – sequential and becomes embedded in how the community thinks.
- Include both short- and long-term issues in the communications, focusing on opportunities, hope, choices, informed decision making, everyone's role.
- Is technical committee's charge clear? Should include problems/goals and solutions, and how the solutions vary across situations and locations.
- At a government level, must be clear on what X solution will yield and how much it will cost in short and long term.

Attachment A8: Technical guidance on community expectations

28 July 2008

Overview: On 28 July 2008, the Yahara Lakes Legacy Partnership (YLLP) convened 20 core members of the various technical committees in a structured workshop. The purpose was to engage technical committee members to identify the technical aspects of community expectations and build a common understanding among technical participants of what those are, as well as enable technical contributors to see the lakes from a community perspective. Beginning in small groups and then working as a whole, participants used words and images to determine the technical boundaries or parameters of *community expectations* for the lakes in the following categories:

Water clarity
Vegetation at or near shore
Water safety and accessibility for recreation
Water level and variation
Fishery health and fish consumption
Litter and debris

For each of these, the teams explored expectations for three scenarios: what the lakes will look like if we *don't* accelerate investment; with accelerated investment, what the lakes will look like in 10 years, and the same for 20 years. While the times were used to frame the discussion, the understanding was that such improvements are gradual and vary substantially by item over time.

Finally, the results of this workshop are only a first step in defining the technical parameters for community expectations. These will be vetted not only with participants and with YLLP partners, but also eventually will be shaped and reshaped over time with community members as they begin embracing a vision and their role in achieving it.

Participants:

- Cory Anderson, UW Engineering graduate student
- Tim Asplund, DNR
- Genesis Steinhorst, City of Madison Engineering
- Kevin Connors, Director, Dane County Land and Water Resources department
- Steve Corsi, USGS
- Greg Fries, City of Madison
- Laura Ward Good, UW
- Mindy Habecker, Dane County/UW Extension
- Ken Johnson, DNR
- Sue Jones, Dane County
- Sue Josheff, DNR
- Kevin Kirsch, DNR
- Sharon Long, WI State Lab of Hygiene and UW
- Ezra Meyer, Clean Wisconsin

- John Panuska, UW
- Ken Potter, UW
- Dennis Presser, Department of Agriculture, Trade, and Consumer Protection
- Dale Robertson, USGS
- Kirsti Sorsa, Public Health-Madison and Dane County
- Pat Sutter, Dane County
- Facilitators: Pat Van Gorp and Anne Carroll, Beacon Associates

What the lakes will look like if we don't accelerate investment	With accelerated investment, what the lakes will look like in 10 years	With accelerated investment, what the lakes will look like in 20 years
Water clarity		
Frequent algal blooms, with variation by lake	Less dense and frequent blooms; some shift in the shallows to plants rather than algae	Infrequent algal blooms except following large storm events (10-year)
Plumes and cloudiness from sediments and suspended solids from rural and urban runoff		Higher clarity and reduced turbidity; fewer sediment plumes, though still likely after major storm events
Vegetation at or near shore		
Lots of aquatic vegetation, especially invasive species	Lots of aquatic vegetation but more native rather than invasive species	Lots of aquatic vegetation; native species flourish and invasive species are under control
Little public shoreline naturally vegetated; even less private shoreline natural	100% of public shoreline naturally vegetated as appropriate, depending on intended use such as beaches, boat access points, etc. 10-20% of private shoreline properties are naturally vegetated Native plants are seen as increasingly desirable and part of the system	The majority of private shoreline properties are naturally vegetated
Odor from decaying vegetation	Reduced odor from decaying vegetation	
Water safety, accessibility		
Frequent or near-constant beach closures due to elevated bacteria (not every beach every day, but people don't make that distinction)	50% reduction in beach closure frequency, number, and duration	90% reduction in beach closure frequency, number, and duration; only following extreme storm events

What the lakes will look like if we don't accelerate investment	With accelerated investment, what the lakes will look like in 10 years	With accelerated investment, what the lakes will look like in 20 years
Illness from algal toxins and other sources	Reduced incidence of illness from algal toxins	
Increased conflicts among types of lake users around activities and access, especially on weekends and in heavy traffic areas	The full range of lake users are able to access and enjoy the lakes year round while respecting other users and activities	
Water level		
Continued wide fluctuation of water levels results in: More flooding causing shoreline erosion, ice damage, wetland destruction; slow or no-wake rules Low levels resulting in some obstructed navigation and reduced fish spawning; low flows associated with low levels result in decreased hydro-energy production		Increased Yahara River base flow throughout the year due to enhanced groundwater recharge, leading to enhanced fishery, more consistent water levels, and less urban and rural damage from flooding
Fisheries and consumption		
Mercury levels high due to global sources	Mercury levels high due to global sources	Mercury levels high due to global sources
Fishery population good overall, with somewhat higher rough fish population	Good overall fishery maintained; rough fish maintained or reduced	Good overall fishery maintained; rough fish maintained or reduced
Litter and debris		
Human-made debris and trash in lakes and on shoreline from littering and stormwater; accumulation in "hot spots"	Reductions in amount of human-made debris and trash and litter getting into lakes; still some after large storms	Virtually no human-made debris and trash getting into lakes, even after storms
Natural "debris" along shorelines such as downed trees	Increased natural coarse woody habitat for fish, birds, and land animals, especially along publicly owned shorelines	Increased natural coarse woody habitat for fish, birds, and land animals on all the lakes and along both public and private shorelines

Attachment A9: Goals, strategies and tactics workshop

November 2008

Overview: A day-long workshop that engaged a powerful and diverse group of 30 stakeholders to generate long-term goals and key mid-term strategies, in order to shape connecting workplans, formal decisions, policies, funding, and strategic actions.

Participants: Tim Asplund, Doug Bach, Jon Becker, Carolyn Betz, Mike Carlson, Kevin Connors, Jerry Derr, David Fischer, Anne Forbes, Mike Gerner, Mindy Habecker, Brett Hulsey, Ken Johnson, Sue Jones, Sue Josheff, Mike King, Dick Lathrop, Jim Lorman, Kamran Mesbah, Ezra Meyer, David Mollenhoff, Jim O'Brien, Dennis Presser, Rick Roll, Tommye Schneider, Bob Sorge, Jon Standridge, Genesis Steinhorst, Dave Taylor, Jake Vander Zanden, Kurt Welke, Jim Welsh

What Do You Think The Yahara Lakes Should Look Like 30 Years From Now?

- Nutrients and sediments are at a level that achieves desired water quality
- Land uses sustain healthy lakes and other water resources
- The waters are safe for community and recreational uses
- Sustainable funding is in place
- Leaders champion collaboratively developed plans, programs, and policies
- People understand how their lives are linked to the watershed and its lakes
- Agricultural practices and systems are economically and ecologically sustainable
- All partners share responsibility and accountability for actions and results
- Aquatic and riparian terrestrial ecosystems are healthy
- Other?

What Should Be Done To Achieve These Goals For The Yahara Lakes?

- Prevent waste, trash, and pollution from entering lakes
- Eliminate urban sources of Phosphorus flowing into the lakes
- Reduce human consumption of toxins from fish
- Conduct education plan
- Clean up beaches so people swim there
- Enforce existing erosion control regulations
- Reduce erosion/runoff
- Protect public and private wetlands
- Engage local watershed groups in wetland restoration activities
- Provide sufficient incentives and funding to purchase and restore wetlands
- Restore wetlands
- Organize individuals and organizations to advocate for watershed improvement
- Deliver key messages to defined audiences
- Create a sense of ownership and empower useful actions
- Organize governmental and non-governmental leaders and groups to work towards watershed goals
- Leverage public and private funding to achieve watershed goals

- Take pride in, and celebrate, progress
- Protect the unique biodiversity of each water body
- Strengthen diverse fisheries
- Strengthen wildlife populations in and around the lakes
- Communicate with rural communities re: problems, solutions, regulations, costs
- Communicate the idea of shared responsibility to both rural and urban communities
    - Engage with rural community partners around watershed goals
    - Change the “us vs. them” rural-urban mentality
- Forge coalitions across the rural/urban divide in the watershed
- Help urban and rural people work together toward the same goals
- Create cost-effective and sustainable agricultural practices for water quality
- Provide funds for Ag best management practices
- Employ Strategies and approaches that are fair, workable, and make sense to farmers
- Build a long-term private-public water protection partnership
- Install/maintain vegetated buffers to reduce Phosphorus flow to waterways
- Reduce nutrient loading to surface and groundwater to achieve Phosphorus and sediment targets

Appendix B: Model existing nutrient and sediment loadings

Attachment B1: Yahara CLEAN Non-Point Source Modeling Report (Watershed-Wide SWAT Model) produced by Montgomery Associates Resource Solutions

The final report from this consulting project is not yet available. When it is complete, information on accessing it will be provided at www.yaharawatershed.org.

Attachment B2: SNAP-Plus analysis of North Fork, Pheasant Branch Creek

Cory Anderson's Project Report, "An Analysis of Phosphorus Runoff from Agricultural Non-point Sources in the Pheasant Branch Watershed, WI, and Potential Reduction Methods and Benefits" is available at www.yaharawatershed.org/resources

Attachment B3: Water Resources Management Practicum: Door Creek Watershed Assessment: A Sub-watershed Approach to Nutrient Management for the Yahara Lakes

This report can be downloaded from:
www.nelson.wisc.edu/assets/docs/grad_programs/wrm/workshops/door_creek_2009.pdf

Appendix C: Assess causes of bacterial outbreaks on beaches

Attachment C1: Summary of *E. coli* samples between 2005 and 2007

Summary of *E. coli* samples between 2005 and 2007 at City of Madison beaches on 303(d) list of impaired waters.

Beach	Water Body	Total # Samples	Total Exceedances	# Years of Data Minimum of 15 Samples	Criteria	Total % Meeting Geometric Mean Criteria (126/100mL)
Vilas Beach	Lake Wingra	67	14	3	>15%	**20.9%**
Esther Beach	Lake Monona	57	23	2	>25%	**40.4%**
Olin Beach	Lake Monona	94	54	3	>15%	**57.4%**
Bernie's Beach	Lake Monona	54	10	2	>25%	**18.5%**
Brittingham Beach	Lake Monona	62	32	2	>25%	**51.6%**
Olbrich Beach	Lake Monona	81	36	3	>15%	**44.4%**

Attachment C2: Brief descriptions of impaired beaches

VILAS BEACH

Vilas Beach is a popular regional City of Madison beach located along the north shore of Lake Wingra, adjacent to the Henry Vilas Park and Zoo. It is the most heavily-use beach in the city. The Vilas family deeded the property to the City of Madison in 1904 for use as a public park with the restriction that an entrance fee can never be collected. A zoo has been located within the park since 1911.

The beach is approximately 250 feet long and 65 feet wide, with a 7% slope. The nearest storm outfall from the direction of the prevailing winds is approximately 1800 feet away (to the west).

There is a large goose population frequently located near the beach, which almost certainly has caused the beach to be closed on numerous occasions due to high bacteria levels. Even so, during the past 5 years Vilas Beach has been the least frequently closed city beach due to bacteria or blue green algae levels. When it has closed, it was most often due to high levels of bacteria. From 2005 through 2009, the beach was closed just once for high blue green algae levels, for a total of 3 days. It was closed 8 different times for high bacteria levels (15 days total). It is currently listed on the EPA's 303(d) list of impaired beaches for high bacteria levels.

In July 1999, a major rain event caused contaminated storm water to flow from a malfunctioning holding tank at the Henry Vilas Zoo into nearby Wingra Creek. Because Vilas Beach is located "upstream" of the storm outfall that drained that part of the zoo, it was not affected. However, Olin Beach on Lake Monona, approximately 2 miles downstream, had to be closed due to high bacteria levels traced to the contaminated effluent. Since then, measures have been taken at the zoo to prevent a recurrence.

OLBRICH BEACH

Olbrich Beach is a frequently used regional City of Madison beach located at one of the city's first parks. The beach is approximately 180 feet long and 78 feet wide, with an 8.3% slope. Between 2005 and 2009, the beach was closed 7 times (13 days) due to high levels of blue green algae, and 9 times (22 days) for high levels of bacteria. It is currently listed on the EPA's 303(d) list of impaired beaches for high bacteria levels.

The beach is located approximately 300 feet northwest of the nearest storm water outfall and 1300 feet southeast from the outlet of Starkweather Creek and a popular boat launch.

Note that all Lake Monona beaches were closed for a week in 2008 due to a raw sewage release from an MMSD pumping station.

OLIN BEACH

Olin Beach is a neighborhood beach located on land purchased in 1912 for use as a park. Originally called Monona Park, it officially opened in 1919 (it was renamed in 1923). Today City of Madison Parks Dept. staff maintains a "managed meadow" at the park in an effort to improve the health of old oak trees that were suffering from lack of water and nutrients from the out-competing turf grass. Soil compaction and frequent mowing that prevented the natural regeneration of the oaks were also compromising the trees. The areas were seeded with a native plant mix and are now mowed just once a year.

The beach is located approximately 400 feet southeast of the Wingra Creek outfall and 250 feet southeast of a popular boat landing and parking lot. It is about 100 feet long and 12 feet wide, with an 8.8% slope. Geese are frequently an issue at this beach, as is stormwater runoff from the surrounding mowed turf areas.

Between 2005 and 2009, the beach was closed 8 times (17 days) for high levels of blue green algae, and 8 times (40 days) for high levels of bacteria. It is currently listed on the EPA's 303(d) list of impaired beaches for high bacteria levels.

Note that all Lake Monona beaches were closed for a week in 2008 due to a raw sewage release from an MMSD pumping station.

In July 1999, sewage problems at the Henry Vilas Zoo (2 miles upstream) caused Olin Beach to close due to high bacteria levels. Public Health–Madison and Dane County staff discovered high levels of fecal coliform at the 30-inch storm outlet along Wingra Creek that drains the south part of the zoo. The source was sewer blockage in a by-pass chamber that diverts contaminated storm water to a holding tank, which is pumped into a sanitary sewer over a period of time to even out the flow during peak rainfall. The blockage was removed and a new maintenance plan was put immediately into place to prevent a recurrence.

ESTHER BEACH

Esther Beach is located along the southeastern shore of Turville Bay in Lake Monona. During the 1870's, Charles Askew and his brother ran a passenger boat business and built a dance hall and picnic grounds at Esther Beach in 1901. The park was named after Charles' daughter who died in 1883. The dance hall, called Hollywood-at-the-Beach, continued through 1952.

Today Esther Beach is a small neighborhood beach prone to problems with weeds due to its orientation to Turville Bay. Prevailing winds tend to blow pieces of floating aquatic vegetation and other debris into this area.

The beach itself is about 70 feet long by 50 feet wide, with a 7.5% average slope. During 2005 through 2009, the beach was closed 12 times (29 days) for high levels of blue green algae, and 7 times (19 days) for high bacteria levels. It is currently listed on the EPA's 303(d) list of impaired beaches for high bacteria levels.

Note that all Lake Monona beaches were closed for a week in 2008 due to a raw sewage release from an MMSD pumping station.

BERNIE'S BEACH

Bernie's Beach is a small neighborhood beach situated in the southeast corner of Monona Bay. While there is not a large goose population present at the beach, there is regularly evidence of their presence. The beach is approximately 68 feet long and 40 feet wide, with an average slope of 8.8%. There is a storm sewer outfall located directly adjacent to the beach.

City of Madison Engineering staff has been regularly sampling water in the beach area (and other locations around Monona Bay) for the presence of blue green algae since 2005. The highest levels for blue green algae in this area tend to occur in the fall, after the beach has already closed for the season. Note that all Lake Monona beaches were closed for a week in 2008 due to a raw sewage release from an MMSD pumping station.

From 2005 through 2009, Bernie's Beach was closed 3 times (13 days) for high levels of blue green algae, and 3 times (7 days) for high bacteria levels. During this period, it was the second least closed city beach, after Vilas Beach. Preliminary analyses by DNR staff have shown there is a moderate correlation between rainfall and bacterial concentrations at this site. It is currently listed on the EPA's 303(d) list of impaired beaches for high bacteria levels.

BRITTINGHAM BEACH

Brittingham Beach is located along the north shore of Monona Bay, in Brittingham Park. In 1904, the bay was full of weeds and trash and was called a "disease breeding hole" at the annual meeting of the Madison Park and Pleasure Drive Association. At that time, the City of Madison owned just a small piece of property along the bay and lacked the finances to improve the area by building a park, as was suggested at the meeting. A short time later, however, a wealthy citizen donated enough money for the city to acquire 27 acres of mostly marshland, which would be the future site of the park. The bay was dredged to fill in the marsh, and the area was topped with soil and vegetation. Built in 1910, it was Madison's first "water park," boasting an expansive water slide and rental swimsuits. Nearly 100 years ago, it was one of the city's most popular spots, yet now it is one of the least frequented beaches for swimmers.

Today most of the park has boulder riprap at the shoreline, with the remaining beach area measuring approximately 80 feet long and 32 feet wide, with an average slope of 9.3%. Storm outfalls sit on either side of the beach, both about 340 feet away. Also, there is frequently evidence of a sizable goose population, though Parks staff has reduced mowing frequency along the shoreline to minimize goose accessibility.

Between 2005 and 2009, the beach was closed 2 times (5 days total) for high blue green algae levels and 7 times (34 days total) for high bacteria levels. It is currently listed on the EPA's 303(d) list of impaired beaches for high bacteria levels. Note that all Lake Monona beaches were closed for a week in 2008 due to a raw sewage release from an MMSD pumping station.

Attachment C3: Summary of beach bacteria statistical methods

Correlation Analyses

Correlation analyses were used to assess relationships between bacteria concentrations and parameters related to weather, water quality, bather use, and wildlife counts. Two approaches were used based on the nature of the parameters. Weather and water quality parameters were considered to be relatively constant over the course of a day. Therefore, individual observations could be linked to individual bacteria concentrations. Bather use and wildlife counts were considered to be relatively variable over the course of a day. Therefore, individual bather or wildlife counts may not reflect the conditions previously in the day that would potentially contribute to that day's bacteria count. For example, a large number of geese could visit a beach early in the day and contribute to a higher bacterial level but not be present during sampling, leading to a low goose count.

For all correlation analyses, Pearson's product moment correlation was used to calculate the strength of each relationship. *E. coli* was selected as the bacteria indicator since the most data was available for it and it is the indicator bacteria used to make decisions on beach closure. Before analysis, *E. coli* concentrations were transformed using the natural log (ln) since concentrations can vary over several orders of magnitude. Correlation coefficients (r) were converted to t-values using the equation below in order to test statistical significance. Correlation analyses were repeated after separating data based on season (June, July, August) and year.

$$t = \frac{r}{\sqrt{\frac{1-r^2}{N-2}}} \quad df = N\text{-}2$$

For weather and water quality parameters, these correlation coefficients were calculated using individual bacteria counts and individual observations for each parameter. The resulting correlation coefficients describe the strength of the relationship between each parameter and that day's *E. coli* concentration.

For bather use and wildlife counts, correlation coefficients were calculated using average bacteria counts (geometric mean) for each beach and average counts for each parameter. The resulting correlation coefficients describe the strength of the relationship between the average bacterial conditions and the average bather population or average wildlife count.

Regression Analyses

Since many of the parameters may be interconnected (for example, turbidity will tend to be higher after rainfall), multiple linear regression using ordinary least squares (OLS) was used to assess the relationships between bacteria concentrations and the parameters. Since multiple linear regression calculates the relationships of bacteria with multiple parameters simultaneously, the relationships between the parameters can be better accounted for.

All regression analyses were conducted using Microsoft Excel's Data Analysis ToolPak. *E. coli* was chosen as the dependent variable and transformed using the natural log (ln) since concentrations can vary over several orders of magnitude.

The potential relationships between parameters can have some consequences related to this regression method. One of the assumptions of the OLS technique is that all independent variables are not correlated with each other. When this assumption is not met (a situation called multicolinearity), regression estimates of parameter coefficients will still be valid, but the standard error associated with the coefficients will be larger than the "true" value. This makes it more difficult to determine whether the relationship is statistically significant and may lead to the conclusion that some coefficients are not statistically significant when they really are. Since it is likely that some of the parameters used in these analyses may be correlated, this effect must be kept in mind. To prevent ignoring relationships that are actually statistically significant, the conditions for statistical significant were relaxed somewhat to include parameters that were statistically significant at the 90% level.

More sophisticated regression analyses were used by many of the UW STAT 998 students. See their papers for descriptions of the techniques used.

Appendix D: Determine Necessary Nutrient, Sediment and Bacteria Levels to Reach the Community Vision

At www.yaharawatershed.org can be found, for the six 303(d) listed beaches, sanitary surveys, aerial photos, topographic maps, and other summary documents related to beach assessments.

Attachment D1: Excerpt from "Understanding Lake Data" by Byron Shaw, Christine Mechenich, and Lowell Klessig, UW-Extension 2004

Pages 7-9 of this publication provide helpful descriptions of trophic state and phosphorus.

Secchi disc values vary throughout the summer as algal populations increase and decrease. Measuring several sites may be useful in some lakes, depending upon the uniformity of the lake. Year to year changes result from weather and nutrient accumulation. *Weekly or biweekly Secchi records (April-November) over a number of years provide an excellent and inexpensive way to document long-term changes in water clarity.*

The color of lake water reflects the type and amount of dissolved organic chemicals it contains. Measured and reported as standard color units on filtered samples, color's main significance is aesthetic. Color may also reduce light penetration, slowing weed and algae growth. Many lakes possess natural, tan-colored compounds (mainly humic and tannic acids) from decomposing plant material in the watershed. Brown water can result from bogs draining into a lake. Before or during decomposition, algae may impart a green, brown or even reddish color to the water.

Color can affect the Secchi disc reading. Table 3 lists color values associated with varying degrees of water color.

Another measure of water clarity, **turbidity** is caused by particles of matter rather than dissolved organic compounds. Suspended particles dissipate light, which affects the depth at which plants can grow.

TABLE 3. Water color. *(Adapted from Lillie and Mason, 1983.)*

0-40 units	Low
40-100 units	Medium
>100 units	High

Turbidity affects the aesthetic quality of water. Lakes receiving runoff from silt or clay soils often possess high turbidities. These values vary widely with the nature of the seasonal runoff.

Suspended plants and animals also produce turbidity. Many small organisms have a greater effect than a few large ones. Turbidity caused by algae is the most common reason for low Secchi disc readings.

Trophic state

Trophic state is another indicator of water quality. Lakes can be divided into three categories based on trophic state—oligotrophic, mesotrophic, and eutrophic. These categories reflect a lake's nutrient and clarity levels.

Oligotrophic lakes are generally clear, deep and free of weeds or large algae blooms. Though beautiful, they are low in nutrients and do not support large fish populations. However, oligotrophic lakes often develop a food chain capable of sustaining a very desirable fishery of large game fish.

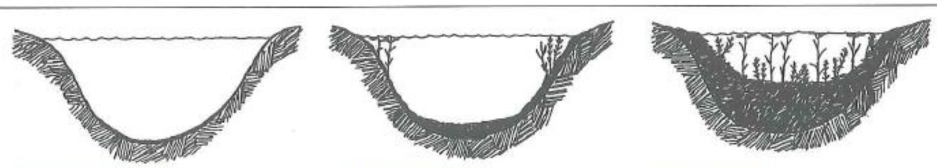
Eutrophic lakes are high in nutrients and support a large biomass (all the plants and animals living in a lake). They are usually either weedy or subject to frequent algae blooms, or both. Eutrophic lakes often support large fish populations, but are also susceptible to oxygen depletion. Small, shallow, eutrophic lakes are especially vulnerable to winterkill which can reduce the number and variety of fish. Rough fish are commonly found in eutrophic lakes.

Mesotrophic lakes lie between the oligotrophic and eutrophic stages. Devoid of oxygen in late summer, their hypolimnions limit cold water fish and cause phosphorus cycling from sediments.

A natural aging process occurs in all lakes, causing them to change from oligotrophic to

The Wisconsin Department of Natural Resources (DNR) operates a "Self-Help Monitoring Program" for lakes. Local volunteers take Secchi disc and other readings and the DNR provides computer data storage and annual reports. For more information, contact a district DNR office or write to:
DNR Lake Management Program
WRM/2
P.O. Box 7921
Madison, WI 53707

FIGURE 3. Lake aging process.



OLIGOTROPHIC
- Clear water, low productivity
- Very desirable fishery of large game fish

MESOTROPHIC
- Increased production
- Accumulated organic matter
- Occasional algal bloom
- Good fishery

EUTROPHIC
- Very productive
- May experience oxygen depletion
- Rough fish common

7

CONCENTRATION UNITS express the amount of a chemical dissolved in water. The most common ways chemical data is expressed is in milligrams per liter (mg/l) and micrograms per liter (µg/l). One milligram per liter is equal to one part per million (ppm). To convert micrograms per liter (µg/l) to milligrams per liter (mg/l), divide by 1000 (e.g., 30 µg/l = 0.03 mg/l). To convert milligrams per liter (mg/l) to micrograms per liter (µg/l), multiply by 1000 (e.g., 0.5 mg/l = 500 µg/l). Microequivalents per liter (µeq/l) is also sometimes used, especially for alkalinity. It is calculated by dividing the equivalent weight of the compound by 1000 and then dividing that number into the milligrams per liter.

TABLE 4. Trophic classification of Wisconsin lakes based on chlorophyll *a*, water clarity measurements, and total phosphorus values. (*Adapted from Lillie and Mason, 1983.*)

Trophic class	Total phosphorus µg/l	Chlorophyll *a* µg/l	Secchi Disc feet
Oligotrophic	3	2	12
	10	5	8
Mesotrophic	18	8	6
	27	10	6
Eutrophic	30	11	5
	50	15	4

eutrophic over time, and eventually to fill in (Figure 3). People can accelerate the eutrophication process by allowing nutrients from agriculture, lawn fertilizers, streets, septic systems, and urban storm drains to enter lakes.

In nutrient-poor areas, the aging process may lead instead to dystrophic and bog lakes which are highly colored, acid, and not as productive as eutrophic lakes.

Researchers use various methods to calculate the trophic state of lakes. Common characteristics used to make the determination are:

- total phosphorus concentration (important for algae growth)
- chlorophyll *a* concentration (a measure of the amount of algae present)
- Secchi disc readings (an indicator of water clarity).

The trophic states associated with these three measures are shown in Table 4. Clearly, low levels of phosphorus are associated with low levels of algae (chlorophyll *a*), which are associated with high Secchi disc readings.

Chemical Properties

Phosphorus

Phosphorus promotes excessive aquatic plant growth. In more than 80% of Wisconsin's lakes, phosphorus is the key nutrient affecting the amount of algae and weed growth.

Phosphorus originates from a variety of sources, many of which are related to human activities. Major sources include human and animal wastes, soil erosion, detergents, septic systems and runoff from farmland or lawns.

Phosphorus provokes complex reactions in lakes. An analysis of phosphorus often includes both *soluble reactive phosphorus* and *total phosphorus*.

Soluble reactive phosphorus dissolves in the water and readily aids plant growth. Its concentration varies widely in most lakes over short periods of time as plants take it up and release it.

Total phosphorus is considered a better indicator of a lake's nutrient status because its levels remain more stable than soluble reactive phosphorus. Total phosphorus includes soluble phosphorus and the phosphorus in plant and animal fragments suspended in lake water.

Ideally, soluble reactive phosphorus concentrations should be 10 µg/l (micrograms

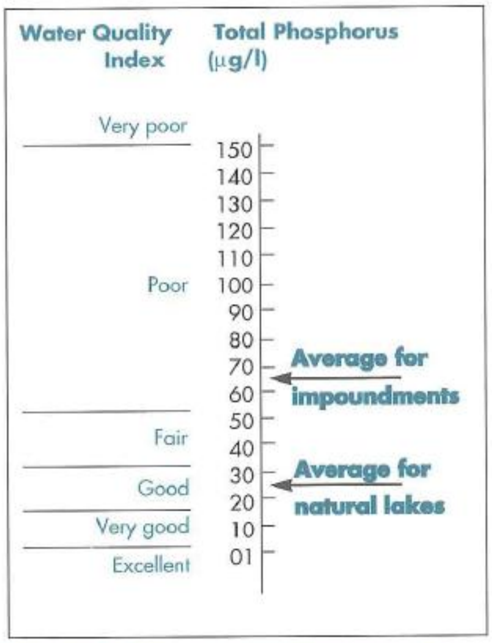


FIGURE 4. Total phosphorus concentrations for Wisconsin's natural lakes and impoundments. (*Adapted from Lillie and Mason, 1983.*)

per liter) or less at spring turnover to prevent summer algae blooms. A concentration of 10 micrograms per liter is equal to 10 parts per billion (ppb) or 0.01 milligrams per liter (mg/l). A concentration of total phosphorus below 20 µg/l for lakes and 30 µg/l for impoundments should be maintained to prevent nuisance algal blooms (Figure 4).

Phosphorus does not dissolve easily in water. It forms insoluble precipitates (particles) with calcium, iron, and aluminum. In hard water areas of Wisconsin, where limestone is dissolved in the water, marl (calcium carbonate) precipitates and falls to the bottom. Marl formations absorb phosphorus, reducing its overall concentration as well as algae growth. Aquatic plants with roots in the marl bottom still get phosphorus from sediments. Hard water lakes often have clear water, but may be weedy.

Iron also forms sediment particles that store phosphorus—but only if oxygen is present. When lakes lose oxygen in winter or when the deep water (hypolimnion) loses oxygen in summer, iron and phosphorus again dissolve in water. Strong summer winds or spring and fall turnover may mix iron and phosphorus with surface water. For this reason, algae blooms may still appear in lakes for many years even if phosphorus inputs are controlled.

Figure 5 shows the increase in total phosphorus for stratified lakes following fall turnover. Since shallow and windswept lakes that stay mixed do not experience oxygen depletion, they have the highest total phosphorus levels in summer following spring turnover and early summer runoff.

The amount of iron that might react with phosphorus varies widely in Wisconsin lakes. Lakes in the southern part of the state are often low in iron due to a higher pH and more sulfur, both of which limit iron solubility. This in turn affects whether phosphorus mixed into lakes during fall turnover precipitates or stays in solution during the winter.

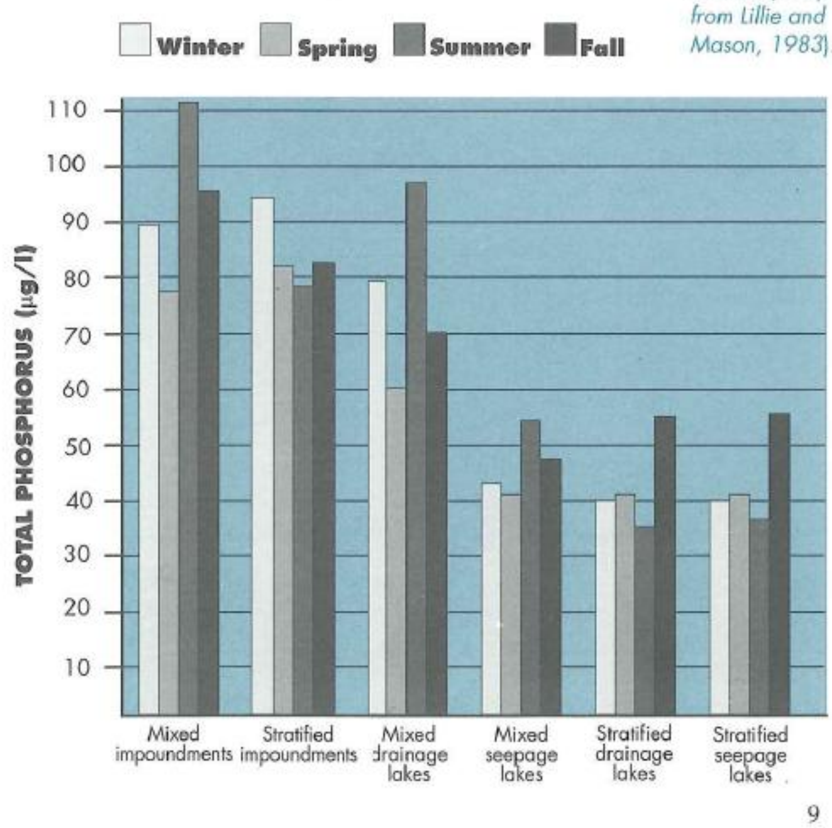
Lakes with low iron and insufficient calcium to form marl are most likely to retain phosphorus in solution once it is released from sediments or brought in from external sources. These lakes are the most vulnerable to naturally occurring phosphorus or to phosphorus loading from human activities because the phosphorus remains dissolved in the water—not pulled down into the sediments. Such lakes often respond with greater algae problems.

Figure 5 also shows that impoundments have the highest phosphorus levels. Mixed drainage lakes sustain intermediate levels, while seepage and stratified drainage lakes have the lowest. Even with the potential for internal phosphorus cycling caused by oxygen depletion, deep stratified lakes tend to have lower phosphorus levels than their mixed counterparts.

Phosphorus control has been attempted in some lakes by using alum (aluminum sulfate) to precipitate phosphorus. Sewage treatment plants use the same process to remove phosphorus. Aluminum phosphate precipitate, unlike iron phosphate, is not redissolved when oxygen is depleted.

Nitrogen

Nitrogen is second only to phosphorus as an important nutrient for plant and algae growth. A lake's nitrogen sources vary widely. Nitrogen compounds often exceed 0.5 mg/l in rainfall, so



▼FIGURE 5. Seasonal total phosphorus averages for six lake types by season. *(Adapted from Lillie and Mason, 1983).*

Appendix E: Activities Necessary to Meet Loading and Bacterial Reductions

Attachment E1: Goose management options

Option		Description	Permit Required?	Timing	Advantages	Disadvantages	Notes
Stop Public Feeding	*No-feeding ordinance*		Need passage by City	Year-round	No direct disturbance of geese (less controversial). Reduces incentive for geese to frequent area. Cited by Wildlife Management staff as an essential part of an overall management plan	Ordinances are often ineffective since they are unenforceable. Public often likes to feed geese	There is often enough food available for geese to survive without public feeding. Public feeding often just serves to entice geese to a specific area.
	Public education		No	Year-round		Varying success, lots of people like to feed geese.	DNR Wildlife Management staff states public education is often more publicly acceptable than regulations
	Fencing off goose route to feeding areas		No	During summer molt (June-July)		Only effective during summer molt when geese cannot fly	Unlikely to be effective on its own
Habitat Modification	*General*	Altering the landscape to deter geese from moving from water to land or making them uncomfortable by cutting off escape routes and reducing vision of potential predators			No direct disturbance of geese (less controversial).	Can have large up-front costs. Can be unpopular among residents. Subject to site constraints	
	Shoreline modification	Altering the shoreline and/or adding rocks and shrubs to reduce visibility and deter nesting	Yes (USACE, DNR, Dane Co)		Same as general	Large up-front costs. Can be unpopular among residents. Subject to site constraints	Can be combined with feeding ordinances or deterrence strategies. Usually not effective on its own. Geese may use shrubs as nesting sites.
	Modification of water levels	Raising or lowering the water level to remove islands where geese nest or connect them to mainland		During nesting	Same as general	Can affect other wildlife. Can be hard or costly to implement.	Illegal if used to drown eggs
	Placement of walking paths by water	Intended to make geese uncomfortable and deter nesting	Yes (USACE, DNR, Dane Co)		Same as general	Not as effective after geese are already established in an area or where people feed geese. Large up-front costs. Limited by site considerations.	
	Overhead wire grids	Grid of wire or string is stretched 1-2 feet above the water surface (10-12 feet if access is necessary). This deters geese from landing and taking off in the water	No		Less up-front costs than other habitat modification techniques	Hard to implement on large lakes/ponds. Impairs human access and use.	
	Fence placement at shoreline	Prevents movement from water to land. Fence should be >30" tall with openings <3". String or mylar tape should be placed ~12" above the ground. Fence needs to extend far enough that the geese will not walk around.	No		Less up-front costs than other habitat modification techniques	Simple barriers (e.g. single line of string) often don't work for long periods of time and need lots of maintenance. Doesn't prevent geese from flying into an area.	Need to ensure that the fence is long enough that geese cannot easily walk around it

Attachment E1: Goose management options

Option		Description	Permit Required?	Timing	Advantages	Disadvantages	Notes
	Vegetative shoreline barriers	Prevents movement from water to land and makes geese uncomfortable by limiting view of potential predators. Need dense, tall (>30") vegetation. Wider barriers are more effective.		Vegetation needs to grow early in summer	Can provide aesthetic benefits as well. Less expensive than shoreline and water level modifications	Not as effective where geese numbers are high. Will not prevent geese from flying into area.	Can decrease the effectiveness of harassment techniques. Used on north side of Wingra lagoon - did lead to less geese in area but geese moved to other nearby areas. Some evidence that geese may have gotten used to the buffer.
	Rock shoreline barriers	Discourages goose movement from water to land by limiting their view of potential predators. Boulders should be >2' in diameter	Yes (USACE, DNR, Dane Co)			If geese are accustomed to people, this is less effective	Can be used with vegetative barriers effectively
	Alternative park maintenance	Reduced mowing, reduced fertilizer use, reduced lawn watering, and planting of less palatable grass species to make area less attractive to geese			Includes easy, inexpensive ways of making area less attractive	Can reduce amount of land useable by people	
	Lure crops and bait stations	Planting favored plant species or placing feed outside of the park to draw geese away from the park				Does not reduce geese populations, just moves them. Often ineffective in urban landscapes since food is readily available.	Cannot be used in combination with hunting since it is illegal to bait geese for hunting purposes
Hazing and Scaring	*General*	Any technique intended to harass geese and make the area feel less safe for geese	No, unless the geese are not touched or handled by a person or a dog		No direct disturbance of geese (less controversial). Makes geese uncomfortable in area.	Can disturb neighbors. Does not chase geese from general area, just specific area near device. Geese can become habituated to noise or visual devices. Can also deter other wildlife species.	Works best before geese become habituated to an area. Need a varied stimulus both in timing and volume
	Sonic devices	Sirens, airhorns, whistles, firearm blanks, bangers, screamers, whistle bombs, cracker shells, cannons, exploders, pyrotechnics, distress calls, ultrasonic devices	No			High level of disturbance to neighbors. May not be feasible in urban environment.	Most effective when used in combination with other hazing techniques and when sounds are varied
	Visual devices	Strobe lights, mylar tape, flags, eye-spot balloons or kites, scarecrows	No		Less disturbance to neighbors than sonic devices	Geese quickly become habituated if used alone and do not disperse far due to visual devices.	Most effective when used in combination with other hazing techniques
	Dogs/Falcons	Using trained dogs to chase and harass geese	May require a permit	Spring nesting, late summer (post-molting)	Recommended by FWS as most effective hazing technique	More labor-intensive than other hazing techniques since dogs must be watched.	Swans have also been introduced to harass geese but can be aggressive toward people and present the same problems as geese
Chemical Repellents	*Methiocarb, methyl anthranilate*	Chemicals that make grass less palatable to geese, making the area less attractive			Don't harm geese, not disruptive to neighbors. Make grass unpalatable to geese.	High costs, need to re-apply frequently, can affect other wildlife, can be ineffective or inconsistent	Some chemicals should not be used near "fish-bearing waters" or have adverse effects on aquatic organisms

Attachment E1: Goose management options

Option		Description	Permit Required?	Timing	Advantages	Disadvantages	Notes
Reproductive controls	*General*	Any technique intended to reduce the number of young produced	Yes (DNR), also need to register with Fish and Wildlife Service		Can potentially affect population numbers without directly harming geese.	Can be costly and labor-intensive. Nests may be far from site, making finding difficult.	Long-term strategy. Need to find all eggs or nests from an adult over its lifetime in order to equal the removal of that adult. Likely results in population stabilization or slow population decline since goose lifespan is relatively long (~40 years). Geese can nest a few miles away from problem area so finding nests can be difficult.
	Nest removal	Removing nest material during the nesting season to prevent geese from laying eggs	Yes (DNR), also need to register with Fish and Wildlife Service	Late March - mid April	Same as general	Costly and labor intensive with the need to visit nesting sites daily. Can be difficult to find all nests if dealing with a large population	
	Oiling, addling, puncturing eggs	Treating eggs to prevent embryo development and hatching	Yes (DNR), also need to register with Fish and Wildlife Service	Late March - mid April	Same as general	Can be costly and labor-intensive. Need to re-visit nest a week after the first visit to ensure all eggs are found.	Egg destruction should be performed after all eggs have been laid in the nest but as early as possible in development (before egg begins to float in water). Nests and eggs should be marked after being addled and re-visited a week after the visit.
	Egg replacement	Replacement of eggs with decoys (wooden eggs, hard boiled eggs, etc.)	Yes (DNR), also need to register with Fish and Wildlife Service	Late March - mid April	Requires less re-visiting than removing nests and oiling or addling	Can be costly and labor-intensive	
	Surgical sterilization	Sterilization of males	Yes (DNR), also need to register with Fish and Wildlife Service		Effective, less need for continual visitations	High labor costs, needs experienced staff. Often ineffective	Sterilized males may behave differently, letting unsterilized males mate, and reducing effectiveness
	Oral contraceptives	Chemicals that inhibit geese reproduction		March-April	Simpler - does not require capturing geese or finding nests	Contraceptives affect all bird species. Needs to be fed to geese regularly before and during nesting.	OvoControl-G (Nicarbazin) is available. Only licensed individuals can apply this chemical. Does not eliminate egg production, only reduces egg production.
Removal	*General*	Usually performed by drive trapping	Yes	During molting for adults or before flight for juveniles	Effective, causes fastest reduction of population size. Generally cost-effective	Usually controversial	
	Translocation	Capturing geese and moving them away from the problem site	Yes		Non-lethal	Translocated adults usually return to the site, juveniles usually do not return but moving juveniles is not as effective at lowering population numbers	Need to identify area to release geese. Many areas will not accept translocated geese. Prior to 2000, DNR contacted 49 states and options for relocation were limited. Can transport juveniles to state-regulated hunting areas.
	Single-sex population	Can be performed by translocating or euthanizing all geese of one sex	Yes			Not effective, labor intensive, expensive	Remaining birds will attract other geese which can take the place of the sterilized males.

Attachment E1: Goose management options

Option		Description	Permit Required?	Timing	Advantages	Disadvantages	Notes
Removal	*Hunting/special-purpose kill permits*	Extending the regular goose hunting season or issuing special kill permits to hunt geese outside the hunting season	Yes		Direct population control. Cost-effective	Need to implement safety guidelines, can be difficult to implement in urban areas	Can enhance the effectiveness of sonic hazing devices and reproductive controls
	Harvesting	Capturing geese using drive netting and euthanizing. Carcasses can be sold or given to food banks	Yes	During molting	Direct population control. Doesn't require use of firearms.	Usually controversial. More expensive than hunting	Need USDA approval before donating to food banks. Need to test for contaminants like heavy metals and PCBs. Can enhance the effectiveness of reproductive controls

Citation	Description
Smith, A.E., S.R. Craven, and P.D. Curtis. 1999. Managing Canada geese in urban environments. Jack Berryman Institute Publication 16, and Cornell University Cooperative Extension, Ithaca, N.Y.	Best summary of all techniques. Cited in just about every other document about goose management
U.S. Fish and Wildlife Service. 2005. Final Environmental Impact Statement: Resident Canada Goose Management. November. Arlington, VA.	Summary of techniques is based on Smith, et al., 1999 but it includes analysis of impacts
Minnesota Department of Natural Resources. 1997. Homeowners' Guide to Goose Problems. St. Paul, MN.	Brochure with general guidelines for individual homeowners to reduce goose visitation on their property
Wisconsin Department of Natural Resources. 2007. Resident Canada Goose Management in Wisconsin. PUB WM-474-2007. USDA APHIS - Wildlife Services.	Pamphlet for public education on goose management. Includes brief summary of management techniques
Craven, S.R. and J. Heinrich. 1996. Canada Geese Crop Damage. University of Wisconsin-Extension, Madison, WI.	Written for agricultural audience, includes brief summary of management recommendations
Ad Hoc Committee on Integrated Waterfowl Management. 2002. Report to City of Madison Common Council. Dated May 8, 2002. ID#31775	Summary of problem and recommendations for addressing the problem in Madison
Lorman, J. 2003. Giant Canada Geese in the Wingra Watershed: A Preliminary Report. Edgewood College, Friends of Lake Wingra.	
http://natsci.edgewood.edu/wingra/wingra_geese.htm	Collection of studies by Edgewood College students on goose population and management.
Humane Society of the United States. 2000. Canada Goose Egg Addling Protocol.	
Humane Society of the United States. 2004. Humanely Resolving Conflicts with Canada Geese: A Guide for Urban and Suburban Property Owners and Communities. Washington, D.C.	
Doncaster, D. and J. Keller. 2000. Habitat Modification and Canada Geese: Techniques for Mitigating Human/Goose Conflicts in Urban and Suburban Environments. Animal Alliance of Canada.	Focuses on habitat modification. Includes guidelines on proper technique and examples.

Appendix F: Advise and communicate progress

Attachment F1: Excerpt from "Yahara Lakes Kickoff Consultant Report: Results, Scoping, and Initial Recommendations"[10]

24 June 2008

Components Necessary for Success

Participants in the Kickoff sessions [see Attachments A3-A8] brought passion and extensive knowledge around the Yahara Lakes issues, as well as deep and lengthy experience on important community issues. From those conversations we gleaned the following list of components that stakeholders believe are necessary to successfully clean up the Yahara Lakes – and keep them clean for decades to come.

Leadership, Belief, and Trust

- Leadership means just that: the future of the region requires current and future community leaders to step up and speak out about the extraordinary importance of this effort for the region's future
- The community must *believe* that water quality *can* be improved and that their investments *now* will make the difference
- Key stakeholders and project leaders must earn and maintain trust and legitimacy among community members

Key Stakeholder Leadership

- Powerful, sustained, and transparent leadership from key stakeholders is critical
- Lead entities – the city, county, DNR, and the University – must publicly champion this work
- Organizing entities must provide guidance and strong leadership without violating local autonomy
- Partnerships must bring groups together with a common voice

Organization and Alignment

- The leadership and decision-making structure must be flexible and responsive enough to evolve over time
- All key stakeholders must understand and agree on clearly articulated principles, values, and goals
- Planning and decisions by lead stakeholders must be guided by those principles, values, and goals
- Investments in solutions must be based on those principles, values, and goals

Authentic Stakeholder Engagement

- The organizational and leadership structure must creatively engage the entire region in unique and appropriate ways so they become tangible contributors to this decades-long effort
- Stakeholders must be authentically engaged
- The work must reflect the voices of the full spectrum of stakeholders

[10] Consultant Report: Results, Scoping, and Initial Recommendations, 27 June 2008. Prepared by YLLP Consulting Team (Pat van Gorp, Anne Carroll, Beacon Associates)

Legitimate and Accurate Implementation

- Implementation structures, funding, and decisions must align with the principles, values, and goals
- Implementation must be timely, appropriately scaled, effective, measured, and reported out
- Problems must be clearly articulated and agreed upon before solutions are selected
- Short-term solutions must be implemented within a much longer-term context
- Solutions must be properly explored and vetted before being implemented

Shared Responsibility

- Benefits must be broadly distributed, and perceived as such
- Funding must be stable, sufficient, and timely
- Cost burdens must be fairly distributed

Appendix G: Yahara CLEAN MOU

Yahara CLEAN

(Capital Lakes Environmental Assessment and Needs)

MEMORANDUM OF UNDERSTANDING

Between Dane County, the City of Madison, the Department of Natural Resources and the Department of Agriculture, Trade and Consumer Protection Regarding Efforts to Improve Water Quality in the Yahara River Chain of Lakes

I. BACKGROUND

The Yahara River Watershed and the Chain of Lakes includes Lakes Mendota, Monona, Waubesa, Kegonsa and Wingra in central Dane County. They are valuable resources contributing to our quality of life and our area's economy. Residents and visitors to the area enjoy the swimming, boating, fishing, and a variety of other activities, and the scenic beauty that these water resources provide.

Dane County and the communities adjacent to and in the watershed of the lakes continue to work toward goals to increase the users' lake enjoyment by reducing the nutrient-caused algal blooms that spoil our beautiful shores and the bacterial outbreaks that harm our beaches. Many steps have already been taken to improve the water quality in the lakes. These steps include: banning unnecessary phosphorous from lawn fertilizers; regulating winter spreading of liquid manure; working with farmers to implement nutrient management plans; purchasing, restoring and conserving wetlands, riparian buffers and other valuable areas; participating in Priority Watershed projects; improving the stormwater and erosion control ordinances; constructing storm water treatment practices and creating a grant program to improve storm water discharge; collecting vegetation and debris from shorelines; manipulating the lakes' macroinvertebrate populations; and many other activities.

The City of Madison has also taken measures to improve storm water quality reaching the lakes, including: expanding weekly street sweeping with parking restrictions; increasing the frequency and awareness of erosion control inspections; constructing rain gardens to promote infiltration; constructing storm water detention ponds to collect sediment; installing inline storm water treatment devices; addressing erosion along the banks of Wingra and Starkweather Creeks; collaborating with Dane County in trash removal along the Monona Bay shoreline; and other activities.

Dane County is unique in that it has a state-chartered Lakes and Watershed Commission that establishes a countywide basis for regulation. This body has broad representation from towns, cities, villages, and other stakeholders within the county.

Government officials, residents and scientists agree that these conservation activities have shown benefits to the Lakes' water quality but believe that even more can be done to reduce the problems of nutrients and bacteria in the Yahara Chain of Lakes.

II. PARTIES

The Parties to this Memorandum of Understanding ("the MOU") are the entities who execute the MOU below and their successors and assigns.

III. PURPOSE

The purpose of this Memorandum of Understanding is to establish a process for assessing water quality conditions in the Yahara River Watershed in Dane County. The MOU will identify possible future actions that can be taken to improve the water quality and thus the users' enjoyment of the Yahara Lakes. Dane County, the City of Madison and the Wisconsin Departments of Natural Resources (DNR) and Agriculture, Trade and Consumer Protection (DATCP) enter into the MOU to participate in Yahara CLEAN (Capital Lakes Environmental Assessment and Needs).

IV. Yahara CLEAN

Dane County, the City of Madison, DNR and DATCP agree to a variety of activities that will assess the existing nutrient and sediment loading to the Yahara Chain of Lakes and determine needs or activities to decrease the loading to improve water quality. Yahara CLEAN will include the following steps or actions:

A. **Develop a Vision** – During 2008, a community vision statement for the Yahara Chain of Lakes will be developed, reflecting extensive input from scientists, residents, agencies, elected officials, businesses, and other stakeholders. This vision statement will guide the goal-setting for nutrient limits.

B. **Model Existing Nutrient and Sediment Loadings** – The University of WI-Madison, under the guidance of a technical advisory board, will engage in the assessment of existing lake- loading conditions. The UW-Madison will complete this assessment by 9/2009 but release relevant parts of the data as available.

C. **Assess Causes of Bacterial Outbreaks at Beaches**

D. **Develop Achievable Goals** – During the first year, the parties, consulting with our partners, will determine the necessary nutrient, sediment and bacteria levels to reach the Vision and determine if the needed reductions can be achieved if reduction activities are taken.

E. **Identify Needs** – The parties will identify the activities necessary to meet the loading and bacterial reductions and estimate the costs of these activities. The needs assessment and cost estimates will be completed by fall, 2009.

F. **Advise and Communicate Progress** - The Dane County Lakes and Watershed Commission will act as the public advisory body and provide regular updates to Dane County residents.

Dane County, DNR, the City of Madison and DATCP agree to be supportive of each other in the pursuit of funds and staff to sustain these activities. Potential funding sources that may be explored include annual budgets, grants and community partners.

Technical and advisory boards of our partners will be established to help guide this process.

V. General Conditions

A. Dane County, DNR, the City of Madison and DATCP will each designate a representative to lead and coordinate implementation of this MOU, including agency communication, representation and participation.

B. If the designated representatives are unable to resolve an issue, the issue will be raised in briefing papers to the Dane County Executive, DNR's South Central Regional Director, City of Madison's Mayor, and the DATCP Administrator for Agricultural Resource Management for resolution.

C. All Parties acknowledge that this executed MOU presents a reasonable approach to assessing and identifying needs to improving water quality in the Yahara Chain of Lakes.

D. This MOU will remain in effect until December 31, 2009.

E. The Parties agree to amend this MOU as updates to Yahara CLEAN are available and warrant change to the process or activities.

F. The effective date of this MOU is the date of the latest signature below.

G. It is anticipated that this effort will result in other partnerships and the need for additional MOUs.

For Dane County

By: ______________________________ 2/13/08
Kathleen Falk Date
County Executive

For the Department of Natural Resources

By: ______________________________ 2/13/08
Matthew Frank Date
Secretary

For the City of Madison

By: ______________________________ 2.13.08
Dave Cieslewicz Date
Mayor

For the Department of Agriculture, Trade and Consumer Protection

By: ______________________________ 2-20-08
Rod Nilsestuen Date
Secretary

Appendix H: References

Attachment H1: Timeline

Yahara Lakes Timeline, 1836 to 2010	
Year	**Event**
1836	Territory of Wisconsin established; legislature convenes in Belmont
1836	Madison founded by former federal judge James Duane Doty, who purchased over a thousand acres of swamp and forest land on the isthmus between Lakes Mendota and Monona within the Four Lakes region, with the intention of building a city on the site.
1837	Cornerstone of state capitol laid
1838	Legislature meets in Madison
1846	Madison incorporates as a village; population 626
1848	Wisconsin statehood
1849	First Tenney Park dam installed; Lake Mendota water level raised 5 feet
1850	Federal "Swamp Acts" in 1849, 1850 and 1860 give title to 3 million acres of swamp land to Wisconsin to be "improved"
1852	First Wisconsin drainage law passed
1854	First railroad comes to Madison
1855	Wisconsin Legislature approves current names of the Yahara lakes, changed from the 1834 names of First Lake (Kegonsa), Second Lake (Waubesa), Third Lake (Monona) and Fourth Lake (Kegonsa).
1856	Madison incorporates as a city; population 6863
1865	UW-Madison student population around 300
1866	Indoor "water closet" installed at state capitol (replaces a brick privy); sewage is piped directly to Lake Monona
1870	Lake Mendota watershed under full agricultural production
1870	Residential "water closets" installed and connected to private sewers which mostly drain directly to Lake Monona
1878	Madison editorial writers note that directing sewage to lakes was leading to sewage buildup on lake shores
1880	Civic leaders realize discharging sewerage into Lake Monona is wrong (situation will not be fully addressed for 80 years)
1880	Private well testing shows 87% of private wells in Madison are contaminated by sewage
1880	Madison's population is 10,324

Yahara Lakes Timeline, 1836 to 2010	
Year	**Event**
1881	Madison Water Utility established
1882	First blue-green algae bloom noted in Lake Mendota
1885	UW-Madison student population around 500
1885	Madison establishes a sewer system based on 26 "districts" each of which drains into either Lake Mendota or Monona
1886	Carp introduced into Yahara Lakes
1890	Lake Monona receives majority of Madison sewerage (untreated)
1891	First drainage district law passed, allowing for creation of special-purpose districts to drain lands
1894	UW-Madison starts limnology research on Lake Mendota
1885	Two Madison landowners and the city of Monona sue Madison over raw sewage collecting along Lake Monona's shore
1899	Madison's first wastewater treatment plant operates from May 1899 until January 1901. Located near Yahara River at East Washington Ave, the plant didn't work. 600,000 gallons of raw sewage flows to Lake Monona daily
1900	Between 1900 and 1919, 800,000 acres of Wisconsin land is included in drainage districts, including in Dane County
1900	UW-Madison student population around 2,000
1901	Madison's second treatment plant, built next to first, operated until 1914. Consisted of septic tanks with cinder filters.
1908	Badfish [Creek] Drainage District organized; expanded later that year
1911	Wisconsin Supreme Court writes that a drainage district could straighten an existing stream
1912	Nine Springs Drainage District formed
1914	Burke sewage treatment plant (consisting of settling tanks & trickle filters) built; effluent discharges into Lake Monona
1915	Madison Public Health Department (MPHD) begins experimental treatment of algae blooms with copper sulfate
1915	Starkweather Drainage District formed; expanded in 1917 (site of current Dane County Regional Airport/Truax Field)
1925	MPHD begins 25 year study of Yahara chain of lakes due to massive discharge of poorly-treated sewerage
1925	MPHD begins systematic use of copper sulfate to treat Lake Monona algae blooms

Yahara Lakes Timeline, 1836 to 2010	
Year	**Event**
1925	Wisconsin Legislature prohibits organization of new drainage districts
1926	MPHD begins using arsenic compounds to kill macrophytes (aquatic plants)
1927	Waunakee sewage system established; discharges to Six-Mile (Waunakee) Creek, which flows to Lake Mendota
1928	First Nine-Springs treatment plant built treating 1/2 of Madison's sewerage; discharges upstream from Lake Waubesa
1930	Madison Metropolitan Sewerage District (MMSD) created by judgment of the circuit court for Dane County
1932	Spring Harbor pumping station (now #5) installed, bringing Middleton & Shorewood Hills sewerage to MMSD
1934	WI Conservation Department (predecessor to the DNR) begins carp removal program on all four lakes
1935	Wisconsin Legislature required colleges, normal schools and high schools to teach conservation education
1936	Expanded MMSD Nine Springs treatment plant treats all Madison sewage; Burke plant not operated
1936	Copper sulfate treatment of algal blooms expands to Lake Waubesa & Lake Kegonsa
1942	Burke sewage treatment plant operated by US government until 1946
1945	Role of Madison sewerage on water quality in lower lakes (Monona, Waubesa & Kegonsa) conclusively proved
1946	Burke sewage treatment plant reverts to MMSD control
1947	Algal blooms in Lake Mendota brings focus to nutrient sources feeding Lake Mendota
1949	MPHD monitoring study (begun in 1925) ends
1949	State law passed prohibiting effluent discharge to Madison lakes
1950	Burke sewage treatment plant rented by Oscar Meyer as effluent pretreatment; operated until 1979
1954	Whole-lake spraying of copper sulfate to control algae blooms ends, due to environmental concerns
1958	All MMSD wastewater discharges diverted into Badfish Creek, downstream of the four Yahara lakes
1960’s	Eurasian water milfoil invades the Yahara Lakes.

Yahara Lakes Timeline, 1836 to 2010	
Year	**Event**
1963	Pumping Station #9 installed, bringing McFarland & surrounding township's sewerage to MMSD
1964	Arsenic treatments to control aquatic plants (begun in 1926) ends
1967	DNR begins limited monitoring on Lake Monona
1969	DNR ends carp removal program begun in 1934
1971	Wastewater effluents from upstream communities connected to MMSD, ending effluent discharge into Lake Mendota
1972	Creation of the Federal "Clean Water Act"
1973	DNR begins limited monitoring on Lakes Waubesa & Kegonsa
1974	MMSD begins to haul sludge from storage lagoons to farmers (precursor to the Metrogro program)
1976	USGS begins watershed monitoring program on storm sewers & major tributaries
1976	DNR begins limited, regular sampling of all four Yahara lakes; ends in 1994
1977	President Jimmy Carter signs executive order declaring protection of wetlands as official U.S. policy and ended all direct federal assistance for wetland conversion
1979	Oscar Meyer ceases operation of Burke sewerage treatment plant; property abandoned & sold
1980	Metrogro biosolids reuse program implemented
1986	Advanced secondary nitrification process and UV disinfection process placed in service
1987	Biomanipulation project begun (large predators (muskie, bass, etc) populations encouraged to reduce planktivorous fish)
1988	Dane County Board creates Lakes & Watershed Commission (LWC)
1989	Wisconsin Legislature defines the LWC's special powers, composition, duties and organization
1990	MMSD sludge storage lagoons placed on the Superfund List due to discovery of PCBs
1991	MMSD commissions gas utilization facilities for co-generation of power and hot water using digester gas
1994	Commissioning of Metrogro Storage Tanks, use of sludge storage lagoons discontinued
1994	Three-year inventory phase of Lake Mendota priority Watershed Project begun
1994	DNR limnological sampling of Yahara lakes ends (transition to NTL-LTER)
1995	Northern Temperate Lakes - Long Term Ecological Research (NTL-LTER) begins on Lakes Mendota & Monona
1996	Verona Pumping Station is constructed, Verona's Waste Water Treatment Plant is abandoned

Yahara Lakes Timeline, 1836 to 2010	
Year	**Event**
1996	Biological nutrient removal process for phosphorus removal implemented
1997	Lake Mendota Priority Watershed Project begins; goal is to reduce P-loading by 50%
1998	Badger Mill Creek effluent return implemented
2000	US Census gives Madison's population as 208,054
2001	Sludge storage lagoon PCB remediation work completed
2002	Purchase of Upper Yahara River treatment plant site.
2004	Certification of Biosolids Environmental Management System
2006	USGS monitoring data indicates that from 1990-2006, 48% of total P-loading occurs between January and March
2006	USGS monitoring data indicates that from 1990-2006, 28% of total P-loading occurs between April and June
2008	Lake Mendota Priority Watershed Project ends; 50% P reduction goal was not met
2008	Yahara CLEAN MOU signed between DNR, DATCP, Dane County, & City of Madison
2010	Yahara CLEAN final report presented to DNR & DATCP Secretaries, Dane County Executive, & Madison's Mayor
Sources	Lathrop, R.C. 2007. Perspectives on the eutrophication of the Yahara lakes. Lake and Reserv. Manage. 23:345–365
	Madison Metro Sewerage District website, http://www.madsewer.org/History.htm Accessed 13 July 2010
	Mollenhoff, David V., Madison, a history of the formative years. University of Wisconsin Press, 2003
	Various wikipedia.org articles, accessed 13 July 2010
	Personal communication with Seth McClure, Wisconsin State Drainage Engineer, DATCP

Attachment H2: Recommendations of various written reports pertaining to the Yahara Lakes

The Yahara chain of lakes are among the most studied lakes in the world, but questions still abound regarding the problems they face and potential solutions to those problems. A partial listing of various recommendations included in reports pertaining to the Yahara Lakes is located at www.yaharawatershed.org.