CLEAN LAKES & BEACHES:

A WATER QUALITY PLAN

2005

CITY OF MADISON

May 18, 2005

ACKNOWLEDGEMENTS

This plan was reviewed and edited by the 'Commission on the Environment Subcommittee to Prepare a Plan to Improve Water Quality in Lakes Mendota, Monona, and Wingra'. Members included the following:
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EXECUTIVE SUMMARY

This report provides a guideline for pursuing water quality improvement efforts for surface and storm water for the next 15 years in the City of Madison. Water quality goals within this report are from several sources, including the Lake Mendota and Yahara/Monona Priority Watershed Plans, standards from Wisconsin Administrative Code NR-151, and lake quality goals set by the City of Madison.

The water quality improvement efforts within this plan consist of in-lake management, methods of controlling suspended solids in stormwater, information and education, and a list of potential future practices and demonstration projects. A copy of the resolution that directed the Commission on the Environment to put this report together is included in the following pages. Within the appendix is a budget and timeline, details related to the NR-151 standards, a list of other ongoing lake management and monitoring from entities outside the City of Madison, and a map of the area watersheds.

The report focuses on the following areas:

I. Water Quality
   A. Area Watersheds
   B. Definition of 'water quality'
   C. Water quality goals
   D. NR-151 Standards
II. Stormwater Quality Initiatives
   A. Street sweeping
   B. Detention Basins
   C. Rain Gardens
   D. Other City Initiatives
III. In-Lake Management
IV. Information and Education
V. Recommendations Summary
VI. Future Directions (includes, but not limited to the following)
   A. Private Rain Gardens
   B. Low Impact Development
   C. Pervious Pavement
   D. Tree Box Filters
   E. Inline Devices
   F. Buffer Ordinance
   G. Stormwater Treatment Facility
VII. Appendices
   A. Budget and Timeline
   B. NR-151 question/answer
   C. Other lake monitoring and management
   D. Map of area watersheds

In subsequent years, similar annual reports will be submitted to the Commission on the Environment and the Common Council for review and approval, reflecting changes in technology, regulations, citizen concerns, management, research, and other water quality-related issues.

RESOLUTION

AGENDA #_____

CITY OF MADISON, WISCONSIN

A **SUBSTITUTE** RESOLUTION directing the City of Madison to develop a plan to improve the water quality in Lakes Mendota, Monona and Wingra.

Drafted by: **Jennifer Zilavy, Assistant City Attorney**

Date: ~~July 22 2004~~ September 20, 2004

Fiscal Note: Approximately 200 hours of staff time must be allocated to prepare the report. Future actions and expenditures resulting from the report, shall be budgeted and/or approved separately.

PRESENTED ~~August 3, 2004~~

REFERRED **Commission on the Environment**

REREFERRED Aloar (4-7)

REPORTED BACK SEP 07 2004 OCT 05 2004

ADOPTED X POF _____

RULES SUSPENDED

PUBLIC HEARING

APPROVAL OF FISCAL NOTE IS NEEDED BY THE COMPTROLLER'S OFFICE
Approved By
Comptroller's Office

RESOLUTION NUMBER 61952

ID NUMBER 36509

SPONSORS: **Alder Gregory Markle, Alder Matt Sloan, Alder Zach Brandon, Alder Tim Bruer, Alder Steve Holtzman, Alder Jean MacCubbin and Alder Ken Golden**

WHEREAS, the quality of life of Madison residents is directly affected by the condition of Lakes Mendota, Monona and Wingra; and

WHEREAS, Madison lakes represent a major economic development engine directly supporting the economic well-being of Madison residents by generating millions of dollars in recreational and tourism spending and increasing general property tax revenue; and

WHEREAS, the potential exists for significant health risks to people, pets, fish and animals due to algae blooms which create unsafe water conditions in Lakes Mendota, Monona and Wingra; and

WHEREAS, Madison residents consistently rate the water quality in Madison lakes as a primary concern; and

WHEREAS, the City of Madison desires to meet its responsibility to the environs which make it a desirable place to live and recreate; and

WHEREAS, the current water quality in Lakes Mendota, Monona and Wingra is unacceptable; ~~and~~

WHEREAS, the City of Madison must comply with NR151 specific levels by 2008 and 2013, the City of Madison must plan for those requirements;

THEREFORE BE IT RESOLVED, that the City of Madison will develop a plan to improve total water quality in Lakes Mendota, Monona and Wingra ~~by twenty-five percent (25%) by 2020.~~

BE IT FURTHER RESOLVED, that the Department of Engineering shall provide an annual report on water quality, as measured by Trophic State Index in Lakes Mendota, Monona and Wingra.

BE IT FINALLY RESOLVED, that by ~~January~~ May 31, 2005, the Commission on the Environment shall forward to the Common Council for its approval, a fifteen (15) year plan to achieve the measures stipulated in this resolution, including a scientifically sound water quality measurement technique, and Best Practice Methods, an estimate of anticipated capital and operational expenses, and a time table for implementation of these measures.

WATER QUALITY

DEFINITION OF 'WATER QUALITY'

The U.S. Geological Survey defines water quality as "a measure of suitability of water for a particular use based on selected physical, chemical, and biological characteristics."[1] Therefore, 'good' water quality can mean different things to different people. A bass fisherman would prefer a more nutrient-rich lake, which would support a healthy population of that species, while a trout fisherman would seek out a clear, spring-fed lake or creek. Water-skiers would prefer a lake without a lot of floating weeds. A parent might be concerned primarily about the level of bacteria in the water near the beach where his or her children are playing. These scenarios only consider surface water, but water quality can also refer to groundwater, stormwater, and even rainwater.

This plan focuses on the quality of surface water and stormwater runoff. For purposes of discussion within this plan, lake water quality will be considered 'poor' when the state of the lake is such that its nutrient, bacteria, algal, or aquatic macrophyte levels adversely affect human health or activities, aesthetics, or wildlife.

AREA WATERSHEDS

The area watersheds differ considerably from each other in their respective land uses and size. The 232 mi^2 Mendota watershed, for example, is 54% cropland, 19.8% developed (about 8% is currently City of Madison), 10.3% grassland/ wildlife/ pasture, 7.5% open water, 4.2% wetland, 2.8% internally drained, and 1.3% woodland.[2] The 7.2 mi^2 Wingra watershed, on the other hand, is almost completely urban. The 1200-acre UW Arboretum is the only 'natural' area that makes up this watershed. While our effects on Lake Mendota would be quite minor, with concentrated efforts Lake Wingra could potentially show water quality improvements. The City of Madison makes up 75% of the Lake Monona watershed and about ⅓ of the City's runoff is directed there. The remaining watersheds include Lake Waubesa, Upper Sugar River, Lake Kegonsa, and Koshkonong Creek. A map of the area watersheds is provided in Appendix D.

The City of Madison can be divided into seven different watersheds. Figure 1 below shows the percentage of each watershed that is within the City of Madison. Figure 2 shows how the City of Madison is divided into each of the seven watersheds.

[1] From http://water.usgs.gov/pubs/fs/fs-027-01/index.html. Accessed March 4, 2005.

[2] Information on Mendota Watershed taken from Wisconsin Department of Natural Resources *Nonpoint Source Control Plan for the Lake Mendota Priority Watershed Project*, Approved 1997.

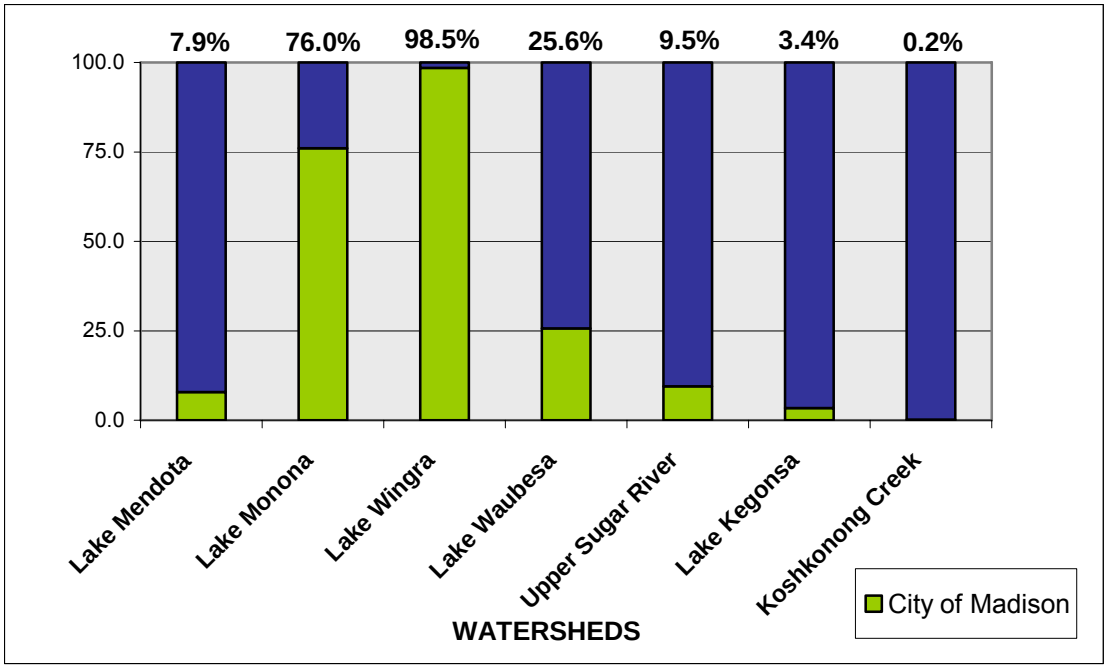

Figure 1: Area Watersheds—Portion within City of Madison

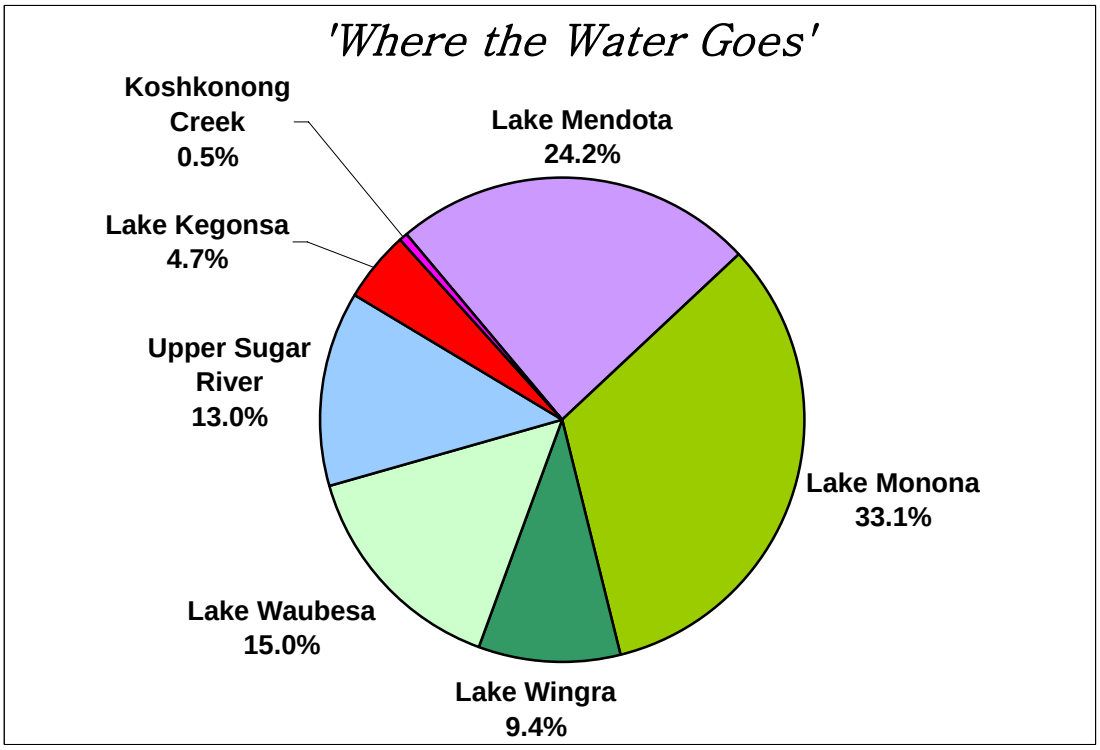

Figure 2: City of Madison Divided into Watersheds

NUTRIENTS

Nutrient-rich stormwater runs into the lakes with each rainfall and snowmelt. During years with above average rainfall, the level of nutrients from stormwater runoff can be extremely high. Weeds and algae require phosphorus, nitrogen, and light to grow. In the Madison lakes, phosphorus is considered the limiting nutrient. This means that there is an adequate supply of the other building blocks for plant growth, and when there is a lot of phosphorus in runoff, aquatic plants and algae flourish. Phosphorus is relatively easy to measure and is much less expensive and simpler to control than nitrogen.

The level of nutrients discharging to the lakes and rivers varies by land use throughout each watershed. The Dane County Land Conservation Department used both the Source Loading and Management Model (SLAMM) and WINHUSLE to estimate that within the Mendota watershed cropland contributes 49% of the total phosphorus; barnyards contribute 21%, construction areas 19%, and the City of Madison about 2% (the other area municipalities contribute the remaining 3%). Figure 3 below shows the percentage of source areas of phosphorus in the Mendota watershed.

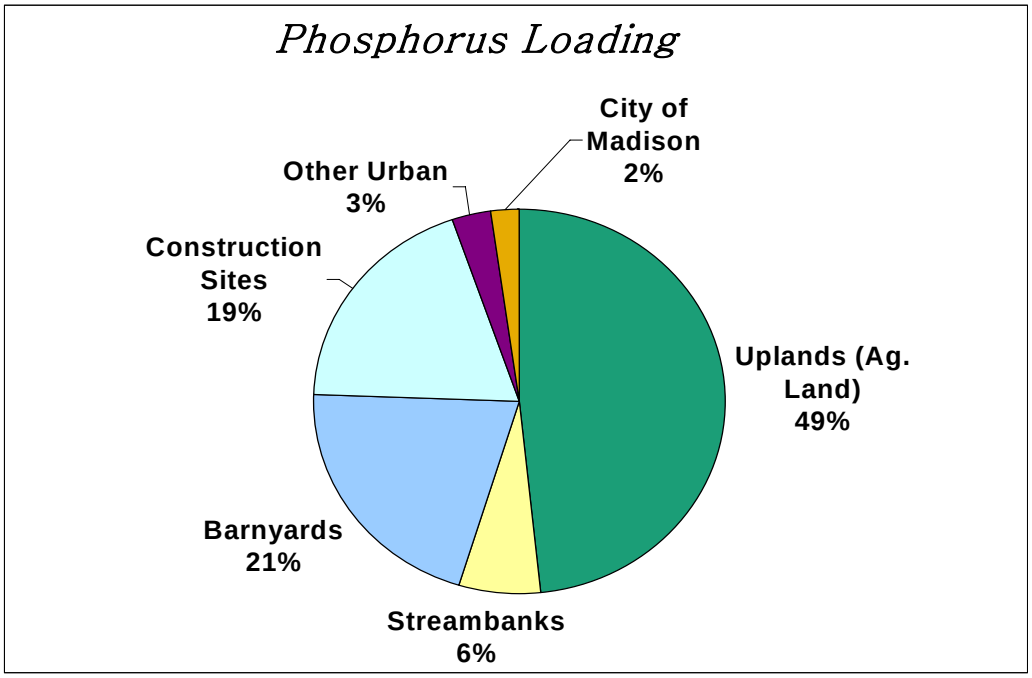

Figure 3: Phosphorus Loading to Lake Mendota by Land Use, as estimated by SLAMM and WINHUSLE

WATER QUALITY GOALS

STORMWATER REGULATIONS: NR-151 REQUIREMENTS

State of Wisconsin NR-151 regulations, which went into effect on October 1, 2004, require the City of Madison to meet specific stormwater management standards. The City has accepted these requirements and, in some cases, has adopted more stringent rules than those set by the State. Appendix B includes a clear, question-and-answer format of the new regulations as they apply to new development and redevelopment in the City of Madison. Following is a brief summary of the components of NR-151.

CONSTRUCTION SITES

New construction site standards require 80% total suspended solids (TSS) reduction when more than 20,000 square feet of land is disturbed. Redevelopment exceeding 4,000 square feet is required to meet this standard as well.

DEVELOPMENT

New and redevelopment sites in Dane County are subject to post-construction control of TSS leaving the site. More recently, NR-151 standards have also required TSS control. New developments are required to control 80% of the TSS off post-construction sites, compared to no controls. In Dane County, the predominant soil type is such that controlling 80% TSS is equivalent to controlling the 5-micron[3] soil particle for a one-year storm event.

Re-development and in-fill sites must meet a 40% TSS control; Dane County allows control of the 20-micron particle during the 1-year storm event to meet this standard. The requirements for redevelopment are less stringent than new development, acknowledging that redevelopments often have less available land for stormwater treatment.

In Dane County, any new development that results in greater than 20,000 square feet of additional impervious area will require detention. The post-development peak flow from the 2-year and 10-year storm events must match peak flows from the area in the pre-development state. Additionally, the City of Madison requires control of the 100-year storm event in the Upper and Lower Badger Mill Creek sub-watersheds.

[3] By most standards, soil particles less than 5 microns are considered clay; soil particles between 5-62 microns are considered silt; above 62 microns are sand particles.

INFILTRATION

Infiltration is required with new construction. The amount of infiltration required differs with land use. Residential areas are required to infiltrate 90% of pre-development infiltration volume or 25% of the 2-year, 24-hour storm volume, *up to* 1% of the site. Commercial areas are required to infiltrate 60% of pre-development infiltration volume or 10% of the 2-year, 24-hour storm volume, *up to* 2% of the site area. There are specific instances when infiltration will not be required, such as very shallow soils (shallow to bedrock or groundwater), or soils that are not conducive to infiltration (clay).

THERMAL CONTROL

In the City of Madison area, any development in the Upper Sugar River watershed must meet thermal control requirements. These can be met at the plat or lot level. In most cases, in residential areas, this requirement will be met at the plat level, while commercial areas will probably address it at the lot level.

OIL AND GREASE CONTROL

Oil and grease control is required if the proposed parking area has 40 or more parking spaces, or if there is a drive-thru facility on the property. This must be addressed at the site (not plat) level. A method that has been approved by City of Madison Engineering must be used to trap oil and grease from the first ½-inch of runoff from the paved areas.

MUNICIPAL REQUIREMENTS

Municipalities permitted under Subchapter I of NR-216 for stormwater discharge, City of Madison included, have additional requirements under NR-151. By March 10, 2008, TSS discharging to waters of the state from areas within the municipal boundary must be reduced by 20%. Five years later, in 2013, 40% of the TSS must be controlled. As part of a pro-active approach to stormwater management, the City of Madison has agreed to meet the 20% standard one year earlier, by 2007, and the 40% standard by 2011. This agreement is contingent upon other area municipalities agreeing to meet these same goals.

TREATMENT DEVICES USED IN SERIES

The Wisconsin Department of Natural Resources Code NR-151 has changed the method of measuring the efficiency of best management practices used in tandem. In the past, if two devices, each 20% efficient at removal of total suspended solids were used in series, it was assumed that the total efficiency was 40%. However, as both devices treat the same-size particles, it was an overestimate of effectiveness. To meet the 40% requirement in accordance with NR-151, one device must be used which has been proven to be at least 40%

effective at removing suspended solids. This will have a financial impact on some projects, as devices that meet these criteria are either more expensive, require more land, or both.

PRIORITY WATERSHED GOALS

The *Nonpoint Source Control Plan for the Lake Mendota Priority Watershed Project*, approved in 1997, clearly outlines goals for each land use regarding phosphorus and sediment loading. The plan set a goal of reducing phosphorus loading to Lake Mendota by 50% overall. The specific goals for urban areas included reducing phosphorus loading by 20%, and sediment by 40%. Another goal of the plan is to reduce the likelihood of algal blooms on any given summer day from 50% to 20%, in other words, from 1 out of every 2 days with an algal bloom to 1 out of 5 days. Additional reduction goals of this project are included in the following table:

Table 1: Reduction Goals from Lake Mendota Priority Watershed Project

Land Use	Phosphorus	Sediment
Agricultural uplands	40%	40%
Streambanks	50%	50%
Barnyards	75%	--
Transitional Areas	60%	80%
Existing Urban	20%	40%
Future Urban	50%	80%

Dane County has been tracking their progress towards the goals on rural lands since 1998. The status of their goals was estimated by reviewing compliance with

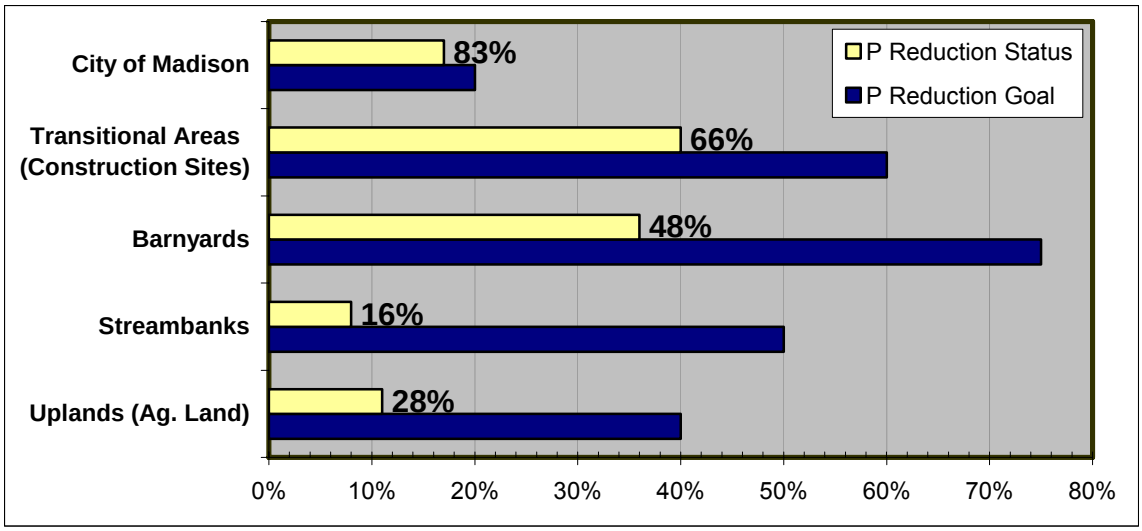

Figure 4: Progress with Priority Watershed Goals, 2003. Percentages indicate portion of goals reached thus far. For example, the City of Madison has achieved 83% of its goal to reduce phosphorus by 20%.

conservation plans, nutrient management plans, barnyard practices, and streambank restoration projects. The City of Madison has also made calculations to assess where we are with our goals, based on street sweeping and detention basin efficiencies. Progress can be seen in Figure 4. The Lake Mendota Priority Watershed Plan is scheduled to wrap up in 2008.

The City of Madison will continue to pursue the goal set forth in the Lake Mendota Priority Watershed Plan to reduce phosphorus loading by 20% by 2008. The Engineering Division has begun modeling each sewershed (with SLAMM) to more accurately determine our phosphorus loading contribution to area lakes, and to better assess where we are with the Priority Watershed goal.

Additional goals include meeting the NR-151 municipal requirements in advance of the established date. The city must reduce total suspended solids (TSS) by 20% by the year 2007 (one year early). In 2011, the city will meet the 40% TSS requirement (2 years early). The sewershed modeling will also be used to prove the 40% reduction, as required by the DNR.

Water quality goals will be reviewed and revised as needed with each annual report.

Table 2: Water Quality Goals from NR-151 and Lake Mendota Priority Watershed Project

GOAL	YEAR	METHOD	SOURCE
Reduce total suspended solids (**TSS**) by **20%**	2007	City has already met 20% requirement—currently TSS reduction is approx. 28.9% with detention basins and street sweeping (modeling sewersheds will give a more definite number)	State Administrative Code NR-151 (sets requirement date at 2008)
Reduce likelihood of **algal blooms** from 50% on any given summer day to 20%	2008	Reduce phosphorus loading by 50% overall	Lake Mendota Priority Watershed Plan
Reduce **phosphorus** loading by **20%**	2008	Modeling sewersheds will give detailed analysis of City's status.	Lake Mendota Priority Watershed Plan
Reduce **TSS** by **40%**	2011	Increased weekly street sweeping with a high-efficiency street sweeper (pending support from street sweeping study) Increase efficiency of detention basins with polymer socks	State Administrative Code NR-151 (sets requirement date at 2013)

The *Yahara-Monona Priority Watershed Project Plan*, from 1992, listed several "Water Resource Management Objectives for the Lake Monona Subwatershed" (taken directly from page 26 of the plan):

1. *Protect against further degradation and seek long-term improvement of lake fertility conditions and heavy metal levels in the sediment of Lake Monona*
   A) *Reduce urban nonpoint source pollutant loadings of phosphorus and sediment by 30-50%*
   B) *Reduce urban nonpoint source pollutant loadings of heavy metals to the maximum extent practicable*
2. *Attempt to reestablish desirable, native aquatic plants (e.g., water lily) in selected areas of Lake Monona*
3. *Improve in-stream habitat conditions of Murphy (Wingra) Creek to enhance use by forage and sport fish*
   A) *Remove contaminated sediments in Murphy Creek near stream outlet to Lake Monona*
   B) *Install streambank stabilization, landscaping and other corridor improvement measures*
   C) *Implement stream aeration equipment*

With increasing street sweeping efforts, the first goal of the Yahara-Monona Plan is being addressed within the City of Madison. The third goal, improving Wingra Creek, is also already being addressed with the ongoing efforts of the Wingra Creek Parkway Plan. Incorporating aeration equipment is not practicable, however, as it is very expensive to run.

Table 3: In-Lake Management Recommendations from '99 WRM Practicum for Lake Wingra

RECOMMENDATION	ADVANTAGE	DISADVANTAGE
Dredging: should only be used if phosphorus loading from the watershed is reduced to acceptable levels	Removes built-up sediments	Costly; disturbs ecological systems; inconvenient for lake users
Alum Treatment: should only be used if phosphorus loading from watershed is reduced to acceptable levels	Removes nutrients from the water column	Costly; may have health risks; may be a short-term solution
Muskellunge Stocking: should continue unless native northern pike populations can be restored	Maintains popular fishery; predatory fish control pan fish population	Costly; ongoing
Plant Harvesting: should continue, especially in areas of heavy public use and areas with dense milfoil growth	Removes problem aquatic plants; removes plant-bound nutrients	Costly; ongoing
Native Aquatic Plant Restoration: should expand research and demonstration plots on aquatic plant restoration; small pilot projects could be expanded as species are found to have a good chance of success	Holds sediments; reduces algae growth; increases biodiversity	Costly
Wetland Management: should concentrate on reducing stormwater runoff impacts, increasing groundwater flows, and continuing exotic plant control	Preserves plant biodiversity and animal habitat	Costly
Boat Wash: should be constructed, particularly if zebra mussels reach the Madison lakes	Prevents zebra mussel invasion	Costly

Table 4: Monitoring Recommendations from '99 WRM Practicum for Lake Wingra

RECOMMENDATION	ADVANTAGE
Sampling and analytical methods should be uniform for water quality monitoring at inflows, in Lake Wingra itself, and at outflows. Data collections should be regularly scheduled and coordinated with other monitoring activities.	Ensures consistency, maximizes efficiency
One or more stormwater monitoring stations should be professionally maintained within the Lake Wingra watershed. The city of Madison should provide funds to resume monitoring at Monroe Street retention basin. The estimated operation cost rage is between $15,000 and $20,000 per year. Long-term monitoring should be conducted throughout the Lake Wingra watershed in order to determine trends; it is difficult to correctly interpret data covering less than a decade.	Identifying trends through long-term monitoring is critical to good lake planning and decision-making
Cooperation, data sharing, and timely communication between data collection entities should be a priority. Annual summaries of water quality data should be prepared and disseminated.	Assists planning and decision making
The city of Madison Public Health Department should continue to monitor the bypass sewer system flowing from the Vilas County Zoo, and determine an acceptable alternative to the combined sewer.	Provides the needed information to ensure public health
Monitoring for fecal coliforms specific to cats and dogs should be conducted in Lake Wingra. If pet waste is found to contribute to fecal coliform counts, monitoring data would support the implementation of a pet waste pick-up program.	Provides the needed information to ensure public health
WDNR fish tissue mercury testing should be continued on an ongoing basis, not only to determine fish advisories for Lake Wingra, but also to better understand atmospheric deposition.	Protects public health, aids important research
Surface water and groundwater pesticide sampling should be conducted downstream of the Lake Wingra watershed golf courses.	A potential impact could be identified and addressed
Sampling should be performed on the Wingra Creek sediments to determine whether heavy metal and other contaminant presence is due to present inflows.	A potential impact could be identified and addressed
Despite complications, springflow monitoring should occur.	Effectiveness of infiltration enhancing practices can be evaluated
The development of long-term citizen monitoring programs should be further pursued.	Reduces the cost of many of the above recommendations, enhances citizen awareness.

The *Lake Wingra Watershed: A New Management Approach* put out by the 1999 UW-Madison Water Resource Management Practicum included a list of recommendations for in-lake management and monitoring efforts. Tables 3 and 4 are taken directly from this plan, from pages 62 and 68, respectively.

MONITORING CHANGES IN WATER QUALITY

One goal of the City of Madison is to be able to directly measure changes in water quality. Often tracking the status of water quality parameters is much more sensible than taking one measurement out of a temporal context, due to the natural fluctuations within (e.g., food chain dynamics) and outside (e.g., climate) water bodies. Some of the parameters that can be measured include dissolved

oxygen, conductivity, water clarity, pH, nutrients, bacteria, algae, weeds, and toxic substances such as pesticides, PCBs, or heavy metals.

Aquatic macrophyte levels can be measured with a variety of techniques, including transect surveys. Nutrient and algal levels can be measured with total phosphorus and Chlorophyll-a measurements, respectively, and are monitored on a regular basis by UW-Limnology.

The Health Department monitors bacteria levels at the 13 public beaches and 2 University of Wisconsin beaches on at least a weekly basis during the summer. A water sample is taken, and the lab analyzes it for indicator bacteria. The City collects data on dissolved oxygen, pH, temperature, heavy metals, and other parameters.

TROPHIC STATE INDEX

One way to track the status and changes in a water body is to regularly take water samples and perform measurements in the field. Three parameters are commonly used to gauge a water body's nutrient-level status. These are total phosphorus, chlorophyll-a, and Secchi disk measurements.

Phosphorus is a key nutrient in plant growth in most Wisconsin lakes. Chlorophyll-a is present in all plant life, and thus is an indicator for the levels of algae in a water body. A Secchi disk is used to measure water clarity. It is an 8" black and white disk, which is lowered into the water until it cannot be seen to determine water clarity. As a side note, the depth to which light can penetrate into the water is often roughly estimated by doubling the Secchi disk reading.

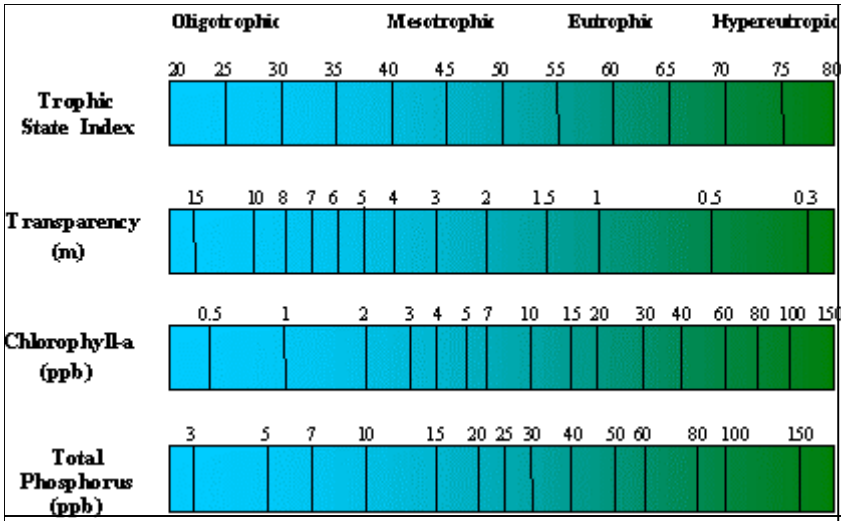

Figure 5: Carlson's Trophic State Index

Water samples are taken to test total phosphorus and chlorophyll-a in a lab. The values of water clarity, total phosphorus, and chlorophyll-a can be entered into three different logarithmic equations to better analyze them against each other. The result of each of these equations is called the Trophic State Index.

The Trophic State Index is a number between 1 and 100, which indicates where a water body falls on a scale of biological activity. *Trophic* means the level of nutrients and biological activity in a water body. The lowest level (1-39) is called oligotrophic (or very little biological activity), the next is mesotrophic (40-50), eutrophic (51-70), and hypereutrophic (70+; extreme biological activity). Lakes Mendota, Monona, and Wingra are considered eutrophic. Stormwater detention ponds can often become hyper-eutrophic.

Each of the three Trophic State Index parameters is reviewed independently; the parameters are not averaged. If one number is significantly higher or lower than the other two, something is happening in the lake to throw them off balance, such as a change in food chain dynamics. For example *Daphnia*, filter-feeding zooplankton found in our lakes, at times affect water clarity during the spring due to their grazing habits. Because there are so many internal variables that affect lake ecosystems, it can be very difficult to accurately predict changes within the lake.

Many different outside factors also have an effect on the Trophic State Index. For example, in years with higher than average rain, the levels of phosphorus may dramatically increase due to more runoff. In contrast, in drought years the Index may be very low. For this reason, it is important that this Index not be used as the only indicator of water quality. It is important to continue to monitor our lakes with this method, but to keep in mind that they can be affected by a variety of parameters.

LONG-TERM ANALYSIS

One goal of this plan is to make certain the average water quality trend improves,

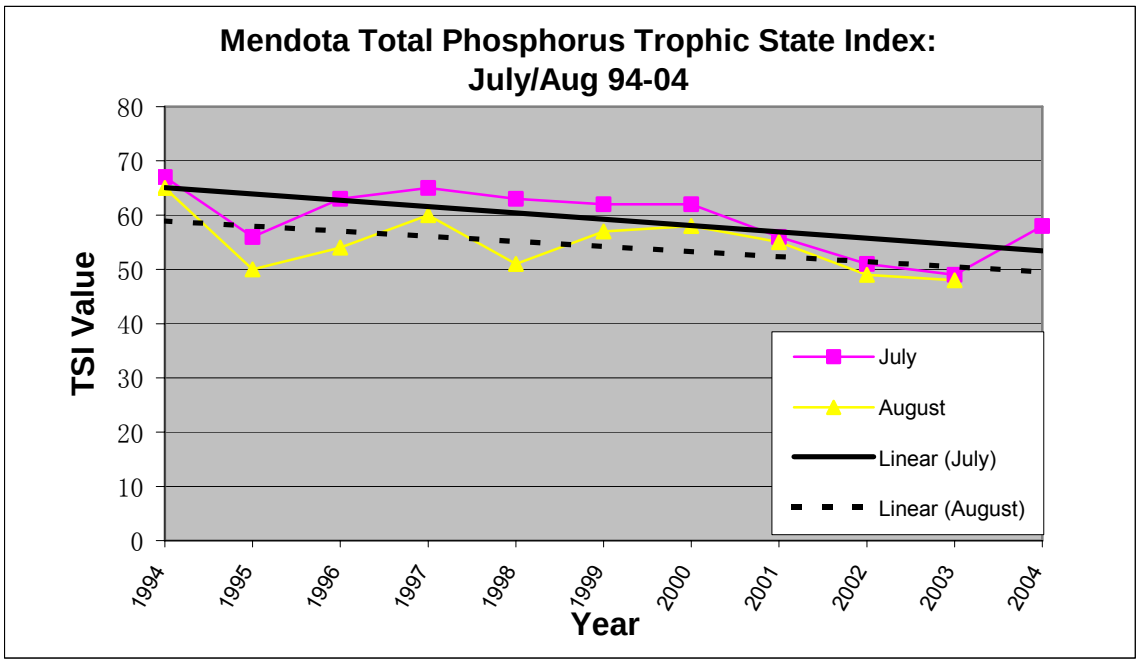

Figure 6: Trend of TSI for TP in Lake Mendota, 1994-2004 (July & August)

based on total phosphorus. In Figures 6 and 7, the July and August TSI values for total phosphorus (data is from Richard Lathrop, DNR/UW-Limnology) in Lakes Mendota and Monona from 1994 to 2004 is graphed. There appears to be somewhat of a trend of improving water quality within Lakes Mendota and Monona, though the trend may be skewed somewhat by significant climate factors. In 1993, there was above-average rainfall, which may have contributed to the slightly higher values for 1994. Also, there was a relatively dry period from fall 2002 through much of 2003 (Richard Lathrop, personal communication 4/7/05). It is always important to consider weather events when looking for water quality trends.

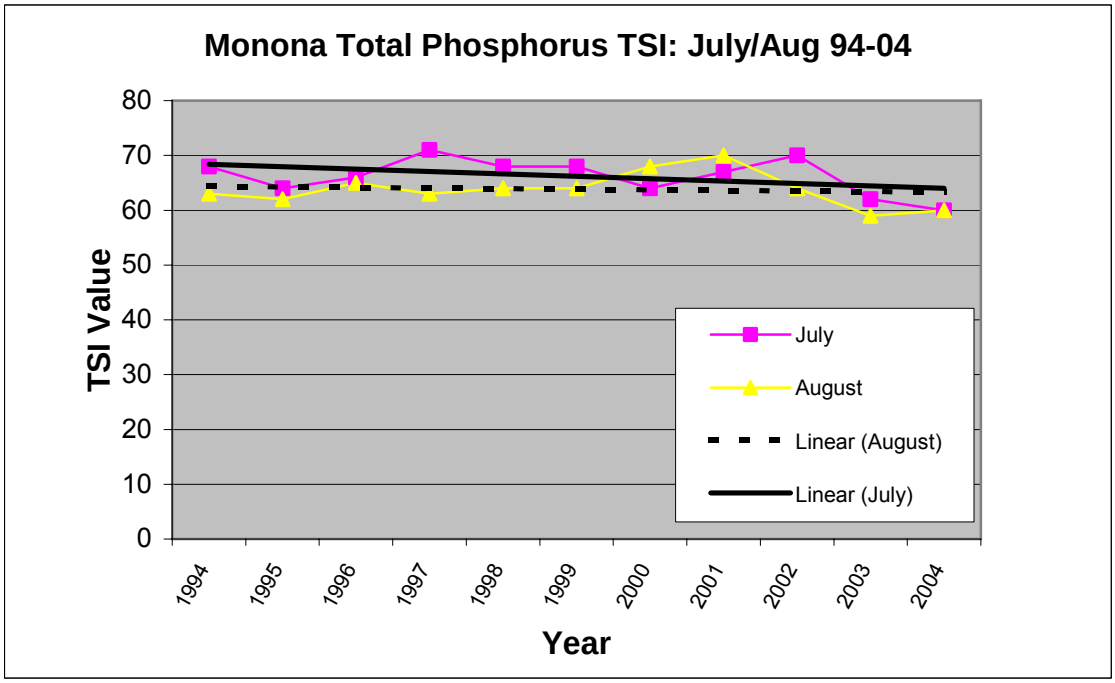

Figure 7: Trend of TSI for TP in Lake Monona, 1994-2004 (July & August)

TROPHIC STATE INDEX GOAL

According to Dale Robertson, USGS, having a goal of total phosphorus concentration of .024 mg/l (TSI of 50) in summer months, while quite aggressive, is a realistic goal for Lakes Mendota and Monona, and possibly Wingra. This would greatly reduce the likelihood of summer algal blooms, and place the lakes on the edge of mesotrophic and eutrophic status.

Statistical software exists for analyzing water quality data more precisely by taking into account more water quality variables. City Engineering will look into purchasing such software, or find another agency that may already be using it.

STORMWATER QUALITY INITIATIVES

Approximately 27% of the area of the City of Madison is treated with stormwater detention basins located within the same sewershed or a connected one. Well-designed detention basins can trap about 80% of the sediment carried in stormwater runoff, as measured in the discharge pipe. The remaining 73% of the city drains directly to receiving bodies of water or to other municipalities. So far, these areas can only be treated with street sweeping and, in some cases, catch basins. Generally, the areas without detention basins were developed prior to 1980.

STREET SWEEPING

Runoff from street surfaces is a major contributor of pollution in the City of Madison. One way to control roadway runoff is to use street sweeping to remove pollutants before they are washed into the lakes. This option may be preferable to structural Best Management Practices (BMPs), which can be costly or take up considerable space.

CURRENT PRACTICES AND EFFICIENCY

The current sweeping practice depends on the location within the City. In some downtown areas, there are parking restrictions during spring, summer, and fall for four-hour periods, once a week. This allows street sweepers to reach the curb, increasing their efficiency. The City sweeps the majority of Aldermanic Districts 2,6, and 13 weekly with parking restrictions. In other areas, monthly sweeping is done without parking restrictions. In these areas, the sweepers try to get to the curb when possible. The City has placed the most emphasis on street sweeping in ultra-urbanized areas that have no other treatment prior to discharge.

Several factors affect sweeping efficiency. During the summer months, approximately 80% of the dirt load is found within about 3 feet of the curb, where sweepers are designed to operate. In the spring (when street dirt loads are the heaviest), it seems to be more evenly distributed across the entire street width. Because of this varying load distribution, the efficiency of street sweepers varies throughout the season. Weekly sweeping with a high-efficiency sweeper can see a range from 30% efficiency during the spring to 80% during the summer as measured by mass removal from the street surface.

The NR-151 standard requires us to measure total suspended solids (TSS) removal by what can be measured in the discharge pipe, not by what is removed from the street. Thus, we have estimated that the overall annual, citywide efficiency of TSS removal from monthly street sweeping with a standard mechanical sweeper is approximately 10%. Moving to weekly sweeping with a

standard sweeper can increase efficiencies to about 20%. Finally, weekly sweeping with a high-efficiency, vacuum sweeper can raise it to about 30%.

STREET SWEEPING STUDY

It is intuitive that the more material that is swept and removed from the street, the more water quality should be improved; however, current and past studies have not been able to detect a statistically significant improvement in water quality due to sweeping. Rather, studies have shown that as removal efficiencies approach 30% (as measured by removal of street debris on a mass-loading basis), the quality of runoff water (as measured in the pipe) can actually decrease. This is typically attributed to existing sweepers removing mainly larger, sand-size particles. This allows the smaller silt- and clay-size particles to be mobilized during an event, and washed into the storm sewer. Nutrients and heavy metals are attached to small-size particles rather than larger, sand particles. The City of Madison wanted to learn more about this water quality discrepancy between the street and the pipe, while at the same time testing a new type of street sweeper.

Since 2001, the City of Madison, the U.S. Geological Service (USGS), the Department of Natural Resources, and the Elgin Street Sweeper Company have jointly undertaken a study to better understand street sweeping. The objective of the study is to determine how great a reduction in dirt load on residential streets is necessary to improve water quality as verified by measurements in the pipe.

The study uses a paired basin approach; data is collected from four basins in different sub-watersheds. We are evaluating four scenarios: weekly sweeping with a mechanical street sweeper (Elgin Pelican), weekly sweeping with a vacuum sweeper (Elgin Whirlwind), monthly sweeping with a mechanical street sweeper (Elgin Pelican), and no street sweeping. The focus is on the efficiency of the sweepers removing material from the street and the associated water quality improvements as measured in the pipe.

The USGS collects vacuum samples once a week from the four basins for the duration of the study. Street dirt data is used to determine the efficiency of the street sweepers and the rate of dirt build-up on the streets.

The schedule has three equilibration periods in it, which are meant to allow the street dirt levels to rise back up to baseline levels after a sweeping period concludes. At the beginning of these periods, the control basin will be swept.

Water samples are sent to the USGS sediment laboratory in Iowa for total sediment concentration and sand-silt split particle size analysis. Concentrations of the following constituents are determined at the City of Madison Department of Public Health Laboratory: ammonia nitrogen, NO_2+NO_3, total Kjeldahl nitrogen, total phosphorus, dissolved phosphorus, suspended solids, total dissolved solids, chloride, hardness, and total recoverable and dissolved metals, including calcium, magnesium, cadmium, copper, lead, and zinc.

Data analysis is performed by the USGS and the City of Madison. It will summarize the efficiency of the sweeping operation. Accumulation rates of constituent buildup on the street surface and the runoff loads will be developed. All runoff and precipitation data will be stored in the USGS database as it becomes available.

As of early 2005, the study is about 80% complete and is expected to be finished in July 2006. It was determined during the course of the study that traditional techniques to measure sediment suspended in stormwater were underestimating the effectiveness of street sweeping operations. In response, the researchers pioneered new procedures to address these deficiencies. Previous street sweeping studies have ignored these problems. The data gained from these new procedures, while not as extensive as the original proposed research plan, show great promise.

FUTURE SWEEPING PRACTICES

NR-151 requires the City of Madison to reduce total suspended solids that are discharged to receiving waters on a municipality-wide basis. By 2008, we need to meet a 20% reduction, and by 2013, a 40% reduction. The City currently treats 27% of the area to an 80% TSS reduction with detention basins. The remainder of the City receives about 10% removal rate with monthly sweeping. We estimate that municipality-wide, the City achieves a 28.9% TSS removal efficiency.

Currently, the City sweeps the majority of Aldermanic Districts 2, 6, and 13 weekly with parking restrictions. If the City switches to the newer vacuum sweeper equipment in these areas, we can assume an efficiency of 30% for TSS removal with weekly sweeping. If this is the only change to the street sweeping program, the citywide TSS removal efficiency reaches 30%. If Aldermanic District 4 is included in weekly sweeping (with parking restrictions to access curb), the overall efficiency reaches 30.2%. In order to meet the 40% removal efficiency, at least 56% of the areas not treated with detention basins would need to have a weekly sweeping program with a high-efficiency sweeper.

The City of Madison is planning to extend the weekly sweeping program to the 4th and remaining portions of the 2nd Aldermanic districts (downtown areas) in 2006. This will require signage for cars to be moved for four-hour periods as well as additional parking enforcement. There is no space in the downtown area to retrofit a detention basin, leaving street sweeping as one of few alternatives for collecting suspended solids in that area.

This year, the City of Madison purchased a new Elgin Whirlwind™ street sweeper, and will possibly purchase more of this style in the future. The sweeper works by using both a brush and a vacuum mechanism in the curb, making it very efficient at removing sediment and debris from streets. The one drawback to

this style is its inefficiency at removing larger debris during the spring and fall when leaves clog the gutters. During these clean-ups, the City will continue to use metal-broom, mechanical sweepers, but will follow in tandem, with a vacuum sweeper. In the future, the City of Madison will also seek out the best street sweeping equipment with the least amount of diesel emissions or other low-emission engines, if available.

At the completion of the current program, the City will look at testing the efficiency of adding polymers to street sweepers. The polymers would be added to the water tank of the sweepers at a rate of 1 cup per 500 gallons of water. The polymer-water is sprayed on the street, and the effects are instantaneous. The polymer causes the smaller-sized particles to bind together, allowing the sweeper to pick up more particles. It is expected that polymers will increase the efficiency of mechanical sweepers from about 10% to at least 20% with monthly sweeping.

Polymer is available for about $120 per gallon. The cost of extending the monitoring to include polymers will cost the City $40,000 over 3 years, starting in 2007.

DETENTION BASINS

EFFICIENCY

Detention basins in newer sections within the city can have an efficiency of up to 80%. Overall, however, the average efficiency throughout the city is probably closer to 60%. As the city expands with new subdivisions that have more-efficient basins, the average efficiency across the city will increase.

MONITORING

Since November 2003, City of Madison Engineering Division has been monitoring six detention basins throughout the city. In the field, a Secchi disk reading is taken to determine water clarity. At the same time, a water sample is taken and later analyzed by the Public Health Department for total phosphorus and chlorophyll-a. Visits to the detention basins take place every 2 weeks during ice-free days of the year. The detention basins that are a part of the monitoring include Greentree Pond, Kings Mill Circle Pond, Nesbitt Pond West, North Blackhawk Pond, Prairie Hills East Pond, and Prairie Schooner Pond.

CHITOSAN POLYMER SOCKS

One way to make detention basins more efficient is to add a polymer to the water. Chitosan is one type of polymer that is derived from crustacean shells. It is biodegradable, and 100% fish-safe. One product that uses chitosan comes in a long “sock” shape, which is attached to the inside of an inlet pipe at a detention basin. As the water passes over it, the chitosan dissolves into the water, causing

the suspended sediment in the water to coagulate. The then-heavier sediment particles sink to the bottom of the detention basin and, in effect, are trapped.

From the detention basin monitoring, a full year's worth of data is already available from six detention basins. We are proposing to add polymer socks to two of the six detention basins and monitor their efficiency for another year before adding them to any other basins in the city.

The socks cost $250 each, and one sock can treat 250,000 – 500,000 gallons of water. In most years, each inlet pipe will go through two socks.

RAIN GARDENS

Runoff is a major contributor of pollutants to our lakes and streams. As impervious areas increase with new development, less stormwater is able to infiltrate where it falls. The adjacent diagram shows how, with increased impervious surfaces, the percentage of runoff increases dramatically. Rain gardens are one method to improve infiltration rates on a small scale.

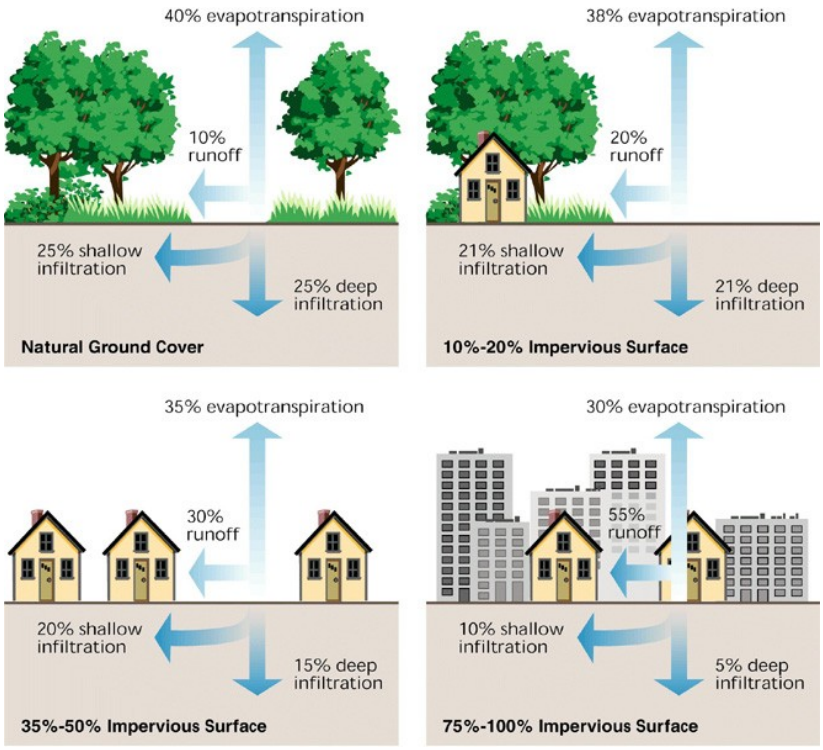

Figure 8: Runoff and Impervious Surfaces (Source: Stream Corridor Restoration: Principles, Processes, and Practices, FISRWG 1998)

DEFINITION

Rain gardens are gaining popularity across the country with businesses and homeowners who see the value of controlling stormwater runoff where it starts. These gardens are simply low areas that have been planted with flood-tolerant, deep-rooted vegetation to encourage infiltration. Most rain gardens are not very big, but by directing roof runoff into a rain garden, the water is able to stay near where it falls, instead of running down the street to a storm gutter. With enough rain gardens in the same watershed, flooding problems could potentially be reduced.

Sometimes it is necessary to dig out some of the existing soil if it is a heavy clay or if there is severe compaction, and replace it with a mix of compost, topsoil, and sand to improve the infiltration. When the existing soil is replaced with 'engineered' soils the practice is referred to as *bio-infiltration*, though when the project is finished it looks identical to a rain garden.

Rain gardens remind homeowners that they can play a role in managing stormwater at a small scale. These gardens are not any more difficult to maintain than a typical perennial flowerbed, and again, each rain garden works to infiltrate stormwater near where it falls.

ADAMS STREET RAIN GARDEN PROJECT

A couple of years ago, The Friends of Lake Wingra brought the proposal of a rain garden street to the City of Madison. Seattle, Washington has already successfully created a rain garden street project. Nine different streets within the Wingra watershed that were scheduled for reconstruction in the next 5 years were considered candidates for the project. The list was narrowed following a site review and consideration of the available storm sewer in the area. The Friends of Lake Wingra and the City of Madison reviewed the final list, and Adams Street was considered by both to be the best choice.

Trying to infiltrate large amounts of water near houses can be a distressing thought to homeowners who worry about their basements flooding. The following steps have been taken to protect their properties:

- Soil borings were taken in the area of the proposed gardens
- Soil will be engineered (remove existing, and replace with a mix of compost, topsoil, and sand) within the garden to improve infiltration
- Underdrains will be installed
- An overflow pipe will be installed in the garden to prevent flooding

Presently, City Engineering is in the process of designing the rain gardens. The amount of water expected to reach each area and the type of soils present will be considered in the plans.

USGS RAIN GARDEN STUDY

The City of Madison wanted to measure the effectiveness of infiltration in rain gardens in coordination with the NR-216 Permit Group. The study is based on two locations within the City of Madison where rooftop runoff is equally divided and directed into adjacent rain gardens. One is at Owen Conservation Park, the other is at a Water Utility Pumping Station on Old Sauk Road by Exclesior Drive.

Each rain garden was constructed using existing sizing guidelines for the typical homeowner. One garden at each site was planted with native species while the

other was seeded with typical turf grasses. As the two sites have dissimilar soils, we intend to monitor the effectiveness of the types of plantings in the different existing soil types.

The primary objective of this study is to evaluate the infiltration rates of rain gardens with different soils and types of vegetation. Secondary objectives include:

- Measuring the vertical flux of infiltrated water beyond the root zone and soil moisture available for evapotranspiration
- Measuring atmospheric parameters necessary to calculate potential evapotranspiration at each location and compare to actual evapotranspiration
- Determining if "mounding" of infiltrated stormwater below ground may lead to lateral spreading that may cause damage to building foundations

Owen Park Rain Gardens

This site was chosen for its primarily undisturbed silty soils. Both gardens at this site are approximately 125 ft^2 and were set up to be ⅓ the size of the roof draining to the garden. The maximum storage depth for this location is 6 inches. The two gardens at the site were constructed with bobcat equipment. Approximately 6 inches of compost was added and tilled into the existing soil. One garden was planted with mix grass seed and the other with native dormant plugs.

Figure 9: Map of City Rain Garden Study Sites

Old Sauk Road Rain Gardens

This site was chosen because it is a typical urban construction project. The area had been totally disturbed during construction and there was no soil structure found at the time of exploration. Both gardens at this site are approximately 520 ft^2 and also sized to be 1/3 of the roof area. Again, 6 inches of compost was tilled into the existing soil, one garden was planted with mix grass seed, and the other was planted with dormant plant plugs. This site was very difficult to construct due to the degree of soil compaction.

The City of Madison was responsible for the construction and planting of each rain garden during the summer of 2003. The gardens were constructed from scratch and will continue to be monitored for a total of 5 years, allowing each vegetation type to reach its maximum infiltration potential. The City is also responsible for maintenance for the duration of the project.

Data analysis is performed by the USGS who will summarize the performance of each rain garden. All runoff, precipitation, soil moisture, and atmospheric data collected is stored in the USGS database as it becomes available.

Soil moisture data is used to determine the volumetric water content below the rain garden at multiple depths and whether water has a positive, neutral, or negative flux. Soil moisture data is coupled with runoff data to calculate an estimated volumetric mass balance of water for each rain garden.

Data collected from each weather station will be used to predict potential evapotranspiration. Results will be compared to soil moisture data to determine if a relationship exists between potential evapotranspiration and soil moisture content.

Data on the rain gardens' discharge and precipitation can be viewed on the USGS real time website (http://waterdata.usgs.gov/wi/nwis/current/?type=flow); under the Rock River Basin there are links for the Owen and Old Sauk links. To view the temperature and humidity data select "Wisconsin Precipitation Table" under the Predefined Displays pull-down menu near the top of the page (Again, look under the Rock River Basin).

The USGS will produce a Water Resources Investigation Report to document the results of the study. The report should be completed around September 2008.

THE CITY OF 1,000 RAIN GARDENS

In May 2005, the City of Madison applied for a grant from the Department of Natural Resources to pursue a project involving cost-sharing rain garden construction in residential areas. The project has already been approved for the City budget in 2005, and will continue for 5 years. The City will focus on areas prone to flooding, such as the University/ Midvale neighborhood, but the project will not be limited to these locations.

If the grant is received, the cost sharing will work out as follows: ⅓ homeowner, ⅓ DNR grant, ⅓ City of Madison, with a maximum cost to the City of $333.33 per rain garden. Gardens over $1,000 will receive a maximum of $666.66 from the grant and the City combined. Once the funds run out or if the City does not receive the grant, the cost sharing may be 50%.

The City will be available for limited technical support and we will direct homeowners to firms that are interested in helping with more detailed designs or installation. The project is set to start in spring 2006.

CONSTRUCTION SITE INSPECTION

There are two review procedures for plans/plats submitted to the City of Madison. The more restrictive reviews are for plats, planned urban developments (PUD), Certified Survey Maps (SCM), and Conditional Use (CU) plans. In these cases, preliminary plans are routed to multiple departments for comment, including Engineering.

At the initial review, City Engineering reviewsthe plans for compliance with all stormwater regulations and identifies any deficiencies. The comments are then forwarded to the applicant. Once plans have gone through this initial phase, they may be submitted under the standard process. In these cases, plans then go directly to the departments for review and sign-off. The erosion control inspectors for the City Engineering review plans that only go through this process for compliance with stormwater regulations, and they reject those that fall short of compliance. Plans that have been through the preliminary review are signed if the initial deficiencies have been corrected. If the deficiencies have not been corrected, it is rejected for re-submittal. In either case, no building permit may be obtained if all department signatures have not been obtained.

Two primary agencies are responsible for erosion control in the City of Madison: Building Inspection and City Engineering. Building Inspection is accountable for erosion control in accordance with the Urban Dwelling Code (UDC) for 1- and 2-family units. City Engineering oversees all other residential, commercial, and plat developments.

In 2004, Building Inspection issued the following:

- 324 citations
- 830 notices
- 838 1- or 2-family permits
- 216 commercial project permits

In 2004, City Engineering issued the following:

- 200 erosion control permits issued
    - 69 permits were renewals or less than 20,000 sq ft of disturbed land
    - 131 sites were greater than 20,000 sq ft disturbed land
- 23 official notices were sent; 0 citations were issued

There are several differences in enforcement methodology between Building Inspection and City Engineering. Building Inspection uses enforcement, while City Engineering has chosen to work with developers to improve initial compliance, rather than issue fines after erosion has taken place. This is consistent with the different audiences the two agencies work with. With Building Inspection projects, there are multiple agents potentially causing the problem, but just one responsible party (the entity who took out the building permit). City Engineering projects typically involve fewer agents who may be causing

problems, and with fewer large sites, it is easier to solve problems before they become critical.

Construction site inspection by City Engineering is done on a scheduled basis instead of a complaint-driven process. This prevents missing the lower-profile sites with erosion control problems.

The City of Madison is also working with Veridian, Dane County, and the Wisconsin Department of Natural Resources on a Green Tier Program that would improve stormwater discharge and allow the developer to do more self-inspection.

City Engineering staff will review current practices of street cleaning near construction sites and will report to the Commission on the Environment with possible resolutions.

ANNUAL MAINTENANCE AGREEMENT REPORT

City Engineering approves Best Management Practices (BMP) (oil & grease traps, rain gardens, inline devices, etc) that will be used on any given lot, and a maintenance agreement is recorded for each practice. In the coming year, the person responsible for maintaining the BMP will be required to submit an annual report with sufficient documentation that they are in fact maintaining the structure. If they fail to submit a report after a reasonable period, city staff will have the option of performing the necessary maintenance and charging the owner of the lot, or assessing a fine for failing to maintain the BMP.

FOCUS ON CRITICAL SITES

There are areas throughout the City with severe erosion and other water quality problems that require direct attention. The City Engineering Division will continue to record these sites in order of importance. Each year the City will focus on one or two sites. One example of a critical site is a greenway in Owen Conservation Park that is in serious disrepair. The area drains to Spring Harbor in Lake Mendota, and is a significant source of sediment. An initial list of critical sites follows:

1. Owen Conservation Park Greenway (entire system)
   A) North Yellowstone Section
   B) Jetty Drive Section
   C) Inner Drive Section
2. Lake Wingra – Forest Hills Greenway (Glenway Street Section)
3. East Mendota – Pheasant Branch Greenway

4. Nautilus Drive Detention Pond (turn to infiltration basin)
5. Mendota-Spring Harbor Greenway
   A) Masthead Drive Section (downstream of Nautilus Drive Section)
   B) Regent Street Section & South Hill Drive Section (downstream of Garner)

'GREEN DESIGN' OF NEW ENGINEERING OPERATIONS FACILITY

The operations facility that houses the Engineering Division Operations Section, located on Emil Street, will be getting a major makeover this spring. Several water quality practices will be incorporated into the new design, including a green roof (both intensive and extensive), a rain garden, an inline device called a Baysaver™, and an underground cistern. The cistern will be used to collect filtered run-off and is equipped with a pump to re-use the water in vactor trucks used to clean sanitary sewers.

Green roofs, also known as eco-roofs or living roofs, help manage runoff by using living vegetation on the roof surface. They mimic a natural ecosystem by means of absorption and evapotranspiration. The roof also stays cooler, as a side benefit. An intensive green roof is over 6" deep to accommodate small trees and shrubs and some human use. Extensive roofs are much shallower (1-5") with just a light drainage system.

Inline devices such as the Baysaver™ are installed underground, often in high-use areas such as parking lots to collect sediment, floatable trash, and sometimes oil and grease. The Baysaver™ is purported to capture all of these using gravity flow.

WINGRA CREEK PROJECT

Wingra Creek is located in a highly urbanized portion of the City of Madison. It is two miles long and runs from Lake Wingra to Lake Monona. Due to low velocity and poor water quality, the creek usually becomes stagnant in the summer months. It is listed by the Wisconsin Department of Natural resources as a 303(d) impaired water body.

In late 2002, the City of Madison held a public meeting to assess community interest in addressing water quality and recreational concerns along the Wingra Creek Parkway. The group was in favor of moving ahead to establish a master plan for the area.

Early in the following year, the City, Friends of Lake Wingra, and the South Metropolitan Planning Council held a community workshop where the participants were asked for their input on three areas of interest: environmental quality, recreation, and community building/education.

City Engineering staff used the comments from the workshop and the original 1994 master plan for the Parkway to write a new master plan to reflect the current needs for the area. A plan was presented to the public in January 2005. Again, public feedback guided further planning efforts.

Strand and Associates has been hired to plan and calculate the specifics of the project from our preliminary, conceptual design in the master plan. The City of Madison has had several meetings with Strand and other involved groups, and continues to move forward with the project.

Many of the restoration treatments that will be used focus primarily on bank stabilization. Several areas along the creek show signs of severe erosion. Our focus will be to correct this problem and to prevent future erosion problems. In some areas where it is appropriate and erosion is not a major concern, the slope of the bank will be re-graded and established with native vegetation (grasses, forbs, and maybe shrubs. Existing vegetation will be left in place where possible.

Construction should begin in fall 2005.

STARKWEATHER CREEK PROJECT

Starkweather Creek also runs through a very urbanized section of the City of Madison. The stream often acts as a backwater to Lake Monona due to low velocities and gradient. The section of stream this project focuses on starts at Interstate Highway 90 and ends at Lake Monona. There are two branches of the creek, totaling 6.1 miles. Shallow areas along the creek make it difficult for recreationalists to enjoy.

Bike paths, parks, and hiking trails both exist currently or are planned for this waterway corridor. The master plan includes these improvements, making them a priority in the planning process. In early 2004, the City of Madison held a public meeting that helped assess the community's interest in addressing problems with Starkweather Creek. The group was in favor of establishing a master plan for the area that would focus on the needs of the neighborhood and the city as a whole.

The master plan has been updated based on public meetings, and it was used to formulate the City’s 2005 capital budget. The budget currently contains $180,000 for water resource improvements. Bike paths, park amenities, and hiking trails were proposed in other areas of the budget.

Construction may begin late 2005, or delayed to 2006.

ROAD SALT USAGE SUBCOMMITTEE

A subcommittee has been recently formed as a part of the Commission on the Environment to analyze private and public use of de-icing products. Staff from the Engineering Division is leading the subcommittee. During the first meeting, the group determined the scope and purpose of the subcommittee. Items to be included in the group's scope include the following:

- Provide recommendations to the City of Madison on how to reduce road salt usage
- Develop/ provide access to educational materials for salt application operators and the public
  - ⇢ Education as related to proper use of salt; effect on environment to raise public concern
  - ⇢ Reduction required to avoid negative environmental impacts
- Estimate future environmental impacts of salt use
- Estimate salt usage on private property/ parking lots
- Cost evaluation comparing reduced salt use/ alternative materials/ environmental clean up
- Evaluate programs already in use by other communities and how that knowledge can be applied to Madison salt reduction

GROUP STORMWATER PERMIT

Since 1991, the City of Madison has been involved in permitting stormwater discharge from our separate municipal storm sewer system. The Environmental Protection Agency (EPA) has made this a requirement as part of the Clean Water Act.

The City's first permit application was due in January 1993, and the Wisconsin Department of Natural Resources (WDNR) issued our first discharge permit in July 1995. The discharge permit from the WDNR/EPA included certain terms the City must meet including monitoring stormwater discharge and reporting on existing activities like street sweeping, leaf collection, and salt use. Initially only Madison, Milwaukee, and the University of Wisconsin-Madison were required to obtain this type of permit.

The latest permit is dated May 1, 2004, and expires on March 31, 2009. Since 1995, the State of Wisconsin has adopted stormwater discharge codes that are more stringent than EPA regulations. As a result, many communities surrounding Madison have been required to obtain a stormwater discharge

permit. Since the City of Madison needed a new permit, we offered to be the lead municipality for a group of 18 additional Dane County municipalities. As stated in the Joint Storm Water Permit Group Information and Education Plan, the goal of the program is to reduce adverse impacts to water quality in our lakes and streams from urban sources of stormwater runoff.

The Permit Group consists of the following: the Cities of Fitchburg, Madison, Middleton, Monona, Sun Prairie, and Verona; the Villages of DeForest, Maple Bluff, McFarland, Shorewood Hills, and Waunakee; the Towns of Blooming Grove, Burke, Madison, Middleton, Westport, and Windsor; Dane County, and the University of Wisconsin – Madison.

The monitoring requirement has been the most significant aspect of the permit regarding cost and data acquisition. The City of Madison chose to go beyond the minimum monitoring requirements of the federal register code, as no new information would have been gained. In cooperation with the WDNR, the City chose to study and monitor specific stormwater management practices for their effectiveness in reducing pollutants in receiving waters. While this decision cost more than performing the minimum requirements, valuable data has been provided as a result.

These studies have included (1) an examination of the Stormceptor® treatment device, (2) a study of phosphorus sources in residential neighborhoods, (3) a study and calibration of a developing 10 mi^2 watershed on the west side of Madison, and (4) a study of the effectiveness of weekly sweeping in residential neighborhoods (see 'USGS Street Sweeping Study').

PHOSPHORUS BAN

On January 1, 2005, a phosphorus ban went into effect for the City of Madison. It will no longer be permissible to apply phosphorus-containing fertilizer to an established residential lawn. While the effects on the lakes will most likely not be noticeable, it is a step towards enabling a homeowner to take some responsibility for what runs off their yard into the storm drain, and into a lake. It is also important to educate homeowners on the importance of testing the soil first to determine fertilizer needs, instead of just applying whatever is on sale.

PESTICIDE POLICY

For years, the City of Madison has had a pesticide policy in place. The NR-216 Group Stormwater Discharge Permit required submittal of the policy. In 2004, an updated policy was put in place. The following excerpts are taken directly from the Policy Regarding Pest Management on City Property.

The City of Madison agrees with the US EPA that "all pesticides are toxic to some degree, and the commonplace, widespread use of pesticides is both a

major environmental problem and a public health issue." For this reason, all departments will evaluate and give preference to non-pesticide management practices and use reasonably available alternative pest control methods, will minimize their pesticide use through Integrated Pest Management, and will use pesticides as a last resort.

Integrated Pest Management (IPM) is a decision making process. The essential parts of IPM are monitoring, setting threshold level for pests, identifying the causes of the pest problem, addressing the cause of the problem, and using pest suppression methods if needed. IPM first uses mechanical and biological methods to control the problem before using chemical controls. IPM develops ways to change the conditions that cause the pest problem, so that pests will be prevented in the future or minimized.

Chemical pesticide use will be considered as a "last resort" if:

a. The non-toxic methods of pest control have been shown to be ineffective
b. Monitoring has indicated that the pest will cause unacceptable health or safety hazards, or an unacceptable reduction in the intended use of the property.

MANAGEMENT OF URBAN WATERFOWL

In 2002, an Ad Hoc committee was formed to address concerns about the number of waterfowl, specifically Canada Geese, on public land throughout the city. The intention of the committee was not to eradicate any species, but to address the problems created by such a large number of waterfowl. The following list of recommendations were made by the Ad Hoc Committee on Integrated Waterfowl Management, based on information from the WDNR, US Fish and Wildlife Service, and citizen comments:

1. The Parks Division, working with other outside agencies, will develop and implement a protocol for the documentation of bird counts, feces quantity, locations, numbers of nesting pairs, and survival rates of hatchlings. The protocol will cover the collection and analysis of data in a scientifically sound manner.
2. The Parks Division will make the data it collects available for the purposes of facilitating discussions with adjoining communities of urban waterfowl management. Discussions would include identifying acceptable locations for nesting as well as acceptable population numbers.
3. An informational brochure will be created and distributed to neighborhood associations and the general public on the problems associated with feeding waterfowl. Parks staff will assist in the

distribution of the brochure to citizens who are feeding waterfowl within the city limits.

4. Initially implement the use of a herding dog(s) at the Yahara Hills Golf Course under the care, custody and control of Parks Division personnel, provided the user groups at Yahara contribute 50% of the costs associated with the purchase, feeding and maintenance of the dog(s). This technique will be evaluated for overall costs and benefits. A protocol will be established for the possible expanded use of dog(s).
5. If dog control proves to be insufficient or impractical, then the Parks Division, under the supervision of USDA Wildlife Services, could employ reproductive control techniques, such as oiling or addling eggs.
6. Practical shoreline modifications and vegetative modifications should be considered.

IN-LAKE MANAGEMENT

STORMWATER OUTFALL TRASH COLLECTION

Neighbors in the Monona Bay area asked the City of Madison to help them with trash collection around a stormwater outfall near Parr Street. The City has received a permit for one year from the Wisconsin Department of Natural Resources to install a device that will help to collect trash in the lake. It will be placed in Monona Bay about 10 feet from the outfall, and consist of netting stretched between stakes in an arc shape. The neighbors will sign a volunteer release form, and use 'skimmers' to collect the trash and deposit it in trashcans provided by the City.

This project is intended to be an interim solution to a more permanent, inline structure the City would install along the storm pipe, before it reaches the Bay.

WINGRA LAKE DREDGING

In 2005, City Engineering will be dredging a portion of Lake Wingra, near Wingra Park. There is a lot of sediment in this area, and it has formed an island near the outfall. Preliminary borings showed a depth of 40-48" of sediment. The full scope of the dredging project will not be clear until the survey and boring analysis are completed.

In conjunction with the dredging project, the city will also look at controlling major sediment sources with weekly street sweeping and critical site control. There is severe erosion along the Glenway Street Section of the Forest Hills Greenway, within the Lake Wingra watershed. This problem needs to be corrected to reduce further sedimentation at the same stormwater outfall.

MONONA BAY WATER CIRCULATION EXPERIMENT

The City of Madison has been offered a free trial use of floating, solar-powered circulation devices called 'SolarBees' from North Dakota Pump Systems, Inc. for use in Monona Bay. The devices have a flexible pipe that extends down into the water, drawing in water at a specific depth, from 31 inches to 100 feet. The water is brought up through the pipe then distributed in a near-laminar flow in all directions. There is a plate at the bottom of the pipe to prevent water from being sucked up directly from the bottom. Instead, the water moves in a lateral direction to the opening between the pipe and the plate. The water moves at a rate of 1 foot per second, which is slow enough to not bring up lake sediments.

Circulating the water prevents blue-green algae from forming mats at the surface because it disrupts their habitat, a type of bio-manipulation. There is also an increase in oxygen in the water column. The added oxygen plus the suppression

of blue-green algae population supports the growth of ‘good’ green algae, which are food for zooplankton, which in turn are food for fish.

A secondary effect of the SolarBee in other cases has been control of aquatic weeds, such as Eurasian milfoil. It is not completely understood how this happens, though it has been suggested that the circulation affects the available nitrogen in the water (nitrogen is a limiting nutrient for aquatic weeds). The Army Corps of Engineers will be doing a study in 2006 in Wisconsin, in part to determine how the SolarBee controls weeds.

The plan is to place 5 SolarBees in Monona Bay. A 6th device will be placed in one of the ‘triangles’ formed by the railroad and John Nolen Drive. The second triangle will not have a device. This will allow for an analysis between areas with and without SolarBees.

The City of Madison has received a permit from the Wisconsin Department of Natural Resources and will be moving forward with this project in the near future.

INFORMATION AND EDUCATION

INVOLVEMENT WITH NR-216 GROUP I & E

The Joint Storm Water Permit Group Information and Education Plan was written to guide the group with our I&E efforts. The City of Madison contributes $8,000 each year to the salary of the I&E position. The rain garden monitoring project is also a part of the I&E for the group, and the City contributes 20% ($14,536) of the cost of the project each year. One outcome of the I&E efforts is campaign to educate the public on stormwater runoff. Information can be found at: www.myfairlakes.com.

ADAMS STREET

The Adams Street Rain Garden Project will be an excellent demonstration project on using rain gardens in controlling stormwater at a small scale. We hope to hold a neighborhood planting day when it's time to plant the rain gardens.

1,000 RAIN GARDENS

The City of Madison will have a great educational opportunity with the 1,000 Rain Gardens project. Homeowners will learn that they have a role in controlling stormwater. The City of Madison will provide information and technical assistance on rain gardens as part of the project.

DEMONSTRATION RAIN GARDENS

Agrecol, a local supplier of native plants, has offered the City of Madison $100,000 in plant materials for city rain gardens. One garden, located at Warner Park, is currently under construction. A second location will most likely be at Brittingham Park. Neighborhood residents will likely help with planting at this garden.

WEBSITE

As part of the NR216 permit agreement, the City of Madison maintains a website on water quality issues. Our website (www.cityofmadison.com/engineering/stormwater) contains information on current projects and links to related information.

EMPLOYEE PRESENTATIONS

City Engineering employees continue to give a variety of presentations to other commissions and the public on current projects and issues, as well as technical training pertaining to water quality issues.

STARKWEATHER CREEK

Two distinct educational programs will grow from the Starkweather Creek project. One will focus on educating area residents and businesses on what the City of Madison will be doing to improve the creek and what they can do individually to help protect it. Areas of interest could be water quality, stormwater infiltration and management practices, pollutants, and land use. The second effort will be environmental education in general. The creek can be used as a resource for teaching biological and natural sciences, ecology, bioregionalism, and natural history.

SUMMARY: CURRENT AND PLANNED PRACTICES

STREET SWEEPING

- Continue study through July 2006
- Purchase Elgin Whirlwind™ vacuum sweeper for downtown areas
- Expand weekly sweeping to all downtown areas
- Experiment with polymers (extend current study)

DETENTION BASINS

- Add polymer socks to inlets
  - Monitor effectiveness on 2-3 basins
- Look at expanding the number of detention basins with polymers in subsequent years

RAIN GARDENS

- Adams Street project moving forward
- City rain garden demonstration sites
- Kick-off 1,000 rain gardens project in spring 2006 (5 year project)
  - Provide information and technical assistance to homeowners
  - Continue project after 5 years if there is sufficient interest

IN-LAKE MANAGEMENT

- Move forward with SolarBee experiment
  - If successful purchase for Monona Bay
  - Possibly purchase more in subsequent years for other problem areas
    - Lake Wingra lagoons may be one possibility

FUTURE DIRECTIONS

There are innovative ways, with the list growing each year, to improve lake water quality. With each annual review, it is anticipated that this list will grow and change. Many of these practices will increase infiltration or even to use rainfall as a resource instead of considering it a hindrance. The following list is intended to keep the City of Madison thinking of new and innovative ways to protect and improve water quality.

PRIVATE RAIN GARDENS

Encouraging new developments to install private rain gardens at lot level places a degree of stormwater control in the hands of private homeowners. This can give a sense of ownership in water quality and provides an example to other developments. Gardens would be maintained by homeowners or through homeowner association fees.

LOW IMPACT DEVELOPMENT

Low impact developments incorporate a variety of environmentally sound practices. When planned at a plat level, there are a lot of options for new developments to minimize impacts on water quality and stormwater runoff. The City of Madison should support such developments.

Practices may include all or any of the following: rain gardens, bio-swales, driveways drained to yard or rain gardens, use of swales instead of curb/gutter to encourage infiltration, and pervious pavers in low-traffic areas.

PERVIOUS PAVEMENT

The City of Madison can experiment with permeable pavers, GrassPave™, and other innovative practices designed to encourage infiltration in low-traffic areas. These concepts can be used in overflow parking areas or emergency access lanes. Permeable pavers can be used in driveways and pedestrian traffic areas such as building entryways, plazas, and patios.

TREE BOX FILTERS

Tree box filters, pictured at the right, accept directed stormwater to the terrace where trees are planted.

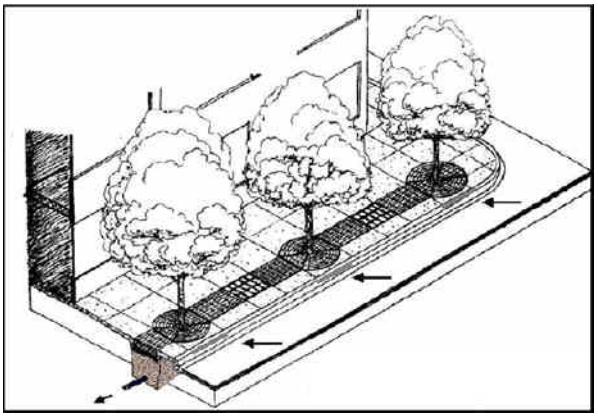

Figure 10: Tree Box Filter
(Source: Virginia DCR Stormwater Management Program)

Vegetation and soil remove nutrients from stormwater before it enters a catch basin. The stormwater runoff irrigates the trees. The filter consists of a bioengineered soil mix, a layer of mulch, an underdrain, and a tree or shrub. An overflow pipe would be provided for large storm events.

INLINE DEVICE INSTALLATION

The City of Madison will consider installation of inline devices at appropriate stormwater outfalls with street reconstructions. Targeted areas should include Monona Bay and Lake Wingra. Inline devices, such as those by CDS Technologies (pictured here) can be retrofitted in very urban areas. They are fitted along a storm pipe before the outfall, and remove sediment, oil/grease, and trash. Each device varies on their efficiency on sediment removal. They also require regular maintenance to maintain efficiency and capacity.

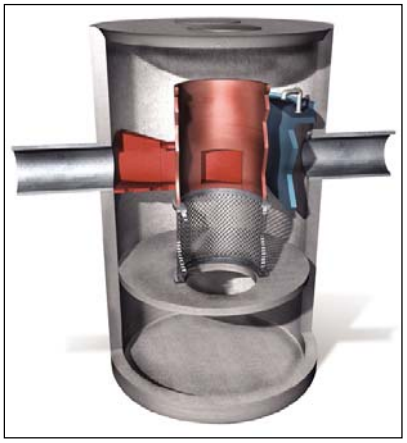

Figure 11: Example of In-line Device from CDS Technologies

BUFFER ORDINANCE

The City of Madison could create an ordinance prohibiting mowing within 15 feet of a detention basin, pond, stream, or lake. Mowing a strip for personal access to lake would be allowed. This is the current policy for City maintenance, and the city has asked homeowners to follow this policy. By leaving a 'buffer' nutrients are captured by the taller vegetation, and it discourages Canada Geese by preventing them from accessing the banks.

LAKE PLANNING GRANT

The City could look into applying for a Lake Planning Grant or coordinate with another agency to hire a grad student group to effectively model and set goals for Lakes Monona and Wingra similar to those outlined in the Mendota Priority Watershed plan. The goals would include (at a minimum): the targeted frequency of algal blooms and a realistic Trophic State Index goal for each lake. A Lake Planning Grant provides a maximum of $13,333, with matching funds from the City.

The Friends of Monona Bay will be applying for a Lake Planning Grant in 2005 to provide funding for a graduate student (Water Resource Management) practicum to write a plan for Monona Bay in 2006. If their plan is funded and completed, the goals and objectives will be incorporated into this plan.

Lake Protection Grant

The UW Arboretum and the Friends of Lake Wingra are applying for a Lake Protection Grant in 2005 to promote small-scale stormwater practices that Wingra Watershed residents can incorporate into their lots. Demonstration projects and technical assistance would be integral to the project. Stormwater "audits" would be done on a lot basis, and possibly include potential locations for rain gardens. The City of Madison has supported their project with a letter of support. The technical assistance of locating ideal spots for rain gardens on individual lots would help the City with the 1,000 rain garden project. The City of Madison would provide cost-share to any resident interested in installing a rain garden with this project

Purchasing Riparian Land

Buffer strips are often used along waterways to catch sediment and nutrients from adjacent cropland. The City of Madison could purchase 100 feet of land on either side of a stretch of waterway and plant it with native vegetation. According to the USDA Natural Resources Conservation Service, a 100-foot filter strip (grass) or riparian buffer (trees and grass), adjacent to cropland, can prevent approximately one pound of phosphorus and ½ ton of sediment from running into adjacent waterways each year.

In 2003, agricultural land that was to be continued as ag. land sold for $4,138 per acre on average (the range was $1,475 to $8,600). Agricultural land diverted to other uses sold for $16,612 on average. The City of Madison may able to purchase riparian land for $5,000 per acre if there are interested and willing sellers. However, it would be possible that without enthusiastic sellers, land could sell for over $20,000 an acre.

A more cost-effective way of reducing phosphorus and sediment is to rent riparian land from farmers or pay them an incentive to plant either native vegetation that would not be harvested or a even a hay crop. Area farmers already take advantage of similar state and federal programs, so it would not be a new concept to sell to farmers. Farmland rental rates depend on the soil type. In Dane County, the rental rates range from about $60 to $200 per acre.

Pollutant Trading

A relatively new idea in pollutant reduction for urban areas is to use pollutant trading as credits towards suspended solids or nutrient reduction requirements. Simple calculations of soil loss equations show a significant reduction in sediment loss by turning cropland that was primarily corn or soybeans into hay fields. A farmer who plants a rotation of corn and soybeans, and practices conservation tillage may be losing 3-5 tons of sediment per acre per year (depending on soil type) and be completely in compliance with their conservation

plan. A continuous hay crop, on the other hand, would limit soil loss to less than 1 ton per acre per year. The Dane County Land Conservation Department estimates rural soils to contain 6 pounds of phosphorus per ton of sediment (urban soil is closer to 3 pounds phosphorus per ton sediment).

Relatively simple changes in crop rotations can significantly change the amount of soil loss on any given farm, depending on soil type, previous crops, slopes, and planting plan. If land planted to continuous corn (spring mulched with 30% residue) was switched to a grass/legume hay crop, by the third year the soil loss would be reduced by about 1 ton per acre per year. Another farmer with steeper slopes and a different soil type might lose 5-10 tons of soil per year, and switching to continuous alfalfa hay would prevent significantly more sediment and nutrients from eroding into the nearest waterway. These scenarios represent reductions of phosphorus loading on the order of 6-30 or more pounds per acre per year. A 40-acre field turned to continuous hay could feasibly save 240 to over 1200 pounds of phosphorus per year. Typical hay farmers reseed alfalfa crops approximately every 4 years, though if the crop is not intended to be pure alfalfa, they can wait up to 7 or more years before reseeding.

Historically, the problem with pollutant trading has been buy-in by the Department of Natural Resources. There are discrepancies with the amount of phosphorus in soils and the ability to minimize soil loss. The idea of pollutant trading has been attempted in the Rock River watershed in cases where point sources were trying to find a more economical method of reducing pollutant loading to the same water body. At that time, the DNR settled on a 10:1 ratio of non-point pollutant to point pollutants. That is, one pound of phosphorus from a point source is worth 10 pounds of phosphorus from cropland (non-point). Pollutant trading quickly became less appealing.

According to the Rock River Watershed Group Assessment of Trading Efforts, the major factors that prevented pollutant trading from being implemented (for point to non-point sources), included the following:

- Lack of cost-effectiveness
- Length of term of trade (DNR would require a long agreement)
- Trade ratio (10:1)
- Determination of phosphorus-reduction from non-point controls
- Inability of the DNR to consider other benefits of non-point programs
- Uncertainty associated with a new program
- Surprisingly difficult to find willing participants

Because the City of Madison would be considered a non-point source, the trade ratio would probably be considerable less than 10:1. However, the inability of the DNR to recognize the potential for such a program in a previous case indicates it would be a difficult undertaking to convince the Department to allow us to take credit for any total suspended solids reduction using pollutant trading.

The Department of Natural Resources would need to view such a program in a whole watershed perspective as opposed to urban vs. rural. The new Green Tier program, which allows the Department to consider unconventional methods of achieving reduction goals, may be a venue to discuss the possibility of pollutant trading.

STORMWATER TREATMENT FACILITY

The Yahara River sub-watershed drains nearly a quarter of the Lake Mendota watershed. The majority of the land in this area is agriculture, and contributes a substantial amount of sediment and phosphorus to Lake Mendota. Preventing the sediment and nutrients from reaching the lake is one way to significantly control the pollutant loading.

The City of Madison could budget for planning efforts to more accurately estimate costs of installing and maintaining a stormwater treatment facility across the Yahara River. The planning effort alone would take at least 2 years, with a total cost of approximately $150,000.

Current estimates calculate the capital costs of constructing such a facility to be between $25-50 million, with about $10 million for annual operating cost. To pay for the cost of installing and running a treatment plant for the estimated costs, stormwater utility rates would increase by a factor of 2.4 if the facility costs $50 million. Treatment would consist of sedimentation/ flocculation and a filtering for nutrients. A major retention system would need to be constructed to prevent bypassing the system in large storm events.

COORDINATED RESEARCH AND MANAGEMENT PLANNING

One challenge with any water quality improvement efforts is to coordinate all interested agencies in the process. The City of Madison continues to work with other agencies on many water quality efforts. Following is a growing and incomplete list of current coordination with other agencies:

- Working with Dane County, DNR, Sun Prairie, and Veridian on the DNR's 'Green Tier' program
- Initiating the coordination of 18 other municipalities in our NR-216 Group Stormwater Permit with the DNR
- Working with UW-Arboretum on the formation and implementation of an overall stormwater management plan for the Arboretum and its watersheds
- Currently involved with the City of Verona and Madison Metropolitan Sewerage District for extending sanitary sewer throughout the Lower

Badger Mill Creek watershed; project will include stormwater management elements
- Sharing stormwater management planning reviews with the Town of Middleton Engineer for developments along or affecting either side of Pioneer Road
- Completed initial construction cost sharing obligations for a stormwater management project with the City of Middleton to manage and maintain water levels for Stricker and Tiedemann's Ponds; we shall continue to share an obligation with Middleton for the long term success of this watershed management system
- Working on rain garden study with NR-216 Stormwater Permit Group, USGS, and DNR
- Working on street sweeping study with NR-216 Stormwater Permit Group, USGS, and DNR
- Collaborating with DNR on SOC standards (NR-151 compliance)

COLLABORATION WITH WATERSHED AND OTHER CITIZEN GROUPS

There are many different watershed and citizen groups actively involved with public outreach and education specific to water quality initiatives. The City has worked with these groups on many different projects in the past and will continue to work with them on an on-going basis to establish priorities and to review and update the success of this plan.

Examples of current collaborations include the following:
- Friends of Lake Wingra—Adams Street Rain Garden Project and Wingra Creek project
- Friends of Starkweather Creek—Starkweather Creek project
- UW-Arboretum and Friends of Lake Wingra—collaborating our efforts with our 1,000 rain garden project and their water quality education outreach efforts
- If Friends of Monona Bay receive a planning grant, we will work with them in preparing a stormwater management plan for their interests
- City Engineering is an active and critical member of the Upper Sugar River Watershed Association; we participate in sharing ideas, problem solving, and watershed planning for and with this group
- City staff are active participants and leaders in the Wisconsin Chapter of the American Public Works Association, including membership in the Water Resources Committee since 1994; city staff has served as Committee Chair for past 3 years
- Stormwater Utility contributes money to the Madison Environmental Program, which includes an educational component for what homeowners can do to better manage stormwater and protect water resources

- Considering joining efforts with local fishing groups for:
    - Improved safety for muskies to cross the weir on the Wingra Dam for spawning purposes
    - Maintain access channel from Lake Mendota to the lagoons of Warner Park to facilitate fish migration for spawning

APPENDIX A: BUDGET AND TIMELINE

Table 5: Budget and Timeline for Short-Term Planned and Proposed Practices

Practice	Improvements	Est. Costs	Total	Year	Project Status	Funding Status	Used to Meet Regulation Requirements	$ per lb phosphorus removed*
Detention Basins	Add polymer socks to 2 test basins	$500/outfall/year	$1,000	2005	Due to other projects, will be delayed until 2006	Budgeted for 2006	Maybe	~$100 (assume 2 socks per inlet per year)
Inline devices	Installed with specific street projects; applicable to pipes of 30" diameter or less	$40,000 per device	$120,000 annually	2005	City Engineering is installing a device with a street reconstruction this year	One for 2005; none yet for 2006	No	~$20,000 (assume device costs $38,000)
Purchase SolarBees for Monona Bay	Pending success with product, purchase 5 at end of experiment	$200,000	$200,000	2005/06	Need a permit from DNR to move forward with this project	No funding required for 2005	No	N/A
Wingra Creek	Streambank, creek, & upland improvements		$800,000	2005-2009	Construction on Phase I will begin fall 2005	Funded	No	N/A
Starkweather Creek	Streambank & wetland improvements, canoe access, inline device installation	$180,000/yr	$540,000	2005-2008	Construction should begin late 2005/ early 2006	Funded	No	N/A
Street Sweeping	No improvements to current practices	$2,000/ street mile	$1,650,000 (2004)	current			Yes	$100
	Purchase high-efficiency vacuum sweeper	$150,000		2005	City has already purchased one sweeper this year; probably more in future years	Funded on annual basis with budget	Yes	$214
Critical sites	Projects designed to fix sites with serious erosion problems	$250,000/year	ongoing	Start 2006, one project each year	Likely to be included in next year's budget	2006 Budget	No	Varies with practice: ~$1250 (for grass); ~$2290 (for riprap)
Annual Maintenance Report	Require annual report of maintenance of BMPs	5% of personnel time (2 employees)	$5,550/yr	2006	Administrative portion will be in place this year; annual reports will be required in 2006	Funded by operational budget	No	N/A
1,000 Rain Gardens	Cost share rain garden plants/construction with homeowners	$50,000/year (5 years)	$250,000	2006-2010	Project kick off will be spring 2006	Funded	No	~$5,000 (assumes a 2000 s.f. roof, $1500 rain garden, lasts 15 years, & 0.06 mg/L particulate P in roof water)
Convert Ag Land to Prairie	Plant prairie species instead of agricultural crops on city-owned cropland	Seed + Labor (for 253 acres) =$70,000-100,000	Initial cost + some maint. cost	2006	Proposed for 2006	Not funded	No	$0.10 to $0.25 (Assume 6 lbs P per ton sediment for ag. Land)

* Cost per pound of phosphorus/sediment is based on estimates of costs of implementing practices and relatively rough estimates of practice efficiencies

Table 6: Budget and Timeline for Long-Term Proposed Practices

Practice	Improvements	Est. Costs	Total	Year	Project Status	Funding Status	Statutory Compliance Requirements	Cost per pound of phosphorus removed*
Street Sweeping	Extend weekly street sweeping	Operating Cost: $7,400/street mi; Capital Cost: $8,050/street mi	(For Entire City) Operating: $6,054,000 Capital: $6,586,000	Incrementally, starting in 2006	Likely that weekly sweeping will be extended to more districts in 2006 and subsequent years	Funding will depend on Engineering budget for 2006	Will be required to meet 40% TSS reduction for NR-151 by 2011	$266
	Include polymers (study)	$40,000	$40,000 (for 3 years)	2007-2009	There is a plan in place to extend the current sweeping study and determine efficiency of adding polymers to high-efficiency sweepers	Will be included in 2007 budget	Not required	N/A
	Include polymers (practice) where there is no detention basin treatment	$134.07 per street mile per year	$80,066.40/year (includes ALL areas not treated with ponds)	2009	Will depend on results of polymer study		Not required	Will be determined by study
Plan for Stormwater Treatment Facility on Yahara River	Consider budgeting for a plan to detemine feasibility, capital, and operating costs	Approx. $150,000 for a study		2006-2007	Plan is in 'proposal' status; there has not been lengthy discussion on possibility	Not Funded	No	N/A
Stormwater Treatment Facility	Construct stormwater treatment facility across Yahara River near Hwy 113	$140-200 million capital costs; same for annual operational costs		N/A	N/A	Not Funded	Not required	~$2800
Purchase 100-ft buffer strips	City would purcahse 100 feet on either side of waterway and plant with native vegetation for a buffer to cropland	Purcahse: $5,000-20,000 per acre (and pound of P); Rent: $60-200 per acre	N/A	N/A	Proposal status	Not Funded	Not required	For 100-ft buffer strips, from $5000-$20,000 per pound
Pollutant Trading	City would pay farmers incentives to plant hay vs corn, for example	Rental price of $200 per acre, allow farmer to take hay crop	N/A	N/A	Proposal status	Not Funded	Not required	Varies with soil type and previous crop rotation; from $3 to $30 per pound P

APPENDIX B: NR-151 STORMWATER REGULATIONS

NEW DEVELOPMENT

Q ***Is an erosion control plan required?***

A If the site disturbance exceeds 20,000 square feet, a plan with Universal Soil Loss Equations (USLE) is required.

Q ***When are stormwater management practices required on a new development site?***

A New development requires stormwater management practices in accordance with City of Madison General Ordinance Chapter 37, if the **disturbed area exceeds 20,000 square feet**. Further, if the disturbed area exceeds one (1) acre the requirements of WDNR standard NR-151 must be met. The City's requirements are as stringent or more stringent in all areas except infiltration. However, when a new development site area exceeds one (1) acre the infiltration standards of NR-151 must be met in addition to the requirements of Chapter 37.

Q ***If stormwater management is required what components are required and when?***

A New development has five (5) stormwater management requirements: sediment control (80% average annual load or 5-micron particle), thermal control, stormwater detention, infiltration, and oil & grease control.

Q ***When are those specific requirements triggered?***

A **Sediment control** applies under all circumstances. New development must provide for 80% (5 micron) control of post development sediment compared to no controls. This can be met at the plat level (regional pond), on the lot level, or as a combination of the two. If a combination is used, the method of measuring the sediment reduction must incorporate a way to track the particle sizes being treated by each device. For example, catch basins and sweeping both treat approximately 25%, but because they treat the same size particles, the "additive" treatment value of them is probably only 30%.

Oil & grease control applies if the exposed parking area has forty (40) or more parking spaces, or if there is a drive-thru facility on the property. This can only be addressed on the site and not at the plat level.

Thermal control applies if the development is in the Sugar River Watershed. Infiltration can be completed at the plat or lot level. Normally, requirements for

residential properties will be addressed at the plat level, and commercial lots will install practices on individual sites.

Stormwater detention is required if, as part of redevelopment, 20,000 sf of impervious area is being added as part of the project, or if the development is in an area with flooding problems. The City Engineer defines the areas upstream of University Avenue from Midvale Boulevard to Highland Avenue and East Washington Avenue from Blair Street to the Yahara River as being at risk for flooding. The required detention shall be pro-rated between the impervious area of the redevelopment and the total impervious area of the watershed in which the redevelopment is located.

It is preferred that stormwater detention is addressed at the plat level, but it can be addressed at the lot level if large commercial lots are planned.

Infiltration is required if the disturbed site area exceeds one (1) acre. Infiltration requirements can be met at the plat level, at the lot level, or through a combination of the two.

NOTE: While rain gardens on individual lots can be used to meet the thermal and infiltration requirements, they shall not be used to reduce the required detention. If rain gardens are used on individual lots to meet these criteria, a deed restriction & maintenance agreement must be recorded against each lot.

Q When these practices are mandated, what are the goals that must be met?

A **Sediment control** – An 80% control of sediment leaving the site post-construction is required. In Dane County, this effectively means that the 5-micron particle must be controlled, post-construction, during a 1-year rain event.

Oil & Grease control – Using the best available technology, oil and grease must be trapped from the first ½" of runoff from the paved areas. The best available technology must be approved by the Dane County Land Conservation Department.

Thermal control –The applicant must show that an effort is being made to reduce the temperature of the storm water discharging from the site. This is typically done with rock cribs, rain gardens, or other infiltration devices.

If infiltration and thermal control are required, meeting the infiltration requirement will meet the thermal requirement

Stormwater detention – The post-development peak flows from the 2-year and 10-year storm events must match peak flows from the area in the pre-developed state.

Detention of the 100-year event is required in the Upper and Lower Badger Mill Creek Watershed.

Infiltration – The size of the infiltration practice must meet the standards of NR-151. Specifically, for residential development (1 & 2 family dwellings) a maximum of 1% of the site area must be dedicated to active infiltration, in commercial developments a maximum of 2% of the site area must be dedicated for infiltration.

Q When is infiltration required?

A Infiltration required by WDNR code NR-151 on new development sites that disturb areas greater than or equal to 1 acre. There are many locations where infiltration is not required. An incomplete listing of those exceptions follows:

1) Redevelopment areas
2) Infill development < 5 acres
3) Industrial developments
4) Depth to groundwater 3 feet min with 20% fines, 5 feet min with 10% fines

REDEVELOPMENT

Q Is an erosion control plan required?

A If the site disturbance exceeds 4,000 square feet, a plan with Universal Soil Loss Equations (USLE) is required.

Q When are stormwater management practices required on a redevelopment site?

A Redevelopment requires stormwater management practices if the disturbed area exceeds 4,000 square feet.

Q If stormwater management is required what components are required and when?

A Redevelopment has four (4) stormwater management requirements**:** sediment control (40% or 20-micron particle), thermal control, stormwater detention, and oil & grease control.

Q When are those specific requirements triggered?

Sediment control applies if there is exposed parking area included as part of the development. Rooftops do not need to be treated for sediment control.

Oil & grease control applies if the exposed parking area has forty (40) or more parking spaces, or if there is a drive-thru facility on the property.

Thermal control applies if the area is in the Sugar River Watershed.

Stormwater detention is required if, as part of redevelopment, 20,000 sf of impervious area is being added as part of the project, or if the development is in an area with flooding problems. The City Engineer defines the areas upstream of University Avenue from Midvale Boulevard to Highland Avenue and East Washington Avenue from Blair Street to the Yahara River as being at risk for flooding. The required detention shall be pro-rated between the impervious area of the redevelopment and the total impervious area of the watershed in which the redevelopment is located.

Q When these practices are mandated, what are the goals that must be met?

A **Sediment control** – A 40% control of sediment from the paved areas of the site is required. In Dane County this effectively means that the 20-micron particle must be controlled, post-construction, during a 1-year rain event.

Oil & Grease control – Using the best available technology, oil and grease must be trapped from the first ½" of runoff from the paved areas. The best available technology must be approved by the Dane County Land Conservation Department.

Thermal control –The applicant must show that they are making an effort to reduce the temperature of the storm water discharging from the site. This is typically done with rock cribs, rain gardens, or other infiltration devices.

Stormwater detention –Post-development peak flows from the 2-year and 10-year storm events must match peak flows from the area in the pre-developed state. Predevelopment refers to the extent of land cover and land use present on the site prior to the proposed development. If impervious area exists on the site that can be taken into account using a RCN of 98, pervious area on the site is requires the use of a maximum RCN of 68. If the existing pervious area supports the use of a lower RCN based on the guidance provided by the Natural Resources Conservation Service that RCN shall be used.

Q When is infiltration required?

A Infiltration is not required by City or State requirements on a redevelopment site.

APPENDIX C:
OTHER LAKE MONITORING AND MANAGEMENT

MONITORING

VOLUNTEER WATER QUALITY MONITORING—MONONA BAY

CONTACT: Donna Sefton 275-3330 (donna.sefton@dnr.state.wi.us)
MANAGING ENTITY: DNR facilitated volunteers
WATER BODY: Monona Bay, Lake Wingra

Trained volunteers measure Secchi depth and note water color, weather, plant conditions, and wildlife. The data is submitted to the DNR lakes database for long-term storage. Sampling is done about every 2 weeks, May through September.

ZEBRA MUSSEL MONITORING

CONTACT: Dick Lathrop 261-7593 (rlathrop@wisc.edu)
MANAGING ENTITY: DNR/UW
WATER BODY: Lakes Mendota, Monona and Wingra

The purpose of monitoring zebra mussels, an invasive species, is to determine if and when the lakes are infested with them; monitoring the veliger (egg) stage is an early indication of infestation. Three times per summer, water is sampled and filtered from three locations at each lake. The samples are examined for the egg stage of the zebra mussel.

A few adults have been found in Lake Monona in 2002, and a few veligers were found in Lake Wingra in 2004.

NORTH TEMPERATE LAKES LONG-TERM ECOLOGICAL RESEARCH

CONTACT: Dick Lathrop 261-7593 (rlathrop@wisc.edu)
MANAGING ENTITY: UW Center for Limnology/DNR Bureau of Science Services
WATER BODY: Lakes Mendota, Monona, and Wingra

Since 1980, Lakes Monona and Mendota have been extensively monitored. Lake Wingra has been monitored since 1995. From early April through early September the monitoring is done on a bi-weekly basis. Monitoring continues on a 4-week basis through late November, with one winter sampling.

The monitoring includes physical and chemical parameters: phosphorus, nitrogen, silicon, and chlorophyll a, plus DIC/DOCs, pH, and alkalinity every 4 weeks. Cation and

anion testing is run quarterly. Zooplankton vertical tows and phytoplankton integrated depth samples are collected on Lakes Mendota, Monona, Wingra, and Fish. Extensive summer macrophyte and fish surveys are conducted as well.

FISH CONSUMPTION ADVISORIES

CONTACT: Candy Schrank, Aquatic Toxicologist, (608) 267-7614
MANAGING ENTITY: DNR
All Water Bodies

The Wisconsin Department of Natural Resources has provided fish consumption advice in 1991. Nearly all fish in Wisconsin have some level of mercury, and so are included in a consumption advisory list, maintained by the DNR.

The DNR put out a publication called “Choose Wisely: A Healthy Guide for Eating Fish in Wisconsin” and it can be accessed online at the following website: http://www.dnr.wi.org/water/fhp/fish/pages/consumption/choosewisely04.pdf.

LAKE LEVELS

Current lake level information can be found at: http://www.countyofdane.com/landconservation/lakelevelpg.aspx.

DNR has established minimum and maximum lake levels for the Yahara lakes. The Dane County Public Works Department checks and regulates the lake levels by making appropriate outflow adjustments. There is only a six-inch difference allowed between summer minimum and maximum levels, and it is very difficult to maintain lake levels within this range. Lake levels are lowered for the winter to prevent shoreline ice damage, especially on Lake Mendota, and to store spring runoff from the watershed.

MANAGEMENT

LAKE MENDOTA PRIORITY WATERSHED

CONTACT: Carolyn Betz 266-9262 (carolyn.betz@dnr.state.wi.us)
MANAGING ENTITY: DNR, Dane County, Columbia County
WATER BODY: Lake Mendota
Started 1998; Ending 2008

The purpose of the Priority Watershed Project is to reduce phosphorus inputs to Lake Mendota by 50% to control nuisance blue-green algae blooms. The DNR works cooperatively with the two county land and water conservation departments. These departments contact rural landowners to change land management practices. Five major municipalities in the watershed also reduce pollution through construction site erosion control and stormwater management efforts.

UW-ARBORETUM FACILITY STORMWATER MANAGEMENT PLAN

CONTACT: David S. Liebl 265-2360 (liebl@epd.engr.wisc.edu)
MANAGING ENTITY: UW-Madison
WATER BODY: Lake Wingra & Nine Springs Creek Watersheds and Wingra Creek
Started January 2004; Ending December 2005

With a Non-point Stormwater Runoff Planning Grant, the Arboretum is developing management practices and procedures, as they pertain to stormwater management, design, budgeting, and implementation of such practices on Arboretum property. They are coordinating and collaborating with surrounding municipalities and other watershed partners on issues related to stormwater management. UW-Arboretum is developing research and outreach education activities that utilize or are affected by stormwater runoff.

UW-ARBORETUM POND 2 RECONSTRUCTION

CONTACT: David S. Liebl 265-2360 (liebl@epd.engr.wisc.edu)
MANAGING ENTITY: UW-Madison
WATER BODY: Lake Wingra
Started January 2005; Ending December 2007

The Arboretum will reconstruct existing infrastructure along the edge of the Arboretum near the Beltline Highway to provide 80% Total Suspended Solids and phosphorus removal. They will use innovative infiltration and wetland basin techniques.

SOUTHWEST BIKE PATH RESTORATION PROJECT

CONTACT: Steve Glass 265-0798 (sbglass@facstaff.wisc.edu)

MANAGING ENTITY: Friends of Lake Wingra/ Dudgeon-Monroe Neighborhood
WATER BODY: Lake Wingra
Starting September 2005

The Friends of Lake Wingra and the Dudgeon-Monroe Neighborhood Association are involved with an effort to remove invasive species and control erosion along the bike path. This area is a major contributor of sediment and phosphorus to Lake Wingra.

WEED HARVESTING

CONTACT: Darren Marsh 246-3899 (marsh@co.dane.wi.us)
MANAGING ENTITY: Dane County
WATER BODY: Lakes Mendota and Monona

Aquatic plants, typically Eurasian watermilfoil, are mechanicaly harvested during the summer under a permit from DNR through Chapter NR109. Navigation lines are the priority for harvesting, and when time permits, dense beds are harvested to improve fish habitat.

CHEMICAL CONTROL

CONTACT: Susan Graham 275-3329 (susan.graham@dnr.state.wi.us)
MANAGING ENTITY: DNR
WATER BODY: Lakes Mendota and Monona
Started 1989, ongoing

Through Chapter NR107, the DNR permits limited application of aquatic herbicides to dense patches of macrophytes and filamentous algae near private piers and Monona beaches. Permits are applied and paid for by private companies. All applications are supervised by DNR staff and conducted by private, certified, and licensed companies.

WATER AND SHORELINE REGULATIONS

SOURCE: Lakes and Watershed Commission website:
http://www.co.dane.wi.us/commissions/lakes/articles/lakemgmt.shtml

All navigable waters in Wisconsin are held in trust by the state for the public. Many activities affecting navigable waters and shorelines require permits or approvals from the DNR. Some of the physical alterations to navigable waters that require permits include: channel changes, riprap, structures, grading, pipelines, sand blankets for improving beach conditions, private bridges, dams, dredging and surplus water diversion. Permits also may be needed from the U.S. Army Corps of Engineers for filling wetland areas. Generally, no permit is required for pier construction unless the pier extends beyond a pierhead line or interferes with the rights of the public or other riparian proprietors.

Local units of government also administer regulations to control development along the shorelands of lakes and streams and within floodplains. Shoreland control is confined to lands within 1000 feet of a navigable lake, pond or flowage, or within 300 feet of a river or navigable stream (or to the landward side of the floodplain). Shoreland, wetland and floodplain zoning ordinances often include: restrictions on filling or dredging in wetland and floodplain areas; permitted use of shorelands, floodplains and wetlands; lot size; setbacks of buildings from navigable waters; tree and shrub cutting along shorelands; and location and size of waste disposal systems. County and municipal zoning administrators should be contacted when activities are being contemplated in these areas.

APPENDIX D: MAP OF AREA WATERSHEDS