Groundwater Resources[3]

Regional Aquifers

Water supplies for domestic, agricultural and industrial uses in the Lake Mendota watershed are obtained from both private groundwater sources and municipal systems. Groundwater is the only source of drinking water in the Lake Mendota Priority watershed. Groundwater is stored underground in pore spaces and cracks in soil and rock layers. Soil and rock layers which hold groundwater are called aquifers. In an aquifer, all the pore spaces and cracks are filled or saturated with groundwater. A well is simply a pipe through which groundwater is pumped from an aquifer to the land surface.

Three aquifers have been identified in the Lake Mendota watershed. From the ground surface down, these include: 1) a sand and gravel aquifer, composed of glacial and other unlithified materials; 2) an upper bedrock aquifer composed of sandstone and dolomite; and 3) a lower bedrock aquifer composed of sandstone of the Eau Claire formation and the Mt. Simon Sandstone. Between the upper sandstone and dolomite aquifer and the Mt. Simon and Eau Claire sandstones there is a confining unit composed of the shale of the Eau Claire formation. This confining unit is not present under the Yahara lakes nor in the eastern portion of the county where the Lake Mendota watershed is located (Fig. 2-2).

The geology of the watershed was recently updated as part of the Dane County Regional Hydrologic Study commissioned by the Dane County Regional Planning Committee (Bradbury and others, 1997). The purpose of the Dane County Regional Hydrologic Study was to improve the understanding of the groundwater system and its relationship to surface water, update the last comprehensive groundwater resource assessment (Cline, 1965) and to provide a three-dimensional groundwater model to be used for water resource management decision making in the future. Products of the study include:

- A database of hydrogeologic data for 4,000 municipal and private wells;
- Water table elevation maps for the entire county at a scale of 1:24,000;
- Maps showing the level of water in wells drilled in the deep sandstone aquifer (potentiometric surface), depth to bedrock and hydrologic properties of the shallow aquifer at a scale of 1:100,000;
- Maps of groundwater capture zones for municipal wellhead protection areas;
- A three-dimensional model of groundwater flow for the entire county.

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[3] This section prepared by Laura Chern, DNR

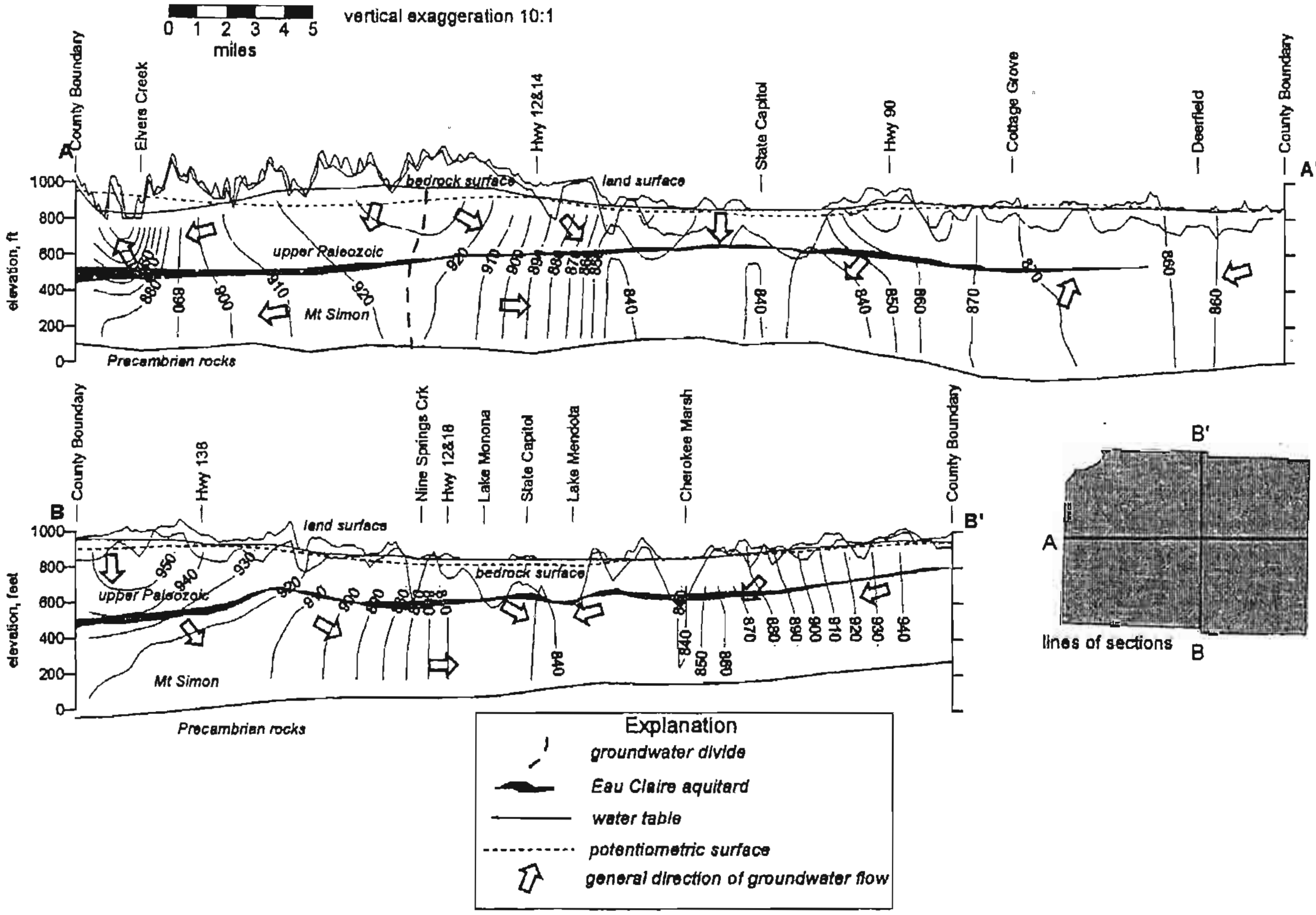

Fig. 2-2. Aquifers in the Lake Mendota Watershed.

Direction of Groundwater Flow

Local groundwater flow in the Lake Mendota Watershed generally follows topography. Groundwater infiltrates (recharges) at topographic highs and is discharged to lakes, streams and wetlands unless it is intercepted by a shallow well. Regional groundwater flow occurs in the deeper Mt. Simon and Eau Claire formations which are also recharged at topographic highs and discharge to the Yahara lakes. In the case of the Lake Mendota watershed, regional groundwater flow is generally to the southwest.

The three-dimensional flow model recently completed as part of the Dane County Regional Hydrologic study compares present groundwater flow to pre-development conditions in order to test research results. The greatest effect of pumping on water levels occurs in and around the city of Madison where water levels in the upper and lower aquifers have declined by more than 60 feet. Similarly, water levels in the Lake Mendota watershed have declined, and the model indicates that groundwater flow direction has been reversed near large cones of depression formed by Madison municipal wells. Groundwater is being recharged from the Yahara lakes, streams and wetlands. By comparing pre-development conditions to 1992 flow at gaging stations, it is apparent that pumping has reduced baseflow.

Groundwater Quality

A total of 157 private well samples were collected for nitrate analysis in the Lake Mendota priority watershed (Table 2-3). An alarming 65% of these samples exceeded the health-based enforcement standard of 10 mg/L. An additional 25% exceeded the preventive action limit of 2 mg/L. The preventive action limit indicates the level at which human actions affect groundwater quality. Most private wells in the watershed draw water from the upper aquifer, and sources of contamination are probably within 1 or 2 miles of affected wells. When contamination is as widespread as it appears to be in the Lake Mendota watershed, runoff from excess manure and fertilizer application is a likely source of nitrate in groundwater.

Concentration for nitrate ranged from not detected to 46.7 mg/L (parts per million). One part per million is comparable to one drop in a 10-gallon fish tank. No specific source of contamination is indicated by the results.

Table 2-3. Well Sampling Results for Nitrates: Lake Mendota Watershed

Subwatershed	Total samples taken	Number of Nitrate Samples and %of samples taken: <2 mg/L	(P.A.L.) > 2 and <10 mg/L	(E.S.) >10 mg/L
Lake Windsor	0	0	0	0
Token Creek	3	0	1 (33%)	2 (67%)
Yahara River	22	1 (5%)	3 (14%)	18 (82%)
Cherokee Marsh	3	1 (33%)	0	2 (67%)
Brandenburg Lake	4	0	3 (8%)	1 (25%)
Sixmile Creek	52	6 (12%)	15 (29%)	31 (60%)
Dorn Creek	29	3(10%)	11 (38%)	15 (52%)
Pheasant Branch Creek	16	3 (19%)	4 (25%)	9 (56%)
Lake Mendota	0	0	0	0
Schoenberg Marsh	3	0	0	3 (100%)
Goose Pond	6	0	1 (17%)	5 (83%
N. Yahara River	19	1(5%)	2 (11%)	16 (84%)
Totals	157	15 (9.5%)	39 (25%)	102 (65%)

1999 Well Sampling Program

In 1999, additional groundwater sampling was offered to rural residents in the Lake Mendota watershed (Dane Co. LCD, 1999). Two-hundred and forty-eight residents participated in the sampling. Some wells were found to be free on contamination; however, significant levels of nitrates and triazines were found in 40 percent and 38 percent of the wells, respectively. The levels of nitrates in the goundwater of the Lake Mendota watershed are among the highest in the state. Forty percent of the wells were found to have nitrate levels above the state and federal drinking level standard of 10 milligrams per liter, which is not safe for pregnant women or infants to drink. Seventeen samples (47%) exceeded 20 milligrams per liter and two exceeded 40 milligrams per liter. Sources of nitrates include fertilizer, septic system effluent and animal waste.

Triazines are a group of chemicals related herbicides, the most common of which is atrazine. Triazines are suspected of causing cancer, birth defects, heart and liver damage and skin allergies. Atrazine levels about 0.3 parts per billion is cause for concern. Seventy-two of the samples contained a measurable amount of atrazine and 38% had levels about 0.3 parts per billion. Atrazine is classified as a possible human carcinogen. Levels of 3.0 parts per billion or more are considered an unacceptable risk for long-term consumption. Public water supplies cannot contain more than these levels and private well owners are advised not to drink their water with readings this high.

Coliform bacteria were detected in 13% of the samples. These bacteria do not usually cause disease by themselves, but indicate that disease-causing bacteria could be present.

Water quality specialists suggested that additional testing be conducted to verify the accuracy of the readings. Depending on the level and type of contamination, various actions are recommended, including well repairs, water treatment devices, or drilling a new well. Education is a key component in groundwater protection, and both Dane County and the state run various programs from well maintenance to pesticide application.

Farm Practices Inventory

The Farm Practices Inventory (FPI) is a formal assessment of land users' nutrient and pest management practices conducted in some priority watershed projects by the University of Wisconsin-Extension. Three reports were completed as a result of the Lake Mendota FPI (See Appendix 2 - Farm Practices Inventory). The second report from this study, "Nitrogen and Phosphorus Management," focuses on the use of farm fertilizers, specifically nitrogen and phosphorus (Nowak and others, 1996b). Each farmer's nitrogen use was assessed independently to determine the total rate of nitrogen application on their most productive corn field. Of farmers surveyed, 50% applied nitrogen fertilizer more than 10 pounds per acre over recommended rates. Of farmers surveyed, 73% either under-credited the amount of nitrogen from manure or didn't credit nitrogen at all from manure application. About 93% of farmers surveyed did not credit enough nitrogen (by 10 percent) contributed by legumes.

The third report from this study, "Farmstead Pollution," focuses on the use of pest management strategies and farmstead pollution prevention (Nowak and others, 1996c). The report documents pesticide storage practices, manure storage, milkhouse waste, fuel storage tanks and farmstead well protection. Improperly abandoned wells present a direct risk to groundwater as they can act as a direct conduit from the surface to the drinking water source. Of farmers surveyed, 26% indicated they have one or more abandoned wells on their farmstead.

Safe Drinking Water Task Force

In the spring of 1996, then Dane County Executive Rick Phelps established the Safe Drinking Water Task Force. The goal of the task force was to recommend specific actions to protect Dane County's groundwater. A final report was completed that fall (Born and others, 1996). In response to the final report, a 5-year plan to ensure safe drinking water was included in Dane County's 1997 budget. The county executive's 1997 Safe Drinking Water Budget Initiative allocated the following for groundwater protection (all of which are related to problems that can be addressed in the Lake Mendota Priority Watershed):

Table 2-4. Safe Drinking Water Task Force Recommendations & Budget

1. A well abandonment program to include : a) an information and education campaign regarding the need to abandon wells properly; b) a 75-percent cost sharing program to properly abandon unsafe, unused and noncomplying wells; c) subdivision review to include well issues. The program will complement a newly created federal program for proper well abandonment in agricultural areas.	$16,000
2. An inventory of all manure storage structures in Dane County to improve regulation of manure storage and insure that old manure pits are properly abandoned.	$6,000
3. Continued support of development of the regional groundwater model.	$2,500
4. Partnership funding to continue flow monitoring of Black Earth Creek. This monitoring will provide critical information on the groundwater-surface water interaction in the western part of Dane County.	$4,650
5. Survey of septic systems in western Dane County, where the risk for septic system failure and groundwater degradation is the highest in the county. A detailed survey will establish how great a problem exists.	$10,000
6. Expansion of the county septic system maintenance program to all septic systems; currently, those installed before 1980 are not covered.	$42,000

The Dane County executive recommended addressing the following over the next four years:

1. Protect wellheads with overlay zoning, appropriate development standards and inter-governmental agreements.

2. Create a partnership with the state to insure that all septage produced in Dane County is properly disposed.

3. Insure that high capacity wells are properly cased and extend into the deep sandstone aquifer.

4. Promote farmer's use of improved pest management techniques so they can reduce their use of pesticides an improve their profitability.

5. Work with state regulators to prevent leaks from underground storage tanks.

Conclusions and Recommendations to Groundwater Contamination Problems

1. The three-dimensional groundwater model completed by the WGNHS and USGS indicates that water conservation is needed in the watershed to maintain baseflow to lakes, rivers, streams and wetlands. Decreased baseflow not only affects water quantity in surface water but also temperature and therefore fish and aquatic habitat.

2. Water conservation is also critical for maintaining a high quality water supply in Dane County. As pumping has increased, water is drawn from the upper aquifer to the deeper aquifer. The shallower aquifer is more vulnerable to contaminant sources due to land use.

   Recommendations for 1& 2: The public education plan (known as "information and education," or I&E, plan) for the Lake Mendota Watershed should contain a water conservation element.

3. Zones of contribution for municipal wells in the watershed have been delineated using the three-dimensional groundwater model. Overlay zoning can be used to set up wellhead protection areas for all municipalities.

   Recommendation: The watershed staff should work with Dane County and the DNR on wellhead protection ordinances or overlay zoning for municipalities in the watershed.

4. More than 65% of private wells tested for the watershed appraisal had nitrate levels greater than the health based enforcement standard of 10 mg/L. Such wide-spread contamination suggests that nutrient management is needed to preserve and enhance groundwater quality in the watershed.

5. The Farm Practices Inventory showed that 50% of farmers in the watershed are over-applying nitrogen fertilizer and not adequately crediting other sources of nitrogen.

   Recommendation: Nutrient management cost sharing to protect and enhance groundwater quality should be available to most farmers in the watershed.

6. Although no well samples were examined for pesticides, information shows that groundwater contamination by Atrazine is fairly widespread in Dane County.

   Recommendation: Pest management cost sharing to protect and enhance groundwater quality should be available to most farmers in the watershed.

7. The FPI indicated that some wells in the watershed are improperly abandoned and could act as direct conduits for contaminants to groundwater.

8. The Dane Executive's 1997 Safe Drinking Water Budget Initiative set aside $68,000 for well abandonment and septic system maintenance.

   Recommendation: The Dane County Executive's 1997 Safe Drinking Water Budget Initiative should be explored as a source of funding for well abandonment and septic system maintenance for septic systems installed prior to 1980 and located within the watershed.

Wetlands[4]

Introduction

Wetlands are an integral part of the Lake Mendota Watershed and have been an important resource for its wildlife, people and water quality since before recorded history. While the extent of wetlands within the watershed has fluctuated greatly in recent geologic times, modification of wetland communities by human activity in the last 150 years has caused significant changes to the present-day Mendota area landscape. Wetland loss and degradation during this period has contributed to a decline in the water quality of Lake Mendota, and reduced the value of the lake as a fishery and habitat for waterfowl and other wildlife.

Wetland History

Geologic Changes -- The outline of Glacial Lake Yahara, a meltwater lake left behind by the retreating glacier some 13,000 years ago, can still be seen in the organic soils surrounding present-day Lake Mendota. In places, these soils still support sedge-meadow or cattail wetland communities. Lake Yahara, with waters estimated to be 12 feet above current Lake Mendota, would have inundated many familiar local wetlands such as Cherokee Marsh and Pheasant Branch Marsh. Nonetheless, net wetland area within the watershed likely surpassed that of modern times for thousands of years after the glacier departed, until outlets for meltwater and precipitation slowly developed through the glacial outwash. The relative area of Lake Mendota, its littoral zone and upland wetlands within the watershed has likely fluctuated for thousands of years.

Early Settlement -- The Four Lakes region has been continually inhabited since about 10,000 BC, by at least four native cultures. Wetlands were important to these cultures for hunting and gathering, fishing and for the extensive wild rice beds. Native peoples used some of the same techniques later employed by European settlers to manage and manipulate wetlands, such as using fire to rejuvenate marshes and make travel easier, reseeding wild rice beds to ensure a continued supply of this annual grass and constructing small dams and weirs to improve navigation or concentrate fish for harvest. It seems unlikely that such early management significantly altered the wetland area of the watershed.

Similarly, European settlement, beginning in the 1830's, did not immediately bring great changes to the Mendota wetland community. Early settlers' first priorities were with breaking prairie soils, clearing land, and building farmsteads. The first significant wetland changes were apparently due to flooding, not drainage, as dams were built for grist and saw mills. The first grist mill was built on Token Creek in 1849, with a second there in 1860. A third grist mill was built on Sixmile Creek near Waunakee also in 1860. These millponds probably inundated some wetland acreage, while creating wetland conditions on adjacent uplands. The net effect may have been to change wetland type as often as acreage, usually to the detriment of water quality, as formerly free flowing streams were slowed, warmed, and

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[4]This section prepared by Mike Foy with field assistance from Cami Peterson.

allowed to acquire silt burdens. But though locally important, these small millponds probably had a minimal effect on the wetlands and water quality of Lake Mendota.

In contrast, construction of the earliest and largest of the milldams, the Farwell Dam at the outlet of Lake Mendota, ranks among the larger human changes to the watershed. Begun in early 1849 by future Governor Leonard Farwell, the dam raised the level of Lake Mendota 3.5 feet to power the grist mills, lathes and saws of Farwell's "Madison Mills" on the present site of Tenney Park. A thriving business for many years, the wood and earth dam washed out in 1866, but was rebuilt only to have the mill burn twice over by 1894. The once marshy slough between the lakes was dredged and straightened in 1849 as well. The dam was eventually rebuilt with locks to allow navigation to Lake Monona. The dam has clearly been a major influence on Lake Mendota wetlands and water quality to this day.

In raising the pool, certain areas of deep-water aquatics were undoubtedly lost, especially as water quality and light penetration declined over the years. Shallow aquatics probably shifted location, while near shore emergents would have been inundated. The lake flooded over the bar in the north bay, fetch increased and the extensive wetlands between the bar and the Yahara River inlet were exposed to destructive wave action. The higher water also floated emergent stands, which became susceptible to calving and loss from the increased wave action, and later, from the increased flood flows as the watershed was ditched and cultivated.

By the turn of the century, calving had apparently removed a large area of emergent wetland in the north bay, resulting in Sixmile Creek emptying directly into the lake, rather than through its former outlet into the Yahara River. Although much of the emergent loss within the lake itself was accomplished by 1900, Cherokee Marsh and the Upper Yahara River have seen steady losses this century, including as recently as 1993, when record precipitation caused large chunks of emergents to break free and float across the lake to rest against the University of Wisconsin shoreline.

Organized and Private Drainage -- By the early 1900's, increasing demand for arable land turned attention to wetland reclamation. University of Wisconsin agricultural research promoted drainage to lengthen growing seasons and improve yields even on only seasonally wet fields, while providing fertilization recommendations to make wetland soils productive. Steam dredges became available, and a 1891 state law authorized the formation of drainage districts and assessments to finance them. At least seven drainage districts were organized in the Mendota watershed since 1916, eventually draining over 3,000 acres through construction of main drains and stream channelization. Of these, four districts are still considered active and will require consideration prior to any wetland restoration projects in the watershed (Table 2-5).

By providing ditch outlets for gravity flow of water within reasonable distance of many farms, the drainage districts (along with improved town road ditches) encouraged additional private drainage. Drainage efforts increased greatly between 1940 and 1970 with swelled demands for providing foodstuffs for two World Wars, growing post-war export markets and improved USDA financial and technical drainage assistance. Nearly all large wetland complexes within the watershed were drained to some extent, and some were lost completely, such the extensive area along Pheasant Branch Creek in the Town of Middleton, known as

Slaughter's Marsh or The Big Marsh. Other significant wetland losses have been to nonagricultural drainage, such as the conversion of wetland into the Cherokee Country Club.

Table 2-5. Active drainage districts within the Lake Mendota watershed.

Drainage District Number	Town or Municipality	Section(s)
11	Windsor	13, 24, 25
22	Vienna Windsor DeForest (Village)	23, 24 18 18
5	Windsor	4, 5, 6, 7, 8
29	Vienna	5,23,26

Dredging and Filling -- Although wetland loss through filling has not equaled that of drainage, these losses are notable because subsequent development makes filled areas virtually irretrievable to any restoration effort, and because they represent a high proportion of former shoreline and near-shore wetlands important to water quality and to fish and wildlife for spawning and nesting.

An estimated 25% of the original City of Madison plat was marshy. These extensive wetlands were among early Madison's least appreciated features. Condemned by physicians and town boosters for their poor aesthetics, stench and disease-carrying mosquitos, they were the target of numerous drainage attempts. Those failing, the wetlands eventually fell victim to dredging and filling for park and residential land. Many of Madison's popular area parks and lakeshore areas were reclaimed by dredging and filling wetlands. Starting in the late 1890s, rock hauled in by train and wagon was used to lay out roads delineating city blocks, which were subsequently filled with sand piped in from Lakes Mendota and Monona by steam-powered dredges. By 1920, the Great Central Marsh was a memory, although it took the construction of a huge storm sewer draining to Lake Monona in combination with filling to finally subdue this last holdout among major Madison wetlands.

Although most of these isthmus wetlands actually drained to Lake Monona, the battle to subdue them set a tone for reclamation efforts on Lake Mendota wetlands that continued well into the 1960's. Significant wetland losses during that decade from dredging and/or filling occurred during the creation of Cherokee Lake and Park from Cherokee Marsh, development of UW recreation facilities adjacent to University Bay and the construction of Interstate 90/94. Occurring on the cusp of the environmental movement, these projects became increasingly controversial, and current regulations would now severely restrict large wetland losses of this type. Unfortunately, as the Mendota watershed becomes urbanized, less obvious but significant filling for road, housing and commercial development continues to this day, often escaping regulation because previous agricultural drainage removed project lands from wetland delineations.

Wetland Protection Efforts -- It has only been in recent years that wetland protection efforts have since been used in the Lake Mendota watershed. All levels of government, as well as private conservation organizations, have promoted wetland preservation through efforts such as the purchase of Cherokee Marsh, Waunakee Marsh, Pheasant Branch Marsh, Sixmile and Dorn Creek Fisheries Areas, Token Creek Park, Governor Nelson Park, Schoenberg's Marsh and Goose Pond, among others.

Wetland protection regulations have come to the forefront since the early 1970's, complementing acquisition efforts. Section 404 of the federal Clean Water Act, and Chapters 30 and 31 of the State Statutes are regulations concerning navigable waters, NR 103 water quality certification, county wetland zoning, local land use ordinances and quasi-regulations such as USDA Swampbuster provisions have also combined to provide protection from wetland losses to ill-conceived projects. Increasingly, wetland mitigation is required as a permit requirement of unavoidable wetland losses.

Finally, incentive programs have shown great promise for wetland protection and restoration on private land. Federal Water Bank, Conservation Reserve and Wetland Reserve programs have provided compensation to landowners who protect wetlands on their property, while U.S. Fish and Wildlife Service, Natural Resource Conservation Service and state and county programs, including this watershed project, are now available to provide cost-sharing for wetland restoration on private land. Private organizations such as Ducks Unlimited, Wisconsin Waterfowl Association, Pheasants Forever and Madison Audubon continue to play a leadership role in private wetland protection.

Wetland Loss, and Watershed Impact, and Named Wetlands

The Lake Mendota watershed historically had large wetland areas, particularly along the low gradient tributaries to the lake. But a significant amount of wetlands have been lost in the watershed. One estimate is that 50% of the wetlands have been lost since 1835 (Lathrop, 1992). A second estimate was generated by the USDA's Natural Resources Conservation Service wetland inventory (1994). Their survey concluded that 31% of historic wetland acres have been lost to agriculture (USDA converted and prior converted categories) while 69% of historic wetlands still remain (USDA wetland and farmed wetland categories) in only the Dane County portion of the watershed. This may still be considered a conservative estimate, as it does not include some historic wetland acres, both lost and remaining, that were not inventoried because they are within urban or other nonagricultural areas.

Table 2-6. Wetland area in watersheds of the Yahara lakes between 1835 and 1974, with percentage lost since 1835.

Wetland Area (acres)								
Year	Mendota	% lost	Monona	% lost	Waubesa	% lost	Kegonsa	% lost
1835	10,176	-	4,891	-	6,200		5,829	
1938	7,879	23%	1,828	63%	4,792	23%	4,248	27%
1974	5,088	50%	371	92%	1,680	73%	1,754	70%

Sources: 1835 - Township survey maps (published by the U.S. Surveyor General's Office in 1851 and 1855).
1938 - Wisconsin Conservation Department (1961).
1974 - U.S. Geological Survey topographic maps (printed in 1976).
Adapted from: Lathrop, et. al., 1992.

Table 2-7. Wetland resources* of the Dane County portion of the Lake Mendota Watershed based on 1994 USDA's Natural Resources Conservation Service Wetland Inventory.

Wetland type		Acres	Total Acres	Percent
Total Remaining Wetland - 1990	Wetland	8,602	9,682	31%
	Farmed Wetland	1,080		
Total Lost Wetland	Prior Converted Wetland	4,262	4,301	69%
	Converted Wetland	39		

* Not including Lake Mendota, artificial wetlands, and non-inventory lands.

These data, while varying in estimates, agree that significant acreage in the Mendota watershed has been lost. The expected effect on the watershed has been greater peak runoff episodes, increased scouring, reduced filtration and ultimately increased sediment and nutrient delivery to Lake Mendota. This in turn contributes to a decline in Lake Mendota water clarity through increased algal blooms, reduced deep water and littoral zone aquatic beds and degraded fish and wildlife habitat.

The wetland resource inventory conducted in 1996 revealed that there are 49 named wetland resources of the Lake Mendota watershed, existing and lost. These are listed in "Appendix One - Wetlands" in recognition of the importance of wetlands to the watershed. Location, ownership (known but not published) and approximate size are shown where known. Wetland size or quality may be greatly reduced at some sites. Protection and enhancement of existing wetland resources in the watershed is important for maintaining and improving the water quality of Lake Mendota, as well as for their own inherent values. Enforcement of construction site erosion control ordinances and improved storm water management are a necessary part of wetland protection in and on the fringe of urban areas. Cooperative landowner agreements and purchase of wetland easements or other land rights are also options for protecting existing wetlands in the watershed.

Wetlands within the Lake Mendota "Flood Pool"

Appraisal for Restoration and Protection

Evaluations in this section are aimed at preventing further loss of emergent beds within the Lake Mendota 100 year flood pool (851.75 feet NGVD at Tenney Park Dam, 853.75 feet at Highway 113 bridge), and investigating possible mechanisms to restore in-lake wetland habitat.

Construction of the Tenney Park (Farwell) dam resulted in the drowning of swamp and deep marsh adjacent to the Yahara River where it passes through Cherokee Marsh (Bedford, 1974). However, the Mendota impoundment is also credited with preserving the Cherokee Marsh by making conversion to other uses difficult. Raising the water level also floated emergent beds along the Yahara and in the North Shore Bay of Mendota, allowing calving or scouring by subsequent high water events or by ice piles during spring breakup. These losses have not attracted as much attention as those of the Winnebago pool lakes at the confluence of the Fox and Wolf Rivers (Wisconsin DNR, 1989). The 1849 impoundment occurred before the memory of recent observers, and the more modest peak flows of the Yahara River have caused emergent loss to occur more gradually. Yet steady incremental losses persist, as evidenced by the loss of the peninsulas that once bordered Cherokee Lake. A comparison of the open water area of the Yahara River between Lake Mendota and the mouth of Token Creek on the 1904 and 1983 USGS topographic maps indicates that about 276 acres of riparian emergent wetlands have been lost this century. These losses can be expected to continue unless 1) Yahara River peak flows are attenuated, 2) Lake Mendota water levels are lowered, at least periodically, or 3) Structural barriers such as riprap are provided to protect riparian wetlands from calving. A more sophisticated evaluation of these alternatives will be required, including the alternative that wetland loss rates are acceptable relative to the cost of abatement.

Alternatives and Recommendations within the Lake Mendota Pool

<u>In-Lake Alternatives</u>

1) Evaluate benefits of raising the historic bar in the North Shore Bay running from Governor Nelson State Park east to the navigation channel for wave attenuation, sediment deposition, emergent and submergent vegetation colonization and fish and wildlife habitat. Cost: ~$30,000 for preliminary study.

2) Evaluate benefits of scheduled summer drawdowns of Lake Mendota on a 10-year interval to encourage colonization of emergent wetland beds in the North Shore Bay and Cherokee Marsh.

3) Evaluate structural protection methods such as riprap to prevent further loss of riparian emergent wetlands at the mouth of Lake Mendota. Cost: $25+/foot.

4) Evaluate benefits of no entry in-water refuges for waterfowl during spring and fall migration periods in North Shore and University Bays.

Cherokee Marsh Alternatives

1) Evaluate structural protection methods such as riprap to prevent further loss of riparian emergent wetlands. Important areas are the City of Madison parklands at Hickory Point in the North Unit of Cherokee Marsh Park, and the South Unit of Cherokee Marsh just upstream of the Highway 113 bridge. Cost: $25+/foot.

2) Evaluate impeding drainage through the Mud Creek tributary to Token Creek to help maintain the water levels in the marsh proper. The objective would help identify the source of the springs in the high value fen areas, without actually inundating the fens or destroying northern pike spawning habitat.

Cherokee Marsh Recommendations

1) Conduct a hydrological study to determine a) if Cherokee Marsh groundwater levels are falling; b) if groundwater levels determine rates of peat oxidation and nutrient release Lake Mendota; c) if there are methods to protect springflow in fens on the state natural area; and d) if limits on groundwater removal are necessary. Cost: ~$25,000.

2) Design and construct plugs for all possible Cherokee Marsh ditches to help capture sediment and nutrients during peak flood flows and reduce nutrient release during low flow periods. Any plans for this work must consider effects on northern pike spawning habitat. Cost: $20,000 - 30,000.

3) Design and construct floating baffle to prevent wave action from causing further enlargement of the sewer intercept ditch in the South Unit of Cherokee Marsh Conservation Park and erosion of the School Road (Wheeler Road) fen. Cost: $5,000

4) Assist state, county and city government in completing land acquisition goals within Cherokee Marsh and encourage cooperative vegetation management by use of prescribed burns and other techniques for control of exotics. Cost: None to priority watershed.

5) Maintain the flood profile between Westport Road and the Highway 113 Bridge (0.5 foot for 10-year flood, 1.5 foot for 50-year flood, 2 foot for 100-year flood) in recognition that increases in pool elevation may be necessary to maximize Cherokee Marsh sediment and nutrient trapping.

6) Develop and implement a design to prevent storm water runoff from across County Highway CV from causing erosion and sedimentation to the fens on the state natural area.

Upland Wetland Sites

Appraisal and Restoration

The upland wetland evaluation looked at wetlands that have been lost through various practices but still retain some wetland characteristics such as hydric soils, ponded water or the presence of wetland vegetation. To identify these sites, a number of data sources were consulted. A primary source was the Natural Resources Conservation Service (NRCS) wetland inventory. This inventory includes the following categories in the Lake Mendota Watershed: Lake Mendota (open water), artificial wetlands, converted wetlands, farmed wetlands, non-inventoried (usually wooded or urban areas), prior converted wetlands, upland surrounded by wetlands, upland, and wetland. Wetlands, farmed wetlands and prior converted lands were of primary interest.

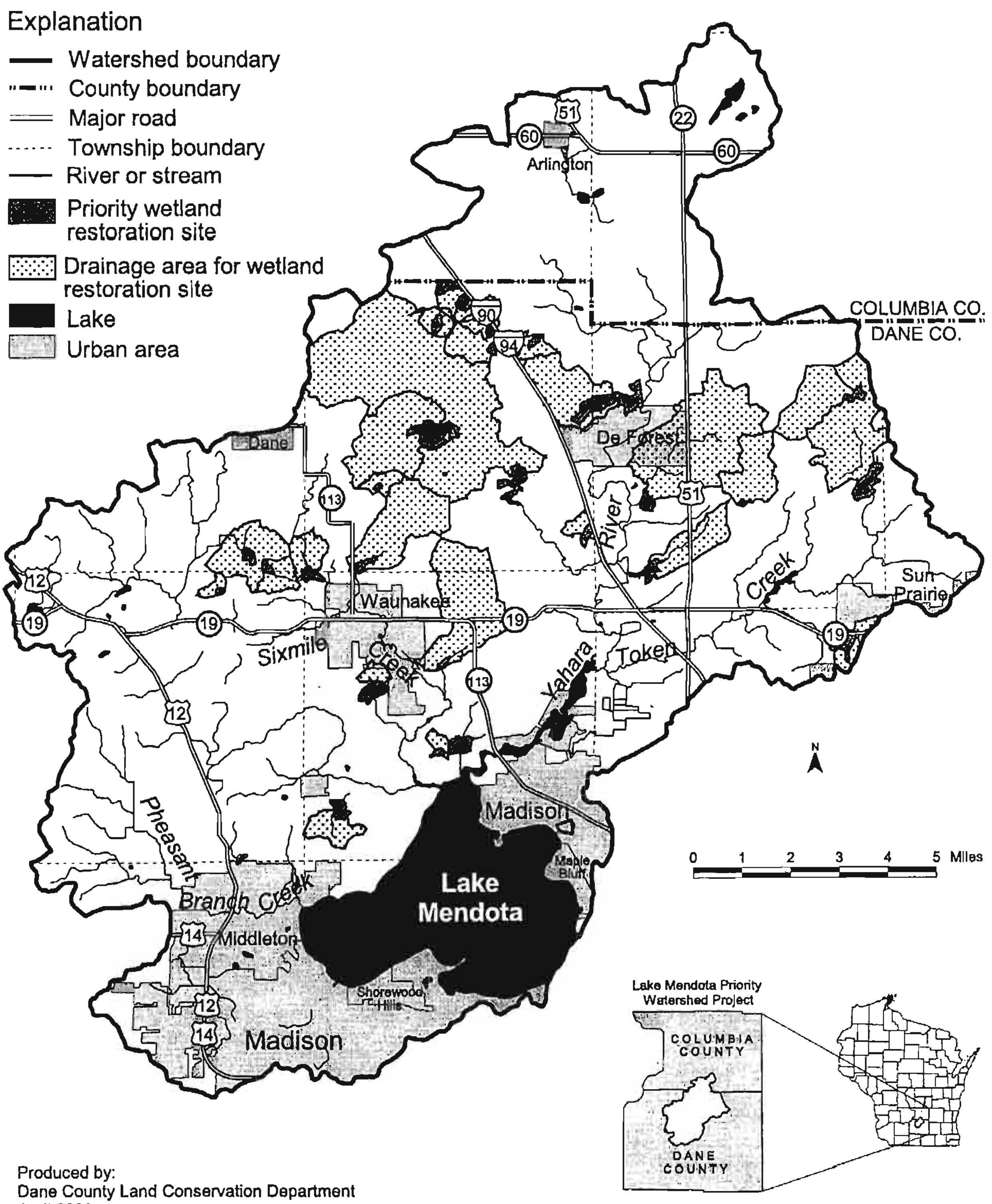
Wetlands (W) are defined by NRCS as lands that have wet, saturated soil during some part of the growing season, and would support plants that grow in wet soils if the area was not disturbed by tillage, mowing or similar actions. Farmed wetlands (FW) are defined as cropland that was cleared, drained or filled *and* cropped before December 23, 1985, *and* is a pothole that still meets wetland criteria, *or* is a wetland that, in many years, still floods or ponds in the spring or fall. Prior converted cropland (PC) is defined as cropland that may contain wetlands that were cleared, drained, filled or otherwise manipulated to make them cropable before December 23, 1985. The fields must also have been used to produce crops prior to this date.

Map 2-9 shows the potential upland wetland restoration sites. A list of possible restoration sites in the Lake Mendota watershed is found in Appendix One-Wetlands. That list presents restorable wetlands in the FW and PC categories. Some additional time was spent evaluating potential for enhancement of existing wetlands. The sites evaluated tend to be larger in size. The reason for this is twofold. First, we wanted to locate those wetland restorations that would have the greatest impact on water quality in Lake Mendota. A potential site was evaluated using the WINHUSLE computer model. The model estimated the sediment loading to a receiving water body, and estimates the ability of the downstream area to receive the load. Delivery efficiency is based on the site's location in relation to Lake Mendota or its main tributaries. Other factors such as wildlife habitat value were also used in the evaluation.

Second, we hoped to identify projects that could not be restored through other programs. Small wetland restoration projects already have funding available from the U.S. Fish and Wildlife Service, NRCS, the Department of Natural Resources, Wisconsin Waterfowl Association and Ducks Unlimited. We wanted to target wetland projects that could be accomplished through the cooperation, resources and financial assistance available though the priority watershed program. However, these agencies and organizations should be encouraged to continue their restoration efforts on the many smaller sites in the watershed.

Any measurements of areas and distances are an approximation only. If the site is reviewed further, more accurate measurements will need to be taken. Second, a cursory investigation

Map 2-9. Priority Wetland Restoration Sites in the Lake Mendota Priority Watershed Project

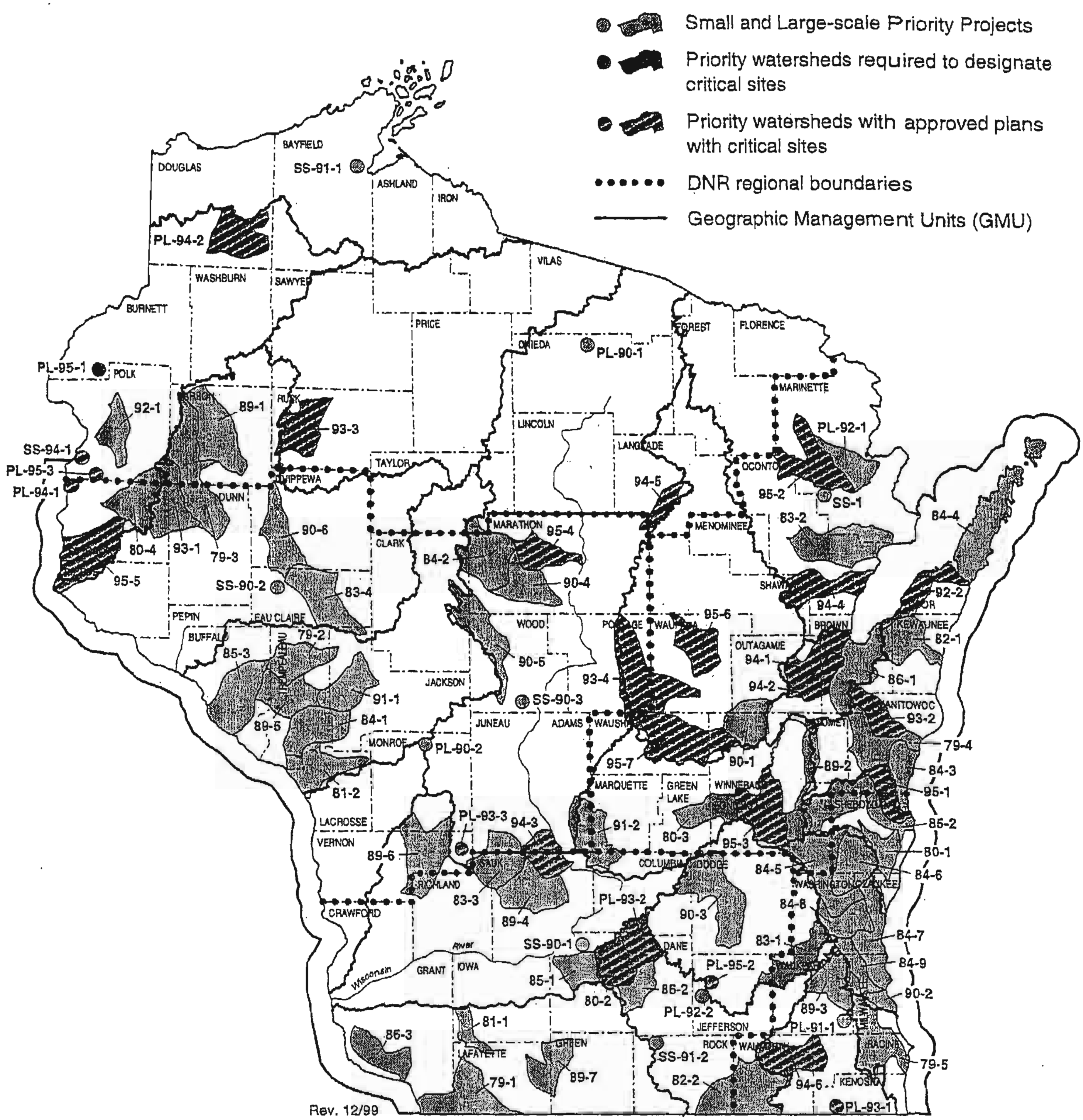


Produced by:
Dane County Land Conservation Department
April 2000

of whether a site is a navigable stream was determined based on its being at least an intermittent stream on the U.S.G.S. 7.5 minute series topographic map. Further investigation may be needed. Finally, no landowner contacts were made, and sites were physically reviewed from the roadway only. The presence of ditches and tile lines at a site may have been overlooked. If a site is pursued, tile records and ditches may need to be researched further.

Appendix One-Wetlands includes all the components of the inventory. These are: site location; list of hydric soils; location in relation to Lake Mendota, the nearest water body, and the nearest urban area; located in an active drainage district; wetland drainage area; size of restored wetland; type of restoration needed; any notes of interest, including but not limited to history of site (if known), current condition of wetland, current condition of surrounding uplands.

Priority Watershed Projects in Wisconsin



Priority Watershed Projects in Wisconsin: 1999

Year Selected-Map Number	Large-scale Priority Watershed Project	County(ies)
79-1	Galena River ♦	Grant, Lafayette
79-2	Elk Creek ♦	Trempealeau
79-3	Hay River ♦	Barron, Dunn
79-4	Lower Manitowoc River ♦	Manitowoc, Brown
79-5	Root River ♦	Racine, Milwaukee, Waukesha
80-1	Onion River ♦	Sheboygan, Ozaukee
80-2	Sixmile-Pheasant Branch Creek ♦†	Dane
80-3	Big Green Lake ♦	Green Lake, Fond du Lac
80-4	Upper Willow River ♦	Polk, St. Crox
81-1	Upper West Branch Pecatonica River ♦	Iowa, Lafayette
81-2	Lower Black River ♦	La Crosse, Trempealeau
82-1	Kewaunee River ♦	Kewaunee, Brown
82-2	Turtle Creek ♦	Walworth, Rock
83-1	Oconomowoc River ♦	Waukesha, Washington, Jefferson
83-2	Little River ♦	Oconto, Marinette
83-3	Crossman Creek/Little Baraboo River ♦	Sauk, Juneau, Richland
83-4	Lower Eau Claire River ♦	Eau Claire
84-1	Beaver Creek ♦	Trempealeau, Jackson
84-2	Upper Big Eau Pleine River ♦	Marathon, Taylor, Clark
84-3	Sevenmile-Silver Creeks ♦	Manitowoc, Sheboygan
84-4	Upper Door Peninsula ♦	Door
84-5	East & West Branch Milwaukee River	Fond du Lac, Washington, Sheboygan, Dodge, Ozaukee
84-6	North Branch Milwaukee River	Sheboygan, Washington, Ozaukee, Fond du Lac
84-7	Milwaukee River South	Ozaukee, Milwaukee
84-8	Cedar Creek	Washington, Ozaukee
84-9	Menomonee River	Milwaukee, Waukesha, Ozaukee, Washington
85-1	Black Earth Creek	Dane
85-2	Sheboygan River	Sheboygan, Fond du Lac, Manitowoc, Calumet
85-3	Waumandee Creek	Buffalo
86-1	East River	Brown, Calumet
86-2	Yahara River - Lake Monona	Dane
86-3	Lower Grant River	Grant
89-1	Yellow River	Barron
89-2	Lake Winnebago East	Calumet, Fond du Lac
89-3	Upper Fox River (Ill.)	Waukesha
89-4	Narrows Creek - Baraboo River	Sauk
89-5	Middle Trempealeau River	Trempealeau, Buffalo
89-6	Middle Kickapoo River	Vernon, Monroe, Richland
89-7	Lower East Branch Pecatonica River	Green, Lafayette
90-1	Arrowhead River & Daggets Creek	Winnebago, Outagamie, Waupaca
90-2	Kinnickinnic River (Milwaukee Basin)	Milwaukee
90-3	Beaverdam River	Dodge, Columbia, Green Lake
90-4	Lower Big Eau Pleine River	Marathon
90-5	Upper Yellow River	Wood, Marathon, Clark
90-6	Duncan Creek	Chippewa, Eau Claire
91-1	Upper Trempealeau River	Jackson, Trempealeau
91-2	Neenah Creek	Adams, Marquette, Columbia
92-1	Balsam Branch	Polk
92-2	Red River - Little Sturgeon Bay	Door, Brown, Kewaunee
93-1	South Fork Hay River	Dunn, Polk, Barron, St. Croix
93-2	Branch River	Manitowoc, Brown
93-3	Soft Maple/Hay Creek	Rusk
93-4	Tomorrow/Waupaca River	Portage, Waupaca, Waushara
94-1	Duck Creek	Outagamie, Brown
94-2	Apple/Ashwaubenon Creeks	Outagamie, Brown
94-3	Dell Creek	Sauk, Juneau
94-4	Pensaukee River	Shawano, Oconto
94-5	Spring Brook	Langlade, Marathon
94-6	Sugar/Honey Creeks	Walworth, Racine
95-1	Pigeon River	Manitowoc, Sheboygan
95-2	Middle Peshtigo/Thunder Rivers	Marinette, Oconto
95-3	Fond du Lac River	Fond du Lac, Winnebago
95-4	Lower Rib River	Marathon
95-5	Kinnickinnic River (St. Croix Basin)	St. Croix, Pierce
95-6	Lower Little Wolf	Waupaca
95-7	Pine & Willow Rivers	Waushara, Winnebago

Year Selected-Map Number	Small-scale Priority Watershed Project	County(ies)
SS-1	Bass Lake ♦	Marinette
SS-90-1	Dunlap Creek	Dane
SS-90-2	Lowes Creek	Eau Claire
SS-90-3	Port Edwards - Groundwater Prototype ♦	Wood
SS-91-1	Whittlesey Creek	Bayfield
SS-91-2	Spring Creek	Rock
SS-94-1	Osceola Creek	Polk

Year Selected-Map Number	Priority Lake Project	County(ies)
PL-90-1	Minocqua Lake ♦	Oneida
PL-90-2	Lake Tomah	Monroe
PL-91-1	Little Muskego, Big Muskego, Wind Lakes	Waukesha, Racine, Milwaukee
PL-92-1	Lake Noquebay	Marinette
PL-92-2	Lake Ripley	Jefferson
PL-93-1	Camp/Center Lakes	Kenosha
PL-93-2	Lake Mendota	Dane, Columbia
PL-93-3	Hillsboro	Vernon
PL-94-1	St. Croix County Lakes Cluster	St. Croix
PL-94-2	Upper St. Croix/Eau Claire River	Douglas
PL-95-1	Big Wood Lake	Burnett, Polk
PL-95-2	Rock Lake	Jefferson
PL-95-3	Horse Creek	Polk, St. Croix

♦ *Project completed*

† *Sixmile-Pheasant Branch is being redone as part of the Lake Mendota project (PL-93-2).*