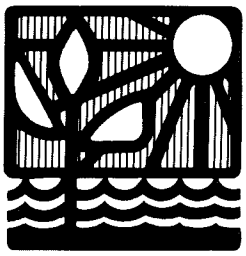
DANE COUNTY WATER QUALITY PLAN

SUMMARY PLAN

DANE COUNTY WATER QUALITY PLAN



SUMMARY PLAN

1990

DANE COUNTY REGIONAL PLANNING COMMISSION

Staff Participating In This Report

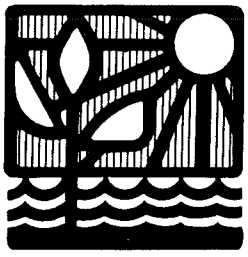
William Lane, Director of Environmental Resources Planning
Paul Gempler, Environmental Planner
Kamran Mesbah, Environmental Engineer
Jill Bates-Warren, Graphics Section Supervisor
Lynnett Miyagawa, Graphics Specialist
Dan Seidensticker, Graphics Specialist
Marcia Peck, Program Assistant

The preparation of this document has been financially aided by funds from the U.S. Environmental Protection Agency and the Wisconsin Department of Natural Resources.

TABLE OF CONTENTS

WATER QUALITY PLAN APPENDICES

CHAPTER I



BACKGROUND AND SETTING

INTRODUCTION AND BACKGROUND

The Dane County Water Quality Plan is the official areawide water quality management plan for Dane County, Wisconsin. The purpose of the plan is to provide a policy framework and guidance for federal, state and local water quality protection programs in Dane County. The initial Dane County Water Quality Plan was developed between 1975 and 1979 under the provisions of Section 208 of Public Law 92-500 (the federal Water Pollution Control Act Amendments of 1972) and the federal Clean Water Act of 1977. A continuing areawide water quality management planning process was established, and the Dane County Water Quality Plan has been continually revised, updated and expanded since its initial adoption and certification in 1979.

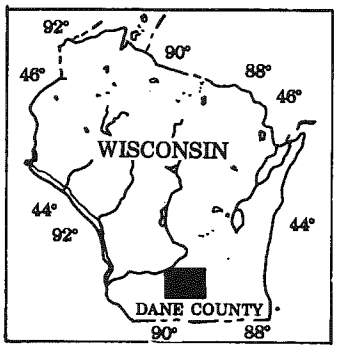
Before 1975, there had been a long history of water quality studies and plans in Dane County. Most of these studies were concerned with municipal sewage discharges, and the effects of those discharges on the Yahara River lakes. The diversion of sewage effluent from the lakes was essentially completed by the early 1970s, so attention began to be directed at remaining sources of pollution causing lake problems. The Water Pollution Control Act Amendments of 1972 required states to develop comprehensive areawide water quality management plans addressing the full range of water quality problems. The federal law provided for the designation of special areas with complex water quality problems, and procedures for designating agencies to accomplish the planning. In 1975, the Governor designated Dane County as an area with complex water quality problems, and the Dane County Regional Planning Commission as the local representative planning agency charged with developing an areawide comprehensive water quality management plan for the region. The Regional Planning Commission worked with federal, state and local management agencies over the next several years to develop the initial Dane County Water Quality Plan. The plan was adopted and certified by the state in 1979 as the official areawide water quality management plan for Dane County.

In accordance with the directives of the federal law, the state established a continuing areawide water quality management planning process. This process is described and guided by state Administrative Rule NR 121, enacted in 1981. The Dane County Water Quality Plan is the areawide water quality management plan for Dane County, but Dane County is also included in the water quality management plans for major river basins, which are prepared by the Wisconsin Department of Natural Resources as part of the statewide continuing water quality management planning process. Basin water quality plans applicable to Dane County include those for the Lower Wisconsin River Basin, the Sugar-Pecatonica River Basin, and the Upper and Lower Rock River Basins (which include the Yahara River and Koshkonong Creek-Maunesha River Basins). The intent and objective is consistency and mutual support between the Dane County Water Quality Plan and the applicable basin plans.

Since completion and adoption of the initial Water Quality Plan in 1979, the Dane County Water Quality Plan has been continually revised, updated, and expanded. Many changes have been made to reflect the achievement or implementation of programs or projects recommended in the initial plan. The plan was also expanded to include subject areas (such as groundwater protection and on-site wastewater management) which were not fully addressed in the initial plan. Finally, several major sections of the plan have been updated to reflect changes in conditions or in federal and state programs and laws.

This summary plan represents a brief overview of the highlights of the full Dane County Water Quality Plan. The plan also includes 11 technical appendices containing detailed data and supporting information in a variety of subject areas, and incorporates and is based on adopted regional land use and development plans, including the Dane County Regional Development Guide and the Dane County Farmland Preservation Plan. The Summary Water Quality Plan has been updated to reflect conditions existing at the beginning of 1990, and includes updated program recommendations for all water quality management program areas, and updated short-range priority actions for all local designated management agencies.

REGIONAL SETTING



Dane County occupies 1,230 square miles in the heart of an agricultural state. Most of the land is very productive farmland. In the center of this farmland is the City of Madison, the state capital and the main campus of the state university. Most of the work force is employed in trade or service industries such as government agencies, insurance companies, retail trade, or the University. Manufacturing provides a relatively small proportion of the available jobs.

As state government and the University have grown in recent years, the County's population has also grown. The City of Madison and other cities and villages have expanded into neighboring agricultural land. In addition, many individual houses and subdivisions have been built on unsewered lots scattered outside of these urban areas. Both the pressures of urbanization and changes in the farm economy have pushed farmers to convert more land to cash crops such as corn. Pastureland has been converted to hay, and drainage in wet areas has been improved to provide more land for corn or pasture.

The expansion of urban areas and changes in farming have affected the region's lakes and streams. There has been some pollution from new industries or overloaded municipal wastewater treatment plants, but the primary problem has been nonpoint source pollution--the runoff from urban and agricultural land. Runoff from construction sites and from cornfields has carried heavy loads of sediment into lakes and streams. Runoff from urban areas has carried a variety of pollutants, including salt, oil and grease, lead, fertilizers, and organic materials such as leaves and grass. Spawning beds

for trout and smallmouth bass have been smothered by silt in many streams. Over the years, the shallow, weedy areas in lakes have increased, algae populations have blossomed, and fish species have been reduced or eliminated from some water bodies. Recreational use of lakes and streams has been impaired by: changes in fish species; by weedy areas which are difficult to swim in or navigate; and by algae blooms which discourage swimming and are odorous and visually offensive.

Trends in population growth, urbanization and agriculture are expected to continue. Therefore, the quality of the region's lakes and streams will deteriorate unless special measures are taken, in both urban and rural areas, to decrease runoff and its accompanying load of sediment, nutrients, and other pollutants.

TRENDS AND FORECASTS

As the second-largest metropolitan area in Wisconsin, and the seat of state government, Dane County experienced very rapid growth in the 1960s. Since then, growth has been at a more moderate level. Future growth is expected to continue at a moderate rate, with the county expected to reach a total population of nearly 406,000 people by the year 2010--an increase of about 25 percent over the 1980 population. About two-thirds of this population is located in the central urban area, 20 percent in outlying urban communities, and 15 percent scattered throughout rural areas of the county.

A growth and development trend which is expected to continue into the future is a slightly greater proportion of new growth occurring in outlying urban communities compared to the central urban area, with rural areas maintaining the present percentage of total population. New urban development is expected to occupy even greater land areas than older development. This is partly due to lower densities of new residential, industrial and commercial construction, and partly due to declining population density resulting from a trend toward smaller household sizes. Other significant trends which are expected to continue include an increasingly older population, and even greater proportion of jobs in the service and retail sectors. The trends and forecasts which have been presented and provide the basis for current plans were developed from the 1980 Census and statewide forecasts. These forecasts will be updated and revised in 1992-93 when 1990 Census information and revised state growth forecasts are available.

Dane County Forecasts

	1970	1980	2010
Population	290,272	323,545	405,862
Dwelling Units	91,880	125,593	184,483
Total Employment	122,646	167,438	229,690
Commercial Employment	41,513	74,293	117,444
Industrial Employment	26,328	32,519	40,175
Govt. & Other Employment	54,805	60,626	72,071

Population Forecasts For Urban Service Areas

USA	1980	1985	1990	2000	2010
Belleville	1,215	1,349	1,417	1,552	1,688
Black Earth	1,179	1,237	1,267	1,328	1,389
Blue Mounds	390	429	453	502	551
Brooklyn	250	291	297	309	321
Cambridge	791	758	801	886	971
Central	218,344	226,004	232,231	244,684	257,138
Cottage Grove	901	1,085	1,178	1,363	1,549
Cross Plains	2,175	2,281	2,631	3,331	4,030
Dane	518	593	602	620	636
Deerfield	1,497	1,563	1,697	1,965	2,234
DeForest	3,659	4,479	4,952	5,898	6,843
Kegonsa	1,956	1,957	1,957	1,958	1,960
Koshkonong	508	512	523	546	570
Marshall	2,366	2,614	2,958	3,646	4,336
Mazomanie	1,333	1,401	1,422	1,463	1,504
Morrisonville	319	324	333	351	370
Mt. Horeb	3,301	3,880	4,011	4,272	4,534
Oregon	3,927	4,398	4,761	5,487	6,213
Rockdale	209	202	211	229	248
Roxbury	217	223	232	250	269
Stoughton	8,256	9,193	9,432	9,910	10,389
Sun Prairie	13,306	14,316	16,093	19,647	23,201
Verona	3,424	3,729	4,031	4,635	5,240
Waunakee	3,890	4,724	5,217	6,202	7,187
Windsor	1,734	1,853	1,962	2,180	2,399

ADOPTED PLANS

The Regional Development Guide

The Regional Development Guide for Dane County is the overall comprehensive land use and development policy framework and guide for Dane County. This plan, which was adopted by Dane County and the Dane County Regional Planning Commission in 1985, replaced the 1973 Dane County Land Use Plan, which previously provided the same policy framework. The objective, in planning in Dane County, has been to develop more detailed plans for specific geographic areas (such as city, village and town master plans) or plans for specific functional or subject areas (such as the Dane County Water Quality or Transportation Plans) consistent with, and in the context and framework of the Regional Development Guide policies and objectives.

The overall regional development objectives and policies are illustrated by three major mapped concept elements illustrating the intended regional development concept. These include: (1) the outer limits of planned urban development, known as the urban service area boundaries; (2) the identification of areas intended to be protected from development, known as open space corridors; and (3) rural areas that include farmland preservation areas and rural development areas.

The urban service areas represent the boundaries or outer limits of planned urban development for all of the communities in Dane County, and contain more than enough land to accommodate anticipated population and development growth to the year 2010. It is intended that a full range of urban services will be provided in these areas, and that urban services will be extended or staged to provide for compact development at urban densities, consistent with regional development policies. There are also limited service areas--areas where only one or a few limited urban services, such as sanitary sewer service, is intended to be provided to special areas, or areas of existing development experiencing special problems. The urban service areas and limited service areas in the Regional Development Guide represent the sewer service areas which are required to be delineated in areawide water quality management plans.

The rural areas shown on the plan map are areas outside of urban service areas intended to remain predominantly rural in character. They include farmland preservation lands, as well as rural non-farm development which is consistent with adopted farmland preservation plans and local town plans.

The open space corridors shown on the Regional Development Guide plan map include two distinct components: urban environmental corridors within urban service areas; and rural resource protection areas outside urban service areas. The urban environmental corridors are a continuous open space network based on natural features and environmental lands such as streams, lakes, shorelands, floodplains, wetlands, steep slopes, woodlands, parks and publicly-owned lands. Rural resource protection areas are based primarily on floodplains, wetlands and shoreland areas--lands protected through zoning or other regulations--together with existing or proposed publicly-owned or controlled lands. These two corridor elements combine to provide a continuous countywide network of open spaces and environmental resources considered to be most critical for protection.

Other Adopted Plans

The Dane County Farmland Preservation Plan, which incorporates land use plans for each of the 34 towns in Dane County, as well as specific city and village master plans, land use plans and comprehensive plans, have been prepared and adopted for most areas in Dane County. In most cases, these plans have been developed within the framework of, and are consistent with, the objectives and policies of the Regional Development Guide. Other regional plans for specific subject areas which have been prepared and adopted, which are pertinent to the Dane County Water Quality Plan, include the Dane County Transportation Plan, the Dane County Parks and Open Space Plan, and the Dane County Solid Waste and Recycling Plan.

ENVIRONMENTAL PROTECTION STRATEGY

In its mission to provide for a safe, healthy and attractive environment for Dane County residents, the Regional Planning Commission has worked with local units of government to develop and adopt a variety of environmental protection plans, including the Dane County Water Quality Plan. In the preparation of plans for environmental protection, the Commission has developed a strategy that incorporates both pollution control and resource protection. Pollution control is not limited to waste treatment facilities, or technology such as emission control devices. Land design and management is recognized as one of the most effective and important approaches to preventing and controlling pollution. Appropriate location and siting of development and of waste treatment and disposal facilities, vegetation management, erosion control, utilization of natural drainage systems and buffer areas--these approaches can go far in protecting the environment if they are used consistently and in concert with resource protection.

Resource protection recognizes that land and natural resources perform critical environmental functions such as groundwater recharge and discharge, water quality improvement, erosion control, storage of floodwaters, wildlife habitat and scenic beauty. Some lands are particularly vulnerable in urban and developing areas. It is important that these critical and vulnerable lands and resources be identified and their environmental functions protected.

The environmental protection strategy in all of the Regional Planning Commission's environmental protection plans, including the Dane County Water Quality Plan, is founded on both pollution control and resource protection--recognizing that either approach alone would not be sufficient.

REGIONAL DEVELOPMENT GUIDE PLAN MAP

DANE COUNTY, WISCONSIN

OPEN SPACE CORRIDOR

INCORPORATED AREA

URBAN SERVICE AREA

RURAL AREA

LIMITED SERVICE AREA

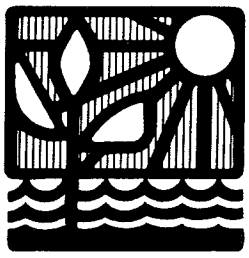
9/90

0 1/4 1/2 1 2 3

Scale in miles

Prepared by: THE DANE COUNTY REGIONAL PLANNING COMMISSION

CHAPTER 2



WATER QUALITY CONDITIONS

INTRODUCTION

The basic facts and conditions most important in understanding water quality issues in Dane County include the climate, the geologic and physiographic setting, and the most important purposes and uses of water resources.

Climate

Dane County's climate is typical of the Great Lakes states. Winters tend to be long, cold and snowy, while summers are short and sometimes humid. The temperature ranges from an average of 17° F in January to 70° F in July. Average annual precipitation is 31 inches, with 60 percent falling from May through September. June is the wettest month with over four inches of precipitation, and February is the driest with about one inch. Snowfall averages 40 inches per year. The ground usually begins to freeze at the end of November and thaws in mid-April. Maximum frost depth averages over 18 inches. Severe storms often occur from late fall through mid-spring. Thus, the potential for runoff and severe erosion is high in March and early April, when a heavy rainstorm may fall on thawing ground scantly covered by dead vegetation or bare due to fall plowing.

Physical Setting

Dane County has a varied and unique geologic and physiographic setting. The western part of the county, known as the valley and ridge physiographic area, or the driftless area, is the only part of the county not affected by glaciation. This area is characterized by steep ridges and valleys drained by fast-flowing streams, generally without natural lakes or impoundments. Most of the streams are fed by springs and seeps flowing from water-bearing layers of bedrock exposed on hillsides. The hills are covered by an irregular layer of soil (quite thin in many places) overlying fractured dolomite or sandstone bedrock. The large valley of the Wisconsin River, also in the western part of the county, consists of deep alluvial deposits of sand and gravel with some organic material, and extensive marsh deposits in the floodplain of the Wisconsin River.

To the east of the driftless area is an area of glacial moraines, located at a major drainage divide where the headwaters of many streams of the Wisconsin, Sugar and Yahara River basins originate. The moraines include the Johnstown terminal moraine at the western edge of the glaciated area, and the Milton recessional moraine farther east. The moraines include hills and mixed and variable deposits of glacial till (including clay, silt and boulders with sand and gravel lenses) which were deposited and left behind as the glaciers retreated.

East of the moraines, in the center of the county, is the Yahara River valley. Here deep glacial deposits dammed up large valleys, forming a chain of large lakes and wetlands. The Yahara River valley physiographic area is primarily glacial ground moraine, with extensive areas of peat and marsh deposits. Streams in this physiographic area are generally flatter and more sluggish than those in the driftless area, and fewer are spring-fed.

The eastern part of the county is known as the drumlin and marsh physiographic area, and consists primarily of general glacial deposits with extensive areas of marsh deposits. This area includes many small drumlin hills interspersed with shallow glacial deposits which created an extensive system of interconnected wetlands with poorly defined drainage. Small streams wind slowly through the lowlands and there are few springs supplying streamflow. The only lakes in this area are small stream impoundments, or shallow, marshy lakes.

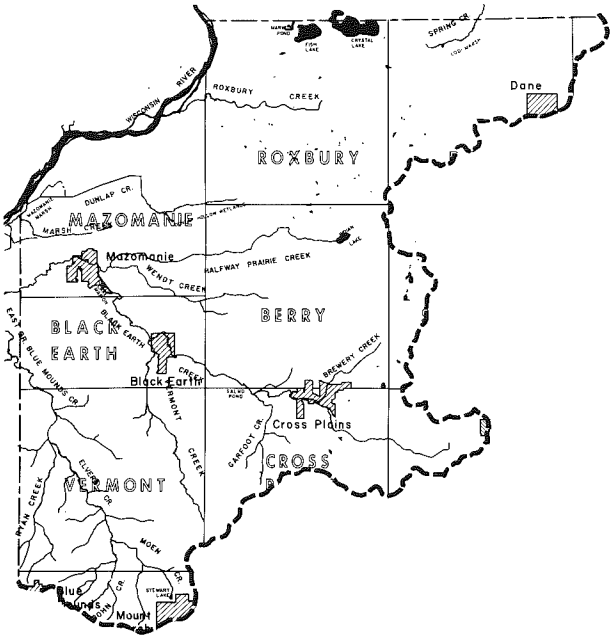
Water Uses

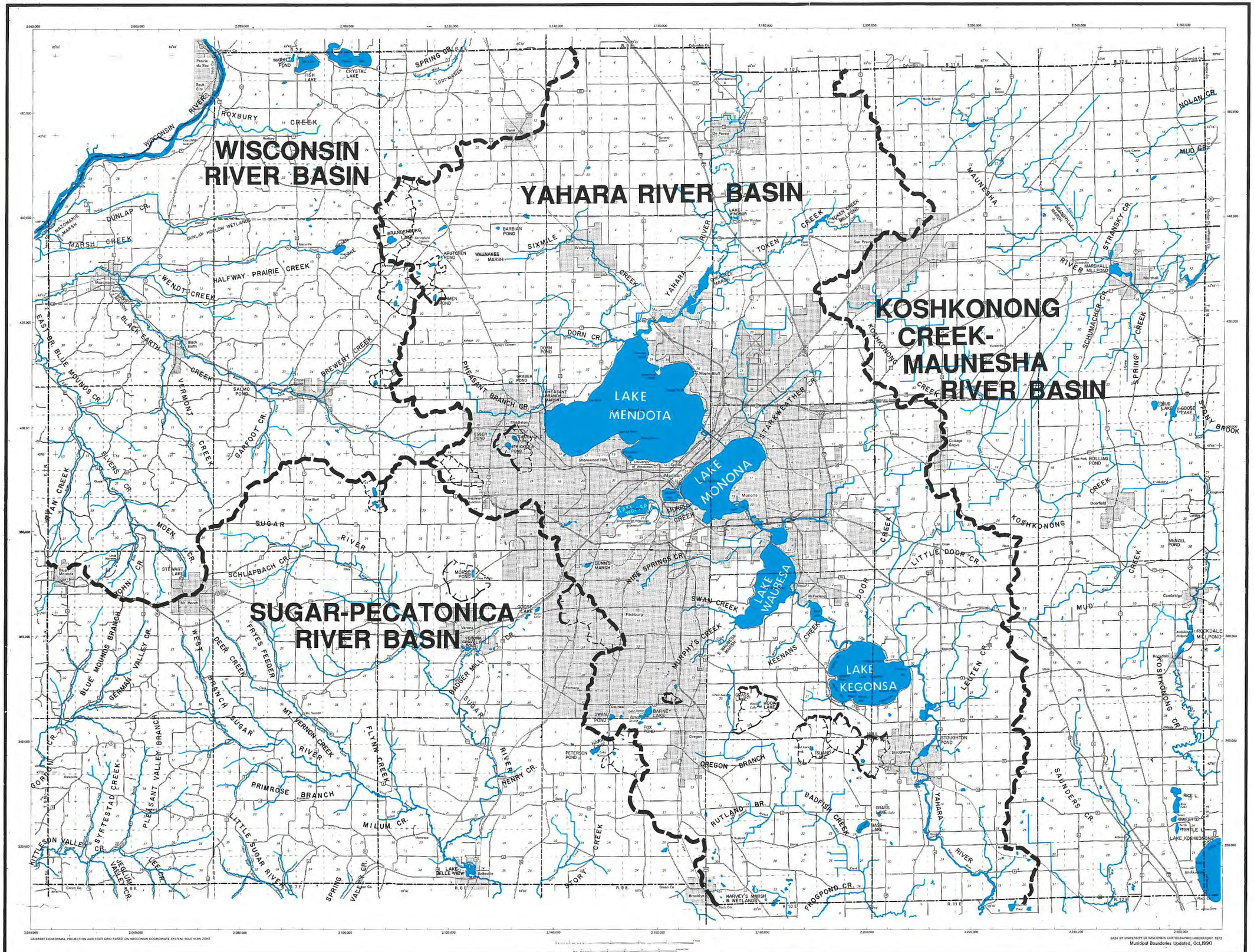
Nearly all domestic and industrial water supplies in Dane County are obtained from groundwater. The uses to which surface waters are put include: support and habitat for fish and aquatic life; recreational uses (mainly fishing, boating and swimming); limited livestock watering in some areas; and dilution and assimilation of treated municipal and industrial wastewater.

SURFACE WATER QUALITY CONDITIONS

Wisconsin River Basin

The northern part of the Wisconsin River Basin includes the bottomlands and floodplain of the Wisconsin River Valley; a hillier moraine area to the east; and a drumlin-marsh glacial area east of the moraines. The Wisconsin River bottomlands include extensive wetland and marsh deposits underlain by deep alluvial deposits. The creeks which wind through the bottomlands generally are spring-fed, but have little baseflow and a flat gradient. The morainal areas are characterized by few streams and small, internally drained areas with kettle holes occupied by marshes or small seepage lakes. The southern part of the Wisconsin River Basin consists mainly of the watershed of Black Earth Creek and its tributaries. While the headwaters of Black Earth Creek are located in the morainal area, most of the watershed lies in the driftless area. Streams generally have steep gradients, gravel and rubble beds and cool steady baseflow.





WATER RESOURCES
DANE COUNTY, WISCONSIN

Major Basin Divide

Non-Contributing Basin

Lakes

Rivers & Streams

1/90

0 1/4 1/2 1 2 3

Scale in miles

Prepared by: THE DANE COUNTY REGIONAL PLANNING COMMISSION

LAMBERT CONFORMAL PROJECTION 4000 FOOT GRID BASED ON WISCONSIN COORDINATE SYSTEM, SOUTHERN ZONE

BASE BY UNIVERSITY OF WISCONSIN CARTOGRAPHIC LABORATORY, 1973

STREAM FISHERY RESOURCES
DANE COUNTY, WISCONSIN

Trout
Forage fish with trout potential
Northern pike-Panfish
Forage fish with northern pike-Panfish spawning use
Smallmouth bass
Northern pike-Panfish-Smallmouth bass-Catfish-Walleyes-Rough fish
Forage fish or rough fish
Streams
Lakes
Major Basin Divide

1/90

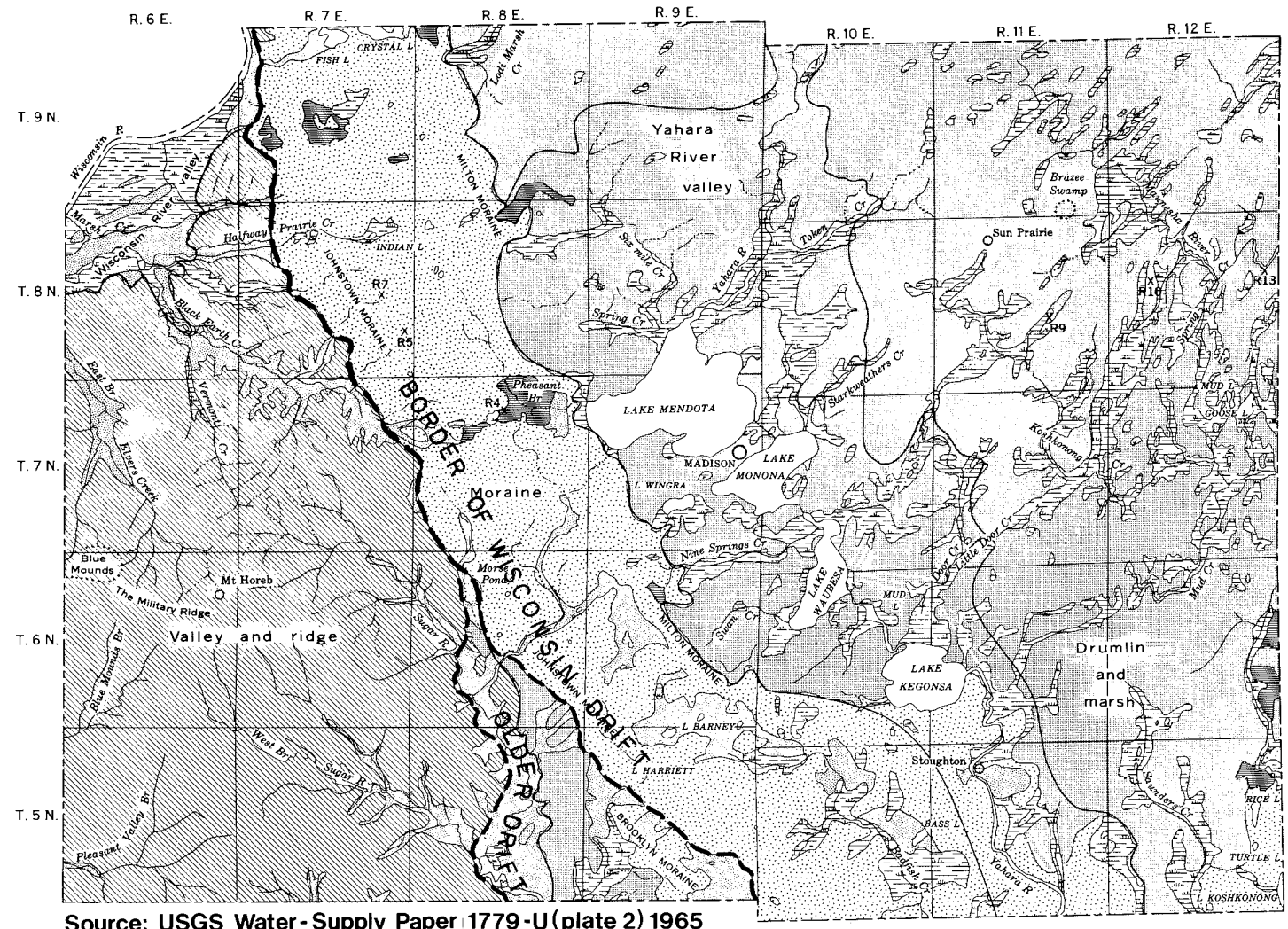
0 1/4 1/2 1 2 3
Scale in miles

Prepared by: THE DANE COUNTY REGIONAL PLANNING COMMISSION

LAMBERT CONFORMAL PROJECTION 4000 FOOT GRID BASED ON WISCONSIN COORDINATE SYSTEM, SOUTHERN ZONE

BASE OF UNIVERSITY OF WISCONSIN CARTOGRAPHIC LABORATORY, 1973
Municipal Boundaries Updated, Oct, 1990

MAP OF DANE COUNTY, WISCONSIN, SHOWING PHYSIOGRAPHIC AREAS AND DEPOSITS OF QUATERNARY AGE



Source: USGS Water-Supply Paper 1779-U (plate 2) 1965

Geology modified from Alden (1918)

Pre-Quaternary rocks
Quaternary deposits thin or absent

Undifferentiated glacial deposits mainly ground moraine
Clay, silt, sand, gravel, and boulders, unstratified to stratified, unsorted to sorted

Marsh deposits
Muck and peat

Morainal deposits
Clay, silt, sand, gravel, and boulders, mostly unsorted and unstratified

Glacial lake deposits
Stratified clay, silt, sand, and marl

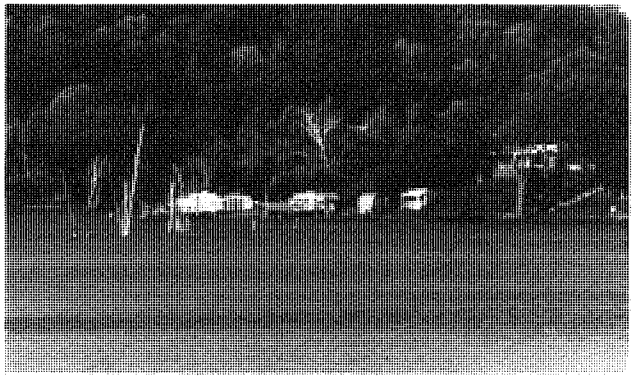
Outwash and alluvium
Mostly sand and gravel, sorted and stratified

Land use in the Wisconsin River Basin is primarily rural and agricultural. The basin includes the unincorporated community of Roxbury in the northern part of the basin, and the communities of Cross Plains, Black Earth and Mazomanie located on Black Earth Creek. Cropland occupies most land in the northern part of the basin, while steep wooded slopes along with cropland predominate in the Black Earth Creek watershed. The number and concentration of livestock operations ranges from low in the northern part of the basin to moderate in the Black Earth Creek Watershed. The main sources of pollution in the Wisconsin River basin include municipal wastewater discharges (from the unincorporated community of Roxbury in the northern part of the basin, and the communities of Cross Plains, Black Earth and Mazomanie along Black Earth Creek), and from agricultural nonpoint sources (primarily soil erosion from cropland but also including some organic pollution from barnyard runoff).

The Wisconsin River is a large river with a diverse warm water fishery. Water quality of the river is largely determined by point and nonpoint sources of pollution located outside of Dane County in its large watershed. Fish Lake is a 252-acre, relatively deep (maximum depth 62 feet) stratified lake which supports a cold water fishery. There has been evidence of increasing eutrophication in recent years. The causes have not been determined; however, contributions from agricultural areas and from septic tanks and development around the lake are suspected. Crystal Lake is a shallow, naturally

eutrophic lake which supports a dense growth of aquatic plants and algae, and suffers winterkill problems. Spring Creek, in the northeastern part of the basin, supports a Class 2 trout fishery, which is limited mainly by the absence of natural spawning sites. Dunlap Creek supports a stocked trout fishery in its upper portions, as well as a diverse warm water fishery in its lower reaches.

The upper part of Black Earth Creek supports one of the two Class 1 trout fisheries in Dane County. Several tributary streams (Vermont Creek, Garfoot Creek, Ryan Creek, Bohn Creek, Elvers Creek, East Branch of Blue Mounds Creek) support stocked trout fisheries. Many of these streams have the potential to support a naturally reproducing trout population if nonpoint source pollution were reduced. The portion of Black Earth Creek below the Village of Black Earth supports a diverse warm water fishery, including smallmouth bass. Other tributaries of Black Earth Creek, including Halfway Prairie Creek and Wendt Creek, support forage fish, but have the potential to support a trout fishery with reduced nonpoint source pollution and improved habitat. General or baseflow water quality conditions in the Black Earth Creek watershed are good. Water quality monitoring conducted on Black Earth Creek indicates a fertile stream with ample baseflow which is moderately high in nutrients (especially phosphorous) and other dissolved solids. The generally good water quality of Black Earth Creek, and its ability to support one of the state's most productive trout fisheries, is highly dependent on the maintenance of high baseflow from groundwater contributions, as well as maintaining a consistent and high level of performance at the wastewater treatment plants discharging to the stream. Studies and monitoring of Black Earth Creek conducted as part of the Black Earth Creek Priority Watershed Plan from 1984 to 1986 provided additional information and pinpointed pollution sources in the upper part of the stream. These studies indicated that, in addition to the overall or major sources of pollution in the basin, erosion from construction activities and barnyard runoff were creating serious localized water quality impacts. Earlier streambank erosion surveys had indicated that streambank erosion, due in part to livestock grazing, is a substantial problem for several streams in the Black Earth Creek watershed. While there is little monitoring information available for most of the streams tributary to Black Earth Creek, available information and evidence indicates that baseflow water quality conditions are generally good, and that the water quality impacts and habitat limitations in these streams are caused mainly by agricultural runoff.



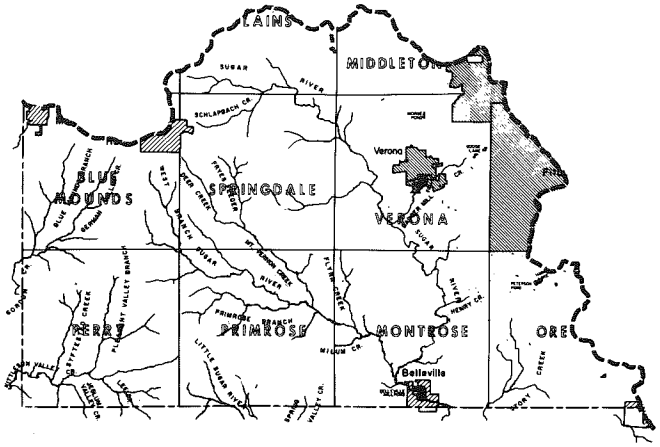
Fish Lake

Black Earth Creek

Sugar-Pecatonica River Basin

Most of the Sugar-Pecatonica River Basin falls within the valley and ridge or driftless area of Dane County. This area is characterized by thin soils over bedrock, steep wooded slopes, and narrow stream valleys with alluvial deposits, few wetlands, and no natural lakes or impoundments. Streams are typically fed by groundwater from bedrock outcrops exposed along hillsides. Stream gradients, temperature, baseflow and habitat conditions are appropriate for trout fisheries in many streams. The morainal area bounding the eastern part of the basin has a poorly developed drainage pattern, with many internally-drained areas.

Land use in the Sugar-Pecatonica River Basin is mostly rural and agricultural. Cropland erosion rates are very high, and this basin has the highest concentration of livestock and dairy farming activities, particularly in the western part of the basin. Municipal and industrial wastewater discharges also represent significant impacts on surface waters in the Sugar-Pecatonica River Basin, including those at the communities of Blue Mounds, Mt. Horeb, Verona, Belleville and Brooklyn. Urban nonpoint sources of pollution represent less serious impacts, except for localized situations. The southwestern portion of this basin represents the areas of most significant potential for livestock waste pollution problems in Dane County.



The primary water resources in the Sugar-Pecatonica River Basin include the Sugar River and its tributaries, and the headwater streams tributary to the Pecatonica River, in the extreme southwestern corner of Dane County. The Pecatonica River tributaries, the West Branch of the Sugar River and its tributaries, and Story Creek support trout fisheries, including Mt. Vernon Creek, which is a Class 1 trout fishery. Lake Belle View is a small millpond on the Sugar River at Belleville. There is only limited water quality monitoring information available for surface waters in the Sugar-Pecatonica River Basin, and almost none in recent years. The limited information and evidence which is available indicates that water quality conditions in the basin are generally good, but are quite sensitive to levels of agricultural nonpoint source controls, and to the performance of wastewater treatment plants. Intensive efforts at soil conservation and streambank protection programs in the Mt. Vernon Creek watershed, for example, have demonstrated that substantial (up to 50%) reductions in erosion and impacts on stream habitat can be achieved with aggressive nonpoint source control programs. Since many of the streams in this basin are limited primarily because of sedimentation impacts from erosion, substantial improvements in stream quality and potential can be achieved in this basin through agricultural nonpoint source management practices. While water quality conditions generally appear to be good in most of the streams in the basin,

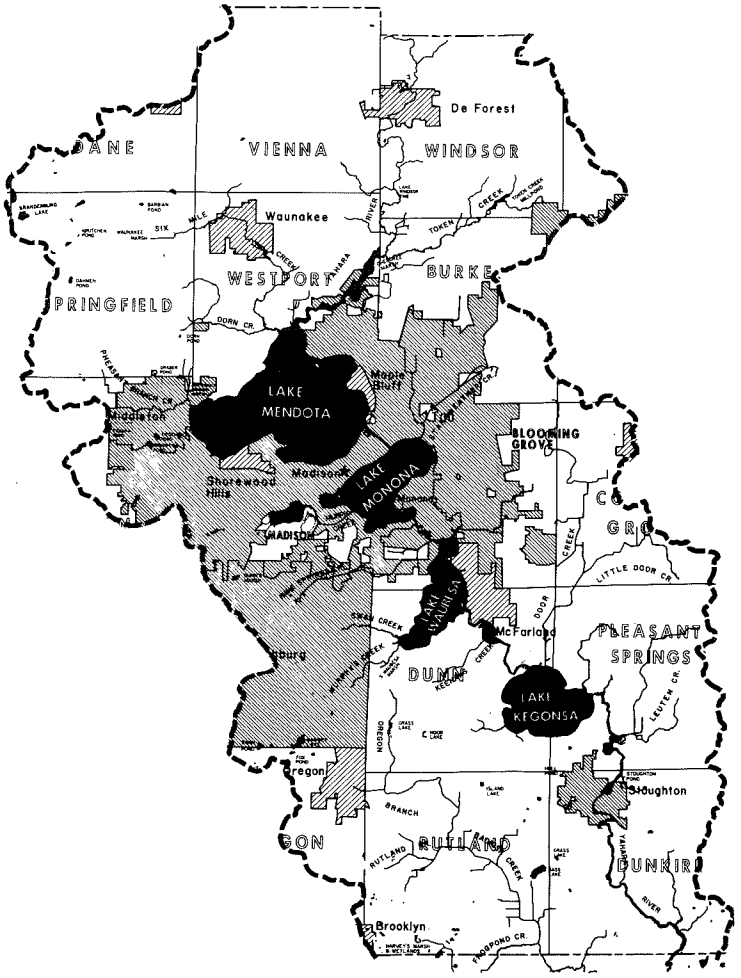
Sugar River

several have experienced serious short-term problems from temporary malfunctions in wastewater treatment plants or from barnyard runoff. Streambank erosion is also a serious problem in the western part of this basin. The basin has been a target of several programs addressing agricultural sources of pollution, including an SCS P.L.-566 program directed at reducing nonpoint source pollution in the upper part of the basin, and preparation of an animal waste management plan focusing on the western part of the basin.

Yahara River Basin

Most of the Yahara River Basin is in the Yahara River valley physiographic area, where deep glacial deposits dammed up large preglacial valleys, forming a chain of large lakes and wetlands. This physiographic area is characterized by general glacial ground moraine deposits, interspersed with large areas of wetlands with marsh and peat deposits. Stream gradients range from flat to moderate in most of the basin. Glacial moraines are located at the western edge of the basin. The morainal area has a less developed drainage pattern, with many internally drained areas and quite variable glacial surface deposits.

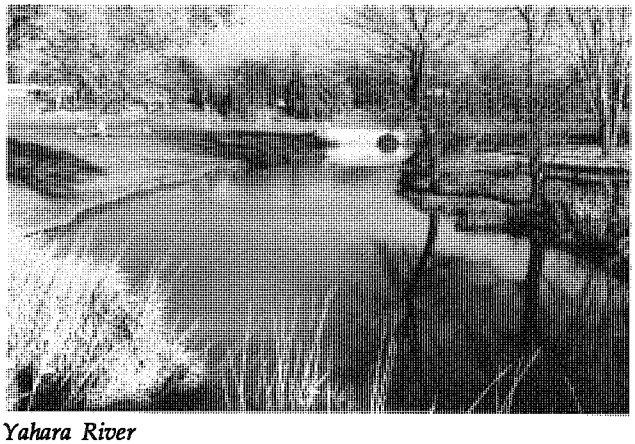
Most of the Yahara River Basin is contained within Dane County, but slightly over 30 square miles of the headwaters of the basin are located in Columbia County to the north. Nearly all of the land in the basin north of Lake Mendota is devoted to agriculture, with a fairly high percentage of cropland. Urban communities in this part of the basin include the Villages of Dane, Waunakee and DeForest, and the unincorporated communities of Windsor and Morrisonville. Most wastewater from this part of the basin is transmitted to the Madison Metropolitan Sewerage District's treatment plant and diverted around the lakes, and some is discharged to groundwater. There are no significant impacts on surface waters in this part of the basin from wastewater discharges. The primary source of pollution is erosion from agricultural lands, which contribute sediment and nutrients to the Yahara River and lakes. Urban areas occupy only a small percentage of the land in this part of the basin, so urban nonpoint source pollution is not as significant. Erosion from construction sites is of growing importance and concern in this part of the basin as development and construction activity increases.



The central part of the basin--the area surrounding Lakes Mendota, Monona and Waubesa--is primarily urban, with limited agricultural uses on the fringe of the central urban area. In this part of the basin, urban nonpoint sources of pollution (including erosion from construction and development activities) predominate, delivering sediment, nutrients and toxic substances directly to the lakes and urban streams such as Starkweather Creek, Pheasant Branch Creek and Nine Springs Creek and Murphy (Wingra) Creek. Agricultural sources of pollution are relatively minor. There are few industrial discharges in this part of the basin, and municipal wastewater is treated and diverted around the lakes, which do not receive any significant wastewater discharges.

The southern portion of the Yahara River Basin, including the area directly tributary to Lake Kegonsa, is predominantly agricultural, with only the communities of Stoughton and Oregon contributing any significant urban influence. The main sources of pollution in this part of the basin include agricultural nonpoint source pollution from both cropland erosion and livestock operations, and point sources of pollution--wastewater discharges from the City of Stoughton to the Yahara River, and from the Village of Oregon and the Madison Metropolitan Sewerage District (the principal wastewater discharge in Dane County) to Badfish Creek.

The surface water resources of the Yahara River Basin represent the most heavily-used and highly-valued in Dane County. The Yahara River chain of lakes--Mendota, Monona, Waubesa and Kegonsa--provide a spectacular setting for the county's central urban region, including the state capital, the main campus of the state university, and a majority of the county's population. The Yahara River lakes are by far the most heavily used recreational resource in the region, and their scenic beauty is one of the prized assets of Dane County. Other important water resources in the basin include the Yahara River and its tributaries, rural and urban streams draining directly to the lakes, including Token Creek, Sixmile Creek, Pheasant Branch Creek, Starkweather Creek, Nine Springs Creek, and Door Creek. Badfish Creek plays a major role in receiving all of the treated municipal wastewater generated in the basin and transmitting it around the lakes, so that none of the Yahara lakes receives any significant point source pollution. Other important resources in the basin include Lake Wingra in the University Arboretum, and large important wetland areas, such as Cherokee Marsh, located throughout the basin.



Yahara River

The streams in the northern part of the Yahara River Basin--upstream from Lake Mendota--have generally good baseflow water quality conditions, although recent monitoring data is lacking. Token Creek has substantial groundwater inflow, and is the most significant contributor of baseflow to Lake Mendota. Token Creek's ample baseflow supports a trout fishery, which is somewhat limited by impoundment effects and habitat conditions. Other streams in this part of the basin generally support warm water fisheries dominated by forage fish, with influxes of northern pike, walleyes and panfish from Lake Mendota during spawning season. The Yahara River just above Lake Mendota supports a more diverse year-round warm water fishery, including game species.

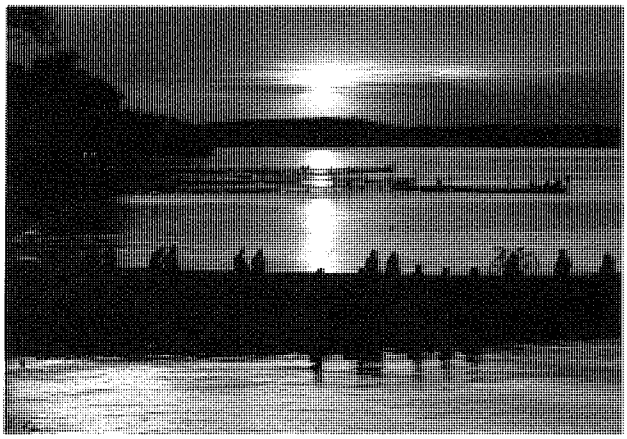
Urban streams in the central part of the basin suffer from alteration and channelization, and from the impacts of urban pollution. Past monitoring has indicated that the baseflow water quality conditions in Pheasant Branch Creek are fair to good, but the setting of the creek in a highly erosive morainal area has resulted in serious stream erosion problems, and the creek is a major contributor of nutrients to Lake Mendota. Starkweather and Nine Springs Creeks are both highly-altered urban streams with low gradients, and generally poor water quality conditions resulting from previous point source discharges and urban runoff. Urban streams and wetlands in the central part of the basin also suffer from the effects of groundwater pumping and diversion, described on page 21, which have substantially reduced groundwater discharge and baseflow sustaining these resources.

Streams in the lower part of the Yahara River Basin are mainly impacted by both agricultural nonpoint source and point sources of pollution. In several instances, point sources of pollution tend to overshadow nonpoint sources. There is no monitoring data to indicate the degree to which water quality of Door Creek, a major tributary to Lake Kegonsa, has improved since wastewater from Cottage Grove was diverted to the Madison Metropolitan Sewerage District in 1982. Badfish Creek is a small stream which receives nearly 40 million gallons per day of treated wastewater effluent from the Madison Metropolitan Sewerage District and from the Village of Oregon. The wastewaters are treated to fairly high levels, and Badfish Creek has been meeting water quality standards for fish and aquatic life in the sections of the stream with this classification (below County Trunk Highway A). Water quality conditions in Badfish Creek appear to have improved substantially since the completion of advanced waste treatment facilities at the Madison Metropolitan Sewerage District's Nine Springs Wastewater Treatment Plant. The City of Stoughton's wastewater is treated and discharged to the Yahara River below Lake Kegonsa. There is adequate baseflow to assimilate the treated wastewater. The water quality conditions and problems in the lower part of the Yahara River are due primarily to the effects of impoundments on the Yahara River, and in-stream biological activity supported by substantial nutrient inputs from the Yahara River lakes.

Lake Mendota is a large (9,800 acres) and deep (maximum depth 83 feet) lake which seasonally stratifies and supports a diverse warm water fishery as well as cisco, a cold water species. Lake Mendota is eutrophic and suffers from nuisance levels of algae and aquatic weeds, which interfere with recreational use and scenic enjoyment. There is little evidence that there have been any major changes in water quality conditions since the turn of the century, however, the lake was at that time already experiencing the impacts of agriculture and urban growth in its watershed. There are no records of Lake Mendota's unpolluted natural water quality and aquatic community before the earliest settlement. Lake Mendota's watershed is primarily agricultural land, however, significant urban areas also drain to the lake. Sediment and nutrients washed from the land surface are the primary cause of the accelerated eutrophication and weed and algae problems of Lake Mendota and the other Yahara River lakes. There are no longer any important point sources of pollution discharging to Lake Mendota or to the other lakes. Although Lake Mendota's water quality conditions seemed to have remained relatively stable over the years, there was a major change in the 1960s in the aquatic weed community in shallow areas of the lake, with the invasion and dominance of Eurasian water milfoil, a less desirable aquatic plant than previously existed.

Lake Monona is a smaller (3,300 acres) stratified lake with a maximum depth of 74 feet immediately downstream from Lake Mendota. Nearly all of the direct drainage to Lake Monona is from surrounding urban areas; however, the main source of nutrients to the lake is the Yahara River outflow from Lake Mendota. Lake Monona received major inputs of pollutants and nutrients from municipal and industrial wastewater discharges until after World War II. Historic data indicate extremely high levels of nutrients and severe eutrophication problems resulting from these discharges, and Lake Monona water quality conditions improved substantially after elimination of the discharges. The lake is still eutrophic and suffers from nuisance levels of algae and aquatic weeds. Previous municipal and industrial discharges to the lake and its tributaries, and the use of chemicals for aquatic weed and algae control have contributed potentially toxic materials to the sediments of Lake Monona and some of its tributaries (including mercury, arsenic, copper and PCBs). While these toxic materials do not appear to be at levels high enough to represent a direct health exposure risk, concentration in the food chain has resulted in the issuance of a mercury health advisory for consumption of large walleyes from Lakes Monona and Waubesa.

Lake Monona



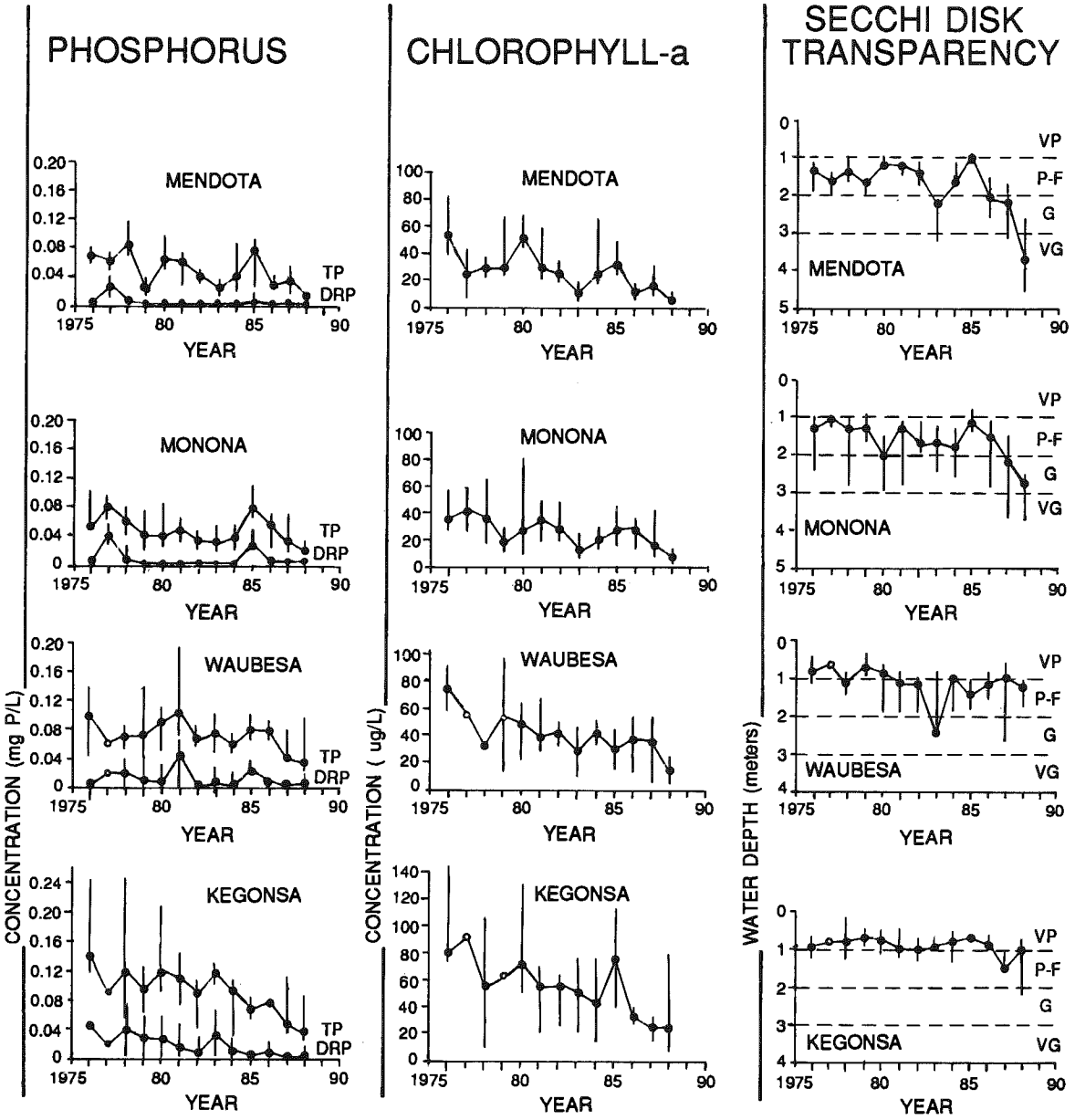
Lake Mendota

Lake Wingra is a small (348-acre) shallow (maximum depth 21 feet) lake located in the middle of the urban area in the University Arboretum. It is a shallow, highly eutrophic lake mainly impacted by urban runoff, and has a warm water panfish fishery.

Lake Waubesa is a shallower (maximum depth of 38 feet) 2,100-acre lake downstream from Lake Monona which supports a diverse warm water fishery. The lake receives direct runoff from both urban and rural areas, but most of the nutrient input to the lake is from the Yahara River outflow from Lake Monona. Lake Waubesa also suffered the effects of direct wastewater discharges through 1958, when the main wastewater discharge was diverted around the Yahara River lakes. When treated wastewater effluent was discharged directly, Lake Waubesa experienced severe eutrophication problems and extreme nuisance weed and algae problems. Since wastewater was diverted, nutrient levels and water quality conditions have improved in Lake Waubesa; however, the lake is still highly eutrophic and suffers from serious aquatic weed and algae nuisance problems.

Lake Kegonsa is a 3,200-acre lake with a maximum depth of 32 feet, and is the furthest downstream of the Yahara River lakes. Lake Kegonsa is located outside of the main urban area, and its direct watershed is primarily agricultural, with some development around the lake shoreline. Lake Kegonsa is a highly eutrophic lake with serious algae problems, although aquatic weed problems are somewhat less severe than the other Yahara River lakes. Lake Kegonsa also suffered from the effects of early wastewater discharges to the upper lakes, since its major input is the Yahara River discharging from Lake Waubesa. During the years when wastewater discharges were affecting Lakes Monona and Waubesa, these effects were also transmitted downstream to Lake Kegonsa, and very serious eutrophication and nuisance algae problems resulted. Since 1958, when wastewater was diverted around the Yahara River lakes, water quality and algae conditions have improved in the lake, but the lake has continued to exhibit a higher level of eutrophication than the other Yahara lakes. The lake received wastewater inputs from Cottage Grove until 1982, and local governments are now in the process of providing sewer service to development around the lake shoreline to eliminate possible contributions from septic tanks. The lake supports a diverse warm water fishery.

WATER QUALITY INDICATORS
YAHARA RIVER LAKES
1976-1988



- ONLY 1 OBSERVATION
- MEDIAN VALUES

RANGE OF VALUES

Note: Trends in surface total P and DRP, chlorophyll-a, and Secchi disk transparency for the Yahara lakes during the summers of 1976-88. For Secchi disk transparency, VP=very poor, P=poor, F=fair, G=good, and VG=very good.

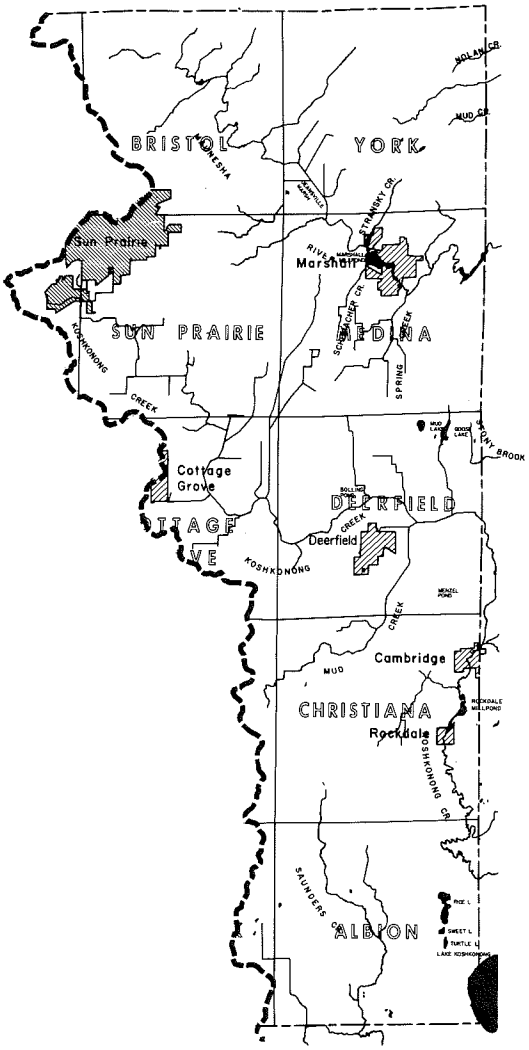
Source: Lathrop, 1989, DNR Bureau of Research

Koshkonong Creek-Maunesha River Basin

The Koshkonong Creek-Maunesha River Basin is in the drumlin and marsh physiographic area of eastern Dane County. In this physiographic region, large areas of interconnected wetlands drained by sluggish streams are bounded by low hills of glacial till called drumlins. Baseflow in streams is generally low and water temperatures are warm because groundwater recruitment is minimal. The small streams which wind slowly through the wetlands have been ditched and straightened in many places to provide more efficient drainage.

Nearly all of the land in the Koshkonong Creek-Maunesha River Basin is agricultural. The City of Sun Prairie, located at the headwaters of Koshkonong Creek, is the largest urban community in the basin. Other communities include the Village of Marshall, located on the Maunesha River, and the Villages of Deerfield, Cambridge and Rockdale, located along Koshkonong Creek. The primary water quality impacts from these urban communities result from the discharge of treated wastewater to the Maunesha River and Koshkonong Creek. The low baseflow and marginal background water quality of the receiving streams in this basin make them relatively sensitive to pollution. Because of the small area devoted to urban land uses in the basin, urban nonpoint source pollution is of primary concern in localized circumstances immediately downstream, or where impoundments are receiving direct urban runoff, as in the case of the Marshall Millpond. The main source of nonpoint source pollution is erosion from cropland. The Maunesha River watershed has an extremely high percentage of land in cropland, and more livestock than the basin as a whole. For the entire basin, soil loss or erosion rates are average for Dane County, as are livestock numbers and concentrations.

The fishery and water quality conditions of streams in the basin are limited by natural background conditions, including low baseflow, flat gradients, warm temperatures, and high inputs of nutrients and sediments from the fertile agricultural watersheds. The Maunesha River and lower Koshkonong Creek support warm water fisheries, but most other streams in the basin are capable of supporting only forage fish with occasional spawning use where wetlands remain. The marginal background conditions are also reflected in the fact that many of the receiving waters for wastewater discharges have classifications lower than full fish and aquatic life standards. In spite of this fact, sensitivity of the receiving waters means that many of the wastewater discharges must be treated to relatively high levels to meet water quality standards. The Marshall Millpond is a small impoundment on the Maunesha River which receives active recreational use. It is a shallow eutrophic impoundment with significant weed and algae problems. Koshkonong Creek is one of the tributaries to Lake Koshkonong, situated at the southeastern corner of Dane County. Lake Koshkonong is a large lake experiencing severe eutrophication from sediments and nutrients contributed from communities and farmlands in its very large and fertile watershed. The Koshkonong Creek-Maunesha River Basin also includes many important and extensive wetland areas, such as the Deansville Marsh and the Mud Lake and Goose Lake wetlands.



Koshkonong Creek

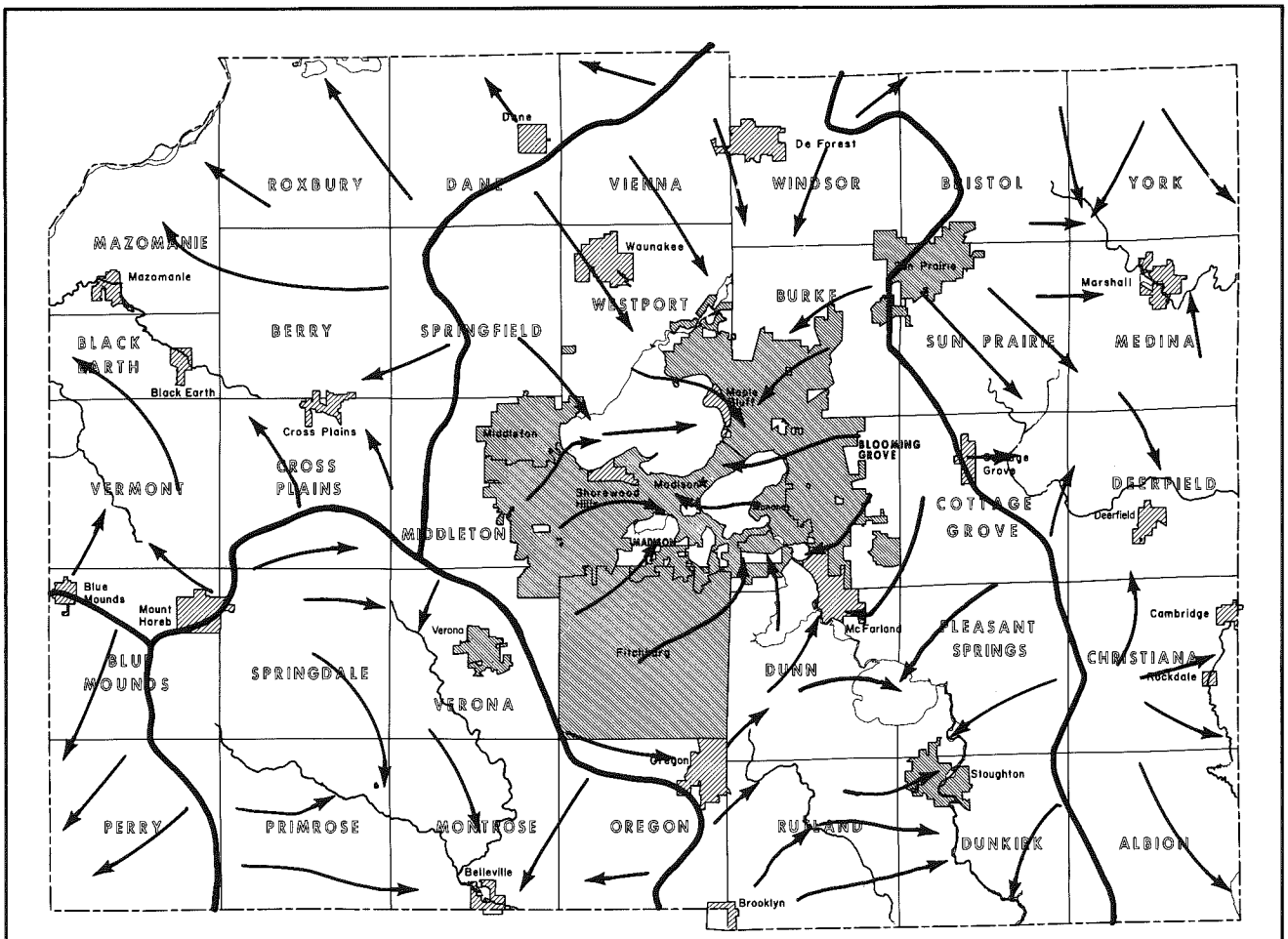
GROUNDWATER QUALITY CONDITIONS

Groundwater Sources and Uses

Since groundwater provides all of the water for domestic and industrial water use in Dane County, it is of critical importance that the quality of groundwater be protected for these uses. Groundwater which is withdrawn and used in Dane County is for the most part recharged locally from infiltration of precipitation. Water supplies are drawn from two basic aquifers--the upper or shallow aquifer which provides the supplies for shallow domestic wells in rural areas, and the deep sandstone aquifer which is a source of water for nearly all of the deep municipal water supply wells. The upper or shallow groundwater flow system mirrors the topography of the land surface, recharging in flatter or upland areas, and flowing toward and discharging in hillsides and low-lying areas such as streams and wetlands. The shallow or local groundwater flow system is of primary importance in questions of local pollution of water supply wells from nearby waste disposal sites, and will show the earliest evidence of contamination from most pollution sources. Shallow groundwater flow patterns are also important in providing baseflow discharges to wetlands and streams which support these resources during periods of dry weather.

The lower or sandstone aquifer, from which nearly all municipal water supplies in Dane County are withdrawn, is separated from the upper aquifer by a semi-confining rock layer. Groundwater withdrawn from the sandstone aquifer for municipal use is replaced by leakage through the semi-confining rock layer, thus this water use is also replaced mainly by local recharge of precipitation.

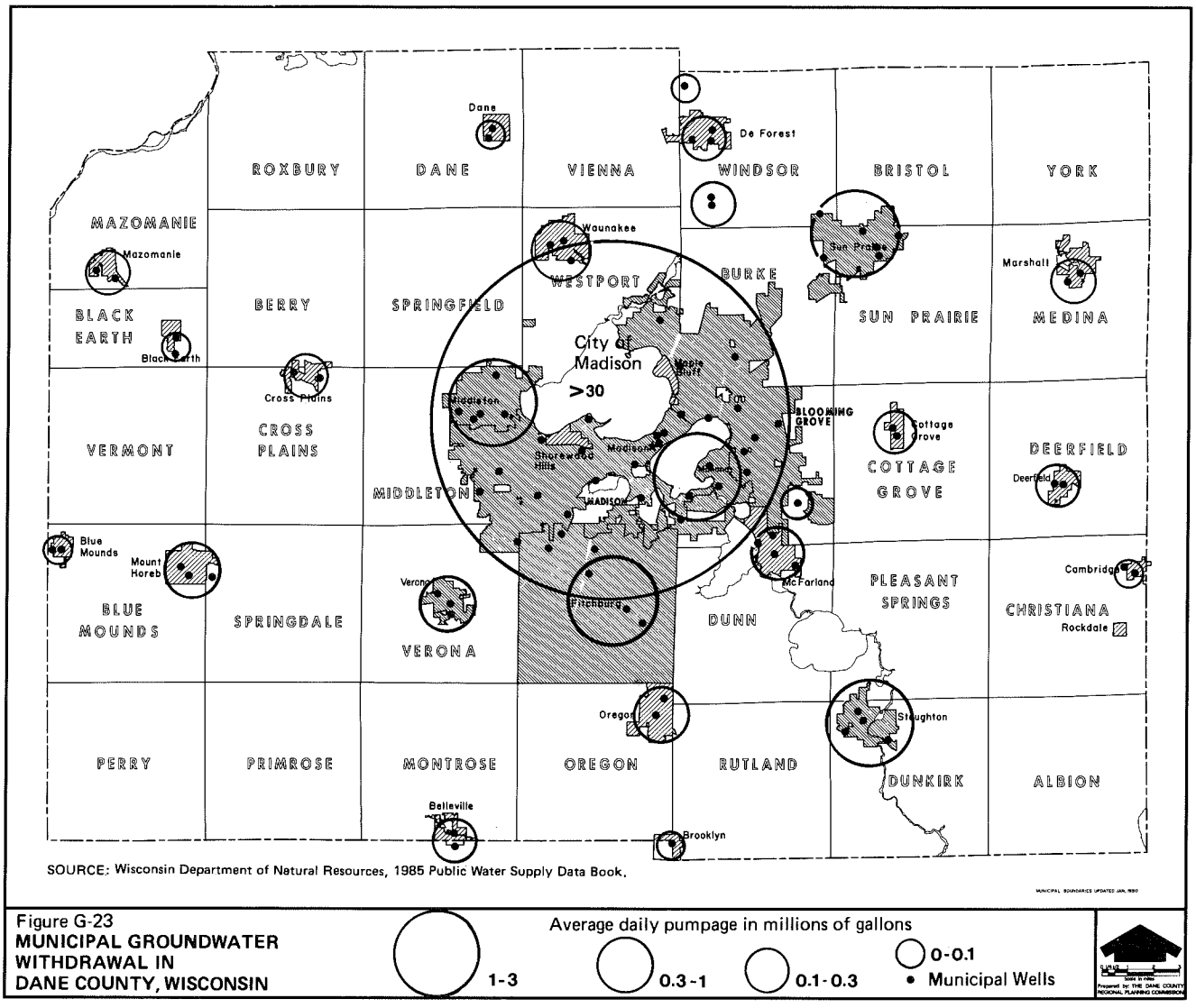
Groundwater supplies nearly all of the water in Dane County for household, commercial and industrial uses. Over 50 million gallons per day of groundwater is withdrawn and used--about 150 gallons per person per day. Most of this water is returned to surface water after use. Public water supplies account for over 80 percent of total groundwater use. This includes water withdrawn and used in municipal and private systems for residential, industrial and commercial purposes. Private sources, such as irrigation, stock watering, rural domestic and self-supplied industry make up the remaining groundwater use. For rural domestic supplies, over 18,000 wells serving over 45,000 people exist in the county. Urban areas account for 85 percent of groundwater use. The City of Madison is the largest single consumer, withdrawing about 30 mgd, and accounts for over half of the total use in the County.



Derived From: Geology and Groundwater Resources of Dane County, Wisconsin, D. R. Cline, U.S. Geological Water Supply Paper 1779-U (plate 7) 1965.

GENERAL GROUNDWATER FLOW IN THE UPPER AQUIFER IN DANE COUNTY, WISCONSIN

Groundwater Flow Direction
Groundwater Divide
Streams



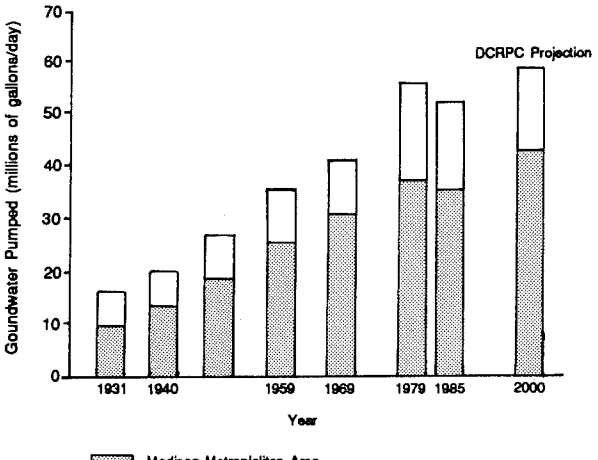
SOURCE: Wisconsin Department of Natural Resources, 1985 Public Water Supply Data Book.

Figure G-23
MUNICIPAL GROUNDWATER WITHDRAWAL IN DANE COUNTY, WISCONSIN

Average daily pumpage in millions of gallons

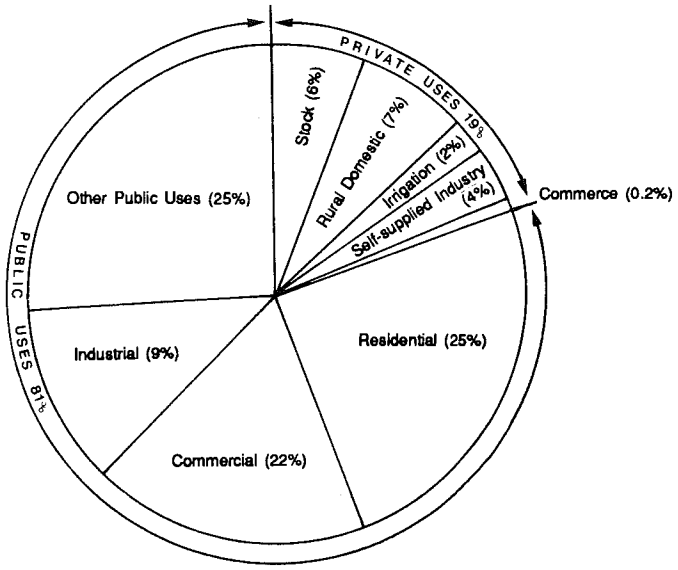
1-3 | 0.3-1 | 0.1-0.3 | 0-0.1 | • Municipal Wells

GROUNDWATER WITHDRAWAL IN DANE COUNTY

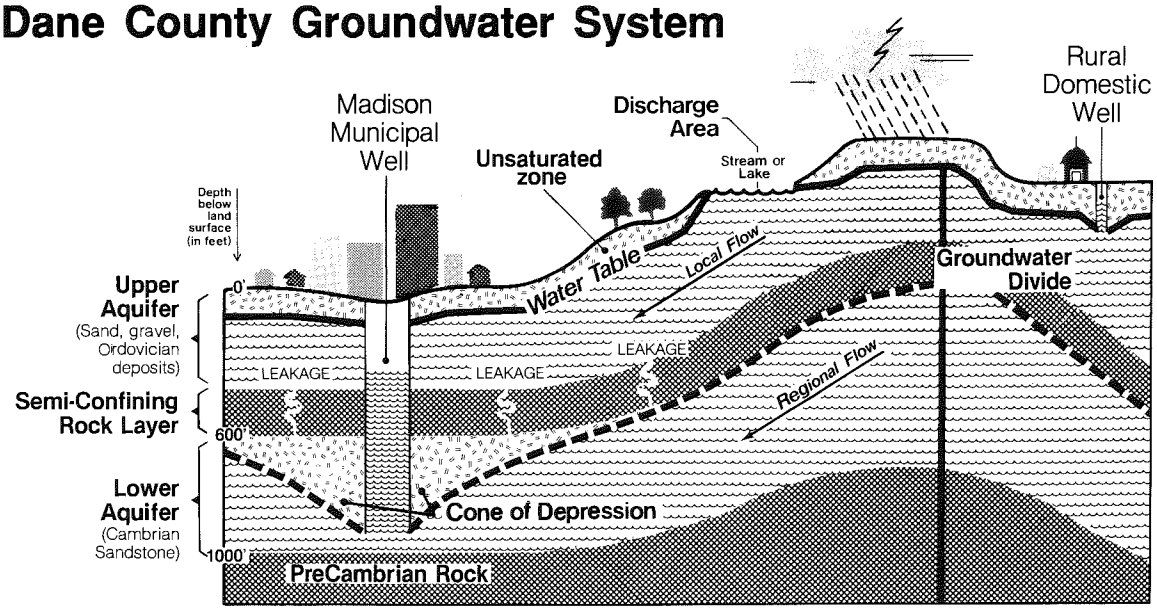


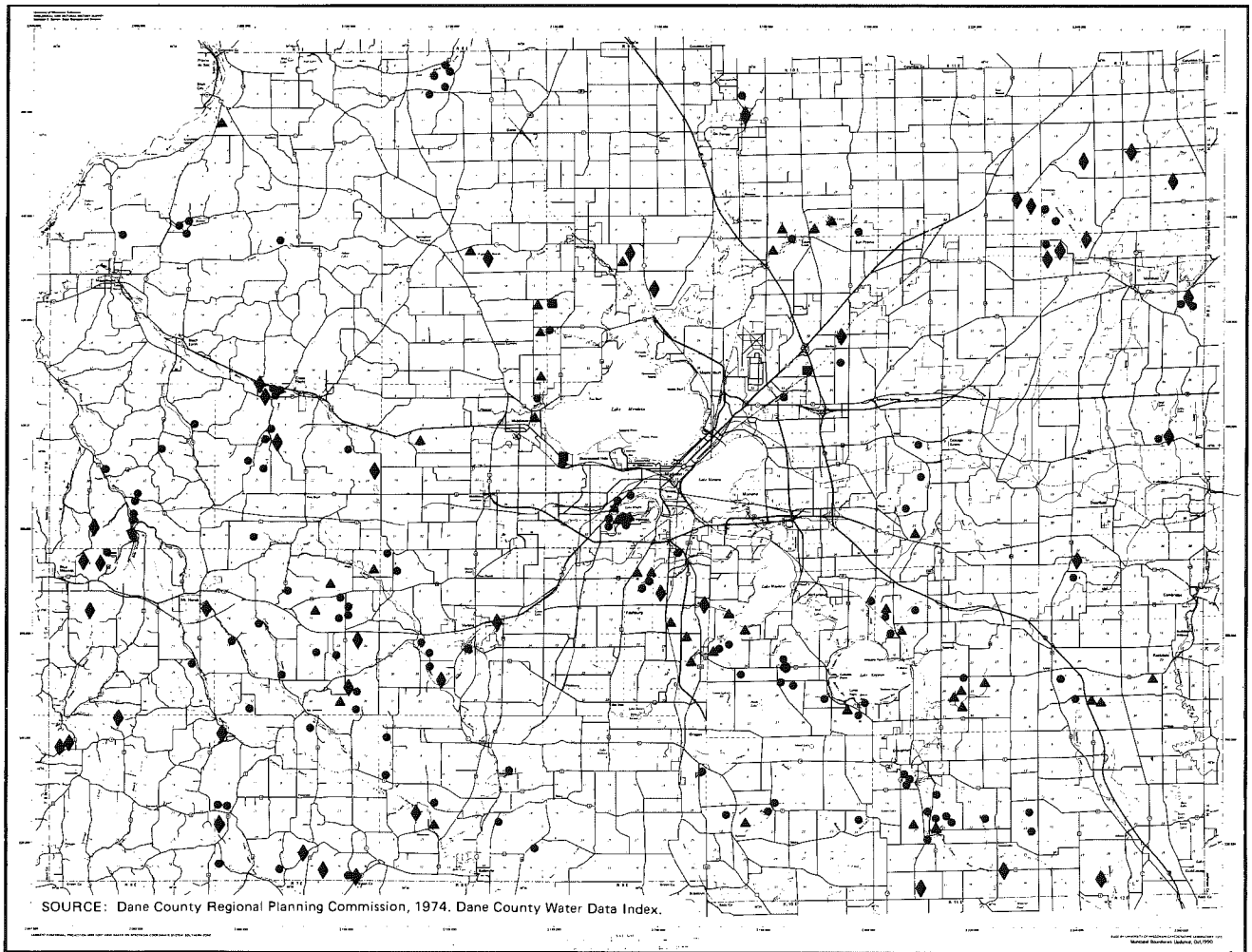
Source: Cline, 1965; Bauer, Sheaffer and McCall, Inc., 1970; Lawrence and Ellefson, 1982; U.S. Geological Survey Water use estimates for 1985; Dane County Regional Planning Commission estimates, 1986.

HOW GROUNDWATER IS USED IN DANE COUNTY



Generalized Illustration
Dane County Groundwater System





LOCATIONS OF SPRINGS IN DANE COUNTY, WISCONSIN

■ = spring flow >100 gpm
● = spring flow <100 gpm
▲ = group of springs
♦ = intermittent spring

1/90

Pollution Sources

There are a large variety of pollution sources which could potentially affect groundwater quality in Dane County. Subsurface pollution sources include landfills and dumps, septic tanks, wastewater infiltration ponds, sanitary sewer leakage, leakage from transmission pipelines or underground storage tanks, and leakage through abandoned wells. Surface pollution sources to groundwater include above-ground storage tanks for chemicals, irrigation, wastewater irrigation and landspreading, application of wastewater sludges or septage from on-site wastewater systems, livestock waste storage and spreading, fertilizer and pesticide applications, road salt storage and use, stockpiles of chemicals, hazardous spills, junkyards and salvage yards, and illegal disposal practices. The Dane County Groundwater Protection Plan (Appendix G of the Dane County Water Quality Plan) includes an inventory and assessment of these potential pollution sources, and proposes specific management approaches to protect groundwater quality from the most significant of these pollution sources. Many potential contaminants or pollutants are reduced or removed from water as it percolates through the soil and rock to the groundwater. This accounts for the high degree of groundwater protection and quality that we enjoy, despite the threat and growing exposure of groundwater to potential pollutants. However, some pollutants, such as dissolved salts or nitrate-nitrogen, may not be materially reduced or removed from groundwater, can migrate long distances, and can potentially contaminate large areas. This can be a particularly difficult problem in cases where treatment at the point of withdrawal and use is impractical.

Effects of Groundwater Pumping and Diversion

Pumping or withdrawal of groundwater, and its eventual return to surface waters in a different location, can have indirect but important impacts on local hydrology and water quality conditions. These impacts can be particularly pronounced in urban areas, where concentrated pumping of groundwater lowers the water table, reducing baseflow contributions to streams and lakes. The impacts are also heightened in urban areas as a result of increased paving and impervious areas which substantially reduce local infiltration of precipitation to recharge groundwater. In Dane County, these effects are most pronounced for the central urban area, where most of the groundwater used in the County is withdrawn in a concentrated urban setting, and the water used is subsequently diverted, after treatment, around the natural Yahara River discharge and flow system. As a result, there have been important effects of lowered groundwater levels on wetlands and stream baseflow in the central urban area, and baseflows in the Yahara River system downstream from Lake Mendota have been reduced by about the same amount as the groundwater pumpage and diversion. In addition, the concentrated withdrawal of groundwater in the central urban area has enlarged the area influenced by groundwater drawdowns to include a larger recharge area, and induced more rapid movement of potential contaminants to groundwater and municipal water supplies.

These effects, in the central urban area, have resulted in a drawdown in the shallow water table ranging up to more than 10 feet, and a reduction in the baseflow in the Yahara River of about 35 percent, as of 1975. Although pumping and diversion levels have leveled off since 1975, these impacts are substantial and growing.

POTENTIAL GROUNDWATER POLLUTION SOURCES

	Waste-Related				Non-Waste			
Place of Origin	Municipal	Industrial	Agricultural	Other	Municipal	Industrial	Agricultural	Other
At or near the land surface	Sludge disposal		Feedlots	Septage disposal	Salt piles	Above and on-the-ground storage of chemicals		Highway deicing
		Wastewater irrigation & land spreading	Manure storage & spreading	Junkyards & salvage yards		Stockpiles Spills	Irrigation Fertilizers Pesticides	Lawn fertilizers
Below the land surface	Landfills		Manure pits Silage pits	On-site wastewater systems		Underground tanks		Improperly constructed & abandoned wells
	Wastewater impoundments or infiltration ponds					Pipelines		Overpumping (induced pollution)
	Sanitary Sewers							

Groundwater Quality

Groundwater in Dane County is generally of good quality and uniform in composition within all aquifers. Although of generally high quality, groundwater has been affected by certain land use activities. The most common and widespread groundwater quality concern is the level of nitrate-nitrogen in shallow wells. Thirty to forty percent of the private wells in Dane County have nitrate-nitrogen levels above the 10 mg/l level established as a drinking water standard for infants. These high concentrations of nitrate-nitrogen in the shallow aquifer system probably result from high natural background levels of nitrate-nitrogen which have been worsened by application of fertilizers on an areawide basis, and locally by discharges from on-site sewage systems, manure or silage pits or other nearby sources of nitrogen. It has become evident, for example, that background levels of nitrate-nitrogen are high enough in many areas that a concentration of on-site wastewater systems, as in a rural subdivision, can result in raising nitrate levels in nearby wells to above drinking water standards.

Bacterial pollution of shallow domestic wells is also a common problem, but usually results from improper well construction and very localized sources of contamination. The problems of bacterial contamination can usually be solved on-site. Another groundwater quality problem of concern is that of volatile organic chemicals (VOCs). VOCs have been detected in several private and municipal wells in Dane County. The most common sources of VOC contamination are suspected to be abandoned landfills and leaking underground gasoline tanks.

Recent groundwater monitoring has detected common agricultural pesticides, such as atrazine, in about 30 percent of rural wells. This is an area of increasing concern and it is likely that increased attention will be paid to monitoring groundwater for pesticides.

Public water supplies are regularly sampled and tested by local management agencies and by the state. Since municipal wells in the County obtain water from the sandstone aquifer, the quality is generally quite high and safe for use. There have been a small number of municipal wells where VOCs have been detected and corrective action taken. In addition, sampling of Madison's wells has indicated increasing levels of sodium and chlorides, probably resulting from road salting. The main concern in this case is the potential health effects of increasing sodium levels in water supplies.

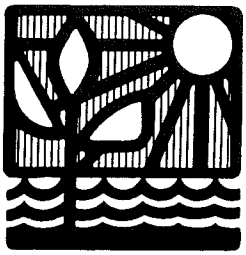
AQUIFER WATER QUALITY IN DANE COUNTY

	Sandstone Aquifer			Sand and Gravel Aquifer		
	Concentrations		Number of	Concentrations		Number of
Constituent	Mean	Range	Samples	Mean	Range	Samples
Dissolved Solids	353	183-659	99	325	255-464	12
Hardness ($CaCO_3$)	327	88-574	104	295	146-385	19
Alkalinity ($CaCO_3$)	289	25-367	102	278	197-364	11
Calcium	67	22-110	101	68	52-93	9
Magnesium	37	9-61	101	33	14-46	9
Sodium	4.6	1.4-41	74	3.8	1-10	8
Potassium	1.7	0.6-7	17	1.6	0.7-2.3	6
Iron (ug/l)	423	0-11500	104	2714	0-21000	19
Manganese (ug/l)	47	0-1406	101	119	0-570	19
Sulfate	22	1-133	102	21	1-58	19
Chloride	8.6	0-77	104	8.1	1.5-50	19
Fluoride	0.1	0-0.5	100	0.2	0.1-0.5	16
Nitrate-Nitrogen	1.5	0-19	76	2.8	0-14	15

Note: All concentrations are in milligrams per liter, unless otherwise noted.

Source: Kammerer, P.A., Jr. (1981). Ground-Water-Quality Atlas of Wisconsin. U.S. Geological Survey, Information Circular 39.

CHAPTER 3



POLLUTION CONTROL

POINT SOURCES - MUNICIPAL AND INDUSTRIAL WASTEWATER DISCHARGES

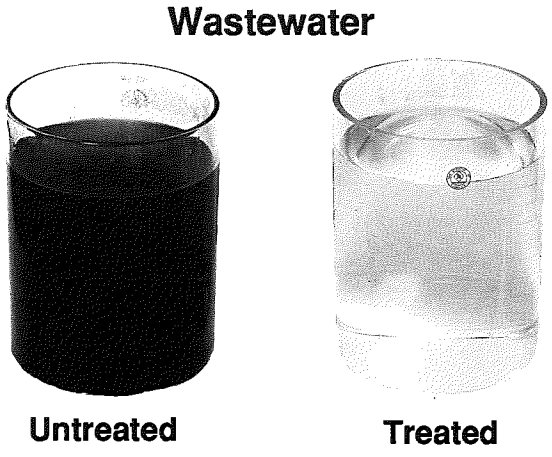
Introduction

Municipal and industrial discharges represent the most significant and concentrated, but also the most controllable, sources of water quality impacts and problems. Sewerage systems collect and concentrate large volumes of domestic and industrial wastewater at a single point for treatment and discharge, concentrating the impact. These discharges are usually continuous, and often represent the primary or only source of pollution to water bodies between storms or runoff events. The continuous nature of these discharges usually means that large volumes of pollutants are discharged over time, and that these pollution sources are of primary importance for the majority of time when baseflow conditions exist and runoff and flooding is not occurring.

The general approach to management of point sources of pollution is to determine water quality standards which are suitable for the intended uses of the receiving water (supporting fish and aquatic life, recreational use, and water supply uses if appropriate). These receiving water quality standards are then used to determine the quality and amount of discharge (effluent limits) which can be tolerated without degrading the water quality seriously enough to interfere with its basic use and purpose. The effluent limits are then used to determine the level of treatment of the municipal or industrial wastewater needed to achieve water quality standards.

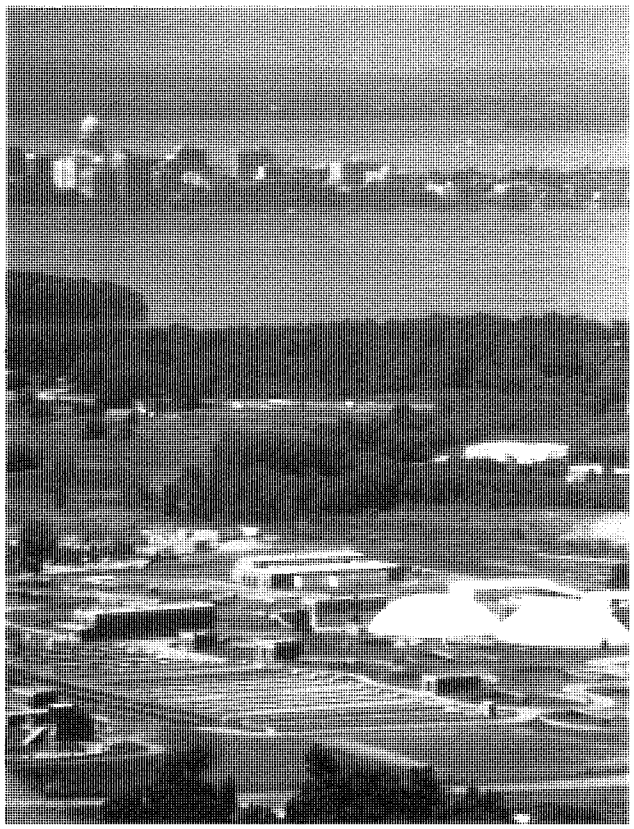
The pollutants of most concern in municipal and industrial wastewater discharges include:

- organic materials and solids, which can result in noxious deposits in receiving waters and reduce dissolved oxygen below the minimum levels needed to support fish and aquatic life;
- disease-causing bacteria, which can expose users or consumers of the receiving waters to health risks;
- materials such as pesticides or heavy metals, which can be toxic to fish and aquatic life or represent health hazards; and
- nutrients, which can stimulate excessive aquatic plant growth in receiving waters.



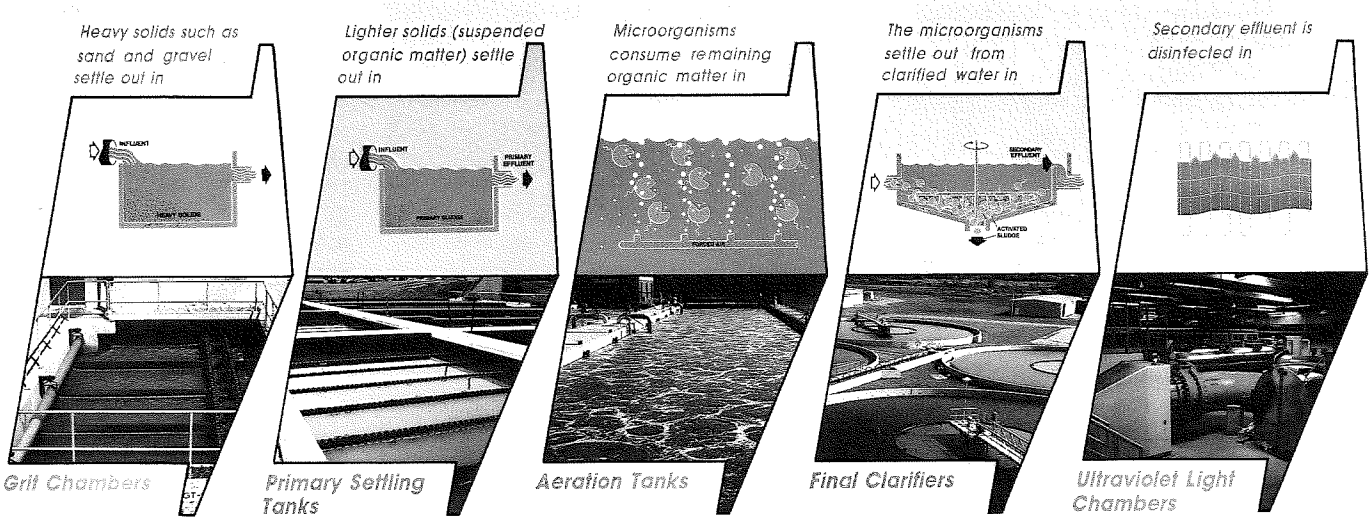
Status and Existing Conditions

There are 20 municipal and 12 industrial point source wastewater discharges in Dane County. A few of these discharges are to groundwater, but most are to surface waters. There are no significant wastewater discharges to the Yahara River lakes since diversion of municipal wastewater around the lakes. Municipal wastewater discharges are dominated by the discharge of the Madison Metropolitan Sewerage District's Nine Springs Wastewater Treatment Plant, which treats nearly 40 million gallons per day of municipal wastewater from the Central Urban Service Area and from the communities of Waunakee, DeForest, Cottage Grove and Windsor. Effluent from MMSD's treatment plant is discharged to Badfish Creek, which carries the treated effluent around the Yahara lakes and returns it to the Yahara River in Rock County.



Nine Springs Wastewater Treatment Plant

The remaining 19 municipal wastewater discharges are associated with individual communities, and are much smaller, ranging in size up to 3 mgd. All of these treatment plants use a combination of physical and biological treatment processes, primarily designed to reduce solids and organic loading to levels which permit the receiving waters to meet basic water quality standards. A major investment in expanding and upgrading the wastewater treatment facilities in Dane County has been made since 1975. As a result, nearly all municipal wastewater discharges in Dane County are consistently meeting effluent limits, and basic water quality standards are being satisfied.



Typical Wastewater Treatment Process

Issues

Since a major investment has been made in upgrading and expanding wastewater treatment facilities, the most important management issue is ensuring an adequate level of operation and maintenance so that facilities continue to meet effluent limits. An important aspect of this management strategy is the compliance maintenance program administered by DNR, which requires an annual evaluation of the performance and potential problems associated with each treatment plant. This allows early detection of emerging problems so they can be avoided or solved before water quality standards are violated.

Another important aspect of wastewater system management is reduction of excessive inflows or pollutant loadings coming to the treatment plant. This management strategy is critical in: (1) reducing the amount of clean water entering the system through infiltration or inflow (which does not benefit from collection and treatment); (2) reducing excessive flows, and encouraging water conservation and wastewater minimization from households, businesses and industries generating wastewater; and (3) reducing loadings of particular pollutants or materials from businesses and industries through recycling or pretreatment requirements. All of these measures are of critical importance in allowing the management agency to economically operate and maintain wastewater treatment facilities, meet effluent limits and water quality standards, and avoid costly expansion and upgrading of wastewater treatment facilities.

There are a variety of potentially toxic materials in wastewater, such as heavy metals or PCBs, which are of increasing concern. Most wastewater treatment plants are mainly designed to remove solids and organic materials. Their ability to reduce or remove specific compounds varies from pollutant to pollutant, and for each treatment process. In addition, there is a lack of monitoring data and information on the levels of potentially toxic materials in wastewater discharged to the treatment plants, in the treated wastewater discharged from treatment plants, and in receiving waters. It has been only recently that water quality standards have been established for many toxic materials, and standards for new substances will be developed on a continuing basis. Substantially increased monitoring of toxics is needed. The difficulty and exorbitant expense associated with trying to remove each of the large number of potentially toxic materials from wastewater at the treatment plant indicates that the best management approach will place initial emphasis on reducing toxic pollutant discharges at the source.

Another issue having potentially major impacts on wastewater management strategy is nondegradation of existing water quality conditions. The state has enacted Administrative Rule NR 207, which has the objective of maintaining existing water quality conditions where they are higher than water quality standards, rather than allowing water quality to be further degraded to minimum water quality standards. Since nearly all communities in Dane County are growing and wastewater discharges are increasing, only increasingly higher and more costly levels of treatment can meet this goal of nondegradation. These restrictions will have their most severe and early impacts for wastewater discharges to high-quality receiving waters such as trout streams. The Village of Cross Plains in Dane County is an example of the circumstances where these restrictions may prove to be important.

Another current issue related to municipal wastewater discharges is providing adequate sludge storage capacity (150-180 days) to avoid the necessity to landspread the organic solids (sludge) removed from wastewater during the winter and spring months. Requirements for disinfecting wastewater effluent to reduce bacteria levels are also being revised, resulting in changes in wastewater management practices. Many treatment plants are now being required to disinfect effluent only seasonally during periods and in situations where there is significant health risk exposure, rather than year-round at all locations.

MUNICIPAL WASTEWATER DISCHARGES

Map No.	Receiving Water & Classification	Management Agency	Treatment Capacity & Process	Needs
1	Black Earth Creek, FAL (WWSF)	Village of Mazomanie	.16 mgd, A.S.	4
2	Black Earth Creek, FAL (COLD)	Village of Black Earth	.162 mgd, A.S.	--
3	Black Earth Creek, FAL (COLD)	Village of Cross Plains	.45 mgd, O.D.	4,5,6
4	Groundwater of the Lower Wisconsin River	Roxbury San. Dist. #1	.02 mgd, S.L.	1,3
5	Allen Creek, INT (LFF)	Village of Brooklyn	.116 mgd, O.D., S.F.	--
6	Sugar River, FAL (WWSF)	Village of Belleville	.27 mgd, O.D.	4
7	Sugar River, DWF (WWSF)	City of Verona	.625 mgd, A.S.	1,5,6
8	W. Branch Sugar River, INT (LFF)	Village of Mt. Horeb	.6 mgd, R.B.C., S.F.	6
9	Williams Creek, INT (LFF)	Village of Blue Mounds	.072 mgd, R.B.C.	--
10	Rock River, DWF (WWSF)	Consolidated Koshkonong San. Dist.	.6 mgd, A.L.	--
11	Koshkonong Creek, DWF (WWSF)	Village of Rockdale	.025 mgd, A.S., P.P.	--
12	Koshkonong Creek, DWF (WWSF)	Village of Cambridge	.355 mgd, A.L.	5,6
13	Mud Creek, INT (WWFF)	Village of Deerfield	.192 mgd, O.D.	6
14	Maunesha River, DWF (WWSF)	Village of Marshall	.31 mgd, R.B.C., S.F.	6
15	Koshkonong Creek, DWF (LAL)	City of Sun Prairie	3.1 mgd, R.B.C., S.F.	3,5,6
16	Yahara River, FAL (WWSF)	City of Stoughton	1.65 mgd, A.S.	3,4,5,6
17	Oregon Branch Badfish Creek, FAL (LAL)	Village of Oregon	.803 mgd, A.S.	3,4,6
18	Oregon Branch Badfish Creek, FAL (LAL)	Madison Metropolitan Sewerage District	50 mgd A.S.	5,6
19	Groundwater of Yahara River	Village of Dane	.072 mgd, T.F., S.L.	--
20	Groundwater of Yahara River	Morrisonville San. Dist. #1	.045 mgd, S.L.	1,3

NOTES:

Existing Biological Use
- COLD: Cold Water Community
- WWSF: Warm Water Sport Fish
- WWFF: Warm Water Forage Fish
- LFF: Limited Forage Fishery
- LAL: Limited Aquatic Life

Receiving Water Classifications
- DWF: Diverse Warm Water Fishery
- FAL: Fish & Aquatic Life
- INT: Intermediate Aquatic Life

Needs
1 = Capacity Expansion
2 = Process or Treatment Level Upgrading
3 = Clear Water Inflow Management
4 = Sludge Storage Expansion
5 = Industrial Loading Management
6 = Toxics Monitoring

Treatment Process
- A.L.: Aerated Lagoon
- A.S.: Activated Sludge
- O.D.: Oxidation Ditch
- R.B.C.: Rotating Biological Contactors
- S.L.: Seepage Lagoon
- T.F.: Trickling Filter
- S.F.: Sand Filter
- P.P.: Polishing Pond

INDUSTRIAL WASTEWATER DISCHARGES

Map No.	Receiving Water & Classification	Discharge Permit Holder	Description of Discharge
21	Black Earth Creek, FALT (COLD)	Capitol Sand & Gravel	Quarry groundwater and rainwater overflow into Creek
22	Saunders Creek, DWF (WWFF)	Wisconsin Plastic Drain Tile Corp.	Contact cooling water discharged to creek
23	Groundwaters of the East Branch of Pecatonica River	Stauffer Cheese, Inc.	Cheese process water is landspread
24	Sugar River, FAL (WWSF), and groundwaters of Sugar River	Anderson Custom Processing	Milk, whey process water and sanitary wastewater is treated and discharged to Sugar River; sludge is landspread
25	Groundwaters of Lower Rock River (Koshkonong Creek)	Stokely USA, Inc. - Sun Prairie	Canning process water is spray irrigated
26	Groundwaters of Upper Rock River (Maunesha River)	Karem, Inc.	Dog food manufacturing process water is land-spread
27	Token Creek, FAL (WWSF)	Wisconsin DNR - Token Creek Fish Pond	Supply water for trout hatchery ponds is discharged to Token Creek
28	Groundwaters of Upper Yahara River	Stokely USA, Inc. - Waunakee	Canning process water is spray irrigated
29	Lake Monona	MG&E, Inc.	Power plant scrubber process water is discharged into lake
30	Groundwaters of Lower Rock River (Lower Yahara River)	Nabisco Brands, Inc.	Screened solids and treatment sludge resulting from taco manufacturing are landspread
31	Nine Springs Creek, FAL (WWSF)	Wisconsin DNR, Nevin Fish Hatchery	Supply water for trout hatchery is discharged to Nine Springs Creek
32	Groundwaters of Lower Rock River (Dorn Creek)	Hazelton Labs America Inc.	Milk operation process water is land applied

WASTEWATER DISCHARGES

MUNICIPAL

Treatment Type

- S — Secondary treatment, Surface discharge
- A — Advanced treatment, Surface discharge
- G — Lagoon, Groundwater discharge

Treatment Capacity

- ‹1mgd
- 1-10mgd
- ›10mgd

INDUSTRIAL*

- G — Discharge to Groundwater
- S — Discharge to Surface Water
- Process Water Discharge
- Mixed Process & Cooling

*Excludes discharges composed entirely of non-contact cooling water.

1/90

0 1/4 1/2 1 2 3
Scale in miles

Prepared by: THE DANE COUNTY REGIONAL PLANNING COMMISSION

Municipal Boundaries Updated, Oct, 1990

POINT SOURCE CONTROL RECOMMENDATIONS

P-1: All municipal wastewater discharges should receive adequate secondary treatment as a basic minimum year-round requirement.

P-2: Advanced waste treatment (additional treatment beyond the secondary level) should be provided for all municipal wastewater discharges where required to achieve general water quality standards for recreation and fish and aquatic life during periods of low streamflow.

P-3: Biological treatment processes which conserve energy and support maximum recycling of organic materials to the land should be preferred when considering treatment plant modifications or expansion.

P-4: The extension of public sewer service should be limited to those areas designated as urban service or limited service areas.

P-5: All point source management agencies should provide adequate funds and personnel for operation and maintenance of municipal wastewater treatment plants.

P-6: The Wisconsin Department of Natural Resources should increase its program of operator training and increase technical assistance to point source management agencies.

P-7: The statutes governing metropolitan sewerage districts should be changed to allow the Madison Metropolitan Sewerage District to make available technical assistance in the areas of monitoring, laboratory analyses, treatment operations, residual waste disposal and sewer system evaluation and rehabilitation to other point source management agencies.

P-8: The performance and loading and operating trends of wastewater treatment plants should be regularly monitored through the Compliance Maintenance Annual Review program in order to identify and avoid potential problems or permit violations before they occur.

P-9: The Wisconsin Pollutant Discharge Elimination System (WPDES) discharge permit program, as administered by the Wisconsin Department of Natural Resources, should continue to be the primary vehicle for enforcement, monitoring and surveillance of municipal and industrial point source discharges.

P-10: Point source management agencies should reduce potentially toxic and hazardous substances in wastewater discharges to levels compatible with water quality standards for the receiving water uses. Primary emphasis in most instances should be directed at reducing or removing toxic/hazardous materials at the source, rather than treatment or removal at the treatment plant.

P-11: Point source management agencies should pursue aggressive source control and flow management strategies, including correction of excessive infiltration/inflow problems, where cost-effective, to most efficiently conserve and utilize the capacity of wastewater collection and treatment facilities.

P-12: Point source management agencies should conduct or participate in and support comprehensive and aggressive public information and education programs directed at household water conservation and hazardous waste issues.

P-13: All significant non-stormwater industrial discharges, including cooling water discharges, should be regulated through the WPDES permit program.

P-14: Potentially toxic or hazardous substances in industrial discharges should be reduced, and eliminated where possible, by modifying production or manufacturing processes, by recovering and recycling toxic materials, or by pretreating wastes before discharge to remove such materials. The Wisconsin Department of Natural Resources should provide technical assistance to businesses and industries to help reduce toxic materials in industrial discharges.

P-15: All industrial point source discharges which discharge directly to the environment, should receive "best available treatment," as currently required by federal law.

P-16: Industrial point source discharges which discharge to municipal wastewater treatment plants should be required, where needed, to provide pretreatment and/or flow-leveling programs in order to maximize compatibility of the waste discharge with the municipal collection and treatment system.

URBAN NONPOINT SOURCES

Effects of Urbanization

Urbanization is one of the most severe land use impacts in terms of lasting effects on hydrology and water quality. The process of urban development involves a great deal of construction and land disturbance, and sediment eroded from these construction activities can be a major source of pollutants. After development is complete, the urban area has a much higher percentage of impervious or paved areas covering the land, and is often served by an efficient stormwater drainage system which is highly effective at transmitting pollutants to receiving waters. The main effects of urbanization on the hydrology of an area include:

- an increase in the total amount of rainfall running off the surface of the land;
- a decrease in the amount of rainfall infiltrating into the soil;
- more rapid runoff and much higher peak flows; and
- reduced base flows in streams during dry weather periods.

While rural land surfaces are almost completely pervious, about one-third of the land surface in the urban area is covered by rooftops and paved areas. In addition to generating more surface runoff, which erodes the land surface and washes off more pollutants, the hydrologic effects have less direct but important downstream impacts. The greatly increased peak storm runoff rates and reduced baseflow associated with urbanization have serious negative impacts on receiving streams, usually resulting in erosion, sedimentation and streambank instability. Combined with reduced baseflow, the scenic, recreational and habitat values of the receiving streams can be seriously degraded, unless a vigorous effort is made to provide management practices and programs to counter the effects of urbanization.

In addition to these hydrologic effects of urbanization, the effects of urban groundwater pumping and diversion in Dane County, particularly in the central urban area, can substantially add to the negative hydrologic impacts of urbanization. The importance and magnitude of the impacts of groundwater pumping and diversion are described on page 21.

Pollution Sources

The developed urban area, because of the extent of its impervious surfaces, efficiently transports pollutants from the land surface to receiving waters. The primary sources of urban water pollutants are:

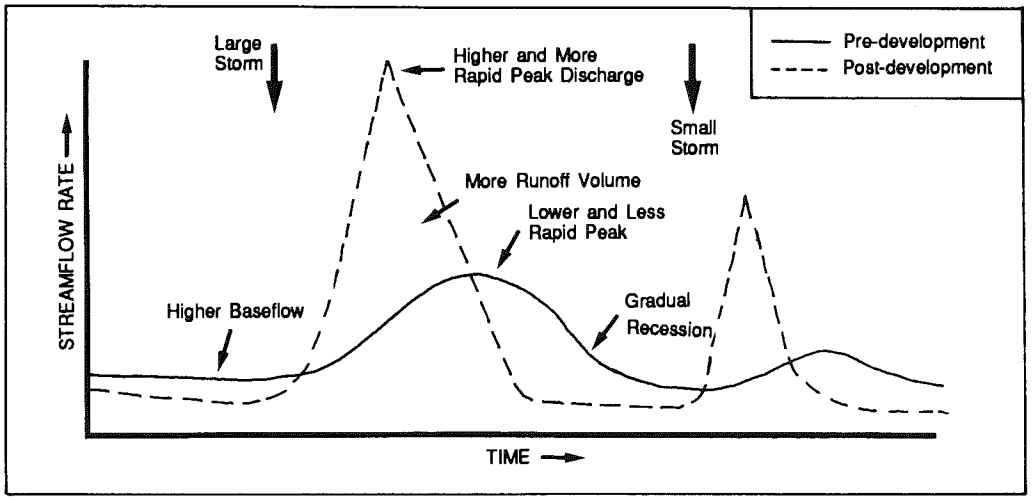
- vegetation (leaves, grass clippings, yard and garden debris)
- atmospheric (dustfall and precipitation)
- traffic-related debris
- de-icing or nonskid materials (sand, salt)
- erosion (sediment)
- animal (pet) wastes
- lawn and garden fertilizers and pesticides
- general litter

These sources all contribute to the high levels of the contaminants of most concern in urban runoff: sediment, nutrients (especially phosphorus), organic matter, toxic materials, and bacteria. The relative importance and degree of contribution of each source to urban nonpoint source pollution is difficult to determine. Previous water quality modeling and surveys of urban conditions and practices have indicated that most urban runoff originates from paved or impervious surfaces, relatively little from grassed or pervious areas. Most pollutants in urban runoff, similarly, are those picked up from and washed off impervious surfaces. The primary concern, therefore, is with those materials and pollutants which end up on streets and other paved surfaces and are washed off into the storm drainage system. Exceptions to this statement include erosion from construction, discussed elsewhere, and concerns about leaching of road salt, fertilizer or pesticides to groundwater from pervious areas.

Characteristics of Developed Urban Land in Four Watersheds in Madison, Wisconsin

Surface	Acres Per Square Mile
Streets	75
Rooftops	80
Parking Lots	35
Sidewalks	15
Driveways	10
Total Acres	215 (33.6%)

Effects of Urbanization on Streamflow



Because much of the waste material transported in urban runoff is organic, it exerts an oxygen demand on the receiving water and can result in depressed levels of dissolved oxygen if discharged to streams. The oxygen demand for urban stormwater can be greater than that from a wastewater treatment plant, but is normally experienced only for short periods of time. Oxygen demand and organic loading from urban runoff is related to flow, and is more of a problem during and after intense rainstorms than during periods of light or steady rainfall.

Most of the water quality effects of urban runoff in Dane County are felt in the central urban area, where urban runoff is discharged to the Yahara River lakes. Since nutrient loadings (particularly phosphorous) are the most important factor in the eutrophication of the Yahara lakes, the nutrient contribution of urban runoff is a primary concern. Nutrient concentrations found in urban stormwater are much higher than those found as natural background levels in Dane County streams. While phosphorous loading from urban runoff does not represent the major source of nutrient loading to the Yahara lakes, it is the most significant source other than agricultural runoff, and needs to be addressed fully as vigorously.

Concern has been increasing regarding the toxic materials contained in urban runoff. Concentrations of heavy metals in samples collected from urban storm sewers in Madison during 1976 indicated that, with the exception of lead, average heavy metals concentrations in urban stormwater runoff were below those encountered in wastewater effluent, but were still significant. Most of the metals in urban runoff consist of iron, lead and zinc, with some magnesium. Limited recent monitoring data indicate the presence of common pesticides in urban runoff, as well as high levels of copper, zinc and bacteria. Sampling of sediments in urban streams and lake sediments have indicated the deposition of toxic materials, including PCBs, mercury, arsenic and copper. Some of these materials originated from now-discontinued industrial and municipal waste discharges to lakes and streams, and others resulted from direct application of algicides and herbicides to the lakes. It is difficult to determine to what extent urban runoff has contributed to these concerns.

Management Practices and Recommendations

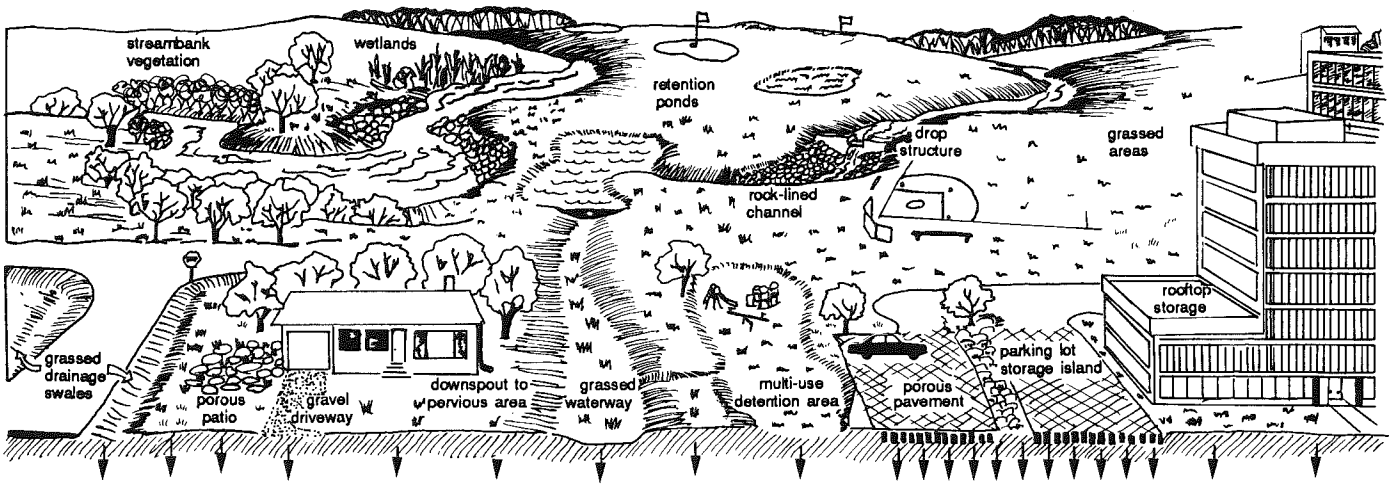
There are a variety of management practices and approaches which can be used to offset the hydrologic and water quality impacts of urbanization, and to control urban nonpoint sources of pollution. Some of these management practices are directed at dealing with the problem at the source--incorporating practices on individual homesites and building lots to control runoff and water quality. These on-site practices include: drain and downspout redirection to pervious areas; incorporation of infiltration areas and on-site runoff control and reduction through landscaping; and appropriate yard and garden management techniques, including limiting fertilizer and pesticide use as well as proper management, storage and disposal (or on-site composting or recycling) of leaves, grass clippings and other vegetative waste.

The approach needed to achieve a significant level of adoption of on-site management practices combines two elements: (1) a vigorous public information/education program, which informs and assists homeowners and businesses in controlling and reducing runoff and pollution from their own property; and (2) regulations and ordinances which require planning and installation of management practices for sites or activities which could have significant impacts on downstream areas. Examples of typical ordinances and regulations include comprehensive erosion and storm runoff control ordinances (already adopted by many local communities) which require preparation of erosion control plans on sites where significant land areas are to be disturbed, as well as the preparation of stormwater runoff control plans on larger sites. Ordinances requiring the installation of flow management practices or pollution control practices on building projects are also examples, as are ordinances regulating the management, storage and disposal of vegetative debris, such as ordinances prohibiting the depositing and/or burning of leaves or other vegetative matter in the street gutters.

Another main area of urban management practice emphasis is in the design and maintenance of the stormwater drainage system itself, which is usually managed by an urban government management agency--commonly a city or village. The primary emphasis in the planning and management of the stormwater drainage system is on preparing overall stormwater system management plans which incorporate water quality considerations and management practices. Management practices applicable to stormwater management systems include stormwater detention and infiltration practices, incorporation of natural drainage systems into the storm drainage network where possible (rather than reliance on underground storm sewers), channel and shoreline stabilization and vegetative management, and protection of floodplains, wetlands and infiltration areas.

Aside from regulation of construction and on-site management practices, the primary source control management activities that are the responsibility of urban government management agencies include: general litter control and street cleaning; the use of de-icing and nonskid materials; and the control of erosion and runoff from public sites and construction of public facilities, utilities and streets. To have a significant overall impact on urban nonpoint source pollution, it is necessary to pursue all of these approaches and management practices together--public and private, on-site and off-site.

The federal Clean Water Act of 1987 will be requiring most urban communities to prepare urban stormwater pollution control plans over the next few years, based on an approach of regulating urban stormwater discharges as point sources, similar to wastewater treatment plants. The difficulty and staggering expense which would result from a need to provide end-of-pipe treatment of urban stormwater discharges to meet effluent limits or water quality standards makes it imperative that urban management agencies and property owners do as much as possible to attack the problem at the source.



Urban Management Practices *Source: WDNR, 1983*

URBAN NONPOINT SOURCE CONTROL RECOMMENDATIONS

U-1: Urban nonpoint source management agencies should enact and enforce leaf and yard and garden debris storage and disposal ordinances in urban areas, particularly those urban areas draining to lakes or impoundments.

U-2: Urban nonpoint source management agencies should include provisions in building codes and ordinances providing that, wherever feasible, drainage from roofs, driveways, and parking lots should be directed toward grassed or vegetated areas, rather than being directly connected to paved areas or storm sewers.

U-3: Urban nonpoint source management agencies should conduct aggressive public education and information programs regarding source control, on an annual basis.

U-4: Urban nonpoint source management agencies should improve leaf pick-up in the fall for areas which are tributary to lakes or impoundments.

U-5: Urban nonpoint source management agencies in Dane County, particularly those tributary to lakes and impoundments, should improve the water quality protection and effectiveness of street sweeping by providing frequent (weekly to biweekly) sweeping of streets in commercial and industrial areas, and regular (biweekly to monthly) sweeping of residential streets throughout the sweeping season, with extra efforts at thoroughly cleaning all streets in early spring and late autumn. Vacuum sweepers should be used where feasible because of greater removal effectiveness.

U-6: Urban nonpoint source management agencies should revise their drainage design practices to emphasize the use of open drainage systems incorporating detention and infiltration areas and natural greenways in developing areas.

U-7: Urban nonpoint source management agencies should adopt and vigorously enforce comprehensive erosion and storm runoff control ordinances to limit erosion and increases in runoff from new development.

U-8: Specific watershed plans for stormwater management, incorporating flow and water quality management practices, should be prepared for all existing and developing urban drainage basins.

U-9: Urban nonpoint source management agencies in Dane County should implement the installation of greenways and detention and infiltration areas in existing developed areas, where feasible, on a gradual basis. Increased state and federal funds should be made available to help implement this proposal.

U-10: Urban nonpoint source management agencies in the central urban service area should cooperate in sponsoring field tests of the feasibility and effectiveness of porous asphalt pavement and infiltration trenches for possible use in parking lots and residential streets.

U-11: Potential approaches to enhancing or improving sediment and phosphorus removal from urban runoff in the design, operation and maintenance of urban drainage systems tributary to lakes and impoundments should receive priority attention and evaluation.

U-12: Urban drainage systems and associated land use practices should be designed to minimize the potential for toxic or hazardous materials being discharged or washed off the land surface into surface waters, with emphasis on source control rather than treatment or infiltration.

U-13: The use of de-icing compounds which could adversely affect surface or groundwater quality should be reduced to the minimum levels possible consistent with safety considerations, and alternative materials and approaches should be explored.

AGRICULTURAL NONPOINT SOURCES

Impacts of Agriculture on Water Quality

Dane County is one of the most productive agricultural counties in the nation. About two-thirds of the land area in Dane County is devoted to cropland, and additional large land areas are in pasture, woodlands, and other rural uses. In most watersheds in Dane County, agriculture represents the predominant land use and the major source of nonpoint pollution to water bodies.

The largest source of sediment and nutrients to lakes and streams is soil erosion from agricultural lands, with the most significant erosion occurring on sloping areas with exposed soils, particularly areas devoted to row crops. In some areas, streambank erosion resulting from overgrazing and in-stream livestock watering is a serious problem. Livestock manure can contribute to high levels of nutrients and organic loading in runoff from barnyards and feedlots and from croplands where manure is spread on the land surface. The organic loading from runoff events can be serious enough to cause dissolved oxygen problems in receiving streams, in addition to adding nutrients to surface water bodies. Improper manure storage practices and excessive use of fertilizers can add to nitrate problems in groundwater. Finally, pesticides used to control weeds and insects contribute potentially toxic materials to groundwater and wells.

Trends and Issues

The economic pressures on agriculture have resulted in a number of trends, most of which have had negative impacts on water quality. In Dane County, these pressures and trends have resulted in fewer but larger farm operations, increasing emphasis on row crops, and greater concentrations of livestock and larger dairy herds. Pressures for greater economic efficiency and overall productivity have also resulted in increased use of pesticides and inorganic fertilizers. Concerns over how these trends may be affecting the sustainability and viability of Wisconsin agriculture may be resulting in a reduction or reversing of some of these trends. The countertrends are reflected in the increasing acceptance and use of reduced tillage practices, more aggressive programs to encourage and require soil conservation planning and practices, and increasing concerns about agricultural pesticides showing up in groundwater and farm wells.

Dane County Farm Statistics

	1970	1978	1986
Number of Farms	4,090	3,620	3,140
Ave. Farm Size, acres	166	179	196
Land in Farms, acres	678,900	646,500	617,000
Cattle and Calves	168,000	155,800	159,000
Hogs and Pigs	168,000	130,800	99,000
Chickens	467,000	247,500	204,700
Milk Cows	69,300	65,100	66,600
Dairy Herds	1,714	1,258	1,038
Ave. Dairy Herd Size	40	52	64

Source: Wisconsin Agricultural Statistics Service.

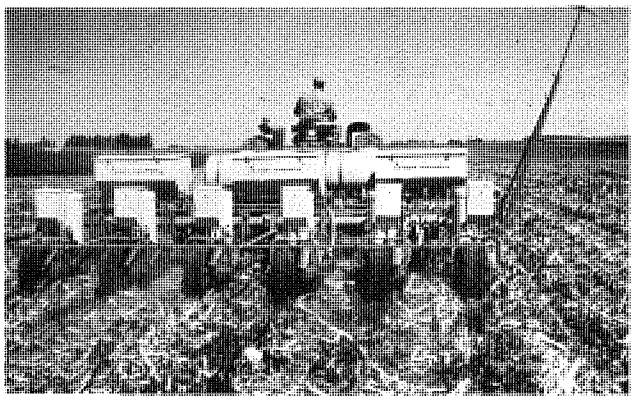
One of the major trends and issues that has evolved over the last 15 years is a change in the management approach from a purely voluntary program, based on cost-sharing incentives, to a program which combines the traditional voluntary program with stronger incentives and requirements. The present approach includes a mix of the traditional voluntary program with cost-sharing incentives, federal cross-compliance requirements which provide additional significant economic incentives for adopting management practices, state requirements for soil conservation planning and practices, and some direct regulatory programs needed to deal with serious water quality problems not addressed by the other programs. A continuing issue will be the development of the best mix of these approaches to reduce the water quality impacts of agriculture consistent with the long-term protection of the land resource, and a stable and sustainable farm economy.

Management Practices and Recommendations

The basic approach to addressing agricultural nonpoint sources of pollution is for federal, state and local agencies to work directly with individual landowners and farmers to develop plans and apply management practices to their farm operations. In addition to preparing plans to allow farmers to comply with regulations or cross-compliance requirements, plans also in many instances provide a basis for providing cost-sharing funds to individual landowners to offset the cost of implementing management practices.

Many of the management practices directed at soil erosion are traditional soil conservation practices which have been utilized for many years, such as contour cropping, strip cropping, diversions, terraces, grass waterways and similar practices. These traditional practices have been supplemented in recent years by reduced tillage practices which can provide both economic and soil conservation benefits to the farmer. Barnyard runoff control plans and manure storage facilities are common approaches to controlling pollution from animal wastes. Reducing the use of pesticides and inorganic fertilizers is often addressed through improved management and accounting, and through new approaches (such as integrated pest management) which rely less on chemicals. Streambank erosion can be effectively corrected through the use of streambank fencing, buffers and construction of livestock crossings.

The key to success of managing this most important source of nonpoint source water pollution is the aggressive pursuit of a mix of voluntary and regulatory programs, which are implemented with and through landowners and farmers on individual farms through the preparation of comprehensive erosion and animal waste management plans for each farm.



Conservation tillage

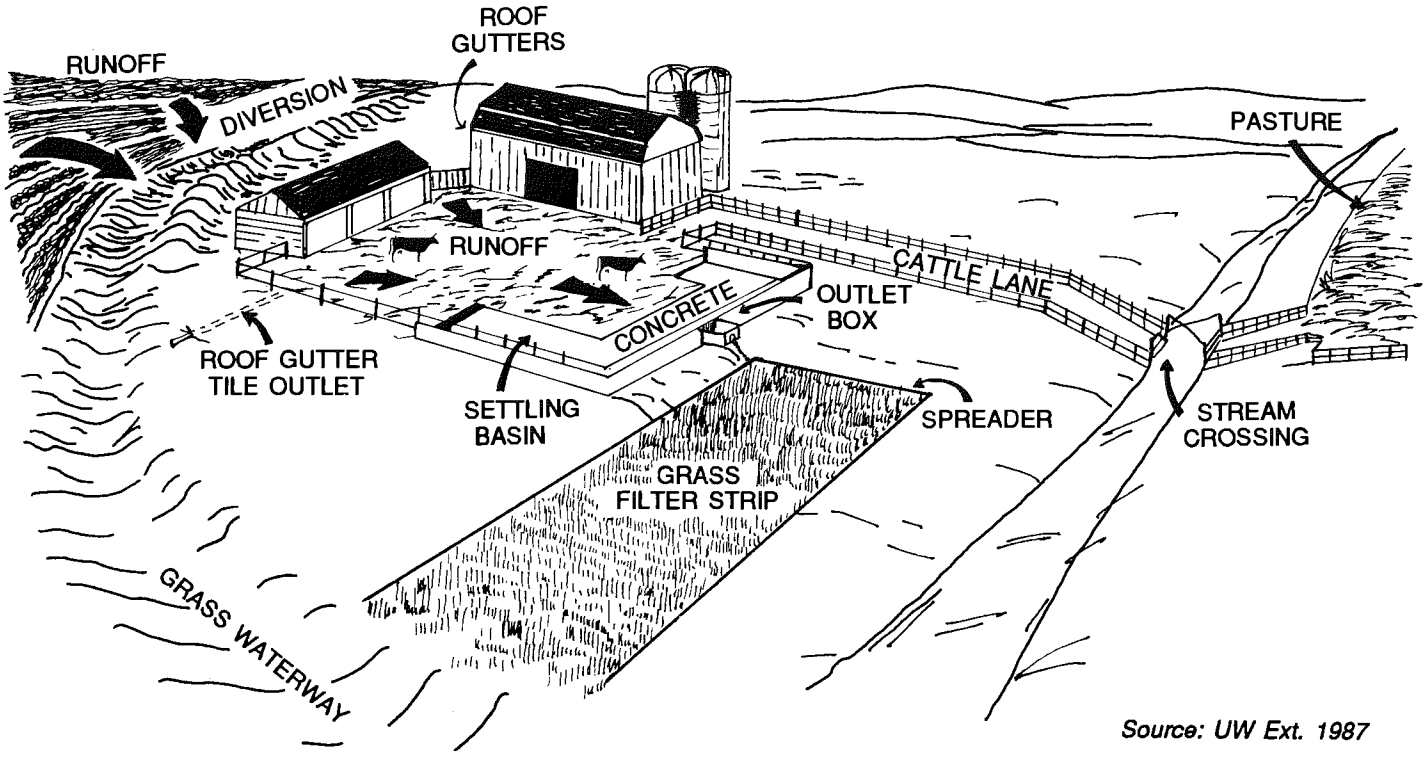
Grass waterway

AGRICULTURAL MANAGEMENT PRACTICES

Management Practice	Effectiveness	Capital Cost	On-Site Benefit
Contour Cropping	High	Low	Moderate
Strip Cropping	High	Low	Moderate
Field Diversions	High	Moderate	Moderate
Terraces	High	Moderate	Moderate
Waterways	High	Moderate	Moderate
Reduced Tillage	High	Low	Moderate
Critical-Area Stabilization	High	High	Low
Grade Stabilization Structure	High	High	Low
Shoreline Protection	High	High	Low
Barnyard Runoff Management	High	Moderate	Moderate
Long-Term Manure Storage Facilities	High	High	Moderate
Short-Term Manure Storage Facilities	High	Moderate	Moderate
Livestock Exclusion from Woodlots	High	Low	Low

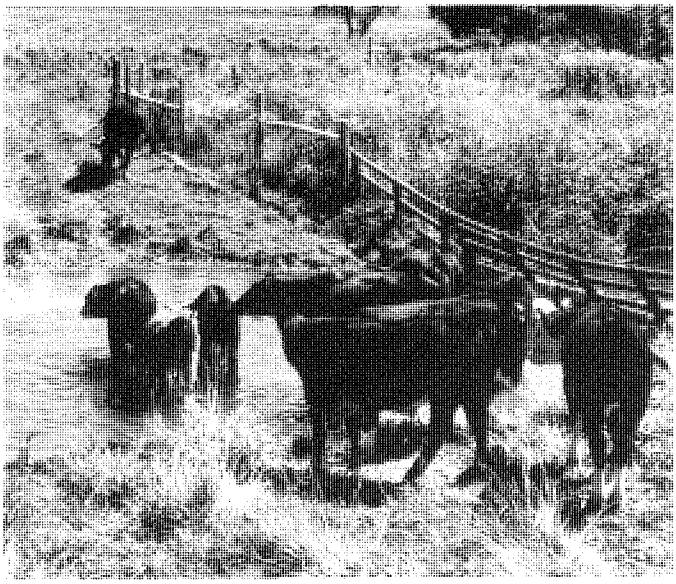
Source: Wisconsin Department of Natural Resources, 1986.

TYPICAL BARNYARD RUNOFF MANAGEMENT SYSTEM

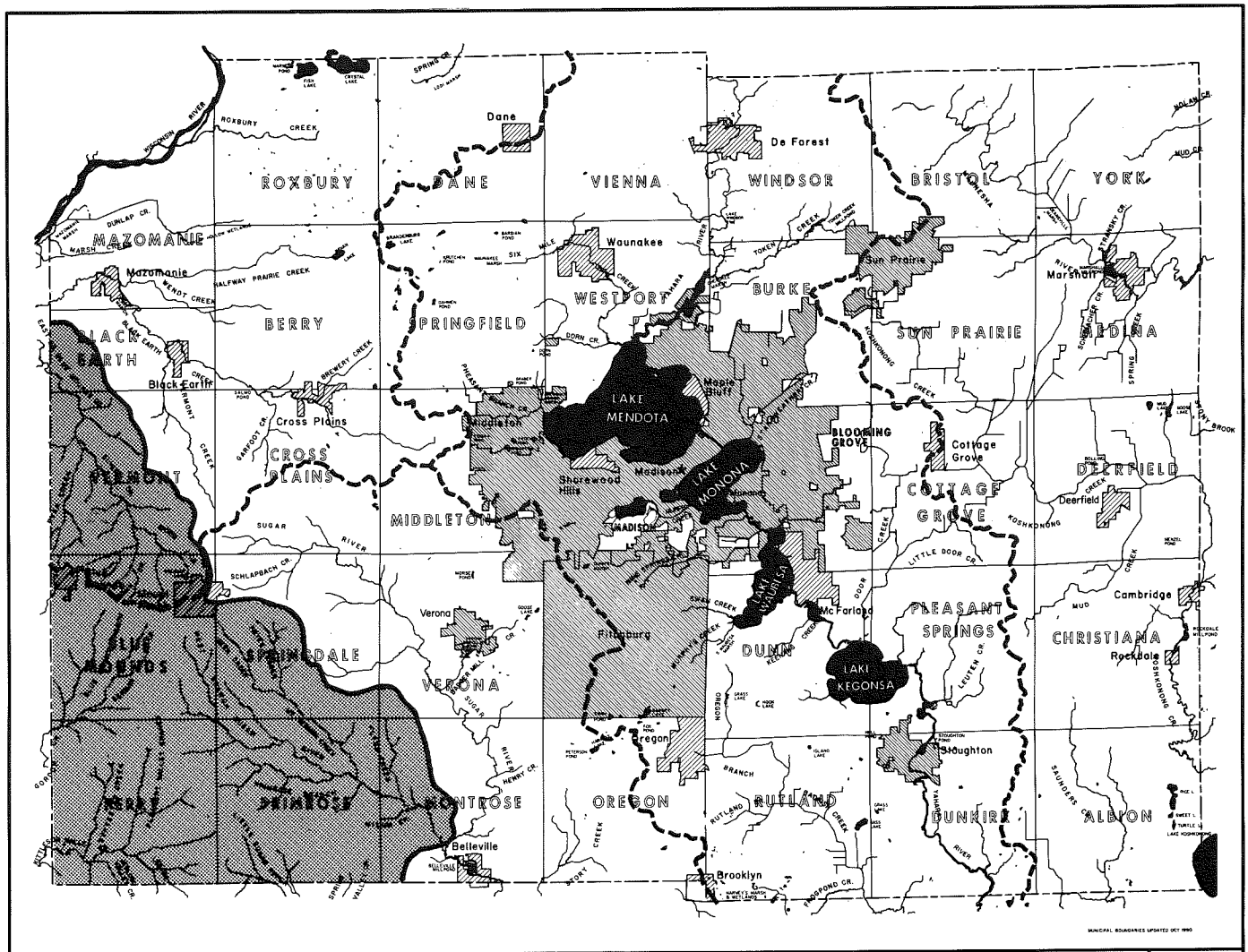


Source: UW Ext. 1987

Streambank erosion from grazing



Fenced cattle crossing



WATERSHEDS WITH THE GREATEST ANIMAL WASTE POLLUTION POTENTIAL
From Dane County Animal Waste Management Plan, 1985

Jan. 1990
1/90

AGRICULTURAL NONPOINT SOURCE CONTROL RECOMMENDATIONS

A-1: The minimum program needed to achieve the objectives of the Water Quality Plan and the statutory objectives of the soil conservation program (Chap. 92, Wis. Statutes) includes three important and necessary elements:

1) *Reliance upon state and federal cross-compliance requirements and the federal Conservation Reserve Program to address most cropland erosion and runoff control needs;*

2) *Reliance upon direct regulatory programs for significant problems or polluters not adequately addressed under 1);*

3) *Adequate cost-sharing funds to offset economic hardships and cost barriers to implementing best management practices required under 1) and 2).*

A-2: Dane County, in cooperation with the Department of Agriculture, Trade and Consumer Protection, the Department of Natural Resources and the Regional Planning Commission, should conduct a comprehensive evaluation in 1993 of the county's progress toward meeting the 1993 interim goals and 2000 final goals of Chapter 92, Wis. Stats. This evaluation should examine the need for adopting a mandatory soil erosion ordinance under Sec. 92.11, Wis. Stats., as well as an assessment of the need for additional cost-share funding or other economic incentives for agricultural nonpoint source pollution control programs.

A-3: Technical assistance and cost-sharing should receive greatest emphasis in areas of the county where both water quality and soil conservation program priorities are high.

A-4: The agricultural conservation program should emphasize comprehensive farm conservation plans and long-term agreements with landowners.

A-5: The farm conservation plan should include all farm operations that affect water quality.

A-6: Local agricultural nonpoint source management agencies should provide sufficient staff to enable contact with owners of high-erosion lands and follow-up on farm conservation plans, and should require that landowners receiving financial assistance for management practices agree to maintain those or similar approved practices for their effective economic life as determined by the cost-sharing administrative agency.

A-7: An evaluation of the level of cost-share funding necessary for landowner adoption of "best management" practices should occur if management practice implementation is insufficient through conservation compliance and voluntary program initiatives.

A-8: The local agricultural conservation program should include substantial technical assistance and information directed at emphasizing the advantages of conservation tillage practices.

A-9: Emphasis should be placed on increasing conservation information and education programs to heighten awareness of the importance of protecting soil and water resources.

A-10: Dane County should place a high priority on the development of barnyard runoff control programs for all barnyards or feedlots where over 25 equivalent animal units (swine or cattle) are kept within 1,000 feet of a navigable stream or lake, for farm operations in vulnerable environmental areas, and for farm operations where pollutant load modeling (ARS Barnyard Model) indicates high animal waste contributions to adjacent water resources.

A-11: The principal means of disposing of animal manures should continue to be year-round application to cropland; however, in some instances provision of winter manure storage facilities may be desirable in order to provide water quality and farm operation benefits.

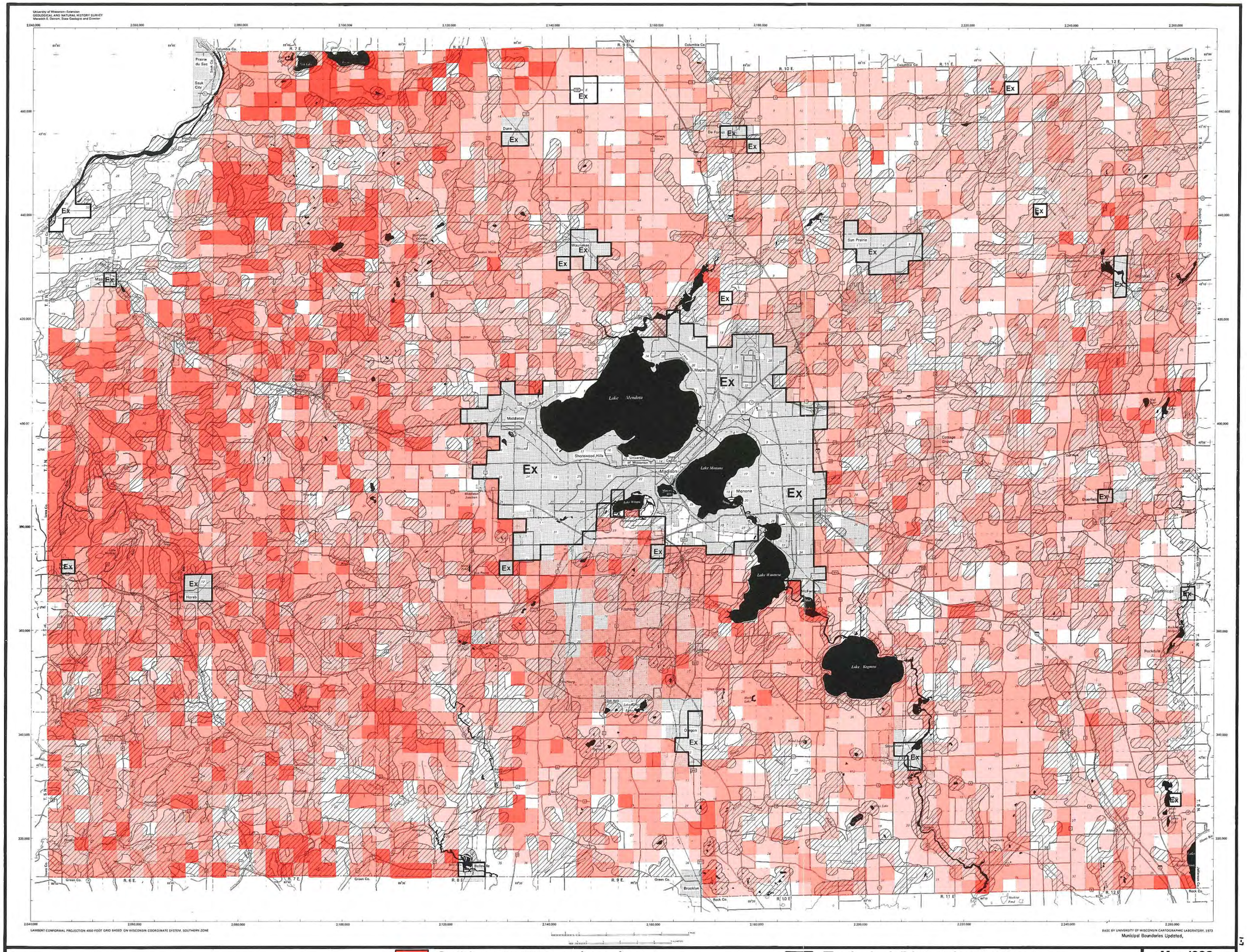
A-12: Manure storage pits or lagoons should be located and designed in accordance with specifications designed to protect groundwater. Large (more than 300 animal units) storage lagoons should not be located in areas of greatest groundwater pollution hazard.

A-13: Streambank protection programs emphasizing streambank fencing and the construction of cattle watering points and crossings should have a high priority in the voluntary conservation program, particularly in the western parts of Dane County where the problem is greatest. Conservation easements for stream corridor improvement should be pursued where necessary, and volunteer groups should be solicited to provide assistance for such improvement work.

A-14: The current pesticide training program sponsored by County and University of Wisconsin-Extension should be extended to include education on fertilizer application.

A-15: Increased monitoring for pesticides in groundwater should be conducted in areas of greatest pollution hazard where pesticides are commonly used.

University of Wisconsin–Extension
GEOLOGICAL AND NATURAL HISTORY SURVEY
Meredith E. Ostrom, State Geologist and Director



LAMBERT CONFORMAL PROJECTION 4000 FOOT GRID BASED ON WISCONSIN COORDINATE SYSTEM, SOUTHERN ZONE

BASE BY UNIVERSITY OF WISCONSIN CARTOGRAPHIC LABORATORY, 1973
Municipal Boundaries Updated,

Soil Loss* and Distance to Waterbodies
DANE COUNTY, WISCONSIN

*Estimates based on Universal Soil Loss Equation From Dane County Soil Erosion Control Plan, 1987.

- Soil loss > 20 tons/acre/year
- Soil loss > 10 and < 20
- Soil loss > 5 and < 10
- Soil loss < 5

Ex Excluded (Not at least 10 acres of ag land)

=1000 ft. distance to lakes, streams.

Note: Individual grid squares represent approximately 160 acres.

May, 1988

0 1/4 1/2 1 2 3
Scale in miles

Prepared by: THE DANE COUNTY REGIONAL PLANNING COMMISSION

OTHER POLLUTION SOURCES

Land-Disturbing Activities: Construction and Mineral Extraction

Soil erosion from nonagricultural land-disturbing activities, primarily construction and surface mining activities (sand and gravel extraction, quarries), are often one of the most significant sources of sediment and nutrients to receiving waters. Sometimes the localized impacts of this erosion are severe and highly visible, filling storm sewers and waterways with sediment, eroding visible gullies, creating turbid water and degrading habitat. Even where the impacts of land-disturbing activities are not highly visible, this pollution source can represent a major proportion of the nonpoint source pollution load from any area where there is growth, development and significant construction activity. Soil erosion from bare disturbed areas will often occur at rates 10-100 times that of tilled agricultural cropland during the period of disturbance and exposure, unless management practices are applied.

The most common management approach to controlling the water quality impacts of land-disturbing activities is to require (through local and county ordinances) the preparation of specific site plans and designs to control erosion and runoff from construction and mineral extraction sites, during the active period of construction or extraction activities, as well as plans for site restoration and stabilization after the land-disturbing activity is complete.

Construction erosion

Most of the larger urban communities in Dane County have adopted comprehensive erosion/runoff control ordinances which require the preparation of plans and installation of management practices for nonagricultural land-disturbing activities. In addition, Dane County has ordinances requiring the preparation of erosion control plans for residential subdivisions and for larger nonresidential projects, as well as ordinances requiring reclamation plans for mineral extraction sites. Erosion and runoff control plans specify practices which are appropriate to the specific site, but are usually based on the common principles of: (1) minimizing the area which is disturbed or exposed at any one time; (2) protecting exposed soil by seeding, mulching, and other protective mechanisms; (3) on-site management of stormwater and diversion and control of erosive stormwater flows; and (4) installation of settling basins and silt barriers to prevent eroded soil from leaving the site.

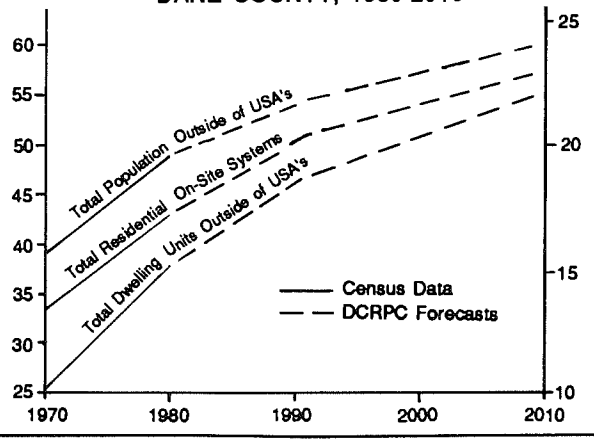
The principal issues and needs related to management of land-disturbing activities are to increase the coverage of land-disturbing activities covered by erosion/runoff control ordinances, and to improve and increase the enforcement and implementation of those ordinances. The greatest need in increased ordinance coverage is to seek adoption of erosion/runoff control ordinances by those urban communities which have not yet adopted ordinances, and to expand the coverage of the County's ordinances in rural areas to cover erosion control of all land-disturbing activities in shoreland areas, and to require runoff control on all larger residential and nonresidential construction projects. The primary needs for increased enforcement of ordinances can be met by providing an adequate and increased level of enforcement personnel, establishing enforcement of erosion/runoff control requirements as a high priority for enforcement personnel, and providing technical assistance and training for site designers, contractors and enforcement personnel in design and implementation of erosion and runoff control management practices.

On-Site Wastewater Management

The disposal of domestic and commercial wastewater in rural areas outside of the sewered urban service areas is handled through the use of individual on-site wastewater disposal systems, primarily septic tanks discharging to subsurface tile disposal fields. There are a small number of on-site sewage holding tanks, where wastewater is temporarily stored before disposal by land application or at a wastewater treatment plant; however, these facilities are normally limited to circumstances involving only occasional or seasonal generation of wastewater, or where site conditions do not permit on-site wastewater disposal.

There were an estimated 17,600 on-site wastewater disposal systems in Dane County in 1980, nearly all of which were systems serving individual residences in rural areas. This number is expected to increase to 23,600 by the year 2010. Many existing systems were installed prior to 1970, when standards for on-site wastewater disposal systems began to be strengthened and upgraded. Generally, newer on-site systems, particularly those installed since 1977, are quite reliable if properly maintained and generally represent an environmentally suitable disposal technique. In addition to lack of proper maintenance, older systems may be functioning poorly because of inadequate design and construction standards in effect at the time they were built, or unsuitable site conditions.

PROJECTED INCREASE IN ON-SITE SYSTEMS
DANE COUNTY, 1980-2010



One of the principal causes of poor functioning or failure of on-site wastewater disposal systems is neglect of proper maintenance and servicing of those systems. Septic systems should be inspected and pumped every two to three years, or they will eventually clog and fail. Although proper maintenance and servicing is not costly, it tends to be postponed or neglected until a serious problem or failure occurs. Since 1980, Dane County has required periodic evidence of adequate maintenance and servicing for all new or replacement on-site systems. If this requirement were expanded to include all on-site systems in Dane County, failures would probably dramatically decrease.

Another concern regarding on-site wastewater systems is the effect of these systems on nitrate levels in groundwater. Excessive nitrate levels in shallow groundwater and private wells is a problem throughout Dane County. It is not likely that scattered on-site systems contribute significantly to the overall problem but they can be a source of nitrate contamination of nearby shallow wells. This is particularly true for large on-site systems, or cases where a number of on-site systems are clustered, as in a rural residential subdivision. The concentration of nitrate-nitrogen from large on-site systems or clusters of systems can, when added to natural background nitrate levels in groundwater, result in raising nitrate levels in nearby shallow wells to above drinking water standards.

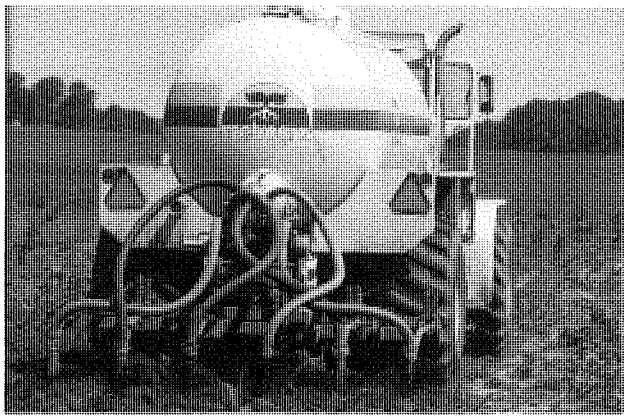
In general, the current design, construction and siting standards for on-site wastewater disposal systems are adequate to result in systems which are reliable and have minimal environmental impact. In addition, alternative designs, such as mound systems, are available which can overcome limiting site conditions. The greatest need is to ensure a basic minimum level of maintenance and servicing of on-site systems to avoid failures and ensure continued functioning and a long life. This could be partially achieved by an expanded program of information and education on proper use and maintenance directed at rural homeowners, but will probably have to be coupled with an expansion of the required or mandatory maintenance and servicing requirements to include all on-site systems in the County in order to be fully effective. The impacts and potential nitrate contamination resulting from large on-site systems or clusters of on-site systems (rural subdivisions) can be addressed by review and evaluation of specific proposals (permit applications, subdivision plat reviews) to determine if there is a likelihood that waste disposal practices will affect nitrate levels in nearby water supply wells. Finally, evaluation of the problems and impacts associated with concentrations of existing on-site systems need to be continued and expanded, and solutions to any significant problems evaluated and pursued. Appropriate solutions to serious problems can range from on-site improvement or replacement of individual systems, to providing centralized sewerage collection and treatment systems, depending on the magnitude and scale of the problem. In other cases, providing a protected water supply may be the best solution.

Land Application of Wastes: Wastewater, Sludges, Septage and Solid Waste

One of the fundamental environmental and resource planning principles in Dane County is the goal of returning or recycling organic wastes to the land, in ways that maximize the beneficial use of organic wastes. Realizing this objective requires careful management to avoid environmental problems and impacts on water quality.

Most municipal and industrial wastewater in Dane County is discharged to surface water after treatment. A few smaller communities discharge to groundwater through seepage lagoons, but none apply wastewater to the land surface. A few industrial wastewater sources apply organic wastewater to the land surface through landspreading or spray irrigation, primarily wastewater from cannery, food processing or dairy wastes. Nearly all wastewater sludges (the solids removed from wastewater during treatment), however, are applied to agricultural lands in Dane County. Wastewater sludges from biological treatment processes represent concentrated sources of valuable organic material and plant nutrients which can provide significant benefits to agricultural lands and partly replace chemical fertilizers. Many of these sludges also contain valuable trace elements as well as potentially hazardous or toxic substances which may be of concern. Septage--the material pumped and removed from on-site wastewater systems--is hauled and disposed of at both wastewater treatment plants and at landspreading sites. Most of the 10 million gallons per year of septage generated in Dane County is applied to a large number of mostly uncontrolled and unregulated land disposal sites. The 1,200 tons per day of solid waste materials generated in Dane County, which include both organic and inorganic materials, is buried in dumps and sanitary landfills below the land surface, so the potential beneficial use of the organic materials in this waste is largely unrealized. There are programs underway to separate those organic components of solid waste, such as leaves and yard waste, which can be composted and suitably applied to the land.

Yard waste composting site



Injecting sludge (Metrogro)

Soil testing at sludge application site

The most important water quality aspects of the management of land application of wastes include: (1) avoiding contamination of surface waters from runoff from the application site; (2) avoiding groundwater contamination from precipitation infiltrating through the waste materials into groundwater; and (3) preventing accumulation or buildup of toxic or hazardous materials in soil, water or plants. It is, of course, also important to maximize the benefits of land application of organic materials to the greatest extent possible, rather than looking at land application as a disposal technique. This means selecting sites and applications where the benefits of the nutrients and organic materials supplied are utilized to the greatest extent in improving soil fertility and productivity, reducing erosion, and replacing chemicals through plant utilization and uptake of nutrients.

The management principles and practices which provide the necessary foundation for environmentally sound land application of organic wastes include:

- selecting site locations which minimize the potential for surface or groundwater contamination;
- requiring site design, operation and land application procedures which avoid surface and groundwater pollution problems (such as avoiding application of wastes on sloping lands near surface waters or requiring incorporation of waste materials into the soil rather than spreading on the land surface);
- analyzing and monitoring the waste materials, ground and surface waters, and site soils and plants to ensure that waste application rates, amounts and techniques do not result in accumulation or buildup of unacceptable or dangerous levels of trace materials or toxic substances.

CONTROL PROGRAM RECOMMENDATIONS
OTHER POLLUTION SOURCES

Land-Disturbing Activities

O-1: *Units of government should adopt and vigorously enforce ordinances limiting erosion from all significant construction and other nonagricultural land-disturbing activities.*

O-2: *Mineral extraction sites (sand, gravel, clay, quarries) should be regulated by Dane County and the Wisconsin Department of Natural Resources to ensure that site design and operations protect against impacts on surface and groundwater. Larger continuously-operating sites should be regulated by DNR under the WPDES permit program, while smaller and intermittently-operated sites should be regulated by Dane County through zoning and land use controls.*

On-Site Wastewater Management

O-3: *Dane County should maintain an aggressive inspection and enforcement program on new on-site wastewater disposal systems.*

O-4: *Dane County should expand the program of registration and required maintenance of on-site wastewater systems to include all on-site systems.*

O-5: *Designated local management and planning agencies should jointly investigate problems and alternative solutions for existing concentrations of development on septic tank systems in unincorporated areas.*

O-6: *Large (over 8,000 gallons/day) on-site wastewater systems should be regulated as wastewater treatment facilities under the WPDES permit program.*

O-7: *Large on-site wastewater systems and clusters of systems (over 100 gallons/acre/day loading) should only be approved where wells and water supplies can be protected from excessive nitrate levels.*

O-8: *Holding tanks should be used for wastewater disposal only in instances when adequate servicing and pumping can be assured, and when suitable disposal methods (well-regulated land disposal sites or wastewater treatment plants) are specifically available for receiving the wastes.*

O-9: *Municipal wastewater treatment plants should include provisions for receiving and treating holding tank wastes and septage generated within a reasonable service area or distance. Point source management agencies and the Wisconsin Department of Natural Resources should cooperate in expanding the availability of authorized septage discharge points to municipal wastewater treatment systems.*

Land Application of Wastes, Sludge and Septage Disposal, Solid Waste Disposal

O-10: *Sites for land application of wastewater should be carefully located and designed to avoid groundwater contamination, and should not be located in areas of greatest groundwater pollution hazard or municipal well protection zones.*

O-11: *Dane County should assume responsibility for regulating land application sites for disposal of septage and holding tank wastes. The program should include site location and licensing requirements, application and operating criteria and procedures, surveillance and enforcement procedures, and license fees necessary to support the program.*

O-12: *Organic sludges produced by biological wastewater treatment processes should be recycled as a fertilizer and soil conditioner to agricultural cropland, nurseries, sod farms, or other lands where plants utilize the nutrients and are harvested. Subsurface injection or other means of ensuring immediate incorporation into the soil should be required and practiced to minimize surface runoff.*

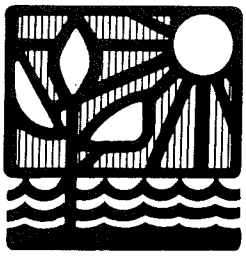
O-13: *The location and operation of sludge application sites should continue to be regulated by the Wisconsin Department of Natural Resources. Criteria for sites should be expanded to reflect additional information on groundwater protection, and additional monitoring of sludge characteristics should be required. Application sites should not be located in areas of greatest groundwater pollution hazard or in municipal well protection zones.*

O-14: *Wastewater treatment plants should have adequate sludge storage capacity (150 days) to avoid the need to apply sludge to land during winter months or under saturated soil conditions.*

O-15: *Solid waste disposal sites and landfills should be located and designed to protect surface and groundwater. Proposed landfills should be located outside of municipal well protection zones and in areas of least-to-moderate groundwater pollution hazard.*

O-16: *Groundwater monitoring of the effects of existing or closed solid waste disposal sites in areas of greatest pollution hazard in municipal well protection zones should receive high priority.*

CHAPTER 4



RESOURCE MANAGEMENT

STREAM AND SHORELAND MANAGEMENT

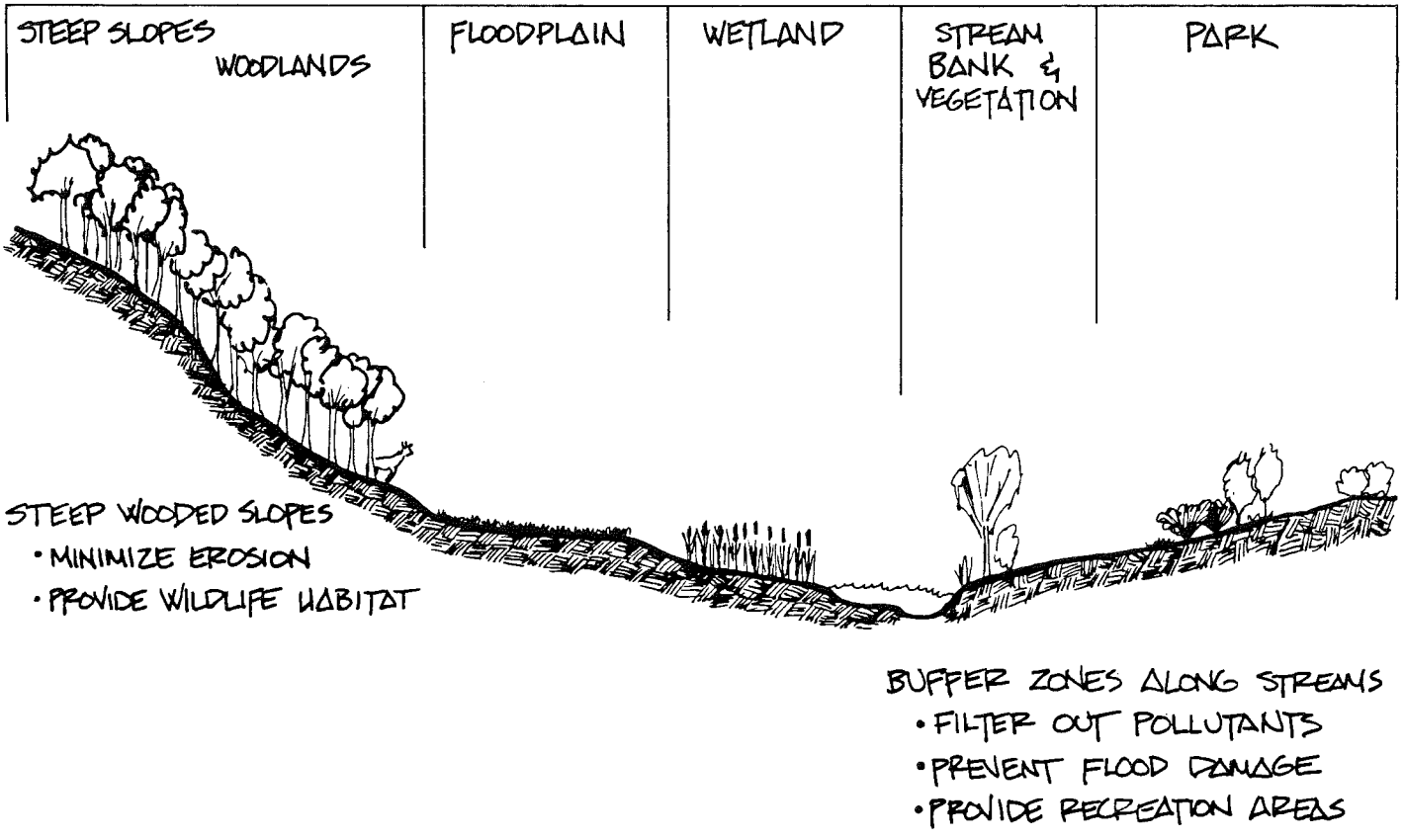
Environmental and Open Space Corridors

The open space corridors illustrated on the Regional Development Guide Plan Map (page 5) provide the basic planning framework and foundation for resource protection, including stream and shoreland protection and management. The open space corridors are continuous open space systems based on natural resources and environmentally important lands. The corridors are based primarily on streams, lakes, shorelands, floodplains and wetlands. Steep slopes, woodlands, parks and publicly-owned open space lands may also be included. Protection of open space corridors from disturbance and development is important because these lands are critical to a variety of community concerns and environmentally important functions, including:

- protection of water resources, drainage and hydrologic functions;
- pollution control;
- protection of public health, safety and property;
- provision of outdoor recreation and education opportunities;
- protection of wildlife habitat; and
- enhancement of scenic beauty and shaping of urban form.

The delineation and protection of a continuous areawide open space corridor system is based on recognition of the interrelatedness of adjacent landscape types and the importance of protecting valuable ecological units and linkages. The corridor system, therefore, is primarily associated with stream valleys and water features, emphasizes the importance of continuity of environmental systems and protection of the land/water edge.

The open space corridor system shown on the Regional Development Guide Plan Map includes two distinct components: (1) urban environmental corridors within urban service areas; and (2) rural resource protection areas outside of urban service areas. While both of these components represent continuous corridor systems, and are connected with each other, there are some differences and distinctions between the two components. Urban environmental corridors generally face greater pressure from adverse development or modification, higher densities of surrounding development and land use, and greater need and use of corridors for public open space and recreation. As a result, the urban environmental corridors have a higher proportion of land in public ownership, are more extensively used for recreation, and have a greater emphasis on protecting intermittent streams and drainageways which are threatened by development and landscape alteration. The urban environmental corridors often require more stringent protection measures or acquisition to adequately protect critical or scarce resources.



This schematic diagram depicts the resource elements one finds in a typical environmental corridor. Often one or more elements are found in the same locality, such as woodlands and steep slopes.

The urban environmental corridor systems represent a substantial framework for the basic open space and environmental network in a community. As an example, the environmental corridor system in the Central Urban Service Area (the largest urban service area in Dane County) includes approximately 11,000 acres of land, or about 20 percent of the total land area. About 8,000 acres (75 percent) of this land is in public ownership. Most of the remaining 3,000 acres is subject to environmental regulations of some sort (such as shoreland, wetland or floodplain zoning), and some of this land will be acquired in the future through purchase or dedication.

Rural resource protection areas are based mainly on floodplains, wetlands and shorelands delineated in town plans and protected through zoning or other regulations, together with existing and proposed publicly-owned or controlled lands needed for resource protection, continuity or public recreation. There is less pressure for alteration or development of these lands, and less land is needed for public open space and recreational use. As a result, most of the lands in rural resource protection areas will remain in private ownership, and there is less need for acquisition or stringent regulation of such resources as intermittent streams and drainageways, woodlands or steep slopes.

The countywide open space corridor system illustrated on the Regional Development Guide Plan Map has evolved from a general planning concept to a specific and detailed tool used for guiding land use and environmental management decisions. Urban environmental corridors have been mapped and adopted for all of the urban service areas in Dane County. The environmental corridor delineations have been incorporated into local land use and comprehensive plans, and provide the basis for decisions on acquisition, regulation and protection of open space in urbanizing areas. The primary protection mechanisms for environmental corridor lands and resources at the local level include land use regulations (such as floodplain, wetland, shoreland and conservancy zoning, subdivision regulations, official mapping), and acquisition (through purchase or dedication). These protective mechanisms are reinforced by using the environmental corridors as the basis for federal (404 permits) and state (Chapter 30 and 31 permits) actions and decisions. In addition, the requirement that sanitary sewer extension approvals be based on a delineation of sewer service areas which include the identification of lands (environmental corridors) which are to be excluded from sewered development provides an additional powerful tool in protecting corridors from urban development.

The open space corridor system shown on the Regional Development Guide Plan Map represents the basic skeleton of an areawide open space network. It is expected that this basic system will be expanded by adding buffer areas, areas for protecting scenic views and community separation, and areas desired for active recreation or public use.

OPEN SPACE FUNCTIONS OF ENVIRONMENTAL CORRIDOR RESOURCE FEATURES

FUNCTION	RESOURCE FEATURES: Lakes, Ponds & Streams	Wetlands	Floodplains	Shoreland Buffer Strips	Steep Slopes	Woodlands	Parks	Unique Vegetation or Geology	Problem Soils
Protect Water Resources, Drainage & Hydrologic Functions	▲	▲	▲	▲		△			△
Provide Pollution Control		▲	△	▲	▲	△	△		
Protect Public Health, Safety & Property	▲	△	▲		▲				▲
Provide Outdoor Recreation & Education Opportunities	▲	△	△	△		△	▲	△	
Provide Wildlife Habitat	▲	▲	△	△		▲	△	△	
Enhance Scenic Beauty & Shape Urban Form	▲	▲	△	▲	▲	▲	▲	▲	

▲ Primary Function △ Secondary or Supplemental Function

The most important current issues and priority needs in regard to open space and environmental corridor protection are: (1) using the adopted open space/environmental corridor system as a consideration in all local land use and siting decisions and planning; (2) continuing to emphasize the use of the open space corridor network as basic guidance and priorities for open space acquisition and protection programs; and (3) providing emergency acquisition funds to ensure protection of important corridor lands and critical environmental resources which are endangered or threatened by development which cannot be adequately protected through other means.

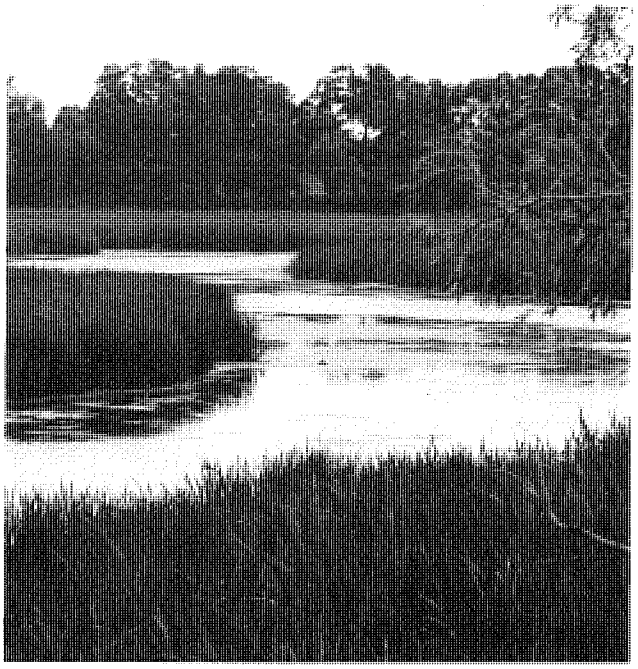
Urban shoreline corridor

Floodplain, Wetland and Shoreland Protection Programs

Within the overall context of protection of open space and environmental corridors there are several specific programs directed at protection of streams and shorelands from adverse impacts which would affect or detract from the environmental functions of these resources. These programs are directed at regulating activities in floodplains, shorelands and wetlands. Programs include the federal Section 404 permit program (administered by the U.S. Army Corps of Engineers) regulating the discharge of dredged or fill materials into all waters of the United States, generally including all lakes, streams and adjacent wetlands which are part of a surface tributary system to and including navigable waters. State Chapter 30 and 31 permits (administered by the Department of Natural Resources) regulate a variety of activities in, or directly affecting, navigable waters of the state. State law requires counties to adopt and enforce restrictive zoning of shorelands along navigable streams or lakes in unincorporated areas. Shorelands are defined as areas lying within 1,000 feet of lakes, ponds or flowages, and within 300 feet of rivers or streams, or to the landward side of the floodplain, whichever distance is greater. Minimum standards and criteria for regulation of land use in the shoreland areas are included in Chapter NR 115 of the Wisconsin Administrative Code. State shoreland protection requirements have been expanded to require counties (in unincorporated areas) and villages and cities to adopt shoreland-wetland zoning ordinances which provide substantial additional protection measures for wetlands located within shoreland areas. NR 115 and NR 117 are the administrative rules providing standards and criteria for these zoning programs. State law also requires counties, cities and villages to adopt floodplain zoning ordinances under criteria and standards established in NR 116 of the Administrative Code.

Dane County has adopted the required general shoreland zoning, shoreland-wetland zoning, and floodplain zoning for the unincorporated areas of the county. Nearly all of the villages and cities in Dane County with areas subject to flooding have adopted floodplain zoning ordinances. The requirement that villages and cities adopt shoreland-wetland zoning is more recent, and local communities are in the process of developing and adopting the required shoreland-wetland zoning ordinances. At the present time, most of the incorporated communities which have significant shoreland-wetlands have developed and adopted wetland zoning ordinances, or are in the process of development and adoption.

The most important issue in regard to floodplain, wetland and shoreland protection programs are limitations in the degree of protection provided, and the incomplete scope or coverage required of the zoning programs. Since the basic intent of floodplain zoning is to limit flooding damages, these ordinances do not restrict development or other activities in the floodplain which adversely affect other environmental functions. Similarly, general shoreland zoning is required to address certain basic criteria and standards for development and activities within the shoreland area, but many potential activities and impacts are not required to be addressed. Required shoreland-wetland zoning provides a greater degree of protection to covered lands than floodplain or general shoreland zoning, but shoreland-wetlands smaller than five acres, and wetlands outside the shoreland area are not required to be covered by these ordinances. The protection of critical environmental resources afforded by these programs would be substantially improved if the county and local units of governments responsible for adopting and enforcing these ordinances went beyond the minimum state requirements in the degree of protection provided by these ordinances for covered lands, and extend the coverage of wetland zoning ordinances to include wetlands not required to be zoned under current state law.

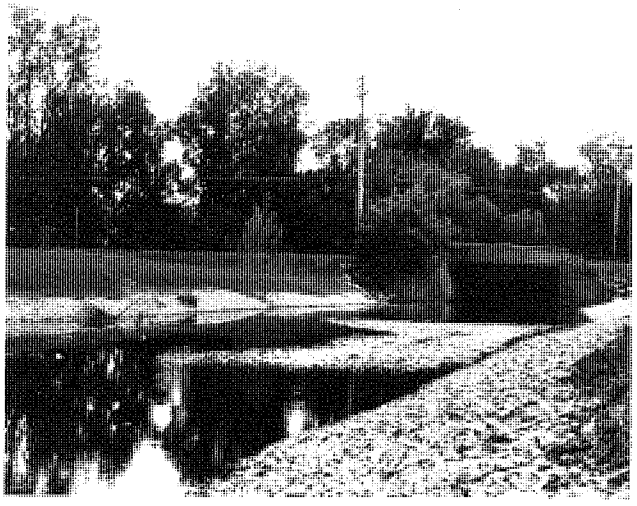


Shoreland wetland

Streambank and Shoreline Protection and Improvement

The management and improvement of streambanks and shorelines is another important aspect of resource management. These programs include such management activities as acquisition of shorelands, easements and buffer strips; vegetation management; stream bed and bank stabilization measures and structures, such as riprap or sheetpiling, dredging and grading; fencing and streambank crossings for livestock exclusion; improvements to upgrade recreational use and access; and improvements to enhance habitat for fish and wildlife. The basic purpose of these management programs and activities is to protect or enhance the basic environmental and open space functions of the resource, including maintenance of flow capacity, erosion control, improving recreational use and access, improving fish and wildlife habitat, and providing adequate protective buffers between land uses and environmental resources.

There is no clear-cut overall responsibility for stream management for major streams which involve more than one local jurisdiction. The Wisconsin Department of Natural Resources, designated the trustee of all navigable waters of the state (including groundwaters), exercises fairly complete regulatory control over navigable waters of the state, but its role in streambank and shoreline protection and improvement programs has generally been limited to specific projects and locations where the state has an active role in fish, game and resource management. Local programs for streambank stabilization and shoreline protection and improvement projects have been pursued by individual local units of government for specific areas in their jurisdiction. These programs and projects have included: streambank and channel stabilization projects and structures using public funds, equipment and personnel; sponsoring or providing funding to private conservation groups for streambank and shoreline improvement projects; and sponsoring and supporting volunteer shoreline cleanup and vegetative management programs.



Shoreline maintenance

Streambank stabilization

Dane County government could play a much greater role in stream, streambank and shoreline management under recent state legislation granting the County Lakes and Watershed Commission additional authority and financing tools.

The importance and role of streambank and shoreline buffer strips and easements in protecting and managing streams is being increasingly recognized, and more attention and effort will need to be directed to acquisition programs, including dedication and easement approaches. Stream and shoreline buffer strip acquisition and protection is, of course, consistent with and supportive of the overall approach to open space and environmental corridors.

Other Stream Management Issues

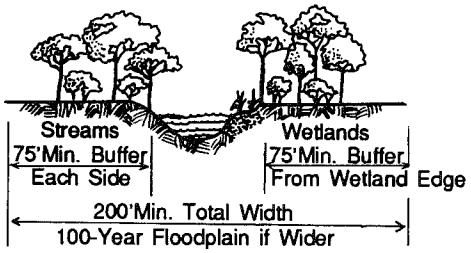
Other direct stream management issues include monitoring, fishery management and habitat improvement, maintaining and improving navigation and flood handling capacity, and providing access and facilities for in-stream recreation. In Dane County, there is generally a scarcity of up-to-date information on surface water quality conditions, and it is difficult to determine whether water quality in any particular stream is adequate or suitable for supporting the intended uses in that stream. It is, therefore, important to support a continuing program of monitoring streams to provide information on flow, chemical characteristics and biological characteristics to determine whether or not the conditions are supporting the stream's potential for use, or whether the stream's use is being limited or impaired by pollution or other impacts.

In-stream construction, or dredging and grading activities designed to maintain or improve navigation and flood-carrying capacity, or to provide recreational facilities or access, can have adverse effects on water quality if not undertaken with care and in concert with an overall stream and shoreland management program.

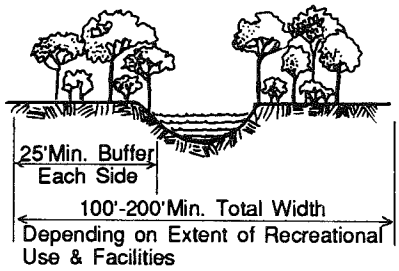
From the standpoint of in-stream fishery or shoreland wildlife management programs, the Department of Natural Resources is the principal agency having both the technical expertise and the institutional responsibility for these programs. The role of local units of government is primarily to participate in and support those state management programs.

BUFFER STRIP RECOMMENDATIONS

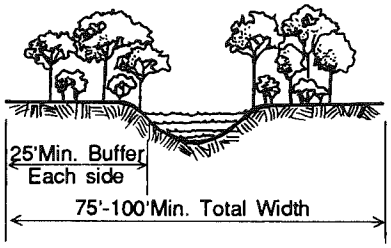
NAVIGABLE STREAMS & WETLANDS

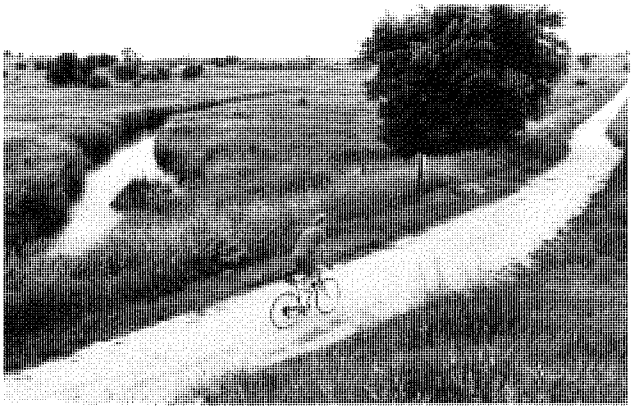


INTERMITTENT STREAMS & DRAINAGEWAYS WITH PUBLIC ACCESS FOR RECREATION



INTERMITTENT STREAMS & DRAINAGEWAYS NO RECREATIONAL ACCESS





Sugar River wetland and bike trail

Starkweather Creek corridor and bikeway

STREAM AND SHORELAND MANAGEMENT RECOMMENDATIONS

S-1: The environmental and open space corridors illustrated on the Regional Development Guide Plan Map should be adopted and incorporated into the plans, land use controls and resource protection programs of all units of government and designated water quality management agencies in Dane County. The corridor system should be adopted as the basic skeleton or framework to develop communitywide and countywide open space and resource protection networks, and should be expanded to include additional needed lands and resources.

S-2: Wetlands, steep slopes, buffer strips and wooded areas in or near water bodies which have significant water quality protection functions should be protected from adverse development or impacts through regulation or acquisition.

S-3: Park and open space land acquisition policies in Dane County should continue to place priority on acquisition of water-oriented parks and water-related resource protection areas.

S-4: Dane County and cities and villages in Dane County should establish emergency acquisition funds to provide money for quick acquisition of wetlands, floodplains, shorelands or groundwater recharge/discharge areas threatened with adverse use or development.

S-5: The role of woodlands in the hydrologic cycle and as water quality protection should be enhanced and promoted through woodland management and protection plans and financial incentives.

S-6: Adequate vegetative stabilization and buffer strips to protect and stabilize the land/water edge and stream corridor functions should be included in land use and development plans and controls or regulations.

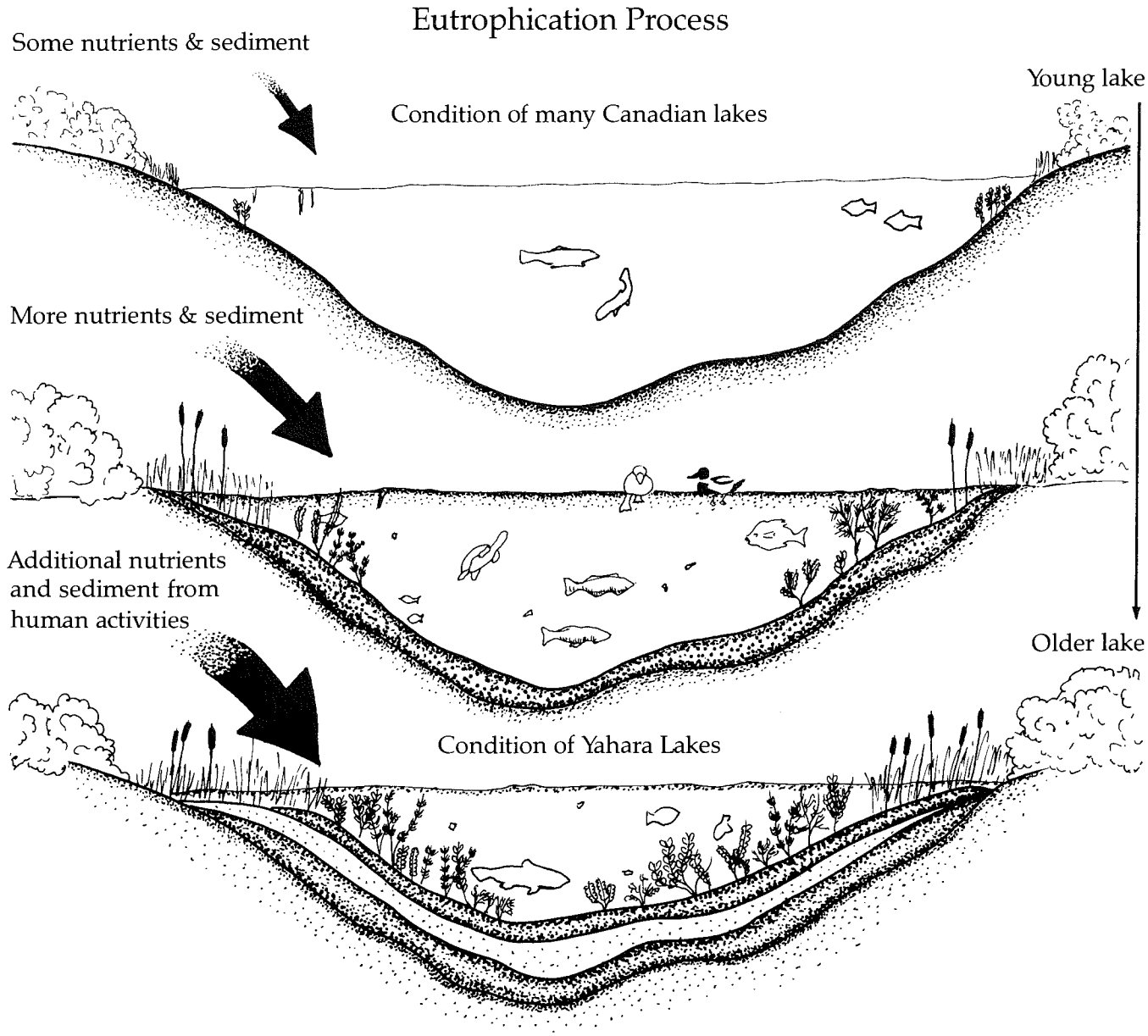
S-7: An ongoing program of monitoring stream water quality conditions, use suitability and limitations, and corridor evaluation should be supported and conducted by the Wisconsin Department of Natural Resources, Dane County and local management agencies.

LAKE MANAGEMENT

Lake Conditions and Management Problems

Lake management issues in Dane County are dominated by the Yahara River chain of lakes, since these are the largest, most prominent, and heavily used lakes. There are other, smaller lakes throughout Dane County including seepage lakes such as Fish Lake and Crystal Lake, as well as small stream impoundments and millponds like the Marshall and Rockdale millponds, Lake Belle View, and the Yahara River dams below Lake Kegonsa. The most important water quality problems and management concerns for most of these smaller lakes are the same as those for the Yahara River lakes--excessive fertility and eutrophication resulting from high nutrient and sediment loading. Specific and detailed management plans for each of these smaller lakes and impoundments need to be developed before management practices and programs can be undertaken, in order to reflect the particular problems, circumstances and pollution sources affecting each lake.

The Yahara lakes, Lake Wingra and most of the other lakes and impoundments in Dane County are classified as eutrophic lakes. Eutrophic lakes have an ample supply of nutrients, and usually an abundant crop of aquatic weeds and algae. Natural eutrophication is a slow process in which sediment and nutrients enter the lake from runoff from the lake's watershed, causing an increase in plants and a gradual filling-in of the lake. The time required for this filling or "aging" depends greatly on the surrounding landscape and on the nature of the lake itself. The rate of aging or eutrophication can be speeded up by human inputs of sewage and polluted runoff from farms and cities. Through this process of "cultural" or accelerated eutrophication, the lakes can quickly become more fertile and support nuisance levels of aquatic plants and algae. The Yahara lakes are certainly victims of cultural eutrophication. Problems with algae growth were first reported in the 1880s, possibly caused in part by sewage discharging into Lake Monona from an expanding urban population. Although Lake Mendota never received large quantities of sewage, Lakes Monona, Waubesa and Kegonsa were all heavily affected by the discharge of treated sewage



from the Madison area. Most sewage was diverted from Lake Monona in 1936 and from Lakes Waubesa and Kegonsa in 1958. Following these diversions, the lower three lakes improved greatly. In 1971, remaining treatment plant discharges from small communities upstream from Lake Mendota were diverted around the lakes; and in the 1980s, all remaining wastewater discharges tributary to the Yahara lakes were diverted, so that none of the lakes now receives any significant impact from point sources of pollution. However, the lakes continue to receive sediment, nutrients and other types of pollutants in runoff from the surrounding farmlands and cities.

The public and lake users have long identified poor water quality and shoreline conditions caused by excessive aquatic weeds and algae as the main problems and obstacles to enjoying the lakes. Aquatic weeds and algae are natural and important elements in the lake ecosystem, but excessive growth of these plants causes nuisance conditions. Aquatic plant growth is fueled by the availability of nutrients, especially phosphorus, washing into the lakes from the watershed. Since this is the cause of the water quality problem, the most important aspect of lake protection and management is reducing the input of sediment and nutrients to the lakes, while also controlling and harvesting aquatic plants so they don't interfere with recreational and aesthetic enjoyment of the lakes. Reducing nutrients available to algae and weeds in the lakes can reduce the problem if the reductions are substantial enough. It is difficult, however, to achieve any dramatic or visible changes in the water quality of the Yahara lakes in the short term, because nutrients have also accumulated in the sediments of the lakes and can be recycled and used by plants. Nevertheless, an aggressive watershed pollution control and management program is absolutely essential and the most important ingredient in the long-term management strategy of the lakes for several reasons: (1) such programs, if aggressively pursued and well funded, can result in long-term improvement in lake water quality conditions; (2) aggressive watershed management programs are necessary to ensure that watershed nutrient loadings do not increase and worsen algae and weed problems to the point that they become unmanageable; and (3) most watershed nutrient and sediment control programs provide important benefits in addition to reducing nutrient loadings to the lakes--reduction of loss of topsoil and productivity on agricultural land, improved urban stormwater management conditions, and reduction of drainage and flooding problems. Thus, the most important element in the long-term strategy to protect and manage our lakes is the reduction in nutrient and sediment inputs from the lake's watersheds, applying the urban and agricultural nonpoint source pollution control practices and programs described in Chapter 3.

Lake problems caused by runoff

Direct Lake Management Programs

In addition to reducing pollution inputs to the lakes, there are a variety of direct or in-lake management practices and programs which are designed to avoid or manage nuisance conditions or problems, enhance use and enjoyment of the lakes, and ensure that the lakes are safe and healthy environments for recreational use and support of fish and aquatic life.

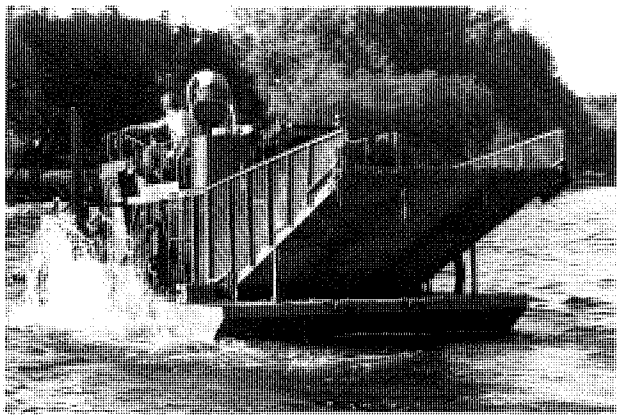
Nuisance algae blooms, and subsequent die-off and decay, create obnoxious and odorous conditions which seriously impair or interfere with scenic enjoyment and recreational use of the lakes. The only safe and proven long-term strategy to preventing nuisance algae blooms is to reduce the nutrients which fuel these blooms. Algae can be controlled and killed by applying chemical algicides to the lakes, and algicides such as copper sulphate have been heavily used in the past for algae control on the Yahara River lakes. Chemical control of algae, while cheap and effective in treating short-term algae bloom problems, does not resolve the need for nutrient reduction, or avoid problems caused by the organic decay of dead algae. In addition, algicides accumulate in bottom sediments of the lakes to levels that can become of environmental concern. In summary, chemical control of algae, while an economical approach, is primarily of short-term and cosmetic benefit. Lasting effects are potentially deleterious, so that the use of chemicals for algae control is presently limited to small areas, and is not a significant lake management technique. A biological approach to algae control which has promise is the manipulation of the food chain and fish species composition in the lake to favor zooplankton which feed on algae. Experiments are currently being carried out in Lake Mendota. Further experimentation and evaluation is needed to determine whether or not this approach, combined with nutrient reduction, can be effective in reducing algae populations.

In addition to algae, excessive sediment and nutrient inputs can fuel growth of large aquatic plants and weeds to nuisance levels which interfere with aesthetic and recreational enjoyment and use of the lakes. Rooted aquatic plants are important and necessary elements in the lake's ecosystems, and provide important fish habitat and cover as well as food.

In the 1960s, however, the Yahara lakes were invaded and dominated by a species of aquatic weed (Eurasian water milfoil) which was less desirable in many respects than previously dominant plant communities. This change in species dominance increased the nuisance factor and management problems. The lake management problems caused by dense growths of aquatic rooted plants in shallow areas include serious interference with recreational boating and navigability; interference with swimming and other shallow area recreational activities; and acceleration of sediment deposition and filling of shallow areas (which also expands the area suitable for growth of weeds). Subsequent die-off and decay of excessive aquatic plants also contributes to the odors and oxygen depletion caused by decay of organic materials.

The primary management practices used for control of excessive weed growth include physical control (such as mechanical harvesting), and chemical control. Dane County presently maintains an aggressive program of mechanical cutting and harvesting of aquatic weeds in the Yahara lakes and other lagoons and lakes in the County. The basic purpose and objective of the mechanical harvesting program is to maintain adequate recreational navigability and access, and to enhance the overall recreational or aesthetic value of the lakes. Other physical weed management techniques which have promise and have been used in some circumstances include lake drawdowns to expose and kill or remove aquatic weeds in shallow shoreline areas, and the use of bottom screens or barriers to prevent or limit aquatic plant growth in small selected areas.

Application of chemical herbicides is an economical approach to killing aquatic weeds, and has been extensively used in the Yahara lakes in the past. The same concerns and effects are associated with the use of chemical herbicides such as sodium arsenite to control weeds as those described for the use of chemical algicides--the approach provides only short-term and cosmetic benefits, does not avoid the problems of nutrient availability and organic matter decay, and represents potential long-term environmental risks. At the present time, chemical herbicides are used for control of aquatic weeds only in small areas of the Yahara lakes, generally along private shorelines, and are restricted to approved herbicides applied under the DNR's supervision.



Weed harvesting

A promising biological approach to managing aquatic plant problems is direct management of aquatic plant communities to create conditions which favor more desirable plant species and plant community compositions than those presently existing. This approach is receiving increasing attention and experimental efforts are being considered for the Yahara lakes.

The extent of rooted aquatic plant beds in the Yahara lakes is generally limited to shallow areas where sunlight is able to penetrate a sufficient depth to support plant growth. The expansion of shallow areas through sedimentation can increase the area suitable for rooted aquatic plant growth. Paradoxically, the improvement of water transparency from reduced algae populations can also expand the area suitable for aquatic plant growth. In other words, the situation can result that, as the water becomes clearer and algae problems are less serious, the extent and growth of nuisance rooted aquatic plants can increase. Conversely, in lakes where algae problems are serious enough to create very poor water clarity, growth of aquatic weeds can be limited.

Another lake water quality concern is the deposition of potentially toxic or hazardous materials in lake sediments as a result of pollution sources or previous applications of chemicals for algae and aquatic weed control. Substances of concern which have been found in lake sediments include mercury, arsenic, copper and PCBs. Although levels of these materials in lake sediments do not appear to be a serious concern in terms of direct exposure, some of these materials can be concentrated or accumulated in the food chain. As a result, a mercury health advisory for consuming large walleyes from Lakes Monona and Waubesa has been issued. Current sources of these pollutants can be reduced through nonpoint source pollution control programs. The effects of dredging or disturbance of previously deposited in-place pollutants is of concern and requires careful evaluation.

Other Lake Management Issues

There are other important lake management issues related to lake use which are interrelated with water quality management concerns and programs. These include programs to enhance recreational use and scenic enjoyment of the lakes and lake shorelines, management of lake levels and lake outflows, lake shoreline cleanup and maintenance activities, dredging, and management of the fisheries of the lakes.

The Yahara River Lakes Water Recreation Study (RPC, 1987) examined lake recreational uses, problems and issues, many of which are related to lake water quality conditions and management programs. This plan proposed management programs, in addition to water quality improvement and lake management, directed at providing sufficient access and support facilities for swimming and boating, developing and enforcing boating and water safety programs and regulations, monitoring water quality conditions at swimming beaches, and monitoring and evaluating the growth and patterns of recreational use of the lakes in order to anticipate and avoid future use conflicts and problems. The Water Recreation Study also stresses the importance of lake shoreline maintenance and cleanup activities, and supports studies of dredging needs and improved management of the lakes' fisheries.

The Yahara lakes support a diverse fishery, and fishing is one of the most popular uses of the lakes. DNR is the principal agency having both the technical expertise and institutional responsibility for managing the fisheries in Dane County lakes. Fishery management includes a variety of approaches, including fishing regulations, stocking, habitat improvement and rough fish removal. Fishery management is also interrelated with aquatic weed and algae control.

Dane County manages lake levels and lake outflows under criteria and guidelines established by DNR. It would be useful to develop improved, more sophisticated and more precise operating rules for lake levels and outflows, treating the Yahara River lakes as a series of multipurpose reservoirs. These operating rules would need to address all of the competing, and sometimes conflicting, concerns related to lake levels and outflows. Improved lake level and flow management could result in improved flood control benefits and reduced flooding problems, better satisfaction of recreational access and use concerns related to lake levels, maintenance of lake levels most conducive to fish spawning conditions, use of lake level manipulation to better control and manage shallow shoreline aquatic weed growth and conditions, reduced shoreline ice and erosion damage, and better baseflow control to offset the effects of groundwater pumping and diversion.

Finally, the Yahara lakes, particularly Lake Mendota, and Lake Wingra and the Arboretum, represent important field laboratories for technical and scientific analysis and the study of limnology and lake ecosystems. A substantial amount of scientific and technical information for these lakes has been gathered over a long period of time that is important in lake studies and limnological research having benefits beyond the boundaries of Dane County. It is important, both from a standpoint of managing the Yahara River lakes, and from the standpoint of maintaining the scientific data base and increasing our knowledge of limnology, lake ecosystems and lake management, to continue to monitor water quality, physical and biological conditions of the major lakes in Dane County, particularly the Yahara lakes, Lake Wingra and Fish Lake. In addition, these lakes can serve as field laboratories for the conduct of experiments in promising lake management programs and approaches, and research.

Public information and education about the lakes and lake management is absolutely critical to maintaining public support for lake protection and management programs, and for increasing public understanding of the lakes' complex ecosystems, the problems and their causes, and developing a realistic view of what the lakes are and can be.

LAKE MANAGEMENT RECOMMENDATIONS

L-1: Dane County should continue to provide sufficient funds and personnel for mechanical weed harvesting and other environmentally sound aquatic plant management programs. Harvested weeds should continue to be recycled to land as mulch, fertilizer and soil conditioner rather than disposed in landfills.

L-2: The use of chemicals for control of aquatic plants should continue to be limited to shallow water areas where other suitable management alternatives do not exist and should be supervised by the Wisconsin Department of Natural Resources. Chemical treatment should be prohibited in sensitive lake areas identified by the DNR.

L-3: Dane County should research and evaluate flow and lake level management strategies for the Yahara River lakes as a series of multipurpose reservoirs, and develop optimal operating and outflow/lake level control rules for the entire Yahara River system.

L-4: Dane County should conduct a countywide study of dredging needs and associated problems of recreational navigability.

L-5: Dane County and lakeshore municipalities should continue to develop and maintain active shoreline cleanup, improvement and maintenance programs aimed at reducing shoreline erosion and loss of riparian lands, and improving the aesthetics and stability of shorelines. Dane County should continue to coordinate an annual volunteer lakeshore cleanup event on all the Yahara River lakes and other county lakes where interest exists.

L-6: A long-term program of monitoring indicators of lake conditions should be continued on the major lakes in Dane County.

L-7: Local municipalities responsible for lakeshore parks and beaches should conduct frequent monitoring at beaches throughout the swimming season to ensure conditions are safe for water-contact recreation.

L-8: The potential for promising in-lake management techniques should continue to be explored and evaluated. In-lake management approaches which appear to have some future promise or potential include: algae control and fishery improvement through biomanipulation of the food chain; improved fishery management and rough fish removal; hypolimnetic phosphorus inactivation and precipitation through alum treatment; phosphorus reduction by treating lake inflows; aeration and hypolimnetic pumping in smaller lakes; reestablishment and management of more desirable and diversified aquatic plant communities; and lake drawdown and dredging.

L-9: Information and education about lake management and water quality issues should be conducted along with other water quality information/education programs aimed at landowners, residents, citizens and lake users.

GROUNDWATER MANAGEMENT

Introduction

Since groundwater represents the source of all water supplies in Dane County, protection and management of the groundwater resource is a high priority. The discussion of groundwater quality conditions and problems in Chapter 2 indicated that groundwater in Dane County is of generally good quality, but that there have been localized instances of contamination from nearby pollution sources, particularly in the upper or shallow aquifer affecting most individual private water supply wells. Areawide water supply concerns relate primarily to potential increases in nitrates, dissolved salts, and volatile organic compounds, which could affect the deep aquifers, from which most municipal water supplies are drawn.

The basic approach to groundwater protection and management is founded on two major considerations: (1) location and siting--seeking to locate potential pollution sources in locations which minimize the potential risk of contaminating groundwater supplies, and using groundwater supply sources which are protected from potential contamination; and (2) employing management practices and programs which are designed to reduce the extent or degree of risk of groundwater contamination from potential pollution sources.

Siting and Land Use Decisions

Siting and land use decisions which are based on an evaluation of potential groundwater impacts are the most effective defense against groundwater contamination problems which are costly to correct or irreversible. Siting and land use decisions include decisions which allow potentially polluting activities or land uses to locate in certain areas, as well as decisions which result in location or development of water supplies in specific locations. It is important to evaluate, as part of the process of making these decisions, whether the location of a potentially polluting activity or land use has a high risk of contaminating the groundwater resource, or whether the location of water supply sources in relation to pollution sources results in a high risk of well contamination. Examples of these land use and siting decisions include issuing permits for landfills, waste disposal and land application sites, zoning changes, subdivision reviews and conditional use permits related to a variety of potentially polluting activities, such as large on-site wastewater disposal systems or clusters of on-site wastewater disposal systems (as in rural residential subdivisions), junkyards and salvage yards, pesticide or hazardous waste storage and handling facilities and terminals.

Groundwater pollution hazard maps have been developed as a tool to assist in initial screening and evaluation of the relative groundwater pollution hazard from potential pollution sources. One of the maps indicates the relative pollution hazard to the bedrock aquifer (from which municipal water supplies are withdrawn) from subsurface activities such as landfills, underground storage tanks and other pollution sources which are located below the soil zone. The other map indicates the relative pollution hazard from those activities conducted on the surface of the land, such as pesticide, fertilizer, sludge and septage applications. The maps also indicate areas (well protection zones) where the pollution or contamination has a greater likelihood of reaching municipal water supplies. Factors considered in developing these maps and determining the hazard of potential pollution include depth to bedrock, type of bedrock, depth to groundwater, and the permeability or filtering characteristics of the subsurface material. The type and pollution removal characteristics of the surface soil is an additional factor included in the surface hazard map. The groundwater pollution hazard maps can be used for initial screening and evaluation of the potential for groundwater pollution from potential pollution sources or land uses, and suggested guidelines and criteria for the use of the groundwater pollution hazard maps and for siting decisions have also been developed.

Since the groundwater pollution hazards are based on generalized areawide information, they cannot be used to indicate the potential for localized problems or contamination of shallow, private wells from nearby pollution sources. To determine potential problems for these cases, as well as to evaluate situations for which the initial evaluation indicates a potential risk, requires development of more detailed site-specific information on which to base decisions.

Pollution Control Practices

The application of management practices designed to reduce the risk of groundwater contamination from potential pollution sources was discussed in Chapter 3 (Pollution Control) for the major potential sources of groundwater contamination, including fertilizer and pesticide applications, livestock manure storage and application practices, on-site wastewater disposal practices, landfills, and land application of organic wastes. Many of the program recommendations in Chapter 3, therefore, are specifically directed to groundwater protection and management. Pollution control practices not specifically covered in the recommendations in Chapter 3 include registration, monitoring and testing of underground and aboveground storage tanks for gasoline products and chemicals, and emergency response programs designed to control and manage spills of contaminants or hazardous materials from storage, handling or transportation. Programs have been developed to address these areas of groundwater protection, and need to be further expanded and strengthened.

Water Supply Protection

Another aspect of groundwater protection and management includes programs and practices designed to ensure that water supplies are protected from contamination by locating wells (in relation to pollution sources) to minimize the risk of potential contamination, to utilize the most protected groundwater resources (the lower sandstone aquifer) for water supply where the risk and exposure to large populations from potential contamination is large, and the employment of adequate construction standards to ensure that water supply wells are protected from direct and inadvertent contamination. In addition, proper procedures for sealing and abandoning wells, and restrictions on the use of wells for disposal of waste direct to groundwater aquifers are also important management tools.

GUIDELINES AND CRITERIA
USE OF GROUNDWATER POLLUTION HAZARD MAPS

Pollution Source	Hazard Map to Use	Guidelines and Criteria
1. Sanitary Landfill	Subsurface	Proposed landfills should be located outside of municipal well protection zones and in areas of least to moderate pollution hazard. High priority for monitoring active and abandoned landfills should be for those landfills in areas of greatest pollution hazard in municipal well protection zones.
2. On-Site Wastewater Systems	Subsurface	Proposed large (over 8,000 gpd) on-site systems or clusters of on-site systems (over 100 gal/acre/day overall loading or 1 residential system per 1.5 to 2 acres) should not be permitted in areas of greatest pollution hazard. In addition, proposed large systems or clusters should not be permitted in any area unless it can be demonstrated that existing wells will not be polluted and proposed water supplies will be protected from nitrate contamination and other contaminants.
3. Land Disposal of Wastewater		
A. Wastewater Lagoons and Infiltration Ponds	Subsurface	Proposed wastewater lagoons and infiltration areas should be located outside of municipal well protection zones and in areas of least to moderate pollution hazard. Existing lagoons and ponds in municipal well protection zones should be monitored.
B. Wastewater Irrigation and Landspreading Sites	Surface	Proposed wastewater irrigation and landspreading sites should not be located in areas of greatest pollution hazard. Existing and future sites in municipal well protection zones should be monitored and subject to stringent design and operating requirements.
4. Underground Storage Tanks	Subsurface	More stringent design and periodic testing for corrosion protection and leak containment should be required of all existing and proposed underground tanks storing hazardous or flammable materials within municipal well protection zones and in areas of greatest pollution hazard outside of well protection zones. Existing tanks in these areas not providing adequate corrosion protection or leak containment should be immediately replaced or properly abandoned.
5. Above-ground Storage Tanks	Surface	Strict design criteria should be required for spill or leak containment for all above-ground tanks storing hazardous or flammable materials within municipal well protection zones and in areas of greatest pollution hazard outside of well protection zones. Existing tanks in these areas without adequate spill or leak containment should be replaced or properly abandoned.
6. Land Application of Sludge and Septage	Surface	Application sites should not be located in areas of greatest pollution hazard. Sites in areas of moderate and marginal pollution hazard should receive highest priority in enforcement of existing siting guidelines, and should receive increased surveillance to ensure applications adhere to state guidelines and criteria.
7. Large Manure Storage Lagoons and Feedlots	Subsurface	Proposed large (greater than 300 animal units) feedlots and manure storage lagoons should not be located in areas of greatest pollution hazard. Strict design criteria and monitoring of storage lagoons should be required for all large lagoons in areas of moderate pollution hazard.

Information and Education Needs

In some cases, there is a lack of information on potential groundwater contamination problems, and additional monitoring is needed to determine the extent and seriousness of these problems. Problem areas which should receive priority for additional monitoring include monitoring of existing and abandoned landfills in municipal well protection zones; monitoring of agricultural pesticides in groundwater, particularly in areas most susceptible to contamination; and monitoring to determine the effects of clusters of on-site wastewater systems on local shallow groundwater nitrate levels.

Another groundwater information management need is providing a more centralized and available cataloging or storage facility for groundwater information so it is more available for use and evaluation. Currently, groundwater information is gathered by a number of different agencies and is housed in different locations, which makes it difficult for management agencies to utilize the information and evaluate problems and conditions.

A third groundwater information and education need is to provide an expanded public information and education program directed at those households most vulnerable to potential groundwater contamination--rural households depending on shallow, individual water supply wells. The needed public information and education directed at these households would include information on proper siting, construction and (especially) maintenance and servicing of on-site wastewater disposal systems; proper siting, construction and testing needs for wells and water supplies; and information and guidance on proper use, storage and disposal of potentially hazardous or toxic materials such as pesticides, cleaning agents and other similar potential household hazards or pollutants.

University of Wisconsin-Extension
GEOLOGICAL AND NATURAL HISTORY SURVEY
Robert E. Ostrom, State Geologist and Director

GROUNDWATER POLLUTION HAZARD TO THE BEDROCK AQUIFER FROM SUBSURFACE ACTIVITIES*

*(LANDFILL, UNDERGROUND TANKS, ETC.)

Greatest Hazard

Moderate

Least

Well Protection Zone

Note: Individual grid squares represent approximately 40 acres.

DANE COUNTY, WISCONSIN

April 1987

Scale in Miles

0 1 2 3

Prepared by: THE DANE COUNTY REGIONAL PLANNING COMMISSION

LAMBERT CONFORMAL PROJECTION 4000 FOOT GRID BASED ON WISCONSIN COORDINATE SYSTEM, SOUTHERN ZONE

BASE BY UNIVERSITY OF WISCONSIN CARTOGRAPHIC LABORATORY, 1972
Municipal Boundaries Updated, January, 1987

University of Wisconsin-Extension
GEOLOGICAL AND NATURAL HISTORY SURVEY
Meredith E. Ostrom, State Geologist and Director

LAMBERT CONFORMAL PROJECTION 4000 FOOT GRID BASED ON WISCONSIN COORDINATE SYSTEM, SOUTHERN ZONE

BASE BY UNIVERSITY OF WISCONSIN CARTOGRAPHIC LABORATORY, 1973
Municipal Boundaries Updated, January, 1987

GROUNDWATER POLLUTION HAZARD TO THE BEDROCK AQUIFER FROM SURFACE ACTIVITIES*

*(SUCH AS PESTICIDE, FERTILIZER, SLUDGE, AND SEPTAGE APPLICATIONS)

- Greatest Hazard
- Moderate
- Marginal
- Least

Well Protection Zone

Note: Individual grid squares represent approximately 40 acres.

DANE COUNTY, WISCONSIN

April, 1987

Scale in Miles
0 1 2 3

Prepared by: THE DANE COUNTY REGIONAL PLANNING COMMISSION

GROUNDWATER MANAGEMENT RECOMMENDATIONS

G-1: *All land use and siting decisions in Dane County should include evaluation of potential groundwater and hydrologic impacts. Applicants for any land use or siting approvals, such as zoning or subdivision approvals, site or development plan approval, urban service area additions, or state, federal or local land disturbance or discharge permit approval, should be required to provide sufficient information to allow the regulatory agency to evaluate the potential groundwater and hydrologic impacts of the proposed activity or development. Evidence of significant unaddressed or unmitigated groundwater or hydrologic impacts should provide the basis for withholding approval for the requested activity or development, or for requiring additional information to be submitted by the applicant before approval is granted. Compliance with state surface and groundwater quality standards should be included in the evaluation along with hydrologic impacts. The guidelines and criteria listed in the table on page 54 should be used in conjunction with the groundwater pollution hazard maps for preliminary screening and evaluation of proposed impacts.*

G-2: *Land use regulatory agencies in Dane County should adopt more stringent siting and land use regulations for potentially polluting activities in wellhead protection zones or the well protection zones indicated on the groundwater pollution hazard maps. The guidelines and criteria for the use of the groundwater pollution hazard maps in the table on page 54 can provide a basis for these more stringent land use and siting criteria in well protection zones.*

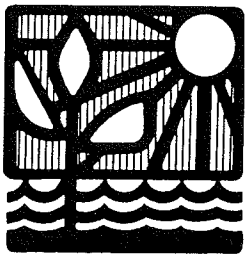
G-3: *Additional groundwater quality monitoring should be conducted in Dane County, with specific needs related to the impacts of closed landfills, barnyards and livestock waste storage, agricultural fertilizer and pesticide use and the impacts of unsewered subdivisions.*

G-4: *Groundwater quality and monitoring information in Dane County should be consolidated in the County Environmental Health Division to allow for systematic filing and ease of retrieval and evaluation.*

G-5: *Underground and above-ground storage tank monitoring and testing programs, and emergency spill response and cleanup programs, should continue to be developed and strengthened.*

G-6: *Dane County should conduct an aggressive public information and education program to inform rural homeowners of proper use and maintenance of on-site waste disposal systems, along with information on well protection and household hazardous wastes.*

CHAPTER 5



FRAMEWORK FOR ACTION

DESIGNATED MANAGEMENT AGENCIES--ROLES AND RESPONSIBILITIES

All areawide water quality management plans, including the Dane County Water Quality Plan, must include a description of those local management agencies which are designated to carry out the recommendations, programs and actions proposed in the Water Quality Plan. The management agency designations in the Water Quality Plan have been based on current programs responsibilities, and on detailed analyses of the legal and financial authority and capability to carry out the programs and actions assigned to them. Management agency designations in the initial Dane County Water Quality Plan, along with the proposed recommendations and actions, were reviewed by all proposed management agencies prior to plan adoption. There have been only a few changes in management agency structure and designation since adoption of the initial Dane County Water Quality Plan, which are reflected in this updated summary. The principal changes include the replacement of the state Board of Soil and Water Conservation Districts and Dane County Soil and Water Conservation District by the state Department of Agriculture, Trade and Consumer Protection, and the Dane County Land Conservation Committee as agencies with primary responsibility in the area of agricultural nonpoint source control. In addition, the state Department of Agriculture, Trade and Consumer Protection has been assuming increasing program responsibilities at the state level in the area of agricultural nonpoint source funding and regulatory programs and some groundwater protection programs, in concert with the Department of Natural Resources. State program responsibility in the area of on-site wastewater management has been transferred from the Department of Health and Social Services to the Department of Industry, Labor and Human Relations. Finally, Dane County has recently created the Lakes and Watershed Commission to coordinate and pursue the County's role and responsibilities in lake and watershed management and water quality protection and improvement programs. State legislation which became effective in May 1990 vested substantial additional authority and financing capabilities in the County Lakes and Watershed Commission, particularly in the areas of lake management, watershed management and urban nonpoint source management.

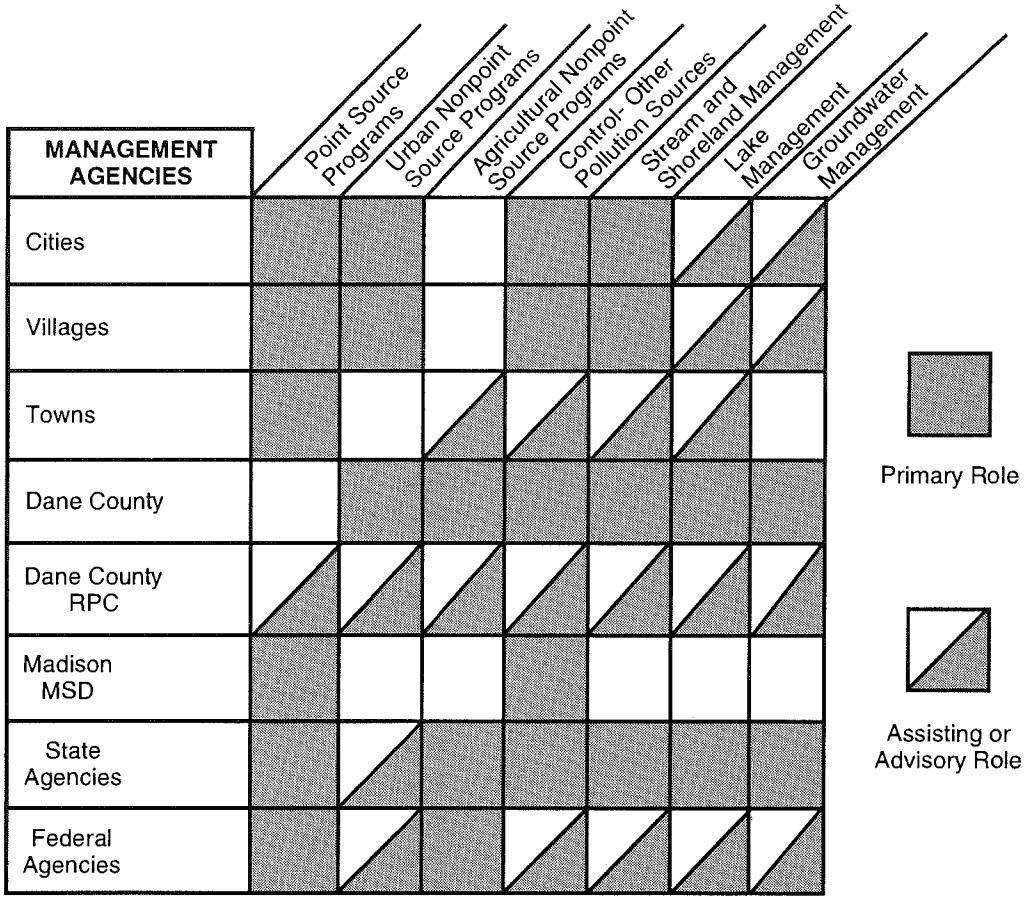
Point Source Control (Wastewater Collection and Treatment): Federal agencies involved in wastewater collection and treatment include the U.S. Environmental Protection Agency, which administers federal laws and guidelines for water quality management programs and provides funding, and the USDA Farmers Home Administration, which provides some funding. The Wisconsin Department of Natural Resources is the primary state agency with responsibility for administering point source control programs--establishing and enforcing water quality standards and effluent limits, issuing discharge permits, enforcing most state water quality standards and laws and regulations related to point source discharges, and providing funding for wastewater collection and treatment systems. Local management agencies responsible for constructing and operating wastewater collection and treatment systems include all cities and villages, town sanitary and utility districts with wastewater collection or treatment systems, and the Madison Metropolitan Sewerage District, which provides regional wastewater collection and treatment service for the communities within its jurisdiction.

Urban Nonpoint Source Management: Urban nonpoint source management programs are primarily the responsibility of local urban governments--cities, villages and towns with urban areas. The federal Clean Water Act of 1987 provides for programs to regulate stormwater discharges as point sources of pollution, and the U.S. EPA is developing guidance and criteria to implement this program. It is likely that this program will also greatly expand the authority and role of DNR in regulating urban nonpoint source pollution through the point source permit program. DNR also provides financial assistance for urban nonpoint source management practices through the Nonpoint Source Pollution Abatement Program and Clean Water Fund. Recently enacted legislation expanded Dane County's role in urban nonpoint source management by authorizing the County Lakes and Watershed Commission to develop and establish enforceable minimum requirements and guidelines for urban nonpoint source management practices.

Agricultural Nonpoint Source Management: Federal agencies with primary roles in agricultural nonpoint source control programs include the USDA Agricultural Stabilization and Conservation Service (ASCS), which provides cost-share funding for soil conservation practices and structures, through the Agriculture Conservation Program (ACP), as well as having primary administrative roles in the Conservation Reserve Program and Conservation Compliance "Sodbuster" and "Swampbuster" provisions of the federal Food Security Act of 1985. The USDA Soil Conservation Service works with ASCS and state and local management agencies in providing technical assistance for planning and implementing conservation programs.

State agencies with primary involvement in these programs include the Department of Agriculture, Trade and Consumer Protection (DATCP), which administers the state Soil Erosion Control Program, and the Farmland Preservation Program which includes conservation compliance requirements. DATCP also has joint responsibility with DNR in administering the state's Nonpoint Source Pollution Abatement Program in agricultural areas. DATCP also regulates aspects of agricultural storage and use of pesticides and fertilizers. DNR administers the state's Nonpoint Source Pollution Abatement Program, providing funding for nonpoint source abatement projects in priority watersheds. DNR also participates with DATCP in enforcing laws regulating serious pollution problems caused by animal waste practices, and provides funds and technical assistance for streambank and shoreline stabilization and woodland management.

Local agencies with primary responsibility for agricultural nonpoint source management programs are the Dane County Land Conservation Department which, with the assistance of the USDA Soil Conservation Service, is the lead agency for carrying out local, state and federal soil and water conservation programs. The Department operates under the authority of the Land Conservation Committee, a county committee which replaced the former Soil and Water Conservation District. The LCD is involved in three primary functions: providing technical assistance to landowners; allocating and distributing cost-sharing funds; and carrying out public information/education activities in concert with the Dane County Extension.



Management Agencies--Other Pollution Sources: Regulation of land-disturbing activities is primarily the responsibility of local general units of government--Dane County along with towns for unincorporated areas, and cities and villages for urban areas. Some technical assistance is provided by DNR and SCS. Recently enacted legislation granted the Dane County Lakes and Watershed Commission the authority to establish minimum criteria and guidelines for ordinances regulating land-disturbing activities.

The state agency with primary responsibility for regulation of on-site wastewater systems is the Department of Industry, Labor and Human Relations (DILHR), with local enforcement and management responsibility vested in the Dane County Environmental Health Division. DNR shares the regulatory role with DILHR in special circumstances involving large on-site systems, and in regulating the disposal of septage and holding tank wastes. The Water Quality Plan proposes an expansion of the authority and responsibility of Dane County in this program area.

State regulation of most programs involving land application of waste--landfills, wastewater application, land application of septage and wastewater sludges--is the responsibility of DNR. These regulations control and manage the disposal practices of private firms as well as public solid waste and sewerage agencies. Nearly all local general units of government--cities, villages and towns--are involved in operating and managing land application programs. Dane County's role in regulating some of these activities, such as land application of septage and landfills, is expected to grow.

Stream and Shoreland Management: Stream and shoreland management program responsibilities are shared by DNR and local units of government (for areas within their jurisdiction). DNR has a variety of roles, ranging from administering state laws and regulations which provide the framework for floodplain, shoreland, and wetland zoning; directly regulating stream and shoreland activities through Chapter 30 and 31 permits; fishery and wildlife management and habitat improvement programs; acquiring and managing lands for fish and wildlife management areas, state parks, trails and scientific areas; and providing financial assistance through the Wisconsin Nonpoint Source Pollution Abatement Program and other programs.

Dane County has a significant and growing management role in shoreland, floodplain and wetland zoning in unincorporated areas; providing cost-sharing and supporting stream improvement and shoreline cleanup measures; and in land acquisition and management of county parks and open spaces. Local units of government engaged in land use regulation, (cities and villages for urban areas, Dane County and the towns in rural areas) have primary responsibility for the land use regulation aspects of stream and shoreland management, particularly adoption and enforcement of shoreland, floodplain and shoreland-wetland zoning ordinances. In addition, local units of government play key roles in developing environmental corridors, and park and open space plans which are essential ingredients in stream and shoreland management. Dane County and local units are also actively involved in stream and shoreline improvement, cleanup and stabilization projects in their jurisdictions.

Lake Management: DNR is the state agency having primary responsibility for regulating lake management and lake use laws and regulations, including Chapter 30 and 31 permits, lake levels and dam safety, application of chemicals, enforcement of fishing and boating regulations and fishery management.

The local agency with primary responsibility in lake management is Dane County. The county is responsible for the aquatic weed harvesting program; for operation of locks, and flow and lake level management on the Yahara lakes; and for enforcing boating and other safety regulations. The County Lakes and Watershed Commission has recently been granted additional authority in lake management activities, and in financing lake management programs and regulating lake use and activities. A few local units of government are also directly concerned with lake management issues on individual lakes within their jurisdiction. The Town of Windsor has created an Inland Lake Protection and Rehabilitation District for a small lake (Lake Windsor) in the Town. This is the first Inland Lake District created in Dane County.

Groundwater Management: DNR is the state agency with primary regulatory responsibility in the area of groundwater protection and management, although significant roles are also played by DATCP and DILHR. These agencies administer a variety of laws and regulations related to specific pollution sources threatening groundwater quality, and also share responsibility in administering the state's Groundwater Law.

Dane County is the local designated management agency with the most authority and responsibility for groundwater protection and management programs, with the role of cities, villages and towns being more limited. Land use decisions and permits are the main areas of responsibility in groundwater management which are most directly controlled by local units of government. Dane County and local units also have important responsibilities in programs directed at protecting ground and surface water from leaks or spills from storage tanks, and from storage, handling or transportation of hazardous materials.

NONPOINT SOURCE POLLUTION CONTROL-- WATERSHED PRIORITIES

State and federal funding programs for nonpoint source control have generally adopted the approach of selecting priority watersheds for intensive funding and management efforts. The usual approach is to prepare detailed implementation plans for priority watersheds, and to direct implementation funding into these watersheds. An evaluation and ranking system has been developed and is utilized by DNR for considering potential nonpoint source priority watershed projects for funding under the state's Nonpoint Source Pollution Abatement Program. This ranking system establishes priorities for large-scale priority watershed projects, small-scale priority watershed projects, and priority lake projects, and also identifies watersheds or water resources where additional monitoring is needed.

Watershed priority ranking is based on ranking of streams, lakes and groundwater resources in each watershed. Stream ranking is based on three factors: (1) potential for positive response to nonpoint source controls; (2) presence of nonpoint source problems; and (3) designation of the stream as an outstanding or exceptional resource. Lake ranking is based on five factors: (1) sensitivity to phosphorus loadings; (2) existing water quality conditions; (3) fish and wildlife value of the lake; (4) recreational value of the lake; and (5) presence of problems which would be responsive to nonpoint source controls. Groundwater ratings are based on: (1) susceptibility to groundwater pollution; (2) presence of known groundwater quality problems caused by nonpoint source pollution; and (3) potential for groundwater quality improvement through nonpoint source controls.

The accompanying table indicates the results of applying this evaluation and ranking system to Dane County watersheds, and the map indicates proposed large-scale and small-scale priority watershed projects and priority lake projects which are recommended to be pursued as high priority projects.

All of the watersheds with a high ranking are proposed for large-scale priority watershed projects, except for the Roxbury Creek Watershed. In this high-ranking watershed, a more selective approach to nonpoint source problems is proposed, by recommending a small-scale priority watershed project and a priority lake project for the more sensitive resources in the watershed.

In addition to the Roxbury Creek watershed projects, four new large-scale priority watershed projects are proposed (displayed on the map), with the Yahara River-Lake Mendota watershed having the highest priority. Of the other watersheds in the region, three were not ranked because they have already been designated priority watershed projects, three were not ranked because most of the watershed is outside of Dane County, and two were not ranked because of insufficient data for evaluation--additional monitoring is needed.

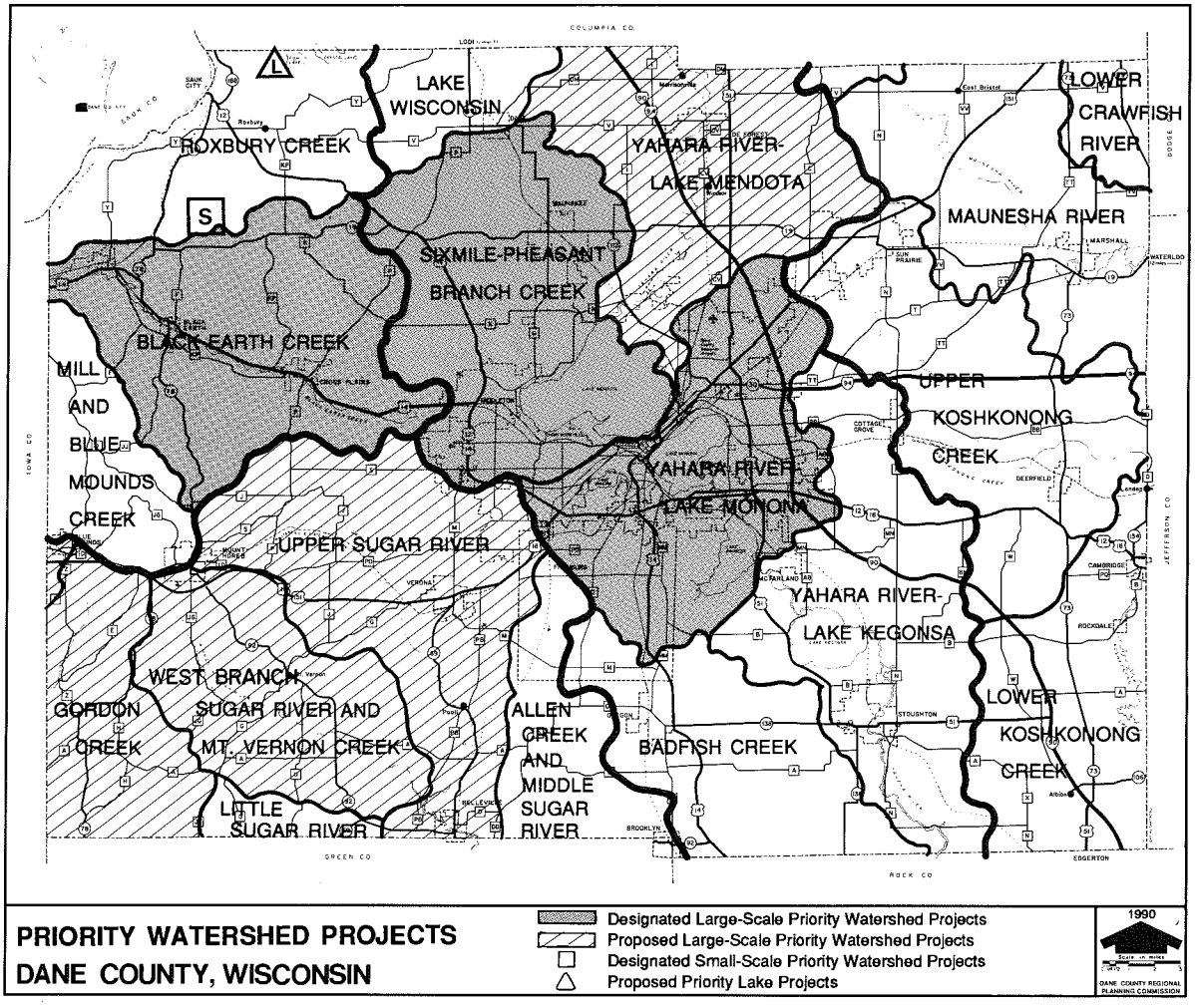
In addition to the proposed priority watershed projects illustrated on the map, there are many individual streams receiving a high ranking which are not indicated. These streams would be eligible for small-scale priority watershed projects, but are not proposed as such because they are included in an existing or proposed large-scale priority watershed project.

The priority rankings reflected in the table and map represent nonpoint source priority projects for the immediate or short-range future. The rankings and proposals will be updated as projects are initiated and completed, and as additional information becomes available.

NONPOINT SOURCE WATERSHED PRIORITY RANKING

Watershed	Ranking		
	Stream	Lake	Groundwater
LOWER WISCONSIN RIVER BASIN			
Roxbury Creek	High	Medium	High
Lake Wisconsin		Not Ranked (2)	
Black Earth Creek		Not Ranked (1)	
Mill & Blue Mounds Creek		Not Ranked (3)	
SUGAR - PECATONICA RIVER BASIN			
Gordon Creek	High	None	High
W.B. Sugar River - Mt. Vernon Creek	High	None	Medium
Upper Sugar River	High	Low	Medium
Allen Creek - Middle Sugar River	Low	Low	Medium
Little Sugar River		Not Ranked (2)	
YAHARA RIVER BASIN			
Yahara River - Lake Mendota	High	High	Medium
Sixmile - Pheasant Branch Creek		Not Ranked (1)	
Yahara River - Lake Monona		Not Ranked (1)	
Yahara River - Lake Kegonsa	Low	Medium	Medium
Badfish Creek	Medium	Low	Medium
KOSHKONONG CREEK - MAUNESHA RIVER BASIN			
Upper Koshkonong Creek	Low	Low	Medium
Lower Koshkonong Creek	Low	Low	Medium
Maunesha River		Not Ranked (3)	
Lower Crawfish River		Not Ranked (2)	

Notes: (1) Already designated priority watershed project. (2) Most of watershed outside of Dane County. (3) Insufficient data--monitoring required.



PRIORITY WATERSHED PROJECTS
DANE COUNTY, WISCONSIN

- Designated Large-Scale Priority Watershed Projects
- Proposed Large-Scale Priority Watershed Projects
- Designated Small-Scale Priority Watershed Projects
- Proposed Priority Lake Projects

1990

DANE COUNTY REGIONAL PLANNING COMMISSION

SHORT-RANGE PRIORITY ACTIONS FOR LOCAL DESIGNATED MANAGEMENT AGENCIES

The 82 general water quality management program recommendations which are presented in Chapters 3 and 4 represent the long-term recommendations, policies and objectives of the Dane County Water Quality Plan. These general program recommendations provide a framework to evaluate whether actions proposed by individual management agencies are consistent with the plan, and also provide a framework and guidance for the development of specific projects to be considered by individual management agencies.

The following tables list specific short-range high priority implementation actions suggested for local designated management agencies. These priority actions represent actions which are capable of being carried out or initiated in the immediate future (over the next five years or so) and represent significant actions which would have an important beneficial impact on water quality. The short-range priority actions are presented as an action plan to assist designated management agencies in moving to carry out the policies and recommendations of the Dane County Water Quality Plan.

WISCONSIN RIVER BASIN

Management Agency	Priority Action
Village of Black Earth	1) Adopt erosion/runoff control ordinance for land-disturbing activities. Include a provision, or revise building ordinances to require roof drainage to grassed areas, where feasible, for new construction.
	2) Adopt wetland zoning ordinance.
	3) Initiate semi-annual (spring and fall) street-sweeping program.
	4) Prepare a stormwater management plan for the Village, including water quality protection measures.
Village of Cross Plains	1) Prepare a stormwater management plan for the Village, including water quality protection measures.
	2) Revise building ordinances or erosion/runoff control ordinance to require roof drainage to grassed areas, where feasible, for new construction.
	3) Adopt wetland zoning.
	4) Evaluate the source of high BOD loading to the wastewater treatment plant, and conduct toxics monitoring of wastewater influent and effluent. Expand sludge storage capacity to provide for 150-180 days storage capacity.
Village of Mazomanie	1) Revise building ordinances to require roof drainage to grassed areas, where feasible, for new construction.
	2) Prepare a stormwater management plan for the Village, including water quality protection measures.
	3) Increase sludge storage capacity at the wastewater treatment plant to provide for 150-180 days storage capacity.
Town of Roxbury	1) Work with the Dane County Lakes and Watershed Commission and the Department of Natural Resources to evaluate the causes of declining water quality in Fish Lake. Consider the need to create an Inland Lake Protection and Rehabilitation District for Fish Lake to be responsible for ongoing lake management activities.
	2) The Roxbury Sanitary District should conduct an operation and needs review of the wastewater treatment plant regarding management of inflows, and to reevaluate the BOD rating and need for capacity expansion of the treatment facility.

Management Agency	Priority Action
Town of Roxbury (cont.)	3) Conduct a drainage study of the Roxbury Urban Service Area to assess any adverse impacts on the sewer system, flows and operations of the wastewater treatment facility.
	SUGAR - PECATONICA RIVER BASIN
Village of Belleville	1) Adopt erosion/runoff control ordinance for land-disturbing activities. Incorporate requirement, or revise building ordinances to require roof drainage to grassed areas, where feasible, for new construction.
	2) Adopt wetland zoning ordinance.
	3) Adopt ordinance prohibiting leaf burning, and provide special leaf pickup program in fall.
	4) Evaluate reducing use of road salt.
	5) Apply for lake management planning grant to conduct a public survey and develop goals and objectives for Lake Belle View.
	6) Increase sludge storage capacity at the wastewater treatment plant to provide for 150-180 days storage capacity.
Village of Blue Mounds	1) Adopt erosion/runoff control ordinance for land-disturbing activities. Incorporate requirement, or revise building ordinances to require roof drainage to grassed areas, where feasible, for new construction.
	2) Prepare a stormwater management plan for the Village, including water quality protection measures.
	3) Initiate a semi-annual (spring and fall) street-sweeping program.
Village of Brooklyn	1) Adopt erosion/runoff control ordinance for land-disturbing activities. Incorporate requirement, or revise building ordinances to require roof drainage to grassed areas, where feasible, for new construction.
	2) Adopt wetland zoning ordinance.
	3) Initiate semi-annual (spring and fall) street-sweeping program.
Village of Mt. Horeb	1) Revise erosion/runoff control ordinance to increase runoff control requirements. Incorporate requirement, or revise building ordinances to require roof drainage to grassed areas, where feasible, for new construction.
	2) Prepare a stormwater management plan for the Village, including water quality protection measures.
	3) Conduct toxics monitoring of wastewater influent and effluent.
City of Verona	1) Adopt erosion/runoff control ordinance for land-disturbing activities. Incorporate requirement, or revise building ordinances to require roof drainage to grassed areas, where feasible, for new construction.
	2) Prepare a stormwater management plan for the City, including water quality protection measures.
	3) Adopt wetland zoning ordinance.
	4) Evaluate reducing use of road salt.

Management Agency	Priority Action
City of Verona (cont.)	5) Prepare facilities plan to determine expansion needs and alternatives for the wastewater treatment plant. Evaluate means of control of industrial flows and loading to the wastewater treatment plant, conduct toxics monitoring of wastewater influent and effluent.
	YAHARA RIVER BASIN
Village of Dane	1) Adopt erosion/runoff control ordinance for land-disturbing activities. Incorporate requirement, or revise building ordinances to require roof drainage to grassed areas, where feasible, for new construction.
	2) Initiate semi-annual (spring and fall) street-sweeping program.
	3) Evaluate stormwater drainage system for opportunities to incorporate water quality protection measures.
Village of DeForest	1) Revise erosion/runoff control ordinance to strengthen runoff control requirements. Incorporate requirement, or revise building ordinances to require roof drainage to grassed areas, where feasible, for new construction.
	2) Adopt wetland zoning ordinance.
	3) Prepare a stormwater management plan for the Village, including water quality protection measures.
	4) Evaluate reducing use of road salt.
City of Fitchburg	1) Work with DNR and Dane County to implement nonpoint source programs and projects proposed in the Yahara-Monona Priority Watershed Project Plan.
	2) Increase enforcement of erosion/runoff control ordinance by hiring additional seasonal inspection staff. Revise building ordinances to require roof drainage to grassed areas, where feasible, for new construction.
	3) Increase street-sweeping program by providing frequent (weekly to biweekly) sweeping of streets in commercial and industrial areas and regular (biweekly to monthly) sweeping of residential streets throughout the sweeping season, with extra efforts at cleaning all streets in early spring and late fall.
	4) Prepare a stormwater management plan for the Nine Springs Creek watershed, including water quality protection measures.
	5) Adopt ordinance specifying practices for storage and disposal of leaves and yard/garden debris. Initiate a special fall leaf pickup program.
City of Madison	1) Work with DNR and Dane County to implement nonpoint source programs and projects proposed in the Yahara-Monona Priority Watershed Project Plan.
	2) Increase enforcement of erosion/runoff control ordinance by hiring additional seasonal inspection staff, and provide greater inspection and enforcement activities during initial grading activities. Revise building ordinances to require roof drainage to grassed areas, where feasible, for new development.
	3) Increase street-sweeping program to provide frequent (weekly to biweekly) sweeping of streets in commercial and industrial areas and regular (biweekly to monthly) sweeping of residential streets throughout the sweeping season, with extra efforts at cleaning all streets in early spring and late fall.
	4) Prepare a stormwater management plan for the City, including water quality protection measures to satisfy WPDES stormwater discharge permit program requirements.

Management Agency	Priority Action
City of Madison (cont.)	5) Adopt ordinance specifying practices for storage and disposal of leaves and yard/garden debris. Establish a public information/education program, or participate in a countywide program with Dane County, for proper storage and disposal of leaves and yard/garden debris and use and application of fertilizers and pesticides.
	6) Participate with DNR in evaluating sources of toxic materials in stream and lake sediments and cleanup efforts, including the Starkweather Creek Remedial Demonstration Project, Murphy (Wingra) Creek and Monona Bay as first priorities.
	7) Conduct a field test and demonstration of the feasibility of using porous pavement in parking areas and residential streets.
	8) Undertake a feasibility study of means of enhancing sediment and phosphorus removal at stormwater detention and sedimentation basins.
Village of Maple Bluff	1) Adopt erosion/runoff control ordinance for land-disturbing activities. Incorporate requirement, or revise building ordinances to require roof drainage to grassed areas, where feasible, for new construction.
	2) Adopt an ordinance prohibiting leaf burning and specifying practices for storage and disposal of leaves and yard/garden debris. Provide special fall leaf pickup program.
	3) Evaluate reducing use of road salt.
	4) Evaluate stormwater drainage system for opportunities to incorporate water quality protection measures.
Village of McFarland	1) Work with DNR and Dane County to implement nonpoint source programs and projects proposed in the Yahara-Monona Priority Watershed Project Plan.
	2) Prepare a stormwater management plan for the Village, including water quality protection measures.
	3) Revise building ordinances to require roof drainage to grassed areas, where feasible, for new construction.
	4) Adopt ordinance specifying practices for storage and disposal of leaves and yard/garden debris. Provide special leaf pickup program in fall.
	5) Evaluate reducing use of road salt.
City of Middleton	1) Increase enforcement of erosion/runoff control ordinance by hiring additional seasonal inspection staff. Revise building ordinances to require roof drainage to grassed areas, where feasible, for new construction.
	2) Adopt an ordinance specifying practices for storage and disposal of leaves and yard/garden debris.
	3) Increase street-sweeping program to provide frequent (weekly to biweekly) sweeping of streets in commercial and industrial areas and regular (biweekly to monthly) sweeping of residential streets throughout the sweeping season, with extra efforts at cleaning all streets in early spring and late fall.
	4) Prepare a stormwater management plan for the City, including water quality protection measures.
	5) Adopt wetland zoning ordinance.
	6) Evaluate reducing use of road salt.

Management Agency	Priority Action
City of Monona	1) Work with DNR and Dane County to implement nonpoint source programs and projects proposed in the Yahara-Monona Priority Watershed Project Plan.
	2) Increase enforcement of erosion/runoff control ordinance by hiring additional seasonal inspection staff. Revise building ordinances to require roof drainage to grassed areas, where feasible, for new development.
	3) Increase street-sweeping program to provide frequent (weekly to biweekly) sweeping of streets in commercial and industrial areas and regular (biweekly to monthly) sweeping of residential streets throughout the sweeping season, with extra efforts at cleaning all streets in early spring and late fall.
	4) Prepare a stormwater management plan for the City, including water quality protection measures.
	5) Support water quality monitoring of City storm sewer discharges as part of the countywide water quality monitoring program.
	6) Adopt ordinance prohibiting burning of leaves and specifying practices for storage and disposal of leaves and yard/garden debris.
Village of Oregon	1) Revise building ordinances to require roof drainage to grassed areas, where feasible, for new construction.
	2) Prepare a stormwater management plan for the Village, including water quality protection measures.
	3) Evaluate sources of excessive inflow and infiltration of clear water into the sanitary sewer system, and adopt flow management program which prohibits connection of sump pumps and other clear water sources to the sanitary sewer system.
	4) Increase sludge storage capacity to provide for 150-180 days storage. Conduct operation/needs evaluation to support increase in rated capacity of treatment plant, or need for plant expansion. Conduct toxics monitoring of wastewater influent and effluent.
Village of Shorewood Hills	1) Adopt erosion/runoff control ordinance for land-disturbing activities. Incorporate requirement, or revise building ordinances to require roof drainage to grassed areas, where feasible, for new construction.
	2) Adopt an ordinance specifying practices for storage and disposal of leaves and yard/garden debris, and provide special fall leaf pickup program.
	3) Evaluate reducing use of road salt.
City of Stoughton	1) Revise building ordinances to require roof drainage to grassed areas, where feasible, for new construction.
	2) Adopt wetland zoning ordinance.
	3) Prepare a stormwater management plan for the City, including water quality protection measures.
	4) Evaluate sources of excessive flows or clear water inputs to the sanitary sewer system resulting in unusually high per capita flows. Establish flow management program reducing clear water inputs and industrial flow reduction or pretreatment. Conduct toxics monitoring of wastewater influent and effluent. Increase sludge storage capacity to provide for 150-180 days storage.
Village of Waunakee	1) Prepare a stormwater management plan for the Village, including water quality protection measures. Revise building ordinances to require roof drainage to grassed areas where feasible, for new construction.

Management Agency	Priority Action
Village of Waunakee (cont.)	2) Adopt an ordinance prohibiting burning of leaves and specifying practices for proper storage and disposal of leaves and yard/garden debris. Provide special fall leaf pickup program.
Towns with urban service areas tributary to the Yahara River lakes (Towns of Blooming Grove, Burke, Dunn, Madison, Middleton, Pleasant Springs, Westport and Windsor)	1) For areas within urban service areas, adopt package of urban nonpoint source management programs, including: a) erosion/runoff control ordinance for land-disturbing activities; b) building ordinance revisions to require roof drainage to grassed areas, where feasible, for new construction; c) ordinance prohibiting burning of leaves and specifying practices for storage and disposal of leaves and yard/garden debris; d) providing semi-annual street sweeping in spring and fall, and special fall leaf collection program; e) adoption of environmental corridors; f) evaluation of stormwater drainage system, and preparation of stormwater management plan, if appropriate, to include water quality protection measures; and g) evaluate reducing use of road salt.
Town of Windsor-Morrisonville Sanitary District	1) Evaluate sources of excessive inflow and infiltration of clear water into the sanitary sewerage system, and establish program to correct and reduce those flows. Complete facilities planning evaluation of whether to upgrade wastewater treatment facility or connect to the Madison Metropolitan Sewerage District.
Madison Metropolitan Sewerage District	1) Conduct toxics monitoring of wastewater influent and effluent, and expand program to reduce industrial flow and loading through pretreatment, flow reduction and in-plant recycling. 2) Evaluate approaches to restoring the existing sludge lagoons to wetlands, and safely removing and disposing of PCB-tainted sludges from the existing lagoons.
	KOSHKONONG CREEK - MAUNESHA RIVER BASIN
Village of Cambridge	1) Adopt erosion/runoff control ordinance for land-disturbing activities. Incorporate requirement, or revise building ordinances to require roof drainage to grassed areas, where feasible, for new construction. 2) Adopt wetland zoning. 3) Prepare a stormwater management plan for the Village, including water quality protection measures. 4) Conduct toxics monitoring of wastewater influent and effluent, and establish program to monitor and control industrial wastewater flows and loadings.
Village of Cottage Grove	1) Adopt erosion/runoff control ordinance for land-disturbing activities. Incorporate requirement, or revise building ordinances to require roof drainage to grassed areas, where feasible, for new construction. 2) Adopt wetland zoning ordinance. 3) Increase street-sweeping program from once/year to semi-annual, in spring and fall. 4) Prepare a stormwater management plan for the Village, including water quality protection measures.
Village of Deerfield	1) Adopt erosion/runoff control ordinance for land-disturbing activities. Incorporate requirement, or revise building ordinances to require roof drainage to grassed areas, where feasible, for new construction. 2) Adopt floodplain zoning ordinance and wetland zoning ordinance. 3) Prepare a stormwater management plan for the Village, including water quality protection measures.

Management Agency	Priority Action
Village of Deerfield (cont.)	4) Conduct toxics monitoring of wastewater influent and effluent.
Village of Marshall	1) Adopt erosion/runoff control ordinance for land-disturbing activities. Incorporate requirement, or revise building ordinances to require roof drainage to grassed areas, where feasible, for new construction.
	2) Adopt an ordinance prohibiting burning of leaves and specifying practices for storage and disposal of leaves and yard/garden debris. Establish special fall leaf collection program.
	3) Prepare a stormwater management plan for the Village, including water quality protection measures.
	4) Conduct toxics monitoring of wastewater influent and effluent.
Village of Rockdale	1) Adopt erosion/runoff control ordinance for land-disturbing activities.
	2) Adopt floodplain zoning.
	3) Establish semi-annual (spring and fall) street-cleaning program.
	4) Evaluate stormwater drainage system for potential for incorporating water quality protection measures.
City of Sun Prairie	1) Revise building ordinances to require roof drainage to grassed areas, where feasible, for new construction.
	2) Revise and update the stormwater management plan for the City, to include water quality protection measures.
	3) Conduct toxics monitoring of wastewater influent and effluent. Establish or expand program to monitor and control industrial wastewater flow and loadings.

SHORT-RANGE PRIORITY ACTIONS FOR DANE COUNTY AND COUNTYWIDE AGENCIES

County Agencies or Departments	Priority Action
Lakes and Watershed Commission (L&WC), with assistance from Regional Planning Commission (RPC) and Land Conservation Department (LCD)	1) Develop required implementation plan, including minimum standards for shoreland, floodplain and wetland zoning, storm drainage system plans, minimum standards for urban street sweeping, road salt use, shoreline maintenance and leaf collection, cropland erosion plans, barnyard and feedlot runoff waste management plans, minimum standards for construction site erosion control ordinances, standards for algae and aquatic plant management, and financing proposals.
L&WC, LCD, RPC	2) Emphasize maximum management practice implementation in completing Black Earth Creek and Upper Dunlap Creek priority watershed projects. Develop and implement an implementation plan and program for the Yahara-Monona Priority Watershed Project. Seek designation of the Yahara-Mendota (upper Yahara River) watershed as a large-scale priority watershed project, and prepare implementation plan.
LCD	3) Complete soil erosion control plans for all high-erosion agricultural lands to meet federal and state (Chapter 92) and local (Dane County Soil Erosion Control Plan) requirements. Place priority on directing technical and cost-sharing assistance to locations and practices where water quality benefits are greatest. Evaluate, in 1993, progress toward meeting the interim and final objectives of Chapter 92, and assess the need for adopting mandatory erosion control ordinances or the need for additional cost-share funding or other incentives for implementation.
LCD	4) Expand inventory efforts and develop animal waste management plans for farms where over 25 animal units are kept near water bodies, or where significant pollution potential exists.
	5) Work with state agencies (DNR and DATCP) to evaluate extent and severity of common agricultural pesticide (atrazine, etc.) groundwater contamination in Dane County.
L&WC, LCD, Land Regulation and Records, Public Works, Highways and Parks	6) Expand coverage of the County's erosion control ordinances to cover all nonagricultural land-disturbing activities in shoreland areas, and to require stormwater management plans for all residential activities disturbing more than 5 acres, and all nonresidential activities disturbing more than 3 acres. Increase enforcement of ordinances by using additional seasonal enforcement staff. Establish erosion and runoff control policies and requirements for County construction projects and land-disturbing activities. Provide training and technical assistance to local units of government in administering erosion/runoff control ordinances and reviewing erosion and runoff control plans, and in field enforcement and evaluation of erosion and runoff problems.
L&WC, LCD, Public Works, Parks	7) Develop and carry out a coordinated and comprehensive program directed at improvement and maintenance of shorelines, stream corridors and shorelands. Program should include: a) continuation and expansion of existing volunteer lake shoreline cleanup program; b) continuation and expansion of stream channel and shoreline improvement and cleanup activities using youth employment programs; c) obtaining conservation easements and installing fencing, livestock crossings and other improvements needed to protect stream corridors and reduce streambank erosion; and d) pursue other shoreline, corridor and shoreland improvements important to protecting and enhancing water quality and uses of the water resources.
L&WC, Extension	8) Expand information/education efforts directed at agricultural nonpoint source control. Additional emphasis should be placed on fertilizer management and use, integrated pest management, and minimization of pesticide use and safe handling of pesticides and other farm hazardous materials.

County Agencies or Departments	Priority Action
L&WC, Extension	9) Establish, in cooperation with urban units of government, a comprehensive information/education program directed at urban residents and households emphasizing on-site urban nonpoint source management practices. Program should address on-site flow and landscaping techniques (downspout redirection, etc.), use of fertilizers, pesticides and other household toxic materials, water conservation, and proper management and disposal of leaves and yard/garden vegetative waste.
L&WC, Parks	10) Emphasize, in open space acquisition policies, protection and acquisition of lands which perform important environmental and water resources protection functions such as wetlands, shorelands, groundwater recharge areas, etc., that are threatened by adverse use or development. Establish or maintain specific acquisition funds directed at these lands.
L&WC, Public Works	11) Continue to expand and develop a comprehensive approach to aquatic weed management. This includes expanding the current mechanical harvesting program, improving harvesting efficiency in shallow water areas, formalizing criteria and guidelines for chemical weed control practices, and exploring ways of improving and managing aquatic plant communities. Prepare aquatic plant management plans for Lakes Mendota, Monona, Waubesa and Wingra.
L&WC, Public Works	12) Conduct a study to determine overall maintenance dredging needs and problems of recreational navigability throughout Dane County, and formulate a program to finance and carry out needed dredging.
L&WC, Public Works, RPC	13) Develop a system of improved and more precise operating rules for hydrologic management (lake level management and flow control) for the Yahara River lakes system.
Environmental Health	14) Expand the current program of required on-site wastewater system maintenance (requiring inspection and pumping of septic tanks every 3 years) to include all on-site wastewater systems in the County. Expand the distribution of public informational materials on proper use and maintenance of on-site wastewater systems and private wells.
Environmental Health	15) Develop a program to regulate land disposal of septage from on-site wastewater systems. Enact a septage site disposal ordinance which specifies application procedures, land disposal site criteria and disposal practices, surveillance and enforcement procedures, and a schedule of fees for site licenses.
Land Regulation and Records, L&WC, RPC	16) Review and evaluate all proposed federal (404), state (Chapter 30) and county permits and land use decisions for impacts on water quality and water resources. County decisions to be reviewed and evaluated include zoning changes, subdivision reviews, conditional use permits, landfill and other waste disposal practices, and major construction projects. RPC decisions to be reviewed and evaluated include urban service area additions.
Highways, L&WC	17) Evaluate the potential to reduce the use of road salt consistent with highway safety concerns.
L&WC, RPC, Public Works	18) Seek funding and prepare lake management plans for specific lake use and water quality problems. Work with and assist local, state and federal agencies in developing lake management evaluations and plans. Priorities include the Yahara River lakes (recreational use and management, aquatic plant management plans, dredging needs, lake level/shoreline management), and Fish Lake (protection and restoration--proposed Priority Lake project). Other needs include Stewart Lake (protection and restoration), Lake Belle View (use and restoration), Lake Windsor (protection and management), millponds (use and restoration or dredging evaluations) and evaluations of the effects of possible abandonment or removal of run-of-river impoundments such as Dunkirk dam or millponds.
RPC, L&WC	19) Coordinate and expand, in cooperation with other local, state and federal agencies, the cooperative countywide water resources monitoring program. Expand stream baseflow and groundwater monitoring to gather additional data on toxics and pesticides. Conduct additional monitoring needed to support priority watershed projects.

County Agencies or Departments	Priority Action
RPC, Environmental Health	20) Identify areas where on-site waste systems represent potential groundwater contamination problems, and prepare evaluations/facilities plans for targeted areas.
RPC	21) Develop, in conjunction with Dane County and other local, state and federal management agencies, a regional hydrologic/groundwater study and management plan needed to evaluate and mitigate the hydrologic and groundwater impacts of urban development, groundwater withdrawals and wastewater diversion.

SELECTED REFERENCES

Bedford, B.L., Zimmermann, E.H. and Zimmermann, J.H., "The Wetlands of Dane County, Wisconsin," Dane County Regional Planning Commission, 1974.

Dane County Land Conservation Committee, "Dane County Soil Erosion Control Plan," Dane County, 1988.

Dane County Regional Planning Commission, "Dane County Water Quality Plan (1979); Appendix A: Socio-Economic Profile (1979); Appendix B: Water Quality Conditions (1979); Appendix C: Point Source Inventory and Analysis (1986); Appendix D: Urban Nonpoint Source Analysis (1979); Appendix E: Agricultural Nonpoint Source Analysis (1988); Appendix F: Residual and Solid Waste Disposal (1988); Appendix G: Groundwater Protection Plan (1987); Appendix H: Lake Management (1979); Appendix I: On-Site Wastewater Systems Management (1986); Appendix J: Legal and Institutional Analysis (1978); Appendix K: Summary of Public Participation (1979)."

Dane County Regional Planning Commission, "Starkweather: A Water Quality Plan for Starkweather Creek," DCRPC, 1983.

Dane County Regional Planning Commission, "Environmental Corridors," DCRPC, 1984.

Dane County Regional Planning Commission, "Regional Development Guide for Dane County, Wisconsin," DCRPC, 1985 (Reprinted 1989).

Dane County Regional Planning Commission, City of Madison, Dane County, "Yahara River Lakes Water Recreation Study," DCRPC, 1987.

Dane County Regional Planning Commission, "Dane County Water Data Index," DCRPC, 1989.

U.S. Geological Survey, "Geology and Ground-Water Resources of Dane County, Wisconsin," Geological Survey Water Supply Paper 1779-U, 1965.

U.S. Geological Survey, "Water-Level Declines in the Madison Area, Dane County, Wisconsin," Open-File Report 78-936, 1978.

University of Wisconsin-Madison Institute for Environmental Studies," Upper Koshkonong Creek: A Watershed Management Study," IES Report 116, 1982.

University of Wisconsin-Madison Institute for Environmental Studies, "Dane County Animal Waste Management Plan," IES Report 126, 1985.

University of Wisconsin-Madison Institute for Environmental Studies, "Black Earth Creek: A Watershed Study With Management Options," IES Report 129, 1986.

University of Wisconsin-Madison Institute for Environmental Studies, "Urban Wetlands in the Yahara-Monona Watershed: Functional Classification and Management Alternatives," 1990.

Wisconsin Department of Natural Resources, "Surface Water Resources of Dane County," WDNR, 1985.

Wisconsin Department of Natural Resources, "Lower Wisconsin River Basin Areawide Water Quality Management Plan," WDNR, 1987.

Wisconsin Department of Natural Resources, "Sugar-Pecatonica River Basin Areawide Water Quality Management Plan," WDNR, 1988.

Wisconsin Department of Natural Resources, "Upper Rock River Basin Areawide Water Quality Management Plan," WDNR, 1989.

Wisconsin Department of Natural Resources, "Lower Rock River Basin Water Quality Management Plan Update (Public Review Draft)," WDNR, 1991.

Wisconsin Department of Natural Resources, "Sixmile-Pheasant Branch Priority Watershed Plan," WDNR, 1981.

Wisconsin Department of Natural Resources, "A Plan for the Control of Nonpoint Sources and Related Resource Management in the Black Earth Creek Priority Watershed," WDNR, 1989.

Wisconsin Geological and Natural History Survey, "A Digital-Computer Model for Estimating Hydrologic Changes in the Aquifer System in Dane County, Wisconsin," Information Circular 30, 1975.