North Mendota

Future Urban Development Area Planning

Environmental Conditions Report

North Mendota FUDA Environmental Conditions Report

February 2012

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Summary 1

Chapter I Natural Resources

Introduction 41
Physical Geography and Surface Geology 44
Mineral Resources 46
Steep Slopes and Woodlands 48
Soils 52
Watersheds and Drainage 60
Surface Water Features 77
Lake Mendota and Its Tributaries 78
a. Pheasant Branch Creek 87
b. Sixmile Creek 96
c. Dorn Creek 101
Black Earth Creek 103
Low D.O. (Excess Nutrients) Sediment, and Temperature 104
Stream Restoration 106
Wetlands 109
Open Space Corridors 118
Groundwater 124
Groundwater Quality 132
Groundwater Quantity 134
Endangered Resources 143
Wildlife Resources and Biodiversity 150
Parks and Open Space 157
Natural Resource Impacts from Urban Development 162
Hydrologic Impacts (Water Quantity and Quality) 162
Habitat Loss and Landscape Connectivity 167
Urban Development Strategies to Maintain and Improve Natural Resource Integrity 170

Chapter II Agricultural Resources

Introduction 175
Agricultural Land Area and Land Conversion 177
Farmland and Farm Operation Characteristics 182
Agricultural Parcels and Farm Base Tracts 182
Contiguity and Concentration 190
Soil Quality 202
Support Services 203
Ecological Services and Functions 208
Considerations for FUDA Planning 211

Chapter III Land Use, Demand and Supply

Introduction 217
Development Trends 218
Total Development 218
Urban Service Area Land Use Trends 219
Urban Development Characterization 219
Urban Land Use in the North Mendota FUDA Area 221
Land Development Densities 224
Estimates of Land Demand 226
Methodology 227
Estimates of Land Supply 229
Infill and Redevelopment 230
Adequacy of Developable Land in the Existing Urban Service Area 243
Development Capacity of FUDA Study Area Outside the USAs 248

Chapter IV Conclusions and Recommendations

Community Recommendations 267
New Urban Development 267
Existing Development 269
Watershed Planning 269
Agricultural Practices 270
Agricultural Preservation 271

Appendix

A Excerpts from the Yahara - Mendota Priority Watershed Report
B Excerpts from the Black Earth Creek Priority Watershed Report
C Excerpts from the Wetlands of Dane County, Wisconsin

Natural Resources References

List of Maps

Summary

Map 1: Study Area and Redevelopment Sites 7

Chapter I Natural Resources

Map 2: Physiographic 45
Map 3: Mineral Resources 47
Map 4: Steep Slopes and Woodlands 49
Map 5: Existing and Former Wetlands 55
Map 6: Depth to Water Table 56
Map 7: Depth to Bedrock 57
Map 8: Building Site Potential for Dwellings with Basements 59
Map 9: Groundwater Recharge 62
Map 10: Streams and Watersheds Regional 64
Map 11: Streams and Watersheds 65
Map 12: Wetland Groups 66
Map 13: Floodplains 67
Map 14: Internally Drained Areas 68
Map 15: Fish and Aquatic Life Study Area 74
Map 16: WDNR Fish and Aquatic Life Designations for Streams 75
Map 17: Land Cover 81
Map 18: Pheasant Branch Creek Watershed 87
Map 19: Thermally Sensitive Areas 93
Map 20: Sixmile Creek Watershed 96
Map 21: Dorn Creek Watershed 101
Map 22: Black Earth Creek Watershed 103
Map 23: Wetland Groups 113
Map 24: FUDA Study Area 120
Map 25: Regional Development Plan 121
Map 26: General Groundwater Flow 125
Map 27: Eau Claire Aquitard 128
Map 28: Simulated Groundwater Flow (Upper and Lower Aquifers) 129
Map 29: Simulated Groundwater Flow (Mt. Simon) 130
Map 30: Springs 131
Map 31: Zones of Contribution for Frederick Springs 133
Map 32: Zones of Contribution for Municipal Wells 135
Map 33: Groundwater Recharge 139
Map 34: Relative Infiltration (Natural) 140
Map 35: Relative Infiltration (Engineered) 141
Map 36: Relative Infiltration (Potential Enhancement) 142
Map 37: Pre-Settlement Vegetation 144
Map 38: Endangered Resources 146
Map 39: Prairie, Savanna and Grasslands 147
Map 40: Habitat Classification 154
Map 41: Parks and Open Space Plan 158
Map 42: Parks and Open Space Plan FUDA Area 159

Map 43: Proposed North Mendota Natural Resources Area 160
Map 44: Bike Plan 161

Chapter II Agricultural Resources

Map 45: Agricultural and Developed Lands 179
Map 46: Agricultural Land Conversion 180
Map 47: City and Village Lands in Cultivation 2005 181
Map 48: Agricultural Parcels in 2005 185
Map 49: Farmland Ownership 2008 186
Map 50: Base Farm Tract Size 2005 189
Map 51: Contiguous Agricultural Blocks 2005 191
Map 52: Agricultural Concentration Between Major Roads 2005 192
Map 53: Livestock Operations 2008/2010 196
Map 54: Crop Type 2005 197
Map 55: Value Assessment of Land 2005 200
Map 56: Value Assessment of Improvements 2005 201
Map 57: Prime Farmlands 2005 204
Map 58: Land Evaluation Classification 2005 205
Map 59: Agricultural Support Services 206
Map 60: Ecological Services and Functions 2005 207

Chapter III Land Use, Demand and Supply

Map 61: North Mendota FUDA Area Land Use 2005 222
Map 62: North Mendota FUDA Area Land Use Changes: 1990-2005 223
Map 63: Middleton TID #5 Parmenter US 12 North sub-area 232
Map 64: Middleton TID #5: Parmenter US 12 South sub-area 233
Map 65: Middleton TID #5 Century-Allen sub-area 235
Map 66: Middleton University Avenue sub-area 236
Map 67: Waunakee Downtown sub-area 239
Map 68: Town of Westport Hwy 113 and CTH M 241
Map 69: Town of Westport CTH M and K 242
Map 70: Developable Land (2005) in Urban Service Areas by Planned Future Land Use 246
Map 71: Developable Land (2005) in Rural Areas by Planned Future Land Use 250

List of Figures

Summary

Figure 1: North Mendota FUDA Study Area 6
Figure 2: Historic Lake Mendota Water Levels 13
Figure 3: Zones of Protection 27
Figure 4: Regional Land Use Comparison 30
Figure 5: Size Distribution of Base Farm Tracts 2005 32
Figure 6: Proportion of Total Area by Base Farm Tract Size 33
Figure 7: Crop Type 33
Figure 8: Land Demand Methodology 35

Chapter I Natural Resources

Figure 9: Watershed Management Units 60
Figure 10: Yahara Lakes Summer Water Clarity Depth 80
Figure 11: Phosphorus Loading Sources to the Yahara Chain of Lakes 82
Figure 12: Historic Lake Mendota Water Levels and WDNR Lake Level Limits 84
Figure 13: General Aquifer System in Dane County 124
Figure 14: Groundwater Flow in the Upper Aquifer 126
Figure 15: Simulate Drawdown at the Water Table NR-(1900-2000) 136
Figure 16: Simulate Drawdown at the Water Table NR-(2000 and 2030) 136
Figure 17: Rain Garden Simulation 138
Figure 18: Trophic Pyramids of Numbers, Biomass, and Energy 150
Figure 19: Zones of Protection for Semi-Aquatic Species 153
Figure 20: Hydrologic Effects of Urban Development and Impervious Cover 162
Figure 21: Changes in Stream Hydrology as a Result of Urbanization 163
Figure 22: Changes in Stream Channel Geomorphology Due to Urbanization 164
Figure 23: Patch Size and Local Extinction 168
Figure 24: Habitat Connectivity 169

Chapter II Agricultural Resources

Figure 25: Regional Land Use Comparison 178
Figure 26: Distribution of Agricultural Parcels by size 2005 184
Figure 27: Distribution of Agricultural Parcels by size 2005 184
Figure 28: Size Distribution of Base Farm Tracts 2005 187
Figure 29: Proportion of Total Area by Base Farm Tract Size 2005 188
Figure 30: Distribution of Contiguous Block Size 2005 188
Figure 31: Proportion of Total Area by Base Farm Tract Size 2005 190
Figure 32: Crop Type 2005 195
Figure 33: Ecological Services and Functions Regional Distribution 209

Chapter III Land Use, Demand and Supply

Figure 34: 2005 Developed and Undeveloped Land by FUDA Community 218
Figure 35: North Mendota FUDA Area Developed and Undeveloped Land 219
Figure 36: Developed Land by Community by Year 219
Figure 37: Land Demand Methodology Flow Chart 227
Figure 38: Infill and Redevelopment Assessment Methodology 231

List of Tables

Summary

Table 1 WDNR Fish and other Aquatic Life Uses 10
Table 2 Simulated Stream Baseflows 22

Chapter I Natural Resources

Table 3 WDNR Fish and Aquatic Life Uses 73
Table 4 Biological Indicators 76
Table 6 Land Use in the Lake Mendota Watershed 79
Table 7 Simulated Baseflows for Selected Streams in Dane County 134

Table 8 Endangered Resources in the North Mendota FUDA Study area 149
Table 9 Mean Minimum and Maximum Core Terrestrial Habitat for Herptiles 151
Table 10 Summary of the Impacts of Urbanization on Aquatic Ecosystems 165

Chapter II Agricultural Resources

Table 11 Agricultural and Developed Land Use 177
Table 12 Agricultural Parcel Data (2000/2005/2008) 183
Table 13 Base Farm Tract Data (2000/2005/2008) 134
Table 14 Contiguous Blocks 190
Table 15 Agricultural Land Cover 194
Table 16 Land Tax Assessment 2005 198
Table 17 Improvement Tax Assessment 2005 199
Table 18 Prime Farmlands & Land Evaluation 202
Table 19 Ecological Services and Functions on Agricultural Parcels 209

Chapter III Land Use, Demand and Supply

Table 20 Dane County Developed Acres 2005 and Percent Change, 1990-2005 220
Table 21 North Mendota FUDA Developed Acres 2005 and Percent Change, 1990-2005 221
Table 22 Residential Densities in FUDA Study Area and Comparative Data: 1990-2005 224
Table 23 FUDA Area Densities and Comparative Data 225
Table 24 City of Middleton Urban Land Demand Projection: 2010-2035 228
Table 25 Village of Waunakee Urban Land Demand Projection: 2010-2035 228
Table 26 Town of Westport Land Demand Projection: 2010-2035 228
Table 27 Total Urban Area Land Demand Projection: 2010-2035 229
Table 28 City of Middleton TID #5 Redevelopment Area-Parmenter/Highway 12 234
Table 29 Middleton TID #5 – Century Ave./Allen Blvd. Area Redevelopment and Infill 236
Table 30: Middleton University Avenue Area Redevelopment and Infill Summary 238
Table 31: Waunakee Downtown Area Redevelopment and Infill Summary 240
Table 32: Town of Westport Redevelopment and Infill Summary 242
Table 33: Potential Infill and Redevelopment and Urban Demand 243
Table 34: Urban Developable Land, Planned Future Uses and Projected Future Demands 245
Table 35: FUDA Area Rural Land Demand Towns of Westport (rural area) and Springfield 248
Table 36: Rural Developable Land, Planned Future Uses and Projected Future 249

North Mendota

Future Urban Development Area Planning

Environmental Conditions Report

Summary

Introduction

The local resolutions that were adopted to ask the Governor to create the Capital Area Regional Planning Commission (CARPC), included a proactive long-range planning effort to align regional goals and objectives with local needs and desires in a collaborative manner. CARPC was created by Governor Doyle under Wis. State Stats. 66.0309 governing regional planning commissions.[1] Under the statute CARPC has the duty and responsibility of planning for the *harmonious physical development of the region*. CARPC is also created to be *an area-wide water quality management planning agency* under Wisconsin administrative code chapter NR 121,[2] working as an agent of the state to work with the Wisconsin Department of Natural Resources (WDNR) to coordinate various water quality management activities in the region, and advise WDNR about local water quality management needs and conditions.[3]

The proactive, long-rage collaborative planning process was named Future Urban Development Area (FUDA) Planning in local resolutions petitioning the Governor to establish CARPC in 2006. Item 7 in the local resolution outlines this planning initiative as follows:

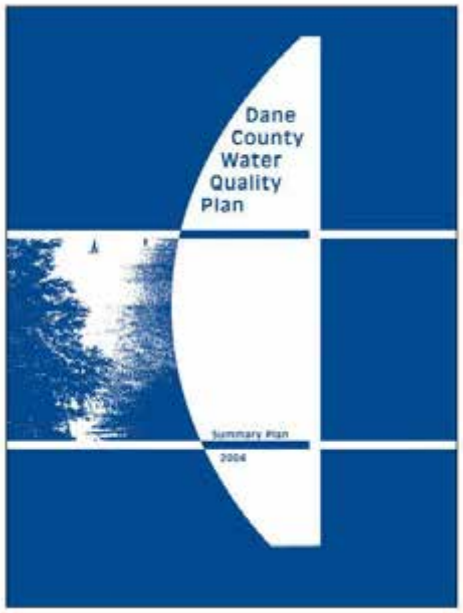
> "The CARPC shall work with communities to update the Dane County Water Quality Plan. In addition to the elements required by NR 121 of the Wisconsin Administrative Code, the Water Quality Plan shall also define areas that should be protected from development based on provisions to protect water quality as contained in NR 121 of the Wisconsin Administrative Code. The Plan shall also define areas that can be developed with measures to protect, restore or minimize degradation of water quality.
>
> "The Plan shall also define a 25-year Future Urban Development Area with 5-year updates. The Plan shall be developed in cooperation with area communities, including towns, and shall consider adopted comprehensive plans and intergovernmental agreements. The Plan shall be developed as follows:
>
> a. CARPC staff shall provide communities with environmental condition reports consisting of maps, text, and information identifying environmental issues that should be addressed.
> b. The CARPC shall give priority to areas of the highest environmental sensitivity and growth pressure. These areas are: all communities within the Central Urban Service Area; all communities within the Northern Urban Service Area; all urban service areas with a year 2000 Census population of 3,000 or more; and the Black Earth Urban Service Area…

1 See the following link to ss. 66.0309 https://docs.legis.wisconsin.gov/statutes/statutes/66/III/0309/10
2 See the following link to NR 121 https://docs.legis.wisconsin.gov/code/admin_code/nr/121.pdf
3 For detailed description of CARPC roles, duties, and responsibilities, see the following link www.capitalarearpc.org/about_the_carpc.htm

c. The Plan, which will identify the 25 Future Urban Development Area, shall be based on the requirements of NR 121 and shall also consider other factors including the impacts on natural and built systems, the efficient use of land including urban densities, and the ability to efficiently provide services to support the development and farmland preservation planning.

d. There shall be separate rules and policies for limited service areas.

e. The CARPC shall adopt policies and procedures for the considerations of amendments to the *Water Quality Plan* between five-year updates of the *Water Quality Plan*…"[4]



To meet this charge, the towns of Springfield, Westport, the City of Middleton, the Village of Waunakee, and CARPC began developing a collaborative pilot[5] planning and implementation FUDA process in Fall 2010. Each participating unit of government designated three (3) appointees to establish a local Steering Committee. The Committee is supported by local and regional staff. The Steering Committee and staff met monthly for over six months to develop the Environmental Conditions Report (ECR) for this part of the region.

Funding for this project comes from CARPC operating budget and grant funds from the Sustainable Communities Regional Planning Grant Program sponsored by US Department of Housing Urban Development . The communities participating in this grant are also members of the Capital Area Sustainable Communities Consortium. To learn more about the grant and the Consortium visit: http://www.capitalarearpc.org/grant.html

More information on this project is available at:
www.capitalarearpc.org/North_Mendota_FUDA.html

4 For the complete text of the local resolutions see www.capitalarearpc.org/USA_List.html.

5 Another pilot project was undertaken simultaneously for the Northern USA and the surrounding area, including the Village of DeForest and the towns of Windsor, Vienna, and Burke.

Purpose

Many communities across the U.S. are beginning to discover the need for an integrated approach to planning for growth and development. Fiscal efficiency and economic sustainability require an approach that minimizes the wasteful use of natural and financial resources. Experience shows that inefficient and uncoordinated approaches to resource use result in wasted economic opportunity, increased financial burden on municipalities and taxpayers, and in eroded community well-being and economic competitiveness, and reduced quality of life. The primary natural resources objective of this approach is to maintain and, where possible, enhance the quality of our natural environment and the associated resource functions and values. However, this needs to dovetail with related growth and development strategies related to local community needs and aspirations, infrastructure planning, community economic development, long-term development visioning and planning, maintaining agricultural production of food and fiber, and reserving open spaces for cultural, recreational, aesthetic, and ecosystem functions.

The purpose of the FUDA process is to empower local decision-making with information and evidence that provide a regional perspective of vulnerabilities and opportunities. The regional impact of local actions can thereby be considered as part of the decision-making together with the local implications of regional trends and concerns.

The purpose of the ECR is to provide an inventory and assessment of the natural, agricultural, and community resources related to this FUDA study area based on the best available information. This information provides technical data and analysis that can be used by local communities in land use decisions, and in planning for development and preservation that respect the integrity of natural areas and incorporate environmental features into development projects. The natural, agricultural, and community resource data provide the foundation for local communities to evaluate where development can occur most efficiently, where resources need to be protected, and identify opportunities for development and conservation to occur together.

The information presented in the ECR is by necessity comprehensive, voluminous, and technical. It is intended to be used by a diverse audience including community decision-makers, technical staff, land owners, preparers of development proposals, and interested individuals and entities. Therefore, the report is designed with elements that target various audiences, allowing selective reading for specific purpose and content based on the following layered approach:

- The Report Summary is aimed at providing a *report in brief* on issues, findings, and recommendations targeted for decision-making. Links to specific maps and resources are included in the Report Summary.
- More detailed information and justifications for the Report Summary findings and recommendations are found in the technical body of the ECR. The ECR also includes technical recommendations that can be used for detailed planning, design, and engineering work by various staff and consultants. This portion can be used as a *technical resource* for the communities in the study area, and a *reference* for consultants and technical professional working in the study area.

- Links to more detailed technical analysis and research references are included in the report.
- CARPC staff are available to work with communities and community leaders and their consultants to provide further content and technical expertise.

The ECR contains ***existing*** natural resource, agricultural, and land demand and supply data and analysis as outlined in the formation resolution quoted above. ***"Environmental Conditions" are therefore defined comprehensively to include various physical systems in the study area, including the natural resources, but not exclusively.*** The ECR provides the data and analysis to inform the FUDA planning process. In particular, existing data covering these topics will inform the baseline conditions for scenario planning exercises and may offer additional recommendations for alternative growth scenarios. This ECR is organized into four principle chapters:

I. Natural Resources
II. Agricultural Resources
III. Land Demand and Supply
IV. Conclusions and Recommendations

The natural and agricultural resources sections are an assessment of assets in and near the subject communities. The aim of this section is to provide details of the vulnerabilities of each natural resource, the potential for restoration for each, and specific recommendations for protecting these resources as valuable assets that add to the quality of life of the community and reduce infrastructure, maintenance, and environmental costs.

The land demand and supply is an assessment of land development and density trends, and projections of population growth. This population growth and related demographic shifts must be effectively managed to protect the natural and agricultural resources identified in this report.

Hierarchy of Scale in Analysis

The challenge of viewing local actions in the context of their regional impacts is typically one of scale and our ability to evaluate and detect these impacts. Every action has positive and negative impacts if considered in the right time and geographic scale. We typically have limited understanding of the consequences of our actions. However, even the consequences that we know about can go undetected if we are not looking at the right time-frame or geographic area. ***This ECR looks at the geographic area based on areas of impact, starting with the regional or large scale, and based on regional trends, and the capacities and susceptibilities of various regional systems.*** This is somewhat like the point-of-view of a skydiver at 30,000 feet. At that height, the skydiver can see the entire region and the interconnectedness of the streams, roads, landscapes, and other features and systems. As the skydiver gets closer to the ground, the viewpoint becomes smaller and the focus more local, and more detail becomes visible. Both viewpoints are relevant depending on the scale of analysis and impact.

Time scale is another consideration in this evaluation. Small, incremental actions have small impacts that are typically below our detection capability. ***Water quality planning requires a 20-year planning horizon and is based on population growth projections for the region.*** Most impacts are best analyzed in the context of "build-out", which provides an analysis of the end-result. FUDA planning includes evaluation of different growth scenarios for communities. ***As part of this evaluation of various approaches to community growth and development, "build-out" analyses are included.***

This hierarchy of scale has the following implications:

- ***Regional vulnerabilities outlined in the ECR apply to all communities within the study area. These vulnerabilities characterize potential "downstream" effects of local actions.***
- ***Sub-regional vulnerabilities outlined in the ECR apply to specific areas within the study area. The ECR outlines areas that influence these sub-regions. For example, sub-watershed boundaries are shown to indicate the areas where increased sediment in stormwater can exacerbate the health of a stream section.***
- ***Local vulnerabilities apply to the small areas with defined impact on the local resource. For example, an isolated wetland is impacted by stormwater runoff from the relatively small land area that drains into it.***
- ***There are numerous networks and systems that need to be considered in combination as part of planning. The transportation network has different areas and scales of analysis compared to the surface water (rivers and streams) network or the school system. The FUDA process attempts to include as many of these networks and systems as is practicable. The participating communities are encouraged to include additional systems and networks in their deliberations and discussions as part of the planning process. The planning process would ideally facilitate an integrated, inter-related, and comprehensive consideration of all the systems.***

Defining the Study Area

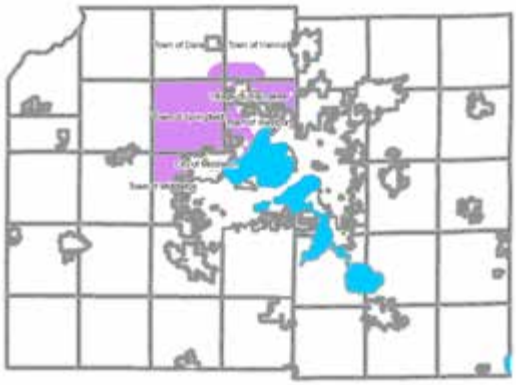
Each FUDA project defines a study area to establish the outer limits of the lands included in the analysis of the ECR and FUDA documents. The lands within the study area are the most likely to develop within the next 25 years (except that the entirety of the Town of Sprinfield was included in this case at the Towns's request).

The outer study area boundary is based on the of the Extra Territorial Jurisdiction of the City or Village. This project expanded the study area to include the entire jurisdictions of the Towns of Springfield and Westport.

Additionally, redevelopment sites identified in existing local plans are included in the land demand and supply section of this report. The communities may identify additional redevelopment sites through this process and include these in development scenarios. The North Mendota Steering Committee defined the study area and redevelopment areas in Map 1.

Figure 1. North Mendota FUDA Study Area

Breakdown by jurisdiction (acres):	
C. Middleton	545 (outside current USA)
V. Waunakee	877 (outside current USA)
T. Middleton	4,536
T. Springfield	23,010
T. Westport	9,692
T. Vienna	3,090
T. Dane	1,130
Total Area	**42,880**



As noted in Figure 1, the amount of land within the study area and outside current urban service areas (USA) is 42,880 acres. The study area includes the City of Middleton (part of the Central USA), and the Village of Waunakee (Waunakee USA). The entire townships of Springfield and Westport are also included. Other town lands included in the study are in the north western corner of the Town of Middleton, the south eastern corner of Vienna and the south western corner of the Town of Dane.[6]

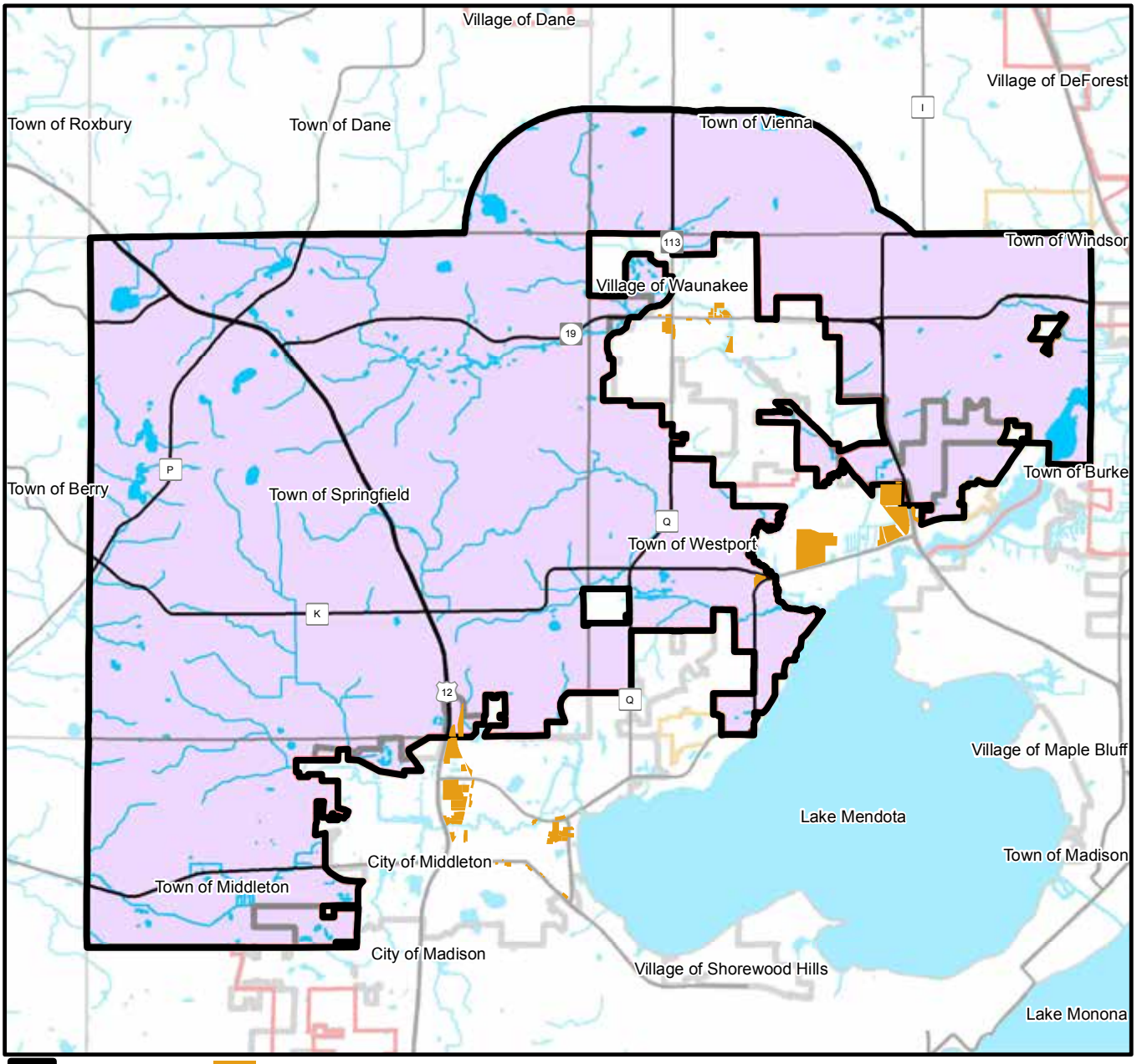
The communities in this project have demonstrated a strong commitment to intergovernmental cooperation in planning and development. This FUDA planning effort will build upon this foundation and existing plans by providing local jurisdictions with more detailed data and analysis to assist them in their local planning and decision-making. Local communities can consider this information as they move into the scenario planning phase of the FUDA planning process. These communities can also integrate recommendations and outcomes from the ECR into the FUDA plan and subsequently into local comprehensive and other municipal plan updates. These recommendations will also update regional plans including the *Dane County Water Quality Plan* and the *Land Use and Transportation Plan*.[7] Finally, the ECR can also serve as a resource for communities and CARPC in future planning and plan implementation activities and for review of USA amendment review of USA amendment requests.

6 Towns of Middleton, Vienna, and Dane have been invited to the Steering Committee, and have been kept informed of the progress of the project.

7 The *Dane County Land Use and Transportation Plan* is programmed to be updated during 2014-2018. http://danedocs.countyofdane.com/webdocs/PDF/capd/landuse_and_transportation_plan.pdf

Map 1: Study Area and Redevelopment Sites

North Mendota Study Area, Dane County, WI



FUDA Study Area
Urban Service Area
Limited Service Area
Water
Redevelopment Parcels

Miles
0 0.25 0.5 0.75 1 1.25 1.5

N

Source: Capital Area Regional Planning Commision February 2012

The study area was derived using the extra territorial jurisdictional boundaries of the City of Middleton and the Village of Waunakee as the base area. The study area expanded to encompass all of the Towns of Springfield and Westport.

Chapter I. Natural Resources

A. Physical Geography and Surface Geology

The regional physiography of Dane County explains the surface and near-surface features and formations that characterize the landscape of the region. These include land forms, geology, soil and subsoil characteristics, vegetative cover, drainage and surface- and groundwater resources, and associated habitats.

1. Mineral Resources

Mineral Resources in the region are typically near-surface sand, gravel deposits. These deposits represent important economic assets. Sand and gravel deposits are potentially critical local and regional areas for enhanced infiltration and groundwater recharge.

Mineral resource areas should be considered for protection from development until the importance of these areas for infiltration and groundwater recharge have been evaluated, or the resources have been mined and the site is ready for reclamation.[8]

2. Steep Slopes and Woodlands

Development on steep slopes can destabilize slopes and create erosion. Steep *wooded* slopes also provide significant groundwater recharge, wildlife, water quality, and aesthetic benefits.

Steep slopes with gradient over 20% should be protected from disturbance and stabilized through re-vegetation. Disturbance of steep slopes with gradient between 12% and 20% should only be allowed with the review and approval of the local municipal engineer. Steep wooded slopes with gradient over 12% and within 75 feet of a water body should be delineated as environmental corridors for protection against disturbance and defoliation.[9]

A detailed evaluation of steep slopes is presented in Environmental section 2, page 48. Woodlands are important biological and natural resources with critical role in maintaining surface and water quality and quantity and improving air quality. A detailed evaluation of the woodlands of the study area, including the presence of invasive species, are presented on page 50 with an outline of opportunities for woodland restoration in various sub-areas.

3. Soils

Soil characteristics provide significant insight into the suitability for development in a particular area, and impose constraints on some construction practices and stormwater management measures.

The soils of the study area were formed in glacial outwash and glacial till. Sub-surface deposits of glacial till provide ready opportunities for enhanced infiltration of treated or clean rainfall runoff as part of stormwater management for development. For detailed information concerning the infiltration characteristics of the soils of the study area refer to page 52.

8 Map 3 on page 47 shows the extent of mineral resources in the study area.
9 Map 4 on page 49 shows the extent of steep slopes and woodlands in the study area.

The study area also includes small areas with hydric soils, soils with shallow depth to bedrock and shallow depth to water table.[10] These soils characteristics pose limitations on development as outlined below:

- ***Hydric Soils*** (indicators of existing and former wetlands) – ***often present significant constraints to development because of saturated soil conditions and other associated stability problems.*** These areas also offer potential for wetland restoration or enhancement, thereby reclaiming water quality, quantity, and wildlife benefits that have been lost over the last century during which half of the wetlands of the region were filled.

- ***Shallow Depth to Bedrock – can increase the cost of urban infrastructure and housing construction.*** *It may also limit the suitability of some stormwater practices due to the potential for groundwater contamination.*

- ***Shallow Depth to Water Table –*** soils with seasonably high water tables ***have limited suitability for development because of soil saturation and potential for groundwater induced flooding.***

4. Watersheds and Drainage

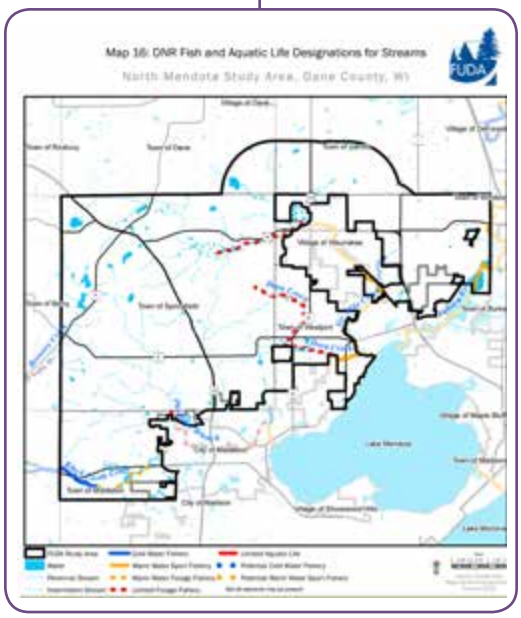
The region is situated at the headwaters of four river basins (Lower Rock, Wisconsin, Sugar-Pecatonica, and Upper Rock), and the study area is located in the first two.[11] Although the main physical and chemical characteristics of water features are defined by surface and sub-surface geology and morphology, the watershed (the land draining to a particular water body) is the basic structural element of water resource protection.

10 These areas are shown on Maps 5, 6, and 7; on pages 55 through 57.
11 See Maps 10, and 11; pages 64 and 65.

While much attention has been directed to protecting, restoring, and enhancing these resources over the last few decades, more work is needed due continued growth pressure in the region and the study area. ***The study area is in the Yahara-Mendota watershed (in the Lower Rock River Basin), with a small area located in the extreme west edge and southwest corner is in the Black Earth Creek watershed and in the Wisconsin River Basin.*** The report goes into detailed explanations and descriptions of the extent and quality of the surface water features in the study area, along with specific planning and design considerations highlighted as recommendations in Chapter IV of the report.

Thumbnail of Map 15
See full page map on page 74

Click to view map



Thumbnail of Map 16.
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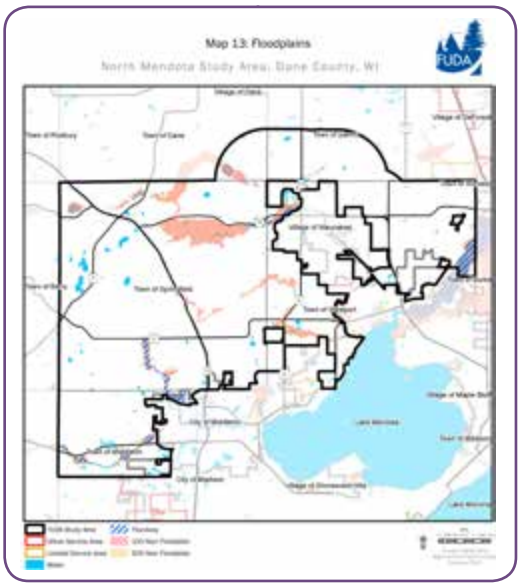
State water quality standards are based on stream classifications provided by the Wisconsin Department of Natural Resources and codified in state law. Table 1 shows these classifications. Maps 15, and 16 on pages 74, and 75 show these classifications for the streams of the region and for the study area.

Table 1: WDNR Fish and Other Aquatic Life Uses

The Department has classified all surface waters into one of the fish and other aquatic life subcategories described below. Only those use subcategories identified in pars. (a) to (c) shall be considered suitable for the protection and propagation of a balanced fish and other aquatic life community as provided in federal water pollution control act amendments of 1972.	
(a) ***Cold Water Communities.*** This subcategory includes surface waters capable of supporting a community of cold water fish and other aquatic life, or serving as spawning area for cold water fish species.	
(b) ***Warm Water Sport Fish Communities.*** This subcategory includes surface waters capable of supporting a community of warm water sport fish or serving as a spawning are for warm water sport fish.	
(c) ***Warm Water Forage Fish Communities.*** This subcategory includes surface waters capable of supporting an abundant diverse community of forage fish and other aquatic life.	
(d) ***Limited Forage Fish Communities.*** (Intermediate surface waters). This subcategory includes surface waters of limited capacity and naturally poor water quality or habitat. These surface waters are capable of supporting only a limited community of forage fish and other aquatic life.	
(e) ***Limited Aquatic Life.*** (Marginal surface waters). This subcategory includes surface waters of severely limited capacity and naturally poor water quality or habitat. These surface waters are capable of supporting only a limited community of aquatic life.	

a. Floodplains

One of the most familiar characteristics of bodies of water is their flooding. Map 13, page 67 shows areas with a 1% chance of being inundated in any single year. Zoning regulations restrict the placement of fill and structures in floodplains. ***Because of potential changes in flood frequencies and flood boundaries, it is important to consider additional buffer areas around floodplains to accommodate such changes. Furthermore, keeping susceptible infrastructure out of the 100-year floodplain adds to the resilience of these infrastructure systems.***



Thumbnail of Map 13
See full page map on page 67

Click to view map

b. Internally Drained Areas

Two large internally drained areas (i.e., closed basins with no outlet) border the South Fork Pheasant Branch sub-watershed within the Madison-Middleton area.[12] The largest of these areas is 950 acres in size and drains to two shallow ponds know as Stricker Pond and Tiedeman Pond. Another closed basin is the area surrounding Graber Pond on the north side of the City of Middleton.

The unique hydrologic characteristics of closed basins make them especially vulnerable to urbanization and flooding. When the watershed of closed basins are predominantly undeveloped (either pre-settlement or agricultural), closed basins are typically wetter in the spring and dry out during the fall during years of normal precipitation. As urbanization increases, summer rainfall events generate significant runoff, which does not allow the pothole to dry out in the summer. The ponds tend to become dominated by open water, and the potential for extended flooding of nearby development increases. Furthermore, because closed basins are not contributors to nearby streams, attempts to drain them increases rate and volume of flow in receiving streams, changing the hydrologic regime of these streams and increasing the risk of flooding in downstream areas. Therefore, it is advisable to maintain the internal drainage of a closed basin other than in emergency situations where water can be discharged during periods of stream low flow to prevent bed and bank destabilization or flooding.

Stricker Pond

12 See Map 14 on page 68. See page 89 for more details.

The following summarizes the actions that have been taken, and those that need to be considered to protect closed basin areas:

Measures taken since 1990s

- ***Volume control at pre-development levels in urban areas since 2004***
- ***Special volume and overflow requirements in closed basins in new urban service area amendments to prevent draining the closed basin, maintaining pre-development runoff volumes, and installing emergency overflow structures for temporary release if needed.***

Additional measures that can benefit the health of closed basin areas

- ***Financial resources for reduction of runoff volumes from agricultural areas in closed basins***
- ***Financial resources for retrofit best management practices in older urban areas especially to reduce runoff volumes***
- ***Restore wetlands, woodlands, prairies, and pastures in select areas***

B. Surface Water Features

The study area is located in the Yahara River/Lake Mendota watershed and the Black Earth Creek watershed. Analysis generally starts at this scale and moves upstream to smaller, local water features. ***All local land use and land management decisions in areas that drain to Lake Mendota will affect the quality and quantity of water in Mendota and the lower lakes of the Yahara system.***

1. Lake Mendota and its Tributaries

The largest and deepest lake in the Yahara Lakes system, Lake Mendota supports a warm water sport fishery. The Lake is "eutrophic", meaning it possesses high fertility and is susceptible to the addition of phosphorus in storm runoff, which further fertilizes the Lake and encourages algae blooms. The Lake has a watershed area that is 20% urban and 54% in agricultural cropland. Algae blooms have been a continual water quality problem for the Lake since the late 1800s. Algae blooms in Lake Mendota are fed by nutrient phosphorus which is washed into the Lake with sediment carried by stormwater. The following list outlines issues related to Lake Mendota water quality:

- ***Modeling in year 2000 showed that 75% of the total annual phosphorus load to the Lake was from agricultural areas of the watershed.*** *This figure pre-dates implementation of new stormwater quality and quantity management ordinances in urban areas.*
- ***The modeling also showed a higher amount of phosphorus delivered per acre of land from construction erosion in urban areas.***[13] *This figure pre-dates implementation of new stormwater quality and quantity management ordinances in urban areas.*
- ***Both agricultural and urban conservation practices are necessary to reduce the flow of phosphorus to the Lake.***

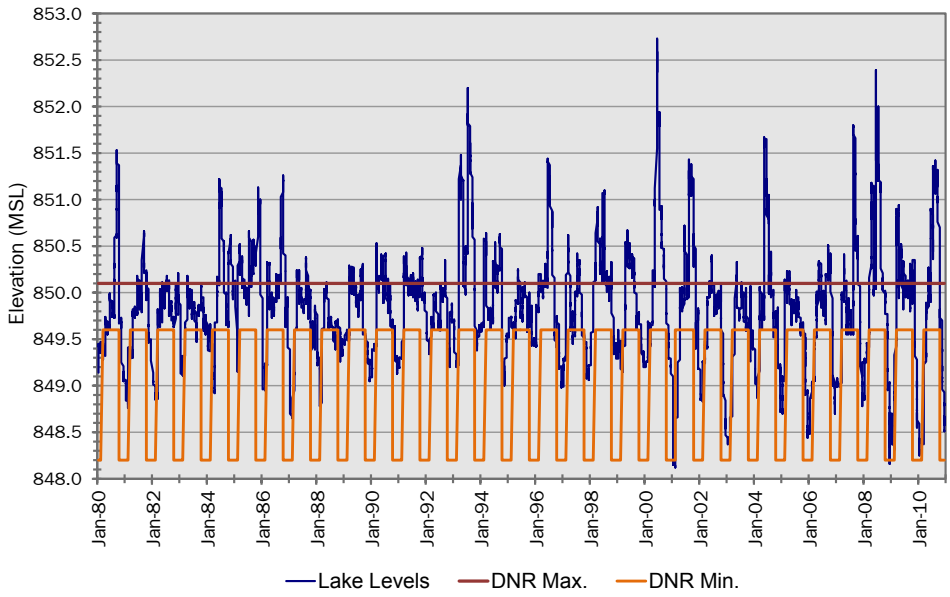
13 See Figure 11, page 82 for details of phosphorus loading to Lake Mendota.

- ***Water quality goal for Lake Mendota is phosphorus concentration of 0.074 mg/L during spring. This is expected to reduce the likelihood of algae blooms by 50% during summer months.***
- ***Phosphorus loading to Lake Mendota cascades into the lower lakes (Monona, Waubesa, Kegonsa) in the system and causes algae bloom in those lakes.***
- ***Algae blooms are not only an unsightly nuisance, but impact the water quality of the lakes and the health of their aquatic habitat. Furthermore, the lakes are significant regional recreational and aesthetic resources that create a desirable regional setting and quality of life, and attract businesses and professionals to the region. Therefore, these water quality problems result in economic loss for the entire region.***
- ***Lake Mendota has been included in the Rock River Total Maximum Daily Load (TMDL) by the USEPA[14], imposing restrictions on discharge of sediment and phosphorus into the Lake.***

Another concern for Lake Mendota is the potential for flooding, even though lake levels are managed by Tenney Locks. Figure 2 shows lake levels in the past two decades compared to maximum lake levels established by the WDNR. This problem stems mostly from older urban areas which were developed without stormwater management measures and changes in the intensity of rainfall in the region. Furthermore, flooding in Lake Mendota passes downstream to Lake Monona and the lower lakes in the system. Development activities in the Mendota watershed should consider negative effects on flood conditions in the entire system.

For a more detailed information on Lake Mendota refer to pages 78 through 84.

Figure 2: Historic Lake Mendota Water Levels and DNR Lake Level Limits



Source: Dane County Dept. of Land & Water Resources

14 For Rock River TMDL Details see http://dnr.wi.gov/org/water/wm/wqs/303d/rockrivertmdl/Final_Rock_River_TMDL_Report_with_Tables.pdf

Substantial public monies have been expended to assess and improve the water quality in Lake Mendota, including priority watershed projects. The following list summarizes actions which have been taken in recent years, and those that need to be taken by municipalities and land owners in the Lake Mendota watershed to address issues associated with the health of the Lake:

City of Middleton & Lake Mendota

Measures taken since 1990s

- ***Implementation of agricultural best management practices to provide the following:***
  - ***reduce soil erosion***
  - ***utilize nutrient management to optimize the use of fertilizers***
  - ***reduce the transport of manure by stormwater into streams***
  - ***prevent livestock from getting into streams***
  - ***manure digester installations to reduce phosphorus in manure***
- ***Implementation of urban best management practices to provide the following:***
  - ***control construction erosion***
  - ***control peak stormwater rates at predevelopment levels in new development***
  - ***maintain runoff volumes to predevelopment levels in new development areas by including infiltration requirements in stormwater ordinances***
  - ***provide stormwater treatment in new development areas***
  - ***require exclusion of phosphorus from lawn fertilizers sold in the region***
  - ***implement retrofit sediment reduction measures in existing urban areas***

Additional measures that can benefit the health of Lake Mendota[15]

- ***Increase financial resources for broader implementation of agricultural best management practices for water quality and runoff volume reduction***
- ***Increase financial resources for broader implementation of retrofit urban best management practices in old urban areas for water quality and runoff volume reduction***
- ***Restore wetlands, woodlands, prairies, and pastures in select areas for water quality improvement and runoff volume reduction***
- ***Capitalize on opportunities for capturing phosphorus within the watershed and exporting it***

In selecting additional measures for implementation, it is important to consider the cost-effectiveness of urban projects compared to projects in agricultural areas that may result in similar or more effective water quality or quantity improvements at the same cost. CARPC staff can facilitate discussions between municipalities to achieve such cost efficiencies. Such collaborations may require intergovernmental agreements between municipalities to ensure that water quality and quantity improvement measures are maintained.

a. Pheasant Branch Creek

This stream flows through the Town of Springfield and the City of Middleton to Lake Mendota. The watershed land area is composed of 46% agriculture, 16% residential, and 10% transportation. It supports a warm water sport fishery in a one mile reach from its mouth on Lake Mendota, and supports a limited forage fishery in the nine-mile reach farther upstream. Most of the Pheasant Branch Creek watershed (portion located upstream of USH 12) was historically an internally drained area which was artificially drained to the east into what is now the main stem of the Creek. Consequently, the main stem channel is still adjusting to the higher flows and has an unstable bed that is susceptible to erosion. The City of Middleton has implemented stormwater volume reduction measures and has built a confluence pond on the Creek to reduce flows and stabilize the Creek.

Pheasant Branch Conservancy

15 These measures should be considered in all communities in the study area, since they are all tributary to Lake Mendota.

Pheasant Branch is on the state's impaired waters list for degraded habitat and low dissolved oxygen due to sediment and phosphorus. The stream is included in the Rock River Basin Total Maximum Daily Load, imposing restrictions on discharges of sediment and phosphorus.

In addition to actions listed above under Lake Mendota actions, the following list summarizes actions which have been taken in recent years, and those that need to be taken by municipalities and land owners within the Pheasant Branch watershed to address issues associated with the health of the Creek.[16]

Measures taken since 1990s

- ***Implementation of urban best management practices to provide the following:***
  - ***construction of a pond at the confluence of the North and South Forks of the Creek to control flow peaks and sediment load***
  - ***installation of channel bed and bank stabilization measures on the main stem of Pheasant Branch Creek***

Additional measures that can benefit the health of Pheasant Branch Creek

- ***Increase financial resources for broader implementation of agricultural best management practices for water quality and runoff volume reduction***
- ***Increase financial resources for broader implementation of retrofit urban best management practices in old urban areas for water quality and runoff volume reduction***
- ***Restore wetlands, woodlands, prairies, and pastures in select areas for water quality improvement and runoff volume reduction***
- ***Capitalize on opportunities for capturing phosphorus within the watershed and exporting it***

b. Sixmile Creek

This stream flows through the Town of Springfield and the Village of Waunakee to Lake Mendota. The 43 square mile watershed area is composed of 72% agriculture, 14% residential, and 5% transportation. ***The stream is classified as an exceptional resource water defined in the state administrative code as "surface waters which provide valuable fisheries, hydrologically or geologically unique features, outstanding recreational opportunities, unique environmental settings, and which are not significantly impacted by human activities."*** The stream supports a warm water sport fishery in its reach from Woodland Drive to Lake Mendota. The corridor of Sixmile Creek from Bong Road downstream to Lake Mendota is identified as a Natural Resource Area (NRA) in the Dane County Parks and Open Space Plan. NRAs consist of lands that contain especially valuable natural resources or greenbelt corridors identified through a public process. Lands within the NRA are eligible to be purchased and protected using state and local conservation funding. This is an entirely voluntary program conducted in cooperation with participating landowners.

16 See pages 87 through 94 for additional detail on Pheasant Branch Creek.

Hogan Tributary of Sixmile Creek is a cold stream.

Sixmile Creek watershed includes a large wetland complex west of the Village of Waunakee. This complex is an important habitat resources and one of the few remaining large wetlands in the watershed. The stream is impacted by sedimentation from agricultural practices and urban construction erosion, and has been included in the Rock River total maximum daily load, which imposes restrictions on the levels of phosphorus and sediment that can be discharged to the stream in stormwater.[17]

Sixmile Creek actions taken to date, and those needed to be taken are the same as listed above for the Lake Mendota watershed. Special efforts in improving implementation of agricultural best management practices would be particularly important for improving the health of the stream. Equally critical to the health of the stream habitat is widening of riparian buffers, especially in reaches where buffers are narrow or non-existent.

c. Dorn Creek

Dorn Creek flows through the Towns of Springfield and Westport before flowing into Sixmile Creek upstream of Lake Mendota. The 12.7 square mile watershed is predominantly agricultural. The watershed includes shallow marsh and sedge meadow areas that are spawning areas for northern pike and panfish. This reach of the stream is identified as a Natural Resource Area (NRA) in the Dane County Parks and Open Space Plan. NRAs consist of lands that contain especially valuable natural resources or greenbelt corridors identified through a public process. Lands within the NRA are eligible to be purchased and protected using state and local conservation funding. This is an entirely voluntary program conducted in cooperation with participating landowners.

Although the stream retains its natural meandering configuration, it supports a forage fishery. The health of the stream is impacted by heavy sedimentation due to intense agricultural activities in its watershed. The stream has been included in the Rock River total maximum daily load, which restricts the sediment and nutrient levels in the stormwater that discharges to the Creek.[18]

17 See pages 96 through 101 for further details on Sixmile Creek.
18 See pages 101 through 102 for further details on Dorn Creek.

Dorn Creek actions taken to date, and those needed to be taken are the same as listed above for the Lake Mendota watershed. Special efforts in improving implementation of agricultural best management practices would be particularly important for improving the health of the stream.

Black Earth Creek

2. Black Earth Creek

Black Earth Creek is in the Wisconsin River basin and is located at the southwest corner and west edge of the study area. Its headwaters are at a terminal moraine on the west edge of the City of Middleton. The Creek flows west about 27 miles to the confluence with Blue Mounds Creek and the Wisconsin River. Land use includes agriculture (40 percent), woodlands (30 percent), residential (9 percent), transportation (5 percent), and wetlands (2 percent). Most of the watershed is dominated by thick deposits of glacial outwash and alluvium, materials that form an excellent aquifer for sustained stream flow.

Black Earth Creek is a regionally popular trout stream and trout enthusiasts have rated it one of the top 100 trout streams in the nation. ***The state administrative codes designate Black Earth Creek as an Outstanding Resource Water from Twin Valley Road downstream to the Village of Cross Plains wastewater treatment plant.*** This designation reflects the Class 1 (self-sustaining) trout fishery supported in this reach of the stream.

The Upper Black Earth Creek watershed is identified as a Natural Resource Area (NRA) in the Dane County Parks and Open Space Plan. NRAs consist of lands that contain especially valuable natural resources or greenbelt corridors identified through a public process. Lands within the NRA are eligible to be purchased and protected using state and local conservation funding. This is an entirely voluntary program conducted in cooperation with participating landowners.

The Black Earth Creek watershed has been the subject of a priority watershed planning project and ongoing research, restoration, and conservation efforts. The Creek is a high quality trout stream that is subjected to low dissolved oxygen levels due to excess nutrients in the stream, sedimentation, and water temperature increases that can prove toxic to cold water fish species.[19]

The following list summarizes the actions that have been taken, and those that need to be considered to protect Black Earth Creek:

Measures taken since 1990s

- ***Implementation of agricultural best management practices to provide the following:***
  - ***reduce soil erosion***
  - ***utilize nutrient management to optimize the use of fertilizers***
  - ***reduce the transport of manure by stormwater into streams***
  - ***prevent livestock from getting into streams***
- ***Implementation of urban best management practices to provide the following:***
  - ***control construction erosion***
  - ***control peak stormwater rates at predevelopment levels in new development***
  - ***maintain runoff volumes to predevelopment levels in new development areas by including infiltration requirements in stormwater ordinances***
  - ***provide stormwater treatment in new development areas***
  - ***require exclusion of phosphorus from lawn fertilizers sold in the region***
  - ***implement retrofit sediment reduction measures in existing urban areas***
  - ***plans for the possible removal of a dam at the Village of Mazomanie and plans for stream restoration in the former impoundment area and downstream***
  - ***abandonment of a municipal wastewater treatment plant at the Village of Black Earth and regionalization of treatment in a new treatment plant downstream of the Village of Mazomanie***

Additional measures that can benefit the health of Black Earth Creek

- ***Increase financial resources for broader implementation of agricultural best management practices for water quality and runoff volume reduction***
- ***Increase financial resources for broader implementation of retrofit urban best management practices in old urban areas for water quality and runoff volume reduction***

19 See pages 103 through 108 for additional information on Black Earth Creek.

- ***Restore wetlands, woodlands, prairies, and pastures in select areas for water quality improvement and runoff volume reduction***
- ***Provide financial resources for implementation of dam removal and stream restoration at Mazomanie***
- ***Undertake a comprehensive watershed ecosystem study for the upper reach of the watershed prior to further expansion of urban service area into this part of the watershed (as required by the WDNR).***
- ***Adopt more protective local stormwater standards for urban areas***

3. Wetland Resources

Over half of the wetlands in Dane County and the U.S. have been lost over the last century. Many of the wetlands that remain have been degraded. This has resulted in the loss of ***important wetland functions and values such as flood protection, water quality improvement, wildlife habitat, aesthetics, and natural resource appreciation and recreation opportunities.*** Because of their scarcity and the significant benefits they provide, existing wetlands should be protected and enhanced. An extensive evaluation of the wetlands of the region was conducted by Bradford and Zimmerman in 1974 as part of the initial natural resource inventory for developing the *Dane County Water Quality Plan*. Additional work was performed by CARPC staff in the 2008 to prioritize the wetlands of the region based on susceptibility. Preliminary ecological assessment of wetlands in the FUDA study area were conducted by CARPC staff ecologist in 2011.[20]

Waunakee Marsh

20 Map 12, page 66 shows the wetland resources of the study area.

Wetland restoration methods correct three essential elements of a healthy complete wetland. These are the natural hydrology or water quantity regime, the natural chemical input to the wetland (water chemistry; pollution levels; fertilizers), and the natural plant community (generally follows the first two, but invasive species may have to be uprooted to allow natural plan species to re-establish themselves). ***Wetland enhancement methods elevate one or more of these functions*** to a higher level, leaving the wetland in a healthier, though not original, state.[21]

The following wetland restoration sites in the study area that were identified through these assessments:

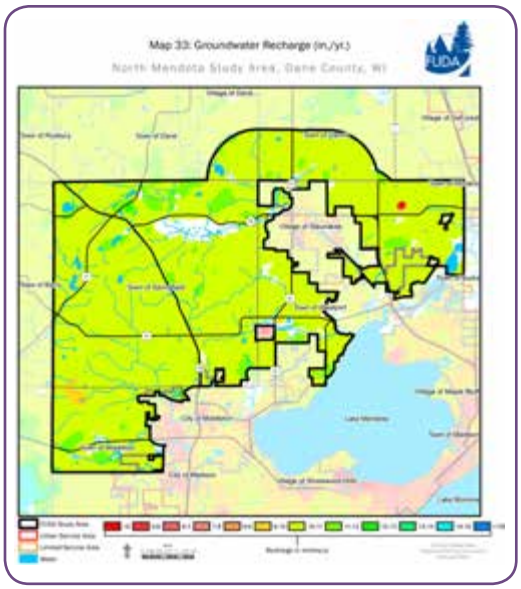
- ***Middleton***
  - ***Located at CTH Q & Onken Road; also need to address reed canary grass invasion***
- ***Waunakee***
  - ***Located at CTH Q and Easy Street; also need to address reed canary grass invasion***
  - ***Located at CTH Q & Meffert Road; also need to address re-vegetation and reed canary grass invasion***
  - ***Waunakee Marsh; also need to address invasion by hybrid cattails***
- ***Consider opportunities for enhancement or restoration of former wetlands that have been ditched or drained, to revive the lost water quality and quantity protections provided by these former wetlands.***

C. Groundwater

All of our domestic water supplies come from underground sources. Groundwater also contributes to surface water resources, providing clean, cold baseflow discharge during dry weather periods. The regional geology does not provide a seal for the deep groundwater which is the source of municipal water. The geologic layer that separates the shallow groundwater and the deep groundwater is absent in places, and is relatively thin in others. The result is that the deep groundwater depends on the shallow groundwater for recharge.[22]

The groundwater/surface water balance can be upset by human activities that reduce natural recharge of groundwater or withdraw more groundwater than is naturally resupplied. Both of these changes have occurred in the region and the study area, resulting in reduced stream and spring base flows[23] and in the lowering of groundwater levels. Natural groundwater recharge levels in the FUDA study area and the capacity of the soils of the study area to accommodate enhanced infiltration and recharge measures are shown on Maps 33 through 36, pages 139 through 142. Table 2 shows current and projected baseflow reductions for the stream of the FUDA study area and downstream areas.

21 For a more detailed treatment of the subject see pages 114 to 117.
22 For more detail on groundwater characteristics in the region see pages 124 and 142.
23 See Map 30 on page 131 for major spring locations and flows in the FUDA study area.



Thumbnail of Map 33
See full page map on page 139

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Thumbnail of Map 34
See full page map on page 140

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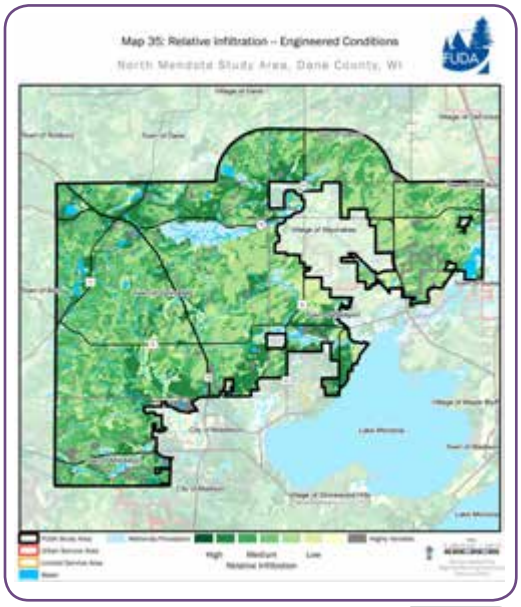

Thumbnail of Map 35
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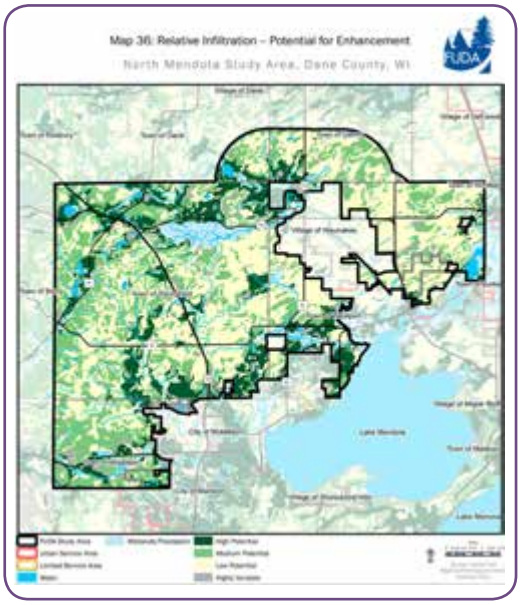


Thumbnail of Map 36 See full page map on page 142

Click to view map

Table 2: Simulated Stream Baseflows for Selected Streams in Dane County

Station	Pre-Development cfs	2000 cfs (% reduction)	2030 cfs (% reduction)
Upper Black Earth Cr.	1.70	0.60 (65%)	0.19 (89%)
Pheasant Branch Cr.	2.20	0.85 (61%)	0.29 (87%)
Sixmile Cr.	4.46	3.40 (24%)	2.77 (38%)
Yahara R. at McFarland	127.28	70.00 (45%)	54.21 (57%)

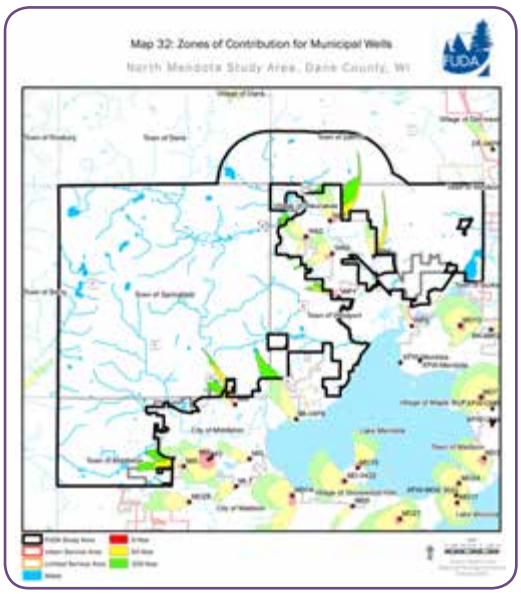
Source: DCRPC 2004

Activities which alter the quality of the groundwater can also make the water unsuitable for domestic and industrial uses, and can result in adverse impact on aquatic habitats that depend on groundwater discharge for their health. Rural private wells generally draw from the shallow groundwater table. This shallow aquifer is more susceptible to contamination from activities on the land surface. Research indicates that over-application of nitrogen fertilizer is elevating background nitrate levels in the shallow groundwater. Elevated salt levels in both the shallow and the deep groundwater is another emerging groundwater quality concern, and is a reflection of winter salt use on roads. Map 32, page 135 shows the zones of contribution for municipal wells in the FUDA study area.

Strategies that are focused on maintaining and restoring infiltration of precipitation and groundwater recharge can reduce both volumes of stormwater as well as pollutant loads to receiving surface waters. In addition, municipal well water withdrawal studies and plans (including water conservation and re-use strategies) will help reduce the impact on our more vulnerable aquatic systems. Figure 15 and 16, page 136 show the historic and projected lowering of the regional groundwater as the result of groundwater withdrawal.[24]

The following planning considerations can minimize the adverse impacts of development in the FUDA study area:

- ***Preserve areas best suited for active and passive groundwater recharge***
- ***Locate future municipal water wells outside of capture zones for springs***
- ***Increase water conservation with low flow fixtures and rainwater harvesting for irrigation purposes***
- ***Enhance the infiltration of stormwater by directing downspouts to vegetated areas and lawns, by installing raingardens, and by constructing active infiltration basins as part of urban stormwater treatment and management***



Thumbnail of Map 32
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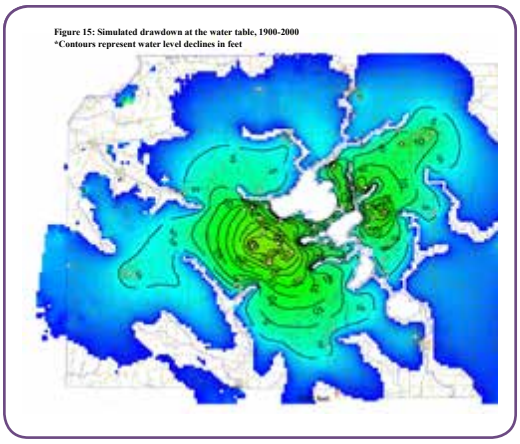

Thumbnail of Figure 15
See full page graphic on page 136

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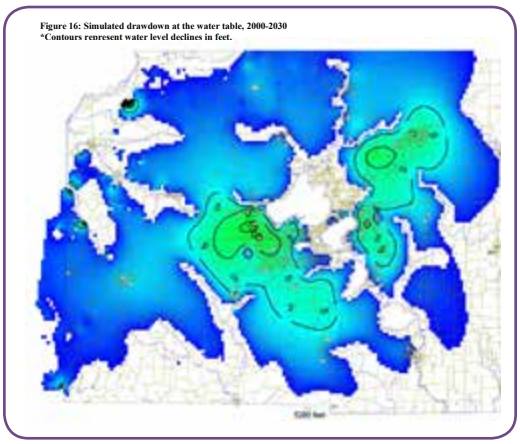


Thumbnail of Figure 16
See full graphic on page 136

Click to view Graphic

24 See pages 132 to 142 for a detailed treatment of groundwater resources and issues, and methods to address these.

D. Open Space Corridors

Open space corridors are mapped based on natural features and environmentally important areas such as streams, lakes, shorelands and riparian areas, floodplains, wetlands, steep wooded slopes, and also include parks and other publicly-owned lands. Open space corridors are a required part of water quality planning under the federal Clean Water Act and Wisconsin state administrative codes (identified as environmentally sensitive areas, or ESAs, in NR 121). ***The Corridors are intended to provide the skeleton for a continuous open space system or framework of connected natural areas among communities, to be expanded upon where opportunities exist and to provide additional recreational easements and open space areas. For example, there is an opportunity as part of FUDA planning, to connect the environmental corridors for Six Mile Creek, Waunakee Marsh, Dorn Creek, the Dorn Creek Wetlands, and nearby prairie remnants and recharge areas to create a North Mendota E-Way.***

1. Riparian Areas

Riparian areas, lands immediately adjacent to water bodies, play a significant role in the health of surface water features and are typically included in open space corridors as buffers. Part of this role is due to natural fluctuation and movement of surface water features. Streams shift and meander over time, and expand with changes in precipitation. Wetlands and lakes expand in response to groundwater levels and long-range natural variations in precipitation, and riparian areas accommodate periodic wet conditions. Adequate riparian breadth provides room for these natural variations and movements. Riparian areas also provide important habitat functions for water bodies. These include temperature and light regulation, infiltration and filtration functions, provision of woody debris for aquatic habitats, and provision of safe access to upland seasonal habitat for amphibians and other wildlife that depend on both water and dry land for their life cycle.[27]

An important opportunity in the study area is in restoring or re-establishing riparian areas. In both the Sixmile and Pheasant Branch Creek watersheds the type and width of open space corridor varies greatly. For example, in the lower parts of Pheasant Branch, Sixmile, and Dorn Creeks extensive wetlands and floodplain border the stream on both sides. Farther upstream the streams are bordered by hardwood forest species such as box elder and willow. The width of this forested band varies with each land owner. ***Most of the ephemeral and very small tributaries in the highest reaches of the watershed have very little or no protection provided by a riparian area. Potential opportunities may exist for re-establishing or expanding riparian buffers in these areas as part of FUDA planning and as part of collaborative inter-jurisdictional conservation and open space planning.*** Additional opportunities can be foreseen through pollutant trading between agricultural and urban sources involved in the Rock River TMDL project, though this aspect of the program has not yet been defined. Potential opportunities also exist through the Conservation Reserve Program and other voluntary cost-share/set-aside/nonpoint source control programs administered through the Dane County Land Conservation Department, based on landowner participation and support.

The following considerations are recommended for the restoration or re-establishment of riparian areas:[25]

- ***Riparian re-establishment and restoration requires land owners to be unified in their support behind the project.***
- ***Riparian areas can be designed to reduce stormwater runoff and sediment input into water bodies from immediately adjacent land areas.***
- ***Riparian areas provide natural landscape breaks in otherwise continuous and densely developed urban environments. This provides a relief from the perception of crowding and high density in urban environments.***
- ***Riparian areas need to be maintained to prevent invasive plants from establishing themselves. In the study area, and emergent understory of willows and cottonwood needs to be controlled.***
- ***Public funding may be available for establishing riparian areas around wetlands as part of wetland restoration funding and stream restoration funding.***
- ***Riparian restoration benefits can be maximized by including consideration of watershed and habitat connectivity.***

25 See pages 143 to 156 for a more detailed treatment of open space corridors and riparian area considerations.

E. Endangered Resources

Plants and animal species are considered one of the fundamental building blocks of ecological landscapes and biological diversity. Rare species and unique natural communities are often good indictors of ecological significance. The presence of one or more rare species and natural communities in an area can be an indication of an area's health and ecological importance, and should prompt attention directed toward the species' conservation, management, and restoration needs. The WDNR Bureau of Endangered Species maintains a Natural Heritage Inventory database. This information is confidential and site specific. CARPC staff should be consulted early in the planning process for specific development proposals and sites to screen the project and help determine if potential mitigation measures may be needed. ***Where significant natural features are present (e.g., wetlands, lakes, and streams), an endangered species review may be necessary to determine whether or not endangered species are present or the area is of particularly significant habitat value.*** Such findings present opportunities for inclusion of such sites in nature preserves and parks. See pages 143 through 149 for a detailed coverage of endangered resources in the study area, and for guidelines for their protection.

F. Wildlife Resources and Biodiversity

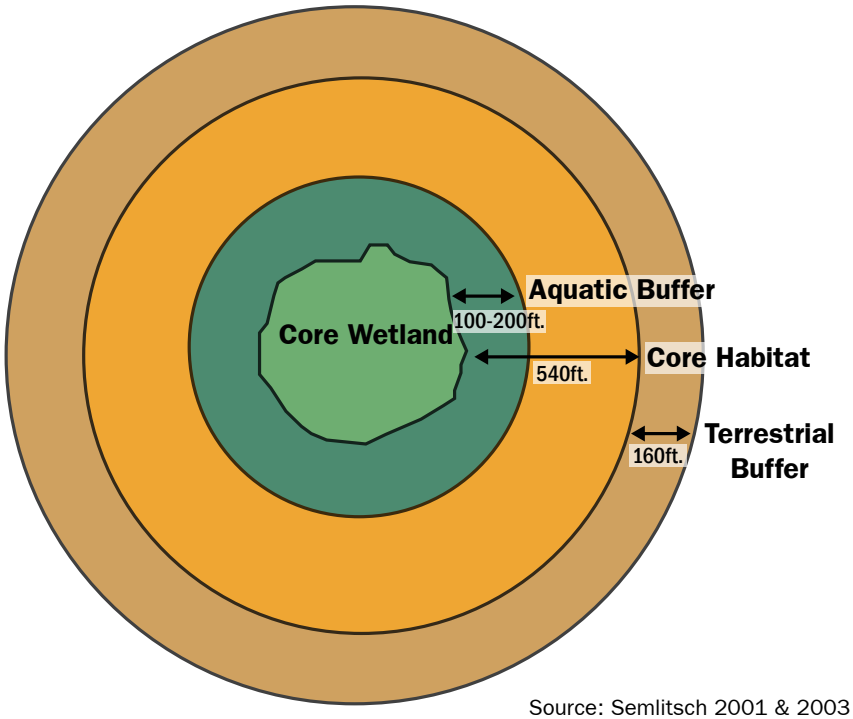
While the protection of water resources from human activities such as agriculture and urban development is obvious, it is often less apparent that the terrestrial areas surrounding our surface waters[26] also serve as "core habitat" for many semi-aquatic species (amphibians and reptiles). These species depend on both aquatic and terrestrial environments to fulfill their full life-cycle requirements (e.g., mating, reproduction, over-wintering, etc.). These in turn serve as food for higher level organisms and the circle of life continues. Scientists sometimes identify certain "umbrella" species in the hopes of saving a whole range of animals and plants in a given area and thereby maintaining overall biologic health and diversity. The idea is that by protecting an important umbrella species and preserving its habitat, vari-

26 This is an area beyond the riparian zone.

ous other species that depend on the same habitat will also be protected. Amphibians and reptiles play particularly important roles in biologic food webs because they occupy a middle position as both predator and prey. Development activities that cut too deeply into the food pyramid can upset the stability of these systems and they can become diminished and even collapse. For example, leading ecologists have identified a minimum Core Habitat distance of approximately 540 feet from wetlands and 300 from perennial streams for amphibians as being critical in fulfilling their life-cycle requirements and as an important umbrella species. An additional 160 foot (50 m) buffer is suggested for wetlands to protect Core Habitat from adjacent land uses.[27]

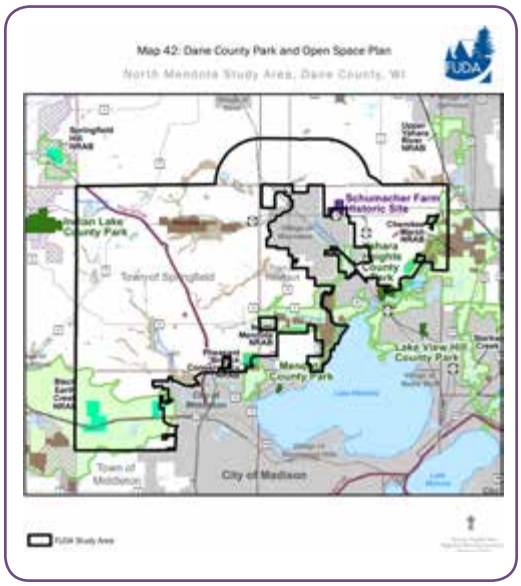
Core Habitat areas are not intended to be restrictive to development or represent "no-build" zones. Instead, these areas are intended to highlight ecological connectivity and stewardship opportunities (e.g., open space and wildlife movement corridors, biofuels, community supported agriculture, etc.). Because of their critical nature and position in the landscape, these areas offer unique constraints and opportunities that need to be considered early on in the community's overall development and resource protection plans. One strategy might be to avoid development in these areas, if possible, directing it to other areas that may be much better suited instead. Another strategy might be more conservation-friendly development designs. These areas could also become the basis of a community's overall park and open space plans.

Zones of Protection for Semi-Aquatic Species



Source: Semlitsch 2001 & 2003

27 Refer to pages 143 through 156 for a detailed description of habitat resources and considerations for planning in the FUDA study area.



Thumbnail of Map 42
See full page map on page 159

Click to view map

Thumbnail of Map 43
See full page map on page 160

Click to view map

G. Parks and Open Space

Dane County plays a special role in the partnership among federal, state, and local units of government as well as private conservation groups. The *Dane County Parks and Open Space Plan* defines that role and recommends how the Dane County can work with communities in achieving regionally supportive and mutually beneficial natural resource protection, restoration, and enhancement goals and implementation plans. Dane County Parks staff and their local counterparts should be consulted early on in development planning to promote opportunities and coordination, as well as avoid potentially incompatible or conflicting proposals.[28] Map 42, page 159 shows the elements of the Park and Open Space plan in the study area. The North Mendota Natural Resource Area proposed in the Park and Open Space Plan is shown on Map 43, page 160.

H. Mitigating the Impacts of Urban Development on Natural Resources

Dane County is the second-largest metropolitan area and one of the fastest growing counties in the state. ***This urban growth and development must be properly planned and managed or the quality of our ground and surface water resources, the wildlife communities they support, and the quality of our everyday life will deteriorate.*** The impacts of urban development on natural resources comes from changes in several natural processes:

- Increased volumes and peak discharge of stormwater runoff from impervious surfaces in the absence of stormwater management facilities. This results in changes in the physical character of receiving streams (width, depth, vegetation, and bed material) which adversely impact the health of the stream habitat.[29]
- Changes in water quality from pollution from urban activities that are carried in stormwater runoff in the absence of stormwater treatment facilities. In our region, due to the predominance of agricultural land uses, this change in water quality is generally from an agricultural pollution load to an urban pollution load.
- Loss of habitat and habitat connectivity due to development creates isolated islands of habitat that cannot support wildlife and removes the needed cover for wildlife movement. The consequence is depletion or compromised habitat health and value.[30]

28 For a detailed description of the elements of the Park and Open Space Plan with relevance to the study area refer to pages 157 though 161.

29 A detailed treatment of this subject is provided in pages 162 through 164, and in Appendix D of the *Dane County Water Quality Plan* http://danedocs.countyofdane.com/webdocs/PDF/capd/2011_postings/WQP/WQP_Appn_D_Urban_Nonpoint_Source_Analysis_2011_web.pdf.

30 A detailed treatment of this subject is provided in pages 167 through 169.

Waunakee Infiltration Basin

Efforts focused on maintaining pre-development hydrologic characteristics, water quality, and habitat quality and value can help mitigate or offset the negative effects of development on our natural resource base. Urban development strategies to maintain and improve the integrity of the natural resources have been highlighted for a more pro-active consideration in planning and development activities:[31]

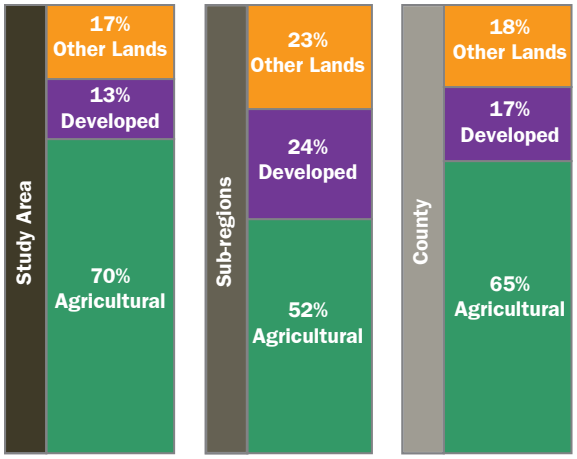
- ***Approaching local issues from a regional watershed perspective.***
- ***Directing development away from sensitive natural resource areas to areas better suited for it.***
- ***Increasing the efficient use of land resources through compact development patterns and optimizing the use of current urban areas through infill and re-development.***
- ***Allowing land use density transfers (e.g., Transferable Development Rights) away from sensitive natural areas to areas with lower natural resource risk.***
- ***Incorporating and integrating natural features into development design, and applying conservation design principles.***
- ***Considering the long term impacts when selecting a site location, especially the soil and water resource constraints (e.g., shallow soils, high water tables) and opportunities (e.g., existing or enhanced infiltration, groundwater recharge).***
- ***Minimizing impervious areas in design, which can upset the ground/surface water balance.***
- ***Reducing pollution sources on all land surfaces, and looking at collaborative inter-jurisdictional solutions with broader effectiveness.***
- ***Tailoring stormwater management measures and strategies to the susceptibilities and protection needs of the environment instead of adopted minimum stormwater standards.***

31 For a more detailed treatment of these strategies and additional design recommendations refer to pages 172 through 174.

Chapter II. Agricultural Resources

The region is a significant agricultural producer, and agriculture is an important contributor to the regional economy. The region also has one of the fastest population growth rates in the state. Because of the predominance of agricultural land uses in the region, most urban expansion comes with an equal loss in agricultural acreage. Furthermore, financial pressures on town government dictates some residential development in rural towns to increase tax revenues for local services. Analysis indicates that in Dane County the acreage of agricultural land lost to urban expansion (through annexation) is approximately equal to that lost to rural residential development in towns.

Figure 4. 2005 Regional Land Use Comparison



The Middleton, Waunakee, Westport, Springfield jurisdictions contain highly productive and economically valuable agricultural lands. The North Mendota FUDA study area covers approximately 49,000 acres with approximately 31,000 acres under agricultural production in 2005, the latest available inventory of land use in the study area.

Between 1980 and 2005, the townships in and surrounding the FUDA study area lost approximately 18,000 acres of agricultural land, with 1,750 acres of this loss having occurred since year 2000.[32]

Table 3 shows the share of each of the towns in the sub-region.[33]

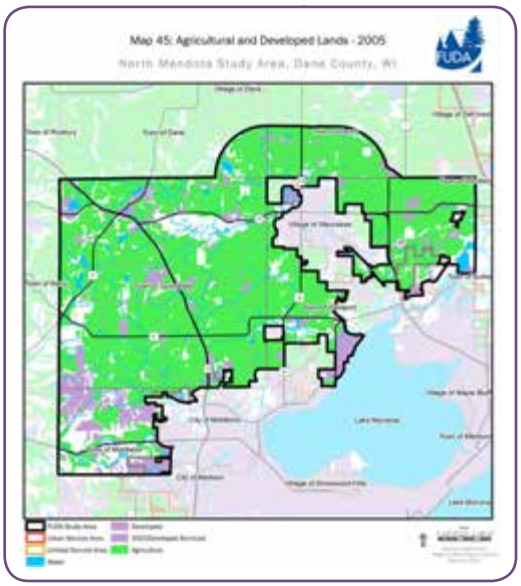
Table 3. Conversion of Land Out of Agriculture (1980-2005)

	Reduction in Agricultural Use Acreage (ac)
Middleton	8,009
Westport	5,346
Dane	1,745
Springfield	1,700
Vienna	1,335

32 Not all of this acreage has been converted for development. Some of the land has been removed from agriculture for conservation purposes, or has been left fallow.

33 Includes townships of Middleton, Westport, Dane, Springfield, and Vienna.

Map 45, page 179 shows the agricultural and developed acreage in the FUDA study area based on the 2005 land use inventory conducted by the CARPC.[34]



Thumbnail of Map 45
See full page map on page 179

Click to view map

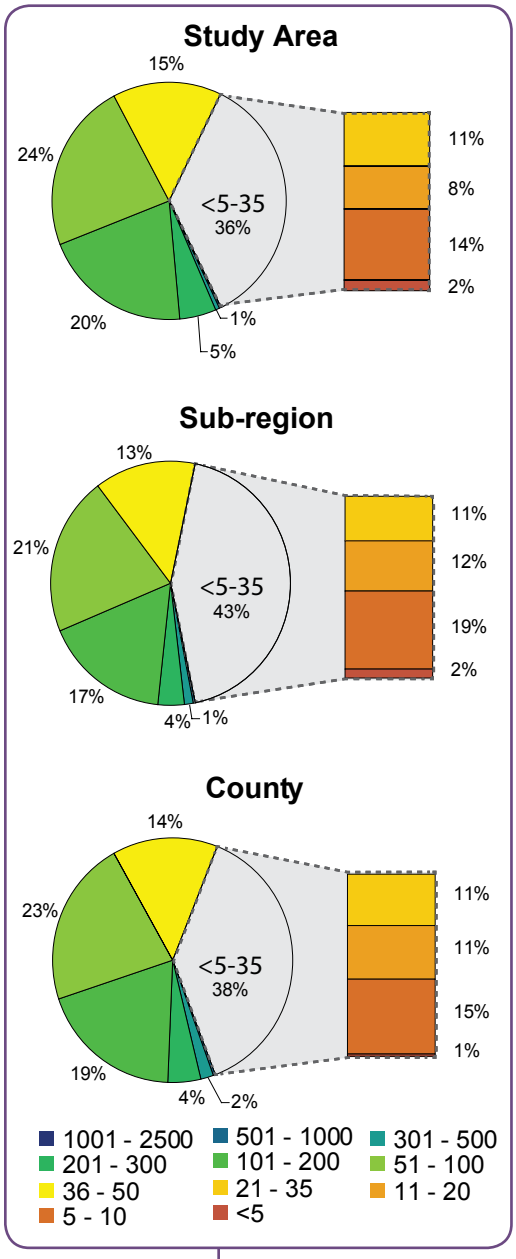
Data and other information in this chapter can be used in local decision-making to identify the agricultural lands a community might preserve, maintain, or develop in the FUDA planning and Comprehensive planning processes. The agricultural inventory presented in this section includes the following:

- Agricultural land area and land conversion trends
- Farmland and farm operation characteristics
- Agricultural parcels and base farm tracts trends
- Agricultural contiguity and concentration trends
- Operation type (livestock, crop, and crop type) characteristics
- Soil quality (prime farm lands and Land Evaluation)
- Tax parcel value assessment
- Support services
- Ecological services and functions on agricultural parcels
- Recommendations for agriculture in comprehensive plans and farmland preservation plans

Town of Springfield

34 A detailed description of agricultural land acreage, land conversion trends, ownership, tenure, and operation characteristics can be found in pages 179 through 198.

Figure 4: Size Distribution of Base Farm Tracts (2005)



As populations increase, communities may need to provide land for development both within the existing urban area through infill and redevelopment and in new areas adjacent to existing developed areas. Urban development can also incorporate various types of agriculture, such as community gardens, a community supported farm, or an agrarian community. ***Protecting large contiguous blocks of agriculture can maintain their economic role and contribution in the local community and the larger region.*** With agricultural preservation as a shared region-wide goal, these large areas may be well suited for continued agriculture for the foreseeable future. Smaller areas, typically near existing urban areas, may be less suitable for continued agricultural production and more suitable for a more intensive urban land uses. ***Existing policies have maintained large areas of agriculture on the periphery of Waunakee, and these policies should be continued.***

Preserving agricultural operations in areas where agriculture is not a dominant land use may require specific preservation tools as other land uses continue to expand in the area. This may be the case in south eastern Westport, where agriculture comprises only 39% of the land area. Lands in largely agricultural areas are more likely to remain in agriculture because they may not be near urban infrastructure within the coming decades. Other methods for preserving agricultural lands include new boundary agreements and extending/continuing existing boundary agreements.

Agricultural land uses are dependent on different types of infrastructure, such as transportation, and the support service network needed for operational inputs, such as veterinary assistance, processors, implement sales, and machinery service. Maintaining a critical mass of agricultural operations combined with proper access to support services creates the necessary market base for local and sub-regional agricultural-sector businesses.

At a site specific level, information about soil quality and tax value assessment can help determine how to best develop a site.

Finally, agricultural land located adjacent to open space corridors and the ecological services and functions they provide may be eligible and targeted for natural resource conservation easement funds. Conservation easements typically allow a smaller proportion of land to be used for agriculture. Typically, agricultural lands in these areas are well-suited for restoration or stewardship practices that improve the integrity and health of the natural communities and resources of neighboring conservation or natural areas.

The City of Middleton, Village of Waunakee, and the Towns of Springfield and Westport can consider these variables and their effect on the greater natural resource and community amenities, and integrate these considerations in scenario planning exercises to create a shared FUDA plan. The North Mendota project communities may benefit from establishing a shared framework for making decisions about farmland preservation and conversion to other land uses, based on the information provided in this chapter and the following recommendations:

- ***Maintain diversity in size and operation type to insulate the regional agricultural industry from drastic market changes in any one sector, and to better support and encourage regional food systems. Consider soil fertility characteristics that specialize these soils for raising crops. Special consideration is warranted when pursuing development in these areas to preserve these lands for food production that is dependent on soils.***

- ***Because of the variable terrain and the prominence of livestock operations in the study area, soil quality is best considered at a site specific level. Broad-brush categorization of prime farmland as a priority criteria for preservation may significantly limit the viability of an agricultural preservation program, and undermine the predominant and economically productive livestock operations that are being operated in non-prime soils in the region.***

Figure 5: Proportion of Total Area by Base Farm Tract Size (2005)

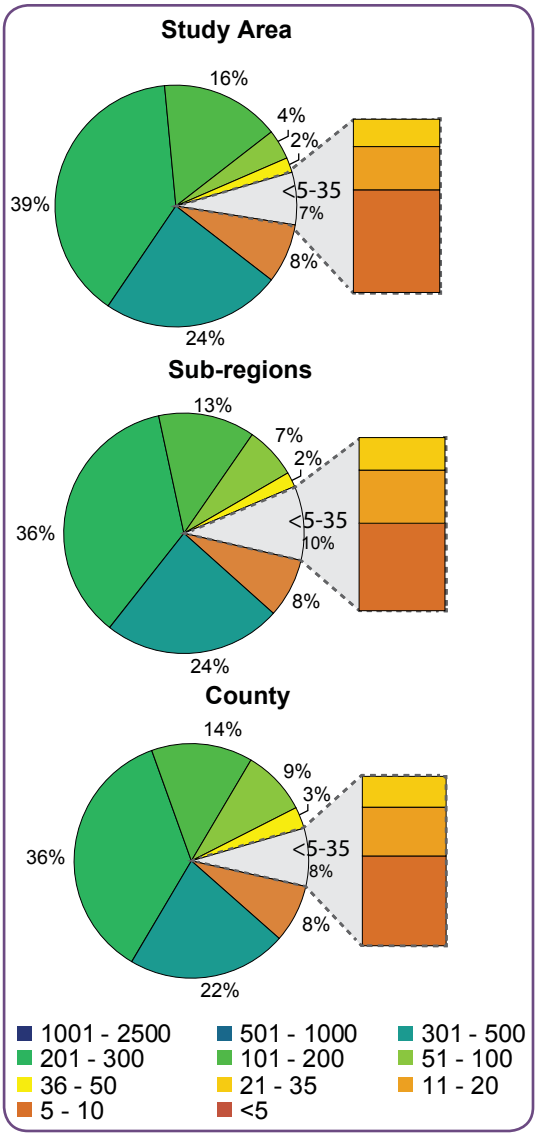
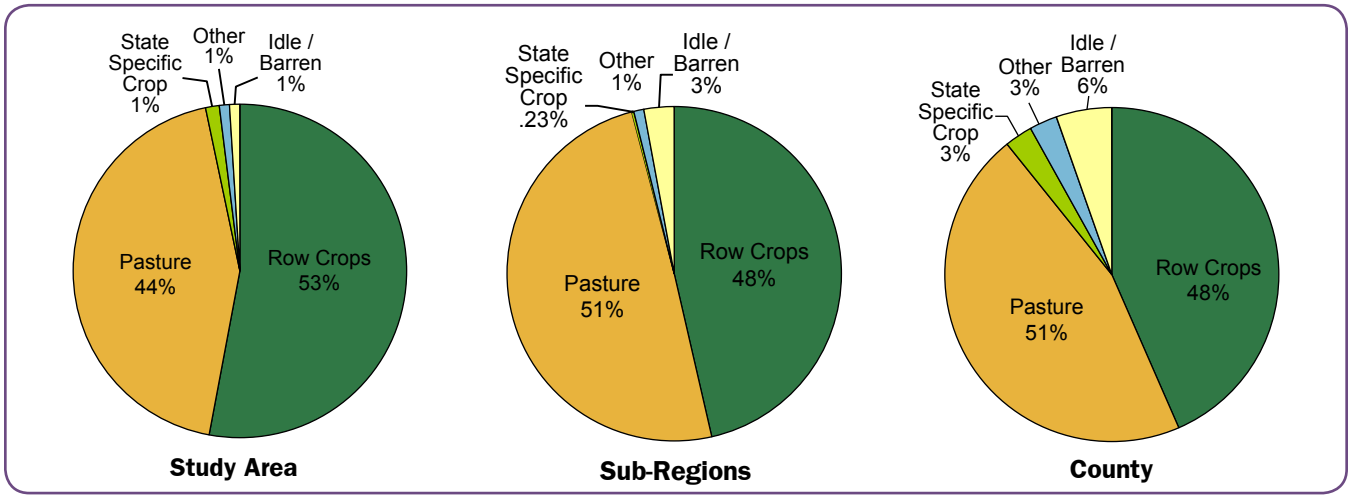


Figure 6. Crop Type (2005)



- ***To identify, enhance, and maintain ecological services and functions of agricultural land effectively, land management practices and the areal extent of these practices need to be considered together. The open space corridors[35] define a network of sensitive natural resource areas that can be augmented with additional conservation areas and practices. This approach can integrate various programs and policies to create a network of permanent agricultural and open space conservation areas which are protected from development. Supporting recommendations for low impact agricultural practices, conservation, and restoration for various locations in the study area can be provided based on ecosystem requirements and opportunities. Other areas may be suited for integrated resource management and for accommodating multiple land uses and ecological services simultaneously.***

- ***Former wetlands, since drained with underground drainage tiles and ditching, are also presented on the Map 5 on page 55 to illustrate where wetland restoration could benefit ecological systems and water quality and quantity in downstream areas.***

- ***In some upland areas, reforestation of agricultural lands could benefit ecological systems and water quality and quantity in downstream areas.***

- ***Some conservation practices would greatly benefit from changes in state law and taxing policy. For example, wetlands are typically assessed at higher land values compared to farmland. Consequently, farmers not only lose cropland and income by restoring former wetlands, but also pay higher property taxes under current tax policy.***

- ***Ecosystem service areas should be designed with the idea that the land owner would continue to benefit financially from the land. This can be either through sale of products from these conservation areas or through payments for the ecosystem service being provided.***

Town of Middleton

35 Map 25 page 121 shows these areas in the FUDA study area.

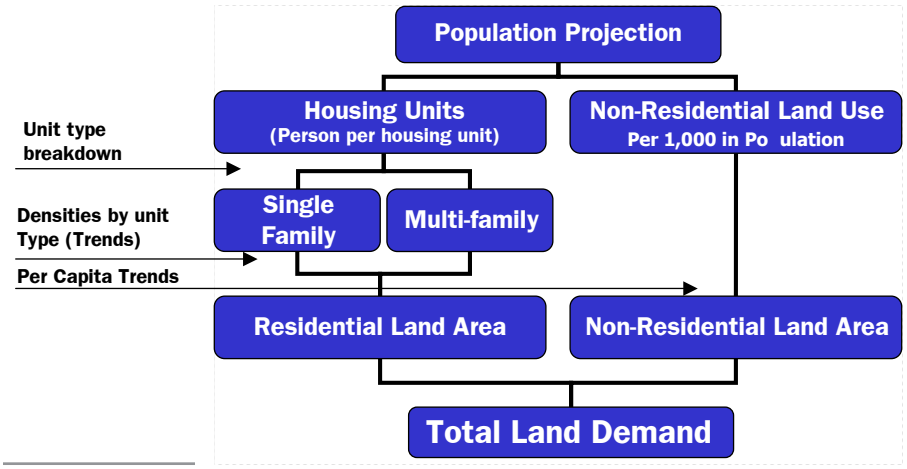
Chapter III. Land Demand and Supply Assessment

The land demand and supply assessment establishes projections of future urban and rural development for the FUDA communities within the 25-year time frame of the study. ***The land demand and supply assessment contains three major components:***

- ***Development Projections:*** Future development projections are based on historic trends for each municipality, documented over the past 30 years, addressing the number of residential units and acreage of major land use categories, including residential, commercial, industrial and outdoor recreation. In communities which contain large amounts of both urban[36] and rural development, the overall demand is allocated between these areas.
- ***Redevelopment Projections:*** Where communities have adopted redevelopment plans, site-specific development projections are made based on the recommendations of that plan. Construction on these sites reduces the amount of greenfield development required to accommodate future community growth.
- ***Land Supply:*** The quantity of developable acres currently inside an urban service area are identified and matched with the planned future use of those areas. This reveals whether the community has an adequate or insufficient supply of land for each of the major land use categories.

The communities within the North Mendota FUDA study area have a total urban land demand of 2,793 acres for the 2010-2035 period.[37] This accommodates the development of 6,004 housing units, and 60 percent are single family homes. Average densities of 3.1 and 12.0 units per acre are projected for single family and multi-family housing respectively, resulting in 1,353 acres for new residential development. Other uses demand 1,440 acres which includes 361 commercial acres, 262 industrial acres, 491 transportation (streets) and utility acres, 132 institutional acres and 195 outdoor recreation acres.

Figure 7. Land Demand Methodology Flow Chart



36 Areas within an urban service area or a limited service area.

37 Land demand is based on a 2005-2035 population growth projection. Increment values are prorated. For a detailed analysis of land demand refer to pages 224 through 229.

The City of Middleton, Village of Waunakee and the Town of Westport have identified redevelopment areas that can fulfill part of the future land demand for 2,000,000 commercial square feet and 575 residential units, and could fulfill 247 acres of future land demand. The nine redevelopment sites in Waunakee cover approximately 25 acres and have the potential to accommodate an additional 12,000 commercial square feet and nearly 300 residential units. Seven sites in the Town of Westport were identified for potential infill or redevelopment and have the potential to accommodate over 500,000 commercial square feet and over 650 residential units, exceeding the projected demands for the Town during the FUDA study time period. All together, ***redevelopment scenarios could offset over 360 acres of future land demand, or 15 percent of projected land demand between 2010 and 2035.***[38]

The final analysis determines the quantity of developable land planned for each land use category within existing urban service areas (Central USA and Waunakee USA) and whether there is sufficient capacity to accommodate projected demand in each community. ***Each community shows an overall insufficient supply of developable land inside current USA boundaries.*** Oversupplies of land planned for residential and industrial could be used to accommodate other uses with insufficient land supply, including commercial and outdoor recreation.

Pheasant Branch Confluence Pond

Growth in rural areas of the Town of Westport and the Town of Springfield is anticipated to require 800 acres of land in order to meet projected demand between 2010 and 2035, though additional demand may also come from the towns of Middleton, Dane and Vienna and from unanticipated demand. Developable land that is planned for future development totals 4,290 acres, over 4 times projected demand. In rural areas, almost 28,000 acres of land is planned to remain in agricultural or be preserved (including woodlands or other natural areas).

38 For a detailed analysis of infill and redevelopment in the study area refer to pages 230 through 244.

The projected land demand and supply numbers form the "historical trends" scenario outcome. The resulting scenario using these parameters serves as the baseline for comparison as other scenarios are developed in the FUDA planning process along with natural resource conservation, agricultural preservation, and other community considerations. These alternative development scenarios will be created that seek to best meet goals and objectives addressing issues such as land use, transportation, water quality, and air quality. Scenario planning can help communities envision alternatives to the existing growth patterns and investigate how various development patterns affect the following quality of life parameters:

- ***Automobile travel***
- ***Air quality and emissions from cars and buildings***
- ***Fuel use and cost***
- ***Building energy use and cost***
- ***Residential water use and cost***
- ***Land consumption***
- ***Fiscal impacts and City revenues***
- ***Public health impacts***

Chapter IV. Conclusions and Summary Recommendations

It is important that future development plans preserve as well as improve the integrity of our natural resources – both for our own quality of life and that of our children, grandchildren, and great-grandchildren. Well-planned and designed development can enable natural systems to retain their diversity and quality, and to provide food, fiber, fuel, recreational and educational opportunities, and economic vitality. Given the advancements that have been made in the art and science of resource protection and urban design, it is often necessary to revisit our plans and update them using more sophisticated and advanced knowledge, methods, and techniques. This Environmental Conditions Report provides an inventory and assessment of the community and natural resources in this FUDA study area based on the best information that is currently available. This information can help local communities in land use decisions and in planning development that respects the integrity of natural areas and resources, and incorporates environmental features into development projects. Conserving and restoring regionally important natural resources contributes to a healthy natural environment and enhances our quality of life. Connecting these regional and local features within environmental corridors helps protect water quality, sustain wildlife and plant habitat, and provides valuable opportunities for recreation and education. Assessing this natural resources information along with agricultural, economic, and community information, provides the foundation for local communities to evaluate where development should be encouraged, where resources should be protected or used sustainably, and where community and economic development can occur together with natural resource protection and enhancement.

North Mendota

Future Urban Development Area Planning

Environmental Conditions Report

Chapter I. Natural Resources

Introduction

This chapter of the Environmental Conditions Report has three main purposes:

1. ***Provide a natural resource inventory and assessment based on local and regional considerations***
2. ***Outline considerations for land use planning and decision-making that protect and enhance the integrity of natural areas, both locally and regionally***
3. ***Outline opportunities for incorporating environmental features in local urban design to enhance the quality of life of local residents and to reduce costs for maintenance and infrastructure locally and regionally***

Conserving and restoring regionally important natural resources contributes to a healthy natural environment and makes the region a desirable place to live and work. Conserving and restoring local natural resources improves the quality of life of residents and enhances beauty of our cities and villages. Connecting these regional and local features within environmental corridors helps protect water quality, sustain wildlife and plant habitat, and provides valuable opportunities for recreation and education. Assessing this natural resources information along with agricultural, economic, and community information, provides the foundation for local communities to evaluate where development should be encouraged, where resources should be protected, and where both can occur together and in harmony.

The present condition of the region's natural resources is dramatically different from pre-European settlement times and continues to be altered for agriculture and development. Agricultural land use dominates where prairies and scattered oak savanna once flourished. Many wetland acres that once filled the river bottoms and other low lying areas were ditched and drained. Stream channels were dredged and straightened. Development increased as populations in cities and villages and scattered rural communities grew, often with little regard for the natural surroundings. Natural communities and ecological systems were fragmented. Urban development in the 19th and much of the 20th centuries was accompanied by uncontrolled runoff from streets and parking lots, and erosion from construction sites and stream banks added sediment and pollutants and degraded water quality and wildlife habitat. With thoughtful planning, development and management practices these resources can be protected from such impacts, and degraded resources can be restored and enhanced.

Impacts from development are, for most individual sites, relatively small. When considered on a regional basis, however, their cumulative impact can result in substantial consequences. To manage these impacts effectively, it is critical to understand them on a regional basis, and collectively address them at the individual site level. In the end, the site level is where the physical changes to the environment are being made and mitigation measures are easier to implement.

Many communities across the U.S. are discovering that a natural resource-based development strategy is a much better alternative to conventional urban design and development, where traditionally less attention has been focused on the environment. The primary objective is relatively straight forward. The quality of our natural environment and the associated resource functions and values should be maintained and, where possible, enhanced. This dovetails with a host of related growth and development strategies related to infrastructure planning, community development, agriculture, and open space.

A resource-based development approach has several characteristics:

1. Tangible, measurable, and readily understood by the participants in the local development review process.
2. Directly linked to the local development review process by making natural resources protection a priority during all stages of the development process – from the conception of how the landscape is to be altered, through the planning, design, and construction of individual projects, to the maintenance of the necessary infrastructure such as stormwater management facilities after it is completed. Each step of the development process should only proceed when it can be reliably determined that the impacts of the development will be mitigated or minimized.
3. Clear and practical management approaches towards local development by explicitly directing development away from environmentally sensitive areas along with other necessary protections and safeguards.

A resource-based strategy should streamline the local review process, reduce administrative burdens on local government, and be fully responsive to the needs of the development community for clear direction, timely review, and reduction of uncertainty and mitigation costs.

The regional physiography of Dane County explains the surface and near-surface features and formations that characterize the landscape of the region. These include land forms, geology, soil and subsoil characteristics, vegetative cover, drainage and surface- and ground-water resources, and associated habitats. Information in this section is organized based on a layered approach and starts with large-scale characteristics followed by characterization at successively smaller scales of analysis. Planning and design implications of these features and characteristics are discussed and highlighted at each step. Information concerning past and current actions and efforts to address problems and issues have also been included to provide the pertinent context for future decision-making.

A. Physical Geography and Surface Geology

The North Mendota study area straddles three of the physiographic areas of Dane County. The physical geography of Dane County has been generally influenced by three major forces: glaciation, the Yahara River, and the Wisconsin River. The county can be divided into four physiographic areas with distinctive features shown in Map 2.

The western part of the county, known as the Valley and Ridge or "Driftless" Area, is the only part of the county and southwest part of the state not affected by glaciation. Only a small portion in the southwest portion of the North Mendota study area is located in this physiographic area. This area is characterized by steep ridges and valleys drained by fast-flowing streams, generally without 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 is located here in the northwest corner of the county consisting of deep alluvial deposits of sand and gravel and extensive marsh deposits in the floodplain.

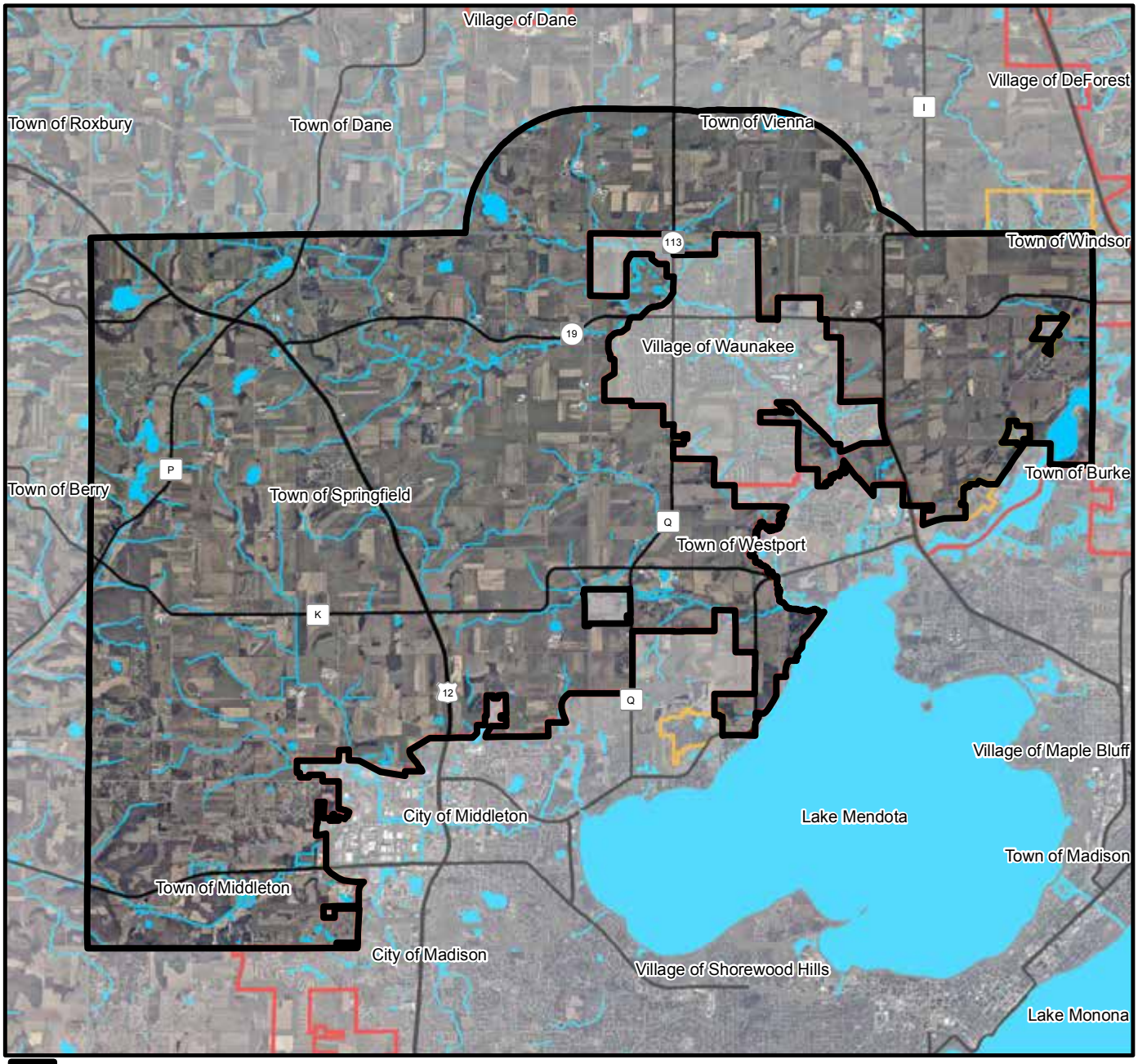
To the east of the driftless area, is an area of glacial end moraines. The moraines include hills and mixed deposits of glacial till (sand, silt, clay, gravel, and boulders), which were left behind as the glacier retreated. This region is typically flat with gentle undulating hills throughout. The gentle relief results in slower moving streams and rivers than those which lie in the Driftless Area to the west. The glaciated area possesses rich soils and constitutes one of the country's major agricultural districts. A large portion of the City of Middleton, the Town of Middleton, and half of the Town of Springfield are located in this area.

East of the moraines, in the center of the county, is the Yahara River Valley. The Yahara River Valley consists primarily of glacial ground moraine with extensive areas of peat and marsh deposits. The Yahara River valley has an irregular topography, ranging from flat and rolling to hummocky and hilly. Slopes are relatively gentle and relief is less than in the western driftless part of the county. Here deep glacial deposits up to 350 feet dammed up a large preglacial valley, forming a chain of large lakes and wetlands. Lakes Mendota, Monona, Waubesa, and Kegonsa dominate the valley. Lowlands along the Yahara River are generally marshy, whereas uplands are well drained. Streams in this physiographic area are generally flatter and more sluggish than those in the driftless area, and fewer are spring fed. The Village of Waunakee and the Town of Westport are located in this physiographic area.

The eastern part of the county is known as the Drumlin and Marsh Area and does not pertain to the North Mendota study area. The area includes many small drumlin hills interspersed with shallow glacial deposits which create an extensive system of interconnected wetlands with poorly defined drainage and few springs. The only lakes in this area are small stream impoundments or shallow marshy lakes.

Map 2: Physiographic

North Mendota Study Area, Dane County WI



FUDA Study Area
Urban Service Area
Limited Service Area
Water

Miles
0 0.25 0.5 0.75 1 1.25 1.5

N

Source: Capital Area Regional Planning Commision February 2012

Aerial imagery is from spring 2010.

1. Mineral Resources

Map 3 shows potential mineral extraction sites throughout the study area. High Potential mineral extraction sites have deposits of either ice contact stratified glacial material or coarse outwash, providing the best potential for an economically viable source of high quality aggregate. ***Low Potential*** sites have deposits of either pitted outwash or finer outwash and are much less likely to be an economically viable source of high quality aggregate.

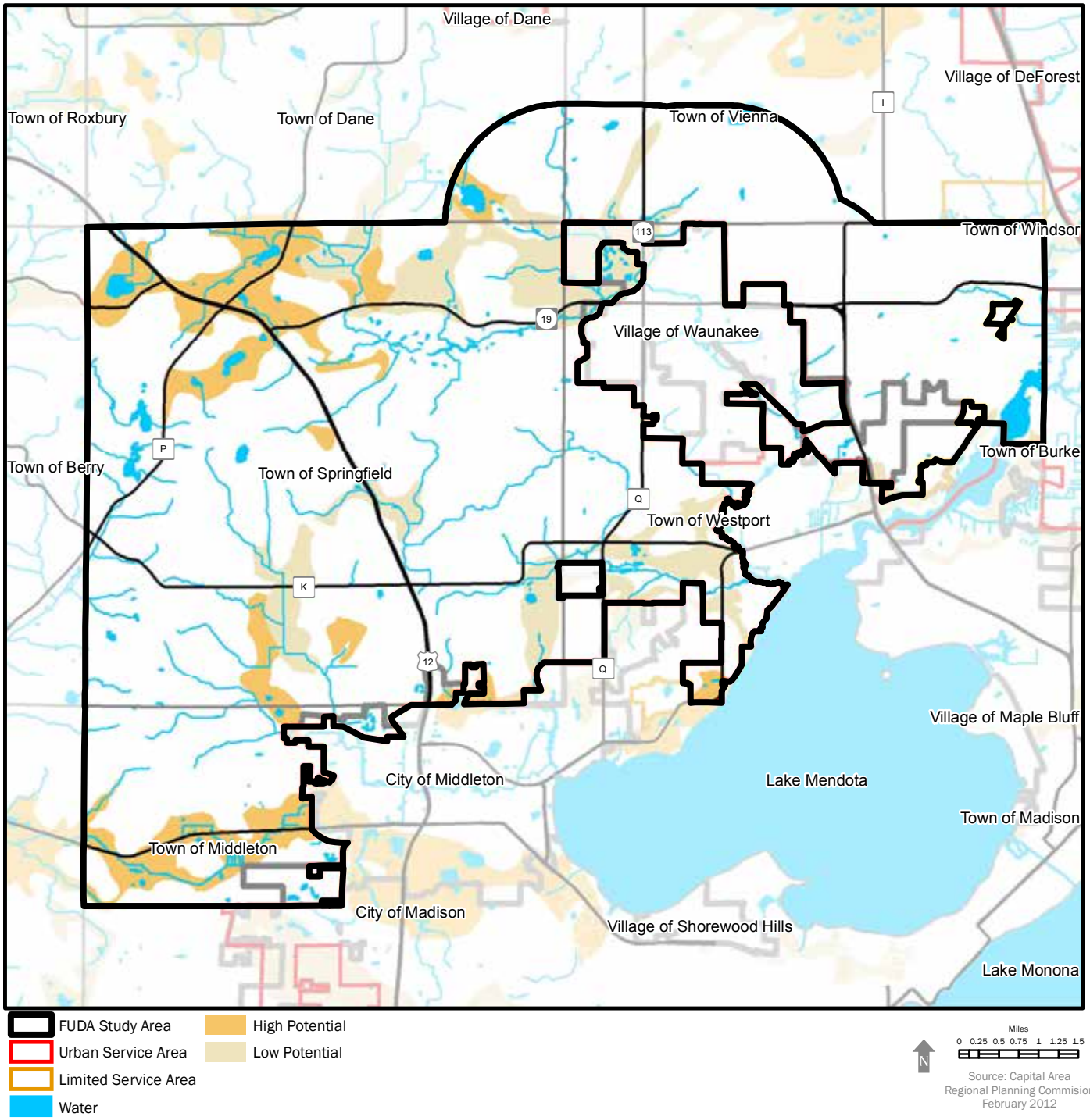
Planning Considerations:

- Preserve mineral resource areas until after the resources have are used.
- Preserve mineral resource areas until their value as regional infiltration and groundwater recharge is investigated.

Mineral extraction operations are eligible uses under the Dane County Zoning Ordinance as a conditional use in agricultural zoning. Section 10.191 establishes procedures and standards of operation for mineral extraction operations. ***Mineral resources are important economic and environmental assets. It is recommended that these areas be protected from development until after the mineral resources have been utilized and the site reclaimed.*** These areas also provide significant opportunities for large-scale enhancement to infiltration and groundwater recharge to maintain the hydrologic regime of area waters. This strategy needs to include stringent measures to protect groundwater quality, and is covered more fully starting on page 124.

Map 3: Mineral Resources

North Mendota Study Area, Dane County, WI



Mineral resources are important economic assets. These areas also provide significant opportunities for regional infiltration practices to replenish the groundwater.

Planning Considerations:

- Protect, preserve, or restore perennial vegetation on slopes greater than 20% to protect against development and slope destabilization.
- Limit development on slopes greater than 12%. Preserve or restore them in perennial vegetation wherever possible.
- All slope disturbance and stabilization measures should be reviewed and approved by municipal engineers.

2. Steep Slopes and Woodlands

Typical definitions for steep slope in Wisconsin vary from 12% to greater gradients. Steep slopes pose a number of development-related concerns and constraints. A significant concern is that developments on steep slopes increase erosion and stormwater runoff. This is problematic since it can adversely affect water quality as debris and excess sediment is washed into surface waters. A scattering of areas with slopes greater than 12% exist in the North Mendota FUDA study area (Map 4). Some of these slopes are wooded, providing the added benefits of wildlife habitat, groundwater recharge, and water quality protection.

Steep slopes and ridges are dominant topographic feature in the Black Earth Creek headwaters west of the City of Middleton. This area serves as the gateway into Wisconsin's Driftless Area, where the landscape is characterized by steep wooded bluffs and narrow valleys. The City of Middleton has identified many of the undeveloped lands in the upper portion of the watershed as the Black Earth Creek Headwater Protection Zone along with accompanying greenway and recreational areas.

Slopes steeper than 20% should be protected from disturbance and development, and protected with permanent vegetation, because such areas are extremely susceptible to slope destabilization.

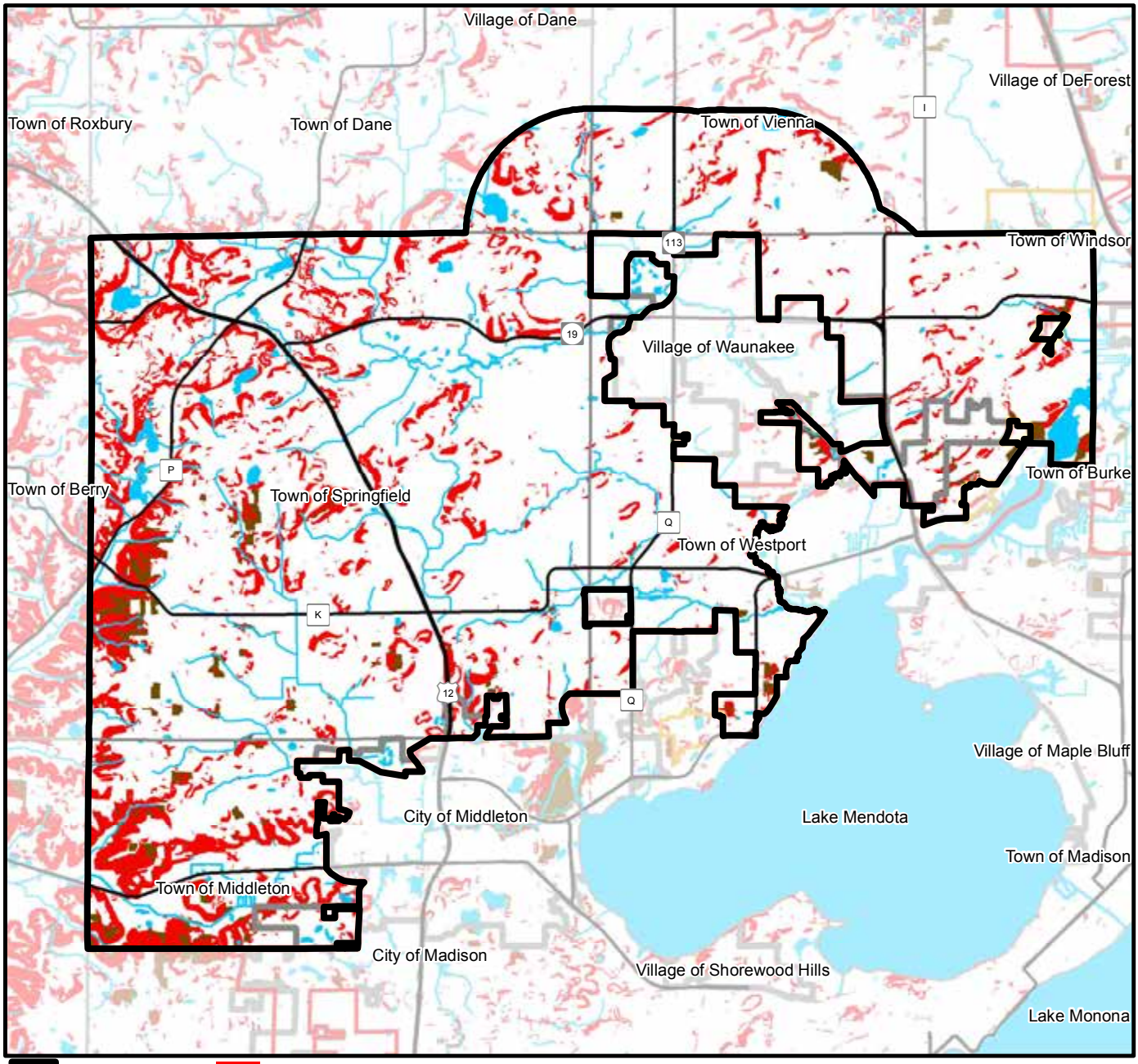
All proposed slope disturbance and stabilization measures for steep slopes with gradient between 12% and 20% should be reviewed and overseen by municipal engineers for the risk of destabilization. It is broadly recommended that areas identified as having slopes in excess of 12% be avoided for development through inclusion in open space amenities or in Environmental Corridors.[39]

Town of Westport

39 Environmental Corridors are continuous systems of open space in urban and urbanizing areas that include environmentally sensitive lands and natural resources requiring protection from disturbance and development (DCRPC 2004).

Map 4: Steep Slopes and Woodlands

North Mendota Study Area, Dane County, WI



FUDA Study Area
Urban Service Area
Limited Service Area
Water
Slopes > 12 %
Woodlands

Miles
0 0.25 0.5 0.75 1 1.25 1.5

N

Source: Capital Area Regional Planning Commision February 2012

Development projects on steep slopes can increase erosion and stormwater runoff, negatively impacting surface water features. They can also negatively affect the natural terrain and aesthetic qualities of an area. Detailed analysis and design is need to prevent slope destabilization in these areas. Revegetation of bare steep slopes can reduce erosion and stabilze these areas. Steep wooded slopes left in a natural condition provide significant groundwater recharge, wildlife habitat, and water quality benefits.

Woodland Restoration

The woodlands of the North Mendota study area may be categorized into three groups; isolated woodland "islands" surrounded by agriculture, riparian woodlands found along streams, and contiguous woodlands and forests found to the west and southwest of the study area. With many of the isolated woodlands, they are found either on elevated terrain that was never converted to farmland, are a farmer's private hunting land, or are part of exurban development where there are isolated residences far from the larger urban areas. These woodland islands are found throughout this FUDA study area wherever there is agriculture. Their size and shape are variable, with no other consistent pattern other than existing in agricultural interiors. Small, isolated woodlands, have limited ecological value for larger organisms because the core habitat, an areal threshold for utility, is too small. Conversely, these woodlands are more valuable for organisms that thrive on utilizing edge habitat, particularly with invasive plants and raptors that use woodland edges for hunting in agricultural fields. Further, according to biodiversity and biogeography theory, small areas tend to have low species diversity. Low species diversity, the raw number of species, is associated with low functional diversity, the number of ecological jobs performed by species, which leads to low resilience, an inability to recover after environmental stress. Low diversity areas are more susceptible to ecological disturbances, which leads to higher colonization by invasive species. This is confirmed by observations of smaller isolated woodland plots show signs of invasive vines covering the bark of most trees near the woodland margin with dead canopies, monotypic stands of black locust (*Robinia pseudoacacia*), and expansive forbs containing garlic mustard (*Alliaria petiolata*).

Issue:

Woodland Restoration

- Identify local stressor causing ecosystem degradation
- Invasive species
- Restore connectivity within the landscape for organism movement
- An entire landscape does not need to be re-vegetated back into woodlands

Road surveys of isolated woodland sample locations do not indicate consistency in tree species diversity or richness, relative species abundance, some locations have shown uniform stands of the invasive black locust (R. pseudoacacia), while others are highly diverse with oaks, maples, hickory and evergreens. Some locations indicate functional diversity across different vegetative layers, with distinct canopies, shrubs and forb layers, while other sites have moderate canopies and highly dense shrubs, yet absent of any forb layers. The relative densities of vegetative layers does have an influence on the distribution of animal species found. It may also have an influence on the ecological functions. According to biodiversity and ecological function theory, functional diversity is more important than species diversity, for regulating ecosystem function. With plant species occupying different niches, regions of the resource continuum, they are collectively more able to utilize site resources. This is particularly relevant to rain interception, soil water absorption and evapo-transpiration. In summary, more diverse woodlands will be able to intercept and control water release better than less diverse woodlands.

With restoration projects, identifying and removing the factor that caused ecosystem degradation is important. If restoration projects proceed without this consideration, they will eventually fail. The main issues detected during surveys include the presence of invasive species, including vines, ground-covering forbs, and edge species. There are few instances where entire mature trees will need to be removed, with the exception of black locust and cottonwood trees. In locations where invasive vines were present, an increase in tree mortality was detected. There were no indications of ozone induced chlorosis in any of the tree stands surveyed, this indicates that ozone air pollution is not enough of a problem to impair tree function. Detecting tree damage, particularly at the trunk, was difficult to discern given the sampling period allotted.

Restoration of wooded areas does not mean that an entire area will need to become contiguous in order to regain functionality. Using forest landscape ecology as an operating framework will promote ecological functionality over pursuing forest cover. Focusing on creating and expanding forest cover is not tenable given the agricultural needs of this area. ***However, identifying areas that will improve connectivity and reduce patch criticality are important for large scale planning. After critical landscape patches have been detected, restoration efforts should be focused on improving forest and woodland quality.*** This type of restoration plan may yield greater benefits at reduced costs.

Management or restoration of these small isolated woodlands may not be warranted given limited resources. ***If these areas are to be considered for larger landscape connectivity and open space corridors, caution should be taken to identify the presence of invasive species, and remove them prior to establishing a contiguous corridor.*** Otherwise some ground creeping vegetation may use connecting corridors to expand into other patches.

Given the importance of riparian woodlands and their functions, this topic will be discussed more fully in the Open Space Corridors section on page 118.

The contiguous woodlands found along the western edge of the study area, near the Town of Berry and along the southern edge, near the Town of Middleton, represent the largest woodland and forested areas in the area. Maintaining large contiguous woodland areas is important given the amount of time that is required for these areas to undergo ecological succession, changes in species composition over time. If any woodland or forests require full restoration, after complete deforestation, it will require several decades before these ecosystems fully regain their functions. Further, it takes some species several decades before they reach reproductive maturity and are able to leave viable seeds. In an ecological landscape context, maintaining large patches is important because they often serve as a source population for plants and animals, which then disperse to other sites.

As large as the western sites are, the forest-woodland landscape complex, with large contiguous patches extends far to the west, well beyond the North Mendota FUDA study area. These contiguous patches are the eastern-most fringe that barely enters this FUDA study area. If exurban development were to occur in these locations, it will negatively impact the biota and ecosystem function on a local scale, but not likely impair the landscape on a regional scale.

Another important landscape management issue to consider is to determine the distribution of older mature stands relative to woodlands undergoing succession. A common misconception is that the best woods, are "old growth forests" and to maximize theses areas through management that removes disturbances. On the landscape scale, woodlands should exist in a variety of densities. This landscape asynchrony allows for recruitment of new trees and allows for environmental heterogeneity, a core aspect to landscape ecology, which promotes species diversity and ecological function.

3. Soils

The geologic history of Dane County is responsible for the productive soils found in the area. Clay and silt loams are found primarily in the glaciated portion of the county while shallower sandy loams are found in the driftless area. Soil type is an important indicator of structural difficulties posed for development. The following characterizes the soils found in the North Mendota FUDA study area:

a. Soils Underlain by Sandy Loam Glacial Till

The soils in this group formed mainly by wind born deposits of silt loam underlain by sandy loam glacial till. Most of these soils have moderate permeability and high available water capacity. ***These soils pose slight to moderate limitations for farming and for urban use.***

Dodge-St. Charles-McHenry Association

This association has a varied landscape that is characterized by ground, end, and recessional moraines. The landscape is mostly gently sloping to sloping. Some areas on benches and in depressions and drainageways can be nearly level, and small areas of moderately steep to steep slopes can also be present. ***Except for small areas in drainageways and steep slopes, this association poses slight limitation for development.***

Plano-Ringwood-Griswold Association

This association consists mainly of gently sloping areas on glacial uplands. Some areas on uplands are nearly level to sloping. There is also a small areas of moderately steep rises or ridges. ***Except for small areas of steep slopes, this association poses slight limitation for development.***

b. Soils Formed in Outwash Material

The soils in this group consist of associations formed mainly in outwash material near streams or adjacent to glacial moraines. These soils are generally loamy and underlain by sand, gravel, or both. These soils have moderate permeability and medium available water capacity. Many of them are good sources of sand and gravel. ***Where these soils are well drained and gently sloping to sloping, they have slight to moderate limitations for most urban uses.***

Batavia-Houghton-Dresden Association

This association has a landscape that consists of outwash plains with depressions and old lake beds. The soil material was deposited by wind and by water from melting glaciers. The texture of the material in which the soils formed is variable, but it is dominantly silt, sand, or gravel. ***Areas with poor drainage (silt and finer soils located in old lake beds) can pose limitation to development from induced flooding.***

Planning Considerations:

- Soils with seasonal high water tables of less than 3 feet and classified as poorly drained can have limited suitability for infrastructure due to potential for groundwater induced flooding
- Hydric soils are good indicators of existing and former (potentially restorable) wetlands
- Consider the potential of areas with high infiltration rates for enhanced regional infiltration and groundwater recharge

c. Hydric Soils

These soil associations contain soils that are "hydric," possessing signature characteristics associated with prolonged periods of wetness or saturation. Hydric soils are good indicators of existing and former (drained) wetlands (see Map 5). Hydric soils with potential for wetland restoration lie along the streams in this area. These include Orion (Or), Otter (Ot), Elburn (Eg), Radford (Ra), Troxel (Tr), and Virgil (Vw) soils. Depth to water table in these areas are generally 0 to 3 feet (see Map 6).

Soils with seasonal high water tables of less than 3 feet and classified as poorly drained can have limited suitability for infrastructure due to their potential for groundwater induced flooding. These areas are well suited for park and open space areas. If these areas are developed, on-site soils investigations are recommended to determine the actual extent of seasonal high groundwater areas and potential increases in groundwater levels as a result of stormwater management practices and increased precipitation. Restrictions are recommended in confirmed problem areas to establish the lowest allowable level of any structure so that it is situated well above the high water table to reduce the potential for groundwater induced flooding. ***These soils conditions may also limit the suitability of some stormwater infiltration practices due to the potential for groundwater pollution.*** More detailed information is provided on page 137.

d. Depth to Bedrock

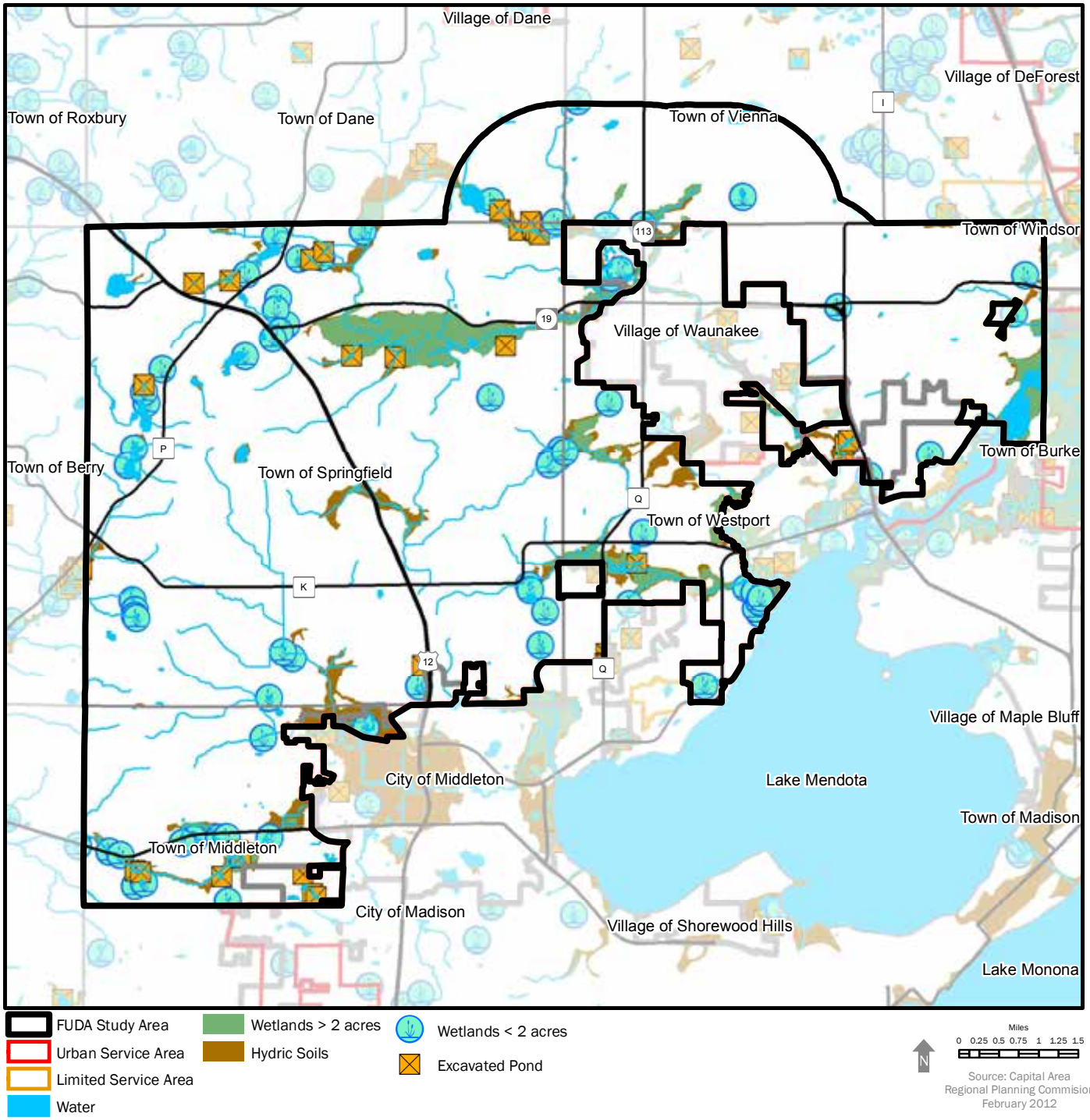
The excavation of bedrock can increase the cost of infrastructure and construction. Bedrock at a depth of 3 feet or less and karst features may also limit the suitability of some stormwater infiltration practices due to the potential for groundwater pollution. Shallow depth to bedrock is less of a concern in the glaciated part of the county. This is because of the significant amount of till left behind by the retreating glacier. This situation is more of an opportunity for development in these areas since the deep soils generally provide considerably greater pollutant removal and easier stormwater management. ***In the North Mendota study area depth to bedrock generally exceeds 5 feet and is more than 50 feet in many areas (see Map 7).***

Planning Considerations:

- Bedrock excavation can increase the cost of infrastructure and construction.
- Bedrock at a depth of 3 feet or less and karst features may limit the suitability of some stormwater infiltration practices due to the potential for groundwater pollution

Map 5: Existing and Former Wetlands (Hydric Soils)

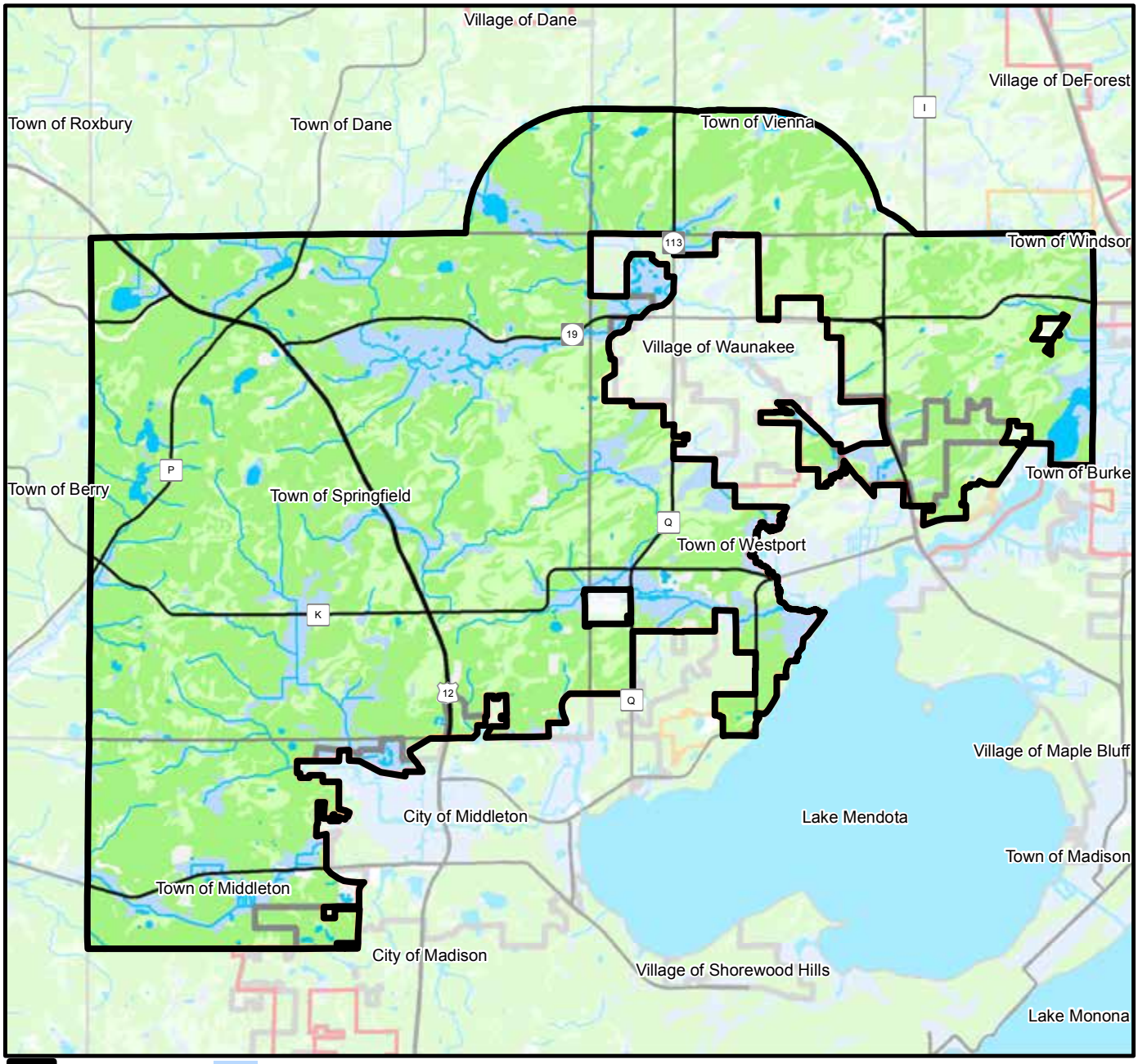
North Mendota Study Area, Dane County, WI



Existing and former wetland soils often present significant constraints to development because of saturated soil conditions with poor bearing capacity. Conversely, these are areas of potential opportunity for restoration and providing additional water quality, flood storage, and wildlife habitat benefits. These areas should be studied in more detail to mitigate potential adverse impacts and promote potential community benefits.

Map 6: Depth to Water Table (feet)

North Mendota Study Area, Dane County, WI



FUDA Study Area	0-3	
Urban Service Area	3-6	
Limited Service Area	>6	
Water	No Value Reported	

Miles
0 0.25 0.5 0.75 1 1.25 1.5

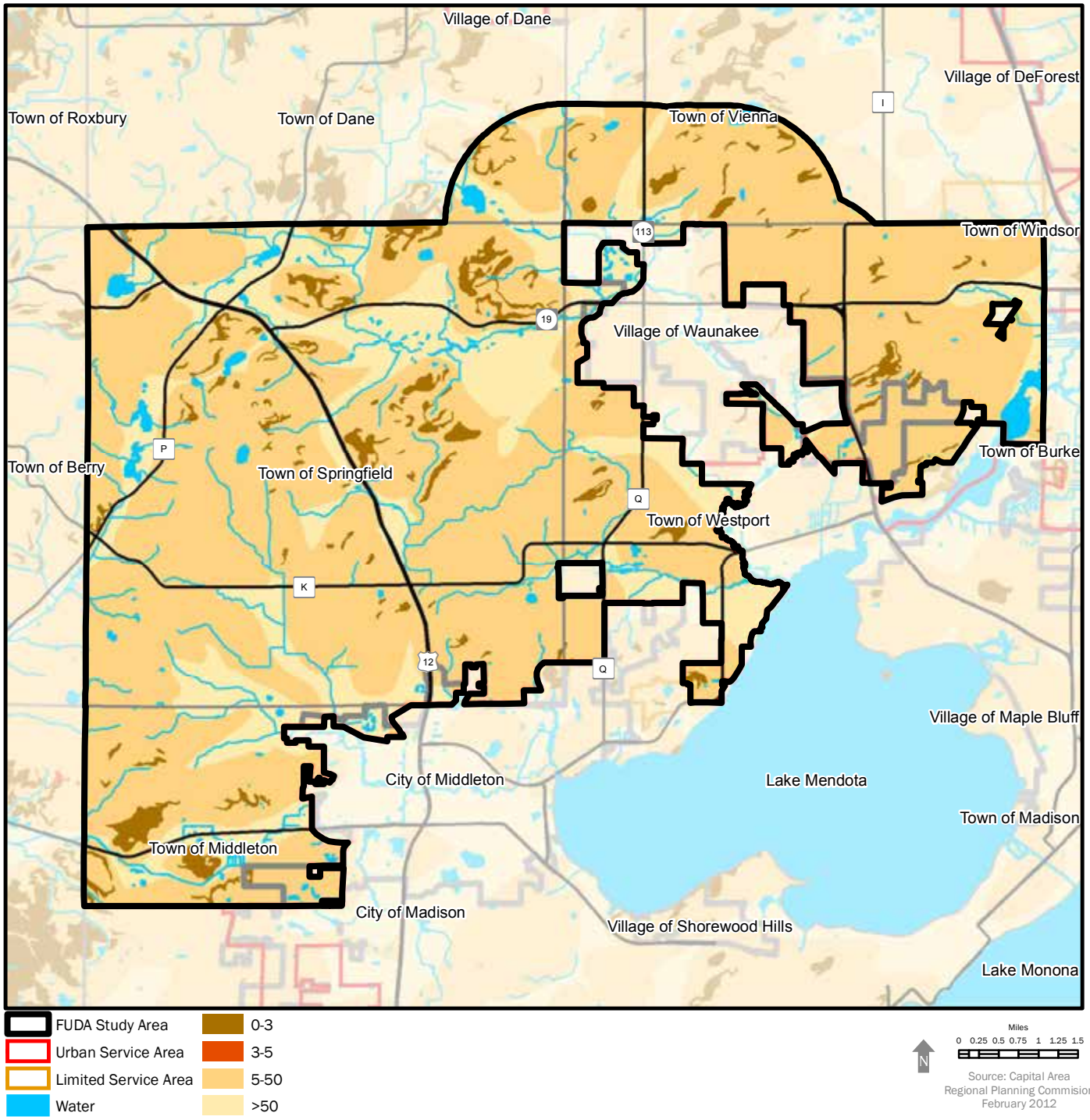
N

Source: Capital Area Regional Planning Commision February 2012

Soils with seasonal high water tables of less than three feet and classified as poorly drained can have limited suitability for roads and buildings due to their potential for groundwater induced flooding.

Map 7: Depth to Bedrock (feet)

North Mendota Study Area, Dane County, WI



Shallow depth to bedrock three feet or less and karst features can increase the cost of urban infrastructure and housing construction. It may also limit the suitability of some stormwater practices due to the potential for groundwater contamination. This is less of a concern in the glaciated portions of the county (such as the FUDA area) compared to the "driftless area," and may actually provide greater opportunity for infiltrating precipitation and runoff as a key stormwater management strategy.

e. Development Site Analysis

The USDA Natural Resources Conservation Service (NRCS) Soil Survey for Dane County[40] is a valuable planning tool. Soil borings or other onsite soils investigation are necessary for detailed engineering analysis and site design work. For example, Map 8 shows building site potential for dwelling units with basements based on soil characteristics. Each situation will be different depending on the intended or anticipated land use, existing or potential soil limitations, and any special planning, design, or implementation that may be needed or employed to minimize or overcome the limitations encountered.

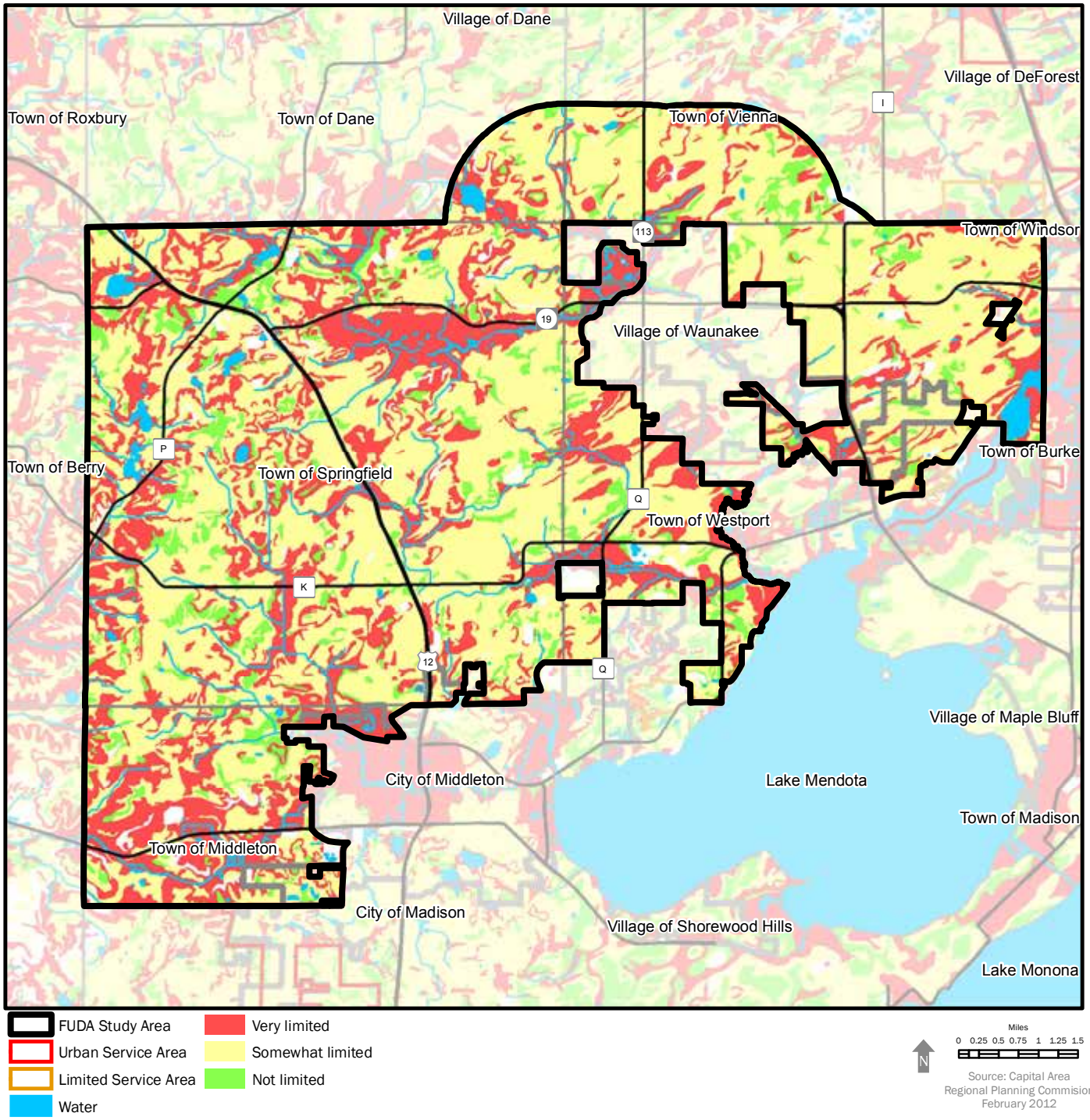
f. Relative Infiltration

CARPC staff, with cooperation from the Dane County Land and Water Resources Department, have conducted an analysis of the stormwater infiltration potential of soils in this area. This analysis used existing topography and soils data to infer infiltration potential based on slope, soil permeability, depth to the water table, and depth to bedrock. ***Infiltration potential in the North Mendota FUDA study area is generally medium, with the potential for enhancement in some areas through the use of engineered soils tapping into deeper sand and gravel deposits. More detailed information on infiltration and groundwater recharge is provided on page 137.***

40 http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx

Map 8: Building Site Potential for Dwellings with Basements

North Mendota Study Area, Dane County, WI



The ratings for dwellings are based on the soil properties that affect the load-bearing capacity and the ease and amount of excavation needed.

Source: USDA Natural Resource Conservation Service Soil Survey for Dane County.

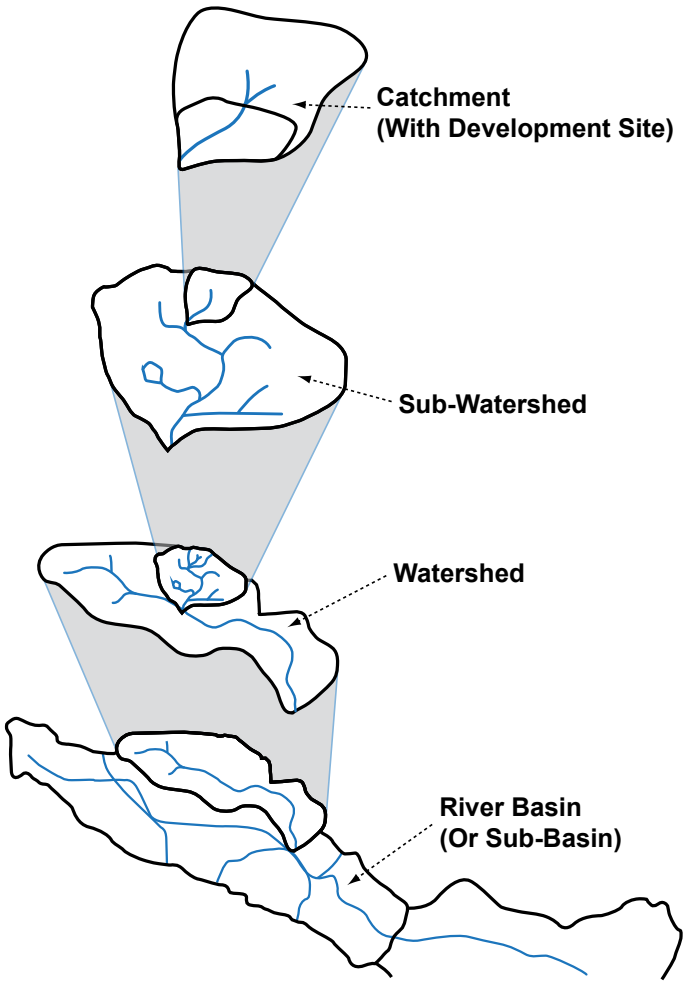
4. Watersheds and Drainage

The basic structural element of natural resources protection is the watershed. A watershed is defined as the land area that drains to a specific body of water (river, lake, or wetland). It has been compared to a topographic bowl, bathtub, or basin separated from neighboring watersheds by ridgelines.

Watersheds are scalable. Like nested Russian dolls they flow into successively larger versions of themselves (see Figure 8). While similar in form and function, for purposes of clarity watersheds are often given more descriptive names depending on the scale being used. For example, a particular ***catchment area*** for a neighborhood in Middleton might drain to the larger Pheasant Branch Creek ***subwatershed***, which drains to the Yahara River ***watershed***, which drains to the Lower Rock River ***basin***, which drains to the Mississippi River ***basin***, and ultimately to the Gulf of Mexico.

All organisms, whether aquatic and terrestrial, are dependent on water and are shaped by watershed dynamics. Many conservation and natural resource management plans use the watershed concept as a means of organization. Careful consideration of development plans in the context of the watershed concept is very important, given that local actions have implications downstream far beyond their point of origin. It is said that "we all live downstream". It is therefore critical to consider potential downstream impacts of changes to land cover and land use as part of the planning or conceptualization of such changes.

Figure 9: Watershed Management Units



Source: Clements, et al. 1996

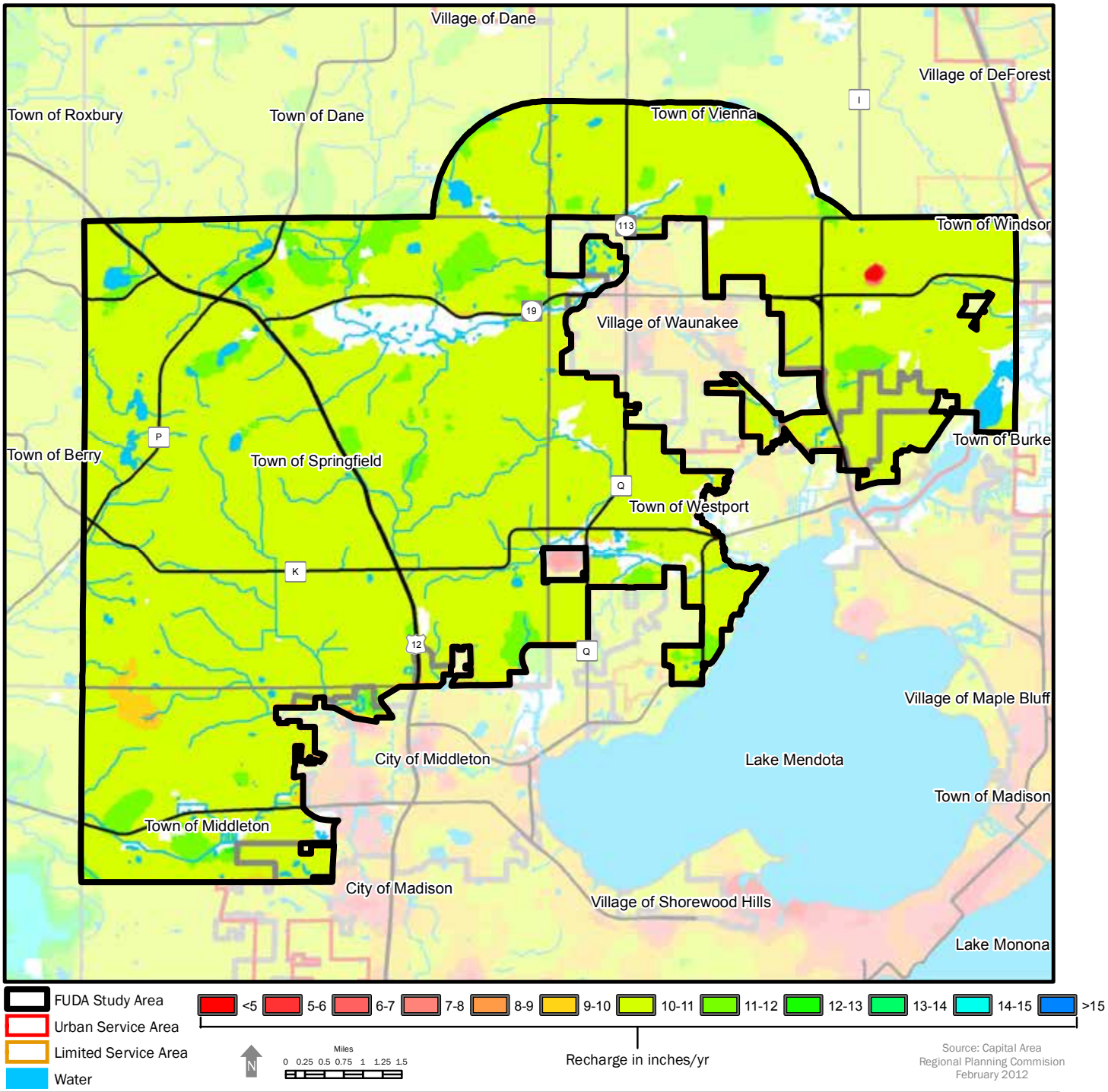
Hydrology and drainage are highly dependent on climate and climate variability. The climate of Dane County is typical of the Great Lakes states. Winters tend to be long, cold and snowy, while summers are short and sometimes humid. Average annual precipitation is about 33 inches, with 67 percent falling from April through September. Average groundwater recharge in Dane County is estimated to be 7.6 in/yr; however, this varies by location (see Map 9). Most recharge occurs in late fall, winter, and early spring when vegetation is dormant and evapotranspiration is minimal. Runoff and evapotranspiration vary widely due to seasonal conditions and land use. August is the wettest month with 4.3 inches of precipitation (1971-2000), and January is the driest with about 1.2 inches. About 84% of the precipitation events are half an inch or less. Snowfall averages 50 inches per year. The ground usually begins to freeze at the end of November and thaws in mid-April. The potential for runoff and severe erosion is often highest in March and early April when heavy rainstorms and snowmelt occur on ground sparsely covered by dead vegetation. Climate change studies and predictions suggest changes in intensity and timing of precipitation have already occurred in our region, and additional changes are expected. The subject of climate variation is covered in more detail in Technical *Appendix D* of the *Dane County Water Quality Plan*.[41]

Map 10 shows the streams and watersheds of the region and provides the regional context for the streams and watersheds of the North Mendota study area, shown on Map 11. The principal streams of the study area are Pheasant Branch Creek and Six Mile Creek. Lake Mendota is the major lake immediately downstream. Black Earth Creek drains west to the Wisconsin River. Significant wetland areas are Cherokee Marsh, Waunakee Marsh, Dorn Creek Wetlands, and Pheasant Branch Creek Marsh (see Map 12). Smaller wetlands are also present, as are numerous ephemeral ponds that are used extensively by migratory waterfowl.

41 Appendix D of the WQP http://danedocs.countyofdane.com/webdocs/PDF/capd/2011_postings/WQP/WQP_Appn_D_Urban_Nonpoint_Source_Analysis_2011_web.pdf

Map 9: Groundwater Recharge (in./yr.)

North Mendota Study Area, Dane County, WI



Precipitation that soaks into the ground and recharges the groundwater, eventually discharges to streams and other water bodies, helping keep water temperatures low and enhancing oxygen supplies. This favors habitat for fish and other sensitive aquatic species. Development without mitigation measures can disrupt the ground/surface water balance resulting in less recharge and more stormwater runoff.

a. Floodplains

A survey of 100-year floodplain boundaries offers insights into the areas most susceptible to flooding (see Map 13). These are areas that have a 1% chance of being inundated in any single given year. Floodplains are designated by the Federal Emergency Management Agency (FEMA) and present significant limitations to development. It is important to note that floodplains are mapped using historic data. Floodplain boundaries can change over time with changes in precipitation and land use. A problem with high water levels has repeatedly occurred in the Yahara Lakes over the last several decades. While measures have been taken in recent years to control the timing and volume of stormwater runoff from new urban development in the watershed, the impacts associated with historic land cover changes from their natural pre-settlement state to agricultural and urban land uses will need to be addressed to ameliorate high water levels in the Yahara system.

Planning Considerations:

- Keep infrastructure that can be damaged by flooding out of the 100-yr floodplain.
- Include an additional buffer area around floodplains to account for changes in floodplain boundaries over time.

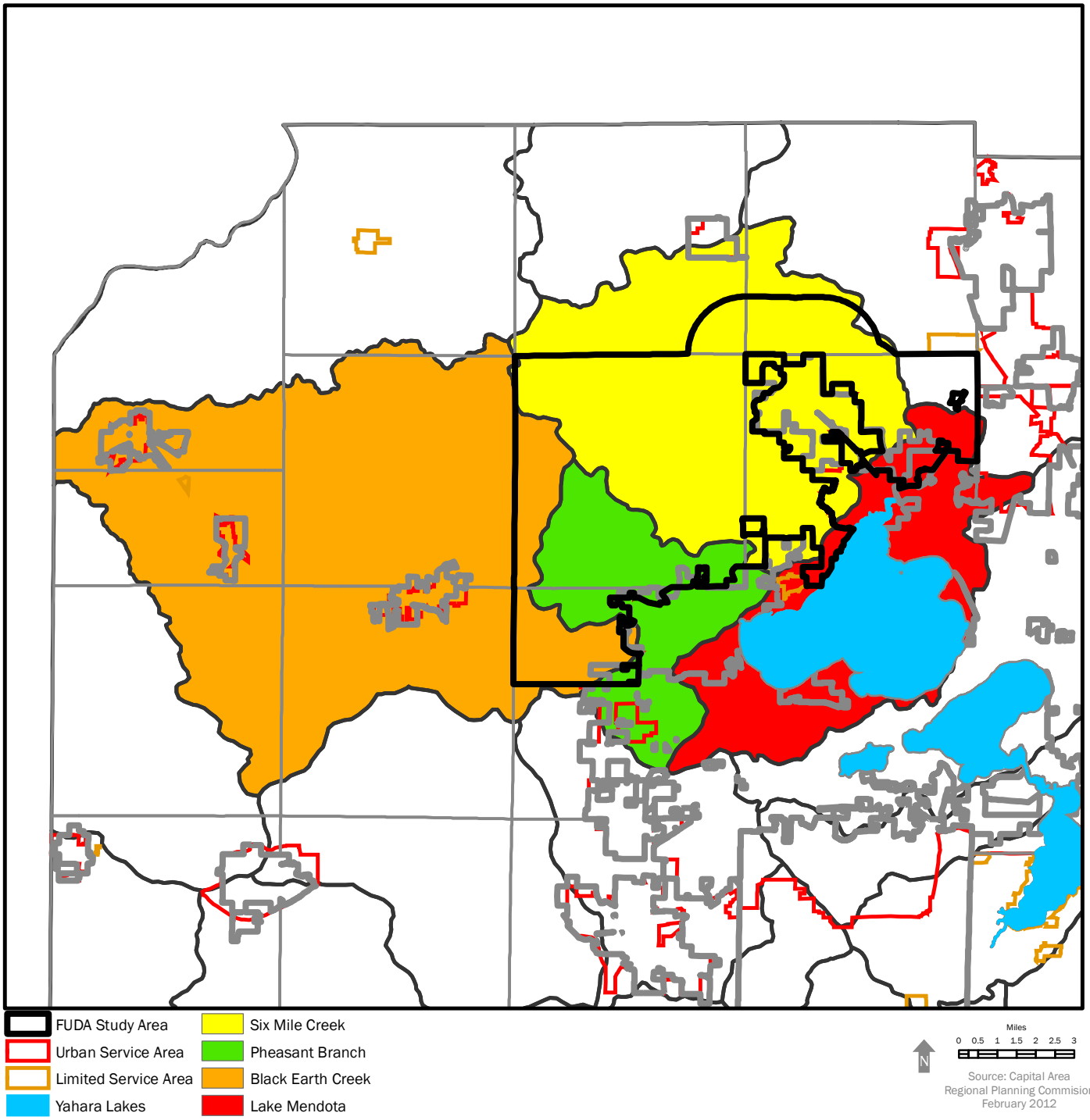
b. Internally Drained Areas

Two large internally drained areas (i.e., closed basins with no outlet) border the South Fork Pheasant Branch subwatershed within the Madison-Middleton area. The largest of these areas is 950 acres in size and drains to two shallow ponds know as Stricker Pond and Tiedeman Pond. The Stricker-Tiedeman Pond area has seen rapid development, resulting in rapid increases in runoff and excessive sedimentation. Because the Stricker-Tiedeman Pond subwatershed is internally drained, significant increases in runoff from new development have raised water levels in the ponds to the extent that a relief discharge pipe has been constructed to Lake Mendota to help alleviate flooding concerns. A second internally drained area, the Esser Pond drainage area (206 acres in size), abuts the Stricker-Tiedeman Pond area on the northwest. The drainage area for Esser pond has been developed with the pond and a surrounding buffer placed in an environmental corridor.[40] Drainage has been artificially redirected to the South Fork such that it is no longer a closed basin and is now contributing water to downstream areas. The result of this is more water flowing to Pheasant Brach Creek and the Yahara Lake Chain than before. Other internally drained areas are located in the northwestern part of the Town of Springfield (see Map 14).

Graber Pond is located in the northern portion of the city of Middleton and can generally be classified as a prairie pothole. A prairie pothole can be described as a small closed basin (non-contributing area) that has no surface outlet under normal conditions. From a hydrologic perspective, closed basins often possess significant seasonal and inter-annual variability in water levels. The only mechanism for water to leave the basin is by seepage and evapotranspiration. These two processes are quite slow compared to watershed runoff entering the basin. For example, it might take weeks for the pond to seep and evaporate runoff from a single storm event that may have lasted only several hours. This unique feature of closed basins is drastically different than a riverine system such as Pheasant Branch Creek where the river can return to pre-storm flow conditions within hours or days after a storm event.

Map 10: Streams and Watersheds Regional

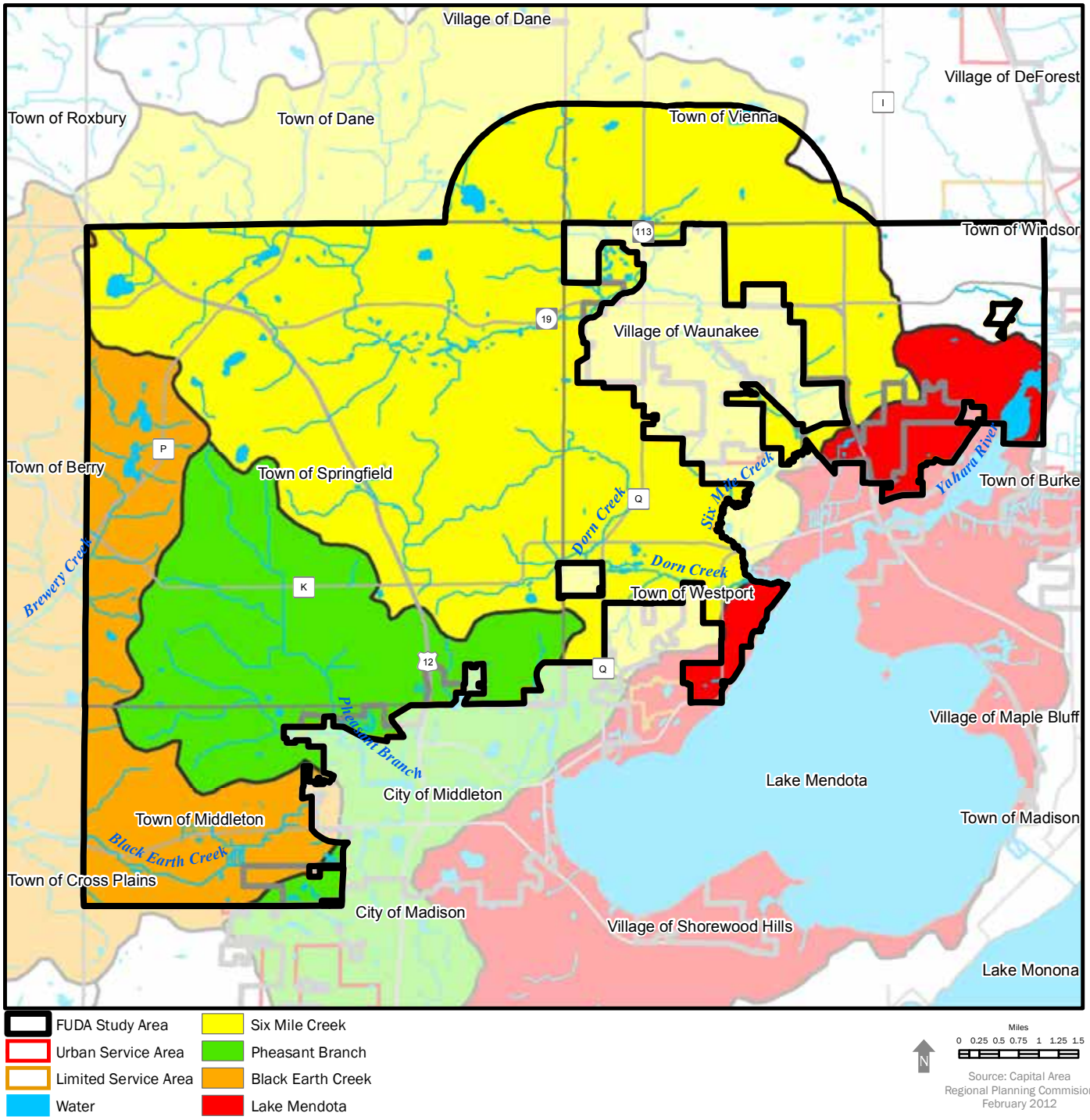
North Mendota Study Area, Dane County, WI



Our water resources are the lifeblood of the region and watersheds, representing the land draining to a particular water body, are the basic structural elements of water resource protection. The health of a particular water body is primarily dependent on the types and land use and practices within its watershed. Note that watersheds are scalable and are defined by the area of scope or interest.

Map 11: Streams and Watersheds

North Mendota Study Area, Dane County, WI



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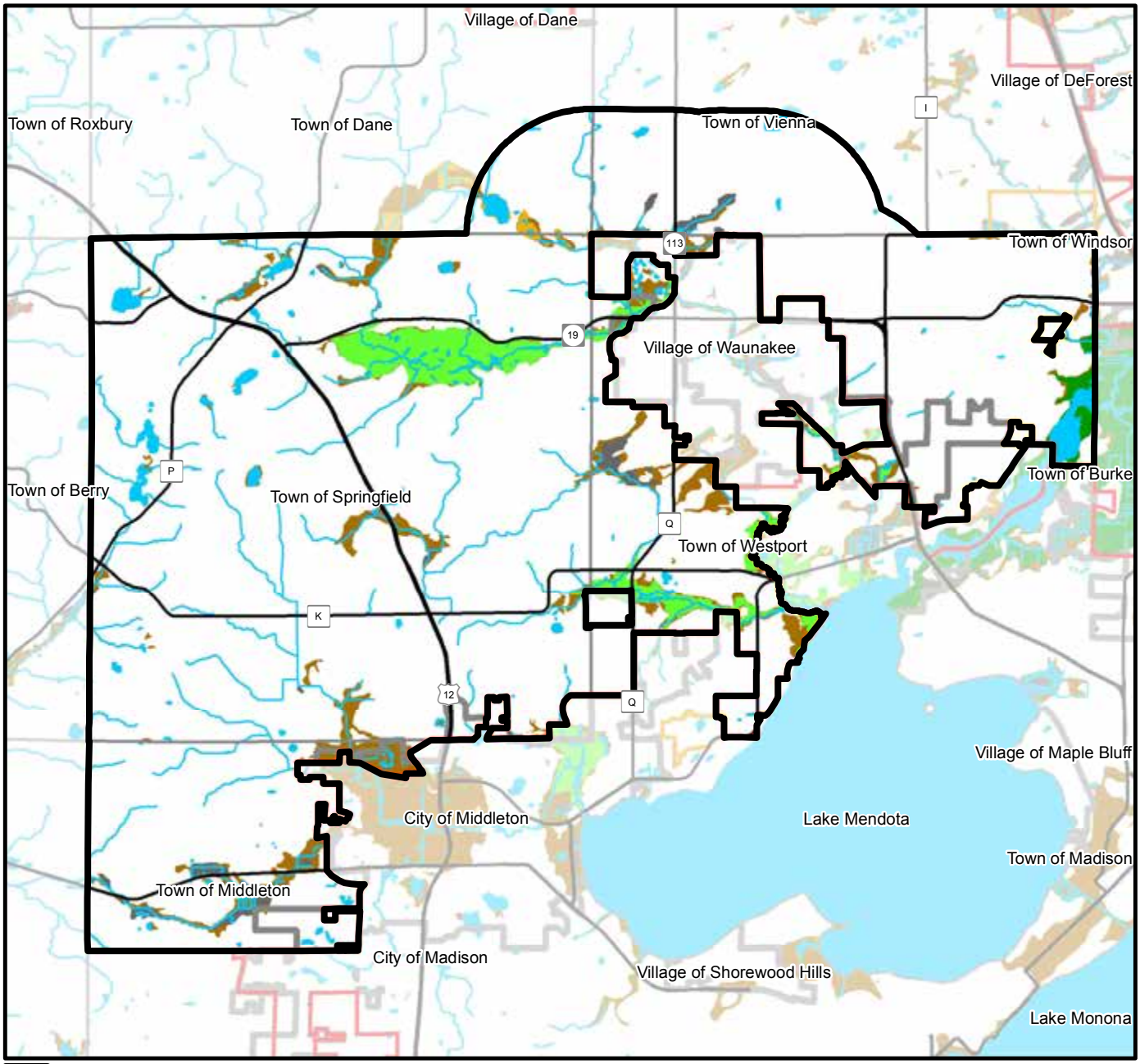
Map 12: Wetland Groups

North Mendota Study Area, Dane County, WI



FUDA Study Area
Urban Service Area
Limited Service Area
Water
Group I (Protected)
Group II (Protected & Enhanced)
Group III (Protected, Enhanced & Restored)
Group IV (Enhanced & Restored)
Group V (Restored)
Not Inventoried
Not all elements may be present

Miles
0 0.25 0.5 0.75 1 1.25 1.5

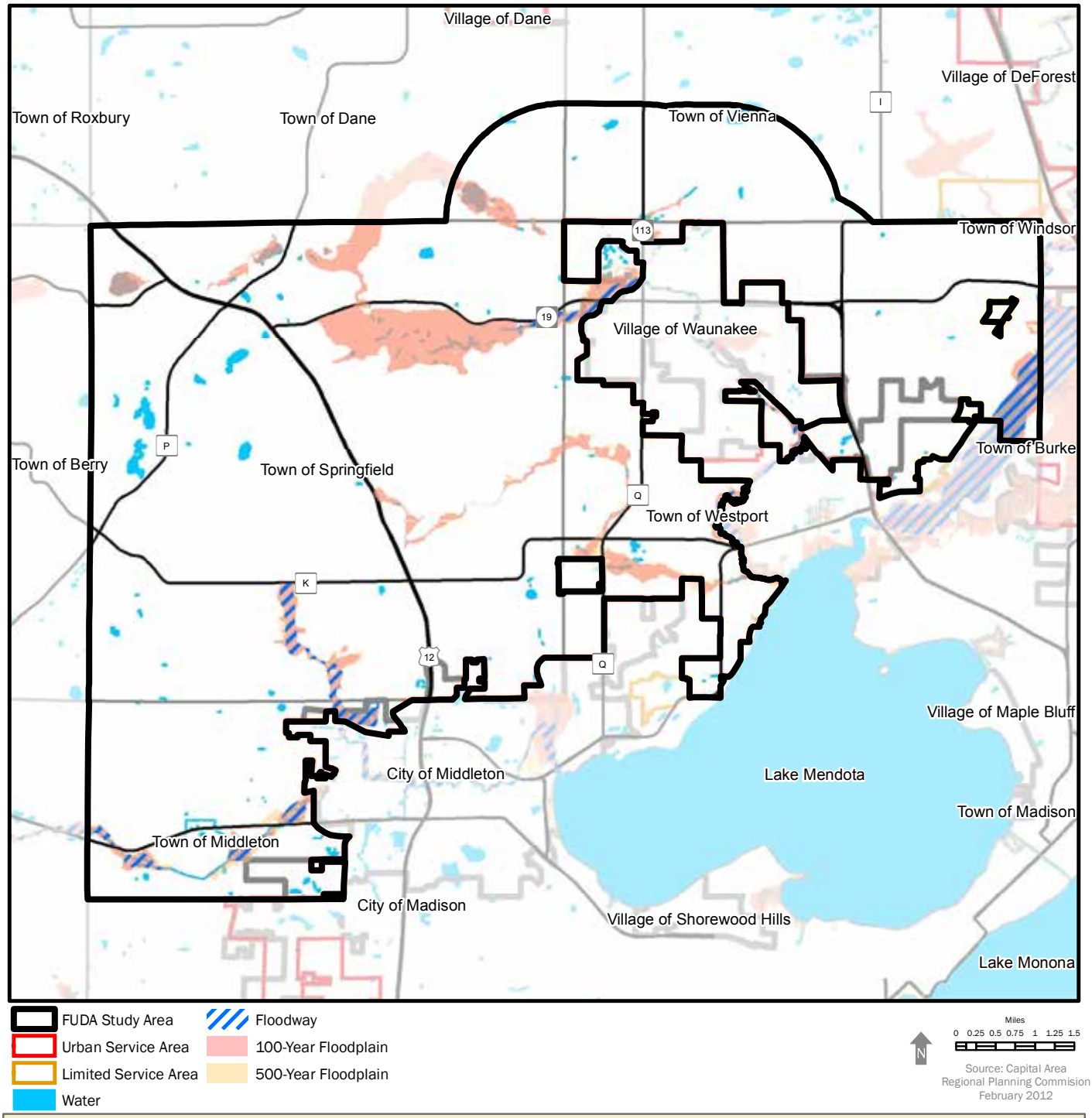
N

Source: Capital Area Regional Planning Commision February 2012

Wetlands are grouped based on their present or potential biological condition, scientific value, public use, extent of degradation, and immediate or long-range threats. While all wetlands have value, decisions must sometimes be made as to where specific approaches and efforts are best tailored or targeted.

Map 13: Floodplains

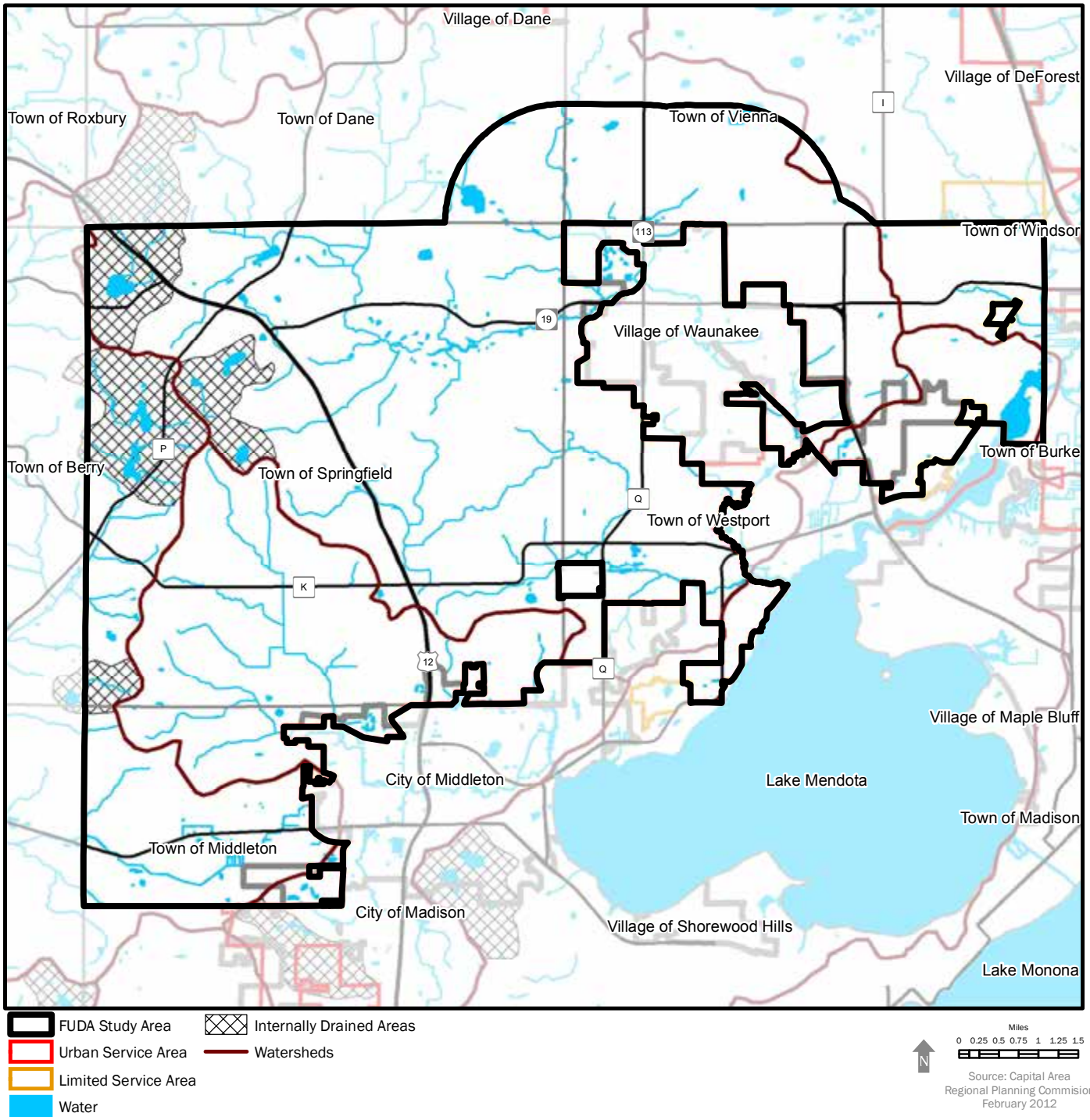
North Mendota Study Area, Dane County, WI



Floodplains present significant limitations to development. Development should be avoided in floodplain areas. These areas represent current conditions. Increased development in the watershed along with accompanying increases in volumes of stormwater runoff can expand the areal extent of the delineated areas.

Map 14: Internally Drained Areas

North Mendota Study Area, Dane County, WI



The unique hydrologic characteristics of internally drained areas make them especially vulnerable to the effects of urbanization. As urbanization increases, rainfall events generate significant runoff, which does not allow the pothole to dry out. The ponds tend to become dominated by open water, and the potential for extended flooding of nearby development increases.

The unique hydrologic characteristics of closed basins make them especially vulnerable to urbanization. When the watershed of closed basins are predominantly undeveloped (either pre-settlement or agricultural), closed basins are typically wetter in the spring and dry out during the fall during years of normal precipitation. As urbanization increases, summer rainfall events generate significant runoff, which does not allow the pothole to dry out in the summer. The ponds tend to become dominated by open water, and the potential for extended flooding of nearby development increases. The City of Middleton has first-hand experience with these consequences of urbanization in prairie pothole watersheds as evidenced by Stricker, Tiedeman, and Esser Ponds.

All three of these ponds have required engineered outlets to lower water levels because of flooding problems caused by urbanization. ***In closed basins, pre-development runoff volumes need to be maintained, and emergency overflow measures included to prevent flooding in case volume control measures fail or are off-line for maintenance.***

Issue:

Runoff Volume

- What has been done:
- Volume control in urban areas since 2004
- Special volume and overflow requirements in closed basins in new USA amendment areas
- What else can be done:
- More resources for agricultural BMP implementation
- Retrofit BMPs in older urban areas
- Restore wetlands, woodlands, prairies, and pastures in selected agricultural areas.

Stricker Pond

c. Stream Classifications and Biological Indicators

Water quality standards are the foundation of Wisconsin's water quality management program. They serve to define the goals for a water body by designating its uses, setting criteria to protect those uses, and establishing provisions to protect water quality from pollutants. The WDNR is authorized to establish water quality standards that are consistent with the Federal Clean Water Act (Public Law 92-500) through Chapter 281 of the Wisconsin Statutes. These water quality standards are explained in detail in Chapters NR 102, NR 103, NR 104, NR 105, and NR 207 of the Wisconsin Administrative Code. These water quality standards rely on three elements to collectively meet the goal of protecting and enhancing the state's surface waters. They include:

- ***Designated Uses,*** which define the goals for a water body,
- ***Water Quality Criteria,*** which are set to protect the water body's designated uses, and
- ***Anti-Degradation Provisions,*** to protect water quality from declining.

Designated Uses

Designated uses are goals or intended uses for surface water bodies in Wisconsin which are classified into the following categories[42] (also see Table 4):

Recreational Use –

All surface waters are considered appropriate for recreational use unless a sanitary survey has been completed to show that humans are unlikely to participate in activities requiring full body immersion.

Public Health and Welfare –

All surface waters are considered appropriate to protect for incidental contact and ingestion by humans.

Wildlife –

All surface waters are considered appropriate for the protection of wildlife that relies directly on the water to exist or rely on it to provide food for existence.

Fish and Aquatic Life –

All surface waters are considered appropriate for the protection of fish and other aquatic life. Surface waters vary naturally with respect to factors like temperature, flow, habitat, and water chemistry. This variation allows different types of fish and aquatic life communities to be supported. Wisconsin currently recognizes the following Fish and Aquatic Life subcategories based on the water body's capacity to support a diverse and healthy fish community.

42 See State Administrative Code Chapter NR102 for full description.

The Fish and Aquatic Life Use Designation of a water body is legally recognized in Wisconsin Administrative Code. This designation is used to determine water quality criteria and effluent limits. A stream can obtain a codified designated use by applying formal stream classification procedures.[43] The current codified uses for individual Dane County Streams may be found by visiting WDNR Water Basin website and viewing the desired watershed and water body details.[44]

Assignment of designated uses for the protection of fish and aquatic life has been an iterative process dating back to the late 1960s. While the WDNR strives to maintain a contemporary list of designated uses, it cannot visit each stream, river, or lake very often. In fact, many of the designated uses that are included in the Wisconsin Administrative Code date back to the 1980s.

Current and Attainable Uses

Determining Fish and Aquatic Life subcategory is one of the first steps in managing water quality. In order to facilitate the determination of a designated use to reflect the most current understanding of stream/river ecology, the WDNR published updated guidance in 2004.[45] The informal guidance is used by biologists who monitor Wisconsin's stream and river communities. It provides a framework for the collection and assessment of field data to recommend which Fish and Aquatic Life subcategory a particular water or segment best fits.

The "Current Use" is the fish and aquatic life community the WDNR biologists believe the water currently supports. This is not a formal designation; it is based on the current condition of the water. Current Fish and Aquatic Life Use determinations for Dane County streams are shown on Map 15, and the determinations for the FUDA study area streams are shown in more detail on Map 16.

- ***The "Attainable Use" is the use the WDNR biologists believe the stream could attain if "controllable" sources of impairment are managed.*** These actions include effluent requirements for point sources, and cost-effective and reasonable best management practices for nonpoint source pollution control. ***Beaver dams, low gradient streams, naturally occurring low flows, and land cover and land use are generally considered "uncontrollable" natural or cultural factors.*** The Attainable Use may be the same as the Current Use or it may be higher.

43 Classifications for water bodies are derived from the following factors:
- Streams classified and listed in NR 102 and NR 104 (*Note: all waters not officially codified in NR 102 or NR 104 are codified as Warm Water Sport Fish Community, which is the default classification and listed as "DEF").*
- Streams formally classified during the WPDES permitting process. These streams are surveyed and classified to provide the basis for the permit's effluent discharge limitations.
- Trout streams identified by reference in WDNR publication *Wisconsin Trout Streams*.
- ORW and ERW streams officially approved as such by the WDNR board and listed in NR 102.10 and NR 102.11. Officially, ORW/ERW water bodies are not fish and aquatic life use designations but are a separate category for the WDNR anti-degradation program. These water bodies receive a fish and aquatic life use classification for the purpose of determining water quality criteria and/or effluent discharge limitations.

44 http://dnr.wi.gov/water/basin/

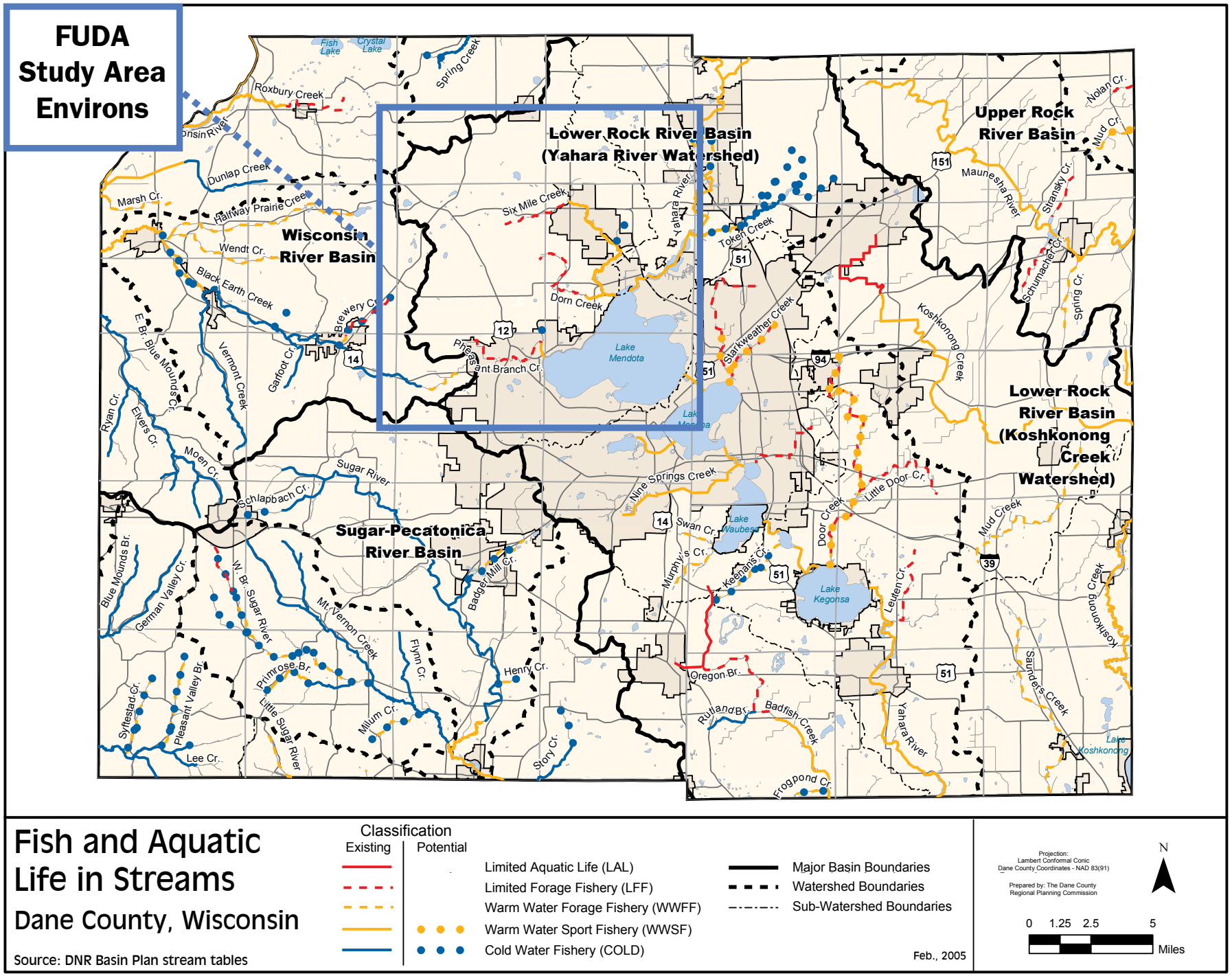
45 Guidelines for Designating Fish and Aquatic Life Uses for Wisconsin Surface Waters" (WDNR PUBL- WT-807-04).

Current and Attainable Uses are not formal designations. They are based on the current condition of the water or the condition that could be achieved through management plans or activities. ***They are not designed for, nor should they be used for, regulatory purposes***.[46] Note that the Current and Attainable Use determinations may actually be different than the codified Fish and Aquatic Life Use designations for some streams. This is because the Current/Attainable Use determinations are used for more informal fisheries management purposes, activities, and guidance; whereas the Codified Use designations are used for more formal or regulatory pollution control and permitting activities where there may be more significant legal and financial considerations.

Table 4: WDNR Fish and Other Aquatic Life Uses

The Department has classified all surface waters into one of the fish and other aquatic life subcategories described below. Only those use subcategories identified in pars. (a) to (c) shall be considered suitable for the protection and propagation of a balanced fish and other aquatic life community as provided in federal water pollution control act amendments of 1972.	
(a) Cold Water Communities. This subcategory includes surface waters capable of supporting a community of cold water fish and other aquatic life, or serving as spawning area for cold water fish species.	
(b) Warm Water Sport Fish Communities. This subcategory includes surface waters capable of supporting a community of warm water sport fish or serving as a spawning are for warm water sport fish.	
(c) Warm Water Forage Fish Communities. This subcategory includes surface waters capable of supporting an abundant diverse community of forage fish and other aquatic life.	
(d) Limited Forage Fish Communities. (Intermediate surface waters). This subcategory includes surface waters of limited capacity and naturally poor water quality or habitat. These surface waters are capable of supporting only a limited community of forage fish and other aquatic life.	
(e) Limited Aquatic Life. (Marginal surface waters). This subcategory includes surface waters of severely limited capacity and naturally poor water quality or habitat. These surface waters are capable of supporting only a limited community of aquatic life.	

Map 15: FUDA Study Area Environs - Fish and Aquatic Life in Streams



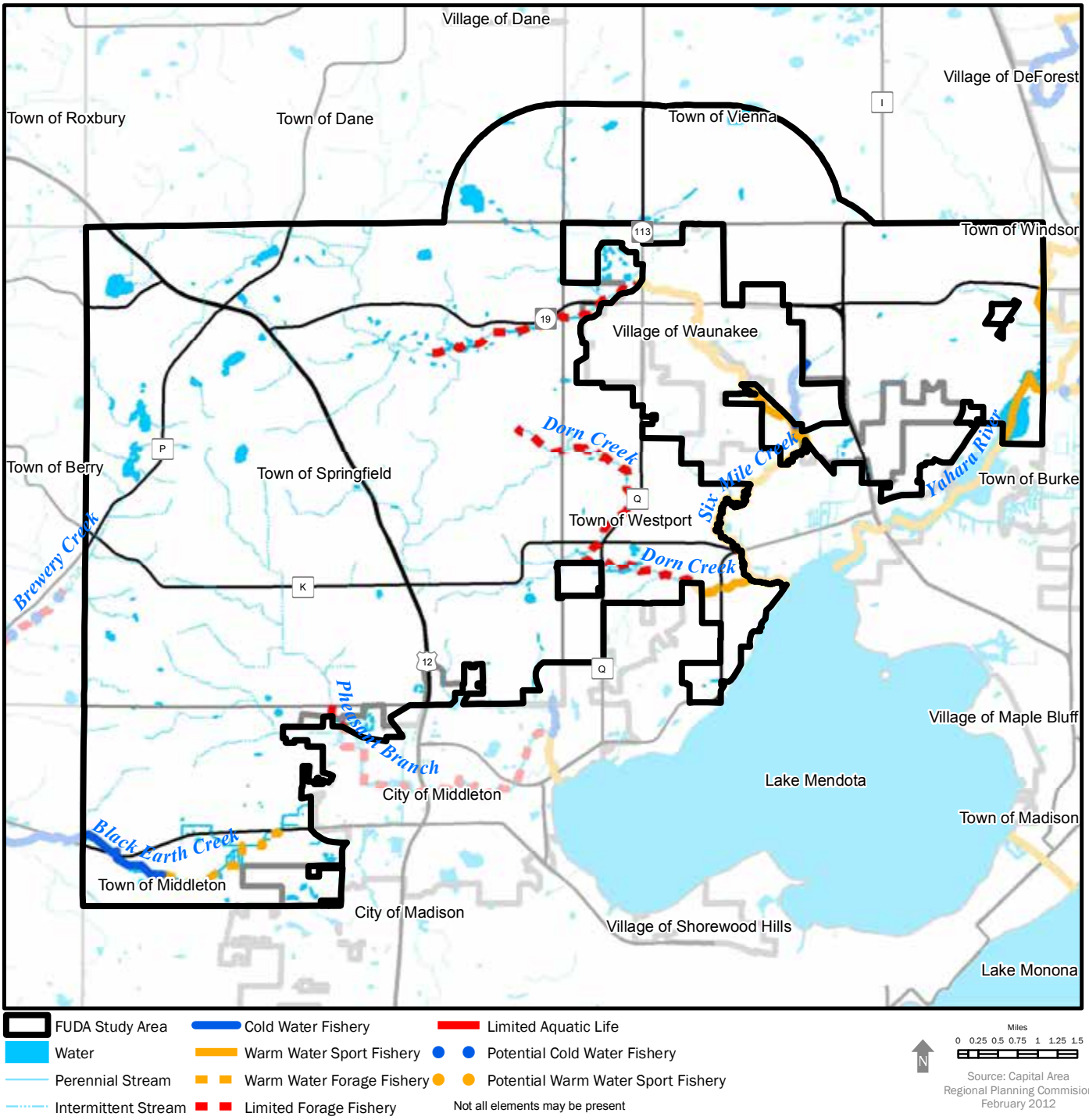
Fish and Aquatic Life in Streams

Dane County, Wisconsin

Source: DNR Basin Plan stream tables

Map 16: DNR Fish and Aquatic Life Designations for Streams

North Mendota Study Area, Dane County, WI



Fish and Aquatic Life categories are based on the condition of the resource and the biological use the DNR believes the stream or stream segment could achieve through proper management of controllable pollution sources. Low gradient streams and naturally occurring low flows can not generally be controlled.

One indicator of stream water quality condition is the type of insects found living on rocks and other stream bottom materials. Certain species of insects will tolerate only undisturbed conditions with limited organic material, while others are able to survive in various types of habitat and water quality conditions. The Hilsenhoff Biotic Index or HBI indicates the degree of organic enrichment in a stream by the types of insects living there. Tolerance values are assigned to various species of insects and an overall score is calculated for the water body. The Index of Biotic Integrity (IBI) is another widely applied and effective tool using fish community data to assess the environmental quality of aquatic habitats (see Table 5).

Table 5: Biological Indicators

Water Quality Scale		
Hilsenhoff Biotic Index	**Water Quality Scale**	**Degree of Organic Pollution**
0.00 - 3.50	Excellent	Organic Pollution Unlikely
3.51 - 4.50	Very Good	Possible Slight Organic Pollution
4.51 - 5.50	Good	Some Organic Pollution Probable
5.51 - 6.50	Fair	Fairly Substantial Pollution Likely
6.51 - 7.50	Fairly Poor	Substantial Pollution Likely
7.51 - 8.50	Poor	Very Substantial Pollution Likely
8.51 - 10.00	Very Poor	Severe Organic Pollution Likely

Interpretation of IBI Scores		
Index of Biotic Integrity (IBI) Score	**Integrity Rating**	**Interpretation and Fish Community Attributes**
100 - 90	Excellent	Comparable to the best situations with the least human disturbance.
80 - 60	Good	Evidence for some environmental degredation and reduction in biotic integrity.
50 - 30	Fair	The stream reach has experienced moderate environmental degredation, and biotic integrity has been significantly reduced.
20 - 10	Poor	Major environmental degredation has occurred, and biotic integrity has been severely reduced.
0 or no score	Very Poor	Human disturbance and environmental degredation have decimated the natural fish assemblage.

B. Surface Water Features

Agricultural practices and historic urban development have either threatened or degraded receiving waters. Uncontrolled rainfall runoff from impervious surfaces in old urban areas can disrupt the natural hydrology of receiving surface water systems. Without infiltration and other stormwater management measures, as natural areas are converted to agriculture or urban development the ground/surface water balance shifts from a groundwater-dominated system to one dominated more and more by surface water runoff. This results in reductions in stream quality and transitions to more tolerant biological communities.

Since these impacts can be gradual and cumulative, it is important to minimize them in all cases where possible. One strategy promoted by the RPC for new development in the region since the mid-90s is to employ stormwater control measures and practices that maintain or otherwise mimic pre-development hydrologic conditions (i.e., the pre-development ground/surface water balance). For example, in addition to maintaining groundwater resources, stormwater management controls and practices that maintain pre-development infiltration and groundwater recharge also help reduce peak flow rates and volumes of stormwater runoff; resulting in less stream bank erosion, cutting and widening of channels and stream beds, and less pollutants being transported to our surface waters. ***Suitable buffers are also needed to protect our waters from surrounding land uses; in addition to providing necessary food, cover, and movement corridors for wildlife. More effort is needed to avoid impacts to these sensitive resources and instead direct future development to more suitable areas through thoughtful planning.*** Stormwater management strategies that maintain or restore pre-development hydrological conditions are particularly critical early on and throughout the development process. These strategies are described in detail in *Technical Appendix D* of the *Dane County Water Quality Plan*.[46]

46 Appendix D of the WQP: http://danedocs.countyofdane.com/webdocs/PDF/capd/2011_postings/WQP/WQP_Appn_D_Urban_Nonpoint_Source_Analysis_2011_web.pdf

1. Lake Mendota and Its Tributaries

The Yahara chain of lakes is the most prominent surface water feature that would be impacted from activities in the study area. Lake Mendota is the largest lake in the system. It is a large glacial lake with a surface area of 9,842 acres, a maximum depth of 82 feet, and an average depth of 42 feet. It is the largest and deepest lake of the four lakes in the "Yahara Chain of Lakes." The other lakes are Lakes Monona, Waubesa, and Kegonsa. The 232 mi2 Lake Mendota watershed is largely rural (see Figure 9). Approximately 20 percent of the watershed land area is urban or experiencing rapid urbanization (see Table 6). Approximately 12 percent is open water or wetland.

Issue:

Excess Nutrients

- What has been done since late 1990s:
- Agricultural Best Management Practices (BMPs)
- Urban BMPs

What else can be done:

- Increase resources for agricultural BMP implementation.
- Retrofit BMPs in older urban areas
- Restore wetlands, woodlands, prairies, and pastures in selected agricultural areas.
- Investigate opportunities for capturing phosphorus and exporting it from the watershed.

Chain of Lakes

Table 6: 2000 Land Use in the Lake Mendota Watershed

	Dane Co. Acres	Columbia Co. Acres	Total Acres	Percent
Cropland	66,105	14,190	80,295	54
Grassland/Wildlife/Pasture	13,960	1,420	15,383	10
Woodland	1,800	198	1,998	1
Wetland	5,915	412	6,327	4
Open Water	11,108	60	11,168	8
Developed	29,304	117	29,421	20
Internally Drained	2,806	1,353	4,159	3
	130,998	17,753	148,751	100

Source: Lake Mendota Priority Watershed Plan. 2000

In 1847 a dam built on the Yahara River on the isthmus caused water levels of Lake Mendota to rise by about 5 feet, flooding its shoreline and submerging a large wetland complex at its headwaters (Cherokee Marsh). Tenney Park Locks further increased lake levels in 1912, creating the modern base lake water level. The fishery of Lake Mendota is excellent and diverse, containing both warm and coldwater species, rough fish, sport fish and forage fish; with the last accounts showing over 50 species present, including walleye, perch, panfish, bass, northern pike and hybrid musky. Cisco, a coldwater species, is also found in the lake. The lake serves as a major recreational resource for the Madison Metropolitan Area, providing residents and visitors with outstanding opportunities for fishing, swimming, boating, and other outdoor recreational activities.

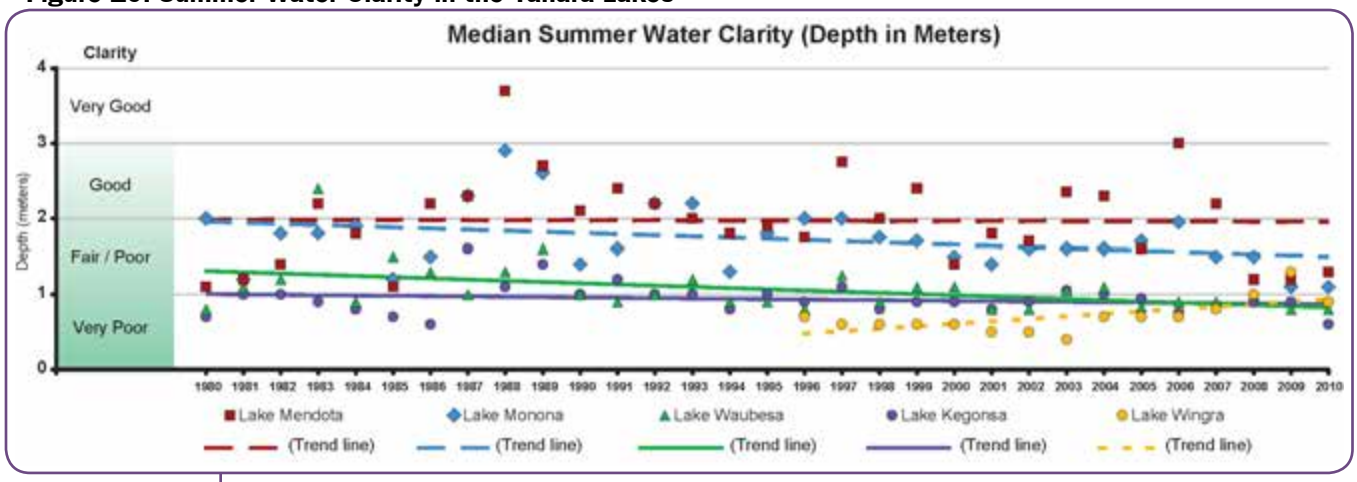
One of the principal water quality conditions of concern for Lake Mendota, however, is excessive blue-green algae (cyanobacteria) concentrations limit water clarity and negatively impacts recreational use. The primary pollutant supporting algal growth in Lake Mendota is the nutrient phosphorus. Like the other lakes in the Yahara chain, Lake Mendota is classified as being eutrophic or possessing relatively high fertility, characterized by having an overabundance of nuisance aquatic plant species. Lake Mendota is also impacted by the aquatic invasive species Eurasian water milfoil, which has a history of becoming dominant in eutrophic, nutrient-rich lakes.

The vast majority of the phosphorus entering Lake Mendota comes from the surrounding land area and is carried to the lake by tributary streams. The land use practices in the lake's tributary drainage area greatly influence the amount of phosphorus washed into the lake. Another source of phosphorus in Lake Mendota is from its high capacity for internal recycling of phosphorus buried in lake sediments. ***Phosphorus is often delivered to the lake attached to sediments. Increased sediment load is detrimental to lake ecology by reducing light penetration, inhibiting photosynthesis and impairing vegetation, and destroying fish and wildlife habitat.*** Tributaries draining primarily agricultural areas include Pheasant Branch Creek, Dorn Creek, Sixmile Creek, Yahara River and Token Creek. Drainage from considerably smaller urban tributaries include the Spring Harbor and Willow Creek storm sewers.

Records of algae blooms date back to at least 1882. Despite conventional understanding, nutrient levels and water quality conditions in the Yahara Lakes have improved since municipal and industrial wastewater was being discharged directly to them stopped. This was the result of diverting municipal wastewater around the Yahara Lakes to Badfish Creek – effectively bypassing the lakes by 1971. Efforts are now being directed towards reducing "non-point" or diffuse sources of nutrients washing off the land surface and into our surface waters. Various regulatory and voluntary measures have been, and are currently being pursued to improve the water quality of stormwater runoff from both agricultural and urban sources.

Low phosphorus concentrations in the lakes are correlated with years of low precipitation and runoff. In general, low flows to the lakes result in lower phosphorus concentrations, which are followed by low chlorophyll, which leads to improvement in water clarity. Lake Mendota has even dropped into the mesotrophic (moderately fertile) category such as in the drought year of 1988. ***This indicates that water quality improvement can be realized through nonpoint source phosphorus reductions and controls.***

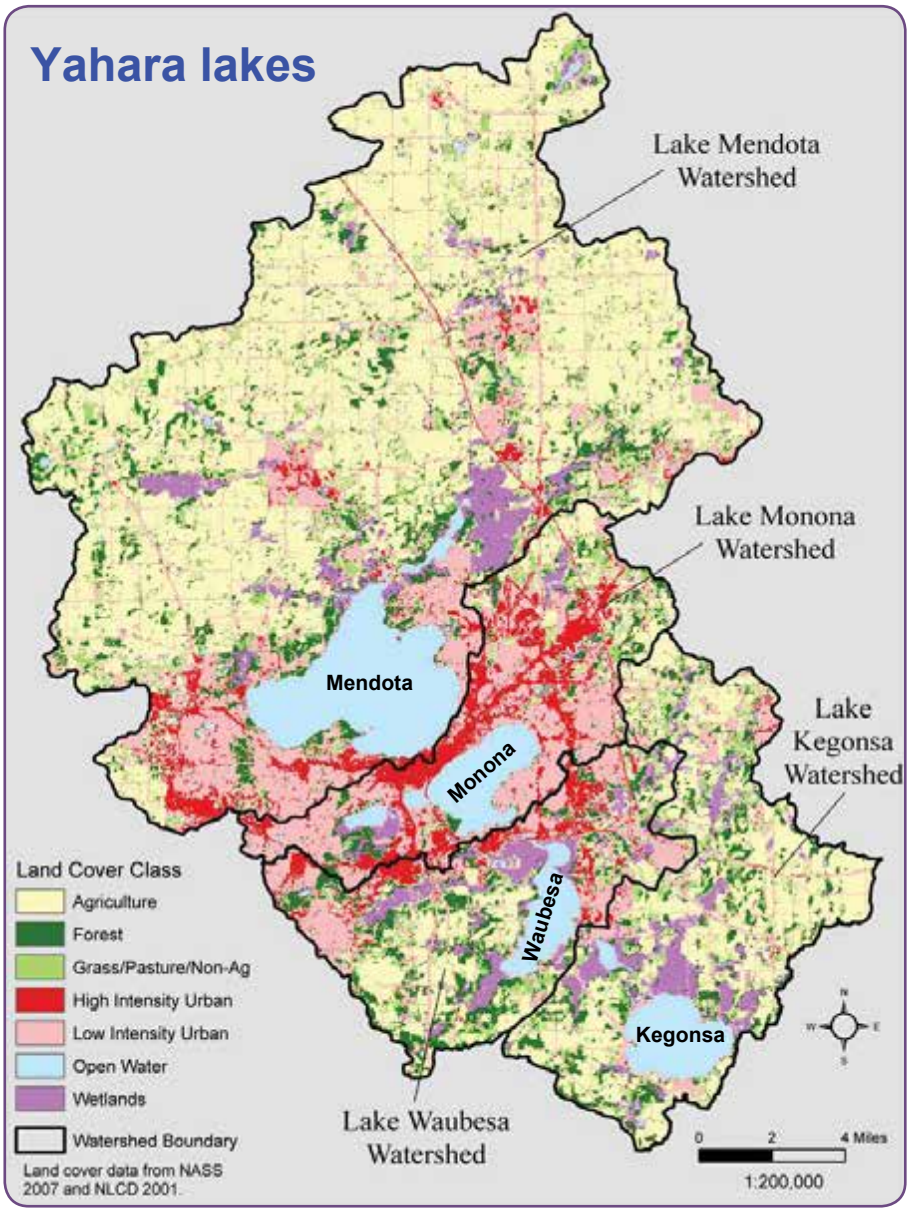
Figure 10: Summer Water Clarity in the Yahara Lakes



While highly variable, water clarity data since 1979 has shown no improvement in Lake Mendota (see Figure 10). Water clarity has declined in downstream lakes. Lake Wingra has improved, likely the result of carp removal in 2008. High population growth and regional development projections will require continued effort to maintain water clarity gains. Innovative approaches will be needed for protecting and sustaining this vital resource.

In 1993, the Yahara River-Lake Mendota watershed and the Pheasant Branch and Six Mile Creek watersheds were selected as a WDNR Nonpoint Source Pollution Abatement "Priority Watershed Project" (NR 120). The goal of the Lake Mendota Priority Watershed Project was to reduce phosphorus and sediment loading to Lake Mendota, the largest and furthest upstream of the Yahara chain of lakes. Approximately 77% of the watershed is agricultural or otherwise undeveloped.

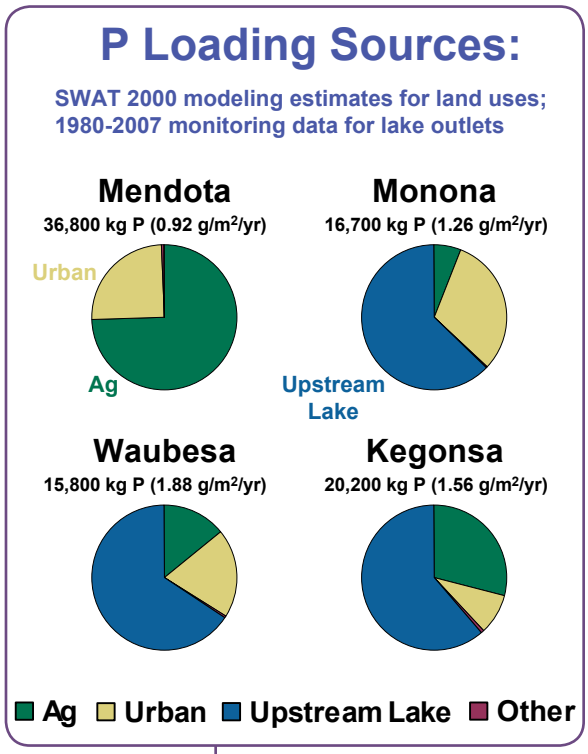
Map 17: Land Cover



Tom Simmons, WDNR

n 2000, modeling estimated that 81,000 pounds of phosphorus entered Lake Mendota annually (see Map 17 and Figure 11). ***Three-quarters of the total phosphorus load of Lake Mendota came from agricultural lands in the watershed.*** This has a cascading effect, since two-thirds of the phosphorus load to the downstream Yahara Lakes comes from the upstream lakes (indicated in blue). ***While the total rural area is greater than the urban area in the Mendota watershed, the amount of phosphorus delivered per unit area of land from construction erosion from urban lands was greater. However, this modeling pre-dates the current stormwater regulations in Dane County and the State of Wisconsin, which have significantly reduced the phosphorus discharge from urban areas.***

Figure 11: phosphorus Sources



Source: R. Lathrop & K. Kirsch, WDNR

Modeling associated with the Lake Mendota Priority Watershed Project[47] indicated that ***a 50% reduction in phosphorus loading (or a reduction of 4,800 tons in the sediment load) to the lake would reduce the number of potential algae bloom days.*** Since phosphorus is often bound to sediment particles, efforts to control sediment reduces phosphorus as well.

According to researchers, ***Lake Mendota water quality could improve relatively quickly if the amount of phosphorus flowing into the lake is significantly reduced.*** Likewise, phosphorus load reductions to Lake Mendota could produce cascading water quality improvements in the downstream Yahara Chain of Lakes as well.[48]

Since a majority of the phosphorus loading to Lake Mendota was found to originate from agricultural lands within the watershed, the priority watershed project was established to provide farmers financial cost-sharing for the installation of BMPs designed to reduce the amount of sediment and phosphorus leaving farm fields and barnyards. Implementation phase occurred between 1998 and 2009.

Sizable investment of public monies have been directed to water quality improvement in the Yahara system. Appendix A of this ECR lists the local project cost-share, not including staffing and other state funded projects. State funding for the construction of various retention and detention facilities in Madison, Middleton, Sun Prairie and DeForest is estimated to be approximately $3.7 million (Parsons 2011). Non-structural BMP measures were also promoted to reduce nutrient and sediment loading. These include the funding of municipal stormwater plans, additional street sweeping, enactment of an erosion control and storm water management ordinance by Dane County, among other projects. The principal goal is to assure that adequate erosion control and storm water management actions and facilities are utilized in developing areas to reduce direct discharges to surface waters by 80%, as well as reducing or controlling peak stormwater flows.

The water quality goal for Lake Mendota is to reduce the concentration of spring total phosphorus to less than 0.074 mg/L. Models indicate this concentration will result in a decrease in blue-green algae to less than 2 mg/L during the summer months. This concentration represents the threshold for algal blooms, identified by green water and surface scum. Given current annual phosphorus loading, the likelihood on any given summer day of a nuisance algae bloom occurring is 50%. With a 50% reduction in annual phosphorus loads to the lake, the likelihood of a nuisance algae bloom occurring is reduced to 20%. In years with high precipitation, with high runoff into the lake, nuisance algal blooms would be more likely that summer, even with the implementation of recommended best management practices (BMPs).

47 For the details of the Yahara-Mendota Priority Watershed project, see the project report at: http://danedocs.countyofdane.com/webdocs/PDF/capd/2012_postings/Publications/Lake_Mendota_Priority_Watershed_Project_1997.pdf
The Yahara-Monona Priority Watershed Report can be found at: http://danedocs.countyofdane.com/webdocs/PDF/capd/2012_postings/Publications/Yahara_Priority_Watershed_Plan_1992.pdf

48 For the details of the most recent research on phosphorus in the Yahara system, see http://danedocs.countyofdane.com/webdocs/PDF/capd/2012_postings/Publications/P_Loading_Yahara_Lathrop.pdf

More recently, Lake Mendota along with other tributary creeks have been included in the Rock River Total Maximum Daily Load (TMDL) project establishing necessary reductions in discharge of sediment and phosphorus.[49] ***These efforts are just beginning. Implementation measures and opportunities that are to be shared among the various agricultural and urban sources have not yet been defined***

It is important to note that some of the sediment and nutrient load reductions to surface waters and the Yahara lakes could be negated if there is an increase in the frequency and intensity of spring and summer storms as projected by some climatologic models. Data from the Wisconsin Initiative on Climate Change Impacts (WICCI) show average annual precipitation has already increased between 4.5 to 7 inches in Dane County between 1950 and 2006[50]. Projections suggest the average annual rainfall from 1980 to 2055 to increase an additional 1.5". The frequency of 3-inch rainfall events has increased over the last 10 years (Lathrop and Carpenter 2010). The WICCI projection is for 2 to 2.5 more rainfall events of 2" or greater per decade in Dane County from 1980 to 2055 (from 12 times per decade to 14 or 14.5 times per decade). Because most of the sediment and phosphorus discharged to Lake Mendota comes from agricultural land uses, the timing of the rainfall significantly influences phosphorus loading. August 2007, the wettest August on record with 15.18 inches of precipitation, resulted in a phosphorus loading of about 6,100 pounds at the USGS station at the Yahara River in Windsor. In comparison, June 2008, the wettest June on record with 10.93 inches of precipitation, resulted a phosphorus loading of about 22,100 pounds. Higher phosphorus loading with less precipitation is likely due to the timing of manure spreading and/or the changes in crop cover during the growing ***season. Additional urban and rural runoff management practices may be needed to improve water quality of Lake Mendota and the downstream Yahara lakes.*** The National Oceanic and Atmospheric Administration's National Weather Service is in the process of updating the rainfall frequency data for Midwestern states, including Wisconsin. The result of this work is scheduled for publication in May 2012 and will be used to adjust the rainfall data used in stormwater modeling as necessary.

Agricultural operations with inadequate control of runoff and soil loss, and old urban areas with inadequate stormwater control have also increased the volumes of stormwater runoff, resulting in more frequent high lake levels and increased flooding. The lake levels for the Yahara Chain of Lakes, (Mendota, Monona, Waubesa and Kegonsa) are managed by Dane County according to the lake level orders established in 1979 by the WDNR. The orders require lake level coordination of the entire chain of lakes as an interconnected system. The target maximum water level for Lake Mendota is 850.10 feet. The 100-yr flood elevation is 852 feet. The target summer minimum water level for Lake Mendota is 849.6 feet from the first spring runoff after March 1st until October 30th.; whereupon it drops to 848.2 feet during the winter season. The persistent problem of high water levels on Lake Mendota is

Issue:

High Lake Levels

What has been done:

- Peak rate control in urban areas since late 1990s
- Volume control in urban areas since 2004

What else can be done:

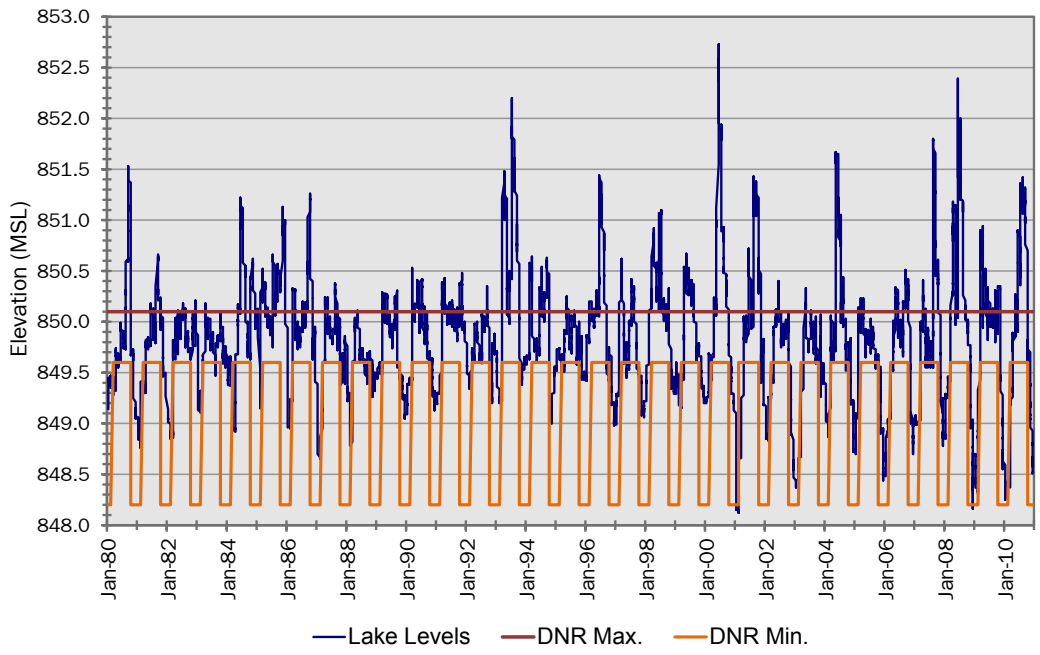
- Retrofit BMPs in older urban areas
- Restore wetlands, woodlands, prairies, and pastures in selected agricultural areas.

49 For details of the Rock River TMDL , http://dnr.wi.gov/org/water/wm/wqs/303d/rockrivertmdl/Final_Rock_River_TMDL_Report_with_Tables.pdf

50 WICCI. http://www.wicci.wisc.edu/resources/wicci_climate_change_maps.pdf

evidenced by the fact that there were 2,892 days when the lake level exceeded the target maximum water level between 1980 and 2011, or 26% (see Figure 12). The exceedances often last for months at a time. ***Since upstream communities contribute additional volumes of stormwater to the lakes, stormwater volume controls are a critical strategy in successfully addressing this problem – both for new as well as existing development. One promising strategy is to restore prior-converted wetlands, prairies, woodlands, or pastures in select areas of the watershed.*** Refer to page 114 for a more detailed discussion of wetland resources and opportunities in the study area.

Figure 12: Historic Lake Mendota Water Levels and DNR Lake Level Limits



Substantial financial resources have also contributed to a greater understanding of pollutant sources and sinks, including remediation and prevention strategies. I***t is important for new development projects to augment this progress through conscientious stewardship and elevated self-imposed standards of development, resource protection, and mitigation of adverse impacts on downstream areas.*** A major focus of the Lake Mendota Priority Watershed Project, and more recent efforts of the Yahara Lakes Legacy Partnership (YLLP) and Yahara Capital Lakes Environmental Assessment and Needs (CLEAN) project[51], has been on continued sediment and phosphorus reductions from agriculture and urban sources, stormwater management, groundwater and wetland protection, and public education. ***Lake Mendota is also included in the Rock River Basin Total Maximum Daily Load (TMDL) project for USEPA-required reductions in sediment and phosphorus.*** These efforts are just beginning. Implementation measures among agricultural and urban sources have not yet been defined. There may also be opportunities for "nutrient trading" or pollutant reduction credits that could be exchanged among the various sources. Such trading opportunities are expected to result in more efficient and cost-effective pollutant reduction and remediation efforts overall.

51 For the details of the Yahara CLEAN project, see http://yaharawatershed.org/articles/CLEAN_Report_090910.pdf

As higher and higher treatment and control have become standard practices in new urban development, a diminishing return can be expected. Additional increments of water quality improvement can be achieved only at higher and higher cost. The same, or smaller, expenditures can instead be applied to improve agricultural conservation practices, resulting in capturing much larger pollution loads. This would require collaboration between urban areas and rural areas within the same watershed or sub-watershed.

Lake Restoration

Lake restoration technologies for the control of phosphorus can be separated into two categories, either controlling flows entering into lakes or diverting flows away from lakes. ***Some of these techniques may not be suitable-for all lakes in Dane County. Lake restoration should only be implemented after evaluation by experienced limnologists and by developing detailed restoration plans and with approval from the WDNR. Furthermore, because most of these restoration techniques are very expensive for large lakes such as the Yahara chain of lakes, they can only be undertaken where there are assurances that the sources of pollution have been removed. The expense of these undertakings also highlights the importance and cost-effectiveness of pollution prevention.*** Lake restoration techniques include hypolimnetic aeration, hypolimnetic withdrawal, artificial circulation, dilution, nutrient diversion, dredging and nutrient inactivation.

Issue:

Lake Restoration

- Restore lake ecosystems by:
  - Controlling flow into lakes
  - Diverting flows away from lakes
- Use ecological engineering through physical and chemical methods
- Control nutrient inputs before it enters lakes.

Before and after: Lake BelleView Restoration Project, Belleville WI

In hypolimnetic aeration, oxygen is pumped into the deep, nutrient enriched and oxygen depleted zone called the hypolimnion. This aeration maintains oxygen and limits phosphorus release from sediments while preventing water layer mixing (destratification). Hypolimnetic aeration has the added benefit of expanded habitat but is offset by expensive operation costs. It may also be difficult to aerate the hypolimnion without causing destratification and promoting algae blooms. Hypolimnetic withdrawal involves siphons that remove nutrient rich and low oxygen waters from the hypolimnion. However, this technique requires draining these areas into downstream waters, which will generate ecological problems elsewhere.

Artificial circulation is the installation of engineering devices including fountains, paddle-wheels and air diffusers which prevent stratification and increase aerobic habitat. These techniques are more suitable for small lakes and ponds.

Dilution directs lower nutrient drainage waters into high nutrient lakes. This generates problems similar to hypolimnetic withdrawal and may use water that is scarce or expensive to acquire.

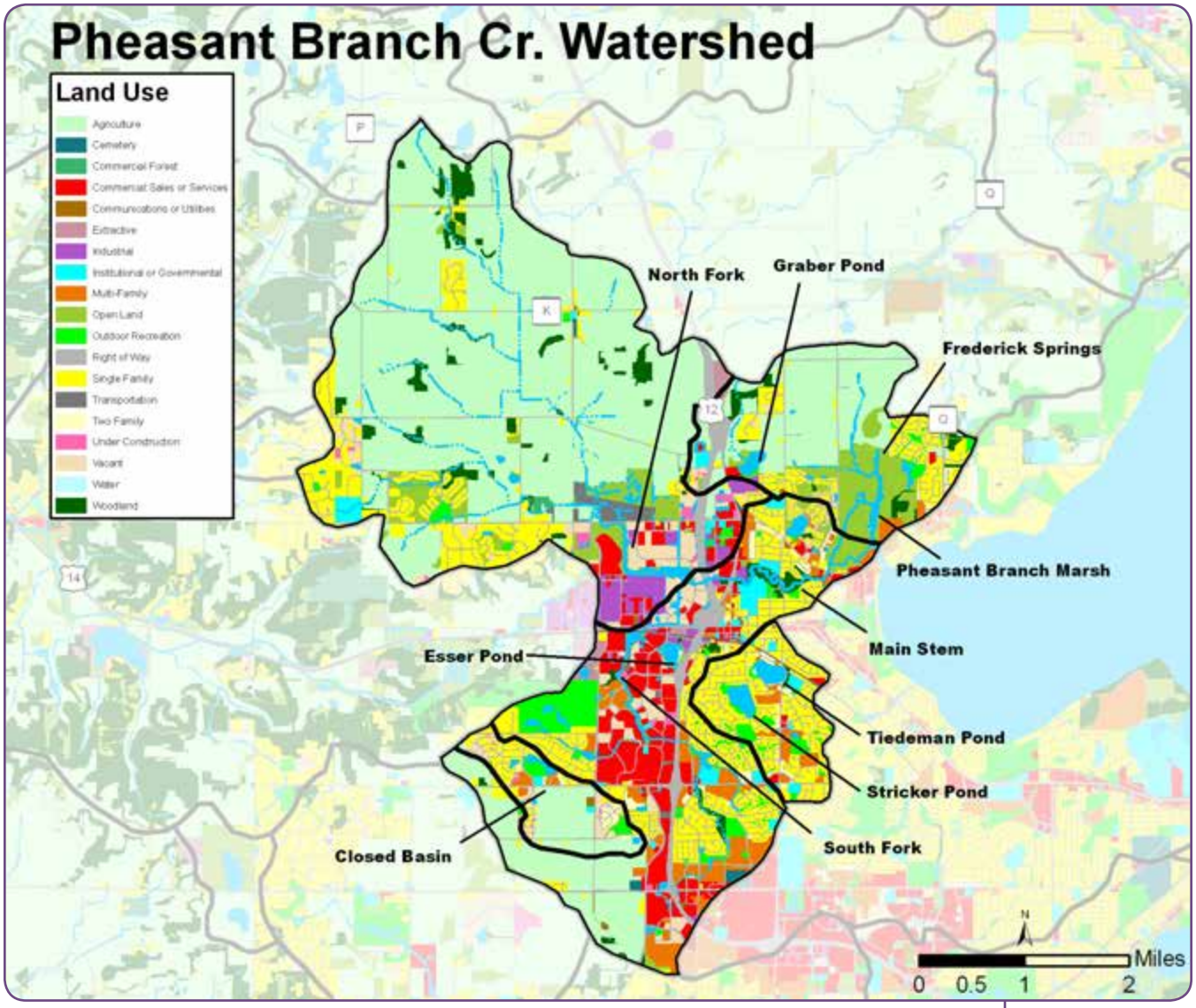
Nutrient diversion uses drainage channels to divert nutrient rich waters around lakes and into the downstream side of lakes. Such diversions may impair fish mobility, particularly for reproduction and is often difficult to find alternate diversion sites. It may be difficult to find new diversions for Madison area lakes considering this engineering has already been enacted for wastewater. Further diversion will also reduce the baseflow in the Yahara system, and this is already a concern due to the adverse impact of groundwater withdrawal.

Dredging uses heavy equipment to remove accumulated sediments. This may also remove nuisance aquatic vegetation, but also temporarily impair habitat. Dredging can be prohibitively expensive and may be most suitable for small lakes.

Nutrient inactivation is accomplished through addition of aluminum, calcium, or more rarely iron compounds. Lake projects typically use aluminum sulfate (alum) to chemically inactivate phosphorus. When added to lake water, the alum forms aluminum hydroxide which forms a flocculent which then precipitates out of the water column. This removes phosphorus and other suspended particles. As the flocculent settles on the lake floor, it forms an insoluble solid at low or zero dissolved oxygen. Nutrient removal efficiencies exceeding 90% are common. Nutrient inactivation effectiveness is determined by lake size and amount of alum applied. This treatment may last for eight years in small lakes and longer in deeper lakes. This method has been used successfully in several Wisconsin lakes in the 1970s. Despite these potential benefits, aluminum can become a toxic metal when water acidity drops below a pH of 6. Lake pH may change if acid rain is a problem. Observations of treated lakes with normal pH do not show any detrimental effects to invertebrates or fish.

There are multiple options may be available for lake restoration for Lake Mendota. Some of them may not be financially plausible because of the large size of the lake.

Map 18



a. Pheasant Branch Creek

Pheasant Branch Creek originates out of the glacial moraine located in the Town of Springfield (T8N, R8E, Sec. 17). It flows southeast through the City of Middleton, through a large wetland, before entering the western corner of Lake Mendota. The stream is seven miles in length having a drainage area of 22.7 square miles (see Map 18).

Land use is dominated by agriculture (46%), followed by residential (16%), Transportation (10%), and wetlands (2%). ***The existing biological use of the first mile of Pheasant Branch between Lake Mendota and the Pheasant Branch Marsh is designated a warmwater sport fishery (see Maps 15 and 16, and Table 4). Above the confluence with the channel coming in from the west, the Marsh is designated as a coldwater fishery.*** The WDNR considers the remaining nine miles to support a tolerant limited forage fishery. Dissolved oxygen readings below the water quality criterion limit of 5 mg/L for warmwater streams (NR 102) have been recorded during USGS and WDNR monitoring in this segment, with the lowest reading being 3.5 mg/L.

Issue:

Excess Nutrients and Sediment

What has been done since late 1990s:

- Agricultural BMPs
- Urban BMPs

What else can be done:

- Increase resources for agricultural BMP implementation
- Retrofit BMPs in older urban areas
- Restore wetlands, woodlands, prairies, and pastures in selected agricultural areas.

Pheasant Branch is included on the state 303d list of impaired waters for degraded habitat and low dissolved oxygen due to sediment and phosphorus[52]. It is also included in the Rock River Basin Total Maximum Daily Load (TMDL) project for these same pollutants. The proposed load allocations are 137 tons/y. total suspended solids and 969 lbs/yr total phosphorus. Implementation measures have not yet been defined among agricultural and urban sources.

Until about the mid-1800s, the Pheasant Branch watershed above USH 12 drained into a large wetland flat that surrounds the present confluence of the North and South Forks of Pheasant Branch near Airport Road. Water stayed in the wetland most years, though it may have spilled westward into the Black Earth Creek watershed during extremely wet conditions. Early settlers created the North Fork channel when they drained the wetlands in the 1800s and redirected water into a natural channel east of Highway 12. That channel became the main Pheasant Branch channel.

The main stem of the creek is almost entirely within the City of Middleton and has a very steep gradient. The gradient has been moderated by a series of engineered concrete drop structures installed between USH 12 and Century Avenue to help dissipate the erosive energy of storm flows. The stream channel in this area is geologically very young, resulting in a shifting stream course, cutting deeply into sandy, highly erodible soils found there. Eventually the creek flows through Pheasant Branch Marsh. ***The marsh is slightly over 300 acres and is one of the prime wetland areas remaining.*** During the 1950s, the creek took a new channel, bypassing the marsh and flowing directly to Lake Mendota. The channel was re-routed back through the marsh in 1971. The stream now follows this re-created channel into the marsh and then follows a natural channel out of the marsh into Lake Mendota.

Pheasant Branch Creek Headwaters

52 See: http://dnr.wi.gov/org/water/wm/wqs/303d/

In 1979, Pheasant Branch and Six Mile Creeks were selected by WDNR as a Priority Watershed Project under the state's Nonpoint Source Pollution Abatement Program (NR 120). The goal was to implement proper land use practices, to reduce soil erosion and nutrient runoff and improve overall stream quality and integrity.. This watershed project was completed in 1991. The project was unsuccessful, however, in reducing the impacts of nonpoint source pollution on these two creeks. This was due to poor enrollment of participants, out of state landowners, and lack of maintenance of best management practices. In 1993, Pheasant Branch Creek was included in the Lake Mendota Priority Watershed Project along with other tributary streams. Over $12 million was spent on agricultural and urban best management practices, stormwater ordinance development, and technical assistance. To date, a comprehensive analysis of the estimated phosphorus and sediment load reductions associated with the Lake Mendota Priority Watershed Project has not been conducted.

Pheasant Branch Creek and the factors that are impairing its water quality vary by reach, or areas showing similar characteristics, as follows:

North Fork Pheasant Branch Creek

Land in the North Fork subwatershed is predominantly agricultural until it gets to Morey Field north of Airport Road. Most of the North Fork channel consists of agricultural ditches constructed to drain extensive wetlands that once existed in the present floodplain. Much of Pheasant Branch upstream of Airport Road has been channelized and straightened to facilitate agricultural production. ***The stream and the drainage ditches leading to it generally have minimum vegetative buffer. There are also some large animal husbandry operations contributing sediment and nutrients to the stream, including manure spills causing fish kills.*** The channel has a small baseflow, mostly occurring south of Schneider Road. Wetland destruction, sediments and nutrients from agricultural fields, and barnyard runoff have destabilized stream banks downstream, elevated water temperatures, and destroyed fish habitats.

Issue:

Ecology of North Fork Pheasant Branch Creek

What has been done since late 1990s:

- Agricultural BMPs
- Urban BMPs

What else can be done:

- Increase resources for agricultural BMP implementation
- Retrofit BMPs in older urban areas
- Restore wetlands, woodlands, prairies, and pastures in selected agricultural areas.

This area has very little available habitat for aquatic macro-invertebrate and fish, and fish movement has been virtually eliminated due to impassible concrete structures used to control water velocities generated during stormwater runoff events.. Sedimentation is a major problem and has covered the suitable substrate with over a meter of fine materials in most areas. The fishery in this reach is comprised primarily of warmwater forage species, with some rough fish and other tolerant species (e.g., brook stickleback, creek chub, and white sucker). The fishery is limited due to aforementioned factors. These flood control structures are located at USH 12 and further downstream. Macro-invertebrate communities also indicate water quality degradation. Organic loading is a major factor impairing overall water quality. HBI[53] scores range from 6.35 to 8.24 (see Table 5) indicating fair to poor water quality. Samples were dominated by Isopods *(Asellus intermedius)*, a highly

53 The Hilsenhoff Biotic Index (Hilsenhoff, 1982) uses aquatic insects as biotic indicators of water quality. The Index is based on organisms' tolerances to low dissolved oxygen levels and is designed to evaluate the status of organic and nutrient pollution in streams. The Index of Biotic Integrity (Lyons 1992 and 1996) is another popular method.

tolerant aquatic arthropod. EPT[54] percentages were also very low, indicating the absence of intolerant organisms indicating poor water quality.

Between Airport Road and Parmenter Street, Pheasant Branch flows through the Middleton commercial park. The section through the commercial park had been channelized, but Middleton has re-meandered the stream within the floodway between Airport Road and Parmenter Street. Middleton has also installed a large detention pond just upstream of USH 12, designed to reduce peak flows and sediment loading. Pheasant Branch is rapidly eroding its channel through the terminal moraine between Parmenter Street and Century Avenue where it has carved a steep, narrow ravine. The peak stormflows exacerbate the erosion downstream of Parmenter Street. The City of Middleton has employed different types of bank stabilization efforts to reduce the erosion. The channelization and straightening of the stream channel, coupled with the rapid urbanization have increased peak flows carrying sediment and nutrients to Pheasant Branch Marsh and ultimately Lake Mendota.

The City of Middleton has a track record of implementing high stormwater control standards for new development. These standards have helped to control increases of runoff volumes and the resulting channel erosion, water quality degradation, and diminished ecological health of the stream. Reduced loads of phosphorus and sediment also help reduce turbidity and summer algae blooms in Lake Mendota. ***Continued good planning and expanded implementation of best practices to older urban areas can enhance ecological conditions in the North Fork. Such practices include innovative stormwater and erosion control techniques such as enhanced infiltration, improved agricultural conservation methods designed to reduce sediment and nutrient discharge, and wetland restoration to help store and control stormwater and trap sediment.*** More detailed development strategies and design recommendations are included on page 172; and in Chapter IV, page 217.

54 EPT refers to the percentage of intolerant insect groups Ephemeroptera + Plecoptera + Trichoptera represented.

South Fork Pheasant Branch Creek

The South Fork of Pheasant Branch is intermittent flowing north from its headwaters near Mineral Point Road to meet the North Fork near the USH 12/14 interchange. ***The South Fork is primarily a stormwater drainageway for a large part of the west side of Madison and Middleton. This area probably had no channel prior to European settlement.*** The present channel resulted from agricultural drainage and urban development, with no baseflow and minimal ecological value. During intense rains the channel exhibits flashy flows which carry high concentrations of suspended sediment from channel and construction erosion downstream to Pheasant Branch Marsh and Lake Mendota. There are good opportunities for retrofit BMPs, even in densely developed areas, but it is generally more expensive than if these practices are installed during initial development. Costs can generally be reduced when retrofits are constructed as part of reconstruction or redevelopment projects.

Issue:

Ecology of South Fork Pheasant Branch Creek

Habitat:

- Artificial drainage, not natural habitat. No ecological value

Species: Indices of Biotic Integrity

- Invertebrates: Potentially useful for emergent adult aquatic insectsRetrofit BMPs in older urban areas
- Fish: Unlikely to have resident fish populations

Pheasant Branch Creek Mainstem

The section of stream from USH 12 downstream to Lake Mendota is uniquely different from that described above. The main stem of Pheasant Branch Creek flows through a highly urbanized area of the City of Middleton. The stream has been impacted by the drainage work which occurred upstream in the old glacial Lake Middleton area. The Pheasant Branch Creek channel is still extremely young (geologically speaking), and in a constant state of change. The slopes of the stream valley are generally very steep, and the native material consists mainly of fine-grained sands which are extremely erodible. This reach of the creek has long been a source of concern and expense for the residents of Middleton due to the unstable banks, the steep channel gradients, the excessive peak flood flows and large amounts of sediment which are transported through the system with subsequent deposition in the downstream marsh areas and Lake Mendota. Considerable effort has been expended in bank stabilization, channel realignment and dredging.

Issue:

Ecology of Pheasant Branch Creek Mainstem above CTH M

Habitat:

- Artificial drainage, not natural habitat. No ecological value

Species: Indices of Biotic Integrity

- Invertebrates: ranges from fairly poor to very poor
- Fish: very poor
- Riparian: Degraded with little plant diversity leading to erosion.

Efforts to decrease stormwater runoff would reduce erosion rates and the public and private costs of repairing erosion damage. Presently, erosion in the upper reach of the main channel valley threatens several structures including two bridges, an old sanitary sewer interceptor buried along the channel and a newer constructed sewer crossing. Since the late 1960s the City of Middleton has spent about a half million dollars for main channel stabilization. These attempts to mitigate upstream problems include streambank reinforcement and structures that reduce flow during peak periods. A stormwater control dam downstream of the CTH M bridge has had a positive impact in regulating stormwater runoff. However, this structure has two major drawbacks since it increases temperature and prevents fish migration. Low baseflow is also a limiting factor impacting the available habitat for aquatic species.

Stormwater runoff from older developed areas continues to be one of the biggest factors degrading this reach. Loss of infiltration areas being replaced by impervious surfaces decreases the amount of infiltration and, in return, generates tremendous amounts of stormwater runoff. This runoff increases water temperatures, depletes dissolved oxygen, increases turbidity, and deposits other contaminants, garbage and debris into the stream. In addition, streambanks from USH 12 downstream to CTH M have areas of severe erosion. Little plant life occurs in the understory due to the inability of sunlight to penetrate through the heavy deciduous foliage. This situation exposes a tremendous amount of bare soil to erosive runoff events.

Issue:

Sediment and High Peak Flows

What has been done since late 1990s:

- Agricultural BMPs
- Urban BMPs

What else can be done:

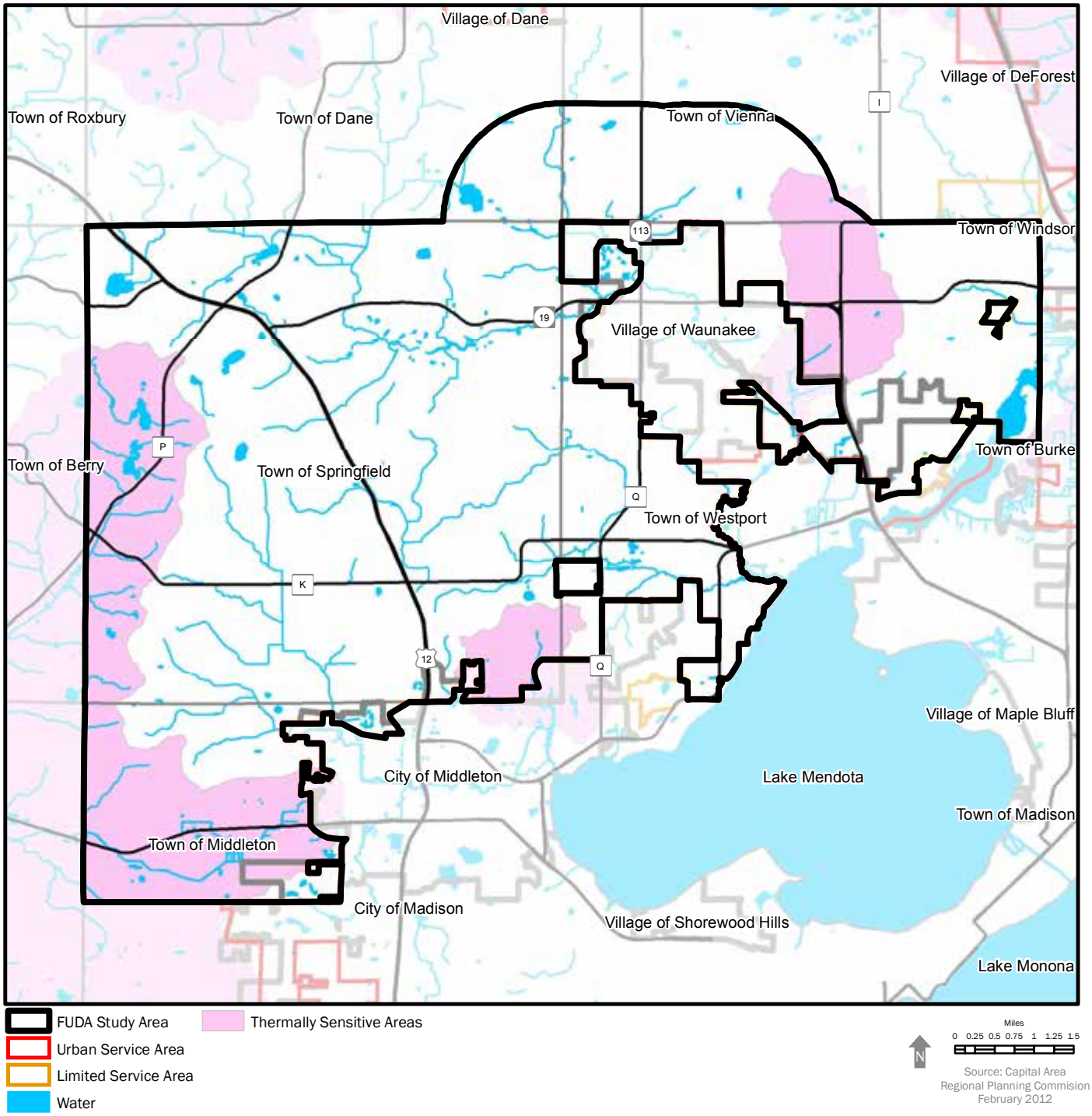
- Increase resources for agricultural BMP implementation
- Retrofit BMPs in older urban areas
- Restore wetlands, woodlands, prairies, and pastures in selected agricultural areas.

The fishery in this section is subdivided into two areas: the area located upstream of CTH M and the area downstream. HBI monitoring of macroinvertebrates ranged from 7.15 to 7.11 (see Table 5) indicating fairly poor to poor water quality conditions for the reach upstream of CTH M to USH 12. Only two species of fish were found in this reach which was surprising given what was considered relatively good habitat conditions. WDNR baseline fish IBI monitoring done in 2009 at two locations indicated the stream had a very poor biotic integrity rating at both stations. This is consistent with earlier IBI monitoring.

The section from CTH M downstream to the entrance of Lake Mendota is quite different from the portion above CTH M. Streambank erosion is minimized the further one travels downstream because the upland corridor changes from a deciduous wooded, highly developed urban landscape to a more naturally occurring area (the Pheasant Branch Conservancy) including a series of small wetlands. From there the lower portion of the main channel flows into Pheasant Branch Marsh where it receives an estimated 1,000 gallons of water per minute from a spring complex to the north (Frederick Springs). The combined flow is then conveyed through the Pheasant Branch Marsh to Lake Mendota. Because the land in this area is very flat, the lake level controls water levels in the final section of the creek. ***This portion of the channel is ecologically important because it connects the lake to the spring-fed marsh. WDNR has identified this area as a coldwater resource, which is also protected by Dane County thermal performance standards*** (see Map 19, and Dane County Ordinance Chapter 14.53(2)(f)).

Map 19: Thermally Sensitive Areas

North Mendota Study Area, Dane County, WI



Thermally Sensitive Areas are areas within a watershed that drain to an existing or proposed Cold Water Community or Class I, II, or III Trout Stream, as designated by the Wisconsin Department of Natural Resources. These streams are capable of supporting coldwater fish and other aquatic life. Special thermal performance requirements have been established in Dane County Ordinance, Chapter 14.53(2)(f).

The stream channel within the marsh has shifted a number of times in the past and has been re-channelized. The channel continues to shift as sediment is deposited in the marsh. ***Sedimentation is a major problem in the Lower Pheasant Branch.*** Some of the sediment carried by the creek is deposited in the marsh, while the rest is conveyed to Lake Mendota. Turbid water prevents vegetative growth in the channel and severely limits wildlife habitat potential. Better erosion control and stormwater management in the watershed would greatly improve conditions in this reach.

The fishery in this section has a diverse warmwater sport fishery reflective of that in Lake Mendota, due to its proximity. Species include bowfin, northern pike, common carp, southern redbelly dace, largemouth bass, and some panfish species. Certain species of fish use the creek during different stages of their life cycles, ***with some species using the stream for spawning and others for brood rearing.***

In 1994, Dane County purchased 161 acres from Vernon and Katherine Fredrick adding to the Pheasant Branch Creek Natural Resource Area (NRA) identified in the Dane County Parks and Open Space Plan. NRAs consist of lands that contain especially valuable natural resources or greenbelt corridors identified through a public process. Lands within the NRA are eligible to be purchased and protected using state and local conservation funding. This is an entirely voluntary program conducted in cooperation with participating landowners. ***This area is one of the largest undisturbed wetlands in the watershed, and contributes significantly to spring flow to Pheasant Branch Creek. This wetland is highly valued for fisheries, wildlife, and human aesthetics. WDNR recently purchased 60.5 acres from Dane County for the protection and enhancement of this wetland. This wetland complex contains many beneficial wildlife, fisheries, and human scenic values. Fisheries Management has a special interest in this area for northern pike (Esox lucius) spring migration for spawning and rearing.***

USGS Hydrologic Study

In 2001 USGS published a study of the hydrologic effects of urbanization with no stormwater management measures on Pheasant Branch Creek (Steuer 2001). The modeling indicated that single family residential development assumed in the undeveloped parts of the sub-watershed (Future Scenario A) would increase overland flow 84% and increase mean annual streamflow by 53%. This scenario would also decrease regional groundwater recharge by 10% and decrease baseflow by 15%. Discharge from Frederick Springs was estimated to be reduced by 5%. The increased overland flow and mean annual streamflow coupled with an overall decrease in baseflow indicates a system with more "flashy" characteristics and greater erosion potential.

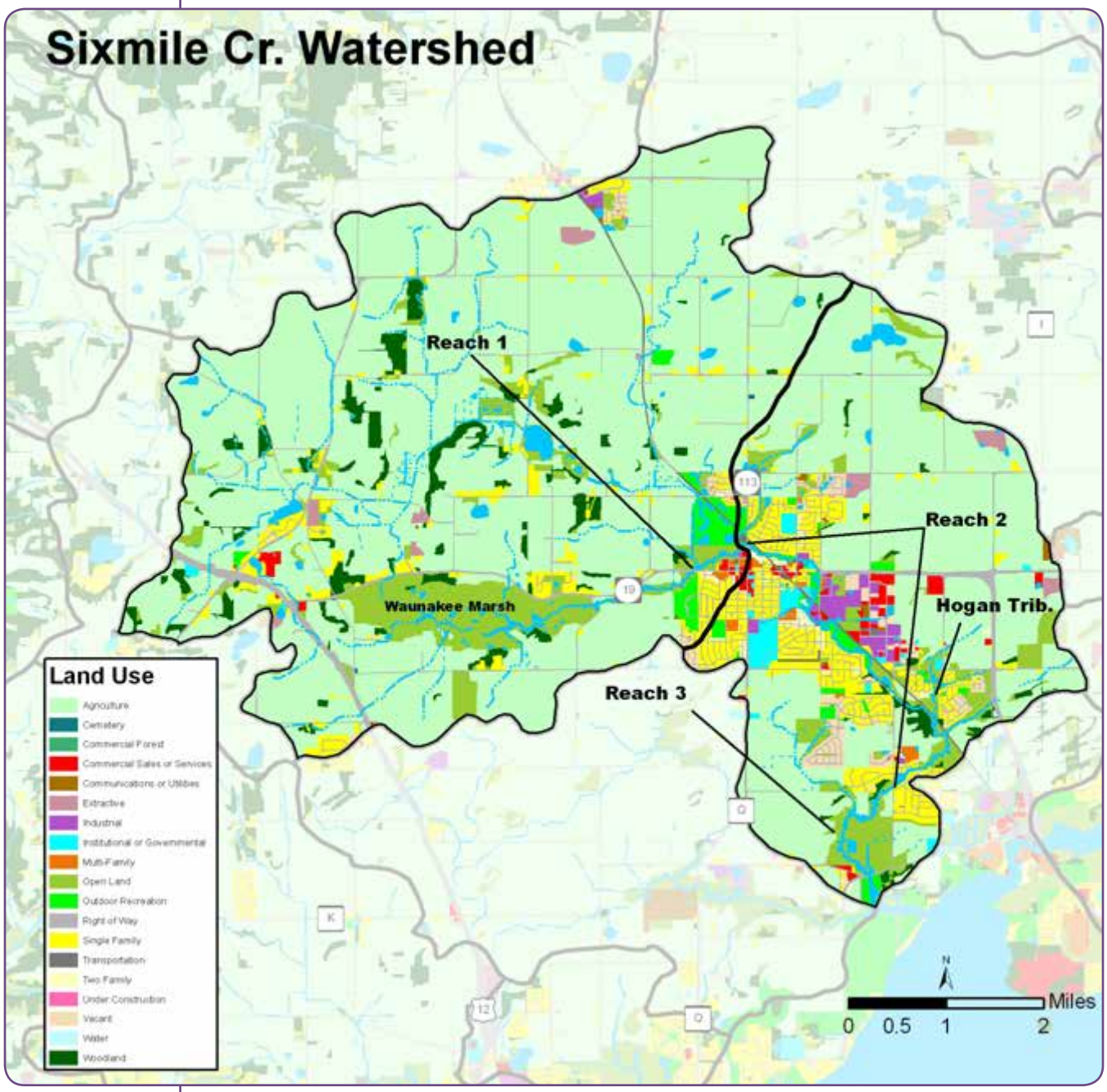
In Future Scenario B, the entire North Fork was modeled to contain 50% commercial and 50% multi-family residential land use. Mean annual streamflow increased by 300%, overland flow increased by 450%, annual recharge to the groundwater system decreased by 53%, and baseflow decreased to zero. Discharge from Frederick Springs was estimated to be reduced by 26%, compared to present conditions. ***It is important to note that neither of these scenarios included stormwater management practices, since this study was conducted before county-wide stormwater management requirements were in effect. However, these scenarios underscore the importance of stormwater management and mitigation measures which are currently undertaken for new development and as retrofit measures in older urban areas.***

According to Hunt (2000), the surface water drainage system is complexly coupled with the groundwater system making it difficult to reliably predict actual impacts of urbanization on surface water baseflow and spring flows. The result of the surface water hydrology and the groundwater recharge modeling conducted in the Pheasant Branch watershed provide the best possible estimates and provides an initial effort to better understand, maintain, and even improve the ground/surface water balance. More detailed development strategies and design recommendations are included on page 170; and in Chapter IV, page 217.

b. Sixmile Creek

Sixmile Creek originates in Springfield township (T8N R8E, Sec. 2), flowing south into the Waunakee Marsh, then east and south through the Village of Waunakee, finally entering the north end of Lake Mendota. Sixmile Creek is 12.0 miles in length with a drainage area of 43 square miles. ***The entire twelve miles of Sixmile Creek is classified as an Exceptional Resource Water (ERW).*** NR 102.11 Wisconsin administrative Code defines an ERW as ***"surface waters which provide valuable fisheries, hydrologically or geologically unique features, outstanding recreational opportunities, unique environmental settings, and Map 20 which are not significantly impacted by human activities."***

Map 20



Primary land uses in this watershed (see Map 20) are agricultural (72%), residential (14%), transportation (5%), and wetlands (5%). As agriculture expanded in the Sixmile Creek watershed over the last century, many of its wetlands were drained to provide pasture and cropland. The major remaining wetlands are the large Waunakee Marsh (1,043 acres) north of the Town of Springfield, and wetlands along the lower parts Sixmile Creek and Dorn Creek near Lake Mendota. Many of the remaining wetlands have been disturbed by grazing, filling, ditching, water level changes, and the invasion of shrubs and other disturbance vegetation. Thick silt deposits have built up on the creek bottom and in many wetland areas, especially south of CTH M. However, ***the remaining wetlands still retain some of their important functions for floodwater retention and spawning habitat for northern pike and panfish.***

Issue:

Excess Nutrients and Sediment

What has been done since late 1990s:

- Agricultural BMPs
- Urban BMPs

What else can be done:

- Increase resources for agricultural BMP implementation
- Retrofit BMPs in older urban areas
- Restore wetlands, woodlands, prairies, and pastures in selected agricultural areas

The major problems having an impact on Sixmile Creek include destruction of valuable wetlands, sediment and phosphorus loading from agricultural fields and barnyards, sediment loading from construction site erosion and urban runoff, excessive emergent aquatic plant growth in the stream, and loss of aquatic habitat due to sedimentation.

Sixmile Creek has been the focus of various remediation efforts over the last 30 years associated with the state's Nonpoint Source Abatement Program (NR 120), along with Pheasant Branch Creek and other Lake Mendota tributaries as described above. A comprehensive assessment of the estimated phosphorus and sediment load reductions associated with these Priority Watershed Projects has yet to be conducted. Recently, ***Sixmile Creek has been included with other streams in the Rock River Basin Total Maximum Daily Load (TMDL) project establishing necessary phosphorus and sediment reductions. These efforts are just beginning. Implementation measures among the various agricultural and urban sources have not yet been defined.***

The factors that are impacting the creek vary by reach, or areas showing similar characteristics, as follows:

Headwaters to STH 113 – Reach 1

This segment contains Waunakee Marsh, a large wetland complex. The marsh is over 1,000 acres in size and has a drainage area close to 12,000 acres. From its headwaters the creek runs through Waunakee Marsh and the channel is lost. The creek becomes re-established just west of Kingsley road. Primary land use in this portion of the watershed is dominated by agriculture followed by grassland. ***Factors impairing this reach include sediment and nutrient loading from agricultural and barnyard runoff, nutrient loading from the wetland itself, lack of habitat, heavy instream emergent aquatic plant growth, construction site erosion, urban impacts, and areas of instream sediment deposition.***

Issue:

Ecology of Headwaters to STH 113 – Reach 1

Habitat

- Stream to inter-marsh habitat, likely useful to birds and aquatic mammals

Species: Indices of Biotic Integrityl

- Invertebrates: fair to poor quality
- Fish: poor quality
- Riparian: open sedge meadows, some willow stands, reed canary grass. Well developed woodland riparian in upland areas.

The biological use in this section is ***designated as limited forage fishery*** comprised of warmwater species (e.g., central mudminnow, creek chub, brook stickleback, white sucker, and fathead minnow). Intolerant species included pearl dace, and northern redbelly dace. These two species were found in abundant numbers at the Kingsley road site, but absent at the STH 113 site. Several sport fish species were also found. Macro-invertebrate samples range from fair at STH 113 (HBI of 6.05) to poor at Kingsley road (HBI of 7.90). Fish IBI monitoring indicate a poor biotic integrity rating. Samples were dominated by Isopods *(Asellus intermedius),* and very low EPT[55] ratios. The substrate in this first reach seems to be a mix of fine materials, until the stream crosses under STH 19. The portion from STH 19 to STH 113 has a more diverse substrate consisting of fine silt and sand, coarse sand, gravel, and cobble. Through its reach just east of Kinglsy road approximately one quarter mile downstream to STH 113, the Creek is well buffered on both banks, evidenced by its change in stream substrate. There is a small intermittent tributary that enters Sixmile Creek just west of STH 113. This tributary has a limited forage fishery, due to its intermittent nature. Species are similar to those found in Sixmile Creek. Macro-invertebrates indicate fair water quality (HBI of 6.17).

STH 113 to Woodland Drive – Reach 2

The second reach of stream includes the section from STH 113 downstream to Woodland Drive. This reach runs through the Village of Waunakee. Land use in this reach includes a rapidly expanding urban component. Below STH 113, the gradient is steeper and the stream substrate changes from sand/silt to a sand/rubble/cobble/boulder streambed with less emergent aquatic plant growth in the main channel. The stream morphology also changes from a continuous run to more of a run/riffle/pool sequence. Consequently ***the fishery also changes from a limited forage fishery to a warmwater sport fishery*** comprised of both sport fish and tolerant forage fish species (see Map 16). Electroshocking surveys identified up to 16 different species of fish. Some of the unique species included central stoneroller, pearl dace, slenderhead darter, and the brook silverside, all of which are intolerant species

55 EPT refers to the percentage of intolerant insect groups Ephemeroptera + Plecoptera + Trichoptera represented.

and indicators of good water quality. Various other species of sport fish, tolerant warmwater forage fish, and several species of rough fish were also found.

Macro-invertebrate samples were fair to good at Mill Road (HBI of 5.26 to 5.76) and good at STH 19 at Waunakee Park (HBI of 5.11). The EPT[56] ratios ranged from 21 to 65 percent respectively indicating the presence of intolerant species and good water quality. ***This reach has the best substrate for aquatic organisms to inhabit. It also has the best diversity of habitat, both for type of organisms and life stage requirements (spawning, rearing, etc.).*** Substrate consisted of fine silt and sand, coarse sand, gravel, cobble, and boulders. Channel morphology is fairly sinuous, and the run/riffle/pool ratio is also good. Pools and runs provide adequate depth, and the riffles provide good diversity of substrate size as well as depth. The gradient is steeper causing water velocities to increase, improving the streams ability to scour substrate, thus transporting sediment bedload downstream. There is evidence of unstable stream banks and bank failures, causing collapse and erosion. These sites are located downstream of Division Street and Mill Road. Signs of construction site erosion and instream sediment deposition are also visible below Mill Road. There is historical evidence of bank failures in several other areas since these sites have been stabilized by using rip-rap, shaping, and seeding. ***The primary threats to water quality in this reach continue to be from urban nonpoint sources, runoff from impervious surfaces and construction sites in the Village of Waunakee and the Town of Westport.*** Fish IBI monitoring in 2000 and 2007 indicate a poor biotic integrity rating, likely the result of upstream urban influences. ***Whereas the habitat and water quality may be good, the fish species present are not reflective of that. More investigation is needed to determine the cause of this discrepancy.***

Issue:

Ecology of Headwaters to STH 113 – Reach 2

Habitat

- Important in-stream breeding habitat. Sites do have streambank erosion

Species: Indices of Biotic Integrity

- Invertebrates: good quality
- Fish: mix of good water quality fish & tolerant warmwater fish
- Riparian: Riparian trees limited in urban areas

Hogan Tributary

There is a small tributary that originates in Westport township (T8N, R9E, Sec. 10), and enters Sixmile Creek in Section 16. ***This tributary is a narrow coldwater stream and is well buffered above Bong Road all the way to Hogan Road.*** Below Bong Road the stream corridor is partially pastured by livestock. The area above Hogan Road is surrounded by agriculture cash crop and a small fruit farm. Macro-invertebrates at Bong Road crossing ranged from good to fair (HBI of 5.13 to 5.60). ***The stream also contains large beds of watercress, an indicator of good water quality and high groundwater discharge.*** The EPT percentages, however, ranged from 0 to 5 percent which are low. Overall substrate seemed to be diverse, with a good run/riffle/pool ratio. The tributary has a mean width of around 3-5 feet, and an average dept of 8 to 10 inches, and the deepest pool of approximately 24 to 30 inches. The reach of stream from Bong Road to Hogan Road has a narrow wetland that buffers the tributary on both banks.

Issue:

: Ecology of Hogan Tributary

Habitat

- Coldwater stream resource

Species: Indices of Biotic Integrity

- Invertebrates: good to fair quality
- Riparian: Clustered, some areas have riparian buffers, others lack buffers

Woodland Drive to Lake Mendota – Reach 3

The third reach includes Woodland Road downstream to the mouth of Lake Mendota. This reach has characteristics that make it quite different from the two upper sections since its overall width and depth increase, and gradient and velocity decrease. This portion seems very turbid and the stream changes from a run/riffle/pool profile to a continuous run. Stream substrate seems to consist of mainly fine sediments. There are also areas of this segment that are obstructed due to large wood/debris dams. An electroshocking survey could not be performed because of the depth.

In the early 1980s the WDNR purchased ***six acres of wetland near the mouth of Sixmile Creek to preserve northern pike spawning habitat.*** Northern Pike enter this controlled wetland to spawn in April. Wetland levels are maintained high until the small juveniles (fingerlings) reach an average size of two inches. The wetland is then drawn down forcing the fingerlings to migrate out of the wetland and into Sixmile Creek and downstream into Lake Mendota. In a good year this six acres of wetland can produce as many as 20,000 fingerlings. ***This is a valuable resource to maintain, since northern pike populations are steadily increasing in Lake Mendota.*** Stocking northern pike is very expensive (estimated $3.50/fish)[56]

Issue:

Ecology of Woodland Drive to Lake Mendota – Reach 3

Habitat

- Stream to Lake transition zone, turbid waters refuge for some fish

Species: Indices of Biotic Integrity

- Invertebrates:
- Fish: Limited data, reach useful for pike
- Riparian: Thick riparian zones, with mature trees closer to Lake Mendota.

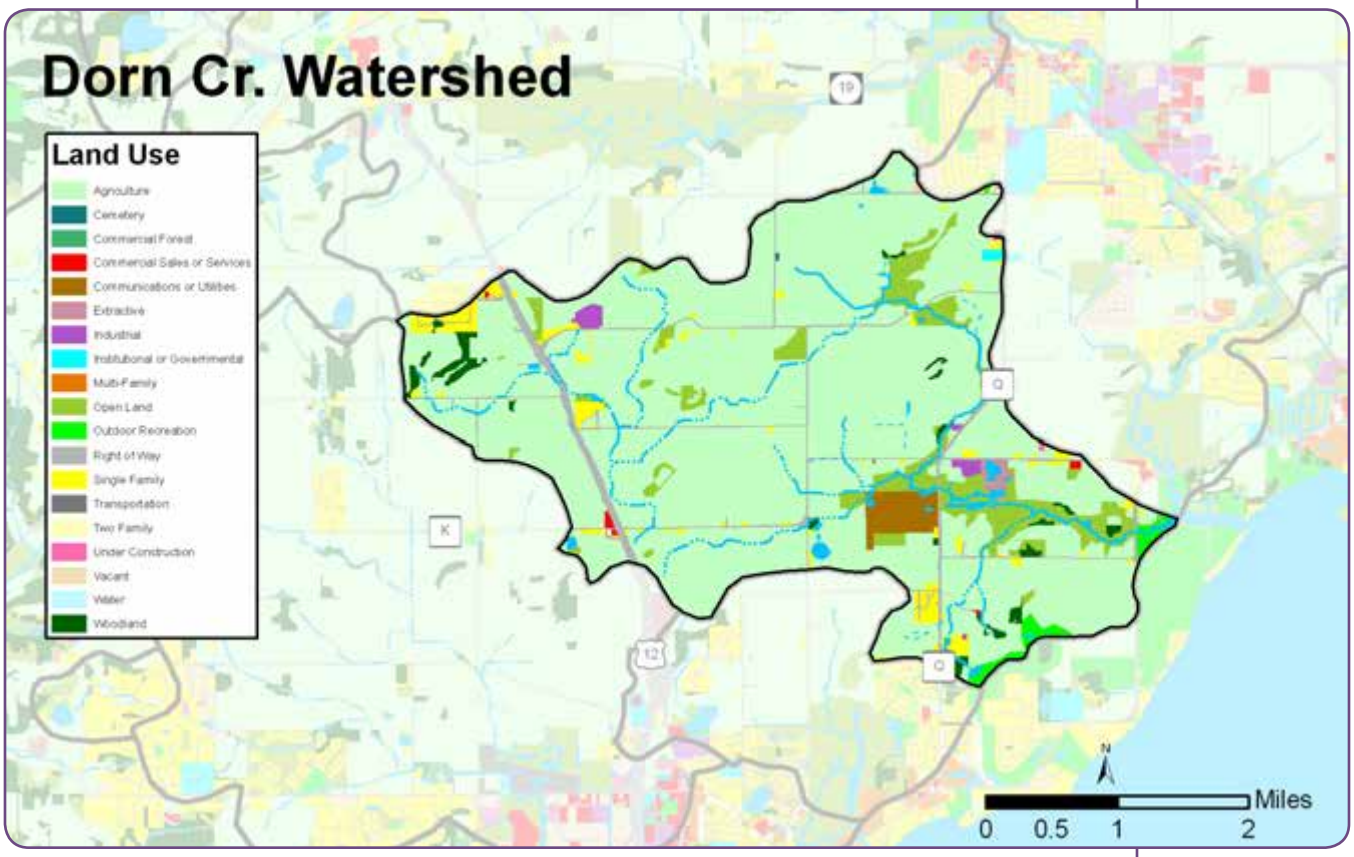
56 Personal communication with Mike Vogelsang, DNR Fisheries Manager 2000

Overall, the primary threats to water quality in Sixmile Creek continue to be from agricultural and urban nonpoint sources in the watershed. Urban sources include runoff from impervious surfaces in the older parts of the Village, and construction sites in the Village of Waunakee and the Town of Westport. ***West of Waunakee, Waunakee Marsh captures much of the sediment and nutrients from agricultural areas tributary to Sixmile Creek, which adversely affects marsh ecology. Some of these pollutants leave the marsh during periods of high water and flows.***

c. Dorn Creek

Dorn Creek originates in the town of Springfield (T8N, R8E, Sec. 13) and flows six miles southeast through agricultural lands and Governor Nelson State Park before meeting Sixmile Creek and Lake Mendota. The stream drains 12.7 square miles that are predominantly agricultural upstream of CTH Q and wetlands downstream of CTH Q. The watershed includes approximately 325 acres of shallow marsh and sedge meadow located near the mouth of the Creek and extending upstream (see Map 21). ***The state has acquired some of these lands as the Dorn Creek Marsh State Fishery Area for protection as spawning areas for northern pike and panfish.***

Map 21



Issue:

Excess Nutrients and Sediment

What has been done since late 1990s:

- Agricultural BMPs
- Urban BMPs

What else can be done:

- Increase resources for agricultural BMP implementation
- Retrofit BMPs in older urban areas
- Restore wetlands, woodlands, prairies, and pastures in selected agricultural areas.

Dane County also owns land along the Creek in this area. ***This area as well as the corridor area of Sixmile Creek up to Bong Road is part of the North Mendota Natural Resource Area (NRA) identified in the Dane County Parks and Open Space Plan. NRAs consist of lands that contain especially valuable natural resources or greenbelt corridors*** identified through a public process. Lands within the NRA are eligible to be purchased and protected using state and local conservation funding. This is an entirely voluntary program conducted in cooperation with participating landowners.

Most of Dorn Creek retains its natural meandering configuration. Although many areas of the Creek are relatively flat, its overall gradient reflects a moderate slope of 21.6 feet/mile. Dorn Creek has the steepest overall gradient of all streams in the Lake Mendota Watershed. However, the groundwater contribution to the Creek is not sufficient to maintain a high baseflow or cool summer temperatures.

A biotic index value determined on Dorn Creek at CTH M in 1980 revealed poor water quality conditions. Re-sampling was done in 1995 as part of the evaluation monitoring for the Sixmile-Pheasant Branch Creek Priority Watershed Project. The results of this sampling revealed fairly poor to good conditions. The better HBI values were near its headwaters upstream from Meffert Road, while the fairly poor value was at CTH Q. ***The stream suffers from heavy sedimentation and poor substrate conditions due to the intense agricultural activities in its watershed.*** Monitoring in a 2009 evaluation of Dorn Creek noted waist-deep silt deposits at CTH Q. The heavy instream sedimentation was also evident at downstream locations. IBIs done at two sites indicated very poor conditions.

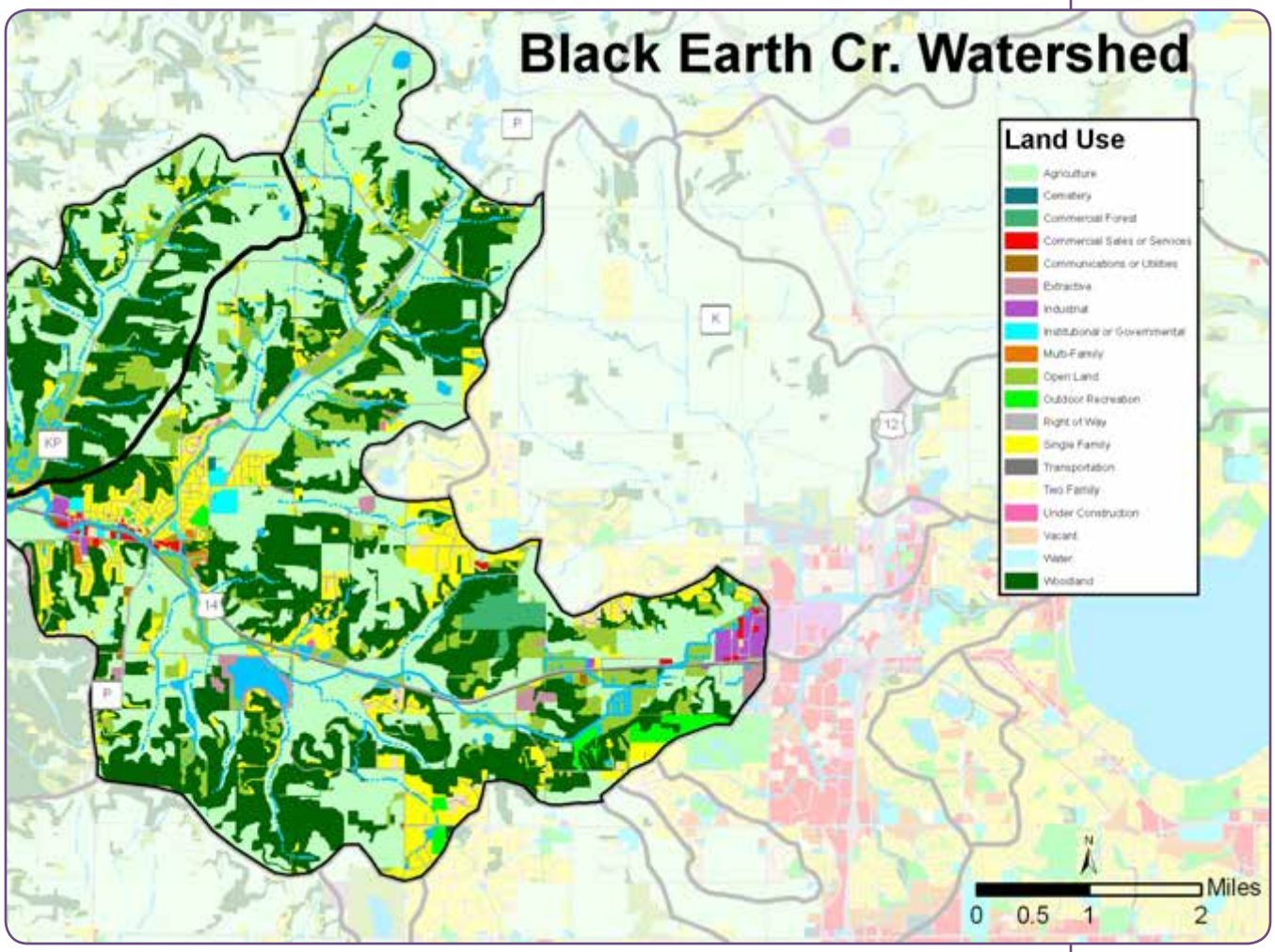
The fishery in Dorn Creek consists primarily of forage species with seasonal influxes of northern pike and panfish that spawn in the adjacent wetlands. Two intolerant species are also known to inhabit the creek – the Northern Redbelly Dace and Pearl Dace. The stream is classified as a warmwater sport fishery for approximately one mile near its mouth. For the remaining five miles upstream, the stream is classified as a limited forage fishery.

The primary water quality problem and threat to Dorn Creek is from agricultural runoff carrying sediment and nutrients from barnyards and cultivated farm fields which degrade water quality and habitat. Dorn Creek is frequently turbid and its bottom is covered in places by silt deposits as deep as four feet. Although its watershed is only about one-third the size of Sixmile Creek watershed, Dorn was estimated to contribute nearly equal the amount of sediment and phosphorus loading to Lake Mendota. This indicates the intense agricultural activities occurring in its watershed. ***Dorn Creek has been listed as a 303d impaired stream because of habitat impairment due to sediment loading. It has also been included in the Rock River Basin Total Maximum Daily Load (TMDL) project. The proposed load allocations are 102 tons/yr. total suspended solids and 867 lbs/yr total phosphorus.***

2. Black Earth Creek

Black Earth Creek arises from the terminal moraine west of Middleton and flows west about 27 miles to the confluence with Blue Mounds Creek and the Wisconsin River. Land use includes agriculture (40%), woodlands (30%), residential (9%), transportation (5%), and wetlands (2%) (see Map 22). Most of the watershed is dominated by thick deposits of glacial outwash and alluvium, materials that form an excellent aquifer for sustained stream flow.

Map 22



Black Earth Creek is a regionally popular trout stream and trout enthusiasts have rated it one of the top 100 trout streams in the nation. ***Under NR 102, Black Earth Creek is designated an Outstanding Resource Water (ORW) from Twin Valley Road downstream to the Village of Cross Plains wastewater treatment plant.*** This designation reflects the Class 1 (self-sustaining) trout fishery when the anti-degradation rule (NR 207) was adopted in 1989. ***The Upper Black Earth Creek watershed is also identified as a Natural Resource Area (NRA) in the Dane County Parks and Open Space Plan.*** NRAs consist of lands that contain especially valuable natural resources or greenbelt corridors identified through a public process. Lands within the NRA are eligible to be purchased and protected using state and local conservation funding. This is an entirely voluntary program conducted in cooperation with participating landowners. ***From Twin Valley Road approximately 1 mile upstream to USH 14 the Creek supports a***

Issue:

Low D.O. (Excess Nutrients) Sediment, and Temperature

What has been done since late 1990s:

- Agricultural BMPs
- Urban BMPs

What else can be done:

- Increase resources for agricultural BMP implementation
- Retrofit BMPs in older urban areas
- Restore wetlands, woodlands, prairies, and pastures in selected agricultural areas.
- More protective standards for both urban and agricultural non point source pollution
- Comprehensive watershed ecosystem study for the upper reach of the watershed.

warmwater forage fishery (see Map 16). North of USH 14 and west of Middleton the flow is intermittent through County-owned property. The County land includes wetlands and areas of prior-converted wetlands used for agricultural production through ditching by the previous landowners. The owners had also installed a pump near USH 14 to lift the water collected in the dewatering ditch to a culvert under USH 14 that drains to Black Earth Creek. The County has been operating the pump since it purchased the land and is planning to restore the wetlands found here.

The headwaters of Black Earth Creek have been uniformly ditched and straightened through the area and the stream flows mainly through cropland. ***The stream receives limited flow from groundwater discharge. Springs near Twin Valley Road offer the only significant groundwater input to this segment.*** Macro-invertebrate populations indicate good water quality. Natural suspension of sediments has been observed. Cropland erosion in this area is believed to be the contributing source. While this reach supports a warmwater forage fishery, isolated brown trout have been found on occasion. ***Habitat is limited because of historic hydrologic modifications. To date, no water quality problems have been associated with the Middleton Industrial Park, although attention should be placed on preventing toxins used by businesses within the park from entering surface water or groundwater.***

USGS maintains "real time" water quality monitoring stations along Black Earth Creek at Cross Plains, South Valley Road and the Village of Black Earth. ***Dissolved oxygen levels have been known to drop below the WDNR water quality criterion limit of 6 mg/L*** for coldwater streams at all three stations. These violations typically occur during storm events when specific conductance levels are lower (reflecting soft rain water inputs) and when creek levels rise. C***hronic low dissolved oxygen in the stream has been documented (Walker et al. 2001). USGS researchers attribute the low dissolved oxygen levels to organic materials with high biological oxygen demand (BOD) being washed into the stream from both rural and urban sources***. In addition to the frequent low dissolved oxygen levels, fish kills occasionally occur and sometimes result in significant trout mortality.

In June of 2001, a storm related fish kill reduced trout densities from 64% to 86% west of Cross Plains. The specific cause(s) that occurred during the 5-inch storm event is still unknown. However, WDNR reported potential sources including manure management, WPDES permitted dairy farms, urban runoff, and tile drains from former wetlands (now cropped) that could potentially have discharge pesticides, crop oils, and commercial fertilizers to the stream. It is unknown whether the fish kill was the result of a single factor or cumulative effect from many sources. The impacts of the fish kill on trout populations appeared to be relatively short-lived. Electroshocking survey results from 2002 and 2003 demonstrated that the wild brown trout are resilient in Black Earth Creek. Both sizes and densities of fish in the Creek west of Cross Plains were found at levels that preceded the 2001 fish kill (WDNR

Waters File 2003). Macro-invertebrate sampling immediately after the fish kill revealed no measureable impact of the pollution. ***Overall HBI scores for the stream indicate good water quality. Fish IBI rated fair above Cross Plains.***

While the popularity of the Black Earth Creek reflects a relatively long history of producing abundant brown trout, ***Black Earth Creek is threatened by more environmental problems than other high quality trout streams within the Driftless Area. These include agricultural ditching, the Refuse Hideaway Landfill (a U.S. EPA Superfund Site), gravel mining thermal discharges, cropland and manure runoff, two municipal wastewater treatment plants, and urbanization.*** The Black Earth Creek Priority Watershed Project (1989-2001) addressed many of these issues with partial success, including Best Management Practices (BMPs) that exceeded pollution reduction goals.[57]

Restoration efforts have not ended with the Priority Watershed Project, as continued habitat improvement and water pollution control activities reflect ongoing federal programs such as the Conservation Reserve Program (CRP), the Wetland Reserve Program (WRP), and nutrient management. Despite of these successes, frequent dissolved oxygen violations, periodic fish kills, expanding development and impervious surfaces continue to pose long term threats to the stream. ***A comprehensive watershed study is required by WDNR as part of the last Urban Service Area (USA) amendment approved in the upper watershed in Middleton.*** New USA expansions will generally not be approved in the Upper Black Earth Creek watershed until the comprehensive watershed ecosystem study has been completed and proposed development plans reflect its findings and recommendations.

Black Earth Creek

57 Appendix B of this ECR provides an excerpt of the Black Earth Creek Priority Watershed Report.

Stream Restoration

Successful stream restoration projects require both scientific understanding and participant cooperation. A fine balance must be struck between the promotion of stream health and the desires and attitudes of landowners. Symptoms of poorly functioning streams are steep bank erosion, high sediment loading, and flooding. Modifications to streams such as rip-rap, channelization, bank armoring, levees and other flood and velocity control engineering only correct in-stream problems yet do not address large scale systemic problems. Maximizing stream restoration benefits occur when the watershed level is considered. This is accomplished through land management practices that hold water and slowly release water into streams.

While restoration projects can occur in one locality, stream restoration requires coordination and negotiation with multiple landowners and jurisdictions in order to be successful. Efforts in stream restoration should be directed toward restoring processes that form, connect and sustain habitats. One challenge is to grant incentives to landowners with properties in stream headwaters, and who do not see the negative impacts of stream degradation, as compared to landowners downstream who most experience erosion and flooding.

Once landowner buy-in has been achieved, stream restoration projects should follow the five criteria for ecological success as described by Palmer et al. 2005, as follows:

1. ***a restoration goal or guiding vision that describes an ecologically healthy state that maintains dynamic properties within its regional context;***
2. ***undisturbed or recovered streams serving as restoration reference sites, specifically when historical data is lacking;***
3. ***using a design approach which uses empirical models that focus on ecological processes;***
4. ***using regional stream classification systems to guide restoration goals;***
5. ***using common sense to notice site details and remove obvious stressors (lack of riparian vegetation, unrestricted livestock).***

Successful restoration in streams requires dynamic qualities, not excessively imposed control leading to static conditions. River dynamics are often described as reaching an equilibrium that describes natural fluctuation around a character state. Stream restoration strategies often seek to correct flow regimes. Alterations in flow regimes have devastating impacts within riverine ecosystems. River flows determine flooding patterns, and it shapes the physical habitats of the river and the floodplain. Changes in flow negatively affects the distribution of organisms, impairs reproductive strategies of aquatic organisms, impairs habitat utilization and in stream connectivity. With these environmental changes, native organisms are quickly displaced by invasive species, which force their own changes on ecological structure and function.

Issue:

Stream Restoration

- • Maximize stream restoration benefits by considering watershed
  - Unify landowners to help
- Streams need to remain dynamic
- Stream restoration methods:
  - Unify landowners to help
  - Modify stream itself (hard)

In general, there are two categories of techniques used in stream restoration: non-structural or structural techniques:

Non-structural techniques use passive restoration; any restoration method that does not involve physical alteration of the environment and landscape oriented methods, changing land use through administrative or legislative means. Streams tend to be resilient ecosystems. If environmental stressors are identified and eliminated, sometimes streams will recover without active human intervention. Methods for non-structural stream restoration use fencing to exclude livestock, establishment of greenways, and conservation easements.

Pheasant Branch Cr. Confluence Pond

Structural techniques use active restoration, which does require modification to the environment. Structural techniques are divided again into two categories, those that use "soft engineering", which focuses on the use of on site natural materials such as alluvium and woody debris. This is contrasted against "hard engineering" which utilizes artificial materials like concrete, sheet piling and riprap. Physical manipulations intend to change stream sinuosity, gradient, substrate and sediment loading. As the amount of human intervention in stream restoration increases, the cost and immediate disruption to the system follows. However, physical manipulations may have more immediate results rather than potentially waiting years for streams to recover on their own.

The most likely areas within this FUDA study area that may require in-stream restoration or enhancement will be in higher order streams. Stream order is a ranking system. First order streams, have no other streams leading into them, and are headwaters of a larger stream ecosystems. The flow here is much less than higher order streams. The best means of protecting first order streams is through the use of vegetative riparian buffers (discussed on page 150). A second order stream is the confluence of two first order streams, as is a third order stream a confluence of two second order streams. As stream order increases so does sinuosity and stream bank erosion until major confluences like the Mississippi River are formed. These middle order stream locations are most conducive to using hard engineering techniques. Major areas that should be thoroughly examined are the lower branches of streams before they drain into the lakes.

The extent of a stream restoration in urbanizing environments will be ultimately determined by social values. Restoring a stream to pre-settlement conditions may not be possible. Stream restorations in this context should be guided by determining what can be done to promote a dynamically variable environment, but constrained by site history and the need to protect property.

Black Earth Creek Headwaters

3. Wetlands

Over half of the wetlands in Dane County and the U.S. have been lost over the last century, including those in the North Mendota FUDA study area. Many of the wetlands that remain have been degraded. This has resulted in the loss of important wetland ecological functions and values, but also incurs socioeconomic costs. It has become increasingly recognized that all wetlands have value – particularly since there are fewer of them remaining. Significant advances have also been made in the science of wetland restoration, as well as public opinion and policies for protecting and restoring wetland acreage, diversity, structure and function.

Wetlands play a critical role in the hydrology of river basins. Wetlands are valuable for flood control, cleansing surface water of contaminants including sediment, heavy metals and pesticides, the organic peat permanently locking many chemicals; and providing important wildlife habitat, trophic support, movement corridors, and scenic qualities. As the North Mendota FUDA study area continues to be transformed from agricultural to urban land uses, retaining these wetland functions and values will remain important.

The Wisconsin Wetland Inventory (WWI) indicates that wetlands exist along streams, small lakes and marshy areas in the study area. Based on the hydrologic modifier codes for the WWI Map units, most of these wetlands appear similar from a hydrologic standpoint, with a modifier of "K" indicating standing water during much of the growing season. Wetlands in the study area include shallow marsh, sedge meadow, shrub carr, and occasionally forested wetlands.

Limited surveys have been conducted to assess the health and quality of these wetlands. Overall, there is a broad range of biological quality among the wetland sites depending on site specific factors. Generally, the quality of these wetlands depends on nearby land use, such as the intensity of agricultural activity (i.e. pasture, cultivated or mowed land, or those that have been ditched or drained); or urban development (such as polluted runoff or filled wetlands). Low disturbance wetlands feature native wet prairie and sedge meadow species. Medium and high disturbance wetlands are characterized by an abundance of reed canary grass or woody shrubs resulting from varying degrees of ditching or hydrologic alteration. Some have been affected by nutrient enrichment or sedimentation promoting more aggressive exotic plant species to displace native species.

As part of the natural resource inventory for the *Dane County Water Quality Plan*, a study of wetlands in Dane County was conducted by Bedford and Zimmerman in 1974. This study provided information for planning, and decision-making, and to also explore strategies for managing wetland resources in the county. The study was conducted on the premise that the information necessary to determine the type of wetland, its condition, and its value can be read from indicators seen in the field. The wetlands covered in the study included all of those known or suspected at the time to be of particular value, including Pheasant Branch Marsh, Sixmile Creek Wetlands, Spring (Dorn) Creek Wetlands, and Waunakee Marsh. These sections are included in Appendix C of this ECR. ***The most valuable of these were studied in detail by the CARPC Restoration Ecologist in 2011. Wetlands that could not be visited are included in the areas labeled as being "Not Inventoried" on Map 23.*** More investigation is needed to evaluate and group these wetlands. Ephemeral or temporary ponds have also not been listed, even though they may provide critical life cycle habitat for some species, especially amphibians. Whereas some of the information contained in the *Wetlands of Dane County* is dated and needs to be re-visited, it provides valuable information, especially when combined with the significant progress that has been made in our understanding, appreciation, and management of these critical resources over the last 35 years.

a. Wetland Groups

The information collected during the 1974 study was used to group wetlands into five categories. ***Wetlands are grouped based on their present or potential biological condition, scientific value, public use, extent of degradation, and immediate or long-range threats.*** While all wetlands have value, decisions must sometimes be made as to where specific approaches and efforts are best tailored or targeted.

Group I Wetlands are the best in the county and, in some cases, among the most valuable in southern Wisconsin (see Map 23). ***Cherokee Marsh is a good nearby example. Although showing signs of disturbance they remain virtually intact.*** In addition to their wildlife value, water quality, and flood protection benefits, these sites also provide important reference sites for designing restoration projects in other areas. Every effort should be taken to protect them.

Group II Wetlands include many of the large peat deposits, which are particularly valuable for protecting the Yahara River and its chain of lakes. ***These include Waunakee Marsh, Pheasant Branch Marsh, Sixmile Creek and Dorn Creek wetlands.*** While the survey information may be somewhat dated, these wetlands still remain in very good condition. Most of the wetlands in this group are large or deep enough to have resilience. Alterations have not had a profound effect. These wetlands should receive the same protection as those in Group I, and it is certainly possible to improve or enhance their condition.

Group III Wetlands, although substantially altered, do in fact receive wildlife use, provide open space, and enhance the environment overall. While all reasonable efforts should be made to ensure their protection, ***enhancement may be especially important to improve one or more degraded functions such as flood protection, water quality, and wildlife habitat.***

Group IV Wetlands maintain some function or exist for temporary periods of time (such as protection from flooding or for migratory waterfowl use). Many of the Group IV Wetlands could not be surveyed during the original study because of limited resources. ***The fact that they can still be considered wetlands after many decades of drainage indicates that they are not well suited for agriculture. Their best use appears, then, to be enhanced or restored for one or more wetland values or functions – rather than continued attempts at drainage.*** The wetlands in the headwaters of Black Earth Creek downstream of USH 14 are a good example.

Group V Wetlands no longer exist or function as a wetland ecosystem. ***Ditching, draining, or filling has destroyed all functions and values.*** It may be possible, however, to restore them by reversing the action(s) that destroyed them in the first place. ***These areas present significant opportunities to restore wetland acreage that has been lost over the last century. The former Pheasant Branch wetlands are a good example of this and the Pheasant Branch Confluence Pond project as an excellent example of how these wetlands can be restored to serve important values and functions (e.g., flood control, water quality improvement, wildlife habitat, outdoor recreation and scenic beauty). Another good example is a Dane County wetland restoration project planned in the headwaters of Black Earth Creek immediately downstream of the Middleton business park.***

Wetlands should be protected regardless of their quality, because they are scarce in the landscape and because of the values and functions they do provide, no matter how small or degraded. ***Many degraded wetlands provide important flood protection benefits and open space corridors.*** Many sites, particularly those where native species remnants exist, have a high potential for restoration or enhancement. So too do those that have been ditched or drained, since it often possible to restore their natural hydrology by plugging ditches or breaking tile lines. In the end, the management strategy for each wetland will be as unique as the wetland itself, based on the site characteristics and available resources and opportunities. Because of the scarcity of remnant aquatic habitat, both aquatic and terrestrial endangered species are often found associated with wetland areas. Likewise, many ephemeral wetlands provide important breeding habitat for amphibians, which serve as food for other wildlife. Therefore, enhancing the quality and extent of wetland habitat in an area helps support and promote natural food webs, biotic health, and overall species diversity. This topic is discussed more fully in later sections.

Wetlands and former or converted wetlands pose significant constraints to development such as high water table levels, potential flooding, and poor soils. County and municipal zoning prohibits development in wetland areas of 2 acres or greater. Wetlands, regardless of size, are also regulated by other state and federal laws. Existing laws and regulations, however, do not always provide adequate protection. ***The best strategy is to avoid these areas completely and direct future development to better suited areas.*** In addition, existing laws and regulations largely ignore opportunities to restore some of the large wetland acreages (and associated functions and benefits) that have been lost over the last century. These remnant wetland acres should provide the basis or framework for carrying out an effective wetland resources protection and restoration strategy here, as in other watersheds throughout Dane County. Property tax law creates a disincentive for farmers who may be interested

in wetland restoration by valuing wetlands higher than cropped farmland. Therefore, by restoring prior converted wetlands, farmers have to be prepared to pay higher property tax and lose income from reduced crop yields.

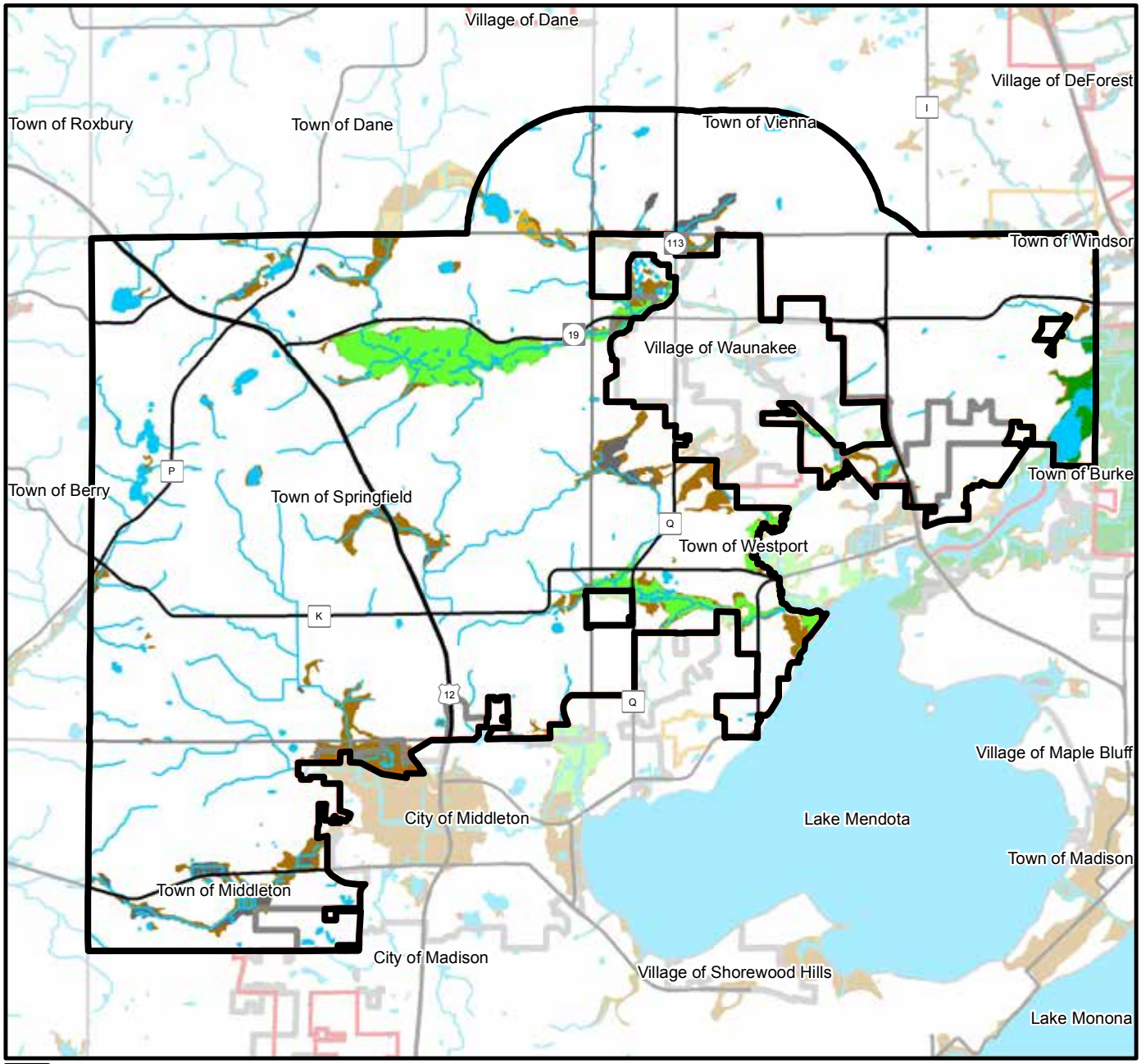
The Bedford and Zimmerman study is a particularly useful reference for those in the early stage of designing their own wetland restoration or enhancement projects. It is important to realize that as with all ecosystems, each wetland is unique. In the end the management strategy must be tailored for each unique wetland.. Wetland protection and restoration plans are routinely developed by consulting firms on behalf of their clients. There is also federal, state, and local funding available to promote these projects. The *Dane County Wetlands Resource Management Guide* (CARPC 2008) outlines a process and framework for developing successful wetland restoration and protection plans and projects in collaboration with public and private partners. In areas that have not been inventoried or information is significantly out of date, CARPC restoration ecologist/biologist can provide more current assessment, recommendations, and assistance especially during the more detailed and technical design work associated with particular development scenarios, plans, or projects.

Overall, wetlands provide very significant and valuable wildlife habitat, recreational opportunities, and water resource benefits and functions. Areas with hydric soils are a strong indicator of historic and potentially restorable wetlands. ***It is recommended that prior converted wetlands be restored whenever possible, and degraded wetlands be enhanced where opportunities permit. Existing wetlands should include a minimum buffer of 75-100 feet for water quality protection, and included in park and open space areas as Environmental Corridors***.[58]

58 Environmental Corridors are continuous systems of open space in urban and urbanizing areas that include environmentally sensitive lands and natural resources requiring protection from disturbance and development (DCRPC 2004).

Map 23: Wetland Groups

North Mendota Study Area, Dane County, WI



FUDA Study Area
Urban Service Area
Limited Service Area
Water
Group I (Protected)
Group II (Protected & Enhanced)
Group III (Protected, Enhanced & Restored)
Group IV (Enhanced & Restored)
Group V (Restored)
Not Inventoried
Not all elements may be present

Miles
0 0.25 0.5 0.75 1 1.25 1.5

N

Source: Capital Area Regional Planning Commision February 2012

Wetlands are grouped based on their present or potential biological condition, scientific value, public use, extent of degradation, and immediate or long-range threats. While all wetlands have value, decisions must sometimes be made as to where specific approaches and efforts are best tailored or targeted.

b. Wetland Restoration

As with all restoration activities, the goal is to create a self-sustaining, self-organizing ecosystem with similar ecological functions relative to historical or reference communities. ***For restoration to be successful, the ecological community will need to remain persistent, maintain ecological function after disturbances -- ecological resistance, and have the ability to return to its previous state after disturbance -- ecological resilience. There are three general approaches for wetland restoration. These are reestablishing hydrology consistent with historical patterns, control contaminants from entering into the wetland, and promoting native species while controlling invasive species.*** Like the stream restoration section described above, wetland restoration can be divided into two general categories, passive and active restoration. General passive techniques include eliminating grazing and mowing, which allows for the native vegetation to return. Active restoration techniques for wetlands include removing fill, changing site hydrology through changes in geomorphology (channel redirection), removal of invasive plant species with replacement by native species.

Wetland restoration occurs on a site by site basis. The potential role for wetland restoration within the watershed scale approach is usually not considered. This is largely due to limited resources and finding willing landowners who wish to participate. ***Restoring wetlands should be considered in a cumulative context, whereby more wetlands within a watershed are restored, the greater the influence on improving water quality. Considering landscape connectivity between wetlands is also important***, not only for animal movement and dispersal but also for controlling the spread of invasive species.

Issue:

Wetland Restoration

- Wetland restoration; three means
  - Hydrology
  - Contaminant control
  - Invasive species control
- Promote connectivity & consider the watershed
- Wetland restoration methods:
  - Modify land use (soft)
  - Modify wetland itself (hard)
- Seek governmental assistance for wetland restoration funding
- Altering land-use practices in adjacent agriculture can improve wetlands by reducing fertilizer inputs.

There are multiple invasive species found within the wetlands of Dane County. The two most prolific invasive species of major concern are reed canary grass (*Phalaris arundinacea)* and hybrid cattails *(Typha angustifolia, T. x glauca).* To a lesser extent within wetlands, willows *(Salix spp.)* can be problematic as high density bush stands. Invasive species are problematic because they often form high density monotypic stands within the ecosystem which causes decreased species diversity, impairing food web interactions, and removing habitat. Invasive species affect ecosystem and watershed processes by altering erosion, runoff and depositional processes. There are multiple means of controlling these invasive species with specific strategies based upon degree of spread. Where there are smaller patches of invasive species, herbicide application and manual removal are known to be effective. However, when the invasive species tend to form large, monotypic stands that blanket the area, heavy machinery and controlled fires will be needed. Invasive species control as part of a restoration plan must be performed on adjacent sites, otherwise the invasive species will settle and colonize the site again. If urban development includes construction in areas with restorable wetland sites, it may be beneficial to use heavy equipment to remove extensive patches of invasive species (after receiving permission from WDNR).

Reed canary grass

There are several wetland restoration opportunities throughout the North Mendota FUDA study area. First, in agricultural areas that are poorly drained, yet persistently fail to produce cash crops. There are government programs designed to assist landowners in becoming natural resources stewards. Some of these programs include the Wildlife Habitat Incentive Program (WHIP), the Wetlands Reserve Program (WRP), and the Conservation Reserve and Conservation Reserve Enhancement Programs. If there are restorable wetlands within these agricultural areas that are not profitable for farmers, participation with these programs may give farmers the financial incentive to participate. ***Second, there have been multiple depressional wetlands that have been discovered on site surveys that either lack any form of vegetative buffer***, usually due to dairy practices and cattle grazing or have been modified by residential landowners and now only contain ornamental trees and lawn grasses. Some of these wetlands occur individually while others exist on along the margins of small ponds. Few restoration efforts have been directed towards restoring depressional wetlands. Depressional wetlands have been discovered on site surveys throughout the FUDA area. General guidelines for restoring these areas is relatively inexpensive and includes the cessation of adjacent agriculture, plugging drainage ditches and breaking drainage tiles. Generally, after environmental stressors have been removed, wetland vegetation may return. If not, then a revegetation program will be needed. ***Third, there have been multiple observations where agricultural practices adjacent to wetlands that has killed stands of wetland plants.*** These plants, mostly sedges and cattails show signs of chlorosis, a complete yellowing of leaves indicating plant death. ***The most likely cause is the over application of fertilizer on fields,*** which accumulates in the wetlands from runoff. Chlorsis is not a consistent problem throughout the FUDA study area, but is the product of individual farming practices. Over application of fertilizers is most detrimental to small wetlands that lack the size to overcome its effects. Larger wetlands are more resilient because they can lose plants along the edge without compromising core habitat.

Within the Middleton proposed land use map, there is one location for potential wetland restoration, located east of the intersection of County Hwy Q and Oncken Road and south of Oncken Road. This location is a larger wetland surrounded by agriculture and is near a much larger wetland complex. The surrounding area is slated for proposed residential and mixed use development. Initial field observations suggest it is largely dominated by reed canary grass, cattails and has some clusters of brush willows. This site appears to drain through a culvert to a larger wetland to the north.

Within the Waunakee Comprehensive Plan Project (WCPP), two areas are good candidates for wetland restoration. One is located at the intersection of County Hwy Q and Easy Street in Waunakee, this site was purchased by Dane County with the intention of expanding an environmental corridor and open space. In the western area of the property, there are vast expanses of reed canary grass, and cattails. Considering the extent of coverage, it is advised that heavy machinery be used to remove it. However, directly to the north, on the other side of Easy Street, the wetland extends and is also dominated by reed canary grass. As with the recommendation above, if removal of invasive species does not occur in adjacent properties, then restoration of native vegetation will be futile. To the east of this property, there is no sign of any wetland vegetation and there is a large depressional pool. This area will require revegetation from outside sources since the site was under agriculture and the native seed bank is not likely viable.

A second location for potential restoration within the WCPP is located along County Hwy Q, west of the Meffert Road intersection. This site is an isolated wetland, surrounded by agriculture. It shows signs of chlorosis, likely caused by adjacent agriculture. If funding is limited, this location may not be the best candidate for restoration considering its size; its location relative to other wetlands, it being on the terminal end of a potential network and having urban areas to the north and east and having a major highway directly to the west; and being surrounded by continued agriculture. The other remaining areas have either already slated for immediate development, or any attempts to restore wetland function would result in potential damage to infrastructure, namely potential flooding of the “Meadows of Sixmile Creek” golf course.

Waunakee Marsh is a major wetland found within the FUDA study area. Most of the wetland is state owned and is managed by the Wisconsin Department of Natural Resources. Observations using aerial and satellite photography indicate there has been a progressive change in plant community structure since the *Wetlands of Dane County* in 1974. Site observations suggest that Waunakee Marsh is still a cattail dominated community. It may be that the invasive and hybrid cattail forms have a different chromatic signatures, and so appear darker on aerial photography, yet these color differences are indistinguishable during field observations. Considering that cattails are known to spread vegetatively, this would explain the progressive annular patterns of plant community change. It is difficult, if not dangerous, to traverse into Waunakee Marsh to confirm this hypothesis. Waunakee Marsh is largely composed of floating peat which supports the vegetation. Excessive cattail growth within marshes limits the available habitat and prevents species diversity. Discussions with WDNR personnel indicate that Waunakee Marsh is not managed frequently. This is due to incomplete ownership of the Marsh. Any management activities, including prescribed burning, may not proceed unless WDNR has consent from the adjacent landowners. An attempt to control the vegetation and to create open channels for vegetation and wildlife was abandoned by WDNR in the mid 1980s. No other major restoration activities have been attempted since then, and no natural wildfires have been allowed to burn the area.

Issue:

Potential Wetland Restoration Sites

- Locations within FUDA study area & major invasive species
  - CTH Q & Oncken Rd. with reed canary grass (RCG)
- • Waunakee
  - CTH Q & Easy St with RCG
  - CTH Q & Meffert Rd. revegetation, RCG control
- Waunakee Marsh, Hybrid Cattails

One concern for the conservation of Waunakee Marsh, and other large natural areas, is development. As development approaches these areas, it impairs conservation value. Waunakee Marsh, however, may be more resilient to changes in hydrology. Land use changes that increase the amount of water entering into the Marsh, such as increased impervious surface, may be less destructive. Since the plant community grows out of floating peat, increased flows to the Marsh will cause the peat to rise. This does not account for changes in thermal or nutrient pollution entering into the Marsh. Adjacent agriculture is another potential problem for Waunakee Marsh, with issues of nutrient and sediment inputs. ***Ideally, a non-marsh vegetative buffer should be expanded in the southern edge of Waunakee Marsh. Currently, there are areas of active agriculture directly next to the edge of the Marsh. Cropping options should be explored to find the best kind of agricultural crop that could be grown, be economically viable given the regional needs, and be the least destructive to the Marsh.***

Wetland restoration should be considered on the landscape level. Interconnectivity between wetlands is important, not only for animal movement between patches, but also for the dispersal of plant propagules. If wetland restoration activities include the control of invasive species, then it is important to note if these invasive species exist in adjacent properties. If these organisms are not controlled, then they will return to the restoration site.

C. Open Space Corridors

An open space corridor is defined as water features and the riparian area of land that has contact with the water either through flooding or soil saturation and can include upland areas in some cases (see Maps 24 and 25). An area of natural vegetation that protects the water from an adjacent agricultural or urban land use is called a buffer strip.

Planning Considerations:

Potential Wetland Restoration Sites

- Consider opportunities to connect valuable natural resource areas into E-Ways for their recreational, educational, and environmental benefits.
- For example, the environmental corridors for Six Mile Creek, Waunakee Marsh, Dorn Creek, the Dorn Creek Wetlands, and nearby prairie remnants and recharge areas could be connected to create a North Mendota E-Way.

Open space corridors promote important values for protecting water quality and habitat for fish and wildlife, as well as for recreational pursuits. In both the Sixmile and Pheasant Branch Creek watersheds the type and width of open space corridor varies greatly. For example, in the lower parts of Pheasant Branch, Sixmile, and Dorn Creeks extensive wetlands and floodplain border the stream on both sides. Farther upstream the streams are bordered by hardwood forest species such as box elder and willow. The width of this forested band varies with each land owner. ***Most of the ephemeral and very small tributaries in the highest reaches of the watershed have very little or no protection provided by a riparian area. Potential opportunities may exist for establishing or expanding riparian buffers in these areas through pollutant trading between agricultural and urban sources involved in the Rock River TMDL project. However this aspect of the program has not yet been defined. Potential opportunities also exist through the Conservation Reserve Program and other voluntary cost-share/set-aside/nonpoint source control programs administered through the Dane County Land Conservation Department, based on landowner participation and support.***

Although the amount of land in the riparian area constitutes only a small amount of the total land in the watershed, it has considerable value for both water quality and the overall life-cycle needs of organisms. Riparian areas link riverine and terrestrial systems and make each more ecologically productive. Riparian areas also serve as habitat for both terrestrial and aquatic species. Insects that emerge from riverine systems feed bird and bat populations. Nutrients from aquatic areas help to support vegetation in upland communities, and this vegetation in turn acts as a filter strip to help protect water quality and prevent upland sediment and associated pollutants from washing into the stream. Riparian areas enhance habitat in many other ways. For example, trees and shrubs along the river help shade the stream from the sun and keep the water temperatures low. Removal of vegetation from headwater streams in agricultural areas can therefore lead to temperature increases in the stream. Logs and branches that fall into the stream provide a suitable place for insect larvae, an important food source for fish. These logs, along with the vegetation that overhangs the stream channel, also provide hiding places and shelter. Fish use these places to rest, hide, and wait for prey. In addition, the leaf litter from trees and shrubs in riparian areas provides nourishment for insects and other stream organisms. Vegetation also provides stabilization for streambanks, with intermingling plant roots providing cohesion, providing drainage and reducing collapse, and buttressing soils from overland forces. Riparian trees dissipate

the kinetic energy from floods and improve soil infiltration through increased soil porosity and improving the capillary action.

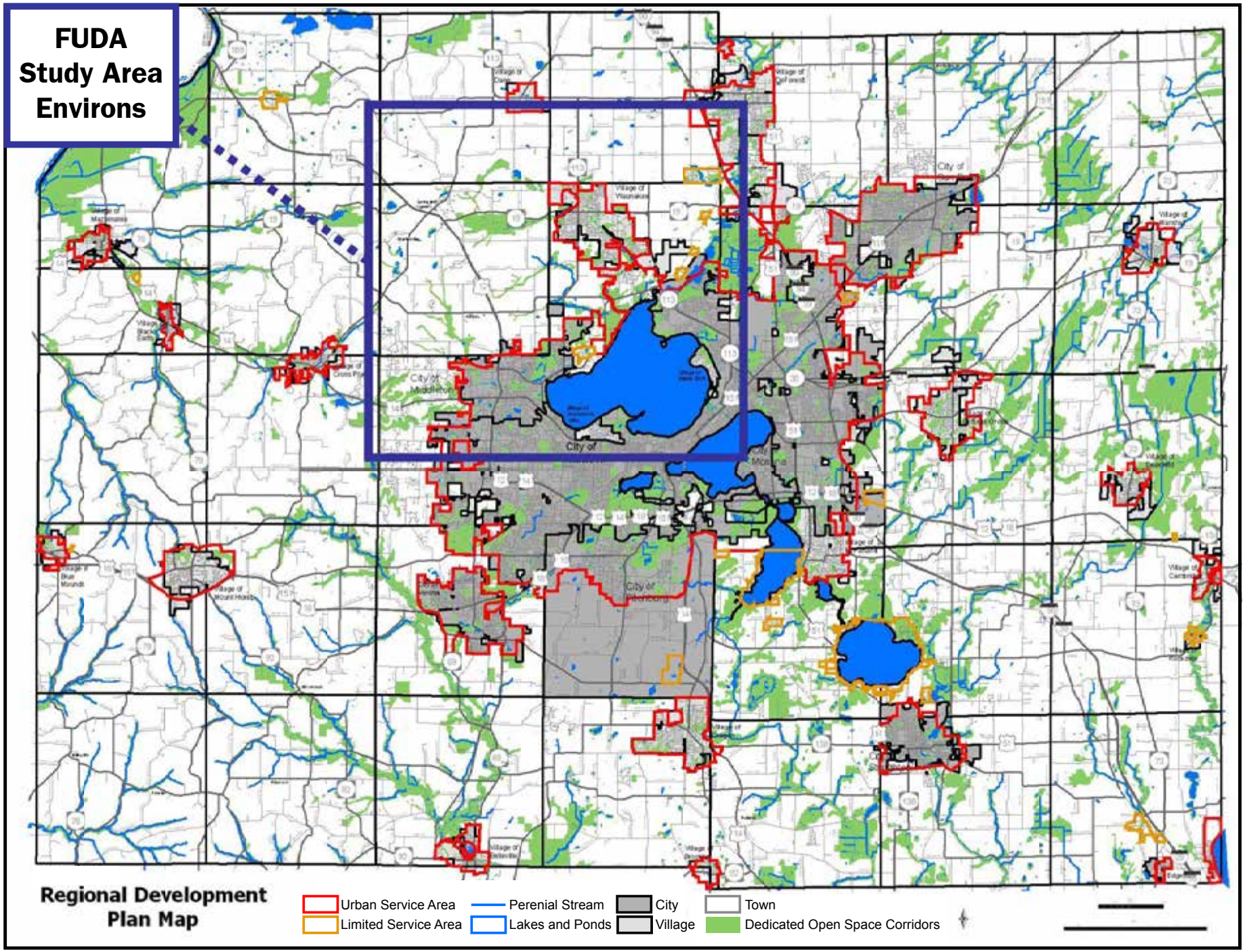
The Open Space Corridors shown on the Regional Development Plan Map (see Map 24) include two distinct components which together provide a continuous countywide network of open spaces and environmental resources considered to be most critical for protection:

Environmental Corridors within urban and limited service areas, provide the basis for a continuous open space system based on natural features and environmentally important lands such as streams, lakes, shorelands, floodplains, wetlands, steep slopes, woodlands, parks, and other publicly owned lands.

Resource Protection Areas in rural areas (outside urban and limited service area boundaries), are based primarily on floodplains, wetlands, and shoreland areas – lands protected through shoreland zoning and other regulations, along with publicly owned lands (e.g., parks). These areas face considerably less intensive development pressures than their urban counterpart.

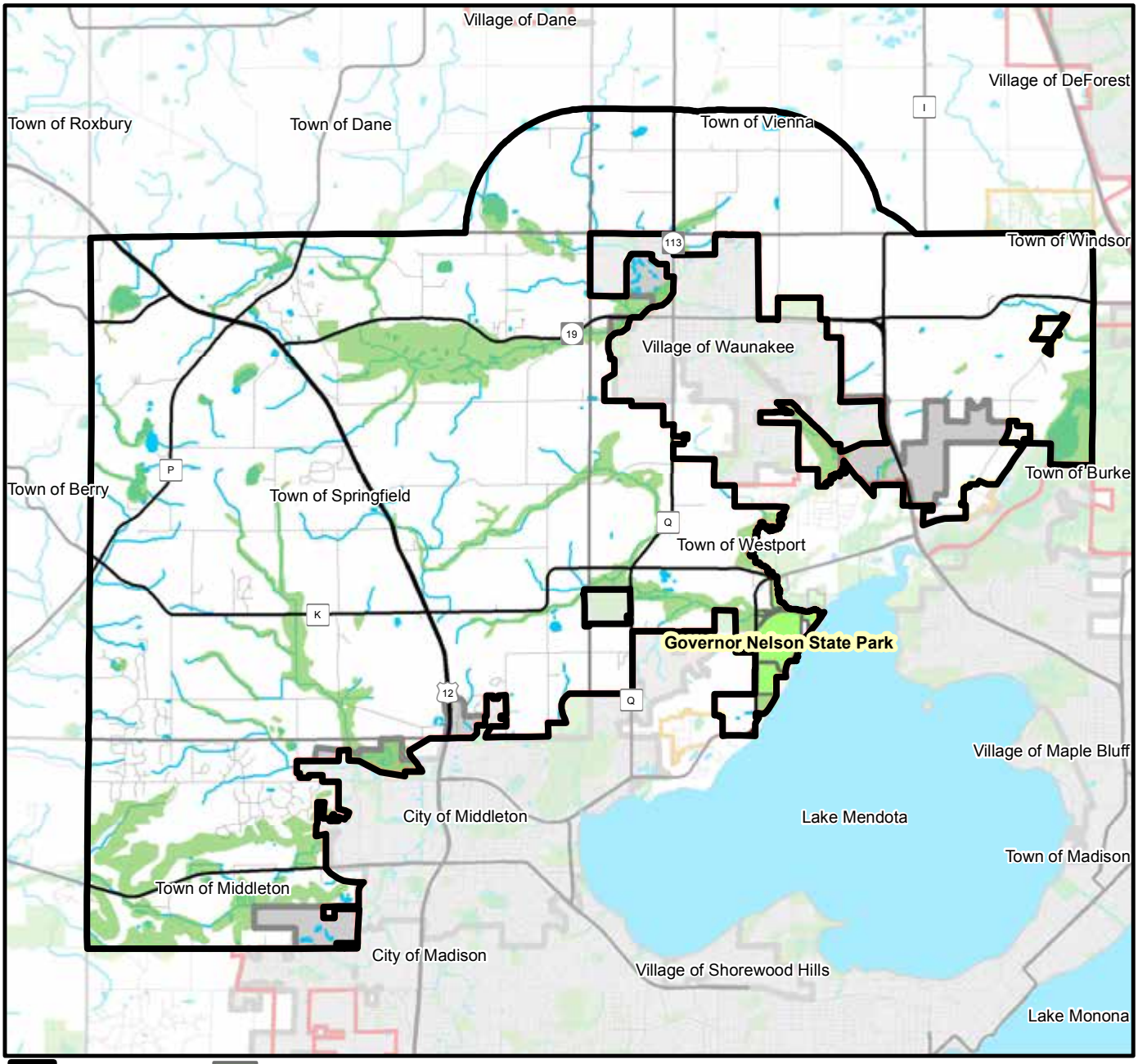
It is important to point out that Environmental Corridors were originally developed to protect sensitive aquatic features from urban development activities where the emphasis was largely directed to water quality concerns (e.g., providing a 75- to100-foot vegetative buffer). ***They were intended to provide a basic skeleton network of connected natural areas which would be expanded through local initiative. The 75-foot vegetative buffers are generally inadequate for protecting habitat, biodiversity, and ecosystem sustainability, which require 150- to 250-foot buffers.*** These concerns have emerged more recently. This is not a significant problem inasmuch as more needs to be done. FUDA planning offers the opportunity to capture and address these broader concerns. With this in mind, more information and discussion is provided in the section of this report dealing with the natural resource impacts from urban development, specifically as it relates to habitat loss and ecosystem health.

Map 24: FUDA Study Area Environs - Regional Development Plan Map



Map 25: Regional Development Plan

North Mendota Study Area, Dane County, WI



FUDA Study Area
Urban Service Area
Limited Service Area
Water
State Parks
Dedicated Open Space

Miles
0 0.25 0.5 0.75 1 1.25 1.5

N

Source: Capital Area Regional Planning Commision February 2012

Regional Development Plan

1. Riparian Areas and Their Restoration

The most effective approaches to addressing riparian restoration is to understand that within a riverine ecosystem, riparian areas shift and change as streams meander throughout time. ***Considerations for the establishment of buffers should include this meandering and expected change.***

Conserving riparia in upslope ecosystems, upstream systems in steep hills, is important for controlling sediment. These areas never achieve static equilibrium and lose sediments in episodic events, mostly during precipitation. Maintaining wide riparian vegetation in these steep areas will be essential for two reasons, (1) steeply sloped areas on the outside bends of stream meanders are not conducive to growing extensive vegetation, this suggests the importance of having wide riparian buffers to control flows through these areas, and (2) precipitation increases due to global climate change will likely make these areas more prone to erosion in the future.

The North Mendota FUDA study area has multiple riparian sites where willows in bush form are present. If this species is allowed to propagate throughout riparian areas, it will reduce stream discharge rates. In southern France, pioneer trees such as willows, along the River Ouvèze, caused a reduction in the mean stream width to decrease by nearly half (from 92 m to 50 m). This change reduced the stream capacity to discharge flood waters, which eventually lead to devastating floods in 1992. ***Conversely, the presence of cottonwood trees, as noted in observations around the Waunakee Marsh area will have the opposite effect. Excessive woody debris inputs into streams will cause it to widen, resulting in warmer streams and the deposition of fine sediments.*** These fine sediments, in turn, remove the small interstitial spaces between river stones, that serve as macro-invertebrate refuge and reproductive sites for some fish.

An important riparian area requiring protection is the steep wooded slopes of Black Earth Creek, directly west of the City of Middleton. These areas drain to the west and provide the environmental factors needed to maintain brown trout populations farther downstream. In a cursory analysis of this watershed, many of the residences are in the form of exurban development and maintain well vegetated slopes with representative species across layers at normal densities. ***Adjacent agricultural sites show signs of channelization and lack protective vegetation. It is recommended that re-vegetation be performed in some of these barren sites.***

Issue:

Riparian Restoration

- Riparian areas help control:
  - Overland water flows
  - Sediment inputs
- Riparian areas are important for:
  - Human population growth
  - Abating impacts from Global Climate Change
- Control for two major invasive species:
  - Willows & Cottonwoods
- Seek governmental assistance for wetland restoration funding
- Maximize riparian restoration benefits by considering watershed & habitat connectivity
  - Unify landowners to help

Another area of concern is the riparian e-way corridor that leads into the Pheasant Branch Conservancy. The outer edges of the e-way system and riparian area have both cottonwood trees *(Populus deltoides)* and willow brush *(Salix spp.)* There are several juvenile trees for both of these species within the Conservancy property boundaries. ***These trees should be removed to prevent further colonization and impediments to stream function.***

It is important to consider ecological restoration of riparian areas, not only in an immediate context, but also with regard to future stressors caused by global climate change. Global climate change models predict increased severity and frequency of weather events. This will likely cause increased flooding and increased droughts. Considering ecological resilience, the ability for an ecosystem to rebound after an environmental stress and remain adaptable to future change, is important for designing ecological restoration plans. This is particularly important when considering restoration of riparian areas that often experience disturbances in hydrology and geomorphology. With global climate change and expanding human populations, it will be necessary to consider if current standards for riparian protection will be sufficient in future years. Research indicates that riparian vegetation are well adapted to these types of disturbances and may be more resilient than upland habitats. However, there are limits to ecological resilience and human activities interrupt ecological processes, often leading to impaired ecosystem function and colonization by invasive species. ***When possible, it may be prudent to expand buffers beyond 100 feet to increase resilience and redundancy in riparian ecosystems*** (for more detail on potential approaches see the concept of "core habitat" on page 151).

Riparian restoration shares with stream restoration the need for cooperation from multiple landowners in order to be effective. Restoration across private lands is important for maintaining connectivity, size and quality of riparian habitat. There are governmental funds available for riparian restoration. Many of these riparian programs are also under the same granting agency as wetlands. Some of these include the Wildlife Habitat Incentive Program (WHIP), the Conservation Reserve Program (CRP), and the Environmental Quality Incentives Program (EQIP). Riparian restoration in agricultural settings may be less interesting to full time farmers on larger plots than part time farmers with smaller plots. The Maryland Department of Natural Resources found higher landowner participation in the installation of forested buffers from small scale farmers who did not receive a majority of their income from agriculture. Farmers of larger tracts of land, who earned their income from agriculture, were more likely to install grass buffers instead of forested buffers.

Ultimately, despite the ability of riparian areas to control overland flows to streams and rivers, riparian conservation cannot be a substitute for good catchment management and land use practices. These areas can be further integrated into broader buffers for park and open space purposes which enhance wildlife habitat and support "core habitat" concepts outlined on page 151.

D. Groundwater

A substantial portion of precipitation that reaches the land surface evaporates. The remainder either infiltrates into the ground or flows downhill as surface runoff. The portion that infiltrates into the ground enters the groundwater system to provide our drinking water and also emerges as groundwater discharge to provide baseflow for streams, lakes, and wetlands. ***Surface water, shallow groundwater, and deep groundwater are closely interconnected. This groundwater/surface water balance can be upset by human activities affecting both the quantity and quality of our ground and surface water supplies. Almost all groundwater in Dane County originates as recharge occurring locally (Bradbury 1999). We are therefore directly responsible for the health of our ground and surface water resources.***

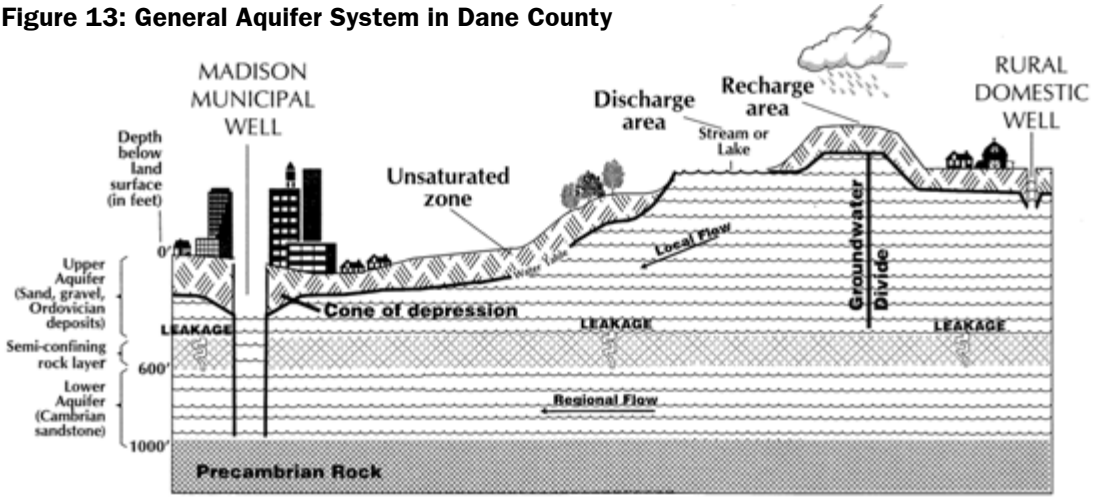
Planning Considerations:

Riparian Restoration

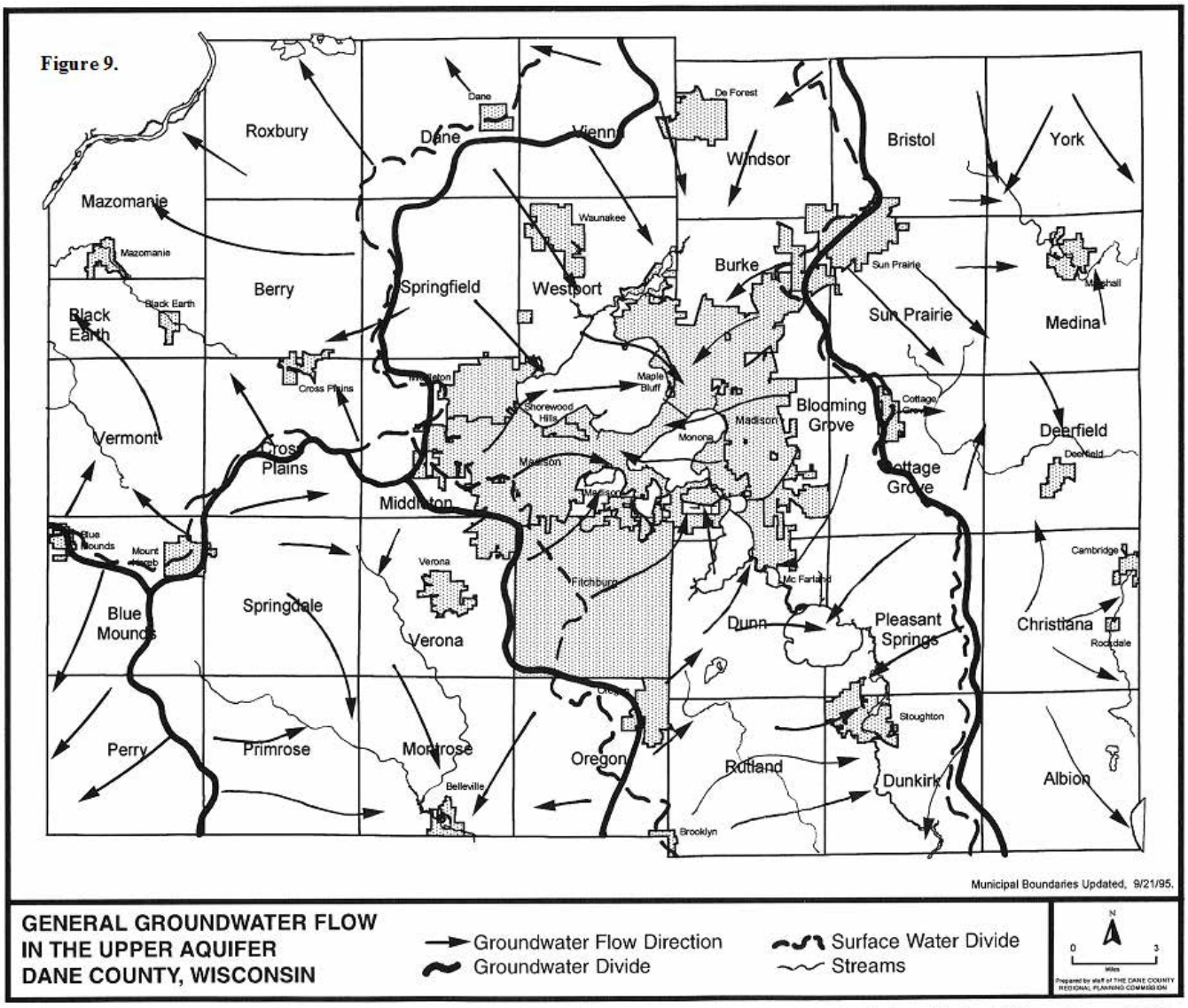
- Identify locations best suited for preservation for active and passive groundwater recharge
- Use every opportunity to infiltrate rainfall runoff to recharge the groundwater
- Locate future water wells outside of capture zones for springs
- Increase water conservation with low flow fixtures and rainwater harvesting.

Most lakes and streams are discharge points for groundwater where the water table intersects the land surface. In general, the water table is a subdued reflection of the land topography (see Figure 13). The depth to groundwater ranges from zero at the fringes of lakes, streams, and wetlands to over 200 feet beneath the ridges in the driftless area. The shallow groundwater in Dane County forms several naturally occurring basins, analogous to but not entirely coincident with surface water basins (see Map 26). Shallow groundwater moves away from groundwater divides. Near major lakes, streams, and wetlands, shallow groundwater flows towards these surface water bodies. Note that groundwater and surface water divides do not necessarily coincide. There are various places in the county where shallow groundwater can move horizontally beneath topographic divides and opposite surface water flow. This is particularly evident where pumping from the Madison metropolitan area has expanded the groundwater divides, thereby capturing more water from the Sugar River watershed in the southwest and the Maunesha and Koshkonong watersheds in the northeast. ***High capacity municipal wells capture water from the deep aquifer often at the expense of smaller streams such as Pheasant Branch Creek, Badger Mill Creek, Starkweather Creek, and the headwaters of Black Earth Creek.***

Figure 13: General Aquifer System in Dane County



Map 26

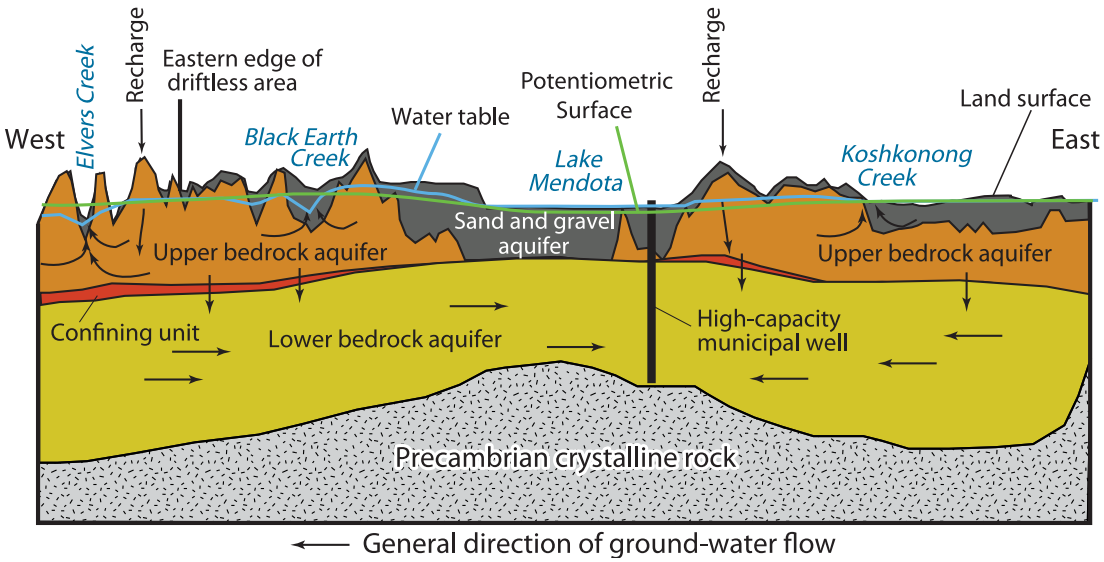


Source: Wisconsin Geological and Natural History Survey, 1995.

Groundwater in Dane County occurs in three aquifers, or useable layers of groundwater (see Figure 14):

1. The Sand and gravel aquifer that fills the buried bedrock valleys of the Upper Yahara River;
2. The shallow sandstone and dolomite bedrock upper aquifer; and
3. The deep Mt. Simon sandstone lower bedrock aquifer, underlying the Eau Claire shale aquitard (a confining layer).

Figure 14. Groundwater Aquifers in Dane County



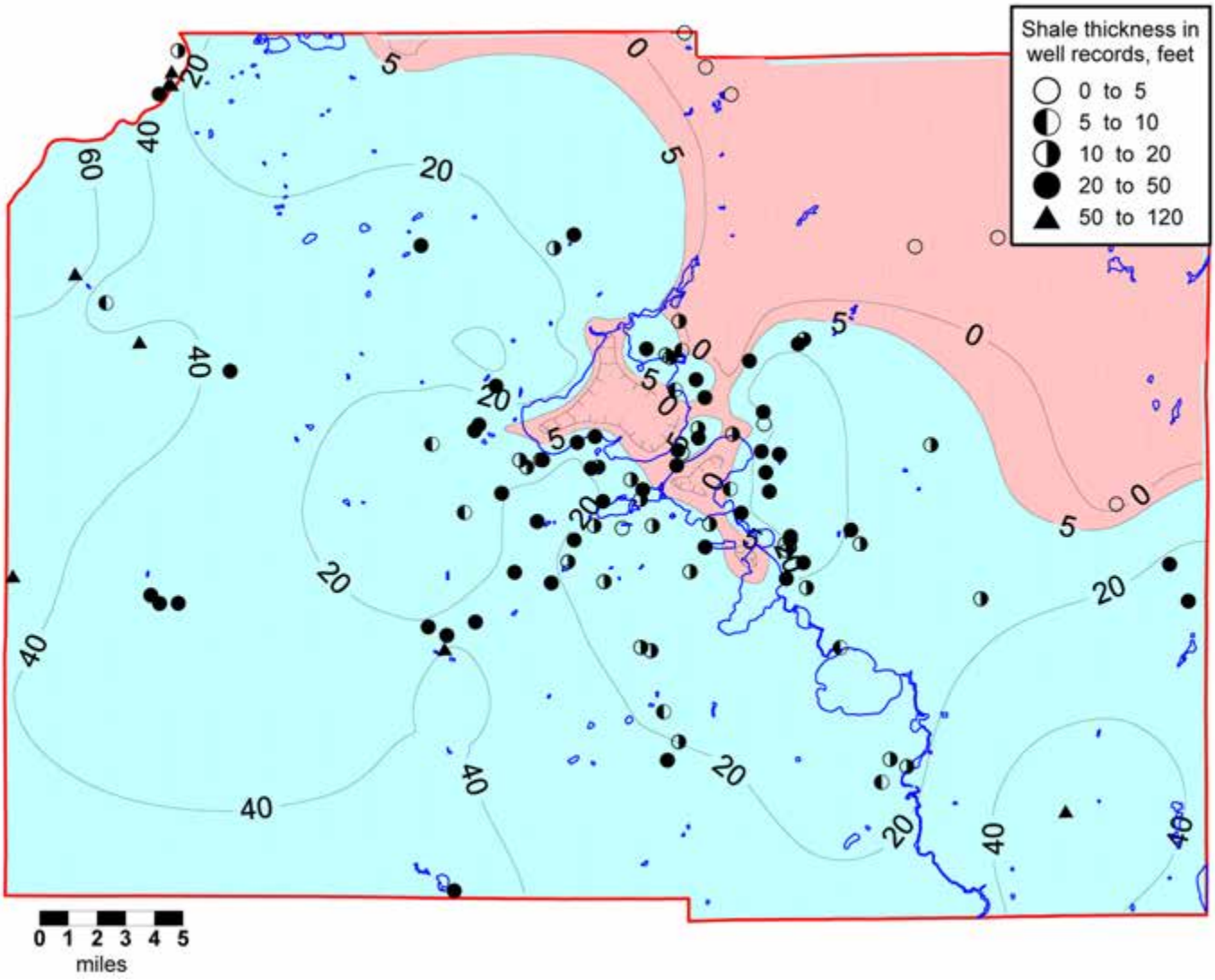
Note that the Eau Claire aquitard separating the shallow and deep aquifer systems in other areas of the county is largely absent beneath the Yahara Lakes and in the northeast portion of Dane County (see Map 27). ***This implies that shallow and deep aquifer systems are more directly connected where the confining layer is absent, and that the effects of high capacity municipal well water withdrawals can more easily propagate to the surface water systems. These effects include declines in water table levels and reductions in stream baselfow.*** Where the confining unit is present, direct or localized impacts to a particular stream by high capacity well withdrawals can be better absorbed by the deeper regional groundwater supply; by spreading the impact out among other surface water systems. Municipalities typically case new wells down into the deeper Mount Simon aquifer for a variety of reasons (both quantity and quality related).

Groundwater modeling and field studies by researchers suggests that streams and springs in the area are fed by both the shallow and deep aquifer systems (see Maps 28 and 29) with contributing areas in the uplands. Maps 28 and 29 show the upper and lower groundwater flow patterns separately to better distinguish these two aquifers. Note that termination of upper aquifer flow lines in the uplands in Map 28 indicate recharge to the lower aquifer in Map 29 Deep aquifer discharge to the upper aquifer near water bodies is not as readily apparent. With regard to the latter, general movement is southeast and east toward Lake Mendota.

The Wisconsin Geological and Natural History Survey (WGNHS) has mapped springs in the North Mendota FUDA study area (see Map 30). Frederick Springs (#16) have been the topic of considerable concern and study in the City of Middleton, particularly with respect to the impacts of urbanization. While some springs may not contribute tremendous amounts of springflow, they are nevertheless viewed as an indicator of a more natural and healthy environment overall. The effect of urbanization and reduced groundwater recharge on springs, however, is complex.

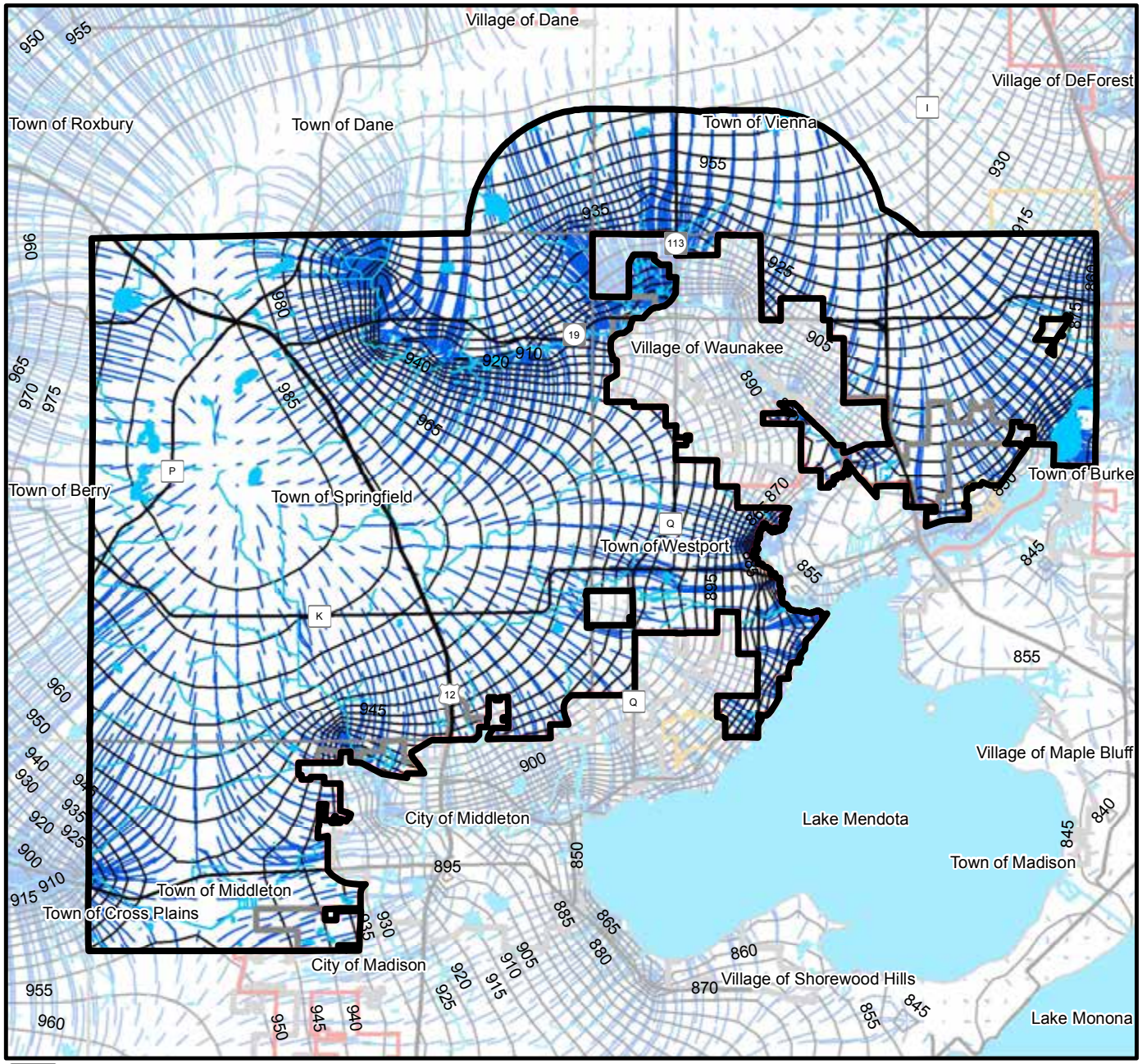
According to USGS, it is difficult to reliably predict the effects of urbanization on stream baseflow and spring flows. Identifying the source waters for the spring is the first step in ensuring its protection. The principle objective of a 2000 study by USGS was to use groundwater flow modeling and geochemical analysis to identify the source of water that sustains the spring complex. ***The calculated capture zone for the Springs showed that they are receiving water that was recharged from areas both inside and outside of its immediate watershed*** (see Map 31). Geochemical sampling of the spring complex showed very large differences in chemistry between the spring vents that were located within 50 feet of each other. The differences were stable in time and showed distinct gradation from high nitrate, high calcium Ordovician carbonate dominated water in the western spring vents to low nitrate, lower calcium Cambrian sandstone influenced water in the eastern spring vents. The difference in chemistry is explained by different bedrock geology in the recharge area shown in Map 31.

Map 27: Lateral Extent of the Eau Claire Aquitard in Dane County (shaded red where less than 5 feet)



Map 28: Simulated Groundwater Flow (Upper Aquifer)

North Mendota Study Area, Dane County, WI



FUDA Study Area
Urban Service Area
Limited Service Area
Water
Upper Aquifer Flow
Water Table Conours (MSL)

Miles 0 0.25 0.5 0.75 1 1.25 1.5

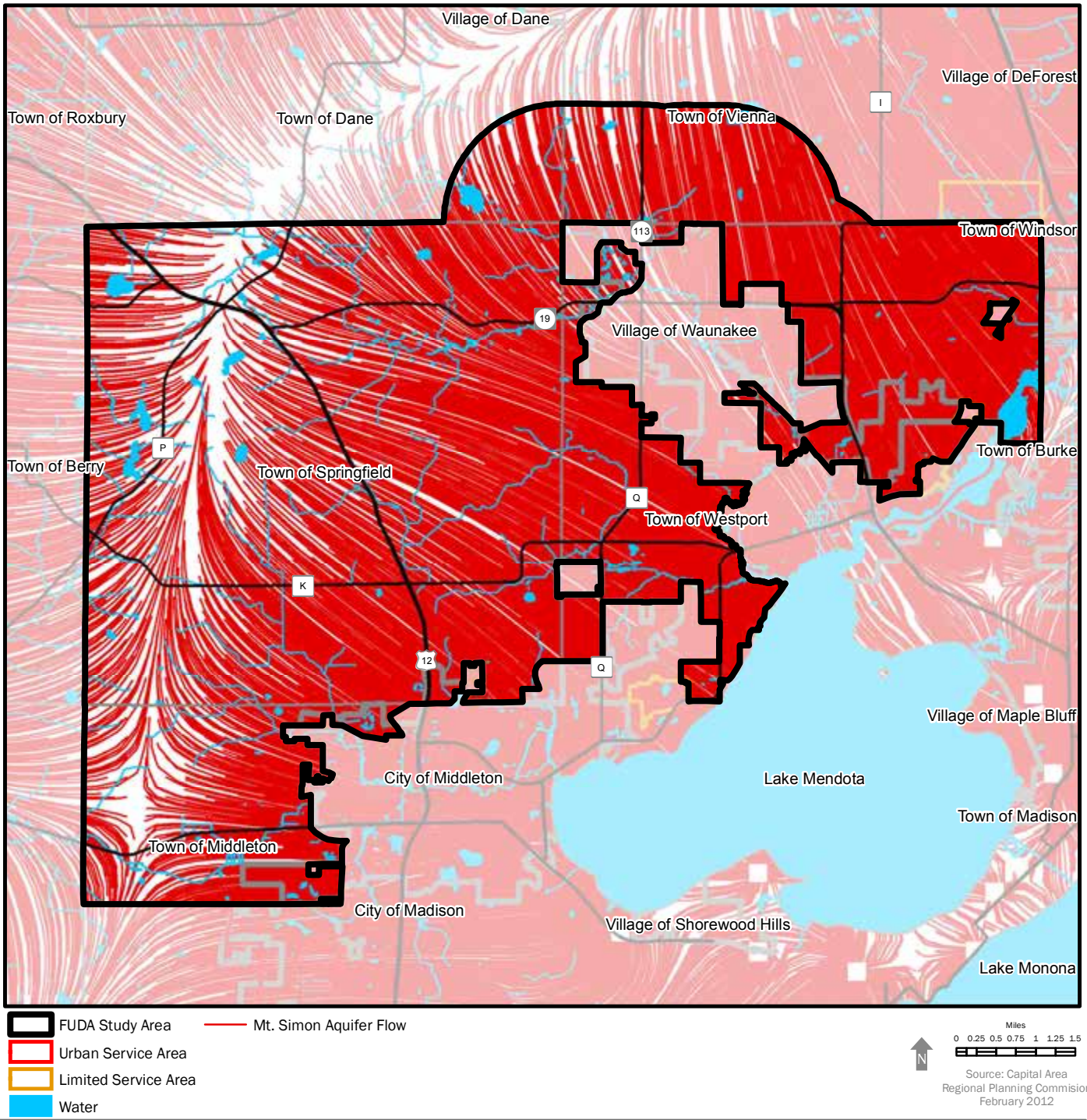
Source: Capital Area Regional Planning Commision February 2012

Similar to topographic contours, groundwater flows downhill or perpendicular to water table level contours. Abbreviated flow lines indicate recharge to the deeper Mt. Simon aquifer.

(Source: 2000 Regional Groundwater Model)

Map 29: Simulated Groundwater Flow (Mt. Simon)

North Mendota Study Area, Dane County, WI

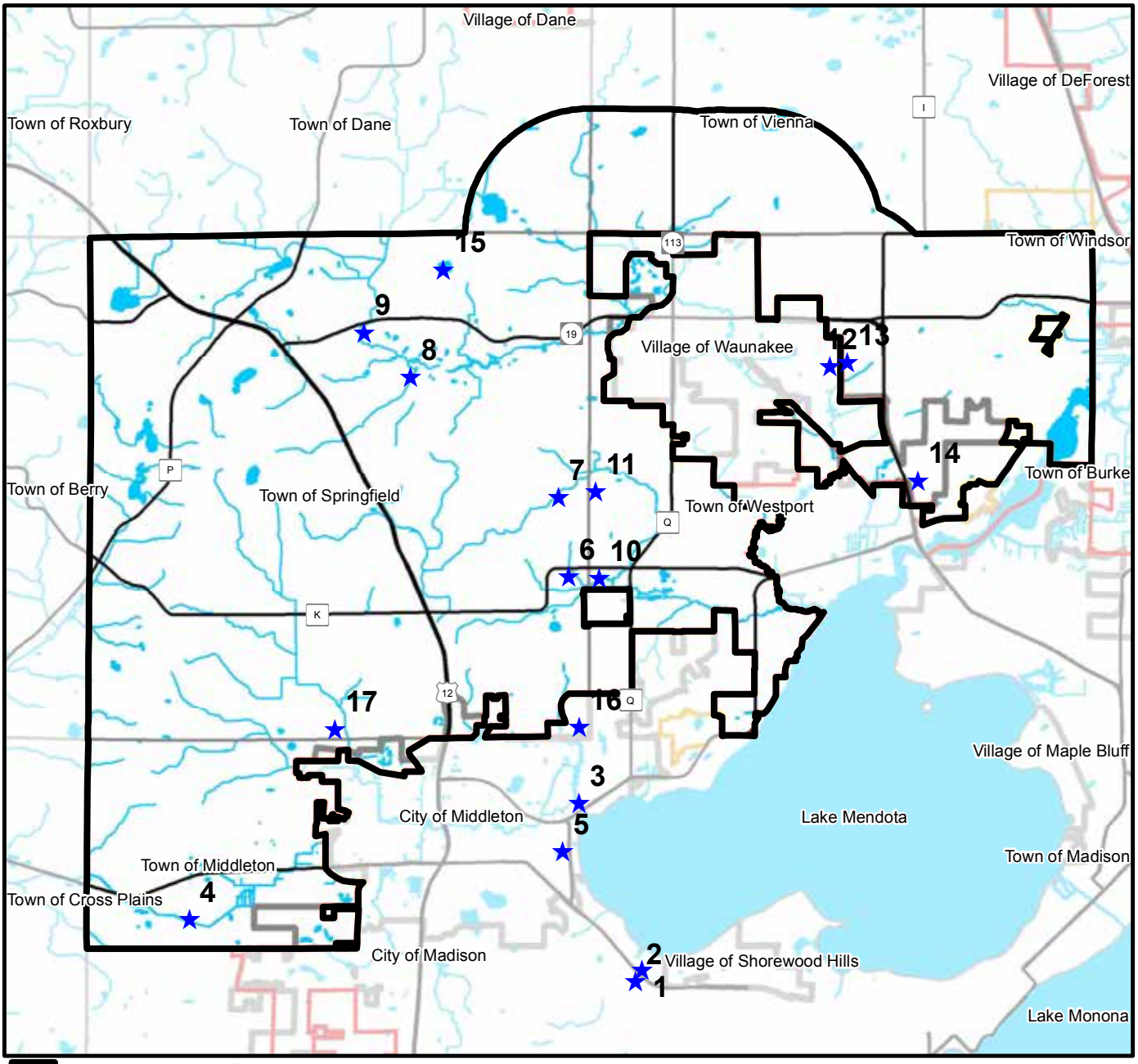


Deeper Mt. Simon aquifer flow indicates more regional groundwater movement.

(Source: 2000 Regional Groundwater Model)

Map 30: Springs

North Mendota Study Area, Dane County, WI



FUDA Study Area
Urban Service Area
Limited Service Area
Water

Springs

1 - 75 gpm	5 - 5	9 - 5	13 - dry	17 - na
2 - 100	6 - 1	10 - 60	14 - dry	
3 - 15	7 - 8	11 - 150	15 - dry	
4 - 10	8 - dry	12 - 1	16 - 7	

Miles
0 0.25 0.5 0.75 1 1.25 1.5

Source: Capital Area Regional Planning Commision February 2012

Springs indicate areas of visible groundwater flow to surface water features. Groundwater discharge to a stream along its length may not be as readily apparent except by measuring its baseflow (i.e., streamflow during prolonged dry-weather periods).
(Source: Wisconsin Geological and Natural History Survey)

1. Groundwater Quality

Groundwater supplies nearly all of the water for our domestic, commercial and industrial uses in the North Mendota FUDA study area as well as Dane County overall. Although there is a relatively unlimited groundwater supply for these purposes, it is especially important that the quality of groundwater be protected. Once groundwater becomes contaminated it is very expensive and difficult to return it back to its original condition. Groundwater is also very important for providing baseflow discharge to wetlands and streams, especially during periods of dry weather. ***Groundwater that is withdrawn and used in the North Mendota FUDA study area is for the most part recharged locally from infiltration of precipitation in the immediate area.***

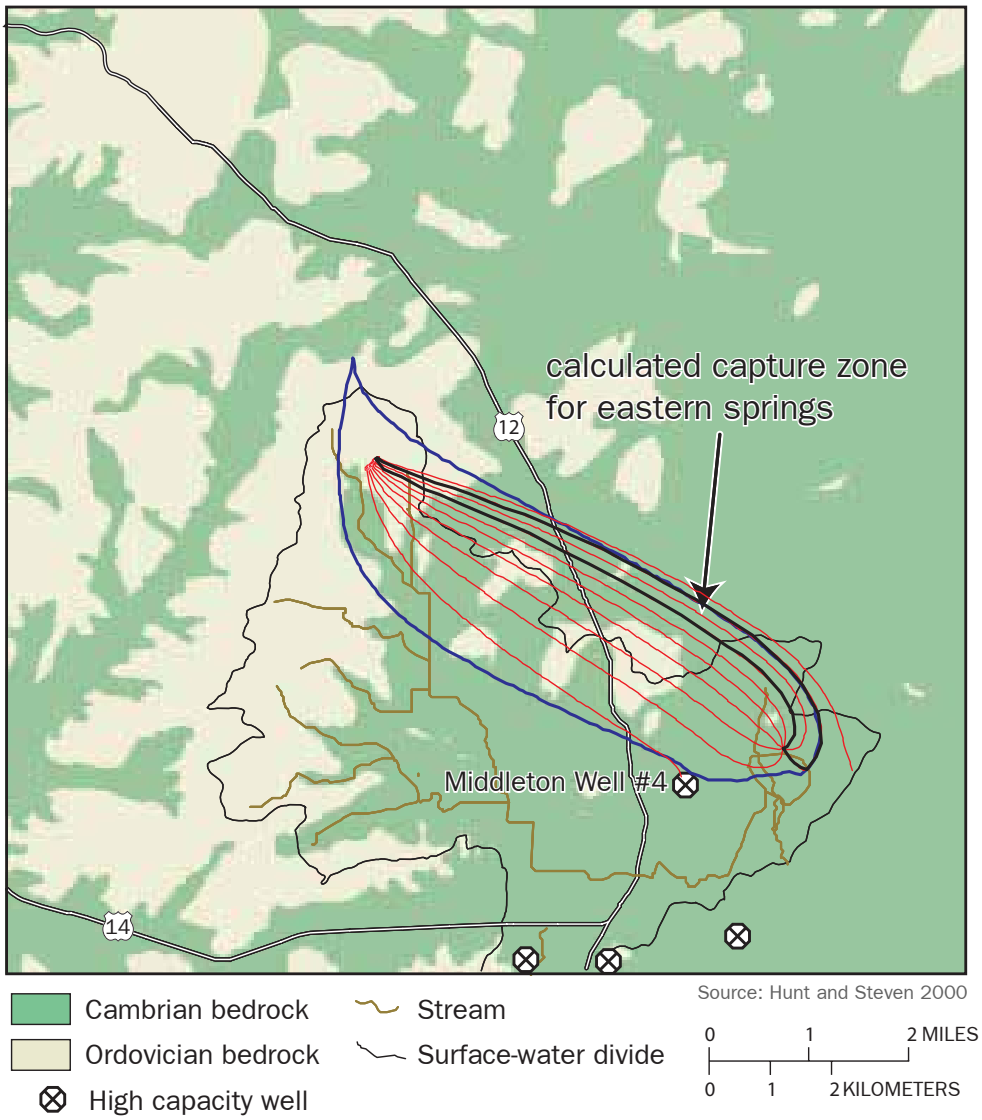
In rural areas domestic water supplies are drawn from the upper sandstone and unconsolidated (glacial) aquifers (see Figure 14). In urban areas deep municipal wells draw water from the deep sandstone (Mt. Simon) aquifer. The shallow groundwater system is of primary importance in questions of groundwater quality. Shallow domestic wells are particularly at risk, compared to deeper municipal wells which are usually drilled to a depth of many hundreds of feet. Deeper municipal wells are also frequently tested. ***Since groundwater represents the source of nearly all our water supplies throughout the county, protection and management of the resource is a high priority.***

While groundwater quality is generally good, there have been localized instances of contamination from nearby pollution sources, particularly in the upper or shallow aquifer affecting shallow private wells. Water supply concerns relate to potential increases in nitrates, dissolved salts, and volatile organic compounds (VOCs), which could affect the deep aquifer from which most municipal water supplies are withdrawn.

Municipal well water quality is highly regulated. Public water supplies in Middleton, Westport, and Waunakee are regularly sampled and tested. The quality is generally quite high and safe for use. In addition, residents receive annual Consumer Confidence Reports from their municipal suppliers required by the Federal Safe Drinking Water Act and U.S. EPA. The reports provide consumers with clear, concise, and accurate information about the quality of their drinking water. Many communities have also defined wellhead protection areas and associated regulations to help protect their wells from contamination.

Map 32 shows the 5-, 50-, and 100-year zones of contribution for North Mendota FUDA communities' wells pumping at projected year 2030 rates. These provide the technical basis for community Wellhead Protection Plans. Middleton, Westport, and Waunakee either have or are in the process of developing wellhead protection plans for their wells. Wellhead protection plans are developed to help guide development and prevent contamination of municipal wells.

Map 31: Zone of Contribution for Frederick Springs



Frederick Springs

2. Groundwater Quantity

a. Pumping and Diversion

Pumping or withdrawal of groundwater from one location and then discharging or diverting it to another location can significantly alter the local ground and surface water balance (e.g., MMSD diversion of wastewater to Badfish Creek, essentially short-circuiting the Yahara River system). ***As part of the Dane County Regional Hydrologic Study (DCRPC 2004) groundwater modeling was conducted to estimate the impacts of high capacity municipal well water withdrawals. These impacts can be particularly pronounced in urban areas where concentrated pumping of groundwater lowers the water table, reducing base flow contributions to streams and lakes.*** Figure 15 shows water table declines as a result of year 2000 pumping by as much as 65 feet on west side of the Madison metropolitan area, and by 45 feet on the east side. The fact that there are two cones of depression indicates that the Yahara Lakes are a significant source of water for groundwater supplies. Figure 16 shows the additional water table declines as a result of projected year 2030 pumping and diversion, concentrated primarily in the developing areas of the region.

The simulations show the increase in pumping from 2000 to 2030 will have a significant effect on baseflow, especially small streams and headwaters like Pheasant Branch Creek and Black Earth Creek (see Table 7). This is in addition to the significant reductions that have already occurred.

Table 7: Simulated Stream Baseflows for Selected Streams in Dane County

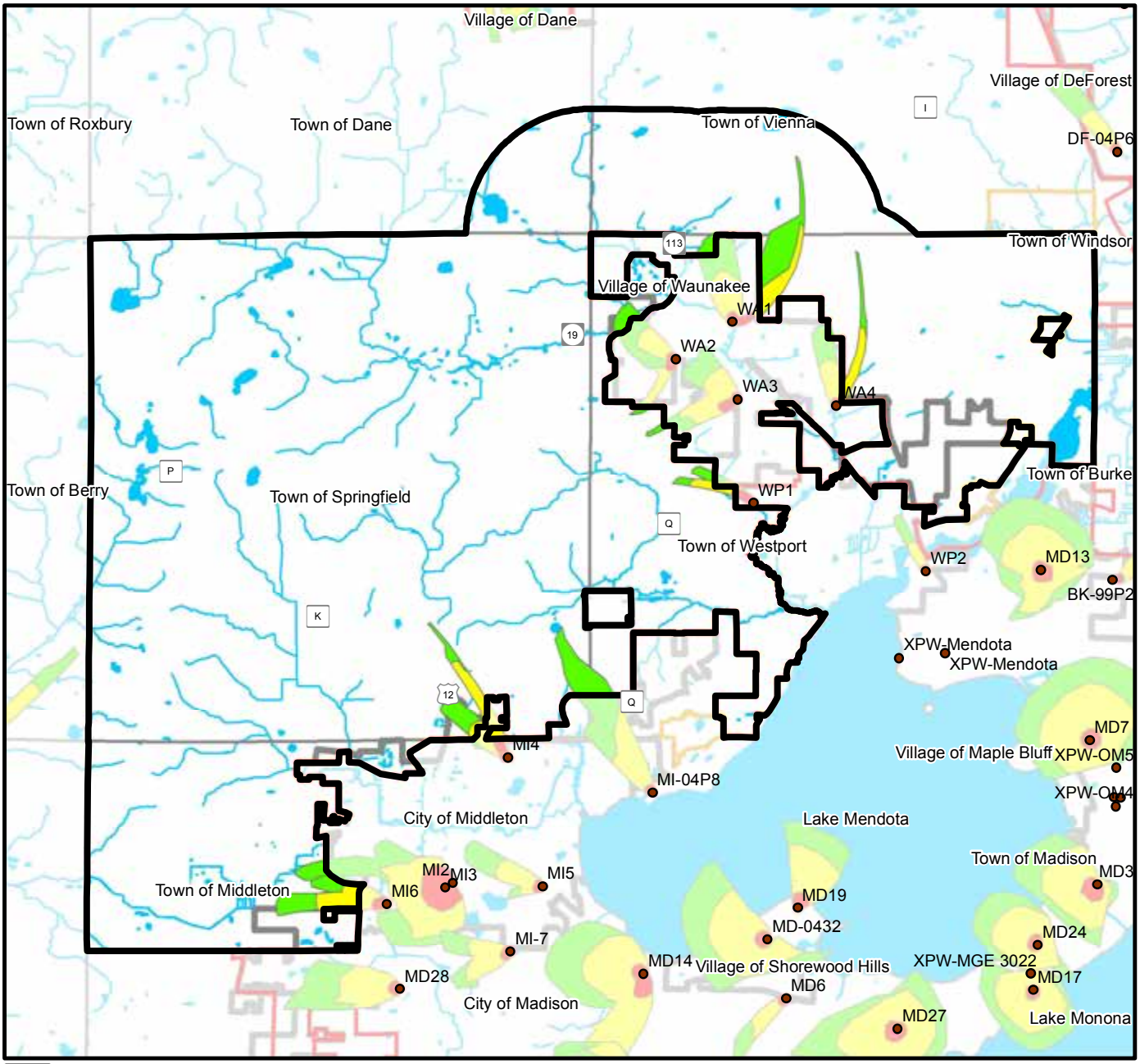
Station	Pre-Development cfs	2000 cfs (% reduction)	2030 cfs (% reduction)
Upper Black Earth Cr.	1.70	0.60 (65%)	0.19 (89%)
Pheasant Branch Cr.	2.20	0.85 (61%)	0.29 (87%)
Sixmile Cr.	4.46	3.40 (24%)	2.77 (38%)
Yahara R. at McFarland	127.28	70.00 (45%)	54.21 (57%)

Source: DCRPC 2004

This reduction in baseflow is a concern both locally and regionally. ***Long-term collaboration, cooperation, and coordination is needed among local units of government and management agencies to achieve regional sustainability goals for interconnected resources such as groundwater and surface water.*** This is being facilitated by CARPC at the regional level by coordinating the update of the Dane County Regional Groundwater model undertaken by the WGNHS. The City of Middleton, Village of Waunakee, and the Town of Westport are participating in this collaborative project. The updated model and its earlier version are critical tools to define the scope of the problem and build a regional consensus in support of strategies ***to address it. In the meantime, the approach of exceeding the natural groundwater recharge rate, where possible, to mitigate the impacts of water withdrawal, as well as fostering water conservation and reuse practices at the local level will help maintain the resource until broader measures can be outlined and implemented.***

Map 32: Zones of Contribution for Municipal Wells

North Mendota Study Area, Dane County, WI



Zones of Contribution (ZOC) indicate the area contributing groundwater to a well for an assumed pumping rate and travel time. This simulation assumes projected 2030 pumping rates for communities based on 2030 population estimates spread evenly among both existing and planned wells. ZOCs provide the technical basis for communities in developing wellhead protection plans. (Source: 2000 Regional Groundwater Model)

Source: 2000 Regional Groundwater Model

Figure 15: Simulated drawdown at the water table, 1900-2000

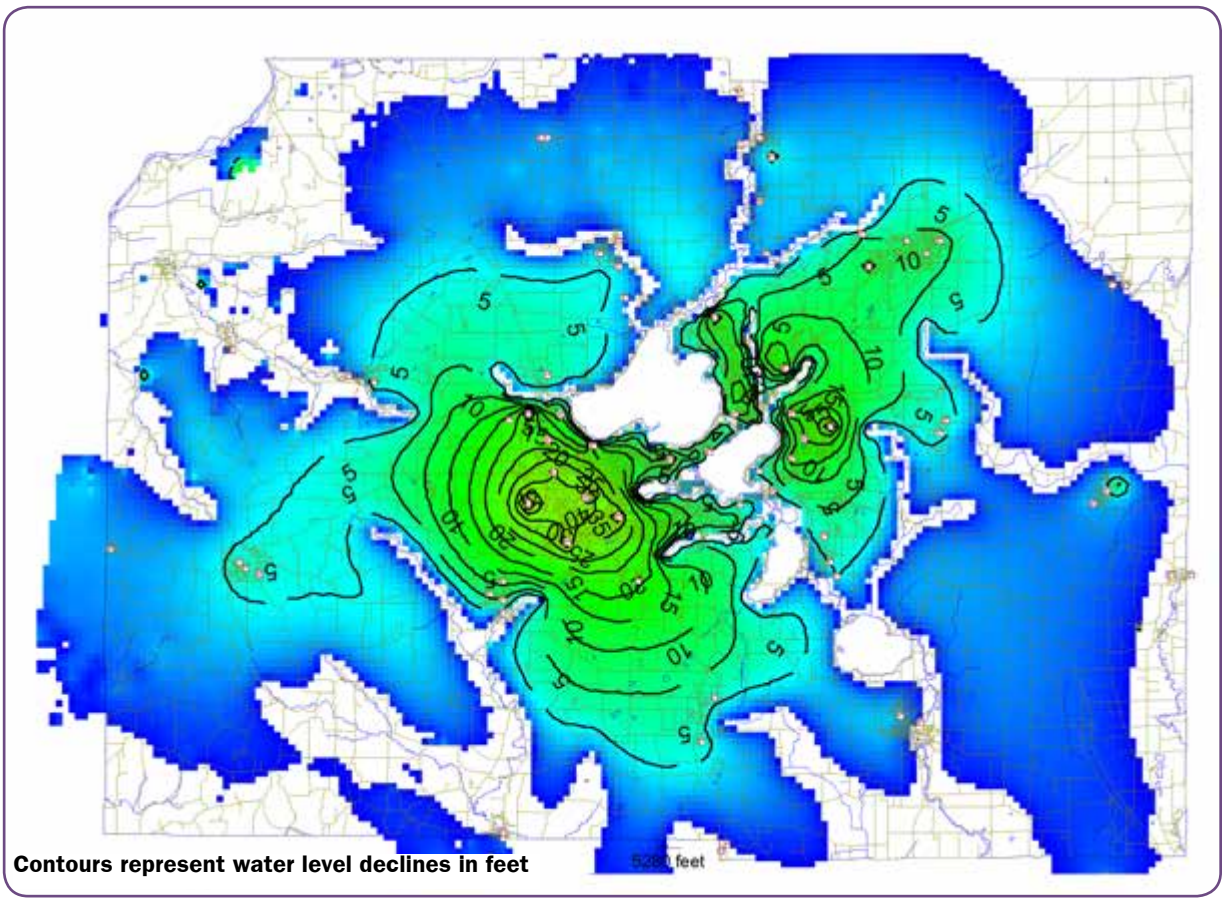
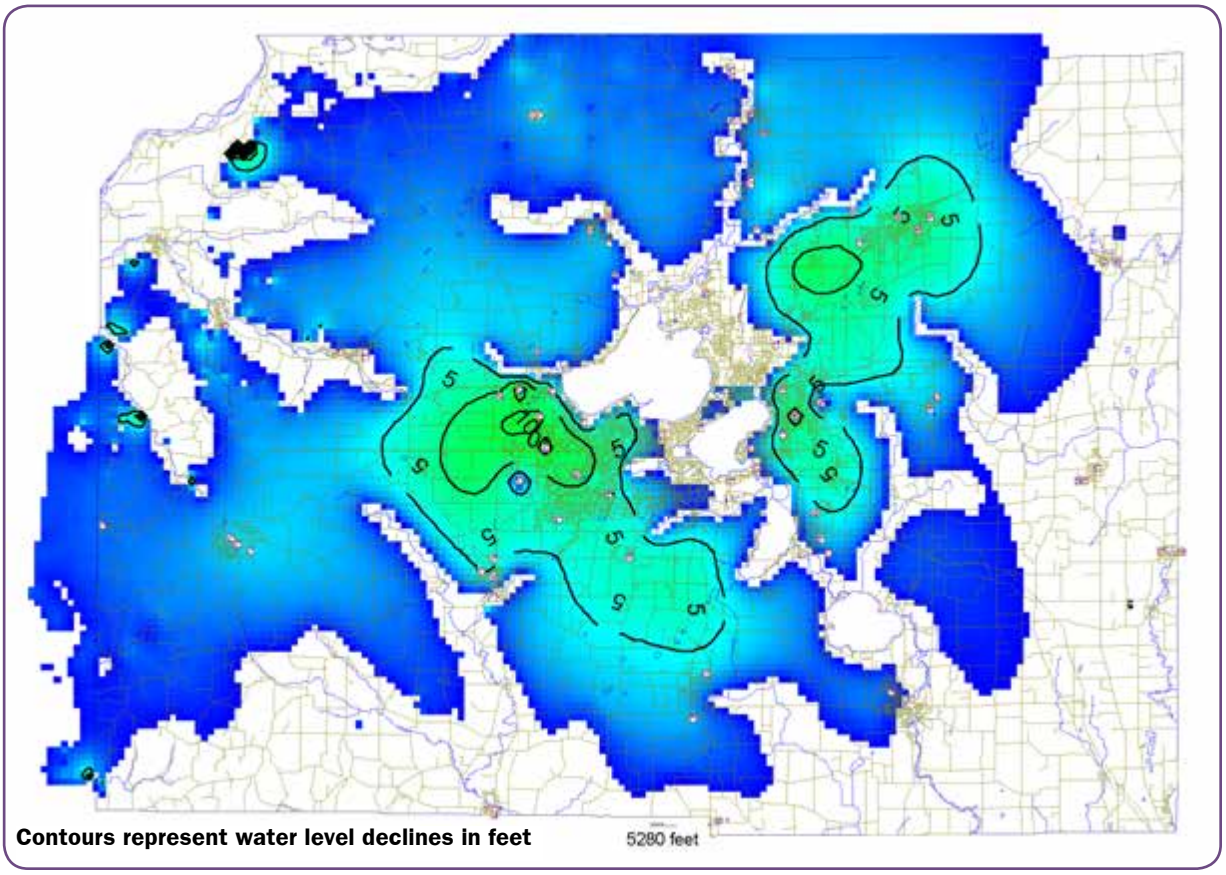


Figure 16: Simulated drawdown at the water table, 2000-2030



b. Groundwater Recharge Loss

One of the impacts of development is the expansion of urban areas and the increase in impervious areas covered by roads, roofs, and parking lots. ***The increase in impervious surfaces in the absence of active stormwater infiltration practices such as raingardens, results in substantial reduction in the natural groundwater recharge through the ground surface.*** While there is no critical shortage of groundwater available for future supply needs, this clear and cold groundwater flowing from numerous springs, seeps, and baseflow discharge does provide an extremely important source of water for maintaining the health and well-being of our surface water resources. Map 33 shows natural groundwater recharge rates for the North Mendota FUDA study area.

Precipitation that soaks into the ground recharges groundwater supplies and discharges to streams keeping water temperatures low, and enhancing water oxygen levels. This favors habitat for fish and other sensitive aquatic species. Alternatively, precipitation that does not infiltrate into the ground typically runs off the land surface picking up pollutants along the way, requiring extensive stormwater quality treatment to protect surface water features. ***Additional runoff volumes, if not controlled, can also result in higher stream flows, and if allowed to continue and accumulate, can cause extensive stream bed and bank erosion and contribute to habitat damage.***

c. Relative Infiltration

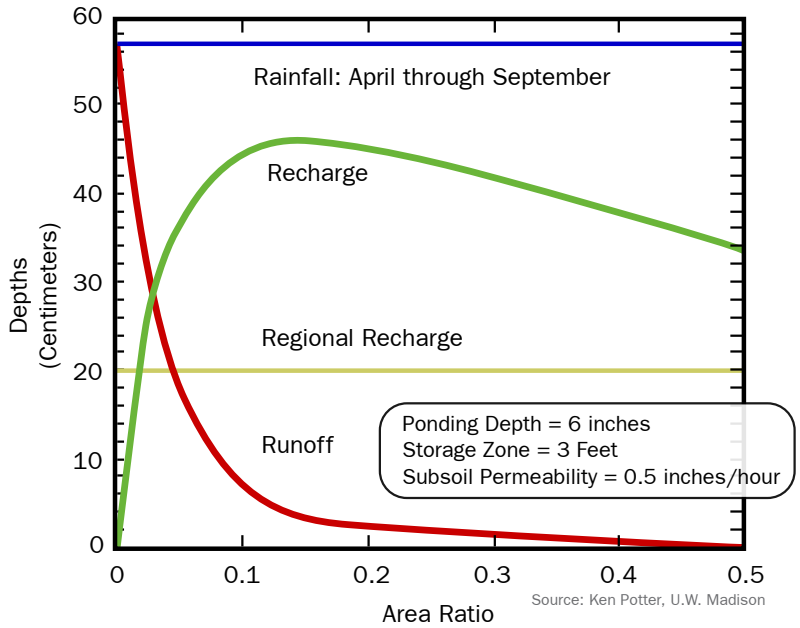
A key modern stormwater management strategy for addressing the impacts of development is to infiltrate as much rainfall and snowmelt into the ground as possible, thereby reducing overland stormwater runoff and replenishing groundwater supplies. Maps 34, 35, and 36 show various opportunities and strategies that can help minimize the impacts of future development as well as retrofit previously developed areas where opportunities permit.

The distinction between infiltration and recharge should be clarified. Whereas all precipitation that reaches groundwater is infiltrated into the soil, not all infiltrated precipitation actually makes it all the way to recharging groundwater supplies. Some of it may be captured by plants and evaporated or transpired back into the atmosphere. The distinction is that infiltrating stormwater runoff into the soil can reduce the volumes of runoff washing over the land surface, but not all of the infiltrated stormwater will necessarily reach the groundwater. Groundwater recharge supplies baseflow discharge to area waters, sustaining them during dry weather conditions.

From an overall stormwater management perspective, areas with naturally high infiltration should be used to recharge the groundwater to the greatest extent practicable. Map 34 indicates generally medium infiltration areas within the North Mendota FUDA study area. Stormwater runoff generated in these areas could be reduced on site to some extent, such as through rain gardens and low impact design. Modeling by a researcher at UW-Madison provides important insight into the beneficial aspects of rain gardens. It has been theorized that over 90% of the annual runoff can be infiltrated into the ground by using a garden sized only 10% of the impervious area draining to it (see Figure 17). The optimum area ratio is between 10%-15% before experiencing a rate of diminishing return. In this manner, infiltration rates in rain gardens can be designed to exceed natural infiltration rates, helping to make up lost infiltration caused by past development and groundwater depression caused by well withdrawals. Stormwater runoff rates and volumes are lowered through infiltration practices, preventing damage to streams. Reducing runoff also results in reduced pollutant loads

washing off the land surface into area waters. This is just one example of the many options available to promote greater infiltration of precipitation, both on-site and off-site.

Figure 17: Rain Garden Simulation

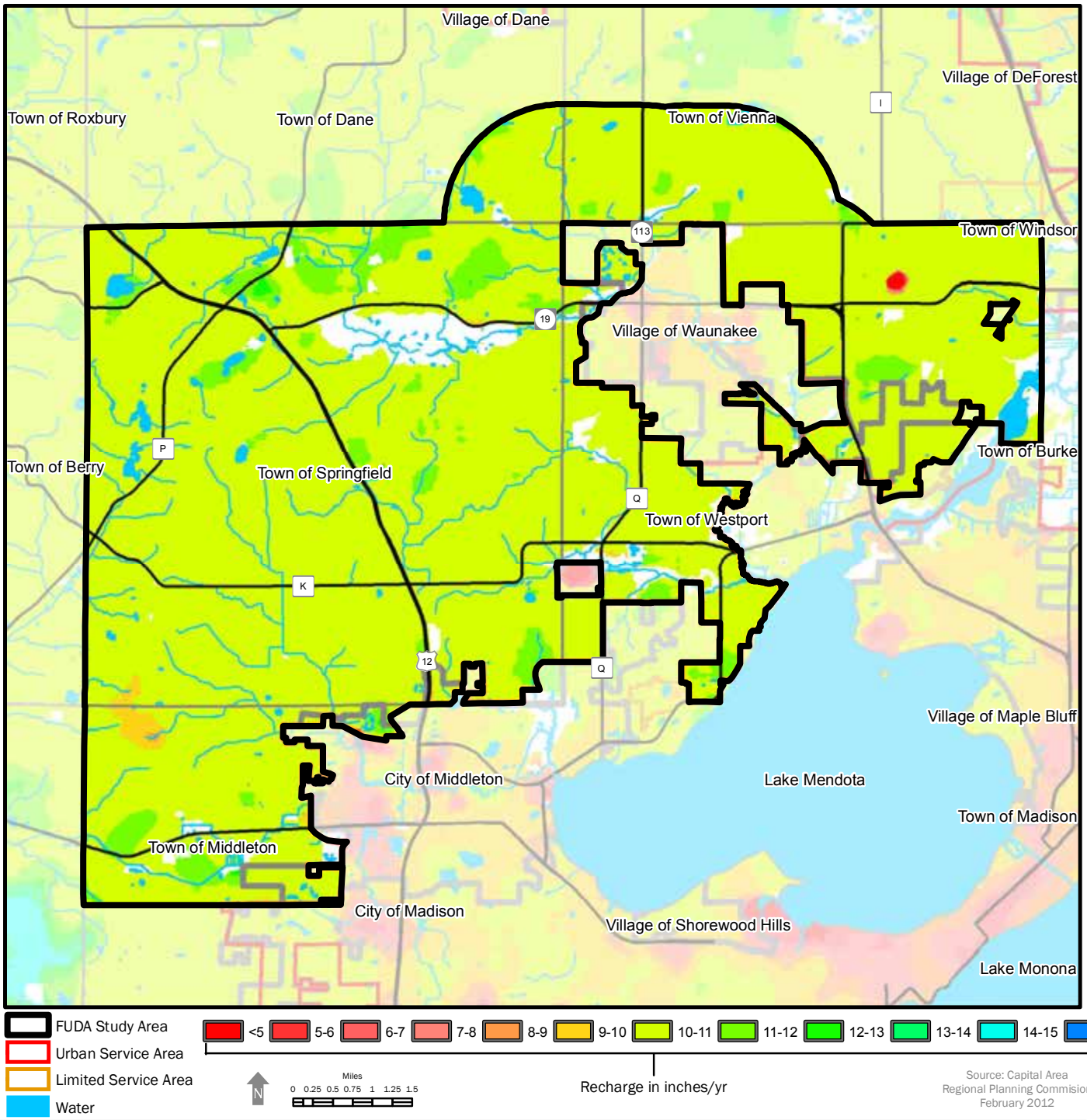


Map 35 presents enhanced infiltration that could result from engineering practices tapping into deeper sand and gravel deposits. Significant opportunities exist within the study area. T***hese may be prime locations for regional infiltration facilities*** that could be used for water recycling and to infiltrate stormwater generated in other parts of the watershed. These facilities would need to be adequately sized and located to accommodate the rates and volumes of stormwater generated by a proposed development. Groundwater quality protection measures should also be considered. For example, directing clean rooftop runoff to infiltration trenches and basins would be one way of dealing with this, as well as engineered soils (e.g., mixtures of sand, clay, and compost) to filter out pollutants, maintaining adequate separation distances to groundwater, along with a whole host of other engineering and conservation design practices. There may also be opportunities for retrofitting previously developed or re-developing areas.

Map 36 shows where the potential for enhancing infiltration may be the greatest. These areas show the greatest improvement in infiltration capacity between the natural and engineered states. Overall, there are many opportunities for enhancing infiltration throughout the study area. The purpose of these maps is to highlight these areas as important elements of site design, so that they may be more fully utilized for water quality protection and groundwater recharge, early in the planning process. While the maps do not replace the need for more in-depth analysis for a particular site, they do provide a useful planning tool to encourage the incorporation of innovative stormwater management practices into more sustainable urban designs.

Map 33: Groundwater Recharge (in./yr.)

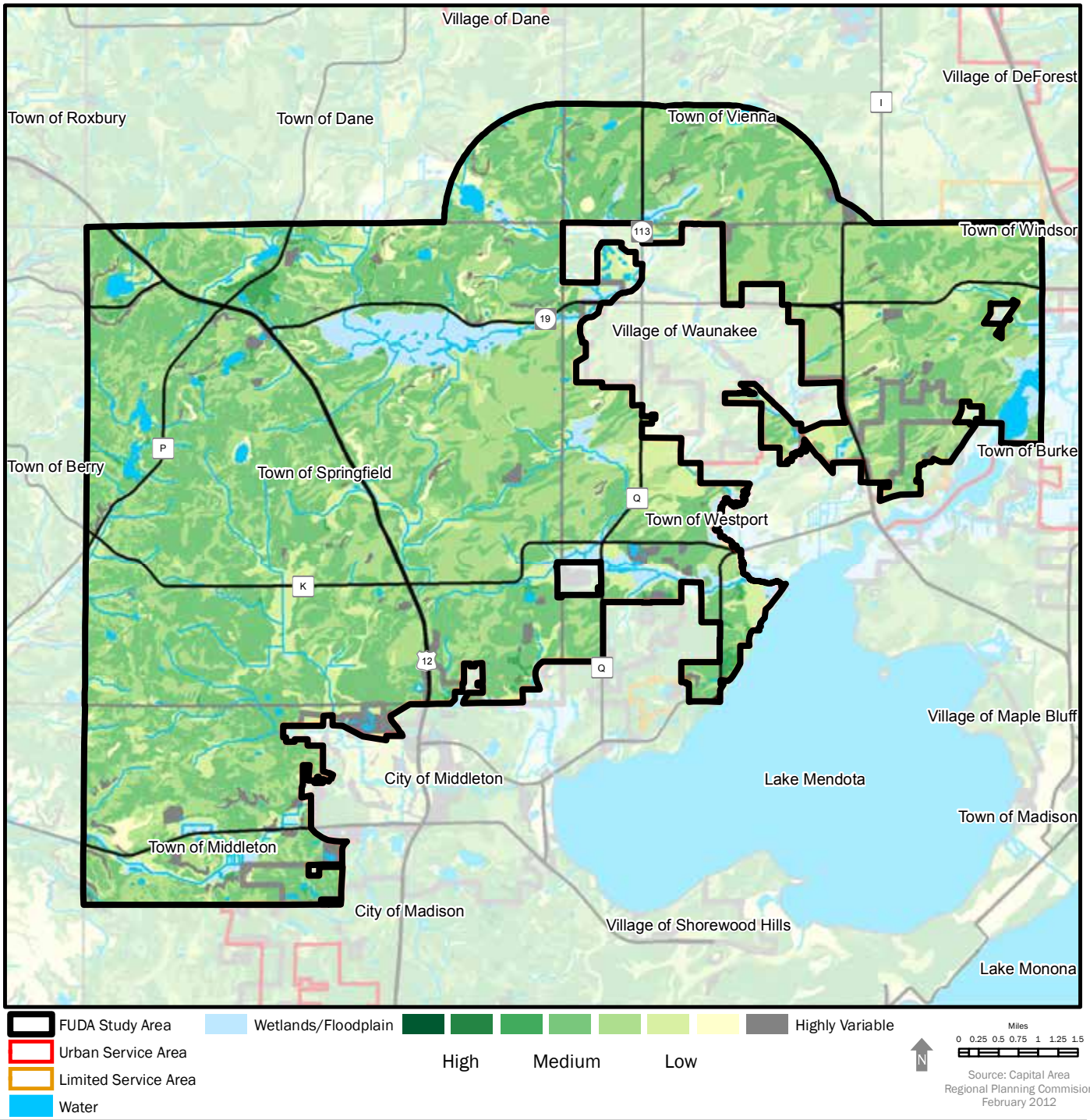
North Mendota Study Area, Dane County, WI



Precipitation that soaks into the ground and recharges the groundwater, eventually discharges to streams and other water bodies, helping keep water temperatures low and enhancing oxygen supplies. This favors habitat for fish and other sensitive aquatic species. Development without mitigation measures can disrupt the ground/surface water balance resulting in less recharge and more stormwater runoff.

Map 34: Relative Infiltration -- Natural Conditions

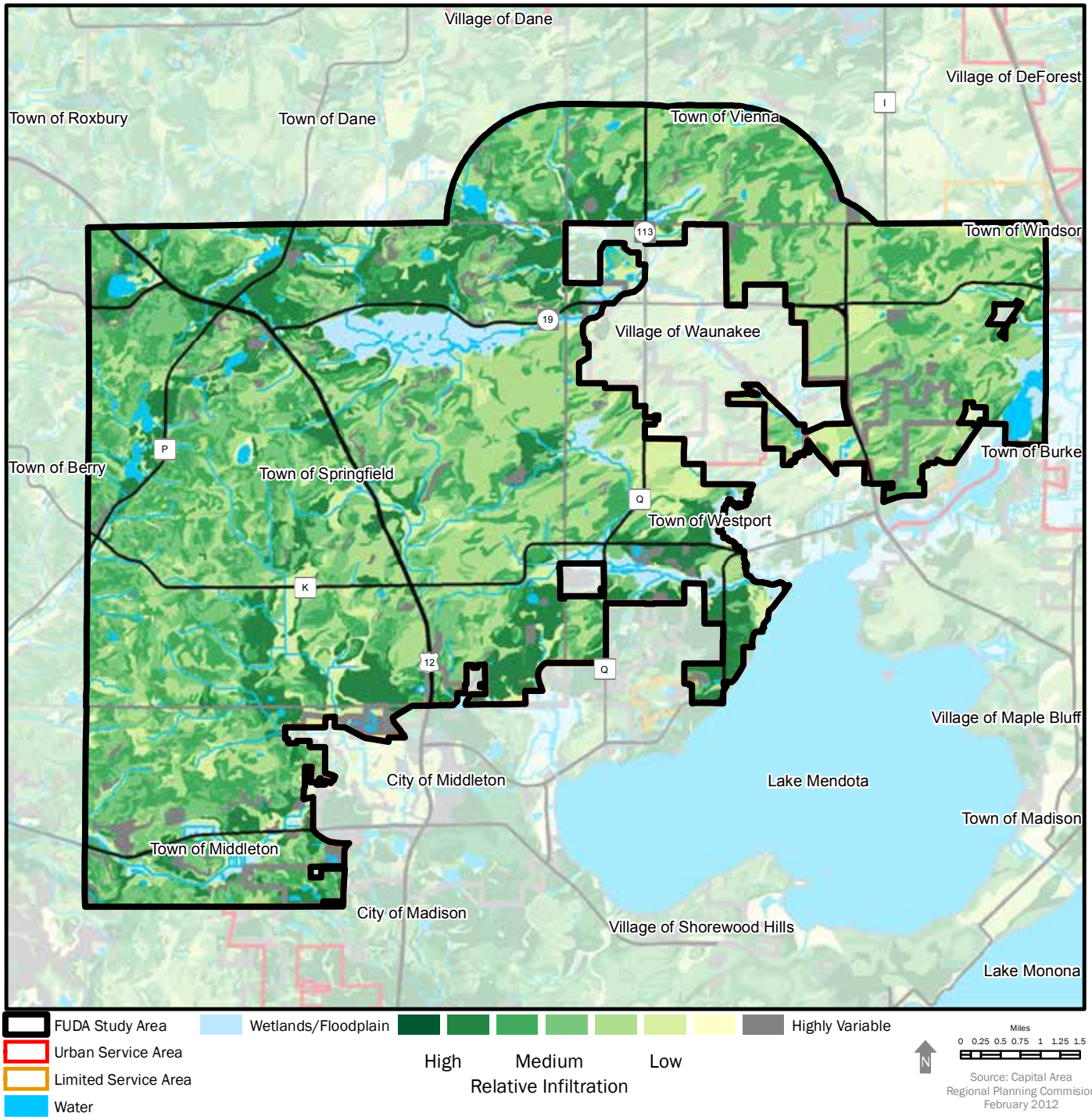
North Mendota Study Area, Dane County, WI



Areas with naturally high infiltration should be used to recharge the groundwater. They may also be prime locations for regional infiltration facilities that could be used for recycling treated water and to infiltrate stormwater generated in other parts of the watershed. Wetland and floodplain areas are generally not conducive to infiltration practices.

Map 35: Relative Infiltration -- Engineered Conditions

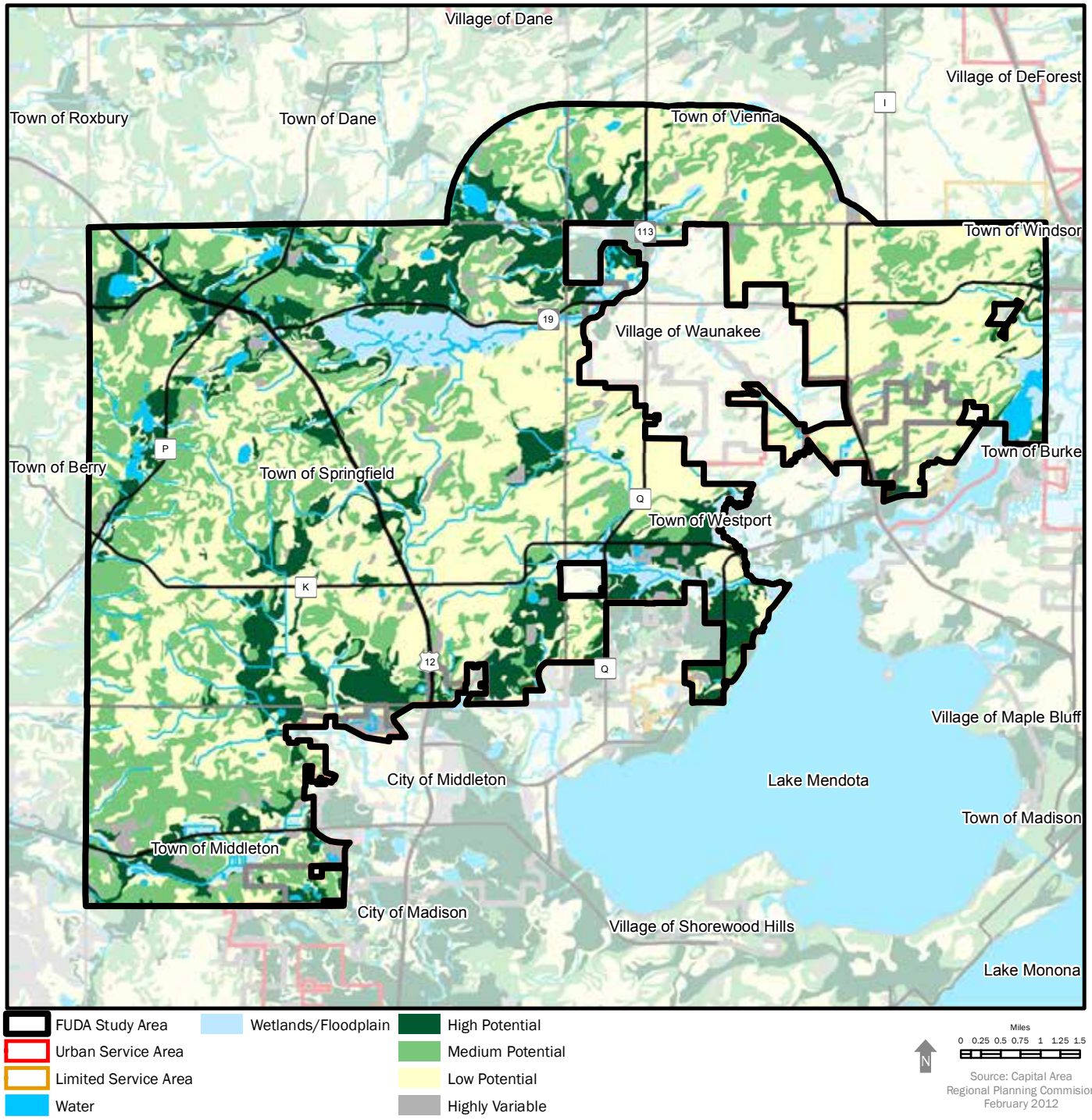
North Mendota Study Area, Dane County, WI



Infiltration can be enhanced through removal of shallow layers of low permeability soils and tapping into deeper sand and gravel deposits. The use of engineered soils can enhance natural infiltration and enhance the opportunities for infiltrating stormwater. There may also be enhanced opportunities or improvements that could be gained by retrofitting previously developed areas.

Map 36: Relative Infiltration -- Potential for Enhancement

North Mendota Study Area, Dane County, WI



This map indicates areas where infiltration enhancement potential may be the greatest. These areas show the greatest difference in scores between the natural and engineered states, highlighting opportunities where more permeable soils (e.g., sand and gravel deposits) may be present deeper in the soil column. These may be prime locations for regional stormwater facilities that could be used to infiltrate stormwater generated in other parts of the watershed.

E. Endangered Resources

Before Europeans arrived, south central Wisconsin was mostly open country dominated by prairies and oak savannas (see Map 37). Grasses, wildflowers and widely scattered oaks were the principal vegetation. Low, poorly drained areas contained extensive marshes, sedge meadows, and wet prairies. For millennia, fire checked the growth of forests and kept the landscape open. Fires were probably ignited by native Americans or naturally occurring by lightning. Areas that burned often and contained few barriers to the spread of fire (such as lakes, rivers, and marshes) were usually treeless prairies, rich in grass and forb species. Areas that burned less frequently developed into oak savannas and woodlands. Like the prairie, these oak communities contained a high diversity of grass and forb species. Bur oaks and white oaks were the dominant trees in this landscape since their thick bark protected them from fire. Areas protected from fire, usually on the leeward sides of lakes and major rivers, developed into sugar maple-basswood forests.

Planning Considerations:

Riparian Restoration

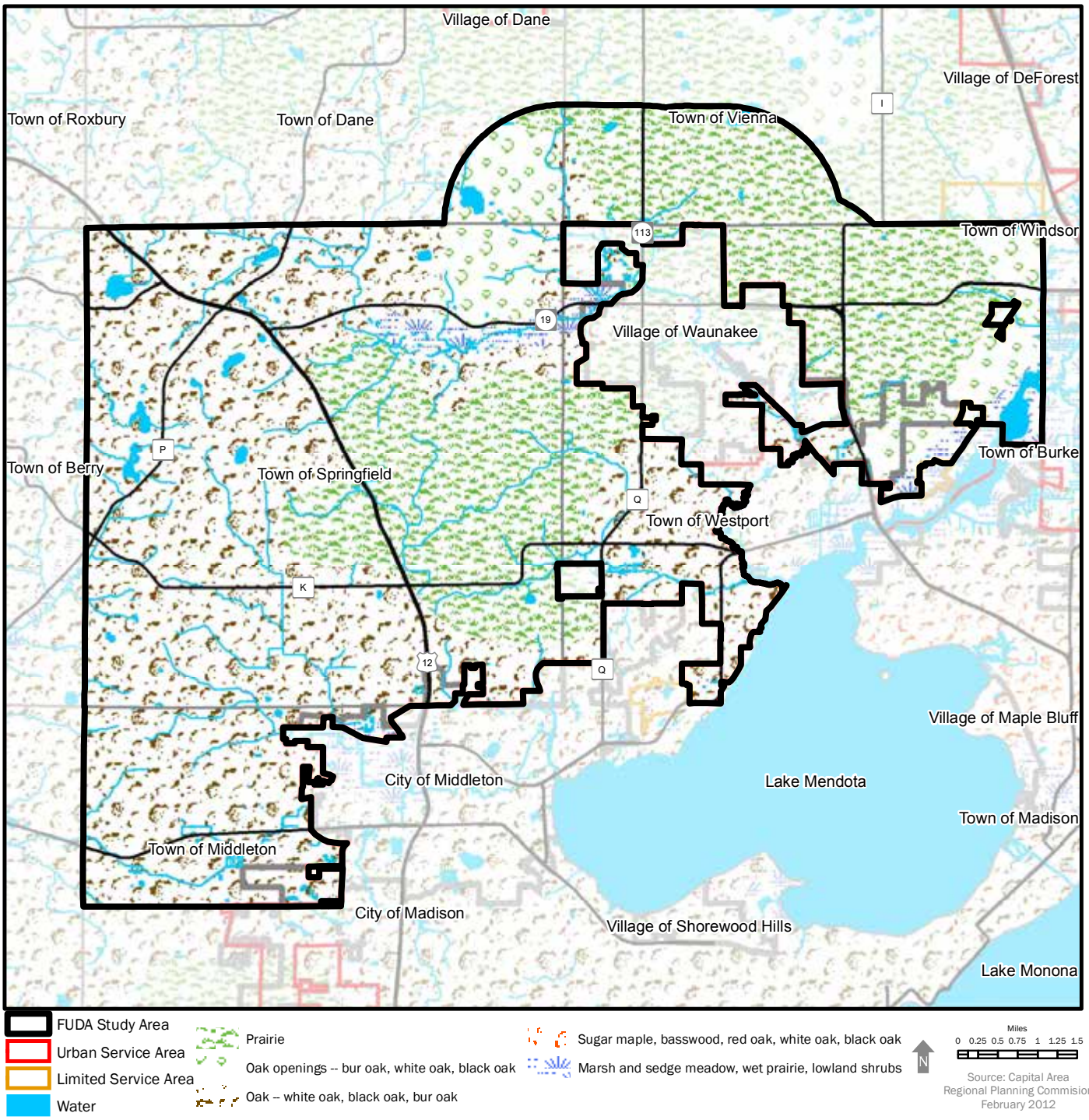
- Look for opportunities to protect habitat for threatened and endangered species in public parks and nature preserves.

Following European settlement, wildfires sharply diminished and eventually halted. No longer suppressed by fire, oak seedling sprouts grew rapidly and formed closed-canopy oak forests within a generation. Eventually fire-sensitive hardwoods, like maples, ashes, elms, and hickories began spreading and displacing oak trees. Lands that were prairies or savannas are now mostly wooded, farmed, or built upon. ***According to WDNR, only 0.5% of the original area covered by prairie and only 0.01% of the area covered by savanna in Wisconsin still exists (WDNR 1995). Ecosystems originally rich in plant and animal species have degraded through structural changes to habitat and subsequent loss of plant and animal species.*** This is the result of widespread clearing of land for agricultural production and urban development, stormwater runoff, drainage of wetlands, channelization of rivers and streams, invasion of exotic species, and extensive fragmentation of natural ecosystems. Only relatively recently have serious efforts been taken to protect and restore these resources. The North Mendota FUDA study area contains a diverse array of streams, wetlands, ponds, woodlands, and grassland habitats which give rise to numerous wildlife species, some of which may be either threatened or endangered.

Plant community structure is the fundamental building blocks of ecological landscapes and determines zoological diversity and drives ecosystem function. Natural communities are valuable and vital component of sustaining biodiversity. Undisturbed communities allow for rare species, which often depend on specific habitat requirements. Rare species and unique natural communities are often good biological indicators of significant areas and ecological function. ***Termed "Endangered Resources," such resources indicate where particularly significant or vulnerable ecological areas exist. The presence of one or more rare species and natural communities is an indication of ecosystem health and importance. Such areas should prompt attention directed toward species conservation, management, and restoration needs.***

Map 37: Presettlement Vegetation

North Mendota Study Area, Dane County, WI



The presettlement vegetation cover data was digitized from a 1976 map created by Professor Robert Finley from land survey notes written in the mid-1800s when Wisconsin was first surveyed. This vegetation cover map can be used to identify regional changes in land cover since the time when the state was first surveyed. This data is not intended for landscape-scale analysis.

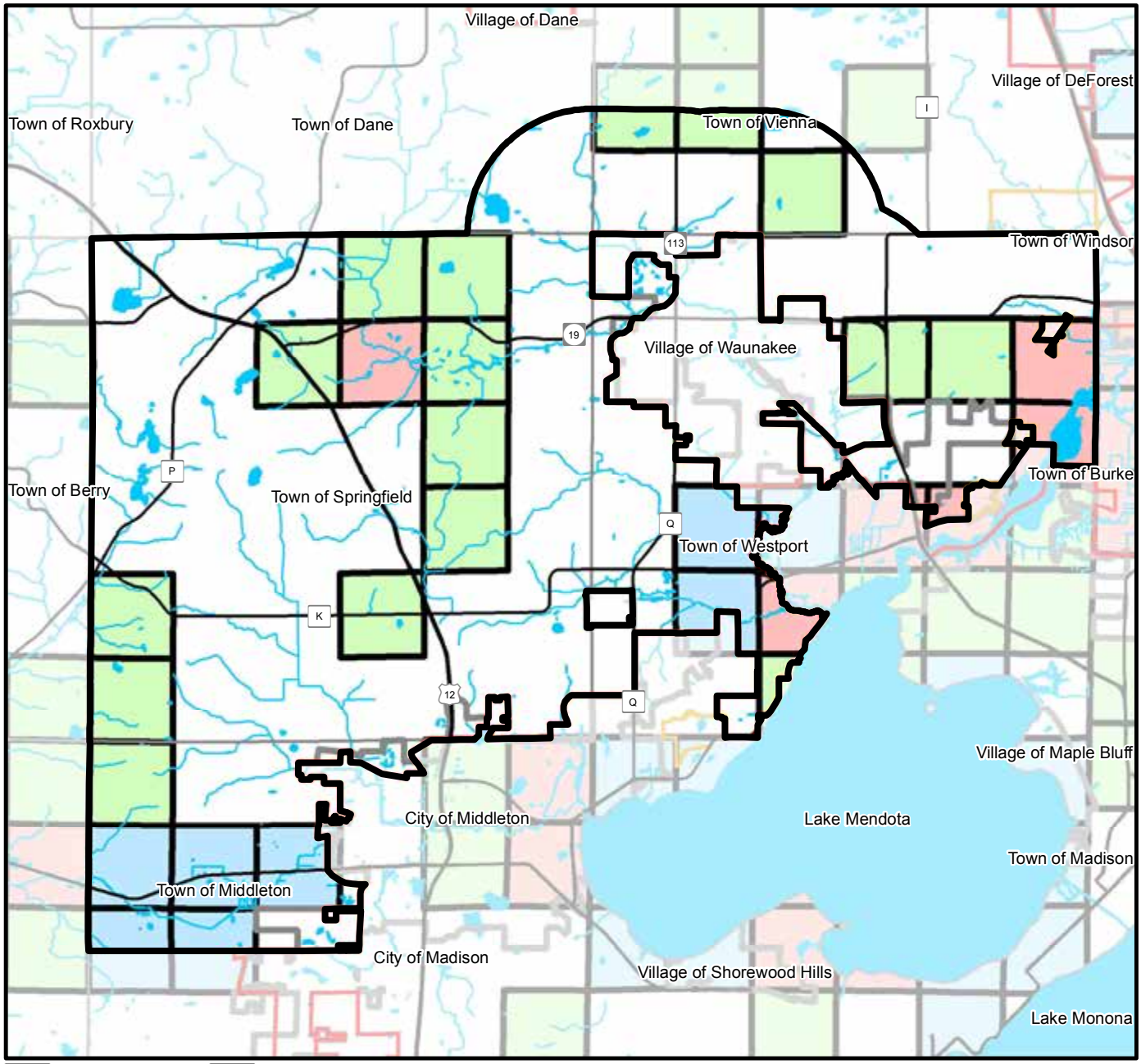
The WDNR Bureau of Endangered Resources (BER) maintains the Wisconsin Natural Heritage Inventory (NHI), a statewide database representing the known occurrences of rare species and natural communities. Map 38 shows generalized occurrences of endangered resources in the North Mendota FUDA study area. This information is confidential and is not subject to Wisconsin's open records law. Publication of the species locations cannot be made to resource managers, the NHI can determine the likely occurrence of rare species in areas affected by development or other land management activities. This information can be incorporated into development designs. ***It is important to note the NHI is not a complete catalogue of the locations of the state's rare species. Users must recognize that many areas of the state have not been inventoried, thus making distribution maps incomplete. Thus an "absence of evidence is not evidence of absence," nor does the presence of one occurrence imply that other occurrences have been surveyed for but not found.***

The typical screening review procedure entails querying the database for a particular area. The results list any know known occurrences in the search area and one mile buffer (two miles for aquatic species). If a known occurrence is found within the search area or buffer, then the search area is evaluated whether the habitat representing that particular species or community is present. If not, the species is not likely to exist. If it is, a field survey may be warranted to assess the suitability of the habitat and whether or not individual species may be present. Surveys are typically conducted during the season when the species can be most easily found and identified.

Since occurrences are generally site specific, the following information can be used as a guide in determining whether or not suitable habitat may exist in a particular area. If so, a more detailed review should be conducted by knowledgeable professionals and, depending on the occurrence, BER staff should be consulted for any specific actions that should be taken. Finding a threatened or endangered species doesn't necessarily mean that development cannot occur. Rather, prescribed management practices are available to avoid impact. Note that destruction of habitat is not an illegal activity, only taking or otherwise killing individual Threatened or Endangered species. The preferred approach, however, is to avoid habitat loss altogether.

Map 38: Endangered Resources* (Section Level Identification)

North Mendota Study Area, Dane County, WI



FUDA Study Area
Urban Service Area
Limited Service Area
Water
Aquatic
Terrestrial
Both
*Threatened and Endangered Species and/or Natural Communities

Miles
0 0.25 0.5 0.75 1 1.25 1.5

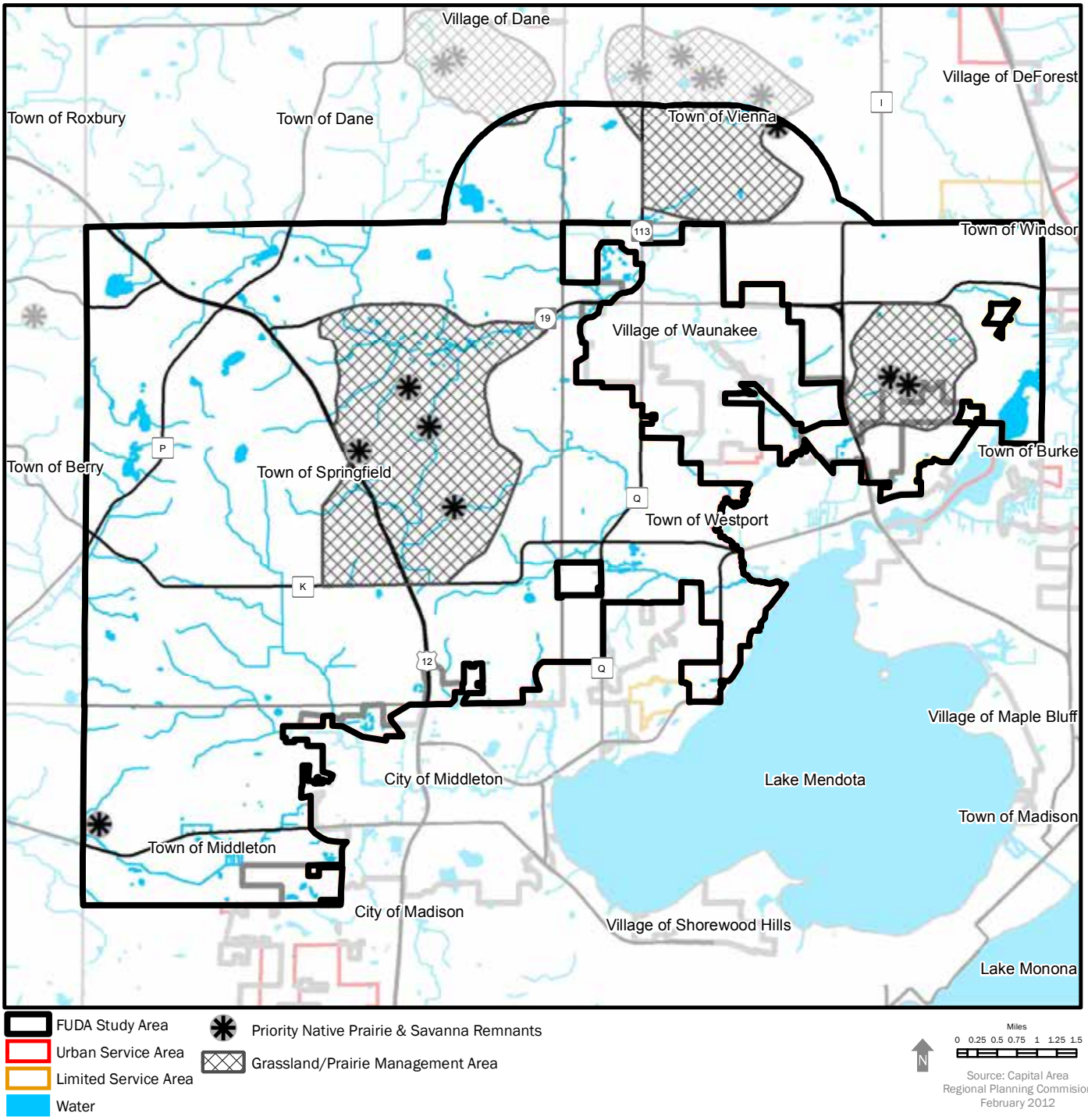
N

Source: Capital Area Regional Planning Commision February 2012

This map shows the generalized location of endangered species by the section in which they occur. More specific information is confidential and can be obtained by contacting CARPC or DNR Endangered Resources staff. Information is available to help minimize the impact of development for these species, largely depending on what is being planned.

Map 39: Prairie, Savanna and Grasslands

North Mendota Study Area, Dane County, WI



Priroty native prairie & savanna remnants and grassland/prairie management areas from Dane County Land and Water Sources Department.

Species listed in the NHI are categorized as one of the following:

1. **Threatened:** Any species which appears likely, within the foreseeable future, on the basis of scientific evidence to become "Endangered."
2. **Endangered:** Any species whose continued existence as a viable component of the state's wild animals or wild plants is determined by the WDNR to be in jeopardy on the basis of scientific evidence.
3. **Special Concern:** Any species whose population is suspected to be declining, but scientific evidence is insufficient to justify this assertion. Species of Special Concern could become threatened in time.
4. **Natural Community:** An identifiable assemblage of plant, fungal, and animal species living together in a particular area. The NHI Program tracks examples of Wisconsin's natural communities that are deemed significant because of their undisturbed condition, size, or for other reasons. For example, Map 39 shows the most prominent prairie remnants and the seven "best" prairie landscape-scale management areas in Dane County.

A screening review conducted by RPC staff identified endangered resource species shown in Table 8. These species have the potential to occur in the FUDA study area if appropriate habitat exists. More detailed information concerning these species can be obtained from the WDNR Bureau of Endangered Resources reference site at: http://dnr.wi.gov/org/land/er/biodiversity/

Occurrences are site specific. CARPC staff should be consulted early on in the planning process with regard to specific plans and sites, and potential mitigation measures that may be needed. Where there is the possibility or likelihood that an endangered resource may be present, an Endangered Resources Review by WDNR may be necessary. The CARPC Restoration Ecologist can provide more current assessment, recommendations, and assistance especially during the more detailed and technical design work associated with particular development scenarios, plans, or projects.

Table 8: Endangered Resources in the North Mendota FUDA Study area

Endangered	Threatened	Special Concern	Natural Communities
Insects	**Birds**	**Mammals**	Calcareous Fen
Red-Tailed Leaf Hopper	Henslow's Sparrow	Arctic Shrew	Dry Mesic Prairie
Silphium Borer Moth		Prairie Vole	Dry Prairie
	Fish	Pygmy Shrew	Emergent Marsh
Plants	Pugnose Shiner	Western Harvest Mouse	Mesic Prairie
Hairy Wild Petunia		Woodland Vole	Northern Wet Forest
Rough Rattlesnake Root	**Reptiles**		Shrub Carr
Prairie Bush Clover	Blanding's Turtle	**Fish**	Southern Dry Mesic Forest
Purple Milkweed		American Eel	Southern Sedge Meadow
	Plants	Banded Killifish	Springs and Spring Runs, Hard
	American Fever Few	Lake Sturgeon	Stream-Fast, Hard, Warm
	Hill's Thistle		Wet Prairie
	Prairie Parsley	**Reptiles**	
	Small White Lady's Slipper	Plains Garter Snake	**State Natural Areas**
	Snowy Campion		Empire Prairies
	Yellow Giant Hyssop	**Insects**	Cherokee marsh
		Broad-Winged Skipper Butterfly	
		Cryano Darner Dragonfly	
		Plains Yellow-Winged Grasshopper	
		Plants	
		Flodman Thistle	
		Glade Mallow	
		Innocence	
		Lesser Fringed Gentian	
		One-lowered Broom Rape	
		Pale Bulrush	
		Prairie False-Dandelion	
		Sweet-Scented Indian Plantain	
		Slim-Stem Small Reedgrass	

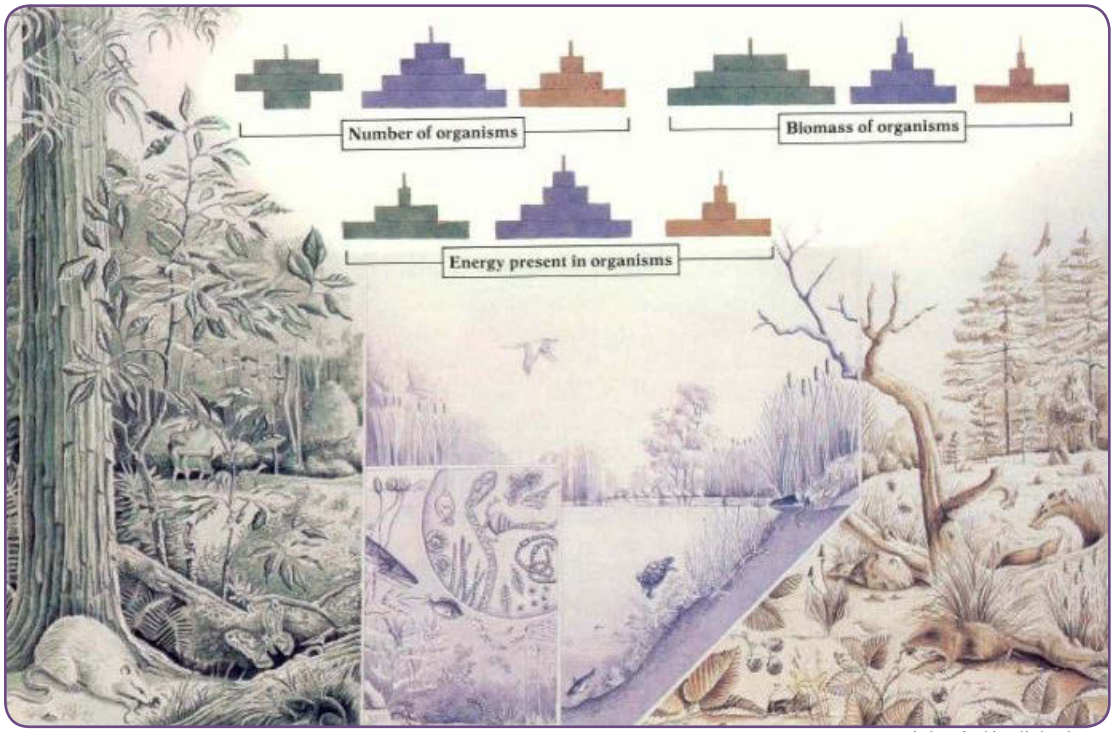
Source: WDNR Natural Heritage Inventory Database (12/2010)

F. Wildlife Resources and Biodiversity

While the importance of the protection of water resources from human activities such as agriculture and urban development is obvious, it is often less apparent that the terrestrial areas surrounding surface waters also serve as "core habitats" for many semi-aquatic species that depend on both aquatic and terrestrial environments to fulfill their life-cycle requirements (e.g., feeding, mating, nesting, and over-wintering). These in turn serve as food for higher level organisms and the circle of life continues. ***Scientists sometimes identify certain species as "umbrella species" in the hopes of saving a whole range of animals and plants in a given area and thereby maintaining overall biologic health and diversity (biodiversity).*** The idea is that by protecting an important umbrella species and preserving its habitat, various other species that depend on the same habit will also be protected.

Amphibians and reptiles (known collectively as herptiles) represent a crucial link between aquatic and land ecosystems. Herptiles play particularly important roles in food webs because they occupy a middle position as both predator and prey, and also because they constitute an enormous amount of the biomass in some aquatic and riparian ecosystems (see Figure 18). Development activities that cut too deeply into the base of these trophic pyramids can destabilize these systems, leading to diminished productivity, negative effects that cascade upwards to higher predators leading to eventual ecosystem collapse.[59]

Figure 18: Trophic pyramids of numbers, biomass, and energy for a forest, a shallow pond, and an "old field."



John A. Keslick, Jr.

59 Wisconsin DNR research shows that an average Green Frog population of 60-80 frogs per mile of waterfront can be expected in undeveloped areas. The population drops to zero where there are 40 homes per mile of waterfront. (personal communication with Gregg Breese, WDNR)

Semlitsch and Bodie (2003) summarized literature on the use of core terrestrial habitats by amphibians and reptiles essential for carrying out their life-history functions (see Table 9). Using the minimum mean group (salamanders) provides a good reference point for establishing a minimum wildlife protection program. If the distances salamanders move from wetlands are assumed to be normally distributed (test of normality $W = 0.927$, $p = 0.2168$), then by definition the mean for adults of all salamander species combined represents a distance encompassing 50% of the population. Furthermore, a core habitat encompassing the majority of the population (95% confidence limits) would encompass a terrestrial habitat of 540 ft from a wetland edge (Semlisch 1997). This distance encompasses the minimum distances for nearly all herptile species in Table 9, except snakes and frogs (specifically) which are typically more motile.

Semlitsch proposed stratified criteria that would include at least three terrestrial zones adjacent to core aquatic wetland habitats (see Figure 19):

1. ***Aquatic Buffer* – starting from the wetland edge, a first terrestrial zone would be restricted from use and designed to buffer the core aquatic habitat and protect water resources (100-200 ft.);**
2. ***Core Habitat* – a second terrestrial zone, overlapping the first, would encompass the core terrestrial habitat defined by the semi-aquatic focal-group (e.g., 540 ft. for salamanders, as above);**
3. ***Terrestrial Buffer* – a third zone, starting from the outward edge of the second zone, would buffer the core terrestrial habitat from edge effects and surrounding land use practices (e.g. 50 m or 160 ft.).**

Table 9: Mean minimum and maximum core terrestrial habitat for amphibians and reptiles (Distance from wetland edges)

Endangered	Mean minimum (ft)	Mean maximum (ft)
Frogs	672	1207
Salamanders	384	715
Amphibians	522	951
Snakes	551	997
Turtles	403	941
Reptiles	417	948
Herptiles	466	948

Semlitsch and Bodie 2003

Streams in Wisconsin are used less than ponds and wetlands for amphibian breeding, unless they possess similar amphibian breeding conditions; i.e., quiet water outside the stream channel or quiet backwaters (Hay 2008). A 300-foot buffer on both sides of the stream is recommended.

These areas are not intended to be restrictive to development or represent "no-build" zones. Instead, these areas are intended to highlight ecological connectivity and stewardship opportunities (e.g., open space and wildlife movement corridors, biofuels, community supported agriculture, etc.). ***More specifically, because of their critical nature and position in the landscape, these areas offer unique constraints and opportunities that need to be considered early on in the community's overall development and resource protection plans.***

Stream corridors provide extremely valuable habitat as well as critical connecting corridors for a wide variety of wildlife species. Areas surrounding wetlands and ponds are also rich habitat areas. According to the Wisconsin WDNR Bureau of Endangered Resources (BER), ***90 percent of the occurrences of threatened and endangered species in Dane County are located within 300 feet of streams and 700 feet of wetlands or small ponds.*** The presence or likelihood of endangered species being present are themselves an indicator of the importance and potential ecological health and diversity these areas can support.

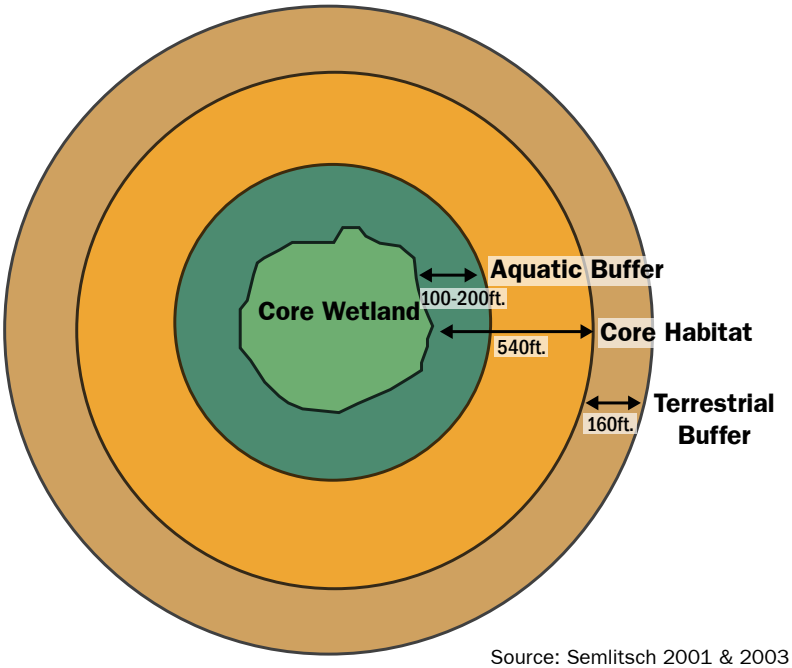
Researchers have also reported positive correlations between forest cover and amphibian and reptile populations in wetlands. ***These studies suggest the need to link terrestrial forest habitats adjacent to wetlands to sustain amphibian and reptile species.*** Map 40 shows a simple habitat classification based on the coincidence of two or more resource features (streams, wetlands, hydric soils, floodplains, and forestlands), including core habitat and wildlife corridors described above. It is probably not too surprising that core physical

and biological components are mutually coincident[60]. In many cases these areas could be improved or enhanced by management activities that allow the land revert back to a more natural condition (passive restoration) and by more active management practices, such as active restoration of farmed wetlands, prairie restoration, and riparian re-vegetation.

The overall conservation objective should be to direct development away from sensitive and critical resource areas. If that is not possible, it should be incumbent on planners to design developments to provide equal or greater natural resource protection. This may be accomplished by advanced conservation design techniques, restoration of other areas, or other means based on the type of development, site characteristics, opportunities, and options available.

A resource-based approach to ecosystem management has proven to be a successful and comprehensive approach to resource conservation. ***A resource-based approach focuses on landscape patterns, manages these natural resource elements to collectively influence species assemblages in a positive direction. We should strive to limit the degree of isolation between existing habitat patches and optimize natural connectivity to allow for the dispersal and re-colonization of sensitive native species among patches. This goal is attainable by establishing habitat corridors, maintaining landscape attributes (e.g., patch size, shape, edge, etc.), and connecting "stepping stone patches" where possible.***

Figure 19: Zones of Protection for Semi-Aquatic Species

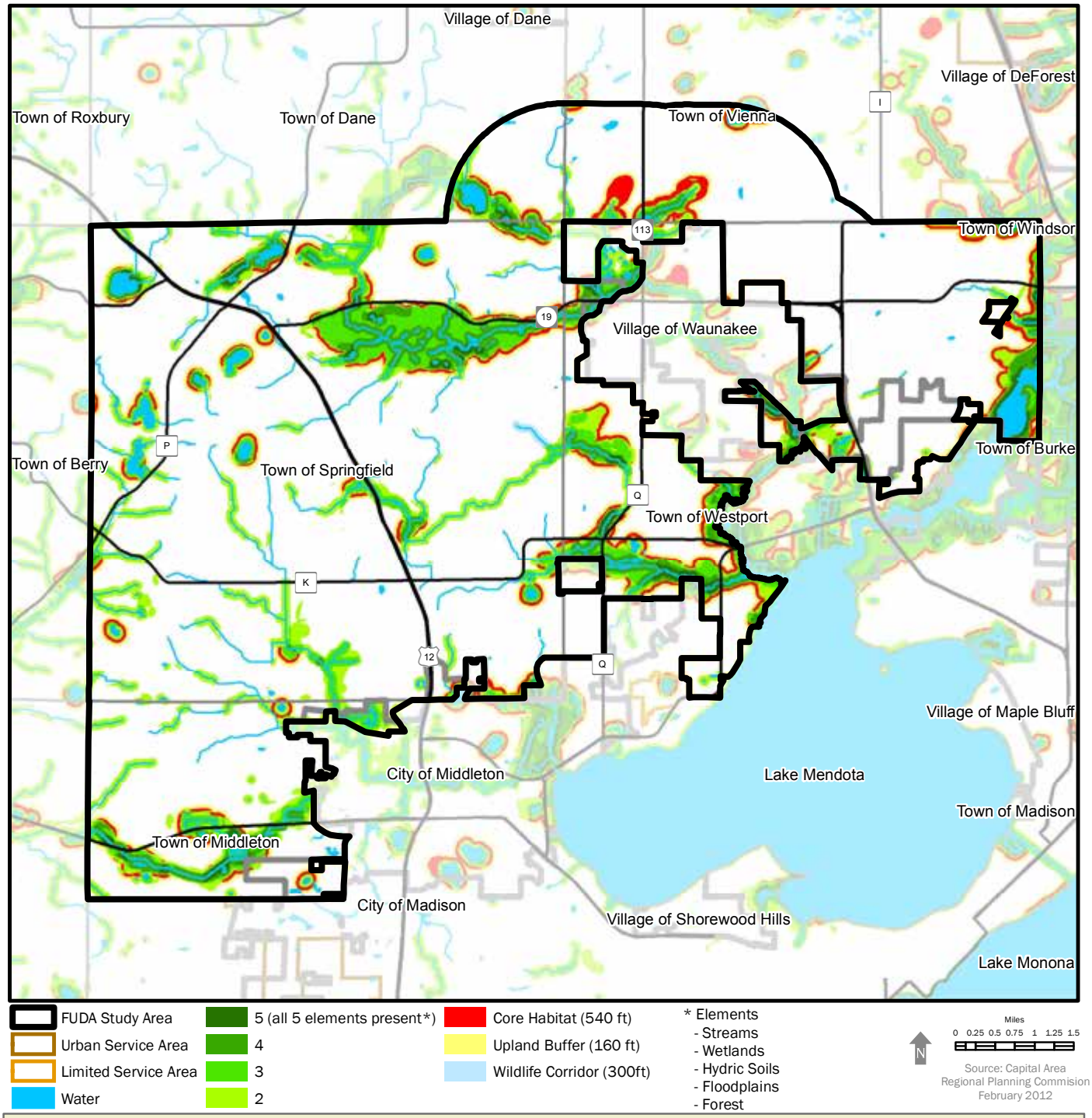


Source: Semlitsch 2001 & 2003

60 Areas that stand out in red are based on WDNR wetlands being present but possessing little else in terms of the other habitat elements.

Map 40: Habitat Classification

North Mendota Study Area, Dane County, WI



This map shows a simple habitat classification system based on the coincidence of two or more aquatic resource features, including core habitat, wildlife corridor, and upland buffer as described in the literature. The overall objective is to avoid these sensitive natural areas and direct development to more suitable areas for it. These critical and sensitive natural areas can also be enhanced and improved by letting the land revert back to a more natural condition, enhancing biological diversity overall.

In general, most natural resource objectives can be accomplished within a corridor width of 300 feet from the edge of a stream and 700 feet from the edge of a wetland or small pond that is greater than two acres. Where there are groups of small wetlands, they should also be combined.

In circumstances where a 300 foot buffer may be considered burdensome for a community, there are alternatives that will allow for natural resources protection, create habitat, and produce a tradable commodity. For example, research into biodiversity and ecosystem functioning theory developed by David Tilman of the University of Minnesota suggests that planting high diversity tallgrass prairies may be a source for biofuels. When compared to other biofuel sources, tallgrass prairies are a better source than either corn ethanol or soybean biodiesel. These prairies produce 51% more energy per acre than other crops. Planting tallgrass prairies for biofuels also serve as better alternatives for low fertility soils than other crops intended for the same purpose, as they will have higher stand biomass. This resource may be collected using standard equipment and practices, and be regenerated every year, leading to a renewable resource. By potentially changing wider riparian areas to biofuel producing tallgrass prairies, communities may be able to promote multi-resource objectives. The limitations of this method will be the size of the converted area, historical landscape coverage, ability to conduct controlled burns that will not endanger infrastructure, and the ability of heavy machinery to access these locations. If the converted area is too small, it may not be economically viable to extract this resource. An experiment funded by the State of Minnesota and the United States Geological Survey is near completion at the Cedar Creek Ecosystem Science Reserve testing the relationship between biofuel production and water quality.[61] The results of this project will contribute greatly to implementation in local communities.

61 USGS, MN Water Science Center: Cedar Creek Biofuels Project (http://mn.water.usgs.gov/projects/cedarcreek/)

1. Ecological Restoration

Ecological restoration of natural resource areas may be necessary to maintain ecological functions and the services they provide, and to maintain our natural heritage for future generations. ***Designs for ecological restoration projects need to be tailored to each specific site, but share the following general characteristics and guidelines:***

- Comparatively, conservation and management of natural resource areas are far less expensive than attempting ecological restoration.
- If a restoration is to be successful, the causal factor leading to the ecosystem's degradation must be identified and removed or abated. If not, then a restoration project will not maintain cohesion, structure and emergent function and will be degraded again after restoration activities.
- When performing restoration, it is often not possible to restore or create an ecosystem that is an exact copy of a natural or idealized ecosystem state.
- Restoration of physical attributes within an ecosystem will not always result in positive biotic responses and will not always lead to the return of all species.
- Restoration will take time to mature. Depending upon the ecosystem, it may take a few years or several decades before restoration is mature. Successful restoration needs monitoring to determine if additional corrections are required.
- Restoration of ecosystems is complicated and not as easily manipulated as human engineered systems. It may not be possible to control for all aspects within a restoration project.
- Each restoration project will have its own unique challenges and specific approaches will be required to resolve those problems. Using a standard repeated approach (cook-book), without considering site specific problems, will likely not result in successful restorations.
- The ultimate goal of restoration is to create a self-organizing and self-sustaining system that no longer requires active human intervention. There may be instances when a complete restoration is not possible and long term management will be required to maintain ecosystems.
- Continually spending large sums of money, time and other resources will not solve ecological problems. Nor will waiting for advances in science and technology resolve degraded ecosystems. Application of current restoration methods is required now to preserve our quality of life and improve it for future generations.

G. Parks and Open Space

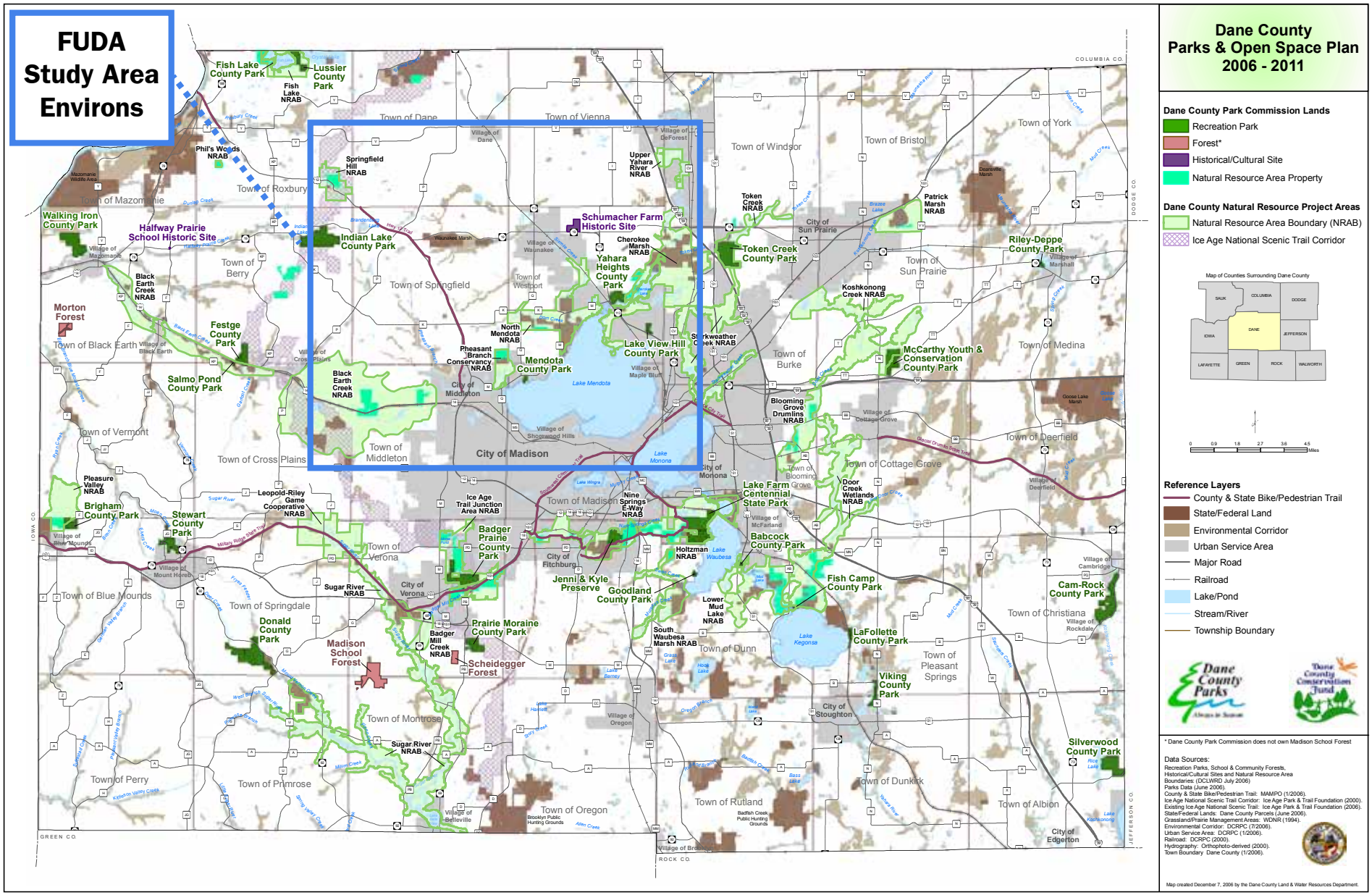
Dane County plays a special role in the partnership among federal, state, and local units of government and private groups in meeting the outdoor recreational needs of residents and visitors. The *Dane County Parks and Open Space Plan* defines this role and recommends how Dane County can work as a partner with other governmental units and the private sector. Adoption of the Plan and acceptance by WDNR enables the county to participate in state and federal outdoor recreation grant programs. The Plan indicates various Natural Resource Areas, existing and proposed land and water trails, recreational parks, and forests, as the focus of these efforts in the study area (see Maps 41 and 42), including:

- Cherokee Marsh Natural Resource Area
- North Mendota Natural Resource Area
- Pheasant Branch Conservancy Natural Resource Area
- Black Earth Creek Natural Resource Area
- Dorn Creek State Fishery Area
- Existing and proposed land and water trails
- Federal, state, and local areas

It is critically important that future land use plans consider and incorporate regional elements into designs. Dane County Parks staff should be consulted early on in development planning to promote opportunities, coordination, and avoid incompatible or potentially conflicting proposals. For example, Map 43 shows the proposed Lake Mendota Natural Resource Area Boundary to be included in the next update of the *Dane County Parks and Open Space Plan*. It is conceivable Waunakee Marsh and Sixmile Creek could be included as part of an expanded E-Way system. In addition, Map 44 shows existing and planned bike-pedestrian trails and improvements needed for connecting urban, park, and open space areas.

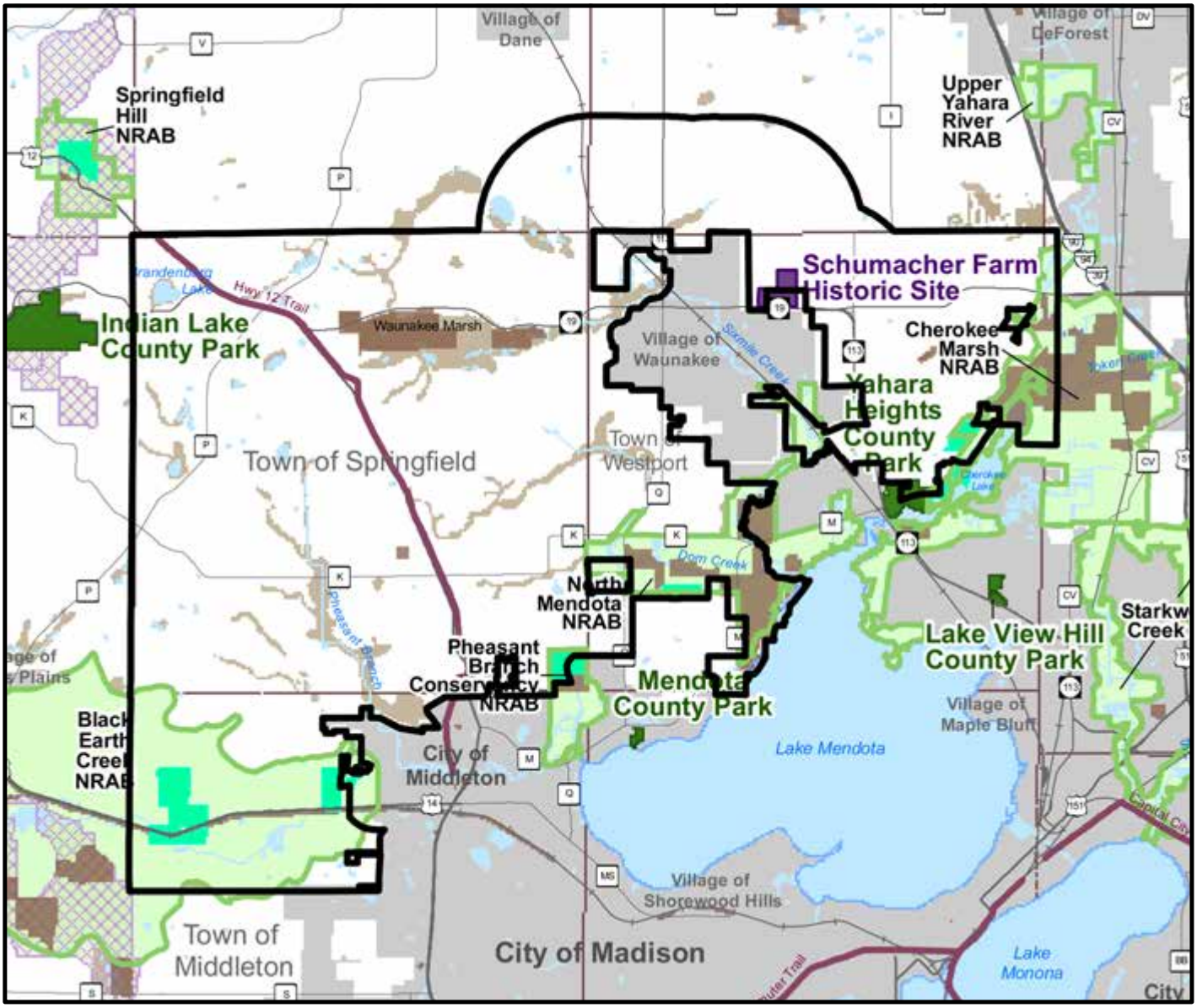
It should be noted that park and purchased conservation areas adversely impact town revenues and add to the cost of maintenance by the responsible park entity. Acquisition considerations for these areas should include revenue sharing measures or approaches to compensate the affected town for this loss of revenue, and to create programs that allow private ownership of buffer areas for agricultural uses that produce income while maintaining ecosystem services of a more natural land cover.

Map 41: FUDA Study Area Environs - Parks and Open Space Plan



Map 42: Dane County Park and Open Space Plan

North Mendota Study Area, Dane County, WI



FUDA Study Area

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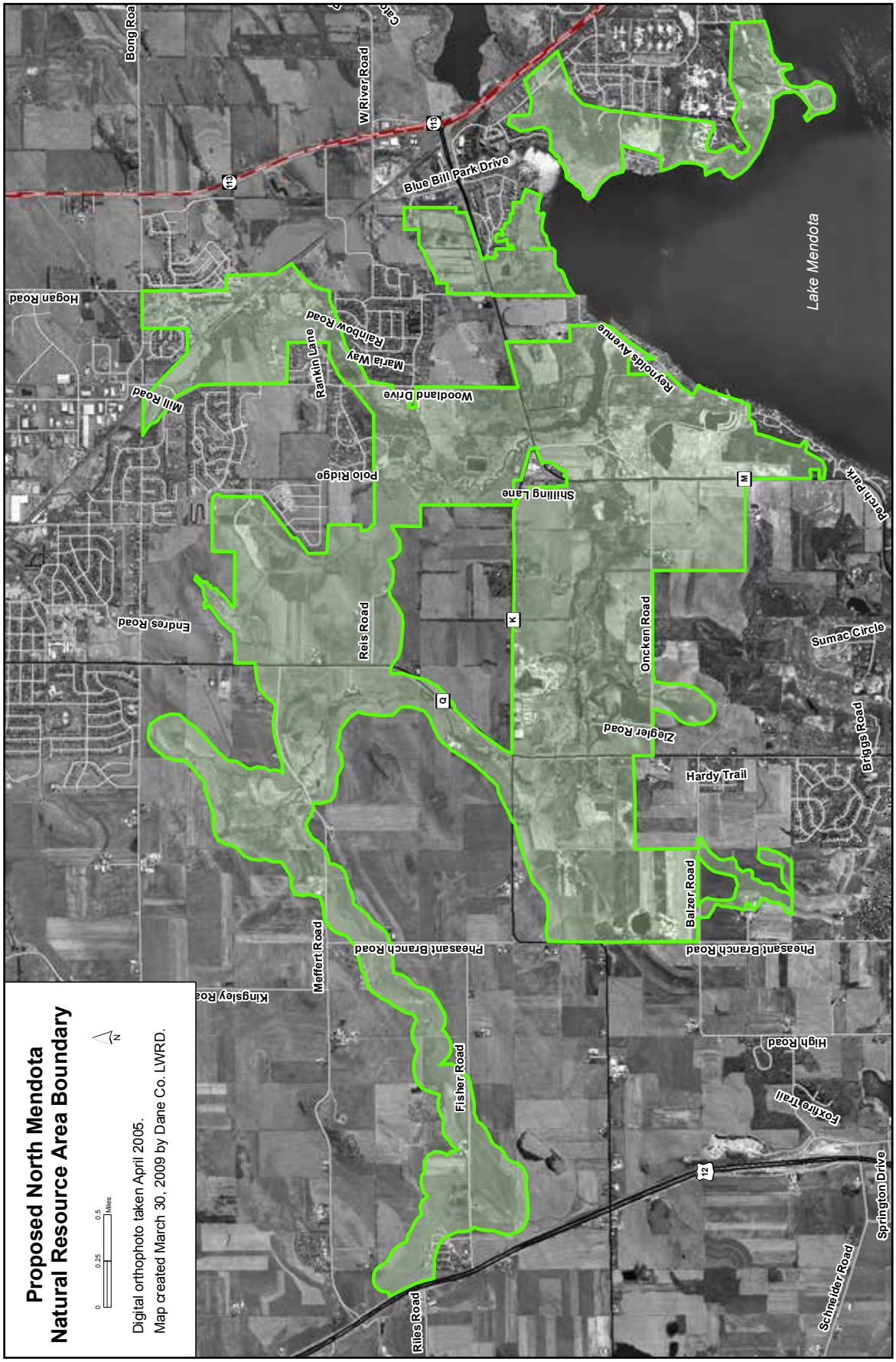
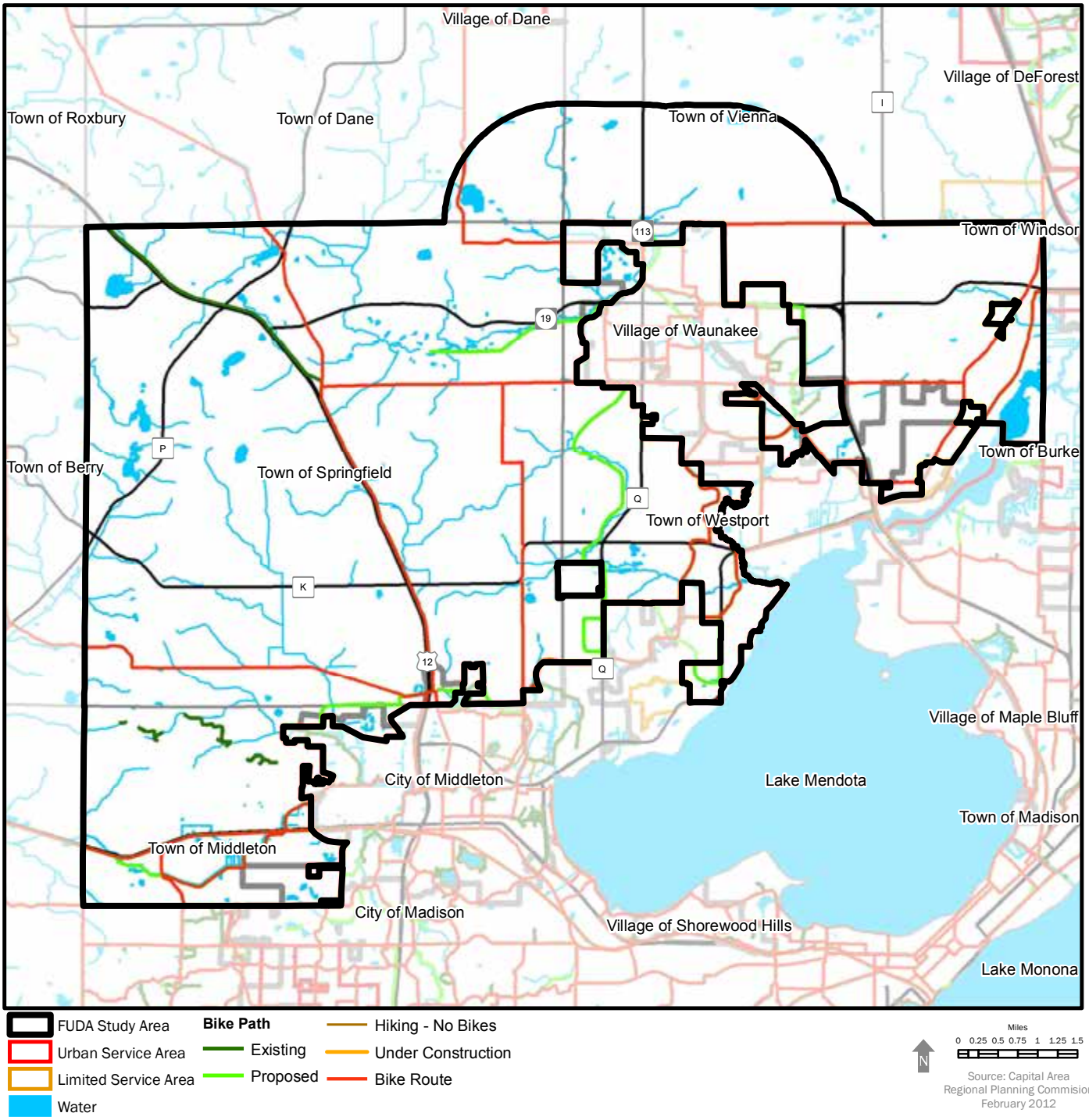
Source: Capital Area Regional Planning Commision February 2012

Map 43 Proposed North Mendota Natural Resources Area



Map 44: Bike Plan

North Mendota Study Area, Dane County, WI



Bike routes and paths including proposed paths are shown.

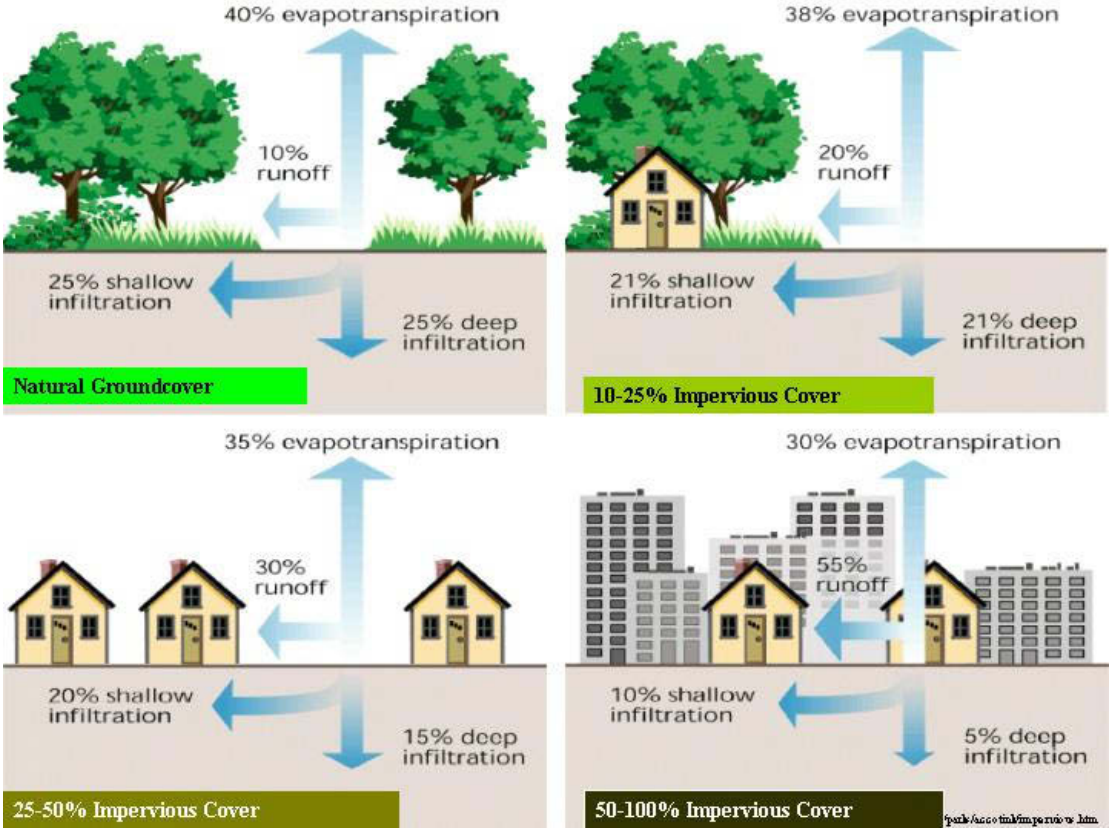
H. Natural Resource Impacts from Urban Development

Dane County is the second-largest metropolitan area and one of the fastest-growing counties in the state. By year 2030 almost 580,000 people are expected to reside in Dane County – an increase of almost 36% over current population. This urban growth and development must be properly planned and managed to mitigate the adverse impacts of urban development to protects the quality of our groundwater and surface water resources, the wildlife communities they support, and our everyday quality of life.

1. Hydrologic Impacts (Water Quantity and Quality)[62]

One of the most obvious manifestations of watershed development is the increase in impervious surfaces in the urban landscape. Urbanization reduces natural ground cover, replacing it with streets, rooftops, driveways, and parking lots. Figure 20 shows the progression of impervious surface area and the changes in the hydrologic regime if development progresses without mitigation. Because of compaction during the development process, turf and landscape areas can also affect the total runoff from built areas, unless this compaction is corrected through mitigation practices such as deep tilling and soil augmentation[63].

Figure 20: Hydrologic Effects of Urban Development and Impervious Cover

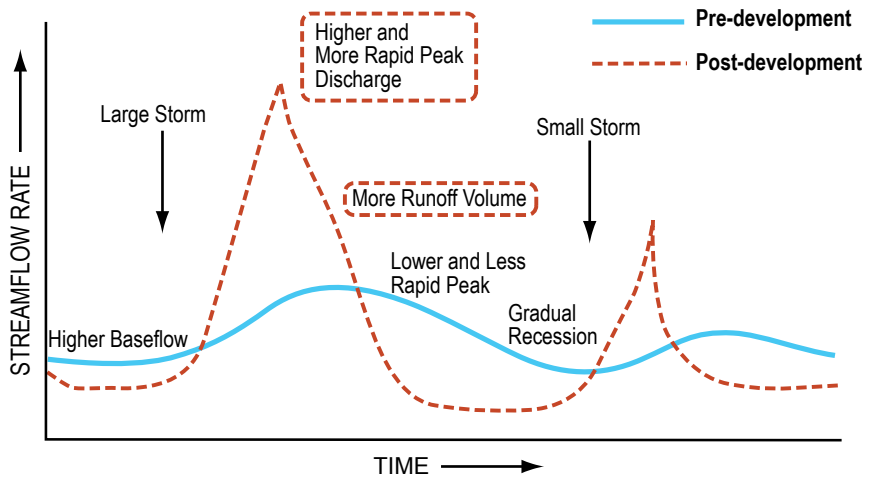


62 Refer to the 2011 update of Technical Appendix D: Urban Nonpoint Source Analysis to the Dane County Water Quality Plan for a more complete discussion and analysis of these potential impacts and the performance standards and management practices that communities have or can put in place to mitigate them. http://danedocs.countyofdane.com/webdocs/PDF/capd/2011_postings/WQP/WQP_Appn_D_Urban_Nonpoint_Source_Analysis_2011_web.pdf

63 Deep tilling uses 4-foot steel shanks placed 4 feet apart on a bulldozer to till and break up the compacted ground after grading is completed. Soil augmentation incorporates composted mulch into the top 12-inch layer of the soil. Both practices serve to reverse the soil compaction that results from grading and other construction activities.

Figure 21 shows typical pre-development and post-development hydrographs for a watershed that is being developed for urban land uses without any mitigation practices. As development progresses the stream hydrology changes from a more gradual and subdued groundwater-dominated system (solid line) to one dominated more and more by flashier surface water impacts (dashed line). The area below the hydrographs represents the volume of rainfall runoff. The increased peak flow and runoff volume resulting from development is significant because of the increased pollutant loading it can carry, as well as potential flooding and channel erosion problems it can cause downstream. In addition, as infiltration of precipitation is reduced by increased impervious cover, the volume of water available for baseflow in streams is similarly reduced. Infiltration and groundwater recharge of precipitation and subsequent discharge to streams and wetlands is critical in sustaining them during dry weather periods.

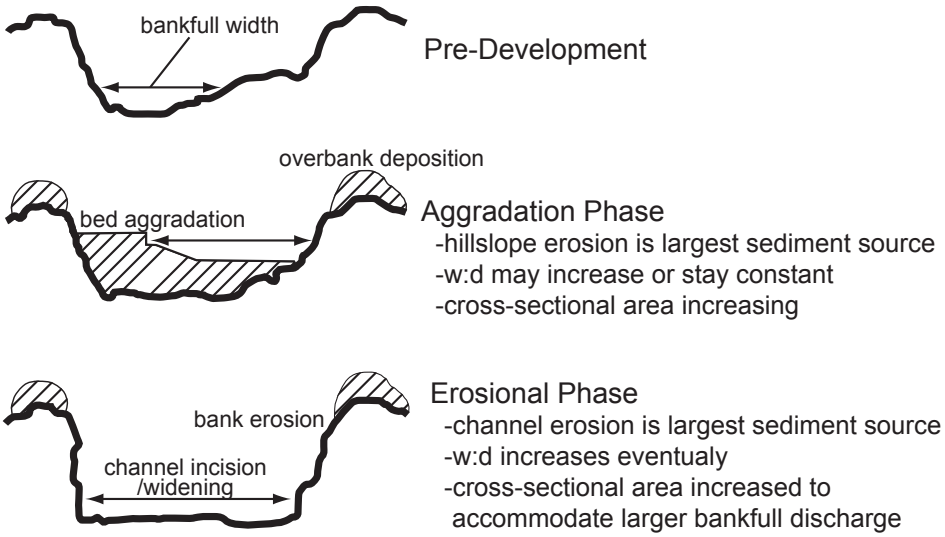
Figure 21: Changes in Stream Hydrology as a Result of Urbanization



Urban land use without appropriate management practices can severely degrade aquatic ecosystems in various ways (see Table 10). Increased peak flows and runoff volumes increase the erosive force of the channel flows and can significantly upset the streambed and bank stability and the sediment load equilibrium that has established itself over time. Increased volumes and rates of runoff overload natural drainage systems that have adapted themselves to pre-development conditions. As the frequency of bankfull events increases with urbanization, the stream attempts to enlarge its cross section to reach a new equilibrium associated with the increased flows. Greater frequencies and durations of higher stormflows can result in channel incision, streambank undercutting, increased streambank erosion, sediment loading and transport along the streambed (see Figure 22).

The results are wider, straighter, sediment-choked streams, greater water temperature fluctuations, as well as loss of riparian cover, shoreland, and aquatic habitat. The streambed is covered by sand and silt; and pollutant loading of other constituents (e.g., toxic materials, metals, and organics) is also increased. ***Research shows that by the time the water quality impacts become evident, the stream ecosystem has already largely been damaged by the water quantity impacts.***

Figure 22: Changes in Stream Channel Geomorphology due to Urbanization



Source: NALMS 2007

Table 10: Summary of the Potential Impacts of Urbanization on Aquatic Ecosystems

Environmental Concern	Potential Impact	Cause/Source
Increase in runoff-driven peak or bankfull stream flows	Degradation of aquatic habitat and/or loss of sensitive species	Increased stormwater runoff volume due to an increase in basin imperviousness
Increase in runoff-driven flooding frequency and duration	Degradation of aquatic habitat and/or loss of sensitive species	Increased stormwater runoff volume due to an increase in basin imperviousness
Increase in wetland water level fluctuations	Degradation of aquatic habitat and/or loss of sensitive species	Increased stormwater runoff due to an increase in basin imperviousness
Decrease in dry season baseflows	Reduced aquatic habitat and less water for human consumption, irrigation, or recreational use	Water withdrawals and/or less natural infiltration due to an increase in basin imperviousness
Streambank erosion and stream channel enlargement	Degradation of aquatic habitat and increased fine sediment production	Increase in stormwater runoff driven stream flow due to an increase in basin imperviousness
Stream channel modification due to hydrologic changes and human alteration	Degradation of aquatic habitat and increased fine sediment production	Increase in stormwater runoff driven stream flow and/or channel alterations such as levees and dikes
Streambed scour and incision	Degradation of aquatic habitat and loss of benthic organisms due to washout	Increase in stormwater runoff driven stream flow due to an increase in basin imperviousness
Excessive turbidity	Degradation of aquatic habitat and/or loss of sensitive species due to physiological and /or behavioral interference	Increase in stormwater runoff driven stream flow and subsequent streambank erosion due to an increase in basin imperviousness
Fine sediment deposition	Degradation of aquatic habitat and loss of benthic organisms due to fine sediment smothering	Increase in stormwater runoff driven stream flow and subsequent streambank erosion due to an increase in basin imperviousness
Sediment contamination	Degradation of aquatic habitat and/or loss of sensitive benthic species	Stormwater runoff pollutants
Loss of riparian integrity	Degradation of riparian habitat quality and quantity, as well as riparian corridor fragmentation	Human development encroachment and stream road crossings
Proliferation of exotic and invasive species	Displacement of natural species and de gradation of aquatic habitat	Encroachment of urban development
Elevated water temperature	Lethal and non-lethal stress to aquatic organisms reduced DO levels	Loss of riparian forest shade and direct runoff of high temperature stormwater from impervious surfaces
Low dissolved oxygen (DD) Levels	Lethal and non-lethal stress to aquatic organisms	Stormwater runoff containing fertilizers and wastewater treatment system effluent
Lake and estuary nutrient eutrophication	Degradation of aquatic habitat and low DO levels	Stormwater runoff containing fertilizers and wastewater treatment system effluent
Bacterial pollution	Human health (contact recreation and drinking water) concerns, increases in diseases to aquatic organisms, and degradation of shellfish harvest beds	Stormwater runoff containing livestock manure, pet waste, and wastewater treatment system effluent
Toxic chemical water pollution	Human health (contact recreation and drinking water) concerns, as well as bioaccumulation and toxicity to aquatic organisms	Stormwater runoff containing toxic metals, pesticides, herbicides, and industrial chemical contaminants
Reduced organic matter (OM) and large woody debris (LWD)	Degradation of aquatic habitat and loss of sensitive species	Loss or degradation of riparian forest and floodplain due to development encroachment
Decline in aquatic plant diversity	Alteration of natural food web structure and function	Cumulative impacts of urbanization
Decline in aquatic invertebrate diversity	Alteration of natural food web structure and function	Cumulative impacts of urbanization
Decline in amphibian diversity	Loss of ecologically important species	Cumulative impacts of urbanization
Decline in fish diversity and abundance	Loss of ecologically important species	Cumulative impacts of urbanization

Source: Fundamentals of Urban Runoff Management. NALMS 2007

The significance of hydrologic changes and pollutant loading associated with urban development that lacks mitigation practices is clear: strategies that maintain pre-development runoff volumes and mimic more natural flow conditions will reduce the frequencies of larger and more erosive flows resulting from that development. Also, since pollutant loading is a function of flow[64], it stands to reason that reducing the volume of runoff will result in reduced pollutant loads as well. This is in addition to conventional practices that capture and treat the "first flush" of pollutants during runoff events. ***Overall, it is much easier to incorporate hydrologic protection measures early in the design before an area becomes developed than to address the problem after development.***

Communities in our region have been working to mitigate these potential hydrologic impacts of urban development for over a decade. In the late 1980s the then Dane County Regional Planning Commission began requiring new urban service areas to provide peak runoff rate control to pre-development levels and to remove sediment from stormwater runoff. Similar standards were adopted by Dane County and the State of Wisconsin in 2002. Infiltration requirements and volume control conditions were pioneered by the Dane County Regional Planning Commission in the mid 1990s. Infiltration requirements and volume control standards were adopted as part of the county-wide stormwater ordinance in 2004, and the standards for commercial areas were improved in 2011.

When properly planned, designed, constructed, and maintained, these standards and the management practices implemented to meet them can effectively mitigate the potential hydrologic impacts of new urban development. The primary sources of impacts to our water resources are agricultural nonpoint source pollution and urban nonpoint source pollution from development that was constructed before these standards were put in place.

64 Total pollution load is pollutant concentration multiplied by volume.

2. Habitat Loss and Landscape Connectivity

Habitat loss or fragmentation is the process whereby contiguous natural areas are reduced in size and separated into discrete parcels due to land conversion for other uses, such as urban development or agricultural production. Because of the prime soils located here, agriculture has had a significant impact on wildlife habitat in Dane County. Due to draining and cropping practices over the last century, most remnant habitats can usually only be found in areas that are either too wet, steep, or stony to be effectively farmed. Also, as is too often the case in Dane County, where farmland has gained a toehold development is often apt to follow. That leaves relatively few areas in the county that have not already been farmed or developed. ***When habitat is destroyed, a patchwork of habitat fragments remains often resulting in patches that are isolated from one another. Since the potential for re-colonization of species is reduced, increased competition and local extinction (extirpation) can result.***

Planning Considerations:

- Establish Environmental Corridor widths sufficient enough to provide habitat needs of present species.
- Provide continuous corridors to provide habitat connectivity whenever possible.

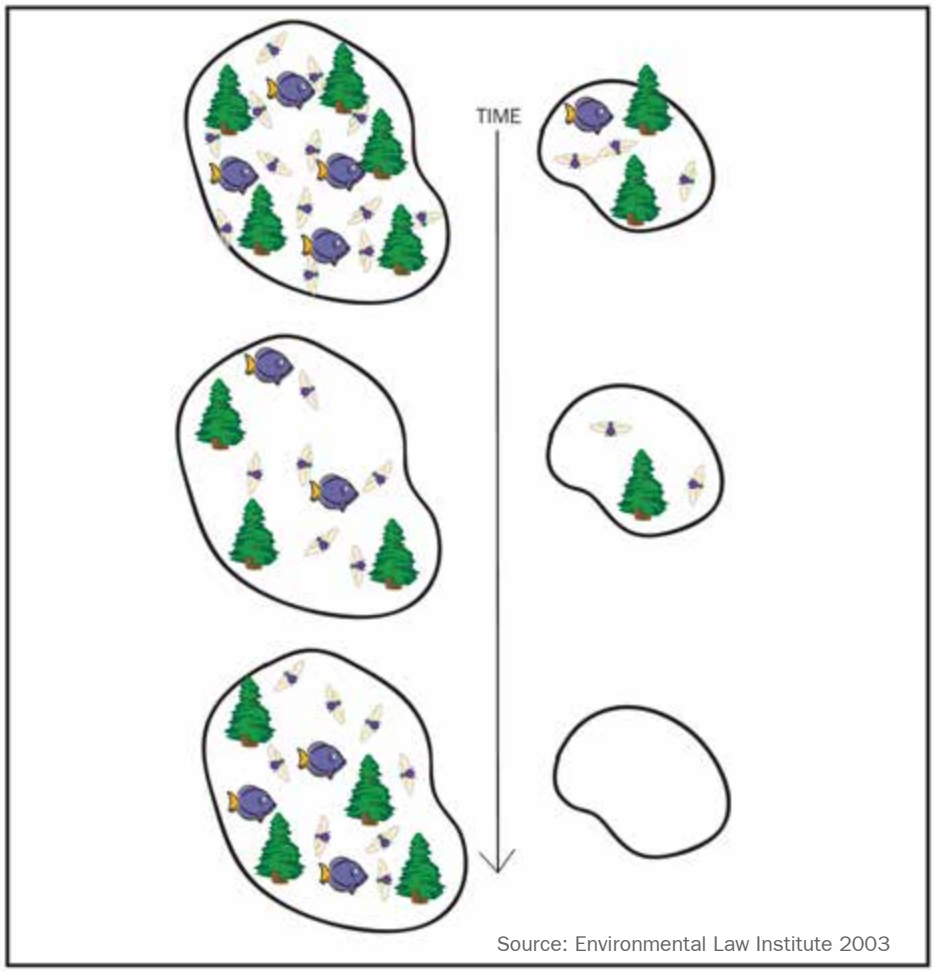
These remnant areas require protection, network re-connection and enhancement where possible.

Figure 23 shows the probability of a local species population being extirpated increases as habitat patch size decreases (right side of the diagram). Conversely, a larger patch generally supports a larger population size for a given species, making it less likely that the species will go locally extinct (left side of the diagram). ***Species viability and diversity are also enhanced by well-connected habitats.*** This is because small, isolated reserves are unlikely to maintain viable populations over the long-term. ***Wildlife Corridors are therefore recommended as a conservation measure to help counter the negative effects of habitat, loss, fragmentation, and patch isolation*** (see Figure 24).

According to Noss (1997), ***landscape designs for maintaining habitat should be based on the following principles:***

- *Species that are well distributed across a landscape have lower extinction risk*
- *Larger habitat patches with large populations are better than small patches with smaller populations*
- *Closer patches are better than distant patches*
- *Contiguous patches are better than fragmented patches*
- *Connectivity of patches is better than isolated patches*
- *Stable populations fare better than fluctuating populations*
- *Peripheral populations perform poorly relative to core populations.*

Figure 23: Patch Size and Local Extinction



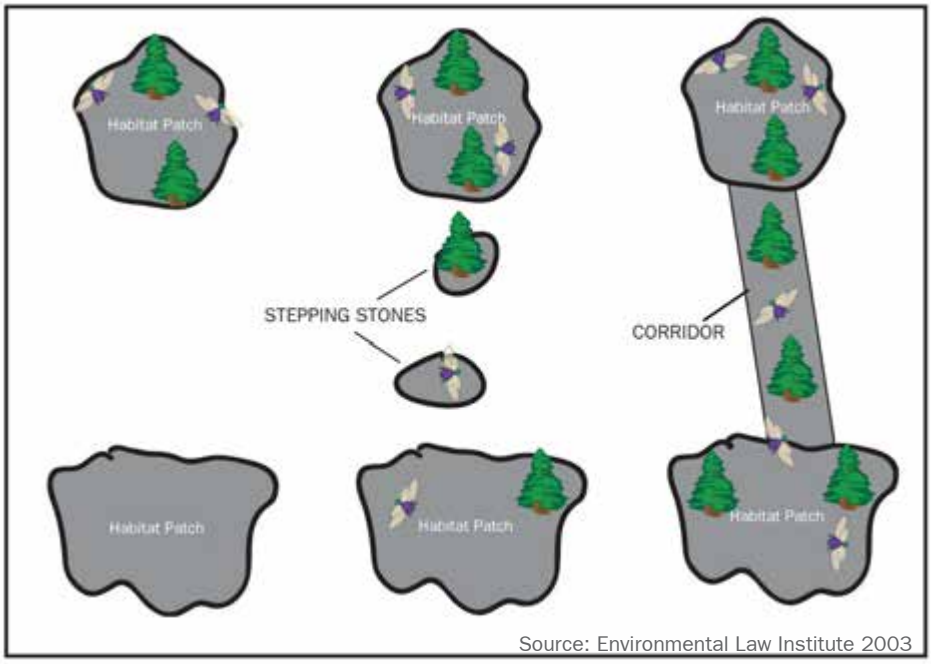
Source: Environmental Law Institute 2003

The probability of a local species going extinct increases with decreasing habitat patch size. A larger patch generally supports a larger population size for a given species than a smaller patch, making it less likely that the species will go locally extinct in the larger patch.

As the landscape is being considered for habitat, it is important to note that not all patches are always occupied by regional species. Due to ecological activities, species may naturally become extirpated. Maintaining a series of patches within a landscape is necessary for prey species to elude predators, refuge from contagious diseases and parasites, and providing re-colonization opportunities.

In general, most natural resource objectives can be accomplished within a corridor of 300 feet from the edge of a stream and 700 feet from the edge of a wetland or small pond (shown on Map 20). This is the area where community stewardship activities will have the greatest beneficial effect. For example, this is the area suggested by leading ecologists for providing core habitat and a protective buffer for semi-aquatic amphibians and reptiles, which serve as umbrella species. By protecting umbrella species, other associated species may also be protected. Semi-aquatic species require both aquatic and terrestrial environments to fulfill their full life-cycle needs (e.g., breeding, hibernation, food, cover, etc.). Since amphibians and reptiles reside solidly in the middle of the food pyramid as both predators and prey, protecting core habitat for these umbrella species protects food, cover, and habitat for other associated species as well (i.e., other birds, mammals, fish, insects, and plants).

Figure 24: Wildlife Corridors



Source: Environmental Law Institute 2003

Protecting stepping stone patches or establishing a corridor can increase habitat connectivity, and improve species migration into extirpated habitat areas.

I. Urban Development Strategies to Maintain and Improve Natural Resource Integrity

Various strategies have been presented below. These strategies can be implemented to minimize long-term impacts in a watershed undergoing urbanization.

1. Approach local issues from a regional watershed perspective

Watersheds and other natural features are not defined by political boundaries. Development impacts in one jurisdiction often spill over into other parts of the watershed. Planning at a watershed level is essential for streams and water bodies. Assessing the impact of each development, and the cumulative impact of development on a watershed scale is essential from a long-term hydrologic perspective. ***Criteria that balance high impact land uses such as residential, commercial, and industrial development with low impact land uses such as forests, wetlands, and grasslands are useful tools in the hands of regional and community land use planners and practitioners. Such criteria can be used to protect sensitive land uses such as wetlands, floodplains, woodlands, and the wildlife that depend on them, while also accommodating economic development that is important for the region.***

2. Direct development away from sensitive natural areas to better suited areas

Large naturally vegetated reserves surrounding our valuable water resources improves water quality by acting as a buffer and filtering out sediments and runoff that would otherwise enter these waters directly. Furthermore, acting as a sponge, these areas promote greater infiltration of the water into the ground, reducing runoff volumes and velocities, and concentrations of pollutants as the water that seeps through the ground is naturally filtered and released much more gradually. Natural resource reserves are particularly important as core habitat for wildlife. They also add to the natural scenic beauty of the landscape and provide an open space balance for the developed areas, increasing property values, outdoor recreation opportunities, and quality of life for residents and visitors alike.

3. Increase the efficient use of land resources through compact development patterns and optimizing the use of current urban areas through infill and re-development

The premature spreading out of urban land uses onto rural and other land areas is often inefficient and unnecessarily wasteful. Urban land uses moving out onto less-expensive land farther out from urban city centers do not typically account for the additional public costs or inefficiencies of providing the necessary infrastructure and services to serve that development (sewer, water, transportation, police, fire, etc.). After several decades of study in other areas around the country, it is apparent that unplanned or premature development imposes significant short-term and long-term costs on local governments, businesses, property owners, developers, as well as the environment.

4. Allow land use density transfers

Density transfers and TDRs can also be used in watershed planning. ***Density transfers allow developers and land owners to achieve the same overall density, therefore the same economic benefit, but concentrate the development in less sensitive portions of the site or the area.*** While overall density of the development is the same, it is concentrated in areas more suitable for it, thereby protecting more sensitive areas. Larger scale TDR programs provide a funding mechanism to compensate landowners located in sensitive "sending areas," directing the development potential of their land to more suitable "receiving areas." Landowners, developers, and the general public reap significant benefits by more efficient economic development activity.

5. Incorporate natural features into development design and apply conservation design principles

Incorporating the existing natural features of the site into the design of a development, rather than clearing the site completely and starting anew, reduces the impact that the development has on the natural state of a watershed. ***Encouraging conservation design principles in the layout for a new development is very effective in preserving the natural state of a watershed.*** Rather than the traditional individual plots and set back style, a clustered development with large passive open spaces is very effective. In many cases, clustered development leads to a dramatic cut in the cost of providing utilities and services – especially those related to transportation and imperviousness – as well as the significant and irreversible costs of natural resources depletion and impact which can be avoided.

6. Consider the long-term impacts when selecting a site

Because the amount of runoff generated by different land uses is a function of the hydrologic soil type and the land use, ***locating land uses based on the hydrologic soil type can in some cases significantly reduce the long-term impact of the development.*** For example, locating land uses that generate large amounts of clean rooftop runoff (e.g., commercial development) near soils that have naturally or potentially high infiltration rates can help reduce the hydrologic impact of the land use change.

7. Minimize impervious areas in design

Limiting road widths, parking spaces and other impervious surfaces to a minimum reduces their water quality and quantity impacts. Paying attention to design details and materials used in construction can add up. Using more permeable materials allows more water to seep into the ground. By looking into the design details that can be modified to minimize imperviousness, a great deal of success can be achieved. For example, utilizing a compact development pattern to reduce road lengths, minimizing overall disturbance of the natural features of the area, and reducing pavement and incorporating more greenspace are just some of the factors that can be considered.

8. Slow stormwater that runs off of the impervious areas and encourage infiltration

Stormwater basins and constructed wetlands reduce the risk of increased flooding due to increases in stormwater runoff rates. These basins retain stormwater and release it more gradually over a longer time period. Stormwater basins can be designed to be aesthetically pleasing and can potentially be used as the focus for open space or recreational facilities on a site. They can also be used for economic benefit by developers and realtors as many people enjoy living near water and are willing to pay higher prices for such plots. While stormwater basins are important for reducing peak flows, they do not solve the problem of increased runoff volumes due to development. An effective way to increase the amount of water that infiltrates into the ground instead of becoming runoff is by implementing effective infiltration control practices and measures. There is a wide variety of mitigation strategies to choose from depending on the characteristics of the site.[65]

9. Reduce Pollution Sources on all surfaces

The amounts of pollutants that get into stormwater can be reduced or prevented through good management practices at the source. Proper disposal of pet waste and reducing the use of fertilizers and pesticides in lawns, gardens, and other good "housekeeping" practices can significantly reduce the nutrients and chemicals in urban runoff.

65 Refer to the 2011 update of *Technical Appendix D: Urban Nonpoint Source Analysis* to the *Dane County Water Quality Plan* for a more complete discussion and analysis of these potential impacts and the performance standards and management practices that communities have or can put in place to mitigate them. http://danedocs.countyofdane.com/webdocs/PDF/capd/2011_postings/WQP/WQP_Appn_D_Urban_Nonpoint_Source_Analysis_2011_web.pdf

North Mendota

Future Urban Development Area Planning

Environmental Conditions Report

Chapter II. Agricultural Resources

Introduction

The Middleton, Waunakee, Westport, Springfield jurisdictions contain highly productive and economically valuable agricultural lands. The agricultural data in this chapter can inform their local decision-making and identify the agricultural lands that these community may preserve, maintain, or develop as part of the Future Urban Development Area (FUDA) planning and the Comprehensive planning processes.

Agriculture serves three general purposes:

1. Providing food, fiber, and fuel resources for use in the wildlife and human ecosystems, and human economic systems. Agricultural lands provide food, fiber, and fuel for life's most basic needs, adequate space for rural facilities and those which require large expanses of open land, and groundwater recharge.
2. Providing cultural resources for the community and region. Agriculture provides a community aesthetic and sense of place built throughout history that can educate citizens and provide them with recreational lands.
3. Supporting ecological systems. In supporting ecological systems, properly managed agricultural lands can be used to recycle nutrients, form soil, and provide some wildlife habitat. Additionally, properly managed agricultural lands can provide pervious land for infiltration of rainfall and snow melt, maintain water temperature and quality, and buffer noise.

Town of Middleton

The important functions and benefits provided by agricultural lands must be weighed when considering development, preservation, and other land use decisions.

The data in this chapter provides information for the 2000-2005 interval. Where available, 2008 data was also included. Comparable geographic data is not available for earlier periods. The information is from county-wide data sources including the Land Use Inventory, tax parcel assessments, and other data provided by the Wisconsin Department of Agriculture, Trade, and Consumer Protection. Data is provided for the local communities, the Moraine and Yahara River Valley physiographic sub-regions (explained further in the Ecological Services and Function section), and for Dane County as whole to provide sub-regional and regional contexts and comparison.

This chapter of the environmental conditions report (ECR) covers the following agriculture related factors:

- Agricultural land area and land conservation
- Ecological services and functions on agricultural parcels
- Agricultural parcels and base farm tracts
- Agricultural contiguity and concentration
- Agricultural operation type (livestock, crop, and crop type)
- Tax parcel value assessment
- Soil quality (prime lands and Land Evaluation)
- Agricultural support services

Town of Springfield

A. Agricultural Land Area and Land Conversion

Agricultural production is one of the most significant land uses across the State. Dane County and the North Mendota FUDA territories are no different in this regard. Simultaneously, Dane County continues to experience one of the fastest population growth rates in the State. The land developed with buildings and infrastructure to accommodate population growth and movement is often taken out of agricultural production.

In year 2000, approximately 451,000 acres of land were categorized under agricultural land use in Dane County, nearly 100,000 acres fewer than categorized as agriculture in 1980. [66] Of the total area removed from agricultural uses since 1980, 37,000 acres were converted to developed uses, representing 37% of the total area removed, and 6.7% of the total area in agriculture in 1980. As of year 2005, 430,178 acres were dedicated to agricultural uses across Dane County.

Agricultural lands are generally in town jurisdictions with a few agricultural areas in cities and villages. The towns of Westport, Springfield, Middleton, Vienna, and Dane directly boarder the jurisdictional limits of he City of Middleton and/or the Village of Waunakee. Table 11, and the corresponding Map 45, show the breakdown of agricultural and developed lands in the study area.

Table 11: Agricultural and Developed Land Area (acres)

Study Area Portion	Agricultural		Developed		All Other Land	
	2000	2005	2000	2005	2000	2005
T. Springfield	18,447	17,597	2,126	2,050	2,728	3,638
T. Westport	8,669	8,185	1,415	2,990	4,231	2,685
T. Middleton	1,593	1,407	1,161	1,505	1,892	1,733
T. Vienna	2,751	2,703	244	170	96	219
T. Dane	932	888	54	46	148	199
Unserviced urban	734	598	438	691	250	134
Regional Comparison						
Study area total	33,126	31,377	5,438	7,453	9,345	8,608
Sub-regions	181,315	174,396	84,406	95,179	84,406	95,179
County	499,000	485,930	127,055	143,584	127,055	143,584

Source: CARPC Land Use Inventory

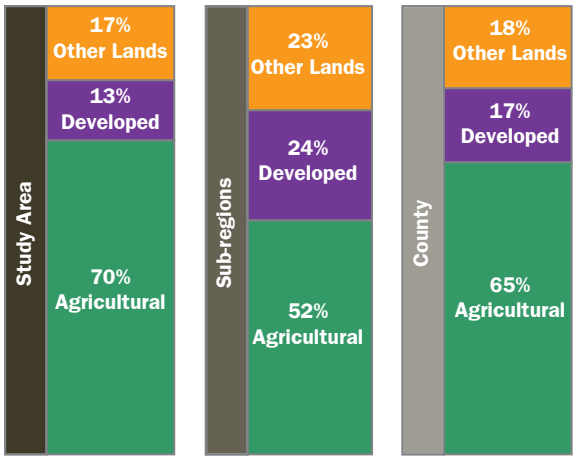
The Town of Westport is composed of two separate areas on either side of the Village of Waunakee. The Town of Middleton retains less than half of its original territory,[67] with the rest of the territory having been annexed into the Cities of Middleton and Madison. Within its territory, the Town of Middleton has significant amounts of developed land compared to most towns in the County, because the town has a significant large lot residential land use component.[68]

66 At the county level, about 95,500 acres of crop and pasture lands were converted to other uses between 1980 and 2000. Less than half of all crop and pasture acreage losses can be attributed to development, with approximately 37,000 acres developed. Thus, significant agricultural acreage is being transferred to land uses such as vacant/unused, environmental corridors, wetland restoration, or open space. See *FLM 1: Farmland Loss in Dane County* , CARPC, 2010. (http://danedocs.countyofdane.com/webdocs/PDF/capd/2010_postings/FLM_1.pdf).

67 A township has an area of 36 square miles or 23,040 acres.

68 The Town of Middleton does not participate in the State and Dane County Farmland Preservation Programs.

Figure 25: 2005 Regional Land Use Comparison



According to Table 11, as of 2005, agricultural lands covered 31,377 acres within the study area; 1,750 less than in year 2000. Approximately 598 acres existed within corporate limits (City of Middleton and Village of Waunakee) but outside the USA boundaries in 2005.

Agricultural land conversions are shown in magenta in Map 46. Development acreage increased by 2,015 acres and could account for most of the agricultural lands converted out of agriculture use. The difference between the change in agricultural acres and the change in developed acres could be from developing non-agricultural lands (e.g. open lands), or lands converted out of agriculture before year 2000 that acted as holding lands until development became feasible in the 2000-2005 period. This is most likely the case in the Town of Middleton where 400 acres of development occurred, yet only one hundred acres of agricultural lands were lost in that same period.

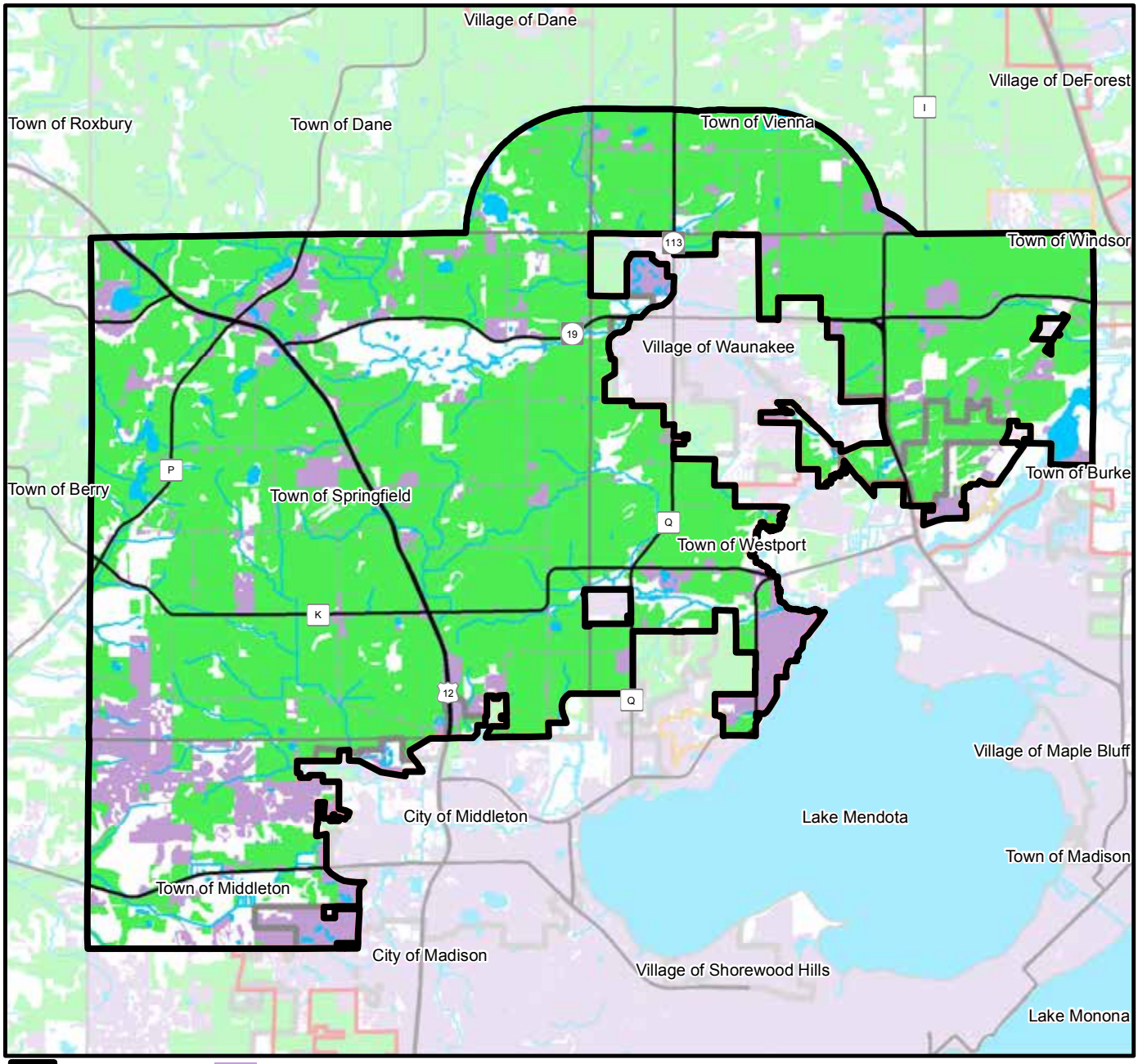
These trends are in line with general historic changes dating back to 1980 and earlier. ***Overall conversions out of agricultural use since 1980 indicate roughly 1,700 acres in Springfield, 5,346 acres in Westport were converted. While it is not possible to determine whether these conversions occurred in the study area, conversion out of agriculture for an entire township can be calculated. Conversion acreages between 1980 and 2005 for the entire townships of Middleton, Vienna, and Dane are 8,009; 1,335; and 1,745 acres respectively.***

Agricultural land in urban jurisdictions within the urban service area boundary are not included in the numbers above, and are worth discussing for their potential as urban agriculture, development or ecological reserve. In 2005, Waunakee had roughly 420 agricultural acres and City of Middleton had roughly 30 agricultural acres within the urban service area. Map 47 shows the location of these lands.

A significant portion of agricultural land in urban jurisdictions is likely intended for eventual development. Typically, land is annexed from a rural jurisdiction because the village or city and landowner seek to develop the land with urban densities requiring public sewer and water. This land can remain in agricultural production (typically leased out) to maintain lower agricultural use tax rates until development occurs. Some communities include agricultural areas within their urban areas. In these cases community gardens, community based farms (a use approved in a recent urban service area request for Bishop's Bay in Middleton), and certain agricultural lands can maintain or enhance the role of agricultural lands in providing buffers between communities or different land uses, and in protecting natural resources. These opportunities can be identified through the FUDA process.

Map 45: Agricultural and Developed Lands - 2005

North Mendota Study Area, Dane County, WI



FUDA Study Area
Urban Service Area
Limited Service Area
Water
Developed
2001Developed Serviced
Agriculture

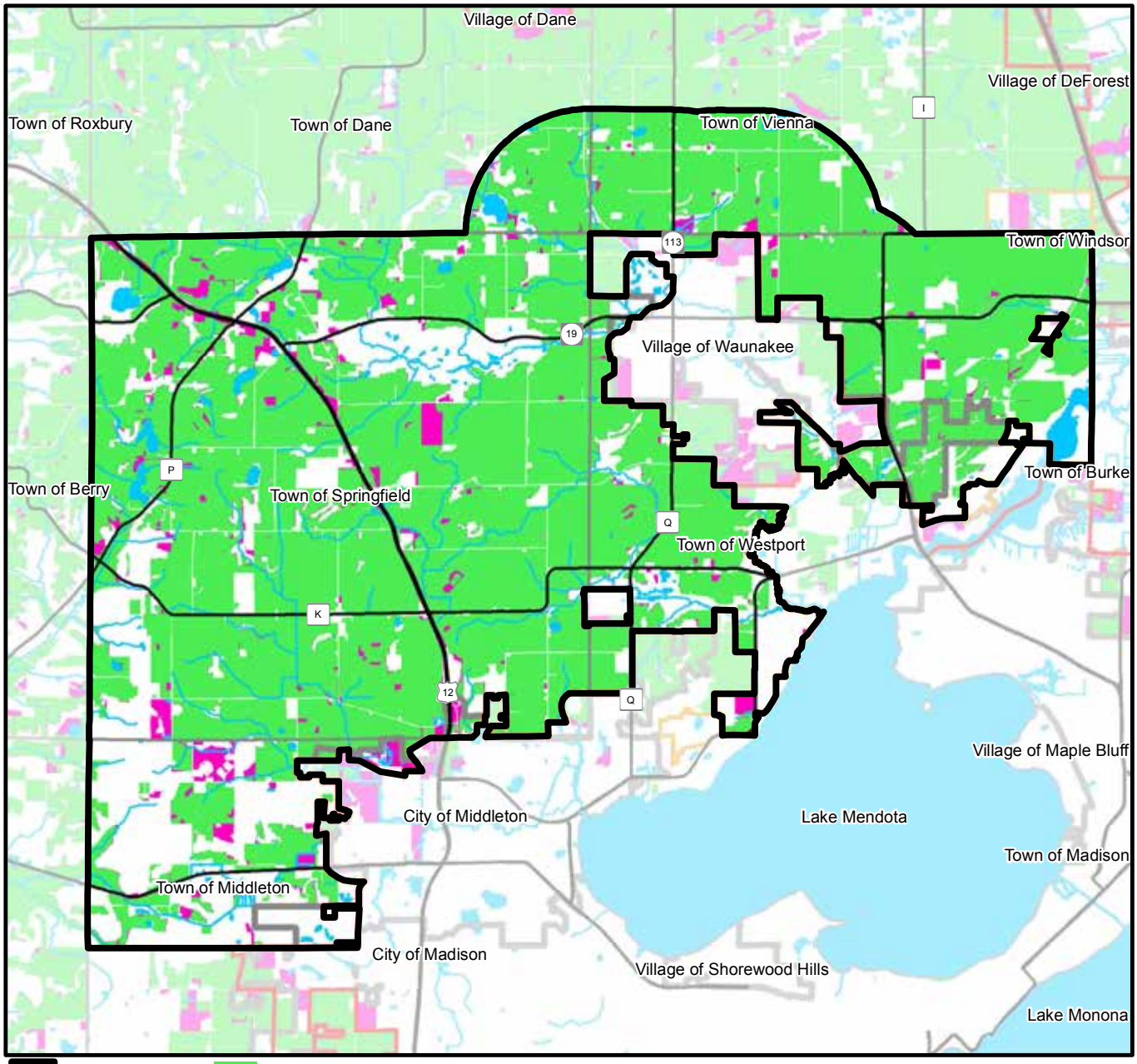
Miles
0 0.25 0.5 0.75 1 1.25 1.5

N

Source: Capital Area Regional Planning Commision February 2012

Map 46: Agricultural Land Conversion 2000-2005

North Mendota Study Area, Dane County, WI



FUDA Study Area
Urban Service Area
Limited Service Area
Water
2005 Agriculture
2000 Agriculture

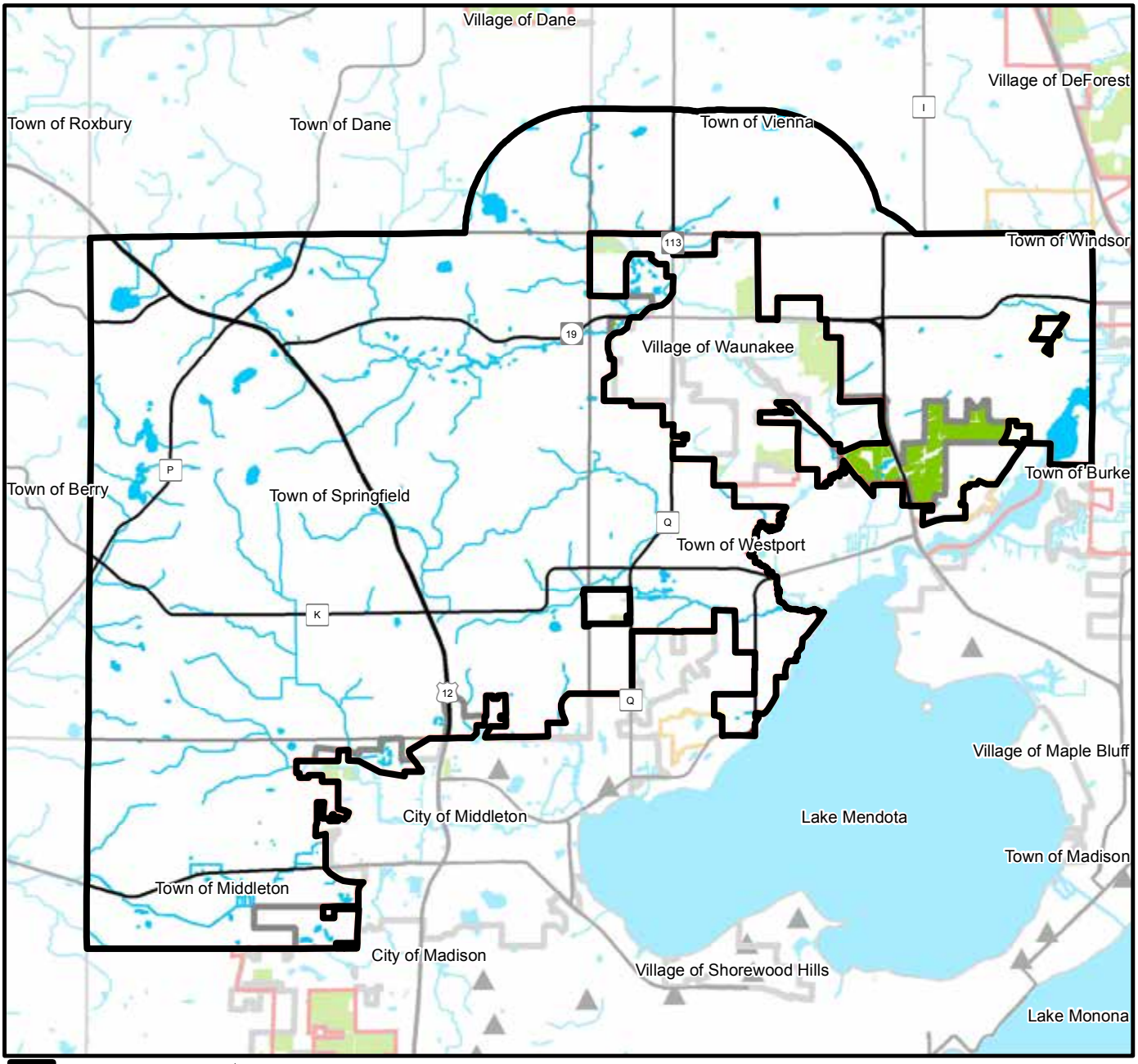
Miles
0 0.25 0.5 0.75 1 1.25 1.5

N

Source: Capital Area Regional Planning Commision February 2012

Map 47: City and Village Lands in Cultivation - 2005

North Mendota Study Area, Dane County, WI



Source: Capital Area Regional Planning Commision February 2012

Approximately 598 acres existed within the incorporated boundaries but outside USA boundaries in 2005. In 2005, the Village of Waunakee had roughly 420 agricultural acres and C. Middleton had roughly 30 agricultural acres within the urban service area.

B. Farmland and Farm Operation Characteristics

The following variables may be useful in planning for urban and rural development and agricultural preservation:

- Agricultural parcels and base farm tracts
- Agricultural contiguity and concentration
- Agricultural operation types (livestock, crop, and crop type)
- Tax parcel value assessment
- Soil quality (prime soils and Land Evaluation soils)
- Agricultural support services

1. Agricultural Parcels and Base Farm Tracts

Agricultural land is typically divided into parcels and often these parcels host other land uses in addition to farming, such as woodlands or water. Parcel acreages are larger than the area which is under active agricultural production. Still, parcels are important to examine because agricultural land is divided and sold by the parcel. Moreover, land use regulations occur at the parcel level and recommendations for agricultural land use will need to be useful at the parcel level as well as the regional level. Finally, parcels are the base unit for determining base farm tracts and contiguous blocks of agricultural land.

Applying the agricultural land use to tax parcel delineations reveals the number of agricultural parcels in the study area. Further analysis reveals parcel characteristics, such as size and ownership. These variables can begin to reveal the diversity of agricultural operations. Maintaining diversity in size and operation type can insulate the regional agricultural industry from severe market changes in any one sector, and can better support and encourage regional food systems. This diversity includes small and medium sized family farms and livestock operations that dominate the western portions of the County, and the potentially larger and contiguous operations in the east.

Town of Springfield

Table 12 shows the number of parcels[69] in the study area. In 2005, agricultural land in the study area was divided into 1,132 parcels.[70] Parcel sizes typically follow zoning and regulatory standards, and do not necessarily reflect the farming operation or needs. The predominant agricultural parcel zoning standard across the county is 1 split for every 35 acres, with a few towns requiring larger split requirements of 40 to 75 acres. Parcel figures reflect this with a mean size of 28 and a median of 34. The largest parcel is 77 acres in Springfield.

Table 12: Agricultural Parcel Data (acres)

Study Area	2000				2005				2008			
	# Parcels	Median	Mean	Max.	# Parcels	Median	Mean	Max.	# Parcels	Median	Mean	Max.
T. Westport	250	28	27	42	223	33	30	55	226	35	29	55
T. Springfield	760	22	25	43	643	35	29	77	674	34	28	79
T. Middleton	112	20	23	41	83	30	27	41	85	30	28	44
T. Dane	44	16	24	41	38	32	27	41	38	33	28	41
T. Vienna	97	35	29	41	94	36	30	41	95	36	30	41
Unserviced Ci/Vil.	31	22	22	41	36	18	18	39	30	20	20	39
Regional Comparison												
Study area total	1,297	23	25	43	1,132	34	28	77	1,149	34	28	79
Sub-regions	6,450	23	28	260	6,291	32	28	261	6,488	23	28	378
County	21,309	23	24	68	18,349	31	27	261	20,706	28	25	378

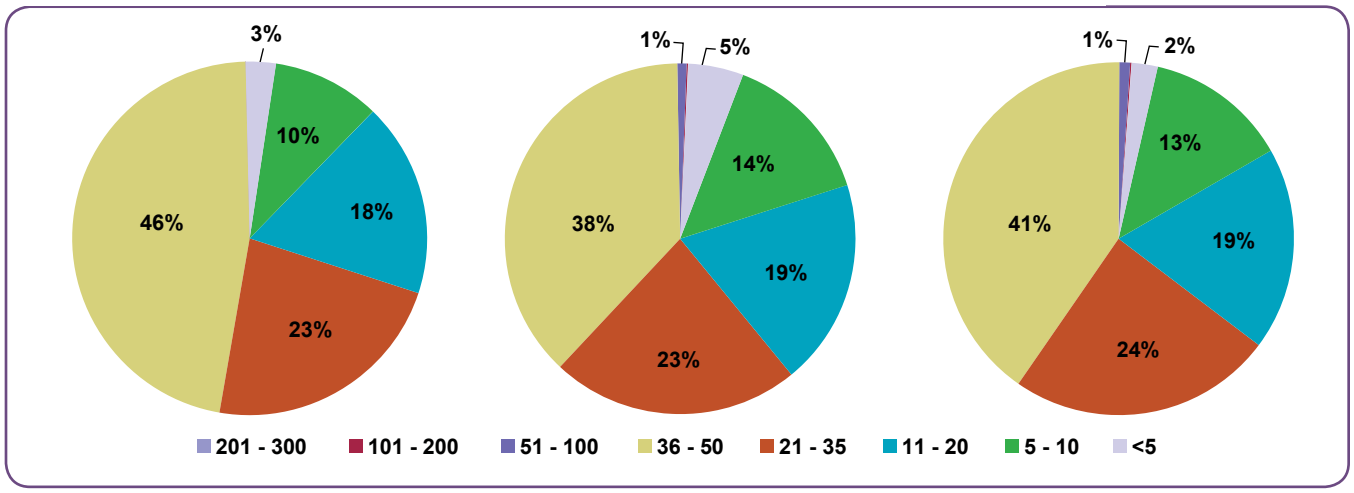
Source: CARPC Land Use Inventory

A look at the distribution of parcels in the study area, shown in Figures 26 and 27 reveals the most common agricultural parcels to be 36-50 acres in size, with 46% of parcels in this range, occupying 64% of the agricultural acreage in the study area. Another 41% of parcels are between 10 and 35 acres in size, and 13% of parcels are under 10 acres though they account for less than 2.5% of a gricultural land in the study area. In Dane County and in the physiographic sub-regions larger parcels can be found up to 300 acres in size, though these parcels represent a relatively small percent of agricultural land.

69 Agricultural parcels are any privately owned 'rural' (as designated in the land use inventory) parcels 5 acres or larger. All parcels determined to be "ex-urban," "potential exurban," or "other" were removed from the agricultural parcel data set (see *FLM 2 Agricultural Lands and Operations*, Appendix A for details http://danedocs.countyofdane.com/webdocs/PDF/capd/2012_postings/Publications/FLM_2_Appendix_A.pdf).

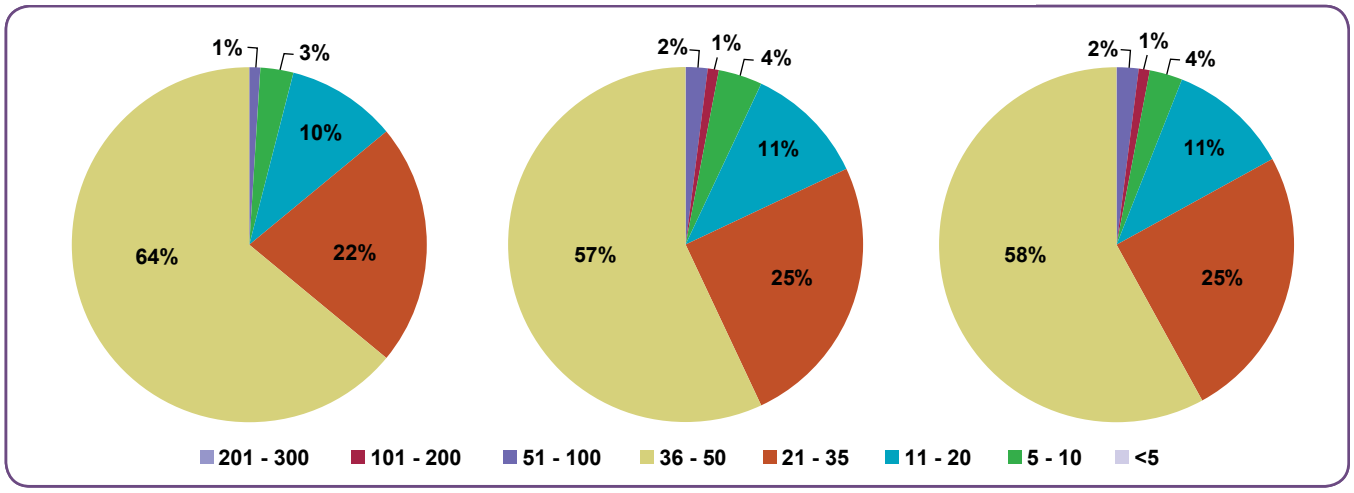
70 Roads, water, parks, and other public lands are not counted in this figure.

Figure 26: Distribution of Agricultural Parcels by Size (2005)



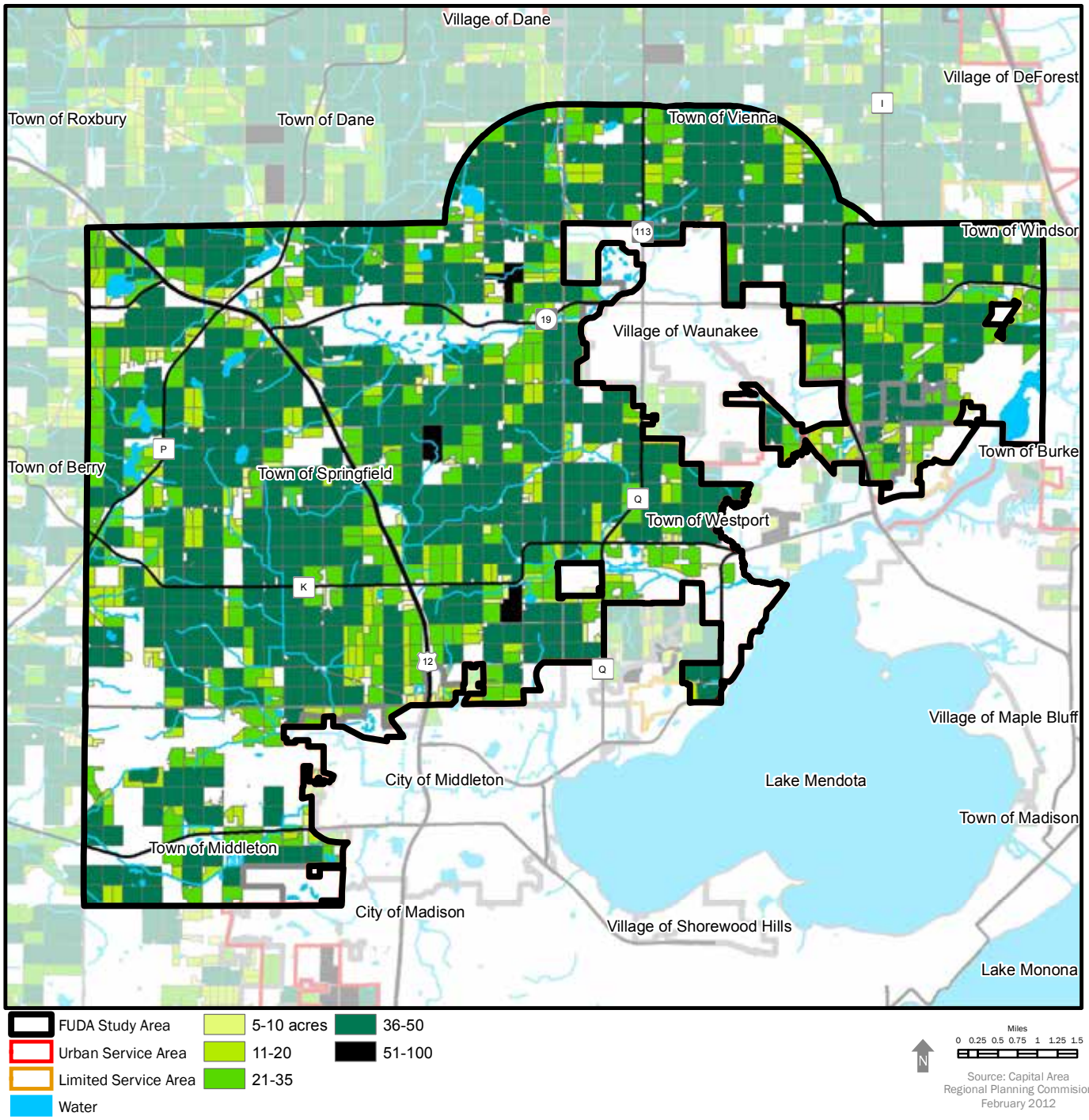
Town of Weatport

Figure 27: Proportion of total area by Agricultural Parcel Size (2005)



Map 48: Agricultural Parcels - 2005

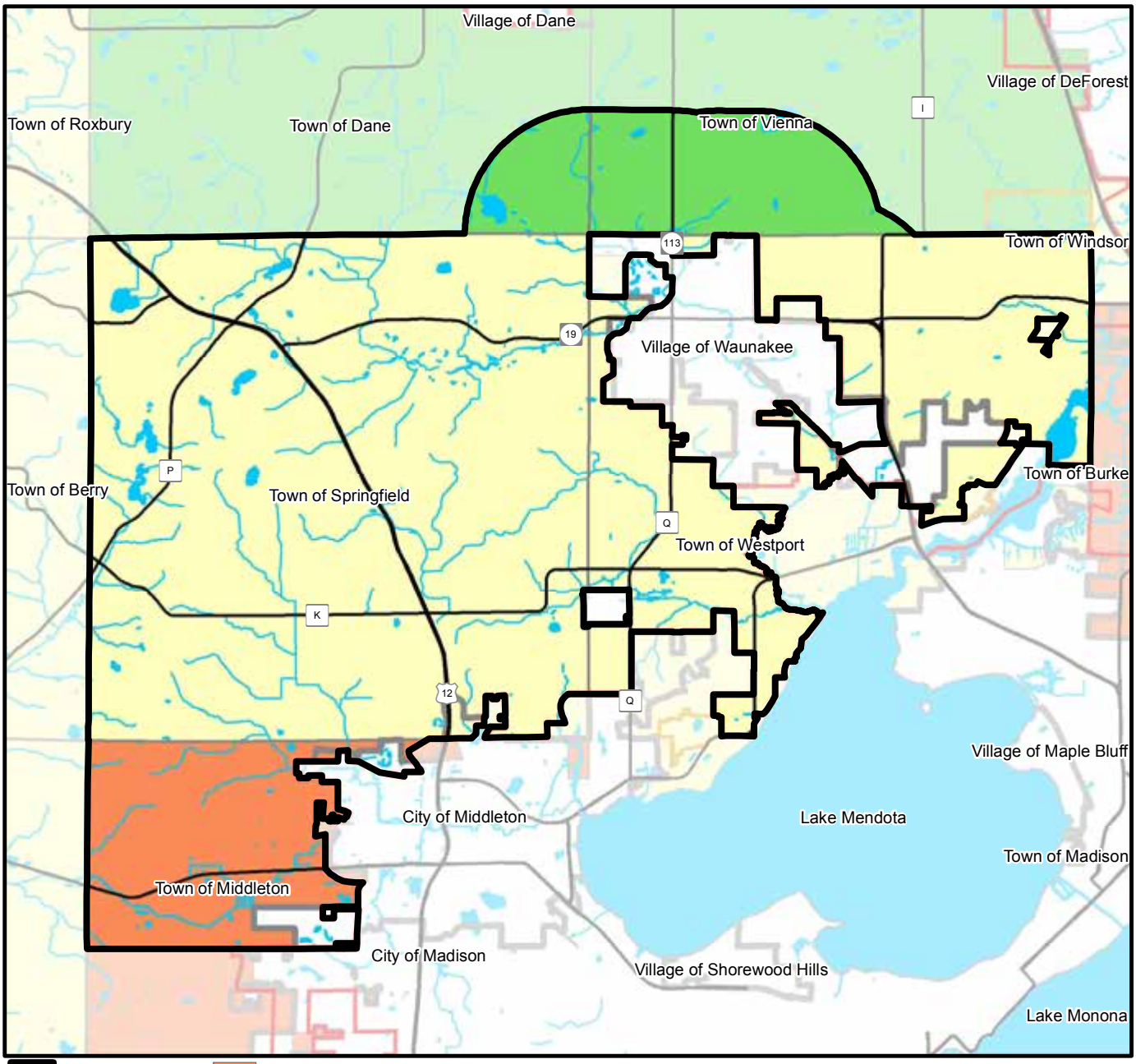
North Mendota Study Area, Dane County, WI



Within the study area, the preatest portion of parcels were 36-100 acres in size. The largest parcel was 77 acres, in the year 2005. The median size was 34 acres and the mean was 28 acres.

Map 49: Farmland Ownership (2008)

North Mendota Study Area, Dane County, WI



FUDA Study Area
Urban Service Area
Limited Service Area
Water
20-49% Owner Operator
50-79%
80% and Higher

Miles
0 0.25 0.5 0.75 1 1.25 1.5

N

Source: Capital Area Regional Planning Commision February 2012

To determine the approximate number of farm operations and estimate their size, bordering parcels owned by the same landowner were combined into one unit called a base farm tract. Base farm tracts are shown in Map 50. Within the study area, there were 442 base farm tracts in year 2005. The true number of farms, in business terms, is likely less than these figures because a base farm tract owner may not actually farm his or her own land. Instead the owner may lease out his or her land to an existing land owner or another individual for agricultural use.

As seen in the 'study area total' row in Table 13, the median tract size was 47 acres and the mean was 73 acres. This difference indicates that a few landowners own very large portions of the agricultural land. The largest base farm tract was 641 acres. This tract and the five next largest in the study area are located in the Town of Springfield.

The size distribution breakdown for all base farm tracts shows the largest interval of tracts to be under 35 acres in the study area. This holds true with physiographic sub-regions and County numbers, ranging from 36%-43% and accounting for 7%-10% of land area. The next largest interval hosts tracts 51-100 acres in size. It should be noted that some base farm tracts at the edge of the study area may also be connected to parcels outside the study area, and can therefore be part of a larger tract than what is shown in the table.

Figure 28. Size Distribution of Base Farm Tracts (2005)

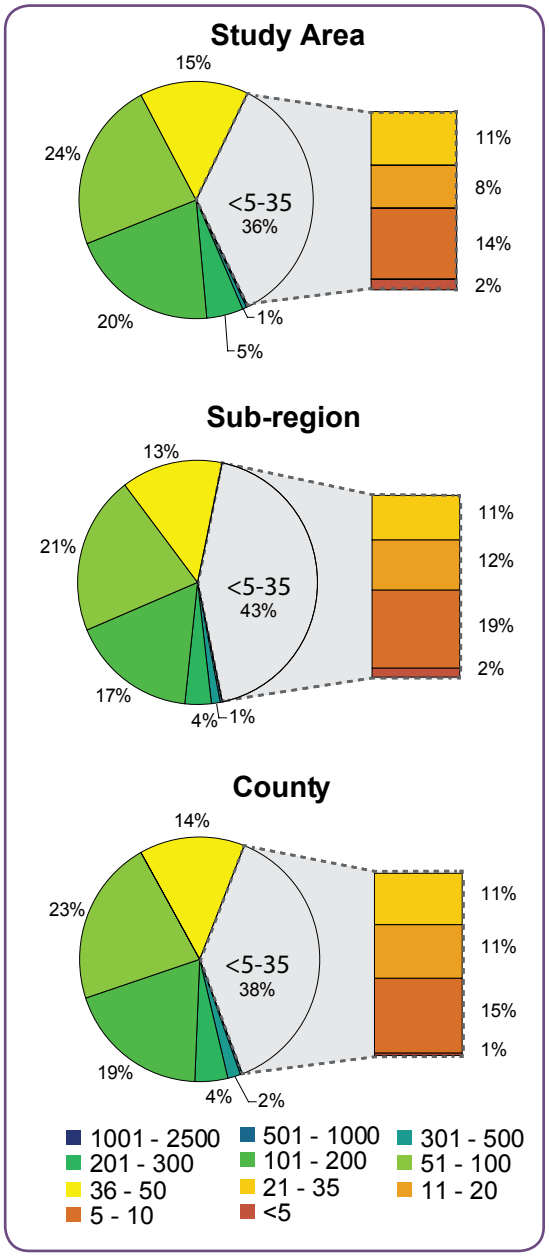
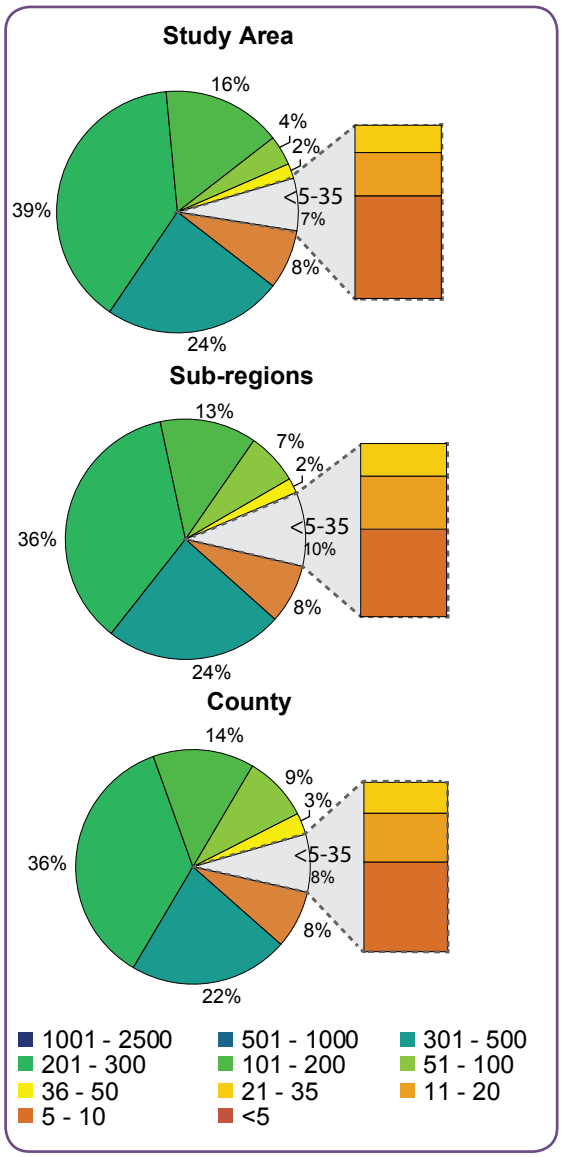


Table 13: Base Farm Tract Data (acres)

Study Area	2000				2005				2008			
	# Tracts	Median	Mean	Max.	# Tracts	Median	Mean	Max.	# Tracts	Median	Mean	Max.
Study area total	416	48	79	560	442	47	73	556	478	37	69	641
Sub-regions	2,760	43	70	673	2,825	40	66	600	2,963	39	66	696
County	6,586	50	78	1,723	6,761	45	74	1,666	6,961	42	75	1,811

Source: CARPC Land Use Inventory

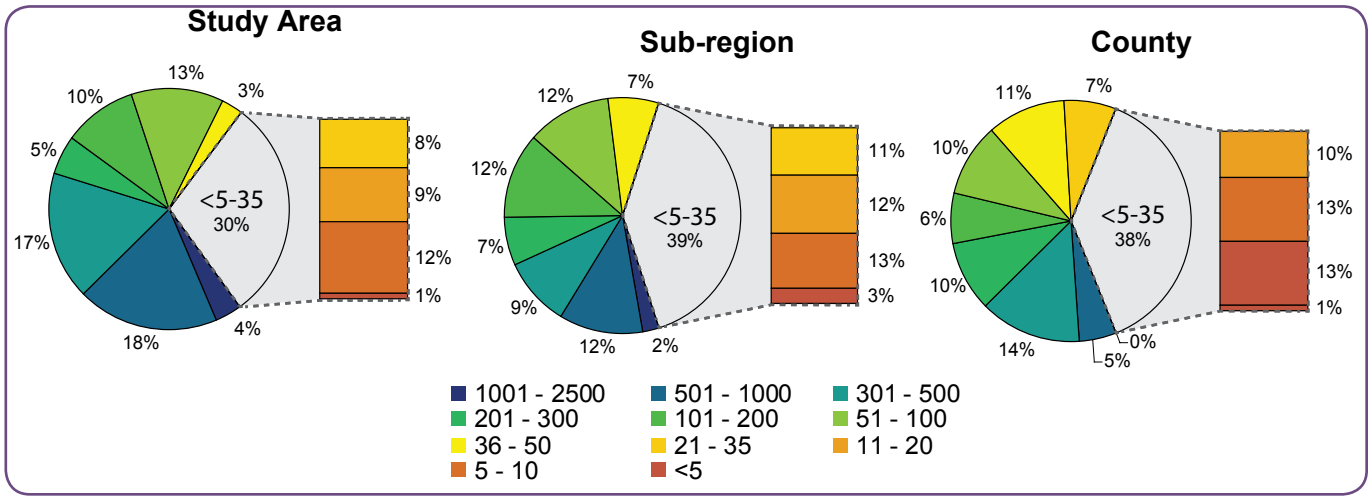
Figure 29. Proportion of Total Area by Base Farm Tract Size (2005)



As mentioned above, a farmer may operate on land leased from a non-operator land owner. While specific data is not available for every parcel or operation (confidential records), the Department of Agriculture, Trade, and Consumer Protection (DATCP) provides summary information on owner-operators at the township level in broad ranges (Map 49). In the Towns of Vienna and Dane, at least 80% of farms are worked by owner operators. In the Towns of Springfield and Westport this range is 50% to 79%. Combining this information with parcel quantities estimates in year 2005, owner-operators farmed 8,600-13,770 acres in Springfield, and 3,800-6,000 acres in Westport, both of which are entirely in the study area. The Town of Middleton has an owner-operator range of 20% to 49%.

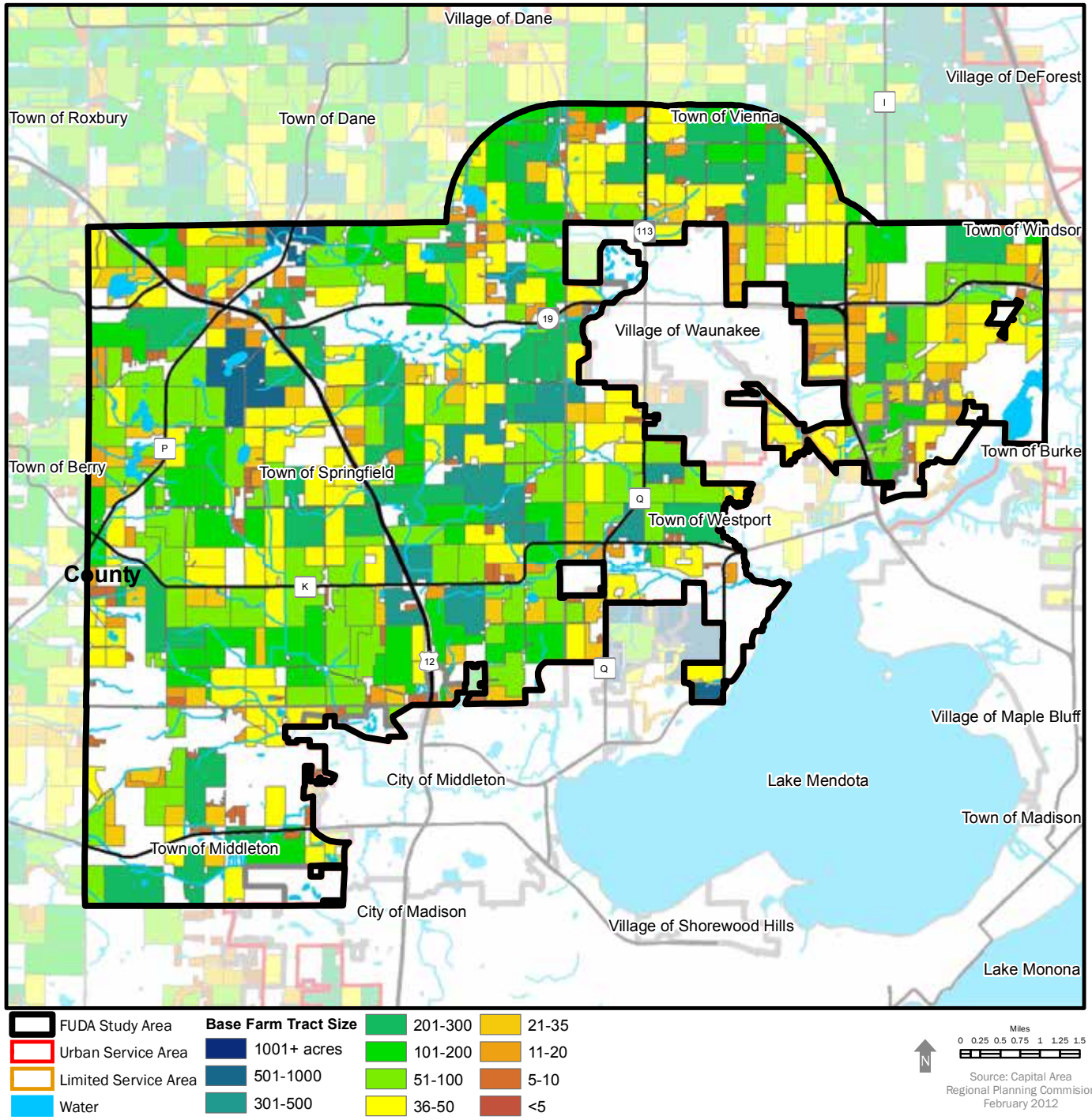
The lower ratio of owner-operators in a town indicates a higher likelihood that these lands will become available for development in the future, because the land owner is not directly using or investing in the land, and the existing farmer using the land might not be bound by long-term contracts.

Figure 30. Distribution of Contiguous Block Size (2005)



Map 50: Base Farm Tract Size - 2005

North Mendota Study Area, Dane County, WI



Within the study area, the largest portion of base farm tracts are 35 acres or less and more than half are 100 acres or less. The largest tract is 77 acres. The median size is 34 acres and a mean of 28 acres.

2. Agricultural Land Contiguity and Concentration

For agricultural operations to remain viable, a critical mass of relatively uninterrupted agricultural land may be necessary. This creates efficiency for businesses providing resources and services to farmers, and prevents conflicts with incompatible land uses, such as residential, that often lead to traffic conflicts on roads shared with large slow-moving farm vehicles, or complaints about farm noise and odor.

Contiguous agricultural blocks measure the current massing of agricultural parcels. The study area boasts large contiguous blocks of agricultural land and portions of large blocks primarily outside the study area, as shown in Map 51. Table 14 presents data for the area (note that the study area boundary crosses some block boundaries and many reduce some block sizes in the figure 31).

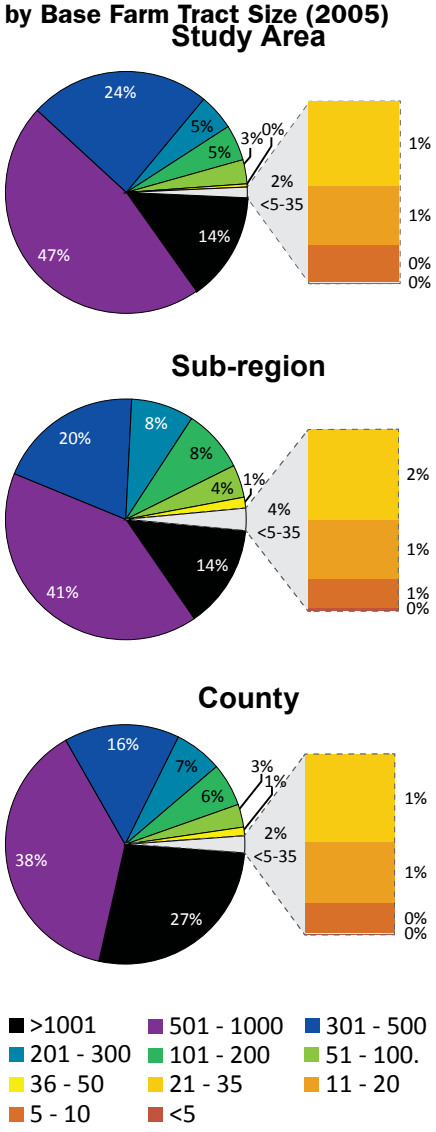
Table 14: Contiguous Blocks (acres)

Regional Comparison	# Blocks	Median	Mean	Max.
Study area total				
2000	113	113	292	1,290
2005	115	108	279	1,286
2008	112	133	290	1,291
Sub-regions				
2000	887	83	218	1,796
2005	954	62	195	1,738
2008	952	53	206	1,956
County				
2000	1,857	88	275	3,764
2005	2,005	72	249	3,137
2008	1,893	69	275	3,955

Source: CARPC Land Use Inventory

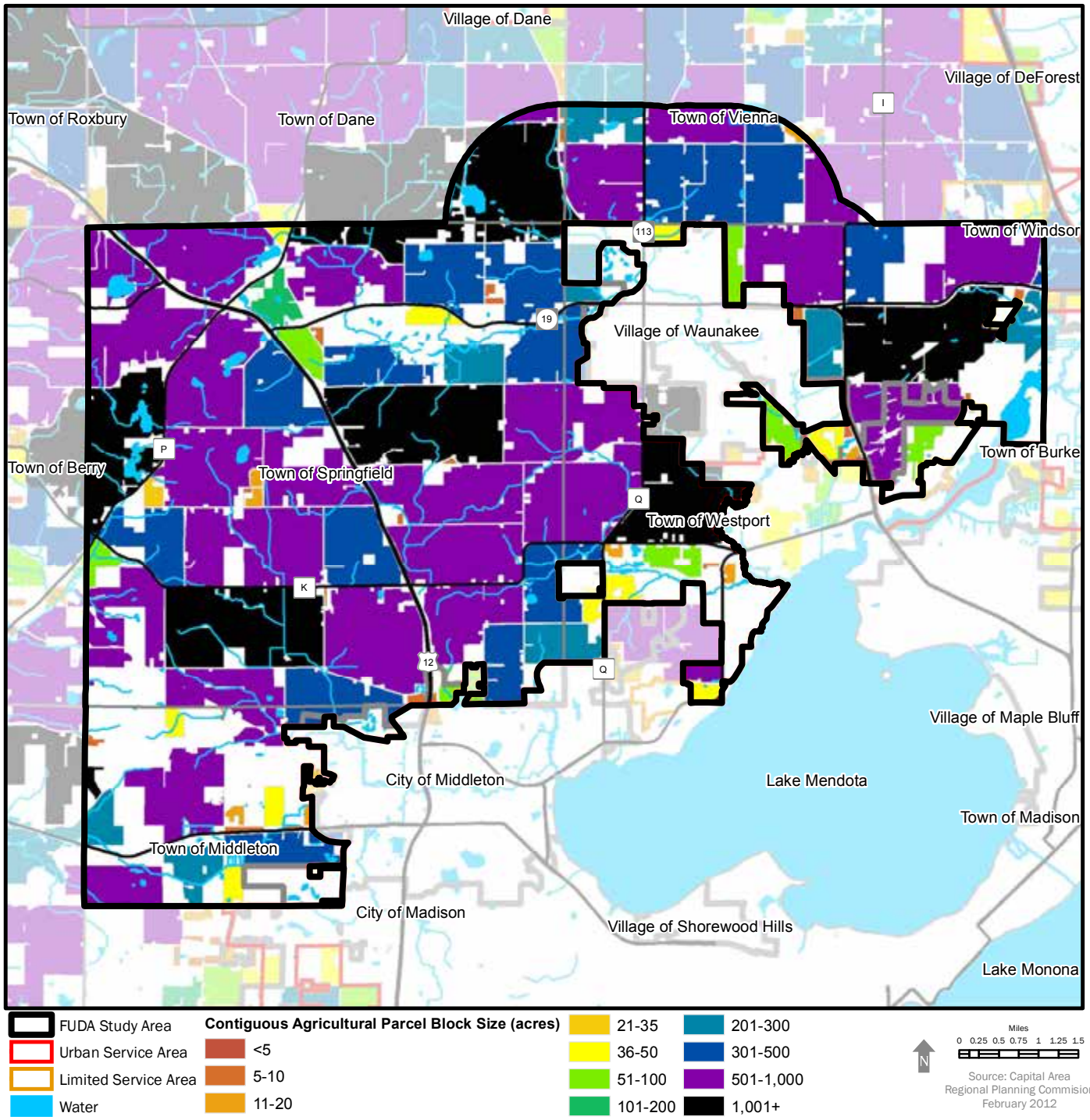
Contiguous blocks: Touching agricultural parcels in one group. Barriers (highways, large water bodies, steep slopes, or other land uses) break land into smaller pieces.

Figure 29. Proportion of Total Area by Base Farm Tract Size (2005)



Map 51: Contiguous Agricultural Blocks - 2005

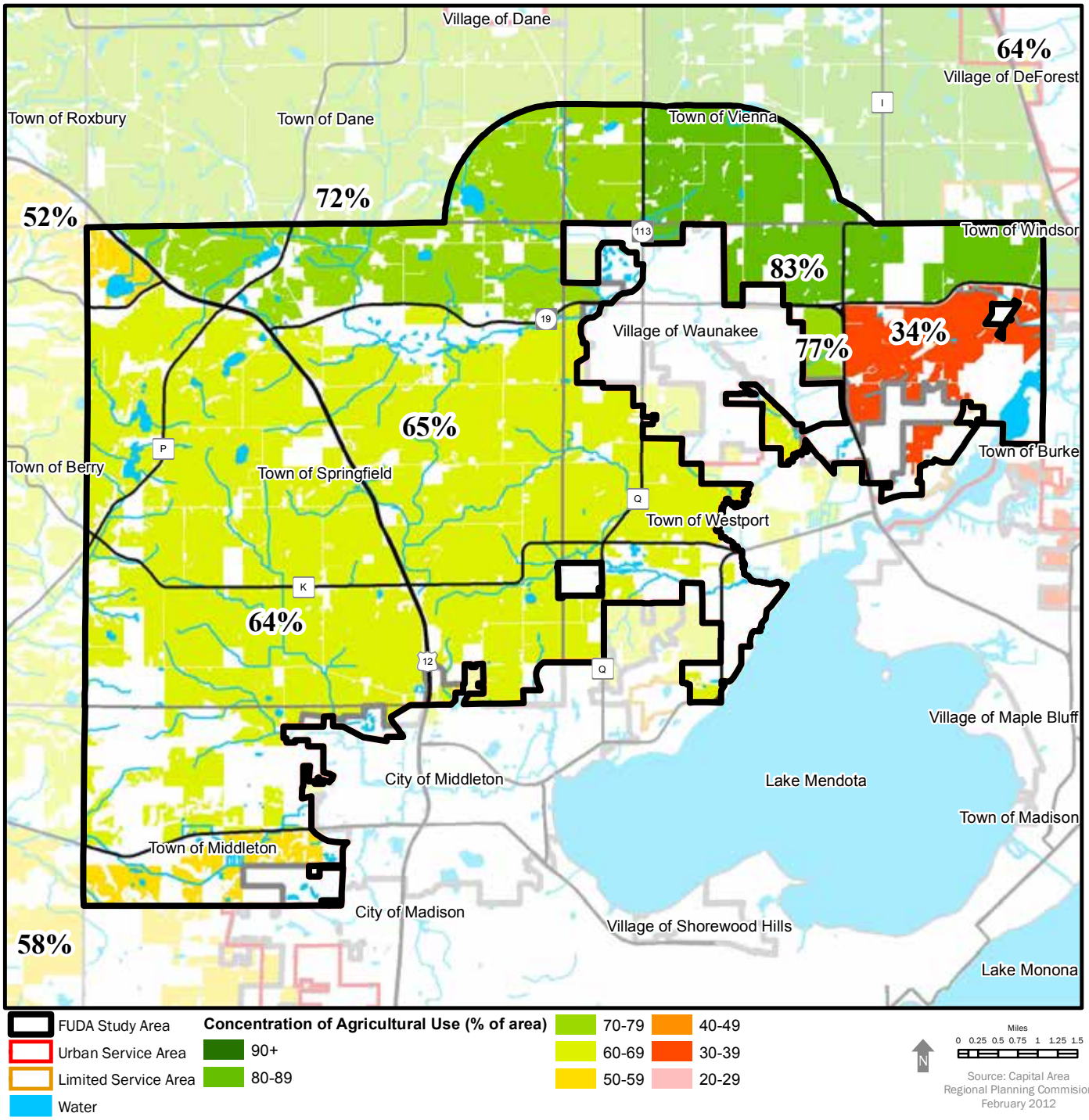
North Mendota Study Area, Dane County, WI



This analysis combines all touching agricultural parcels that are not separated by any roads, major water bodies, other non-agricultural devleopment, or steep slopes. One-hundred fifteen blocks existed in the study area in 2005. The largest was 1,286 acres. The median tract size is 108 acres and the mean is 279 acres.

Map 52: Concentration of Agricultural Use Between Major Roads - 2005

North Mendota Study Area, Dane County, WI



This analysis combines all agricultural parcels bound by major roads and caluclates the percentage of the land that is agriculture with that area. This anaysis was conducted to show contiguous agriculture without considering local roads a barrier to agricultural vitality.

In 2005, the study area had 115 contiguous blocks of agricultural land. The largest block is in the Town of Springfield with an area of 1,286 acres. Springfield also hosts the next largest block, and Westport the third largest block. The Map 51 also indicates that agricultural lands within, near, or bordering urban areas and rural hamlets generally show increased fragmentation. This is especially noticeable in the Town of Middleton, Town of Westport just north of Lake Mendota (mostly within the urban service area), and in the Town of Springfield near the intersection of Hwy 12 and Hwy 19 (the Hamlet of Springfield Corners), and intersection of Hwy 12 and Hwy (Hamlet of Ashton Corners). Large blocks of agricultural land border the western, eastern, and northern boarder of Village of Waunakee, and the northwestern limit of the City of Middleton in the Town of Springfield.

As shown in Table 14, the mean contiguous block in the study area was 279 acres, while the median is 108 acres in 2005. This indicates that there are a few large blocks and greater numbers of smaller blocks.

Examining this size distribution more closely for year 2005 reveals that a third of the blocks are less than 50 acres. This high proportion of the smaller blocks is consistent with sub-regional and regional distributions. The study area does not have as many small blocks as the remaining region. These blocks likely consist of one to a few parcels. Twelve percent of all blocks fall into the 5-10 acre size category. While there are a large number of small acreage blocks, these blocks occupy less than 8% of the agricultural land in the study area. The next two size categories containing a large number of blocks are 301-500 acres and 501-1000 acres. Taken together these two categories account for 35% of the agricultural land in the study area, a much larger portion of the blocks here than in the physiographic sub-region and county areas Overall, these two categories account for 65% of the land area in the study area.

Larger contiguous blocks of agricultural lands maintain a critical mass that fosters a viable farming sector. These land masses are well suited for preservation in agricultural use. Smaller block, especially near developing areas, might infer where long-term farming may not be as viable. If smaller blocks are considered valuable for agricultural use or other uses, these areas may require special efforts to preserve, or to adopt practices to reduce the burden from expanding urban development on nearby farm operations, and maintain the economic viability of an isolated farm operation.

Another useful set of information comes from measuring the concentration of agriculture. Because many local and rural roads benefit agricultural operations, they are removed from the analysis as barriers. Instead, only major roads are considered barriers to agricultural concentration. The resulting concentrations of agricultural land use between major roads are shown in Map 52.

The highest concentrations of agricultural land are found north of Hwy 19, and the lowest concentration in the south-east corner of the study area in Westport north of Lake Mendota. Town of Springfield, south of Hwy 19, is about 65% agriculture. A large portion of the remaining lands in the Town of Springfield are open lands and primarily slopes. To the east and north of the study area, agricultural concentration increases, representing an area that contains some of the highest quality soils in the County.

3. Agricultural Operation Types

Generally, the area of the region supports significant livestock and crop production operations. The Towns of Springfield and Dane host 70-88 operations each, and the Town of Westport hosts 35-51 operations. The Town of Middleton hosts 14-32 operations, yet no Town of Middleton operations are located in the study area. Map 53 shows the location of some of these operations by type. Overall, dairy and beef operations dominate the study area with a few fur bearing animal71 operations scattered throughout. Many operations pasture their livestock to take advantage of the grasses that grow on site. ***Table 15 shows that 14,822 acres, 44% of the total area, were dedicated in 2005 to pasture for livestock in the study area.***

The most common practices on cropland are shown in Table 15, Figure 32, and Map 54 based on data from the National Agricultural Statistics Survey (generally over-estimates). ***The most dominant crops are row crops including corn, soy, alfalfa, and others.***[72] ***Generally, these crops are dedicated to growing feed for livestock used in dairy and beef production.***

Compared to the larger physiographic sub-regions and the County, the study area dedicated a slightly higher percentage of farmland to row crops. Unlike other areas in Dane County, very little of this area is dedicated to winter wheat, oats, vegetables, or state-specific crops.[73]

Table 15: Agricultural Land Cover 2005 (acres)*

Study Area Portion	Row Crops, Grains, Hay, or Seeds**						Pasture***		Fallow/Idle		Total
	Alfalfa		Corn		Soybeans						
T. Westport	627	6%	2,684	37%	1,122	15%	2,654	36%	107	1.47%	7,321
T. Springfield	2,812	14%	5,338	28%	1,898	10%	8,622	45%	189	0.99%	19,089
T. Middleton	166	6%	380	13%	194	7%	2,028	71%	94	3.26%	2,873
T. Dane	232	20%	237	19%	65	5%	562	45%	43	3.37%	1,260
T. Vienna	388	14%	970	36%	334	12%	956	35%	12	0.43%	2,727
Unserviced urban	98	4%	186	7%	97	4%	388	14%	8	0.43%	796
Regional Comparison											
Study area total	4,322	13%	9,794	29%	3,710	11%	14,822	44%	452	1%	33,663
Sub-regions	18,040	8%	58,413	26%	29,767	13%	107,557	48%	7,065	3%	223,101
County	59,109	8%	155,971	20%	95,687	12%	305,726	40%	46,442	6%	766,655

Source: National Agricultural Statistics Survey

*** State specific crop and other crop lands are omitted from the table due to negligible presence in the study area. County wide 20,753 state specific crop acres and 22,910 other crop land acres exist.**
**** In the study area, other hay and grain, winter wheat and oats are negligible at 0 acres, 34 acres, and 47 acres respectively (all less than 1 percent of total) and are not included in this table, these values are factored into the pie charts under Row Crops. At the county level 19,667 acres were dedicated to other small grains and hay.**
***** May contain woodlands and CRP lands not used for pasture**

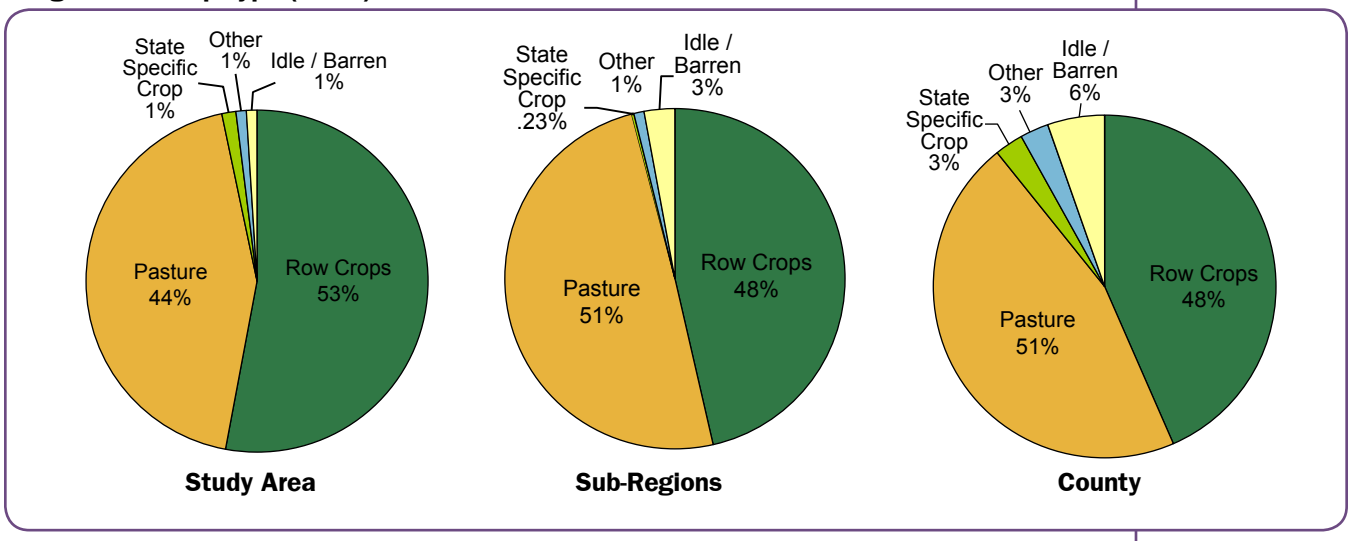
71 Llama, alpaca, sheep, etc.
72 About 665 acres were considered barren across the study area.
73 For example, tobacco.

Town of Westport

The Town of Westport has one, and the Town of Middleton has nine commercial forests in the study area, seven of which are concentrated together. This area is on the edge of the terminal moraine and does not host as high a concentration of these operations as the areas west of the study area. Some forest lands are under the state Forest Land Management Program, noted in red hatched lines on Map 54.

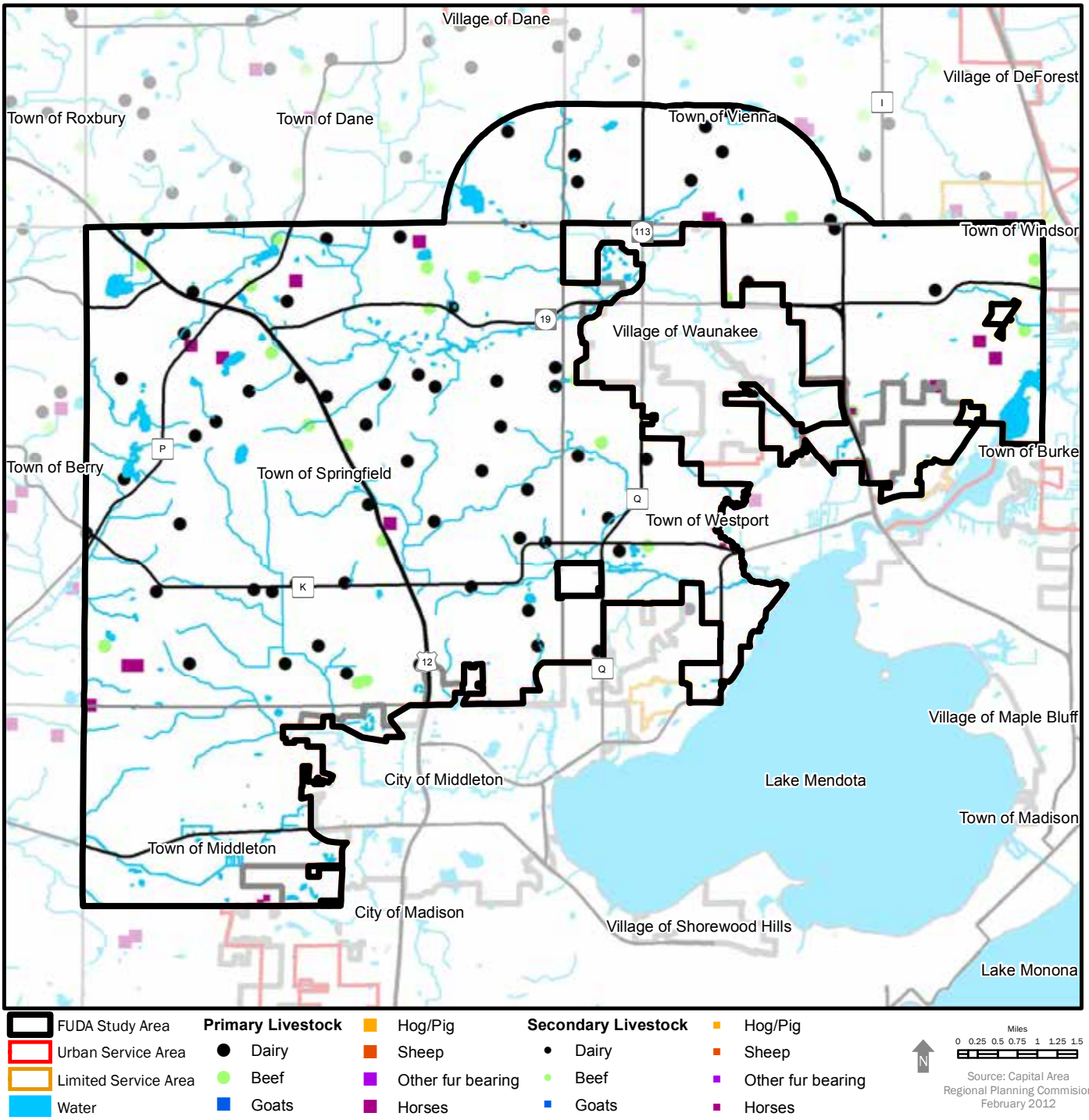
Mineral extraction is also considered a rural use and is often grouped with agriculture because quarry sites are permitted under conditional use permits on agriculturally zoned parcels. Mineral extraction sites are considered a developed land use. Mineral resources provide economic opportunities and can adversely impact agricultural soils if the quarry is not restored with the original topsoil once the resources are extracted. Mineral resources are presented in greater details in the Natural Resources chapter (Chapter I) of this report.

Figure 32: Crop Type (2005)



Map 53: Livestock Operations 2008/2010

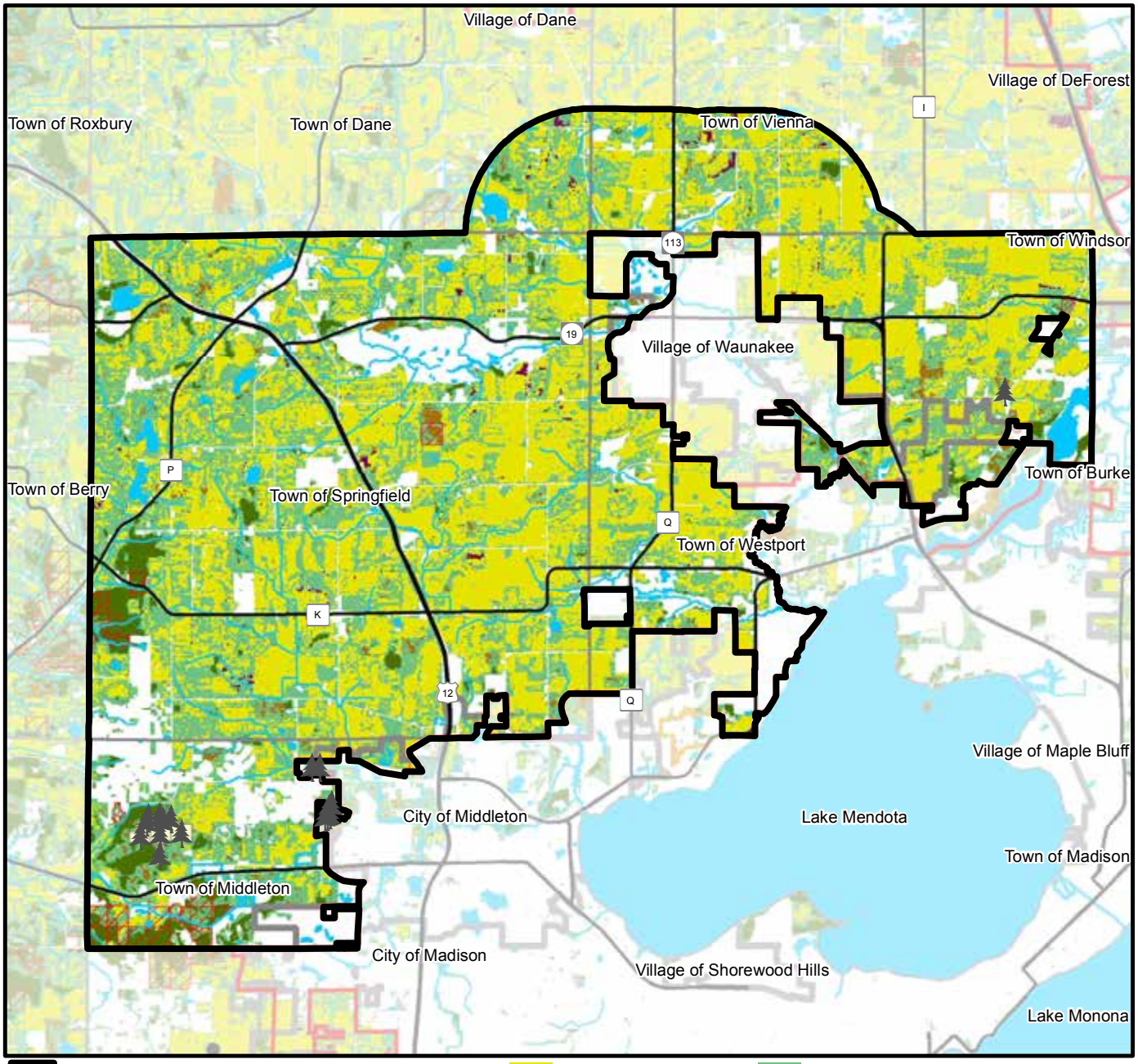
North Mendota Study Area, Dane County, WI



Mineral resources are important economic assets. These areas also provide significant opportunities for regional infiltration practices to replenish the groundwater.

Map 54: Crop Type - 2005

North Mendota Study Area, Dane County, WI



FUDA Study Area
Urban Service Area
Limited Service Area
Water
Community Supported Agriculture
Commercial Forest
Managed Forest Lands
Row crops, grain, hay, seed
Fallow/idle
Other crops
Vegetables
Grassland pasture
Woodland pasture
State specific crop

Miles
0 0.25 0.5 0.75 1 1.25 1.5

N

Source: Capital Area Regional Planning Commision February 2012

White spaces are non-agricultural lands. Row crops include corn, soybeans, oats, winter wheat, grains and alfalfa. Pasture categories are broad and contain open woodlands or grasslands that may not be used for pasturing (may include Conservation Resource Program lands).

4. Land Value Assessment

An examination of assessed land values can reveal areas experiencing high growth pressure and areas where assessment is influenced by agricultural preservation zoning. ***Supplementing this data with improvement assessment values may indicate investment factors that signify the intent to maintain the land in agricultural use and continue to support the viability of agricultural operations.*** Maps 55 and 56 illustrate assessments of land value and improvements for all base farm tracts.

Table 16: Land Tax Assessment 2005 ($/per acre)

Study Area	Total ($)	Median	Mean	Max.
T. Westport	261,997	909	2,220	18,499
T. Springfield	297,816	500	1,324	21,773
T. Middleton	94,764	817	2,256	22,005
T. Dane	17,485	384	1,166	5,287
T. Vienna	25,760	395	644	5,310
Unserviced City/Vil.	107,678	433	6,730	95,597
Regional Comparison				
Study area total	795,211	558	1,799	95,597
Sub-regions	7,234,369	699	2,561	163,345
County	14,913,970	140	2,206	163,345

Source: Dane County Tax Assessor

Tracts with low land value assessment are typically dedicated to crop cultivation or pasture only, and may not generate a profit margin from land sales significant enough to promote converting the land to more intensive developed land uses at this time. Highly valued tracts can remain in agriculture, especially if they are tied to an agricultural improvement or facility that is also high value. A closer examination of the base farm tracts could reveal the agricultural economic vitality of a given area.

Town of Springfield

Town of Middleton

Parcels with high value agricultural improvements, such as large infrastructure investments for agricultural use (milking parlors, processing facilities, etc.), are potentially more likely to remain in agricultural use. Note that improvements are typically built structures and take arable land out of cultivation. Thus, preserving parcels with high value improvements alone is insufficient for food and fiber cultivation. Also note that some improvements on agricultural parcels may not be agriculturally related. A close examination of the improvements may be necessary to determine the likelihood of the conversion of surrounding land out of agricultural land use to development.

Table 17: Improvement Tax Assessment 2005 ($/per acre)

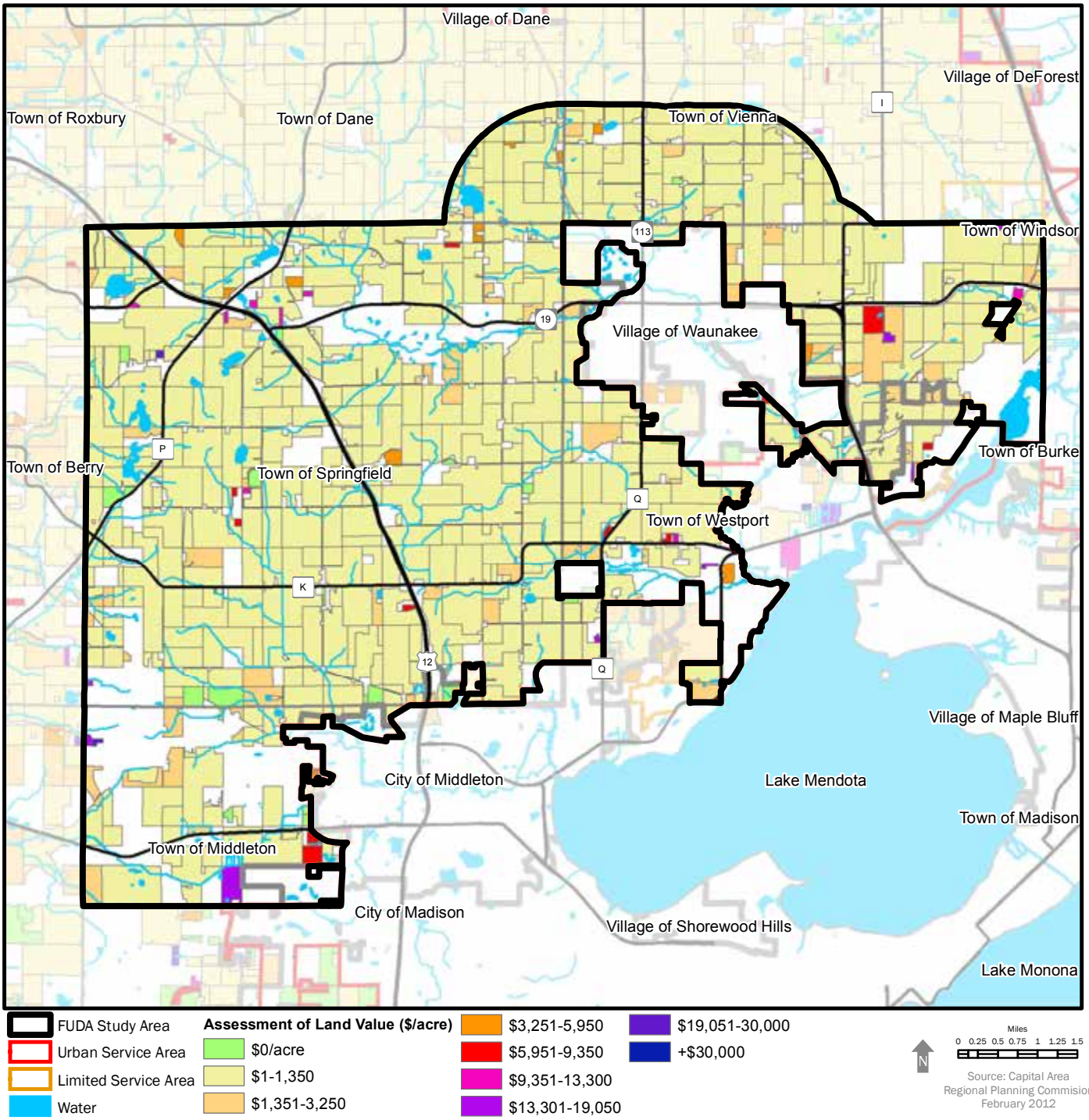
Study Area	Total ($)	Median	Mean	Max.
T. Westport	417,988	1,420	3,542	33,877
T. Springfield	592,102	707	2,632	76,326
T. Middleton	131,910	0	3,141	32,348
T. Dane	95,236	0	6,349	47,511
T. Vienna	58,219	7	1,455	10,497
Unserviced City/Vil.	149,096	674	9,319	120,432
Regional Comparison				
Study area total	1,413,151	576	3,197	120,432
Sub-regions	12,182,374	126	4,312	246,513
County	25,679,550	0	3,798	291,425

Source: Dane County Tax Assessor

Assessment figures are shown in Table 17 for land value and in Table 18 for improvement value. Some parcels have a very low assessment for both land and improvement values. This is evident in the degree of difference between the median and mean assessment values and through a distribution analysis. The difference also reveals that a few very highly valued tracts raise the mean for the entire area.

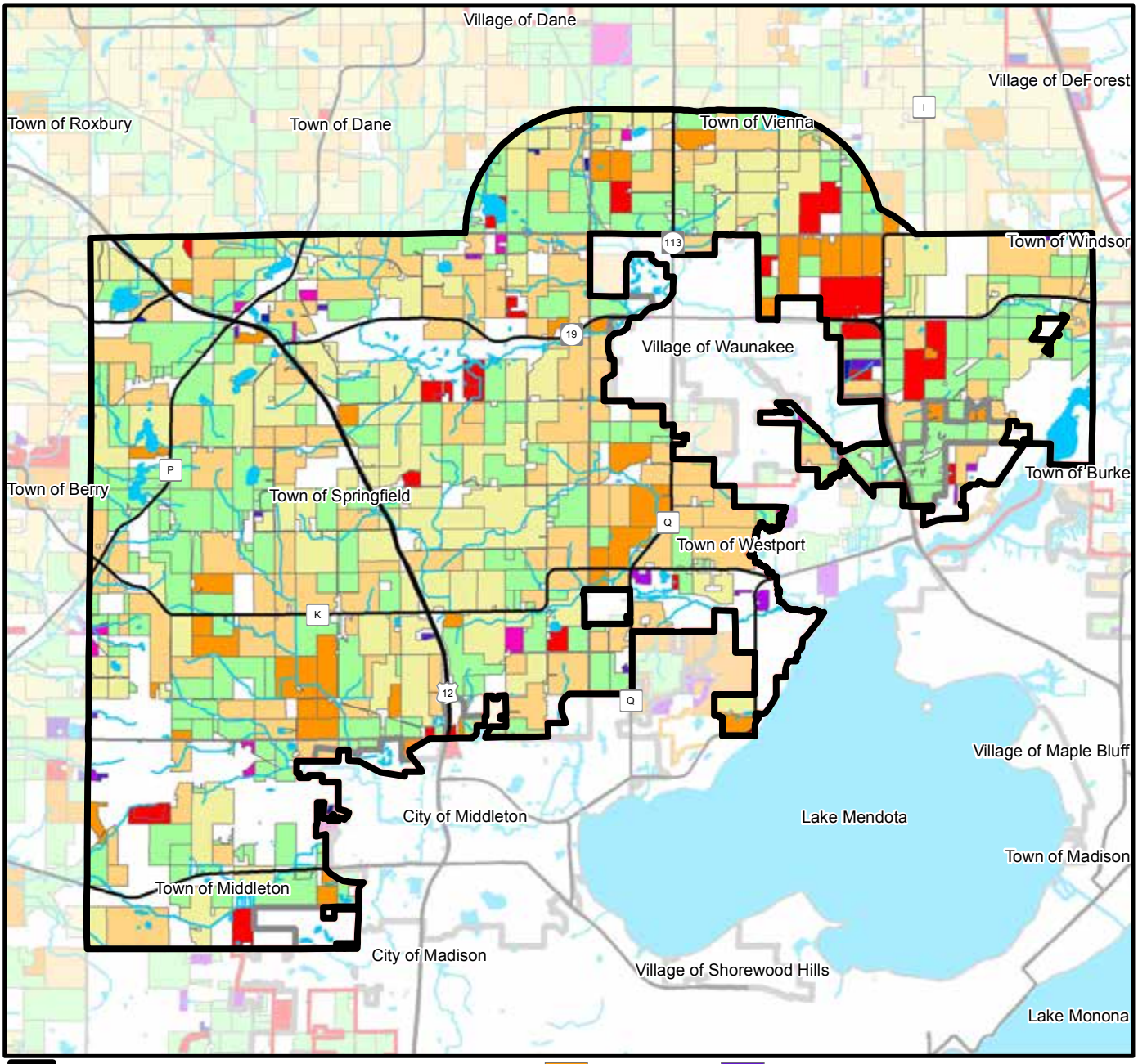
Map 55: Value Assessment of Land - 2005

North Mendota Study Area, Dane County, WI



Map 56: Value Assessment of Improvements - 2005

North Mendota Study Area, Dane County, WI



FUDA Study Area
Urban Service Area
Limited Service Area
Water

Assessment of Improvement Value ($/acre)

$0/acre
$1-1,350
$1,351-3,250
$3,251-5,950
$5,951-9,350
$9,351-13,300
$13,301-19,050
$19,051-30,000
+$30,000

Miles
0 0.25 0.5 0.75 1 1.25 1.5

N

Source: Capital Area Regional Planning Commision
February 2012

Prime Farmland and Land Evaluation Methods

Prime Farmland is land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and that is available for these uses. A combination of factors are present in prime farmland: soil properties, growing season, and moisture supply needed to produce sustained high yields of crops in an economic manner if it is treated and managed according to acceptable farming methods. In general, prime farmland has an adequate and dependable water supply from precipitation or irrigation, a favorable temperature and growing season, an acceptable level of acidity or alkalinity, an acceptable content of salt or sodium, and few or no rocks. Prime soils are permeable to water and air. Prime farmland is not excessively eroded or saturated with water for long periods of time, and it either does not flood frequently during the growing season or is protected from flooding. Users of the lists of prime farmland map units should recognize that soil properties are only one of several criteria that are necessary. Other considerations include: Land use, frequency of flooding, irrigation, water table, and wind erodibility.

5. Soil Quality

Successful cultivation of crops depend significantly on soil quality. In Dane County, soil quality is referenced under two indicators, prime farmland and land evaluation. Communities within the study area use one or the other indicator. Land evaluation (LE) factors in prime farmland to determine soil classes, where Class I is the most preferred, and Class VIII is the least preferred agricultural soil.

Soil characteristics associated with high production agriculture are often also ideal for development. Special consideration is warranted when pursuing development in these areas to preserve high quality lands for food cultivation. This data also reveals where agriculture operations and facilities could locate without covering high quality cultivation soils and compromising cropland productivity. Table 18 provides summary information in Maps 57 and 58.

Table 18: Prime Farmlands & Land Evaluation Classes 2005 (acres)

Study Area	Prime farmlands	LE Classes					
		Class I (Best)	Class II	Class III	Class IV	Class V	Classes VI-VIII
T. Westport	4,559	4,149	938	515	1,763	567	1,430
T. Springfield	9,827	8,037	2,003	1,818	5,006	3,015	3,762
T. Middleton	820	1,017	314	285	907	865	1,010
T. Dane	407	282	157	118	323	111	142
T. Vienna	1,498	1,191	346	258	811	265	198
Unserviced City/Vil.	341	371	145	78	323	114	375
Regional Comparison							
Study area total	17,451	15,047	3,903	3,071	9,132	4,937	6,917
Sub-regions	111,337	70,902	42,902	18,604	46,924	26,294	46,218
County	252,556	133,301	97,297	51,331	96,172	51,693	110,226

Source: Dane County Conservation

High quality soils are present and in agricultural use throughout the study area. Prime farmland and highly rated land evaluation classes are located west of the Village of Waunakee and north of the City of Middleton, primarily in the southeast portions of the Town of Springfield south of Highway 19, and in the southwest portion of the Town of Westport. Another concentrated area is located between Highway I and the north east border of the Village of Waunakee.

6. Agricultural Support Services

All operations require various inputs and support systems to function and remain economically viable. Agricultural operations need land, input resources, and services required to support agricultural functions and the livelihood of farmers. Determining where existing services are located and the services they provide can help to identify areas that are well supported for continued farming, and reveal where additional agricultural support services may be warranted. ***The farming sector needs more than just good land for its viability, farm operators and employees are needed to maintain productivity. A threat to agricultural support services is a threat to agricultural production and, subsequently, to preserving agricultural operations.***

Land Evaluation

Land Evaluation is a component of the Dane County Land Evaluation Site Assessment (LESA) system and rates the soil-based qualities of a site for agricultural use. The factors used to determine agricultural Land Evaluation were developed by the Natural Resources Conservation Service (NRCS) with cooperation from the Dane County Land Conservation Department. The ratings were based on information from Land Evaluation and Site Assessment: A Guidebook for Rating Agricultural Lands, Second Edition, published by the Soil and Water Conservation Society (1996). Three factors were used to determine a numeric LE rating:

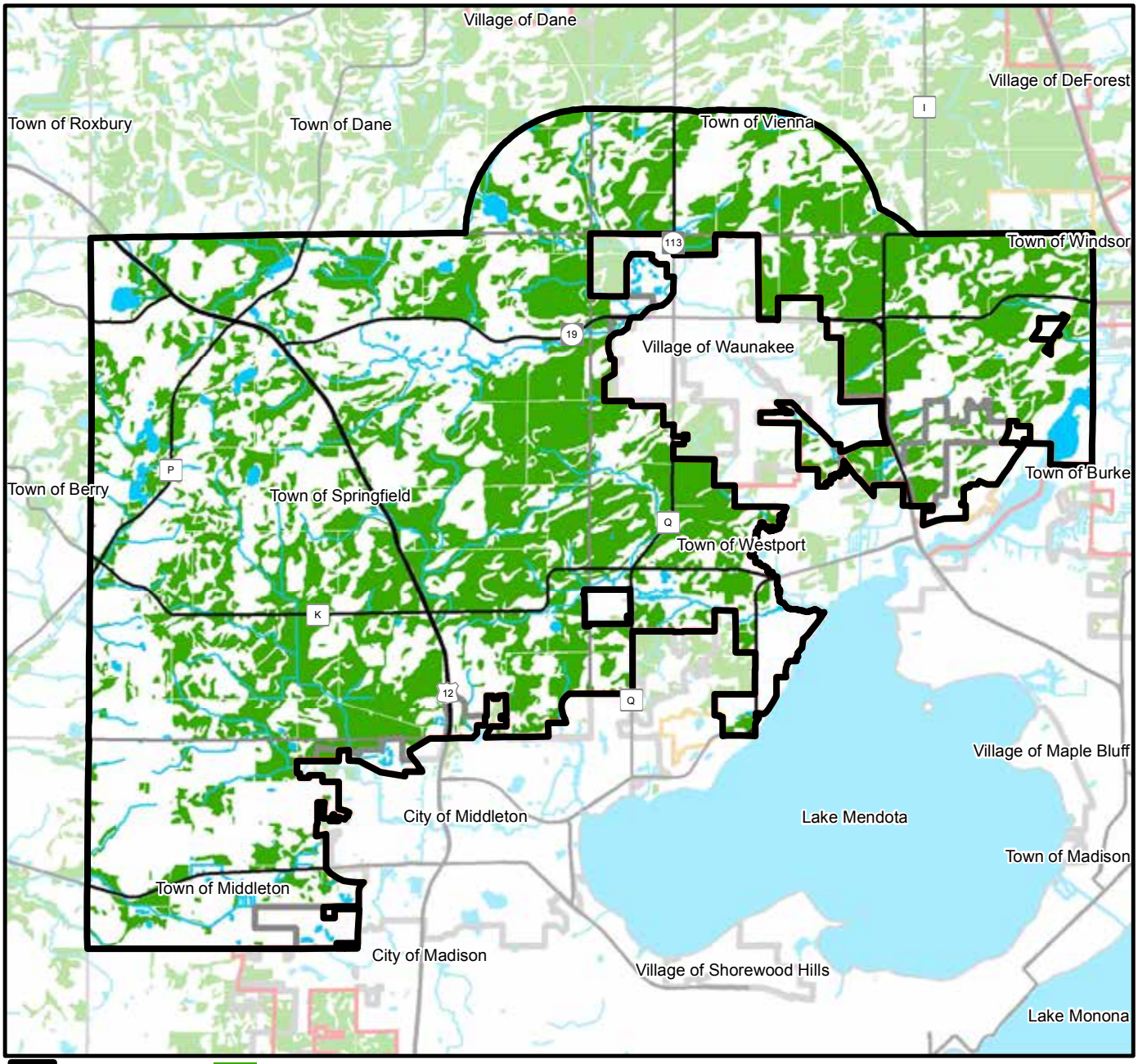
- **prime farmland (10%)**
- **soil productivity for corn (45%)**
- **land capability class (45%)**

As seen in Map 59, services are generally concentrated in urban areas. This highlights the important interdependence between rural and urban areas throughout the region. This data is not exhaustive of the agricultural services that are typically need. Other service, such as veterinary medicine, artificial insemination, and others are also important, and should be collected locally and incorporated into the existing data set.

Town of Westport

Map 57: Prime Farmlands - 2005

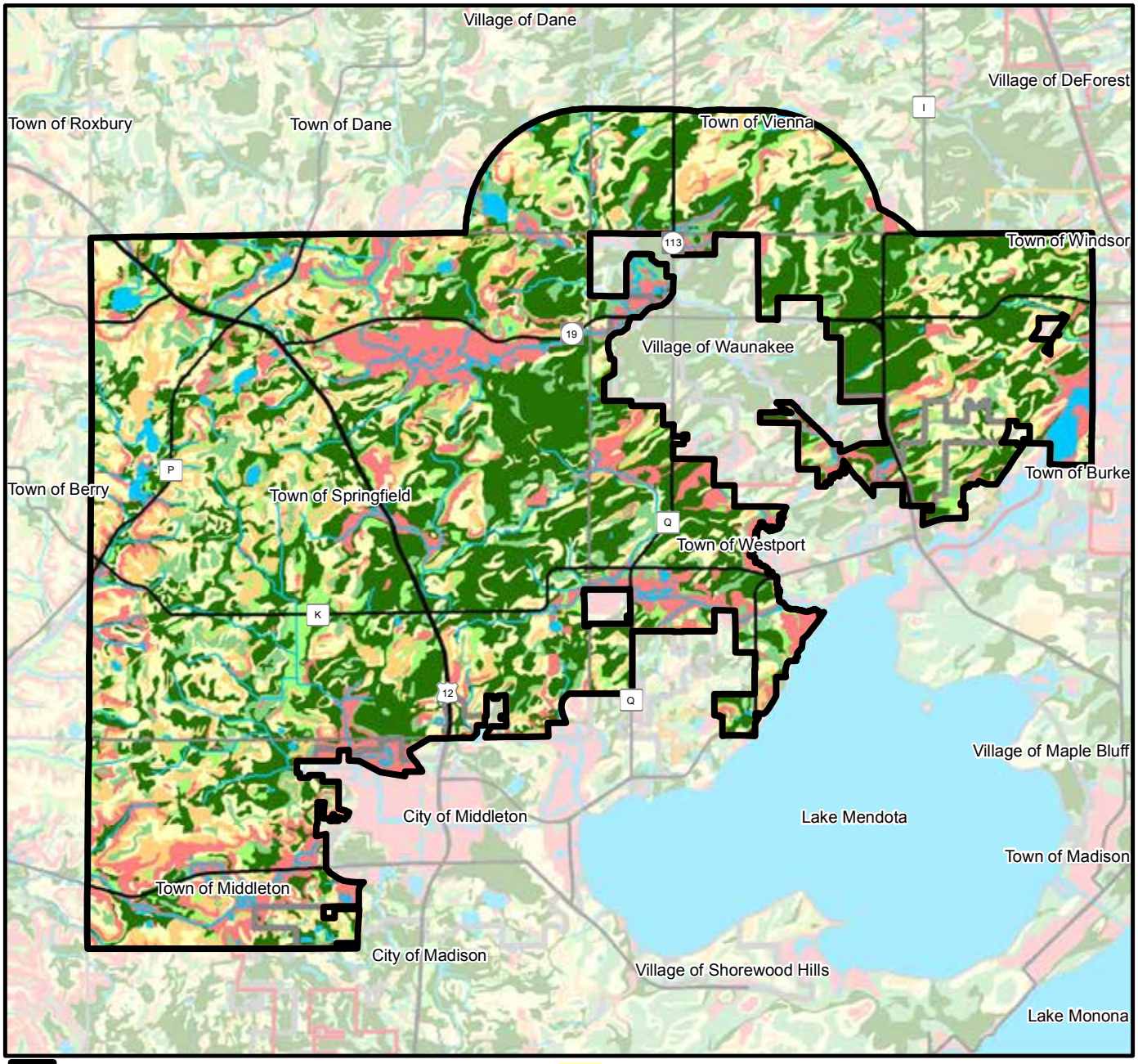
North Mendota Study Area, Dane County, WI



Prime farmland soils are located to the west of the Village of Waunakee and north of the City of Middleton primarily in the south eastern portions of the Town of Springfield and the south western portion of the Town of Westport. Another concentrated area is located between Highway I and the Village of Waunakee's north east border.

Map 58: Land Evaluation Classification - 2005

North Mendota Study Area, Dane County, WI



FUDA Study Area
Urban Service Area
Limited Service Area
Water

Land Evaluation Classification Categories

I Best Class for Agriculture
II
III
IV
V
VI - VIII

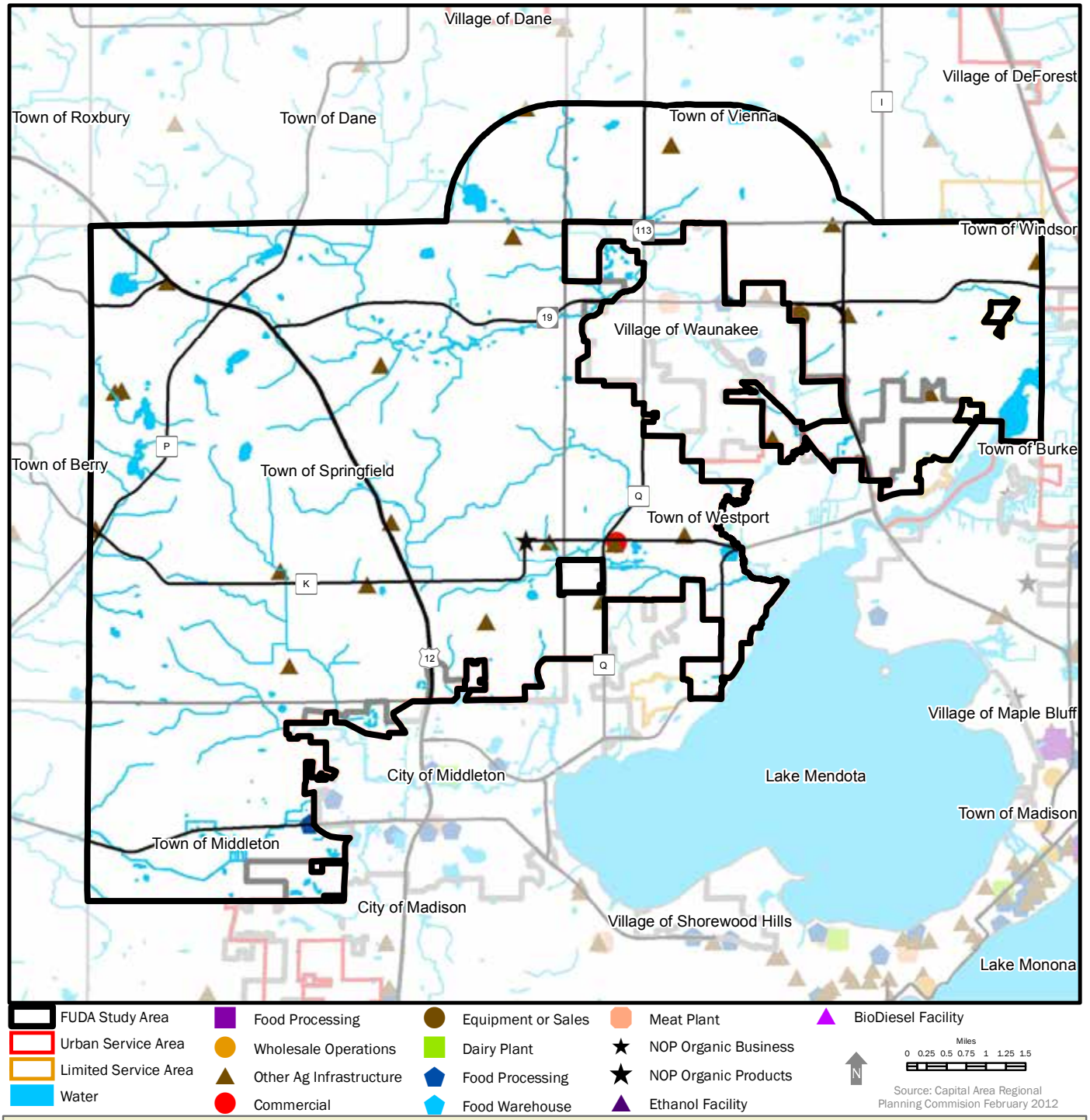
Miles
0 0.25 0.5 0.75 1 1.25 1.5

N

Source: Capital Area Regional Planning Commision February 2012

Map 59: Agriculutral Support Services

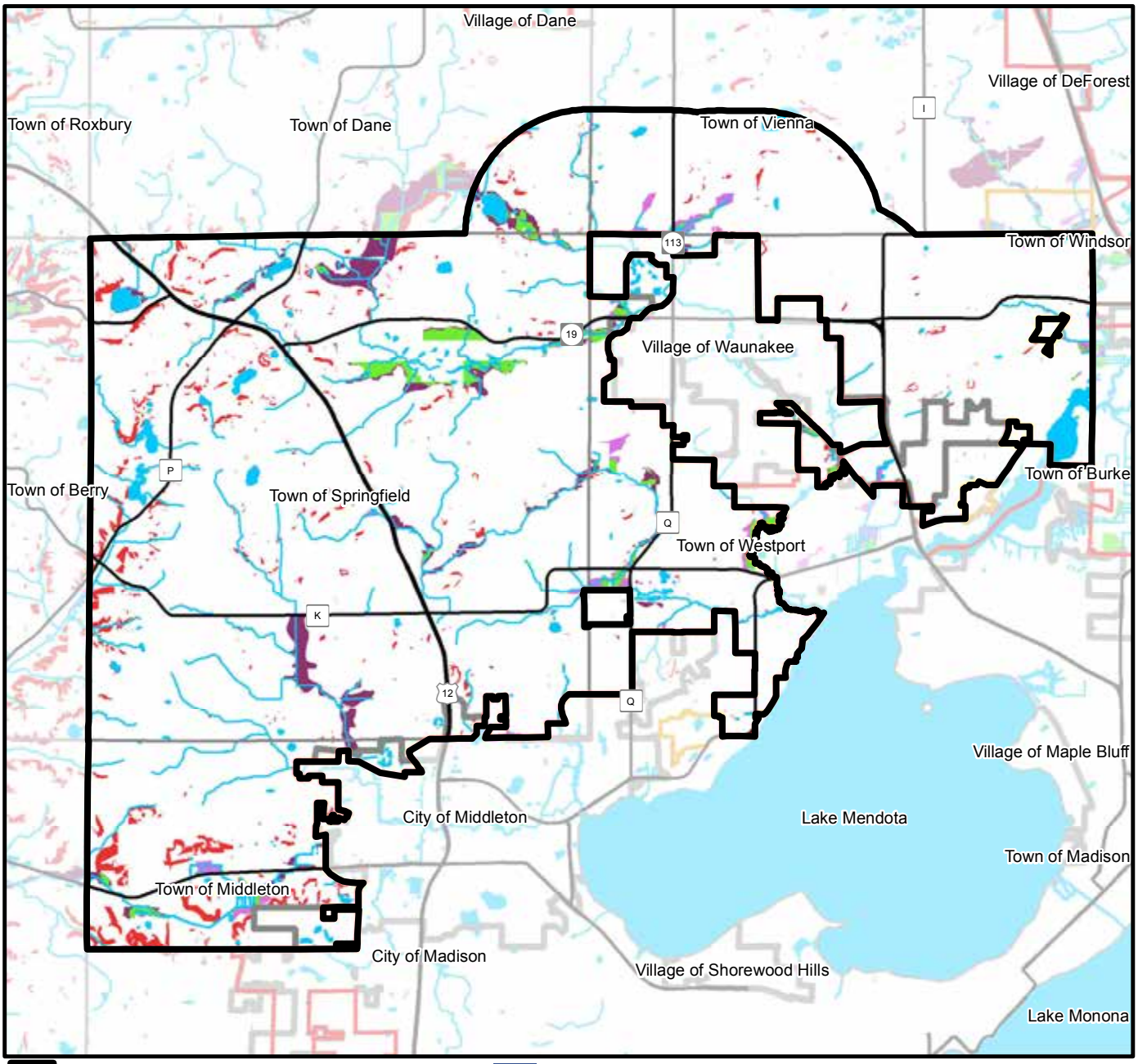
North Mendota Study Area, Dane County, WI



Data in this map comes from two different sources: Department of Agriculture, Trade and Consumer Protection and the Capital Area Regional Planning Commission's land use inventory for 2010. Where data is the same, data points from each set will overlap.

Map 60: Ecological Services and Functions - 2005

North Mendota Study Area, Dane County, WI



FUDA Study Area
Urban Service Area
Limited Service Area
Water

Ecological Resources on Ag Parcels
Floodplain
Floodplain & Wetlands
All three features
Steep Slopes
Wetlands

Miles
0 0.25 0.5 0.75 1 1.25 1.5

N

Source: Capital Area Regional Planning Commision February 2012

This map reveals where natural features providing ecological services and functions occur on agricultural parcels.

C. Ecological Services and Functions on Agricultural Parcels

Parcels hosting agricultural land and natural resource features can play a significant role in maintaining a certain level of environmental quality. Of the four physiographic areas in the region presented in the Natural Resources chapter, the study area covers two, the Moraine and the Yahara River Valley sub-regions. The Moraine sub-region, as referenced in the natural resources section, is the major drainage divide where the headwaters of many of the streams in the Wisconsin, Sugar and Rock River basins originate. The moraines are hilly with glacial till that deposited as the glaciers retreated. The Yahara River sub-region is where deep glacial deposits dammed up large valleys forming a chain of large lakes (Mendota, Monona, Waubesa, Kegonsa) and wetlands.

This analysis uses widely accepted criteria for establishing open space corridors, and includes former wetlands that have been drained for agriculture to determine where natural features occur on agricultural land parcels. Regional open space corridors are continuous systems of drainage ways and stream channels, floodplains, wetlands, steep slopes, and other natural resource features. These corridors maintain and protect the diverse pattern of exceptional natural features essential for preserving the quality of life in the region. ***Identifying Open Space Corridor features on agricultural parcels reveals lands with critical roles in improving and restoring the ecological services and functions the land can provide.*** These functions are described in detail in the Natural Resources Chapter (Chapter I) of this report.

Open Space Corridors

Open space corridors were developed and mapped in a general fashion and became a fundamental planning concept in the 1973 Dane County Land Use Plan. Open space corridors were further refined and mapped in the Dane County Water Quality Plan (1979) in urban and urbanizing areas as a component of sewer service area delineation. Open space corridors within a service area boundary were named environmental corridors. Open space corridors outside service area boundaries were called rural Resource Protections Areas and incorporated in town land use plans and the Farmland Preservation Plan as conservation and preservation areas.

It should be noted that many high-intensity agricultural practices can diminish the ecological services and functions these lands would otherwise provide. The *Dane County Water Quality Plan* includes stream, wetland, and groundwater inventories to identify these features. Taken over the past four decades, these inventories show degradation due to some historic and/or current agricultural practices, such as stream channel straightening, draining pothole wetlands, and dewatering isolated wetlands using drain tiles. Over-application of fertilizer and manure spreading, and changing land cover from forest and prairie to agriculture increase nutrient input into streams and lakes to unnaturally high levels. Historic land application of manure has left phosphorus concentrations ten times greater than crop uptake potential in some field soils. Excess phosphorus flows into surface water through overland flow or by shallow groundwater seepage. Increased nitrogen levels are also present in the shallow groundwater from the over application of nitrogen fertilizer on farm fields. This nitrogen subsequently seeps into springs and streams. Additionally, livestock wading in waterways can cause bank erosion and degradation of water quality and habitat health. Finally, low commodity pricing encourages production maximization and planting in areas prone to soil erosion.

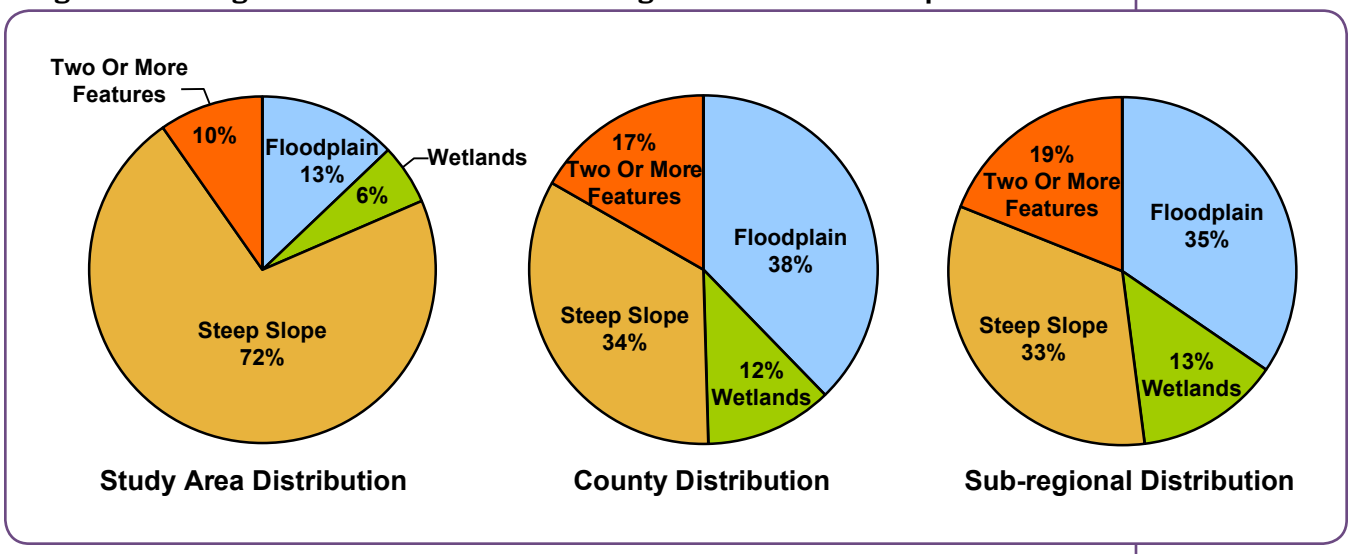
Farmers are dependent on environmental functions and resources for their livelihood, and implement conservation farming practices to reduce the adverse impacts of agricultural activities on natural resources. These practices include conservation tilling, improved nutrient management, and manure management. However, even with these practices, the historic impacts remain and inadvertent new impacts from current practices and products are discovered (such as atrazine contamination of the groundwater). Additionally, an emphasis on technology based remediation and mitigation typically increases the cost of production and encourage overproduction to disperse costs.

Table 19 Ecological Services and Functions on Agricultural Parcels (acres)

Study Area	Floodplain	Wetland	Steep Slope	Multiple	Total
T. Westport	76	112	401	169	758
T. Springfield	567	79	2,704	299	3,649
T. Middleton	64	46	739	56	904
T. Dane	53	2	154	36	244
T. Vienna	<1	93	224	14	331
Unserviced incorporated	5	9	5	<1	19
Regional Comparison					
Study area total	760	331	4,229	574	5,894
Sub-regions	7,204	2,790	6,900	3,949	20,843
County	34,002	10,648	30,406	15,082	90,137

As illustrated in Table 19 and Map 60, the study area hosts agricultural lands that include ecologically significant lands. Figure 33 illustrate the open space corridor acreage reflecting dominant ecological features in the study area compared to open space corridor acreage in the County and the Yahara River Valley and Moraine sub-regions. Steep slopes represent a large portion of open space corridors in the study area and features far less floodplain and wetland acreage compared to the larger region. The steeper terrains lend themselves well to small scale livestock operations, because cropping can be challenging, though some livestock operations can destabilize steep slopes and cause erosion.

Figure 33: Ecological Service and function Are Regional Distribution Comparison



To identify, enhance, and maintain ecological services and functions of agricultural land effectively, land management practices and the areal extent of these practices need to be considered together. The open space corridors[74] define a network of sensitive natural resource areas that can be augmented with additional conservation areas and practices. This approach can integrate various programs and policies to create a network of permanent agricultural and open space conservation areas which are protected from development. Supporting recommendations for low impact agricultural practices, conservation, and restoration of former wetlands and riparian zones for various locations in the study area can be provided based on ecosystem requirements and opportunities. In some upland areas, reforestation of agricultural lands could benefit hydrological systems and be a source for forest products. Other areas may be suited for integrated resource management, low-impact design, conservation design, agrarian design, and for accommodating multiple land uses and ecological services simultaneously.

This concept should be pursued with the idea that conservation areas would produce income for the land owner, and that restoration projects could be completed through pollutant trading opportunities. ***It should also be noted that some downstream mitigation goals for water quality improvement and flood control might be possibly achieved more cost-effectively through upstream conservation measures. Such opportunities should be evaluated as part of plan conceptualization in downstream areas.***

Groundwater recharge is one of the ecosystem functions of open and agricultural land that is often mentioned. The Natural Resources chapter (page 124, Chapter I) of this report outlines the regional groundwater susceptibilities of the region and the study area. The entire region provides groundwater recharge, and recharge alone does not provide a differentiating land characteristic for identifying preservation areas. ***High infiltration areas and zones of contribution have been identified on Map 31, page 133; Map 32, page 135; and Map 33, page 139 show important recharge areas that should be considered in planning and development decisions in the study area.***

74 Map 25, page 121 shows these areas in the FUDA study area.

D. Agricultural Considerations for FUDA Planning

Each community in the Study Area has an adopted Comprehensive Plan and/or is part of the *Dane County Farmland Preservation Plan* that presents background, goal, objective, policy, and program information.

Communities may want to incorporate the above information into their decision-making discussion. Some factors or characteristics maybe more important or useful than others to farmers and the local community. It is up to the local community to determine how to best use this information in decision-making processes that impact agricultural land within the larger context of regional preservation and development.

Adopted Agricultural Goals

City of Middleton

- Outside of the City's projected growth areas, limit the loss of agricultural land, and preserve its value for agricultural use in the future.

Village of Waunakee

- None

Town of Springfield

- "Preserve the rural, agricultural lifestyle within the Town of Springfield through careful planning, design, and placement of land uses; limited, clustered development in planned agricultural areas; community-sensitive regional transportation solutions; and intergovernmental cooperation to manage growth."
- "Preserve agricultural land resources and farming as a viable occupation in the Town of Springfield."
- "Promote an efficient, sustainable, and high-quality land use pattern consistent with the Town's rural/agricultural character."

Town of Westport

- Preserve and protect existing agricultural areas that help define the rural character of the town of Westport.
- Coordinate the planning and preservation of agricultural, natural, and recreational land uses.
- Preserve the rural character of the Town of Westport.
- Preserve agricultural lands and open space in all areas outside the Town center as defined on the proposed land use map.

Communities differ in how they present and use information provided in existing plans, and use different language and criteria to determine related data. For example, to determine agricultural land quality the Town of Springfield utilizes the Land Evaluation system, and the Town of Vienna uses "productive and tillable land." Creating a common language for agricultural decision-making may prove useful when communities come together to jointly plan for growth and preservation.

An effective land management tool for agricultural land preservation is a boundary agreement between two jurisdictions. Boundary Agreements are discussed in local comprehensive plans. Middleton/Springfield and Waunakee/Westport established boundary agreement, while Vienna could establish boundary agreements with the Villages of Waunakee and Dane. These boundary agreements help to ease political tension, create a more simple, predictable, and stable land management framework, and help to direct growth to more appropriate areas.

In addition, town farmland preservation maps, in accordance with the State Farmland Preservation Act, designate lands as either "preservation," "rural development," or "transition areas." These designations should be considered seriously when developing boundary agreements, and in pursuing rural development.

1. Agricultural Parcels and Farm Base Tracts

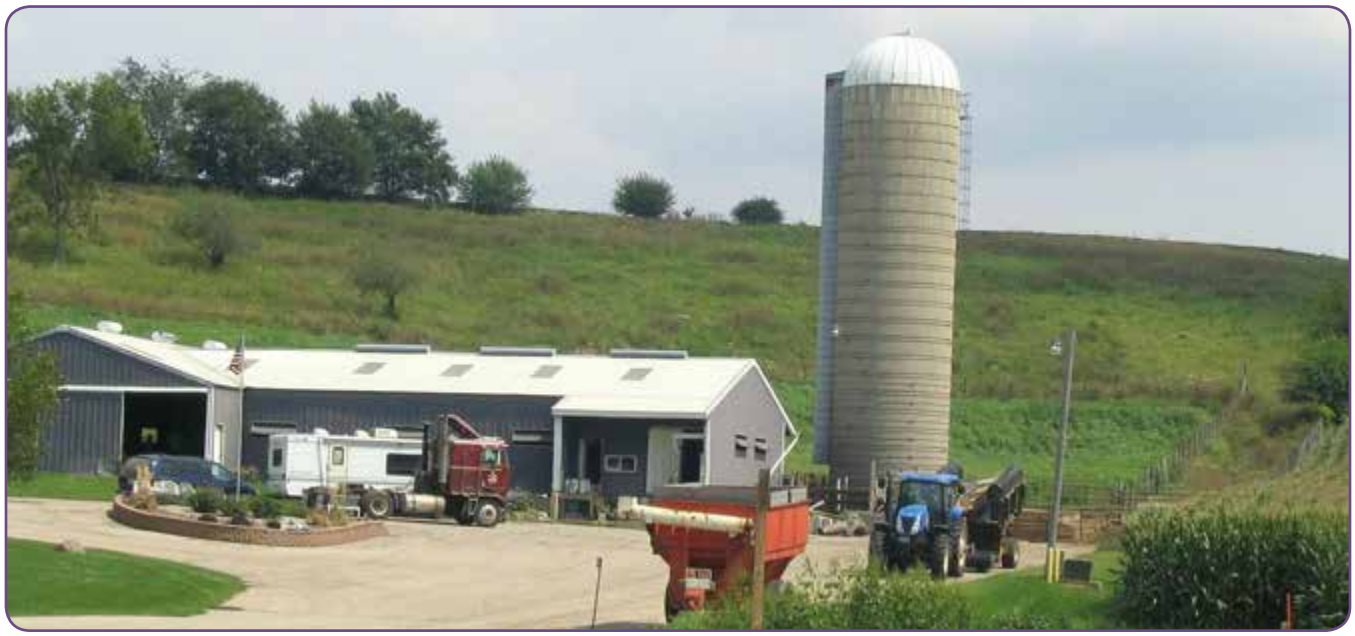
- Maintain diversity in size and operation type to better protect the regional agricultural industry from severe market changes in any one sector and will better support and encourage regional food systems.

2. Contiguity and Concentration

- Maintain contiguous blocks of agricultural land to maintain the land mass that makes farming more viable and provides better protection for agricultural use. Direct urban growth away from contiguous blocks of agricultural land.
- Agricultural concentrations between major roads shows where agricultural land uses may be compromised by the prominence of other land uses. Agricultural lands in low concentration areas that are deemed valuable as agriculture preservation may be a priority for preservation efforts.

3. Support Services

- Maintain sufficient concentrations of agricultural lands to maintain the viability of support service businesses.
- Ensure adequate infrastructure to ensure support services remain accessible to the farming community.



Town of Springfield

4. Soil Quality

- Special consideration is warranted when pursuing development in these areas to preserve these lands for food cultivation dependent on soils.
- Because of the variable terrain in the area and prominence of livestock based operations, soil quality is best considered at the site specific level. Large brush applications of prime farmlands as a priority criteria for preservation might significantly limit the potential of such a program and may work against the predominant and economically productive livestock operations in the region, especially farther to the west where prime soils are not as plentiful.

5. Ecological Services and Functions

- To identify, enhance, and maintain ecological services and functions of agricultural land effectively, land management practices and the areal extent of these practices need to be considered together. The open space corridors[75] define a network of sensitive natural resource areas that can be augmented with additional conservation areas and practices. This approach can integrate various programs and policies to create a network of permanent agricultural and open space conservation areas which are protected from development. Supporting recommendations for low impact agricultural practices, conservation, and restoration for various locations in the study area can be provided based on ecosystem requirements and opportunities. Other areas may be suited for integrated resource management and for accommodating multiple land uses and ecological services simultaneously.

75 Map 25, page 121 shows these areas in the FUDA study area.

- Former wetlands, since drained with underground drainage tiles and ditching, are also presented on the map to illustrate where wetland restoration could benefit ecological systems and water quality and quantity in downstream areas.
- In some upland areas, reforestation of agricultural lands could benefit ecological systems and water quality and quantity in downstream areas.
- Some conservation practices would greatly benefit from changes in state law and taxing policy. For example, wetlands are typically assessed at higher land values compared to farmland. Consequently, farmers not only lose cropland and income by restoring former wetlands, but also pay higher property taxes under current tax policy.
- Ecosystem service areas should be designed with the idea that the land owner would continue to benefit financially from the land. This can be either through sale of products from these conservation areas or through payments for the ecosystem service being provided.

The data in this section is provided to assist in decision-making processes to identify the agricultural lands that the community would preserve, maintain, or develop in the Future Urban Development Area Planning process. The data and subsequent decisions can be updated or incorporated into comprehensive and farmland preservation plans as the communities update them in the coming years. The variables with the most potential for making and measuring the impact of growth on farmland in the study area are contiguous blocks of agriculture and agricultural concentration. Other variable such as ecological services and functions, support services, land and improvement assessment values, and soil quality are best considered at the site level.

North Mendota

Future Urban Development Area Planning

Environmental Conditions Report

Chapter III. Land Use Demand & Supply

Introduction

The Land Demand and Supply chapter of the ECR provides information about the estimated future growth within the study area. This analysis compares projected future community growth against the supply of land in the study area to determine future land area needs.

This chapter includes three major components:

- ***Development Trends:*** This is an evaluation of observed trends in land development, including land use and densities.
- ***Land Demand:*** This component establishes baseline land demand estimates for urban and rural areas for the 25 year planning horizon, based on historic trends and the DOA approved CARPC methodology for growth projections.
- ***Land Supply:*** This component identifies land available to accommodate anticipated development through infill development and redevelopment, and through "greenfield" development in the FUDA study area (within and outside the urban service area).

urban: served by public sewer and water and other urban services, allowing higher urban densities.

rural: served by on-site waste treatment systems and private wells, generally requiring lower density development than urban areas.

The first two ECR chapters, provide inventories and assessments of natural and agricultural assets for the purpose of protecting important resources as development continues. This provides bases for locational decisions on how the communities may wish to accommodate future land demand.

It is important to note that 25-year population projections will be updated every five years with FUDA updates. Also, because FUDA planning is a screening for future USA amendments, the land demand calculations need to follow NR 121 guidelines and methodology for growth projection.

A. Development Trends

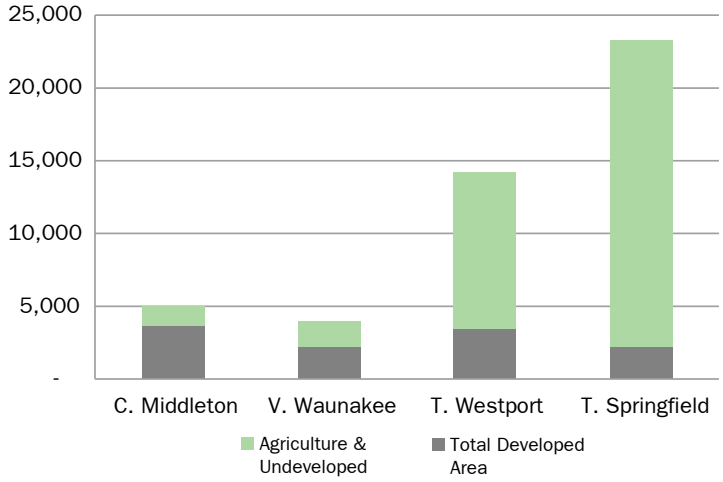
This section examines land use, population and housing data from 1970 (where available) to 2005[76] to identify development trends in the four communities participating in the North Mendota FUDA process. The past trends are used to establish base line projections for future land demand.

1. Total Development (Urban and Rural)

Within the study area, the Towns of Springfield and Westport contain the most land while the City of Middleton and Village of Waunakee contain the most development, both urban and rural (see Figure 34). The Town of Westport has more developed acres than Waunakee, but fewer acres than the City of Middleton. From 1980 to 2005, the total developed land in the study area nearly doubled from 6,252 to 11,886 acres (see Figure 35). The vast majority of undeveloped land is in agriculture.

The Village of Waunakee experienced the largest increase in development during this period (see Figure 36), growing from 726 to 2,251 acres. Together, Middleton and Waunakee accounted for 62% of the development from 1980 to 2005.

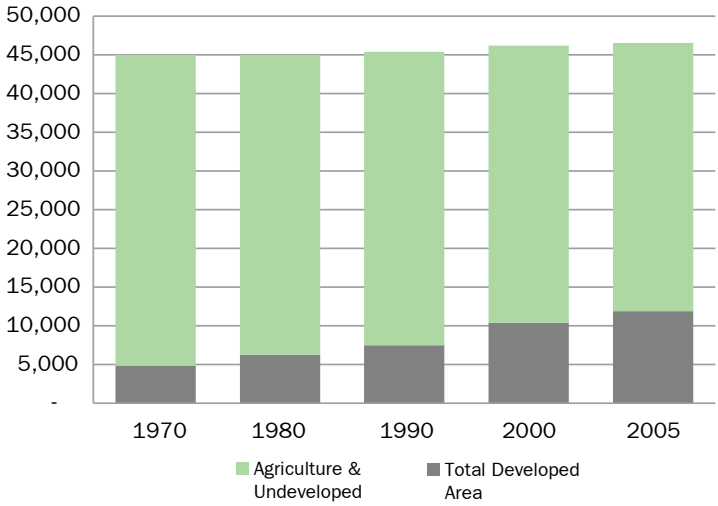
Figure 34: Developed and Undeveloped Land by FUDA Community - 2005



Source: U.S. Bureau of the Census and CARPC

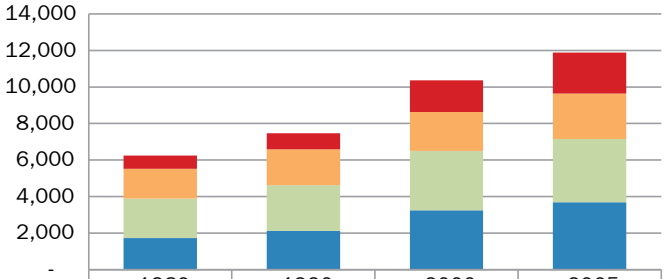
76 2005 is the most recent land use inventory data available at the time of this writing. 2010 land use inventory data is scheduled to be widely available in the fall of 2012. Land use data comes from the regional Land Use Inventory conducted by CARPC on a decennial (and sometimes more frequently) basis, where aerial photographs and field observations are used to classify land uses, which are converted to Geographical Information System (GIS) digital layers.

Figure 35: Developed and Undeveloped Land in Study Area - 2005



Source: U.S. Bureau of the Census and CARPC

Figure 36: Developed Land by Community by Year



	1980	1990	2000	2005
V. Waunakee	726	877	1,731	2,251
T. Springfield	1,634	1,955	2,129	2,477
T. Westport	2,165	2,505	3,260	3,473
C. Middlton	1,728	2,122	3,243	3,685

Source: U.S. Bureau of the Census and CARPC

2. Urban Service Area Land Use Trends

In Dane County, urban development occurs in Urban Service Areas (USAs) and rural development occurs outside of USAs. The FUDA area includes the City of Middleton and Town of Westport portions of the Central Urban Service Area (CUSA) and the Waunakee USA.

a. Urban Development Characterization

In Dane County, residential land uses occupy the largest share of urban land, as shown in Table 20. Residential land use represents between 37% and 43% of all land use across the county. Residential land uses includes single-family, multi-family (including duplexes), farm dwellings, group quarters and mobile homes (see text box). Single-family is the predominant housing form, comprising 76% of city and 86% of village residential land.

Categories of Developed Land Use

RESIDENTIAL
Single Family
Two Family
Multi Family
Farm Dwelling
Group Quarters
Mobile Home

INDUSTRIAL
Manufacturing
Wholesale
Extractive

TRANSPORTATION
Right of Way
Railroad

COMMUNICATION/UTILITIES
Generating Processing
Transmission
Waste Processing

COMMERCIAL RETAIL
General Repair & Maintenance
Transportation Related

COMMERCIAL SERVICES
Lodging

INSTITUTIONAL/GOVERMENTAL
Education
Administrative
Cemetery

Transportation is the second largest category of developed land use, comprising about a fourth of developed land uses. Road right-of-way is the largest portion of transportation land use (note that road right of way does not mean a road is present and the land may be in another use actively, such as agriculture).

County-wide, private employment is the fastest growing land use from 1990 to 2005. This category includes industrial, commercial, and communication and utilities (except public waste processing). The large growth in business parks accounted for a significant portion in this increase dispersing employment throughout the county. Outdoor recreation also grew significantly during this period, especially in small cities and villages.

Villages experienced the largest growth in all land use categories. Small cities also grew significantly. The City of Madison grew more slowly except in the private employment category.

Table 20: Developed Acres in Dane County - 2005 and Percent Change - 1990-2005

	DANE COUNTY			MADISON			SMALL CITIES			VILLAGES		
	2005		% change 1990-2005	2005		% change 1990-2005	2005		% change 1990-2005	2005		% change 1990-2005
	acres	%		acres	%		acres	%		acres	%	
Residential	56,552	40%	18%	13,502	37%	19%	8,663	43%	42%	6,902	44%	68%
Transportation	46,075	33%	23%	9,972	27%	21%	5,496	27%	65%	3,885	25%	75%
Private Employment	15,607	11%	51%	5,633	15%	56%	3,498	17%	38%	1,983	13%	224%
Outdoor Recreation	15,835	11%	43%	4,899	13%	32%	1,373	7%	121%	1,632	11%	159%
"Governmental Institutional"	6,254	4%	8%	2,429	7%	1%	1,352	7%	40%	1,113	7%	56%
Total Developed	140,323	100%		36,435	100%		20,382	100%		15,515	100%	

Source: Capital Area Regional Planning Commission

b. Urban Land Use in the North Mendota FUDA Area

The City of Middleton comprises the largest portion of the urban development in the FUDA study area (Table 21). Between 1990 and 2005, residential land uses in the City of Middleton grew by 32% compared to 42% residential growth in small cities in the region. However, all other land use categories in the City of Middleton saw a higher growth compared to other small cities. Because of significant expansion west of Highway 12, private employment grew approximately three times faster in the City of Middleton compared to other small cities in the region. Compared to other small cities in the region, the City of Middleton stands out with a larger portion of land use in private employment (21%).

The Village of Waunakee experienced greater growth in every land use category compared to other villages in the region. Private employment increased one and a half times during the 15-year period in the Village of Waunakee, but this growth was not the highest in the region. The Town of Westport also experienced significant urban land development.[77]

The distribution of urban land uses in the City of Middleton and the Village of Waunakee is similar to their regional counterparts. Residential comprises 36% and 41%, respectively, and transportation is 25% of land use for both communities. Both Middleton and Waunakee have larger portions of land in outdoor recreation and slightly smaller portions in governmental/ institutional land uses compared to other small cities and villages in the region.

Maps 61 and 62 show the progression of land use change in the FUDA Communities from 1990 to 2005.

Table 21: North Mendota FUDA Developed Acres 2005 and Percent Change, 1990-2005

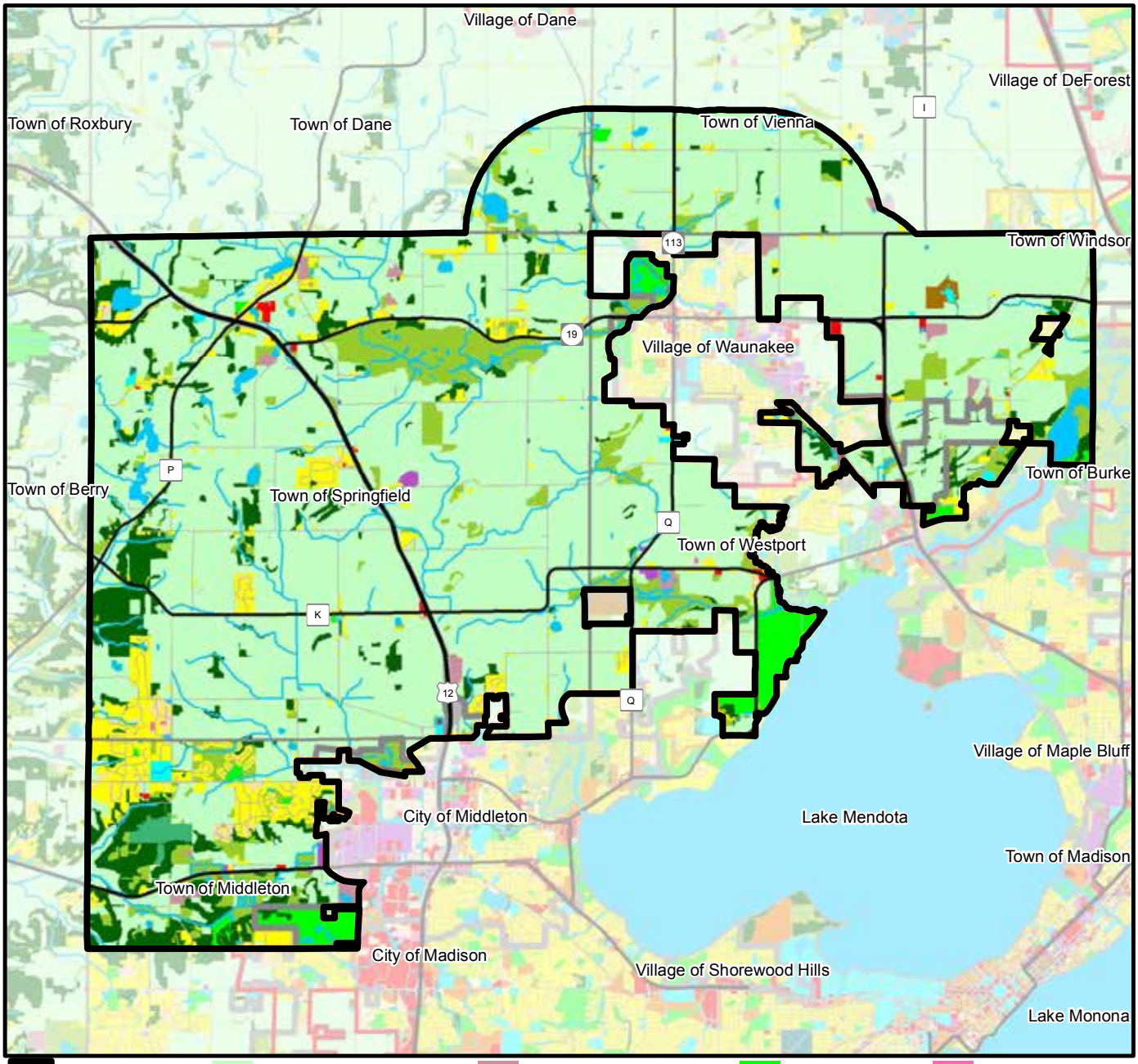
	URBAN SERVICE AREAS								
	Central USA						Waunakee USA		
	C. Middleton			T. Westport			V. Waunakee		
	2005		% change 1990-2005	2005		% change 1990-2005	2005		% change 1990-2005
	acres	%		acres	%		acres	%	
Residential	1,336	36%	32%	629	41%	74%	921	41%	116%
Transportation	925	25%	99%	209	14%	68%	567	25%	157%
Private Employment	773	21%	112%	118	8%	70%	281	12%	148%
Outdoor Recreation	420	11%	223%	530	35%	177%	363	16%	740%
"Governmental Institutional"	230	6%	57%	36	2%	289%	120	5%	64%
Total	3,684	100%		1,522	100%		2,252	100%	

Source: Capital Area Regional Planning Commission

77 There is no total for all urban portion of towns in the county with which to make comparisons.

Map 61: Land Use 2005

North Mendota Study Area, Dane County, WI



FUDA Study Area	Agriculture	Extractive	Outdoor Recreation	Under Construction
Urban Service Area	Cemetery	Industrial	Right of Way	Vacant
Limited Service Area	Commercial Forest	Institutional or Governmental	Single Family	Water
Water	Commercial Sales or Services	Multi-Family	Transportation	Woodland
	Communications or Utilities	Open Land	Two Family	

Parcel based land use inventory for Dane County for the year 2005.

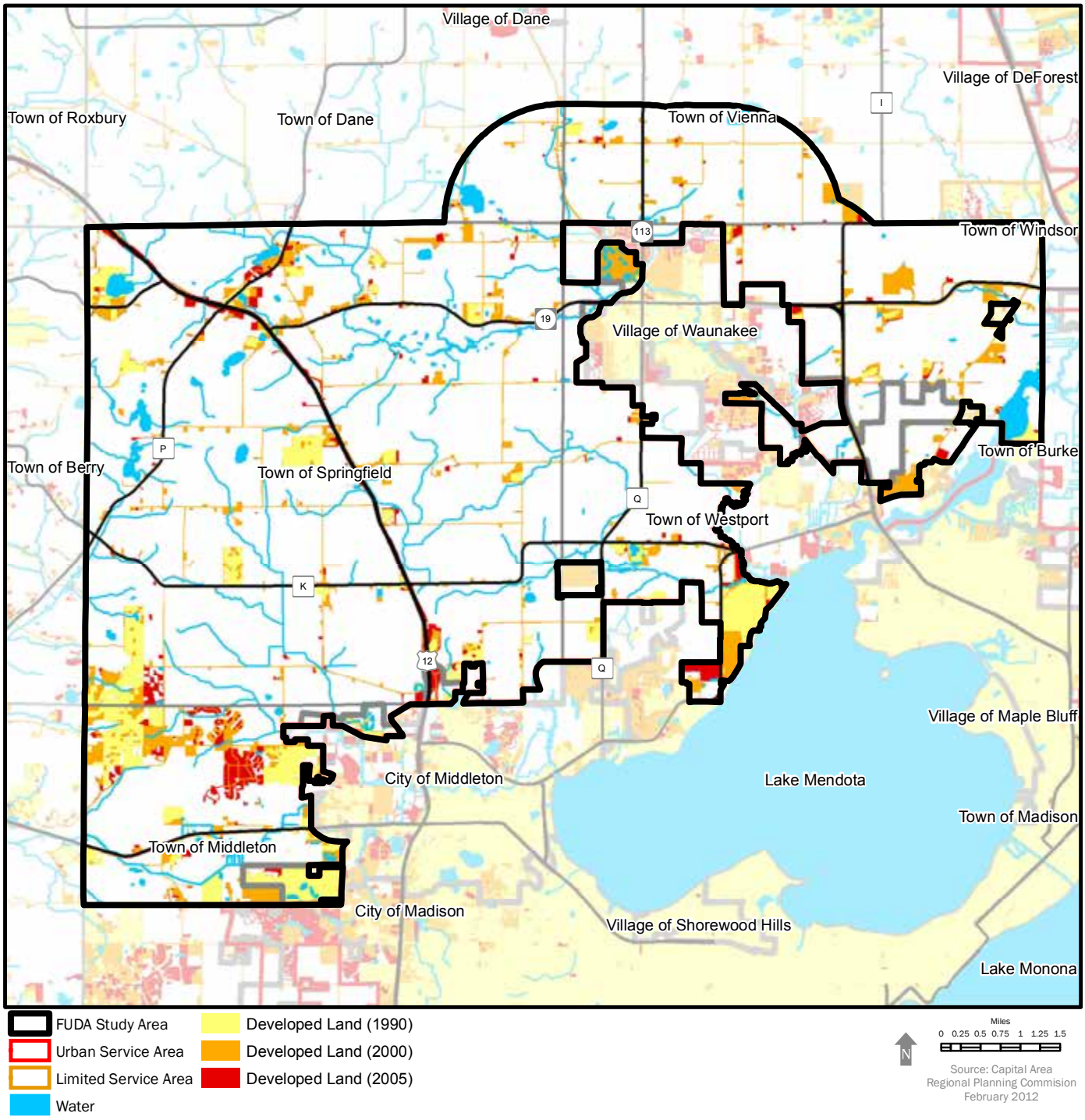
N

Miles
0 0.25 0.5 0.75 1 1.25 1.5

Source: Capital Area Regional Planning Commision February 2012

Map 62: Land Use Changes: 1990-2005

North Mendota Study Area, Dane County, WI



Parcel based land use inventories for Dane County for the years 1990, 2000 and 2005.

c. Land Development Densities

Table 22 shows residential density trends in the FUDA communities and comparative data from 1990 to 2005. The City of Middleton and Village of Waunakee had relatively stable densities, with losses in single family offset with gains in multi-family. This patterns is opposite of what was seen in other small cities and villages, which saw gains in single family and losses in multifamily density. The urban area within the Town of Westport saw a decrease in single-family density coupled with a significant increase in multi-family density, leading to a 39% increase in residential land use overall. The Town of Springfield and the rural area in the Town of Westport both showed increasing densities, of 14% and 19% respectively. This is also contrary to the overall pattern of other towns in the region. However, it should be noted that the decrease in overall town density may be attributable to a change in data methodology that occurred starting in year 2000.[78]

Table 22: Residential Densities in FUDA Study Area and Comparative Data: 1990-2005

	Single Family	Multi-Family	Total Housing		Single Family	Multi-Family	Total Housing
C. Middleton				DANE COUNTY			
2005	4.15	10.88	5.99	2005	2.37	13.69	3.62
2000	3.90	10.90	5.70	2000	2.45	13.71	3.67
1990	4.37	9.65	5.95	1990	2.61	13.06	3.89
"% change: 1990-2005"	-5%	13%	1%	“% change: 1990-2005”	-9%	5%	-7%
V. Waunakee				MADISON			
2005	3.71	9.84	4.49	2005	4.84	17.21	7.80
2000	3.69	9.29	4.48	2000	4.89	16.95	7.70
1990	4.13	7.58	4.73	1990	4.43	16.31	7.07
"% change: 1990-2005"	-10%	30%	-5%	“% change: 1990-2005”	9%	6%	10%
T. Westport (Urban)				SMALL CITIES			
2005	1.24	6.84	1.97	2005	3.36	10.81	4.81
2000	1.26	6.33	1.85	2000	3.29	10.92	4.67
1990	1.48	2.22	1.42	1990	3.20	11.48	4.65
"% change: 1990-2005"	-17%	208%	39%	"% change: 1990-2005"	5%	-6%	4%
T. Westport (Rural)				VILLAGES			
2005	0.67	4.10	0.76	2005	3.31	8.12	3.94
2000	0.56	4.10	0.64	2000	3.31	7.84	3.88
1990	-	-	-	1990	3.13	9.27	3.76
"% change: 2000-2005"	20%	0%	19%	"% change: 1990-2005"	6%	-12%	5%
T. Springfield				TOWNS			
2005	0.90	6.07	0.93	2005	0.98	10.88	1.15
2000	0.92	1.80	0.94	2000	1.06	11.58	1.24
1990	0.80	1.34	0.82	1990	1.28	5.85	1.47
"% change: 1990-2005"	14%	354%	14%	"% change: 1990-2005"	-23%	86%	-22%

Source: Capital Area Regional Planning Commission and U.S. Census.

78 In 2000, new data methodology was used when creating land use maps. The largest differences are seen in rural residential (single family) and transportation. In 1990 these were often integrated into other land use categories. For example, in 1990 a single family home on a large lot would often be classified entirely as open area, though the housing unit would be counted; in 2000, the area surrounding the house is classified as residential and the remainder of the parcel as open area. This results in inflated values for changes between these years.

Table 23 shows densities for the same jurisdictions and time period, measured by acres per thousand persons.[79] This measure of acres per 1,000 people shows decreasing densities overall, including in residential land, in all areas but the towns of Westport and Springfield and towns overall. This trend generally contrasts with increasing densities when measuring units per acre.

Table 23: FUDA Area Densities and Comparative Data: Acres/ 1,000 Persons (1990-2005)

	Residential	Commercial	Industrial	Street ROW	Trans, Comm, Util	Gov, Inst	Recreational	Total Developed
C. Middleton								
2005	79.6	27.6	17.8	47.2	9.4	6.9	25.0	214
2000	81.4	19.1	19.1	44.0	9.2	8.5	24.1	205
1990	73.7	13.9	11.7	31.2	6.8	7.3	9.4	154
"% change: 90-05	8%	99%	52%	51%	39%	-5%	166%	39%
V. Waunakee								
2005	87.7	11.6	14.1	50.3	4.3	11.0	35.0	214
2000	81.1	8.4	20.8	47.2	8.3	12.1	33.7	212
1990	72.4	11.9	6.5	31.7	6.4	12.3	7.3	149
“% change: 90-05	21%	-3%	116%	59%	-33%	-11%	378%	44%
T. Westport								
2005	300.4	26.0	46.7	181.6	26.6	45.9	291.9	919
2000	302.0	18.6	70.5	203.1	33.7	27.4	253.7	909
1990	381.7	18.7	72.1	200.1	27.2	24.8	182.3	907
“% change: 90-05	-21%	39%	-35%	-9%	-2%	85%	60%	1%
T. Springfield								
2005	408.6	15.2	38.7	388.4	0.6	16.5	4.6	873
2000	391.5	12.6	44.4	273.6	9.3	9.4	30.0	771
1990	413.8	5.7	33.1	234.0	6.7	9.0	35.4	738
“% change: 90-05	-1%	168%	17%	66%	-90%	83%	-87%	18%
DANE COUNTY								
2005	123.4	16.1	16.8	91.7	11.6	12.1	34.6	306
2000	115.3	15.6	17.3	93.3	13.7	11.9	30.8	298
1990	130.8	12.9	14.1	91.6	14.4	12.8	30.2	307
“% change: 90-05	-6%	25%	19%	0%	-20%	-6%	14%	0%
MADISON								
2005	60.9	16.8	8.0	36.9	9.7	9.9	22.1	164
2000	58.5	16.7	7.1	35.1	11.6	9.6	19.4	158
1990	59.3	12.4	5.7	32.1	13.6	11.3	19.5	154
“% change: 90-05	3%	35%	40%	15%	-28%	-12%	13%	7%
SMALL CITIES								
2005	92.6	18.7	17.6	54.1	7.9	12.4	14.7	218
2000	90.9	16.6	16.8	53.0	7.9	13.5	13.8	213
1990	90.5	13.0	22.9	44.6	8.3	12.1	9.2	201
“% change: 90-05	2%	44%	-23%	21%	-5%	3%	59%	9%
VILLAGES								
2005	104.7	11.7	17.2	53.9	7.1	16.0	24.8	235
2000	98.9	10.3	15.7	44.5	8.9	15.0	21.2	215
1990	98.5	10.9	13.5	46.4	8.4	16.4	15.1	209
“% change: 90-05	6%	8%	27%	16%	-16%	-2%	64%	12%
TOWNS								
2005	356.4	14.9	40.6	326.8	25.4	14.6	102.8	882
2000	314.0	15.7	47.2	339.3	29.8	14.1	89.3	849
1990	395.0	15.3	29.6	336.8	26.7	15.7	91.5	911
“% change: 90-05	-10%	-2%	37%	-3%	-5%	-7%	12%	-3%

Source: Capital Area Regional Planning Commission and U.S. Census.

79 Increases in residential acres per thousands of persons shows decreases in density (more land developed per person), in contrast with dwelling units per acre, which shows increases in density as the number get larger.

The difference between these two measures of residential density can be explained by decreasing household size (persons per household). Although more homes are being built on each acre, the number of people on each acre is declining.

The FUDA communities generally followed values and trends established by small cities, villages and towns, generally seeing overall increases in land per person for commercial, industrial, street right-of-way, and recreational categories. Small cities as a whole had a decline in industrial acreage, however the City of Middleton increased its industrial area during this time period to a value similar to the regional small city average (17.8 acres per 1,000 persons). Westport also had decrease in industrial land use, though consistent with the value seen in county-wide averages for towns. The Village of Waunakee did see a decrease in commercial acreage per 1,000 residents to 11.6 acres per thousand, close to the county-wide village average.

Increasing land per person is consistent with an urbanizing region, where most growth is occurring on the edges of cities and villages, at lower density patterns than historical development, particularly for commercial land uses which often reflect single story buildings with large parking areas. Policies and market demand led to increases in houses per acre, but these increases were not sufficient to offset the declining household size.

B. Estimates of Land Demand

The purpose of FUDA planning is to protect vital natural resources, promote efficient development, and preserve farmland through cooperative planning for long-term growth. In order to achieve this purpose, estimates of the amount of long-term growth are required. Local communities need an estimate of how much growth is expected so they can plan accordingly.

Estimating growth is an imprecise exercise. The only solid data one can apply to the exercise is what has happened in the past. We know how much growth occurred in the recent past and it is reasonable to expect that growth will continue in the future for similar reasons: a relatively healthy metropolitan economy and high quality of life will continue to attract people. We can make educated guesses about how future decades will be different from the recent past. However, even the best economists cannot predict what our national growth will be a year from now with any significant degree of accuracy. Likewise, we cannot predict how changes over 25-years will be different from past changes with a significant degree of accuracy. Given these limitations, FUDA planning extrapolates current trends as a “baseline” from which to guide decision-making about what kind of future a community desires; and then to revisit and refine as necessary the projection on a regular basis as new information becomes available. This approach recognizes that local decision-making and policies largely determine the pace of community growth.

The Wisconsin Department of Administration (DOA) provides 25-year population and housing projections for metro regions based on past trends in population growth and demographic factors including age distribution and household composition and formation. Metro projections are allocated among local jurisdictions based on past growth levels. DOA projections

are extrapolations of recent trends, which are updated every five years to take into account recent growth.

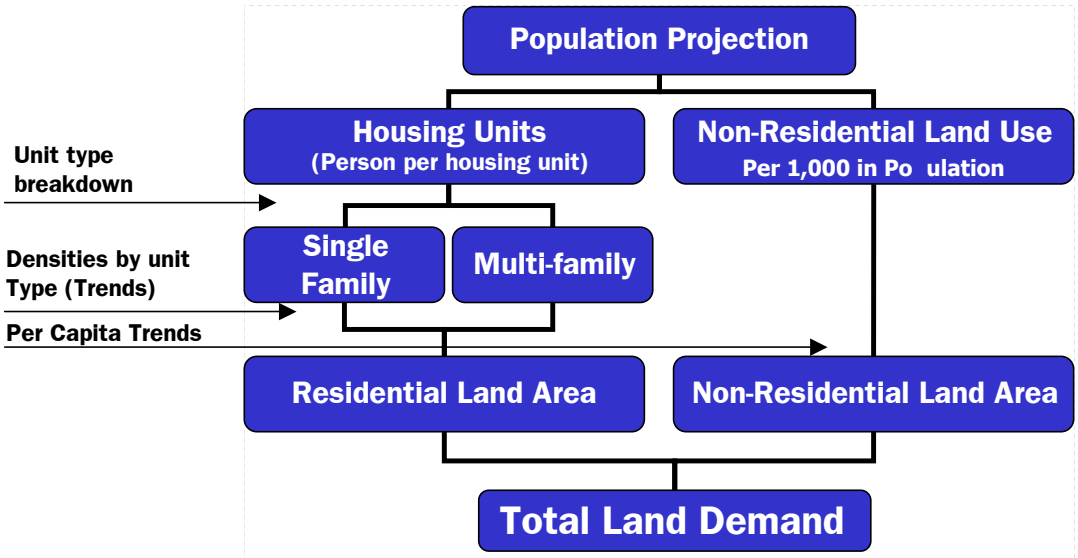
FUDA planning uses DOA estimates of future population growth as the basis for future growth projections because CARPC is required, under Wisconsin Administrative Code (NR 121), to use DOA estimates. Starting with DOA estimates of year 2035 population, CARPC applies a DOA-approved methodology to estimate future housing units and the land area that these units will occupy. Estimates are adjusted based on input from local staff as to variables including the average number of people in each housing unit, and the average land area taken up by each housing unit (housing density). ***FUDA planning is intended to update estimates of growth every five years with new data as it becomes available. Therefore, the projection assumptions for each community are really only operative for the immediate upcoming 5-years.***

1. Methodology

Figure 37 shows the basic components of the methodology for projecting urban growth, or land demand. By CARPC's state-approved methodology, population projections from the Wisconsin Department of Administration provide the basis for projecting demand under the baseline projection included in this report. Population is divided by an estimate of persons per housing unit to generate numbers of housing units. Units are divided into single-family and multi-family (all types). Single-family and multi-family units are converted into land area (acres) with a units per residential acre estimation. Demand for non-residential land is estimated with per capita estimates (acres per 1,000 persons) based on trends observed in each municipality over the past 30 years.

Density values used to project land area demand for future single- and multi-family residential are based on current trends, existing plans and discussions with staff project team or steering committee members.

Figure 37: Land Demand Methodology Flow Chart



Tables 24 through 26 show the projected urban land demand for the City of Middleton, Village of Waunakee and the USA portion of the Town of Westport. Land uses in commercial, industrial, utilities, transportation, institutional and recreational have been grouped under Non-residential land.

Table 24: City of Middleton Urban Land Demand Projection 2010-2035

Data Item	Est. 2005	Change 1970-2005	Projected 2035	Est. Change 2010-2035
1) Total Population	16,760	8,474	23,359	5,499
Population Per Housing Unit	2.08		2.04	0
2) Total Housing Units	7,993		11,140	2,623
% Single Family	50.3%		50.5%	51%
% Multifamily Family	49.7%		49.5%	49%
3) No. of Single Family Units	4,018		5,623	1,338
3) No. of Multifamily Units	3,975		5,517	1,285
4) Housing Area (Acres)	1,335	844	1,876	451
SF Residential Density (DU/Ac)	4.1			4.0
MF Residential Density (DU/Ac)	10.9			11.0
SF Area (Acres)	969	580.2	1,370	334
MF Area (Acres)	365	264.0	506	117
5) Non-Residential Land Use	2,247	1,453	3,153	756
Acres / 1,000 Persons	134	171		137
6) Total Developed Land (Ac)	3,581	2,297	5,029	1,207

Source: U.S. Bureau of the Census and CARPC

Table 25: Village of Waunakee Urban Land Demand Projection 2010-2035

Data Item	Est. 2005	Change 1970-2005	Projected 2035	Est. Change 2010-2035
1) Total Population	10,361	8,180	18,844	7,069
Population Per Housing Unit	2.50		2.50	
2) Total Housing Units	4,082		7,427	2,787
% Single Family	72.2%		71.2%	70%
% Multifamily Family	27.8%		28.8%	30%
3) No. of Single Family Units	2,946		5,287	1,951
3) No. of Multifamily Units	1,136		2,139	836
4) Housing Area (Acres)	909	789	1,561	544
SF Residential Density (DU/Ac)	3.7			4.0
MF Residential Density (DU/Ac)	9.8			15.0
SF Area (Acres)	794	678	1,379	488
MF Area (Acres)	116	112	182	56
5) Non-Residential Land Use	1,309	1,128	1,989	567
Acres / 1,000 Persons	126	138		80
6) Total Developed Land (Ac)	2,218	1,918	3,551	1,111

Source: U.S. Bureau of the Census and CARPC

Table 26: Town of Westport Land Demand Projection 2010-2035

Data Item	Est. 2005	Change 1970-2005	Projected 2035	Est. Change 2010-2035	Urban Change 2010-2035	Rural Change 2010-2035
1) Total Population	3,776	1,365	5,371	1,329		
Population Per Housing Unit	2.03		2.05			
2) Total Housing Units	1,855		2,617	652	594	58
% Single Family	58.3%		58.2%	58%	55.9%	79.5%
% Multifamily Family	41.7%		41.8%	42%	44.1%	20.5%
3) No. of Single Family Units	1,082		1,536	378	332	46
3) No. of Multifamily Units	773		1,102	274	262	12
4) Housing Area (Acres)	1,134	547	1,621	406	358	95
SF Residential Density (DU/Ac)	1.1				1.0	0.5
MF Residential Density (DU/Ac)	7.1				10.0	4
SF Area (Acres)	1026	459.4	1,480	378	332	92
MF Area (Acres)	108	87.4	141	27	26	3
5) Non-Residential Land Use	2,336	986	2,930	494	116	377
Acres / 1,000 Persons	619	722		372		
6) Total Developed Land (Ac)	3,470	1,533	4,550	900	476	472

Source: U.S. Bureau of the Census and CARPC

The Town of Westport land demand was subdivided into urban demand (projected inside the urban service areas) and rural demand by evaluating historic changes of various land uses categories (acreage) and whether they exist within a urban service area.

Table 27 below indicates the total urban land demand projected for the FUDA area, which includes the City of Middleton, the Village of Waunakee and the urban area of the Town of Westport, between years 2010 and 2035. The overall land demand anticipated is approximately 2,800 acres to accommodate growth anticipated during this time period. Residential land is the primary driver of demand, and more than 6,000 dwelling units are anticipated at average densities of 3.1 and 12 units per acre for single family and multi-family respectively.

Table 27: Total Urban Area Land Demand Projection 2010-2035

Data Item	Est. Change 2010-2035
1) Total Population	NA
Population Per Housing Unit	
2) Total Housing Units	6,004
% Single Family	60.3%
% Multifamily Family	39.7%
3) No. of Single Family Units	3,621
3) No. of Multifamily Units	2,383
4) Housing Area (Acres)	1353
SF Residential Density (DU/Ac)	3.1
MF Residential Density (DU/Ac)	12.0
SF Area (Acres)	1154
MF Area (Acres)	199
5) Non-Residential Land Use	1,440
Acres / 1,000 Persons	NA
6) Total Developed Land (Ac)	2,793

C. Estimates of Land Supply

The projected demand for urban development of 2,793 acres in the North Mendota FUDA communities between 2010 and 2035 will need to be planned for within the Study Area.[80] To plan for this projected land demand, three categories of land supply within the FUDA Study Area are considered. First, infill and redevelopment areas are assessed for their potential to accommodate projected demand. Second, developable land in USAs is considered. Remaining demand, once infill/redevelopment and USA areas are identified, needs to be accommodated within the FUDA Study Area outside of existing USA boundaries.

80 FUDA planning focuses on urban development that will take place within an urban service area (existing or future). Rural development that occurs outside of USAs is not the focus of FUDA planning.

1. Infill and Redevelopment

Like many communities, the City of Middleton and the Village of Waunakee encourage infill and redevelopment through existing plans. Westport has also initiated discussions about infill development that may result in future plans. This section identifies infill and redevelopment potential in areas that have been included in adopted local plans for the City of Middleton and the Village of Waunakee, and in an area identified by the Westport in discussions with Town officials. The City of Middleton redevelopment areas include three zones within the boundary of the TID #5 as well as an area along University Avenue. The Village of Waunakee redevelopment areas are primarily concentrated in the village downtown. Additional infill and redevelopment, not included in local plans, may be part of the scenario planning portion of FUDA.

Infill: Development on land surrounded by developed uses on at least three sides (75% of perimeter) with public sewer and water available on adjacent parcels.

Redevelopment: Development on parcels with existing buildings that are replaced, added onto or substantially modified.

Benefits of infill and redevelopment include more efficient use of existing infrastructure, improving property values, creating investment opportunities, and the potential to increase walkability and transit-friendliness by locating housing close to shopping and transit corridors. Infill and redevelopment, given the benefits, would be more commonplace but for the challenges public and private entities face when implementing these policies. Such challenges include multiple landowners, property assemblage, environmental contamination, and local resident opposition.

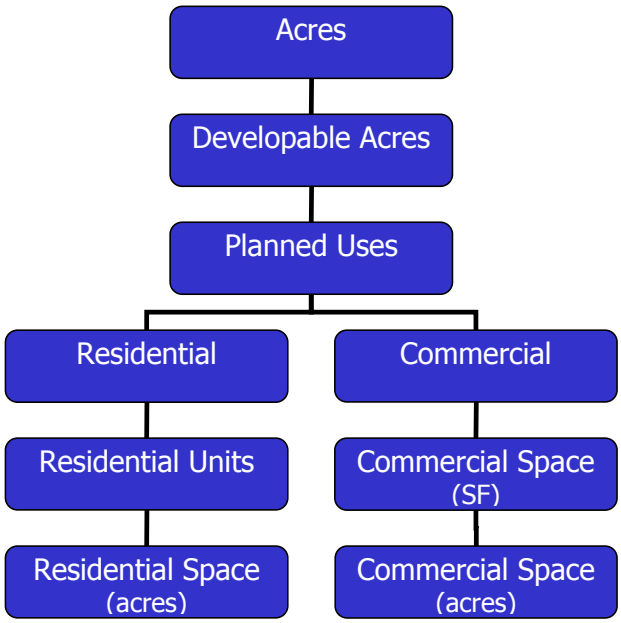
a. Infill and Redevelopment Assessment Methodology

Figure 38 displays the basic steps for determining infill/redevelopment potential. Using information from local plans, the number of acres identified for infill or redevelopment is determined. The portion of infill/redevelopment area that is planned for development (not including buildings that will be preserved) is determined, and the planned uses are identified. For example, a two-acre site may have an existing building with a footprint of half an acre. The planned redevelopment for the remaining 1.5 acres might be a three-story mixed-use building with commercial on the ground floor and residential above.

Redevelopment Assessment Methodology Example

Middleton TID 5 site 1.3 is an 8-acre site with a 12-unit apartment building and various commercial buildings totaling 17,000 square feet. The site is planned for mixed-use development. Of the 8 acres, only 4.7 acres (205,000 sf) are evaluated in the scenario because the remaining development is planned to remain. Dedicated open space is planned as 15% of the site, leaving a buildable area of 175,000 square feet. The building program is ground-floor commercial with two levels of residential above and some underground parking. The building size and required parking was adjusted until the open space, building footprint and parking area filled the developable area. This resulted in an additional 50,000 square feet of commercial and 119 residential units (based on 1,000 sf unit size). Based on the age and size of the buildings and the ratio of building to land value, the development was given a 50% change of occurring within the next 25 years. If developed, the scenario would satisfy approximately 14 acres of demand. However, for the purpose of calculations, only 7 are counted due to the 50% probability or redevelopment.

Figure 38: Infill and Redevelopment Assessment Methodology



Calculations are then made to determine the number of potential residential units and square feet of commercial space that could be accommodated on the site, given the need for parking and open space, and based on a number of assumptions (such as average unit size).

Because it is unlikely that all redevelopments would occur immediately, each site is assigned a redevelopment probability for the 25 year planning period, based on existing site characteristics. The number of projected units and square feet of commercial space for each site is then adjusted based on this percentage.

Finally, residential units and commercial square feet are converted into acreage figures (based on assumptions of densities). The total acres of potential residential and commercial development is compared to projected 2010-2035 land demand to determine what portion of projected demand can be accommodated through infill and redevelopment.

b. Middleton Infill and Redevelopment

The City of Middleton adopted plans for three infill/redevelopment areas. Two of the areas are within Tax Increment District (TID) #5. The other area is a section of University Avenue.

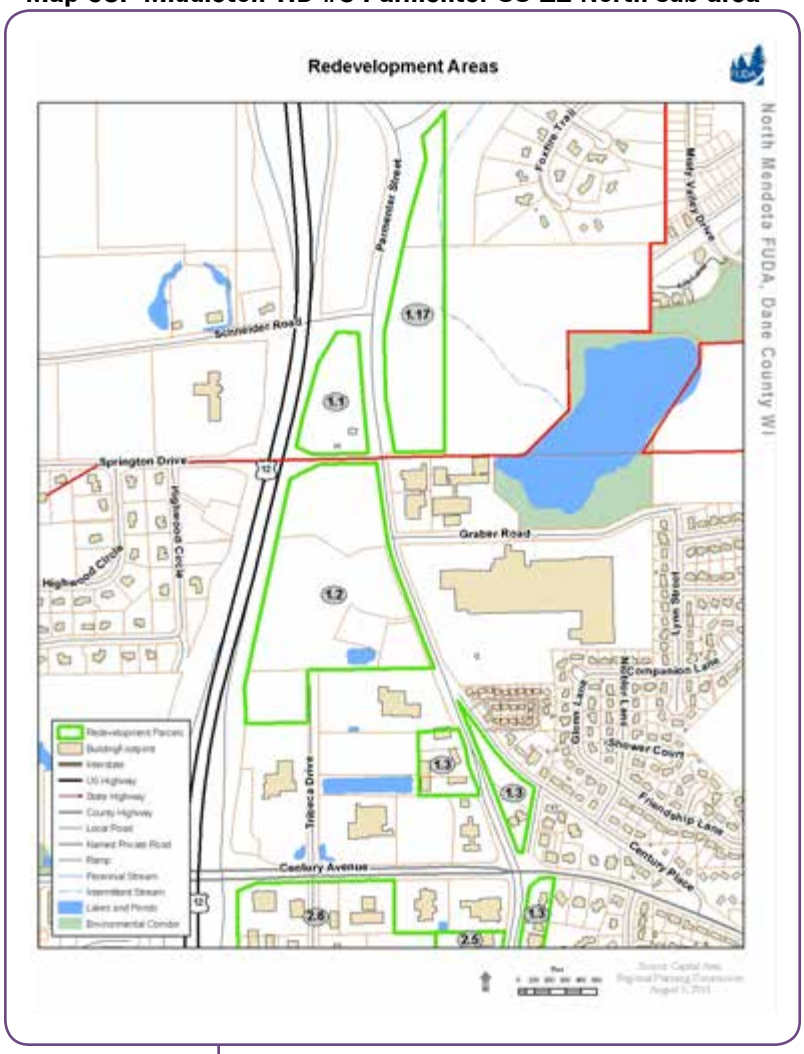
City of Middleton: TID #5

The "City of Middleton Tax Increment District No. 5 Project Plan: City Council Action, August 4, 2009" is intended to "promote the creation of high density, multiple land uses consisting of commercial, office, high technology, industrial and high-density residential to directly curtail urban sprawl, provide affordable workforce housing within Middleton's employment center, redevelop and rehabilitate existing uses that will complement the surrounding neighborhoods and provide necessary services within the community and continue with creation of living wage and high paying jobs within the existing employment area." TID #5 infill/redevelopment areas include the Parmenter/U.S. Highway 12 area, the Pheasant Branch Stormwater Quality Management Area, and the Century Avenue/Allen Boulevard area.

Redevelopment Areas between Parmenter and U.S. Highway 12

The realignment of USH 12 westward created a roughly oblong area running north-south between the new highway and the old highway (what is now Parmenter Street). This relocation shifted highway visibility and traffic counts to the west. Properties fronting on what used to be USH 12 now experience lower visibility and traffic volumes. Properties that used to be on the edge of the developed area of Middleton now face the new highway (see Map 63). Some of the uses on these parcels now fronting USH 12, such as ball fields and low-intensity backyard uses, are now less viable. New, higher intensity, higher value and greater mix of uses are now more financially viable.

Map 63: Middleton TID #5 Parmenter US 12 North sub-area



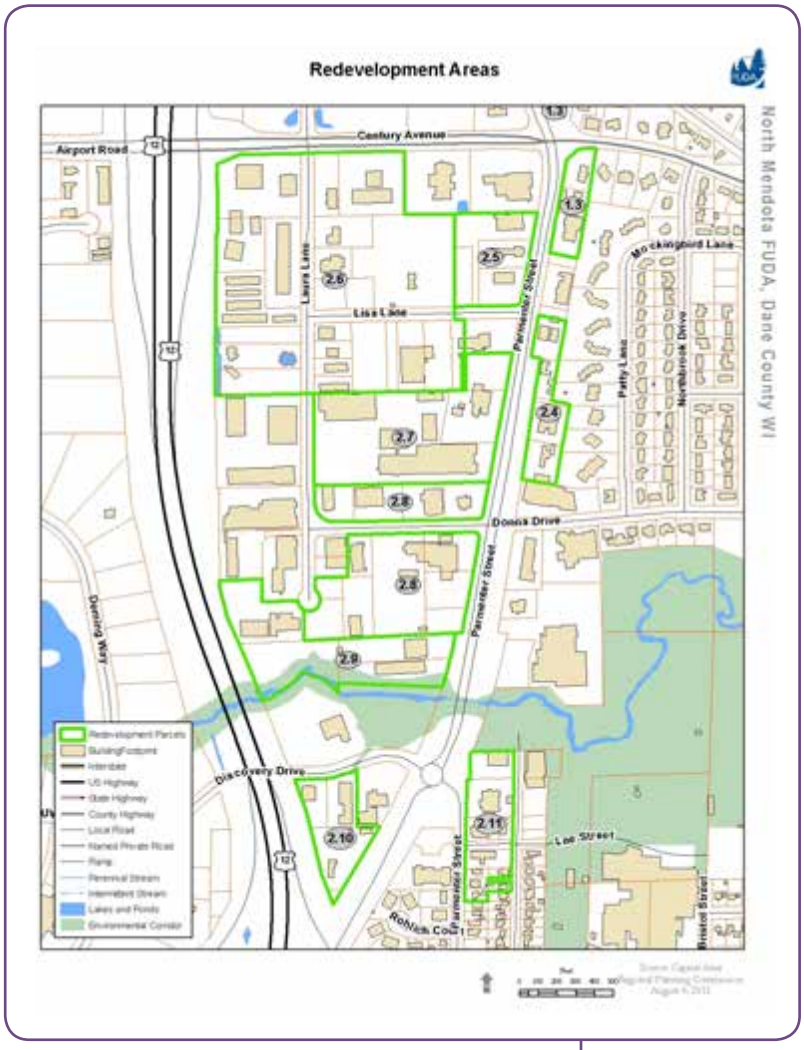
The sub-area north of Century Avenue

This sub-area encompasses 57.6 acres, including approximately 36 acres of developable land (see Map 64). Middleton's 2005 Northwest Quadrant plan identified this area as a future neighborhood center, with a focus on high density residential and high-tech commercial offices. The area is dominated by larger parcels of vacant land and single users, and is therefore suitable for master development, as evidenced by the proposal from T. Wall Development for Tribeca Village, a large, mixed-use, new urbanist style development. Planned land uses in this area could generate a net increase of 862,974 square feet of commercial development and 179 new housing units.

Currently Tribeca Village is the only portion of the sub-area that includes housing in planned land uses. As the proposal for Tribeca shows, however, redevelopment opportunities of this magnitude can create opportunities for mixed-use environments that meet the housing and location preferences for certain market niches, while increasing walkability and increasing potential for transit. The prospect for additional housing in other portions of the sub-areas, in the longer-term, is worth additional consideration.

Also worthy of additional consideration is the long-term opportunity to make better connections between existing and planned commercial land uses (or perhaps mixed-use) along and west of Parmenter, and residential areas immediately to the east. The current development pattern reflects the strategy of strictly separating residential and commercial land uses. The size of Parmenter Street right-of-way also acts as a significant barrier and, although traffic volumes dropped with the construction of new Highway 12, volumes will rise again if new development proceeds. However, over the long-term, if properties along Parmenter redevelop, the opportunity to design buildings that are accessible and friendly to nearby residents is worth exploring.

Map 64: Middleton TID #5: Parmenter US 12 South sub-area



The sub-area south of Century Avenue

This sub-area includes a mix of small and mid-sized parcels containing a variety of commercial and public uses, and vacant parcels. The total land area is 84.0 acres, including 69.3 acres of developable land. Current development intensity, as measured by floor area ratio[81] is low at 0.16. The challenge for redevelopment of this area will be to encourage a shift in uses, over time, from highway-oriented commercial and public facilities to more intensive office, research and retail. A viable strategy could be to identify key properties with the highest redevelopment potential that can serve as catalysts for additional investments.

Overall, the redevelopment potential of the Parmenter/U.S. Highway 12 area is high, with significant amounts of vacant and underutilized parcels. The TID Plan identifies most of the sub-areas for retail and office/research uses. Residential uses are identified for the parcels along the eastern frontage of Parmenter Street, and those fronting Pheasant Branch Creek. Planned land uses could accommodate approximately a net increase of 2.1 million square feet of commercial space and 460 housing units (see Table 28). This number of new units and commercial area could accommodate approximately 177 acres of commercial land demand and 40 acres of multi-family residential demand.[82]

81 Floor Area Ratio (FAR) is a measure of building intensity: the ratio between the total square foot of a building and the total square feet of the site. For example, a 100,000 square foot site with a 20,000 square foot, single-story building would have a FAR of 0.2. If the building was two floors of 20,000 square feet each, the site would have a FAR of 0.4. A FAR of less than 0.2 can be an indicator that a site is underutilized. FAR is one indicator that must be combined with other indicators and observations before conclusions can be drawn.

82 Based on commercial FAR of 0.25 and net housing units per acre of 11.

Table 28: City of Middleton TID #5 Redevelopment Area-Parmenter/Highway 12 Redevelopment and Infill Summary

Sub-Area	Developable Area (SF)	Existing Uses	Planned Uses	Potential Commercial Gain (sf)	Potential Residential Gain (units)
1.1	390,603	Vacant and a house	Office/Research	190,044	-1
1.2	1,187,177	Vacant	Tribeca Village: retail & office/research; residential	684,000	127
1.3	206,237	Various commercial, 12-unit apt., cemetery	Mixed-use, commercial ground floor, residential above	24,281	59
1.2	596,863	Vacant	Office/Research	462,308	0
2.4	144,188	Gas station, hotel, apartment	Mixed-use, commercial ground floor, residential above	24,003	79
2.5	195,484	Retail, warehouse	Retail and Office/Research	53,704	0
2.6	934,049	Ballfields, fun park, vacant lots, public garage, bus barn, commercial	Retail and Office/Research	392,567	0
2.7	211,458	Industrial (Gilson, Inc.) and vacant auto dealership	Office/Research complimenting Gilsons	147,941	0
2.8	333,585	Office, retail and warehouse. Mostly Bruce Co.	Reconfiguration and consolidation with retail/residential complementary to Bruce Co.	40,841	88
2.9	443,623	Warehouse/office/ retail	Residential - senior, workforce, condo/apt.	-13,272	87
2.1	159,296	Vacant retail, SF home, and warehouse	Retail, office & hotel	71,443	-1
2.1	179,737	SF and a duplex, bar, office, warehouse	Mixed commercial-residential	7,672	21
				2,085,532	460
		Land Demand Calculation Rates (FAR, Density)		0.25	11
		Acres		191.51	41.78

Redevelopment and infill development will need to be carefully planned to protect and integrate existing higher-value uses such as Gilson Inc., and Bruce Company, among others. Street design connectivity, walkability, transit-friendliness and quality civic spaces will be important to effectively integrate uses that work together to create a sense of place.

Century Boulevard-Allen Boulevard Redevelopment Area

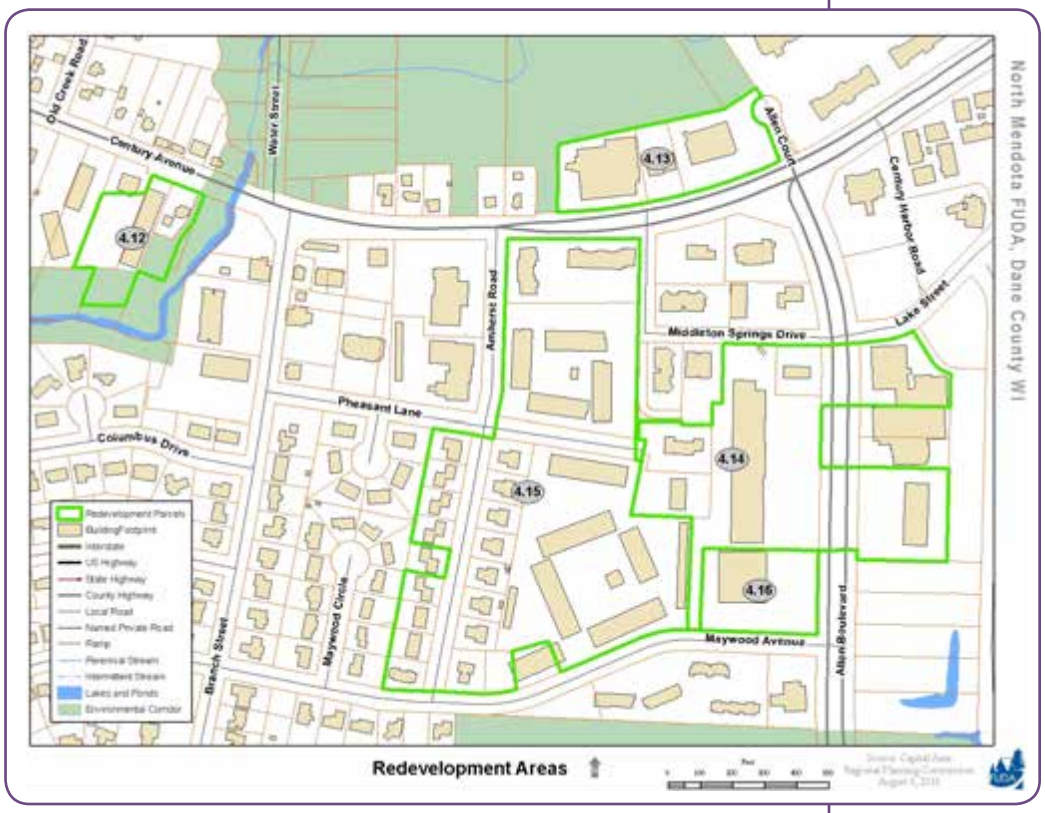
This area includes 36 parcels totaling 35.5 acres of land identified for redevelopment (see Map 65). The land area includes developable land of approximately 29.0 acres. This site is also identified as a neighborhood center in the Northwest Quadrant plan; however, no specific details are discussed for this area. The plan generally calls for additional residential development east of Hwy 12, complimented with mixed-use commercial development serving adjacent neighborhoods. The plan indicates residential development should be varied in terms of housing types and densities.

The redevelopment potential is characterized by older strip retail buildings. Some of the historic retail demand this area served is now met by newer stores in other locations. Another characteristic of this area is the significant amount of residential buildings, including 272 units in large apartment complexes, housing mostly minority populations.

The sub-area east of Allen Boulevard could draw on the amenities of proximity to Lake Mendota (possibly access) and the anchor of Harbor Athletic Club. Likewise, redevelopment of the former Copps store could build on the investment of CVS and Anchor Bank.

The subareas west of Allen Boulevard, however, must address the issue of low-income residents and apartment complexes adjacent to vacant and under-performing retail buildings. Redevelopment that meets the needs of residents, creates a sense of place, and attracts investment and business is a significant challenge. On the other hand, the scale of the area offers opportunities for master planning. A larger master-planned redevelopment that encompasses the residential and commercial portions of this area into a mixed-use, mixed-income walkable, transit-friendly development, connected to area amenities of the lake and nearby parks and natural areas could have the potential to significantly revitalize the area.

Map 65: Middleton TID #5 Century-Allen sub-area



A large retrofit such as this will likely require significant public sector involvement and investment, perhaps including acquisition of properties.

Transit could also play a role in redevelopment of this area. Madison Metro bus line serves Allen Boulevard with 30-minute headway service during peak hours. Redevelopment options should consider the potential for transit-oriented development (TOD). Well designed redevelopment that incorporates convenient, attractive and safe access to quality transit facilities for residents could increase travel options for area residents, increase transit ridership, and reduce energy and pollution associated with single-occupant automobile travel.

Densities of the larger multi-family units in the area (14 units per acre) already exceed those necessary for quality transit service. At present, however, the area is not designed for convenient access for area residents to bus stops. A master-planned redevelopment could meet or exceed those densities by including multi-story, mixed-use commercial-residential buildings along Allen Boulevard. Enhanced transit options would particularly benefit low-income residents and other groups with limited transportation options such as children and the elderly.

The overall anticipated redevelopment is summarized in Table 29. Because the area includes significant amounts of housing and vacant commercial space, redevelopment is estimated to result in a net loss of commercial, and a modest gain of 110 units of multi-family housing. The gain in housing translates to approximately 10 acres of residential land demand.

Table 29: Middleton TID #5 – Century Ave./Allen Blvd. Area Redevelopment and Infill Summary

Sub-Area	Developable Area (SF)	Existing Uses	Planned Uses	Potential Commercial Gain (sf)	Potential Residential Gain (units)
4.1	37,897	Historic Samm House, SF home, and multi-tenant warehouse/office	Relocate businesses into redevelopment area; redevelop into housing	-6,075	12
4.1	59,642	Former Copps store and new CVS and Anchor Bank buildings	Copps into mixed residential/retail	-3,861	7
4.1	325,120	Harbor Athletic Club, shopping center, restaurant, office & warehouse	Consolidation of Harbor Athletic, plus mixed retail/entertainment with residential above	4,958	35
4.2	748,542	Residential (14 duplex, 3 apartment between 40 and 128 units, 2 townhouse, and 2 SF = 305 units	A complete range of socio-economic apartments and condos should be provided to encourage all classes of owner-occupants and renters	0	34
4.2	93,719	Empty retail store	Retail with residential above	986	22
				-3,991	110
		Land Demand Calculation Rates (FAR, Density)		0.25	11
		Acres		-0.37	9.96

Middleton University Avenue Redevelopment District

University Avenue, from Allen Boulevard to Park Street, developed over time with commercial uses primarily serving drivers along the transportation corridor. Towards Park Street and the western portion of the area, houses are more common, reflecting the history as a main street for the City. Over time, properties developed with auto-oriented businesses (large setbacks, low FARs, single-story construction) of various ages and configuration (see Map 66).

Map 66: Middleton University Avenue sub-area

In 2008-9 the City of Middleton commissioned a University Avenue BUILD (Better Urban Infill Development) plan. The purpose of the BUILD plan was to "provide comprehensive, market-based recommendations for improvement." The plan examined existing conditions and opportunities, assessed the market, and provided land use recommendations, design guidelines and an implementation strategy. The opportunity analysis identified specific parcels with redevelopment and/or enhancement potential.

The BUILD plan identified 18 parcels with potential for enhancement (property improvement and upgrades), and 7 parcels (5 sites) with potential for redevelopment. The five sites identified with potential for redevelopment contain 4.6 acres with an overall FAR of 0.14, and an average building age of 41 years (see Table 30). Additionally, the site has an improvement ratio[83] (the ratio of building value to land value) of 0.76. The low utilization of land and value of improvements, combined with the age of existing structures suggests a high potential for redevelopment.

Corridor revitalization can occur as a general enhancement of properties and public spaces (including street rights-of-way), or as a more comprehensive retrofit that seeks to shift the nature of the corridor toward designs that are higher intensity, mixed-use, transit-friendly, pedestrian-friendly, and integrated with surrounding neighborhoods. An enhancement strategy focuses on improving the appearance and values of the corridor, with limited property upgrades. A retrofit strategy focuses on changing the function to encourage alternative modes of transportation, reduce automobile miles traveled and associated environmental impacts, and provide access to shopping for nearby residents.

The BUILD plan emphasizes enhancement, and this is understandable given the challenges for broader retrofit presented by the corridor. Retrofit challenges in the corridor include scattered redevelopment opportunities, wide mix of uses and configurations, and lack of connections to adjacent residential areas. ***Unlike the Century and Allen Boulevard area, where large parcels with under-utilized buildings exist, the University Avenue area contains many small parcels with diverse uses and ownership. A broader retrofit strategy is very difficult without public investments in transit and encouraging alternative transportation modes.***

83 Improvement ratio is the ratio between the assessed value of the improvements (buildings) and the assessed value of the land. A site with land value of $100,000 and building value of $200,000 would have an improvement ratio of 2.0. Improvement ratios of 2.0 or higher generally indicate that sites are performing well in the market. Ratios of 1.5 or lower can indicate that a site is under-utilized. Improvement ratios are one indicator that need to be combined with other indicators and observations before conclusions can be made.

Table 30: Middleton University Avenue Area Redevelopment and Infill Summary

Sub-Area	Developable Area (SF)	Existing Uses	Downtown Revitalization Concept Planned Uses	Potential Commercial Gain (sf)	Potential Residential Gain (units)
Gateway-1	91,820	"Retail 6220-6234 University"	Mixed commercial	15,961	0
Central-2	44,318	"17-Unit residential 6418 University"	Retail and supporting medical	11,230	-9
Central-3	25,250	Gas station & vacant 6504 University Ave	Retail and supporting medical	8,004	0
Central-4	98,612	"Retail & Office 6619-6653 University Ave"	Retail and supporting medical	2,851	0
Neighborhood-5	80,937	"Parkwood Plaza 6921 University Ave."	Mixed commercial and residential	-1,562	10
Neighborhood-6	11,089	"Auto Repair 7008 University Ave"	Mixed commercial and residential	609	3
Neighborhood-7	27,687	"Apartment Building 7107 University Ave"	Residential-Town Home	0	1
				37,094	6
		Land Demand Calculation Rates (FAR, Density)		0.25	11
		Acres		3.41	0.55

A retrofit strategy would likely require coordination with transit enhancements and governmental actions to encourage assemblage of groups of under-utilized properties for larger-scale, transit-friendly developments that also serve area residents and encourage walking and bicycling. If such public investments are seriously considered at some point in the future, the University Corridor through Middleton (not just from Allen to Park) should be revisited to examine the potential of a retrofit strategy.

While a retrofit strategy brings challenges, it also brings opportunities. The University Ave. study area covers 37 acres of property. While the enhancement strategy calls for adding approximately 59,000 square feet of commercial and approximately 22 new housing units, a retrofit strategy could result in much larger levels of investment, commercial and housing uses that make use of existing infrastructure and generate significantly greater tax increments. Coupled with transit enhancements and well-designed mixed-uses, a retrofit strategy can also reduce transportation costs (economic and environmental).

The opportunity to explore the potential of a retrofit strategy was increased with a recent grant awarded to a consortium of public and private entities in the Capital Region. Capital Region Sustainable Communities received a three-year (February 2011 to February 2014), $2 million dollar grant from the U.S. Department of Housing and Urban Development (HUD). A portion of the grant ¬¬will fund studies of the potential to increase bus transit service and associated transit-oriented development (TOD) along regional roadway corridors, including University Avenue. The grant also includes funding for follow-up planning for identified station areas. The transit/TOD studies could provide additional information that identifies broader retrofit opportunities for University Avenue.

c. Waunakee Infill and Redevelopment

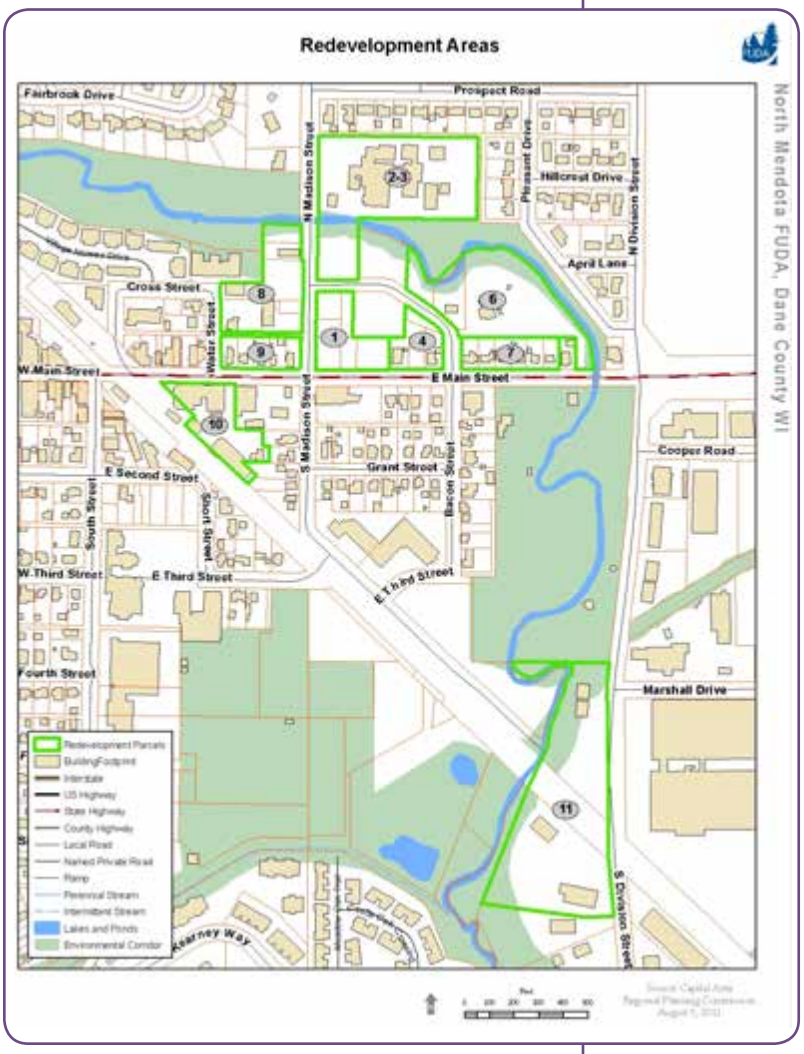
The Village of Waunakee commissioned a Central Business District Master Plan in 2002. The purpose of the plan was "to provide comprehensive guidelines for improvements to land use and business mix, transportation, parking, streetscape design, and district character over the next 10 to 15 years." The Plan assesses the market, analyzes existing conditions, and makes recommendations for a variety of improvements including redevelopment. Map 67 shows the properties in the Plan identified for redevelopment.

Some of the properties identified in the CBD Master Plan have experienced redevelopment, and are thus not included in the redevelopment assessment. The Stokely site has been developed as a Senior and Community Center. St. John the Baptist Church has expanded its facilities and parking. And Summit Credit Union built a new facility at the southeast corner of Main and Madison Street.

Other properties have been prepared for redevelopment and are awaiting developers/investors. Waunakee Alloy at the northeast corner of Main and Madison relocated to the industrial park. Its building has been purchased by the Village and demolished. The Village also owns adjacent properties to the north and has sought developers. The site is planned for townhome and commercial development, taking advantage of the amenity of Six Mile Creek corridor that borders the site to the north. These Village-owned and vacant properties have the highest redevelopment potential.

Another property with high redevelopment potential is the Koltes Lumber site. Koltes closed the facility on Main Street in 2010. The site is 1.8 acres with frontage on Main Street. The redevelopment opportunity could be expanded if the Kwik Trip property next to Koltes along Main Street, and other properties on the block were also considered for assemblage into a larger site. The total area of the block is 3.7 acres. The CBD Master Plan identifies a north-south alley being created through the block.

Map 67: Waunakee Downtown sub-area



Additional properties identified with redevelopment potential are the Qual Line Fence property on Division Street along the railroad tracks and a parcel owned by the Village across the tracks. Together the two properties comprise 6.7 acres with frontage along Six Mile Creek and proximity.

Table 31: Waunakee Downtown Area Redevelopment and Infill Summary

Sub-Area	Developable Area (SF)	Existing Uses	Planned Uses	Potential Commercial Gain (sf)	Potential Residential Gain (units)
1	67,015	E. Main & N. Madison	Commercial, Mixed Retail & Residential/ Office, Public facility/library	2,542	9
2-3	258,176	Former Waunakee Alloy and vacant	Residential (12-16 du/ac N of Creek; 6-8 du/ac S of Creek), public facility/library	15,553	62
4	29,340	315 to 321 E. Main St. Vacant & SF	Commercial, Mixed Commercial & Residential/Office	4,657	9
6	175,573	American Legion Site	Residential (12-16 du/ac), office, civic	13,599	54
7	61,637	Single-Family - N side of 400 E. Main St	Residential (6-8 du/ac), office, retail, B&B	5,894	8
8	105,085	Single-family, commercial, vacant	Multi-family residential (12-16 du/ac)	-9,836	27
9	39,596	Single-family, duplex, MF, and 1 commercial, vacant	Commercial, Mixed Commercial & Residential/Office	4,605	4
10	78,748	Former Koltes Lumber	Commercial, Mixed Commercial & Residential/Office	-8,439	11
				28,577	185
		Land Demand Calculation Rates (FAR, Density)		0.25	15
		Acres		2.62	12.34

The CBD Master Plan identifies a variety of different redevelopment types based on location and site characteristics. Most sites away from Main Street call for residential development, while those on Main Street call for mixed commercial-residential buildings. The total redevelopment area is 17.8 acres with 15.49 acres of developable land. Planned land uses for redevelopment sites emphasize new housing. If redeveloped according to plans, these sites could generate approximately 25,000 square feet of new commercial space, and about 200 new housing units.

Based on the identified redevelopment sites, Waunakee may anticipate the potential redevelopments totaling 28,577 commercial square feet and 185 residential units (net). Using a typical commercial FAR and the multi-family residential density from for Waunakee's land demand, this could reduce the future demand land by 15 acres.

d. Town of Westport Redevelopment

Town of Westport's redevelopment sites are based on the Town's application for BUILD funding assistance submitted to Dane County in 2009 and on the "Town Center" area identified on their future land use map in the comprehensive plan. To date, however, no planning has occurred to evaluate the redevelopment or infill potential for this area.

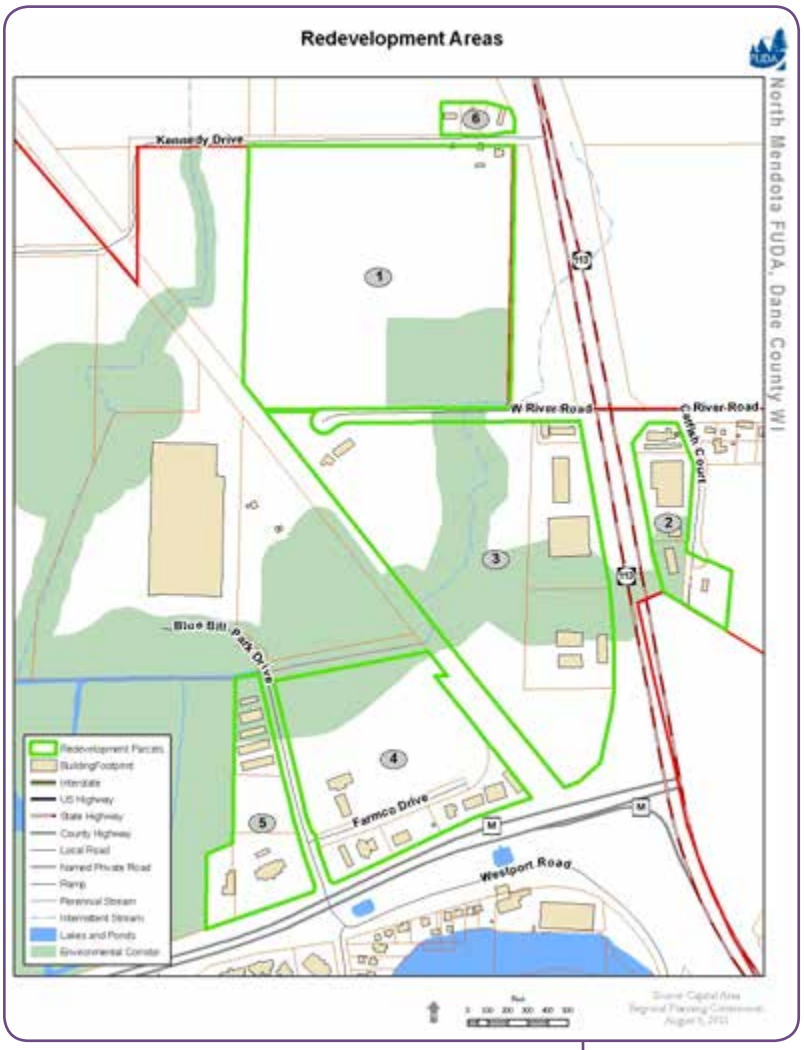
The plan application envisions a series of visioning sessions that could lead to plan goals and objectives for the area surrounding Hwy 113 and CTH M within the Central Urban Service Area (see Map 68). Redevelopment sites selected for this process expanded on those discussed in the BUIILD grant application to capture additional opportunities surrounding this intersection and locations further west on CTH M as shown on their future land use map.

The properties identified for potential redevelopment exist in a variety of conditions, with some recent development including a new Summit Credit union on the corner of CTH M and Blue Bill Drive. There are several active commercial uses within these areas which redevelopment could compliment, such as Kramer Printing and Paddleboard Specialists. Other sites are used primarily for storage or contain vacant or underutilized buildings. A quarry and one agricultural parcel are also included in the redevelopment calculations.

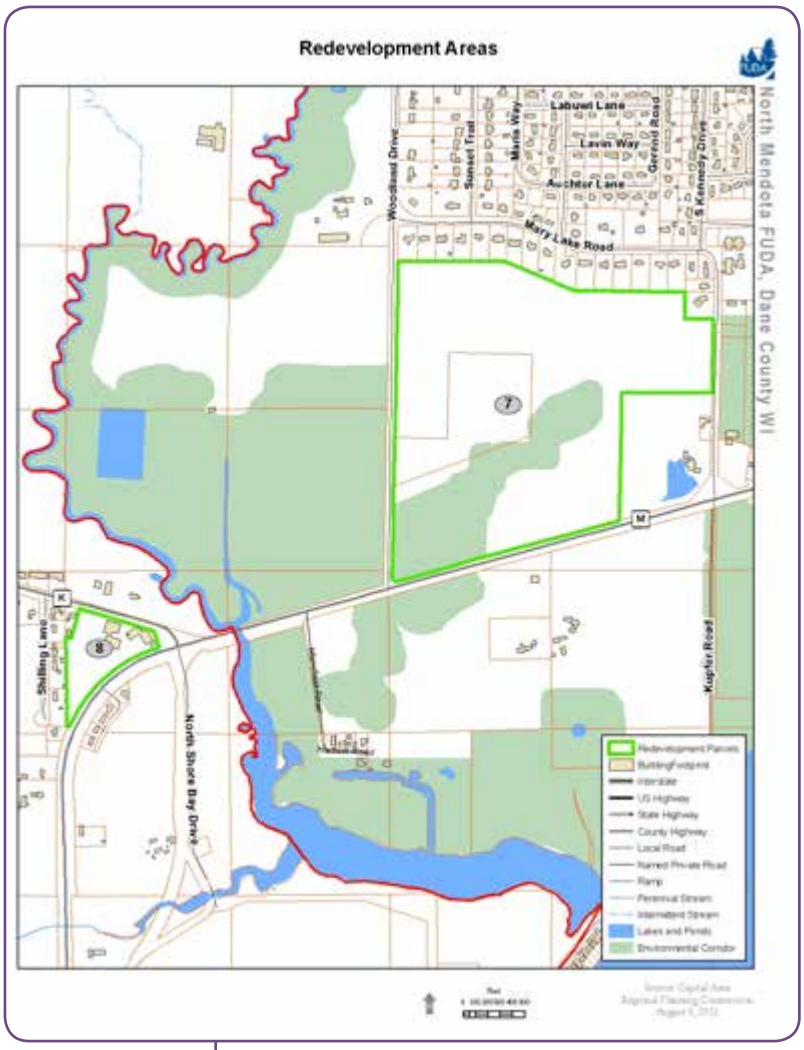
These parcels are planned primarily for mixed commercial uses, with select parcels planned for a mixed residential and commercial development. Because of large land areas and corresponding low FAR values, many of these parcels appear poised for future development.

Another parcel planned for development is a large tract owned by Lena LLC, northwest of the current town hall. The vacant parcel contains some area within an environmental corridor and abuts an existing residential neighborhood to the north. This area is anticipated to contain mixed residential and commercial development.

Map 68: Town of Westport Hwy 113 and CTH M



Map 69: Town of Westport CTH M and K



The final planned redevelopment area is located at the intersection of CTH M and K (see Map 69). The triangular parcel contains a vacant service station and other buildings totaling approximately 50,000 square feet and is also planned for mixed residential and commercial.

Because of the larger sizes of parcels in Westport's potential redevelopment areas, the developable area of select parcels was reduced by an additional 25% to accommodate future right of way which would be required for the parcel to develop appropriately. Even with this reduction in developable land area, potential redevelopment areas in Westport could be developed with over 500,000 square feet of commercial development and almost 500 housing units (see Table 32). These combined for 100 acres of land demand that could be satisfied through redevelopment.

Further planning is required to establish the vision and plan for these potential redevelopment areas, for consideration and adoption by the Town Board.

Table 32: Town of Westport Redevelopment and Infill Summary

Sub-Area	Developable Area (SF)	Existing Uses	Planned Uses	Potential Commercial Gain (sf)	Potential Residential Gain (units)
1	1,088,301	Vacant	Commercial, Mixed Office	264,457	0
2	86,164	Commercial, Single Family Residential	Commercial Office	14,457	-1
3	583,522	Commercial	Mixed Commercial Residential	35,215	77
5		Commercial	No Redevelopment Planned: Floodplain		
6	56,668	Multi-family Residential	Mixed Commercial Residential	9,486	11
7	2,830,695	Vacant	Mixed Commercial Residential	217,822	327
8	337,569	Vacant Service Station	Mixed Commercial Residential	13,956	76
				555,393	491
		Land Demand Calculation Rates (FAR, Density)		0.25	10
		Acres		51.00	49.05

Summary of Potential Infill and Redevelopment

Table 33 summarizes the potential impact infill and redevelopment efforts can have on the total urban land demand anticipated in the next 25 years[84]. Approximately 15% of the total land demand could be accommodated through the identified redevelopment sites.

Table 33: Potential Infill and Redevelopment and Urban Demand

	Prorated Demand (2010-2035)	Potential Redevelopment	Unmet Demand
City of Middleton			
Residential (sf)	334	0	334
Residential (mf)	117	52	65
Commercial	245	195	50
All other catagorires	511	0	511
	1,207	247	960
Village of Waunakee			
Residential (sf)	488	0	488
Residential (mf)	56	12	43
Commercial	95	3	93
All other catagorires	472	0	472
	1,111	15	1,096
Town of Westport (Urban)			
Residential (sf)	332	0	332
Residential (mf)	26	49	0
Commercial/Industrial	25	51	0
All other catagorires	93	0	93
	476	100	425
Total Demand Met Through Redevelopent		362	
Total Remaining Urban Demand			2,480

The redevelopment sections above identified potential capture of 113 acres of multi-family residential and 249 acres of commercial land, totaling 362 acres of redevelopment and infill. The remaining land demand totaling 2,480 acres (2010-2035) will need to be accommodated within the developable portions of the USAs and, if necessary, the FUDA Study Area outside of USAs.

2. Adequacy of Developable Land in the Existing Urban Service Area

The existing urban service areas in the FUDA communities were evaluated to determine the extent to which they contain sufficient developable land to meet the demand anticipated through 2035. This process identified land considered to be developable, and the planned future land use of these areas. For the purposes of this evaluation, land was considered developable if it is not developed and not considered undevelopable (including environmental corridors, floodplains, wetlands or slopes greater than 20%).

Once developable areas were identified, they were compared to a multi-jurisdictional future land use plan compiled by the Madison Area Transportation Planning Board. Following this step, the quantity of planned and developable land for each community was arrived at by using current boundary agreements to estimate future municipal boundaries.

84 Urban land demands include land demands for the City of Middleton, Village of Waunakee and the identified urban demand for the Town of Westport.

The City of Middleton has the largest shortfall of developable land totaling 679 acres, or 47% of projected land demand. There is an insufficient supply of developable land in every land use category, lead by transportation (231 acres), residential (204 acres) and Outdoor Recreation (118). Commercial development fares the best, with a shortfall of only 9 acres, which is largely due to a strong emphasis on redevelopment in this land use category.

The Village of Waunakee has a total shortfall of 257 acres, or 19% of total land demand. The analysis indicates Waunakee has an oversupply of developable land planned for residential and industrial, and insufficient supply of the remaining uses. One again, transportation has the largest shortfall (231 acres) followed by commercial (107) and outdoor recreation (102).

The urban area within the Town of Westport has the smallest deficit of planned and developable land inside the current USA boundaries, being short a total of 36 acres or 6% of future land demand. The town has an oversupply of commercial land and shortfalls in all other categories.[85]

In each community, transportation has the largest shortfall of planned and developable acres. This is because communities generally only indicate large transportation improvements on future land use plans. Local roads, such as those in residential subdivisions, are typically not accounted for. The deficiency in this category will likely be satisfied with the other developments that occur during the FUDA time period. ***The Outdoor recreation land use category also shows deficits in each community.*** Planned parks are often included in environmental corridors, and thus would be excluded from "developable" land in analysis. Future parks may also be dedicated as an element of larger residential developments.

This analysis identified other areas that could be developed, but are planned for preservation (including natural areas and woodlands) or for the continuation of existing agricultural uses. These areas are equivalent to roughly 60% of the net shortfall of developable land within the urban service areas. Expansion of urban service areas may be required in order to accommodate future development while preserving natural features in the North Mendota FUDA study area.

85 Based on historic trends in land use, the projection indicates the town has a negative land demand for utilities. For the purposes of this analysis, it is assumed this negative projection will not occur.

Table 34: Urban Developable Land, Planned Future Uses and Projected Future Demands

City of Middleton	CUSA Land Supply	Waunakee USA Land Supply	Urban Land Demand	Potential Redevelopment	"Supply in Excess of Demand (Insufficient Supply)"
Residential	289	0	541	48	(204)
Commercial	113	0	294	172	(9)
Industrial	121	0	181	0	(60)
Transportation	23	0	254	0	(231)
Utilities	0	0	25	0	(25)
Institutional	2	0	34	0	(31)
Parks and Recre-ation	1	0	119	0	(118)
	549		1,448	220	(679)
Village of Waunakee	**CUSA Land Supply**	**Waunakee USA Land Supply**	**Urban Land Demand**	**Potential Redevelopment**	**"Supply in Excess of Demand (Insufficient Supply)"**
Residential	17	758	652	12	135
Commercial	0	6	114	3	(105)
Industrial	0	252	129	0	123
Transportation	0	1	224	0	(223)
Utilities	0	0	27	0	(27)
Institutional	0	20	85	0	(65)
Parks and Recreation	0	0	102	0	(102)
	0	1,038	1,333	15	(263)
Town of Westport	**CUSA Land Supply**	**Waunakee USA Land Supply**	**Urban Land Demand**	**Potential Redevelopment**	**"Supply in Excess of Demand (Insufficient Supply)"**
Residential	325	0	430	31	(73)
Commercial	134	0	25	20	129
Industrial	0	0	5	0	(5)
Transportation	0	0	115	0	(67)
Utilities	0	0	-8	0	8
Institutional	22	0	39	0	(17)
Parks and Recre-ation	1	0	13	0	(11)
	0	0	571	52	(36)

Source: CARPC and Madison Area Transportation Planning Board

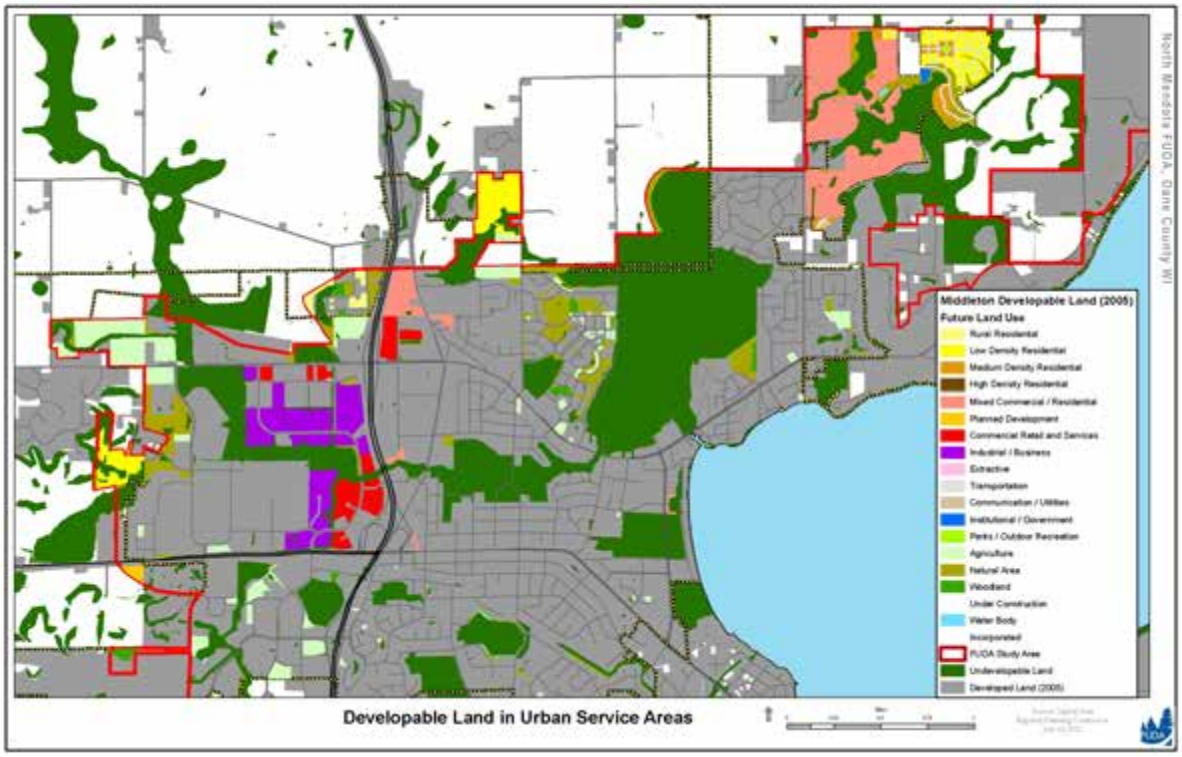
Notes:

Land Use Category "Mixed Commercial/Residential" tabulated as 75% residential, 25% commercial

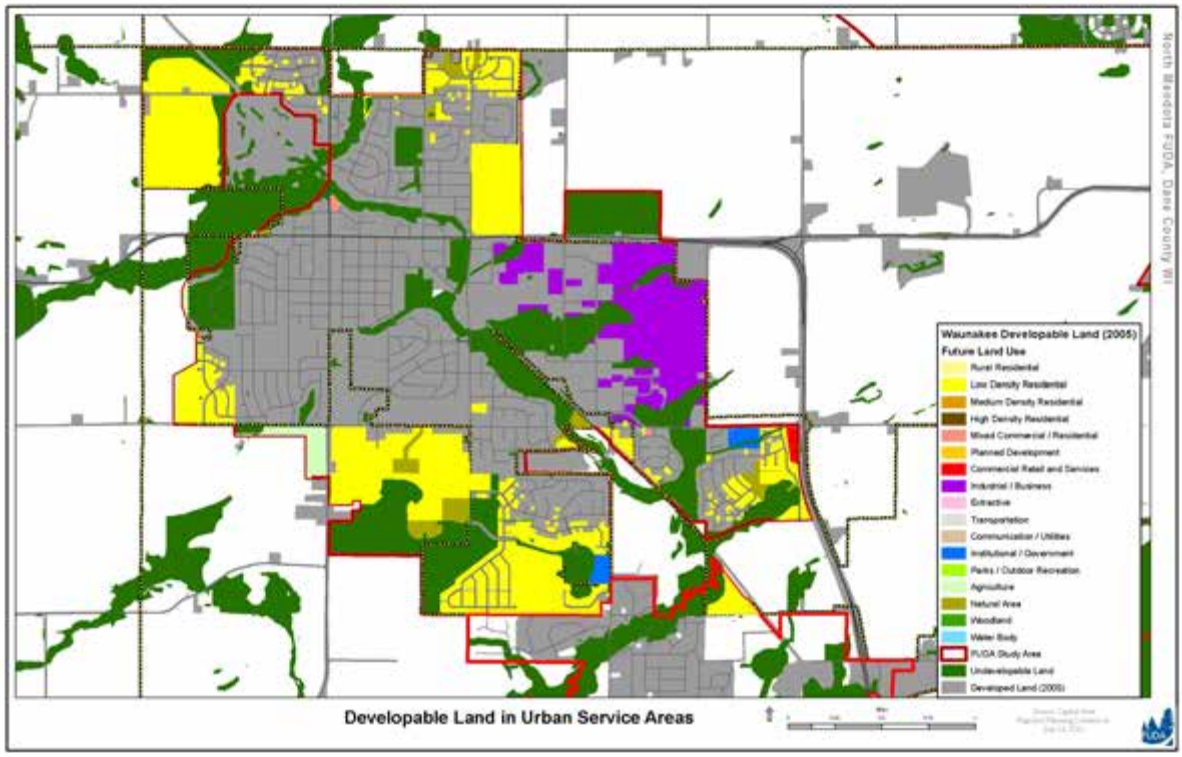
Redevelopment/Infill sites identified as vacant were adjusted to include only the portion of development above typical densities.

City of Middleton CUSA Land Supply includes select area of the CUSA within the Town of Middleton

Map 70: Developable Land (2005) in Urban Service Areas by Planned Future Land Use

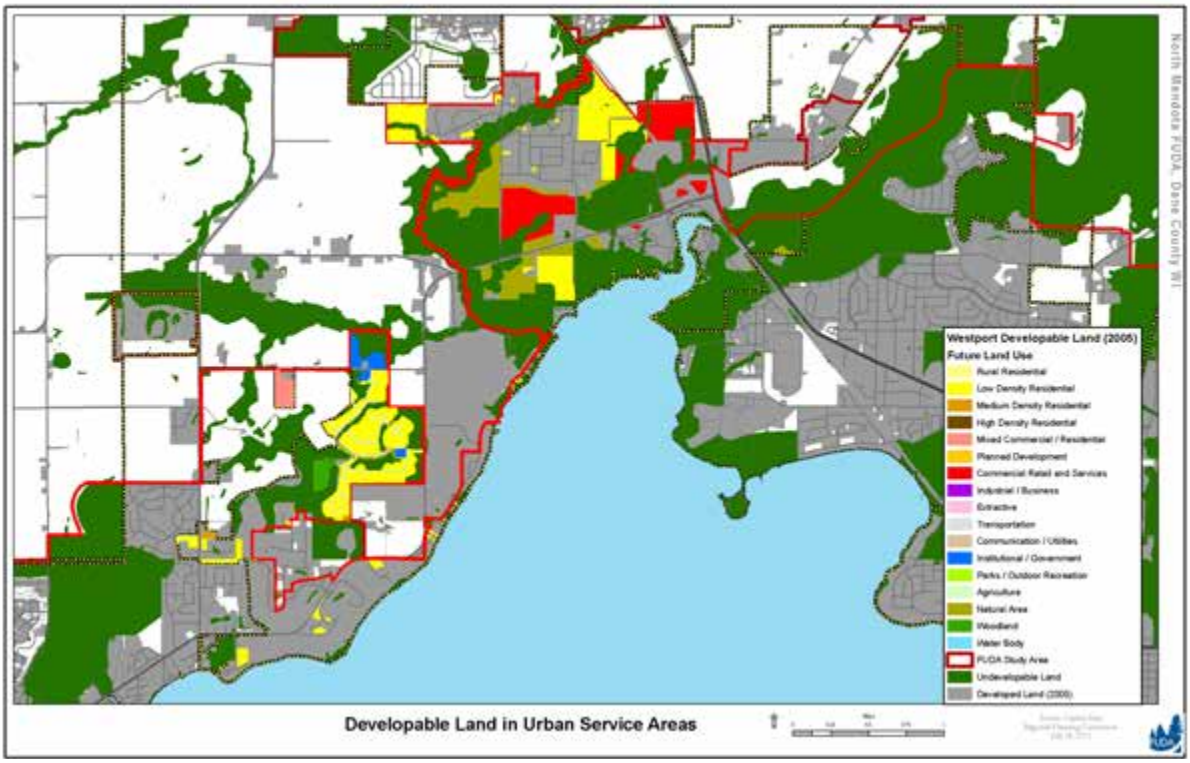


City of Middleton



Village of Waunakee

Map 70 (Cont): Developable Land (2005) in Urban Service Areas by Planned Future Land Use



Source: CARPC and Madison Area Transportation Planning Board

Town of Westport

D. Development Capacity of FUDA Study Area Outside the USAs

Development outside the urban service area boundaries will be primarily attributed to the towns of Westport (rural areas) and Springfield, though demand for land may also come from the towns of Middleton, Dane and Vienna.[86] The total land demand attributed to the rural areas of Westport and Springfield is anticipated to be 800 acres between 2010 and 2035 (see Table 35). While rural development is not the focus of FUDA planning, it must be accommodated in future development area planning. Development outside the current USA boundaries may also result from unanticipated urban demand, property owners unwilling to develop their land, or a variety of other factors.

Table 35: FUDA Area Rural Land Demand
Towns of Westport (rural area) and Springfield

Data Item	Est. Change 2010-2035
1) Total Population	NA
Population Per Housing Unit	
2) Total Housing Units	241
% Single Family	92.0%
% Multifamily Family	8.0%
3) No. of Single Family Units	222
3) No. of Multifamily Units	19
4) Housing Area (Acres)	274
SF Residential Density (DU/Ac)	0.8
MF Residential Density (DU/Ac)	2.9
SF Area (Acres)	268
MF Area (Acres)	7
5) Non-Residential Land Use	526
Acres / 1,000 Persons	NA
6) Total Developed Land (Ac)	800
Source: U.S. Bureau of the Census and CARPC	

Like the previous analysis that identified developable area within the existing urban service areas, a version was prepared for the current rural areas within the FUDA study boundary. This is intended to provide guidance as to where future development of each use is likely to occur and to confirm sufficient planned land exists for future demands in the rural areas.

As shown in Table 36, residential is the largest planned land use outside the existing urban service areas, with over 3,400 acres, or over 10 times the anticipated rural demand. Urban areas of FUDA communities have an unmet residential demand of 142 acres, which could be accommodated within this area, however it appears there may be more land planned for residential than is required during the time period of the FUDA study[87]. The majority of the land planned for residential exists in the southwest portion of the rural FUDA area adjacent to the City of Middleton (Middleton has the largest overall shortfall in developable land inside current USA boundaries). All other uses, except transportation which again has a shortfall, have more modest supplies, but meet projected land demand. The vast majority of area identified as developable land, almost 28,000 acres, is currently planned to remain agricultural or be preserved as natural areas and woodlands.

86 Subject to extra-territorial jurisdiction review by Middleton and Waunakee and provisions of intergovernmental agreements.

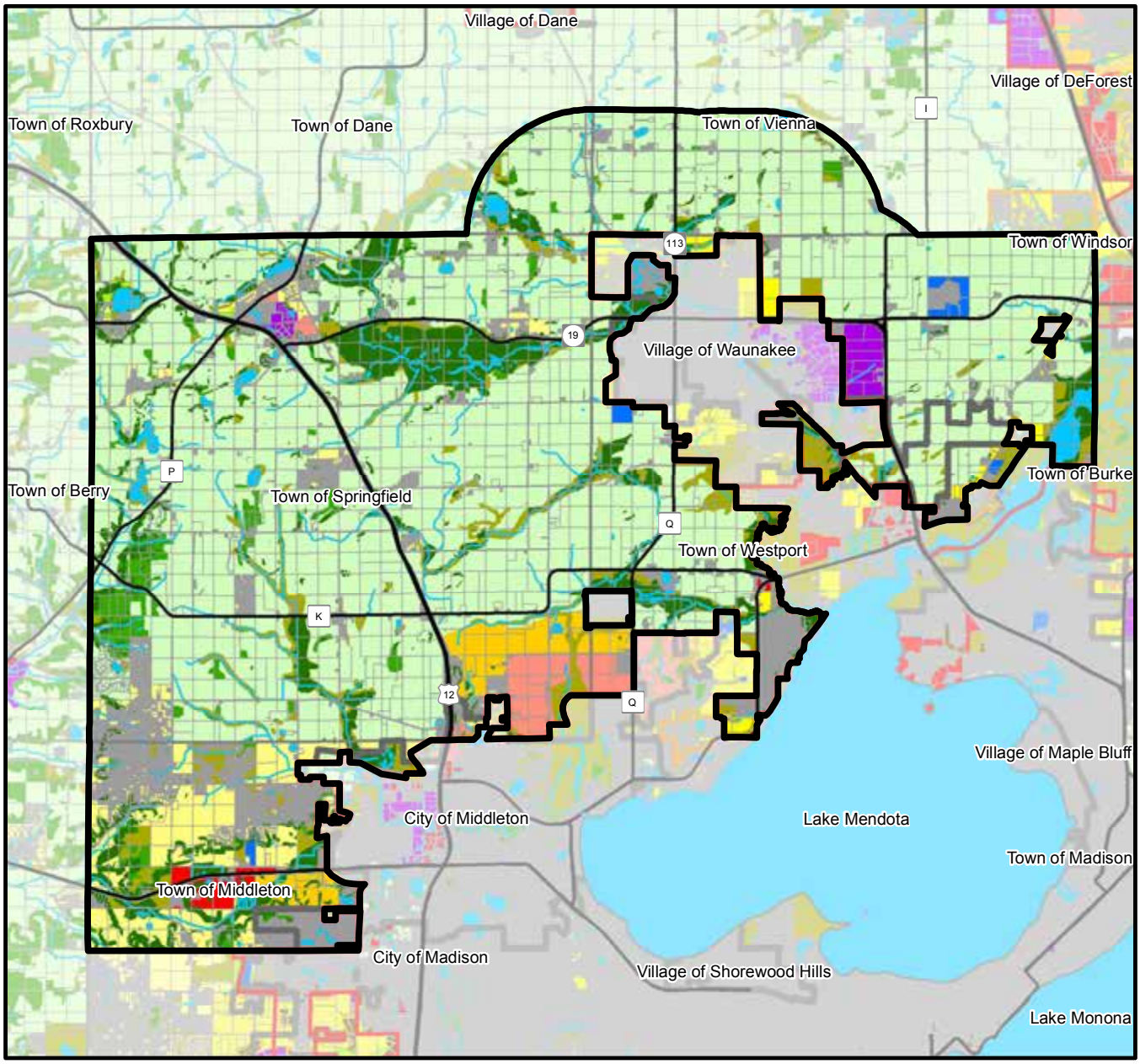
87 Residential land demands were established based on projected number of units and estimated future densities. It is assumed that if urban demand is met through USA expansion into rural areas this development would occur at urban densities.

Table 36: Rural Developable Land, Planned Future Uses and Projected Future Demands

Rural (Non-USA) Developable Acres by Planned Future Land Use (2005)				
	Total Planned Land Supply (Rural)	Total Land Demand (Rural)	Potential Redevelopment	Supply in Excess of Demand (Insufficient Supply)
Residential	3,415	329	0	3086
Commercial	322	55	0	267
Industrial	346	335	0	11
Transportation	15	180	0	(165)
Utilities	0	-15	0	15
Institutional	161	18	0	143
Parks and Recreation	31	24	0	7
				3364
Other	27,912			
10 Water Body	5			
90 Agriculture / Vacant	24,591			
97 Natural Area	2,344			
99 Woodland	972			
999 Under Construction	0			
9999 Incorporated	0			
Source: CARPC and Madison Area Transportation Planning Board				
Notes:				
Land Use Category "Mixed Commercial/Residential" tabulated as 75% residential, 25% commercial				

Map 71: Developable Land in FUDA Study Area

North Mendota Study Area, Dane County WI



FUDA Study Area
Urban Service Area
Limited Service Area
Water

Future Land Use
Rural Residential
Low Density Residential
Medium Density Residential
High Density Residential
Mixed Commercial / Residential
Planned Development
Commercial Retail and Services
Industrial / Business
Extractive
Transportation
Communication / Utilities
Institutional / Government
Parks / Outdoor Recreation
Agriculture
Natural Area
Woodland
Water Body
Undevelopable Land
Developed Land (2005)

North Mendota

Future Urban Development Area Planning

Environmental Conditions Report

Chapter IV. Conclusions & Recommendations

It is important that future development plans preserve as well as improve the integrity of our natural resources – both for our own quality of life as well as the lives of our children, grandchildren, and great-grandchildren. Well-planned and designed development can enable natural systems to retain their diversity and quality. Given the advancements that have been made in the art and science of watershed protection and urban design, it is often necessary to revisit our plans and update them using more sophisticated and advanced knowledge, methods, and techniques. This Environmental Conditions Report provides an inventory and assessment of the community and natural resources in this FUDA study area based on the best information that is currently available. This information is meant to empower local communities in their land use decisions and in planning development that respects the integrity of natural areas and incorporates environmental features into development projects. Conserving and restoring regionally important natural resources contributes to a healthy natural environment and enhances our quality of life. Connecting these regional and local features within environmental corridors helps protect water quality, sustain wildlife and plant habitat, and provides valuable opportunities for recreation and education. Assessing this natural resources information along with agricultural, economic, and community information, provides the foundation for local communities to evaluate where development should be encouraged, where resources should be protected, and where both can occur together.

A. Community Recommendations

The following provides recommendations on the kinds of natural resource conservation measures that should be considered for new development and re-development of existing areas. These considerations should be in the context of the broader agricultural and community development plans and objectives.

1. New Urban Development

Current Requirements

- Maintain at least 90% of the pre-development rainfall stay-on volume for all land uses.
- Maintain pre-development peak rainfall runoff rates for the 1, 2, and 10-year 24-hour design storms. Peak rainfall runoff rate control for the 100-year 24-hour design storm is also required in many communities.
- Account for kettles, wetlands, and closed basins when determining pre-development peak rainfall runoff rates and stay-on volumes, when applicable.
- Reduce sediment in runoff by at least 80% compared to no controls.
- Provide oil and grease control for parking lots.
- Provide thermal control for runoff in thermally sensitive sub-watersheds (i.e. areas draining to coldwater streams).
- Install stormwater practices prior to other land disturbing activities and protect infiltration facilities from compaction and sedimentation during land development and construction.
- Ensure all stormwater management facilities are properly maintained and operated.

- All stormwater management facilities should be placed in Environmental Corridors and should be publicly managed, or have a perpetual legal maintenance agreement with the local municipality.
- Delineate detailed Environmental Corridors boundaries based on a field survey of wetland, stream, and floodplain resources reflecting adopted CARPC policies and criteria.[88]

Recommendations

- Attempt to maintain 100% of the pre-development stay-on volume for all land uses, where not already required by local ordinances.
- Maintain the pre-development peak rainfall runoff rate for the 100-year, 24-hour design storm, where not already required by local ordinances.
- Maintain pre-development groundwater recharge rates.
- Conduct hydrologic analyses and planning to site municipal wells and conduct withdrawals so as not to adversely affect surface water resources.
- Provide additional groundwater recharge, water conservation measures, and/or return or recycling of treated effluent to mitigate the impacts of groundwater withdrawal from municipal wells where opportunities permit, and where groundwater induced flooding and groundwater quality concerns are not present.
- Restrict the lowest level of any structure to a minimum of one foot above the seasonal high water table, based on-site soil evaluations conducted in accordance with COMM 85.60. The on-site soil evaluations should be conducted wherever the NRCS Soil Survey of Dane County indicate seasonal zone of water saturation within 5 feet of the ground surface and hydric, very poorly drained, poorly drained, or somewhat poorly drained soils.
- Conduct a functional assessment for all wetlands (e.g., Wisconsin or Minnesota DNR methodology).
- Maintain wetland hydrology (water level bounce and duration of inundation) within acceptable limits for wetland plant species and minimize the discharge of excess nutrients into the wetlands.
- Restore prior-converted and degraded wetlands to provide flood mitigation and improve water quality and wildlife habitat. Consider watershed level wetland enhancement/restoration opportunities when on-site opportunities are not present.
- Consider reforestation and prairie/grassland restoration to reduce stormwater runoff and to enhance infiltration and wildlife habitat where possible. Consider watershed level reforestation and enhancement opportunities when on-site opportunities are not present.
- Request a WDNR Bureau of Endangered Resources review for all projects where there is reason to suspect such species might be present (e.g., Natural Heritage Inventory screening) and that necessary measures be taken if species are found.

88 http://danedocs.countyofdane.com/webdocs/PDF/capd/USA_Policies_adopted_2.28.08.pdf

- Perform a field archaeology survey if there is reason to suspect artifacts might be present (e.g., wetland areas, local knowledge, etc.).
- Consult with Dane County Parks Department staff early in the development planning process to promote opportunities and coordination, as well as avoid incompatible or potentially conflicting proposals with the natural resource elements identified in the *Dane County Parks and Open Space Plan.*

2. Existing Urban Development

Current Requirements

- Reduce sediment from runoff in existing urban areas by at least 40% or as required by the TMDL[89] for the watershed where applicable.
- Increase enforcement of construction site erosion control.

Recommendations

- Upgrade or retrofit stormwater management practices where opportunities/funding permit.
- Capitalize on converting traditional stromwater management and open space systems to green infrastructure systems.
- Prevent and remediate erosion from urban waterway banks.
- Capitalize on opportunities for urban stream, wetland, and buffer restoration and expansion.
- Capitalize on opportunities for urban reforestation and native plant landscaping.
- Harvest plants growing in existing urban wetlands to harvest captured phosphorus.
- Maintain and expand practices to reduce polluted stormwater runoff (i.e., "housekeeping activities") including street sweeping, road salt minimization and management, restrictions on lawn fertilizers, leaf collection, and community education to keep pet waste and other contaminants out of ground and surface waters.

3. Watershed Planning

Recommendations

- Promote active natural resource stewardship activities in sensitive wildlife and other resource areas (recommended 700 feet from significant WDNR wetlands and drainage lakes and 300 feet along streams).
- Work with other watershed communities (both urban and agricultural) in developing watershed management plans.
- Explore opportunities for nutrient trading between urban, agricultural, and point pollution sources associated with communities in the Rock River TMDL project[90] establishing allowable levels of phosphorus and sediment being discharged to area waters.

89 Total Maximum Daily Load. See Tools to Improve Impaired Waters at http://dnr.wi.gov/org/water/wm/wqs/303d/tmdl.html
90 http://dnr.wi.gov/org/water/wm/wqs/303d/RockRiverTMDL/

- Engage in studies, assessments, designs, and implementation of the best and most economical practices for reducing pollutant sources in the community and the watershed.
- Conduct wetland evaluations and develop restoration plans to enhance the functions and values of wetlands.
- Promote and provide incentives for water conservation activities and practices such as green roofs, rain water collection and use for irrigation, gray water reuse, drought tolerant landscaping, and low flow plumbing fixtures as part of a comprehensive water supply planning and management program.

4. Agricultural Practices

Current Requirements

- Comply with the Agricultural Performance Standards and Prohibitions in NR 151:
  - No overflow of manure storage facilities.
  - No unconfined manure piles near waterbodies.
  - No direct runoff from feedlots or stored manure into state waters.
  - No trampled streambanks or shorelines from livestock.
  - Control cropland erosion to meet tolerable rates.
  - Build, modify or abandon manure storage facilities to accepted standards.
  - Divert clean runoff away from livestock and manure storage areas located near streams, rivers, lakes or areas susceptible to groundwater contamination.
  - Apply manure and other fertilizers according to an approved nutrient management plan

Recommendations

(in the context of nutrient trading and watershed runoff management – above)

- Maintain and expand farming practices that reduce phosphorus loads and runoff, including regular soil testing, nutrient management planning, alternative crop rotations, and perennial crops near streams and in highly erodible areas.
- Remove concentrated manure loadings from the watershed, using a range of strategies to capture and convert concentrated manure sources to nutrient and energy resources, and to allow nutrients to be exported from the watershed; discourage winter spreading; and change to low phosphorus animal feeds.
- Restore wetlands and natural buffers to capture sediments and filter runoff, especially along streams and creeks.
- Eliminate livestock grazing within wetlands and along streambanks (e.g., exclusionary fencing) to reduce the organic, sediment, and nutrient loading, as well as physical damage by livestock.

5. Agricultural Preservation Recommendations

Each community in the Study Area has an adopted Comprehensive Plan and/or is part of the *Dane County Farmland Preservation Plan* that presents background, goal, objective, policy, and program information.

Communities may want to incorporate the information provided in this report into their decision-making discussion. ***Some factors or characteristics maybe more important or useful than others to farmers and the local community and it is up to the local community to determine how to best use this information in decision-making processes impacting agricultural land within the large context of regional preservation and development.***

Communities differ in how they present and use information provided in existing plans. A simple example is that these communities use different language and criteria to determine related data. For example, to determine agricultural land quality the Town of Springfield utilizes the Land Evaluation system, and the Town of Vienna states "productive and tillable land." Creating a common language for agricultural decision-making may prove useful when communities come together to jointly plan for growth and preservation.

An effective land management tool for agricultural land preservation is a boundary agreement between two jurisdictions. Boundary Agreements are discussed in local comprehensive plans. Middleton/Springfield and Waunakee/Westport established boundary agreement, while Vienna could establish boundary agreements with the Villages of Waunakee and Dane. These boundary agreements help to ease political tension, creates a more simple, predictable, and stable land management framework, and help to direct growth to more appropriate areas.

In addition, town farmland preservation maps, in accordance with the State Farmland Preservation Act, designate lands as either "preservation," "rural development," or "transition areas." These designations should be considered seriously when developing boundary agreements and in pursuing rural development.

a. Agricultural Parcels and Farm Base Tracts

- Maintain diversity in size and operation type to better protect the regional agricultural industry from severe market changes in any one sector and will better support and encourage regional food systems.

b. Contiguity and Concentration

- Maintain contiguous blocks of agricultural land to maintain the land mass that makes farming more viable and provides better protection for agricultural use. Direct urban growth away from contiguous blocks of agricultural land.
- Agricultural concentrations between major roads shows where agricultural land uses may be compromised by the prominence of other land uses. Agricultural lands in low concentration areas that are deemed valuable as agriculture preservation may be a priority for preservation efforts.

c. Support Services

- Maintain sufficient concentrations of agricultural lands to maintain the viability of support service businesses.
- Ensure adequate infrastructure to ensure support services remain accessible to the farming community.

d. Soil Quality

- Special consideration is warranted when pursuing development in these areas to preserve these lands for food cultivation dependent on soils.
- Because of the variable terrain in the area and prominence of livestock based operations, soil quality is best considered at the site specific level. Large brush applications of prime farmlands as a priority criteria for preservation might significantly limit the potential of such a program and may work against the predominant and economically productive livestock operations in the region, especially farther to the west where prime soils are not as plentiful.

e. Ecological Services and Functions

- An effective approach to evaluating and maintaining ecological services and functions of agricultural land needs to address both the extent of the area under consideration and the relevant practices. Open space corridors define ecological areas that can be augmented with additional conservation areas and practices—agricultural and recreational. This approach could integrate various programs and policies to create a network of permanent agricultural and open space preservation areas. These areas could be protected from development and have supporting recommendations for improving agricultural practices, conservation, or restoration for different places in the study area. Other areas may be well suited for integrated resource management and host multiple land uses and services simultaneously.
- Former wetlands, which have been drained with underground drainage tiles, are also shown in the report to illustrate where wetland restoration could provide valuable ecological services in agricultural areas.
- In some upland areas, reforestation of agricultural lands could benefit ecological systems.
- Ecosystem service areas should be designed with the idea that the land owner would continue to benefit financially from the land. This can be either through sale of products from these conservation areas or through payments for the ecosystem service being provided.
- Some conservation practices would greatly benefit from changes in state law and taxing policy. For example, wetlands are typically assessed at higher land values compared to farmland. Consequently, farmers not only lose cropland and income by restoring former wetlands, but also pay higher property taxes under current tax policy.

- Ecosystem service areas should be designed with the idea that the land owner would continue to benefit financially from the land. This can be either through sale of products from these conservation areas or through payments for the ecosystem service being provided.

The data in this section can augment the decision-making processes to better inform what agricultural lands a community will preserve, maintain, or develop in the Future Urban Development Area Planning process. The data and subsequent decisions can be updated or incorporated into comprehensive and farmland preservation plans as the communities update them in the coming years. The variables with the most potential for making and measuring the impact of growth on farmland at the study area scale are contiguous blocks of agriculture and agricultural concentration. Other variable such as ecological services and functions, support services, tax assessment values, and soil quality are best considered at the site level.

Appendix A

Excerpts from the *Yahara - Mendota Priority Watershed Report*

Full report can be viewed at http://danedocs.countyofdane.com/webdocs/PDF/capd/2012_postings/Publications/Yahara_Priority_Watershed_Plan_1992.pdf

APPENDIX A
Yahara-Mendota Priority Watershed Report

Grantee Name (county or tribal government):	**Dane County Land and Water Resources Department**
Grant Number:	**YME-13000-N**
Priority Watershed Project Name:	**Yahara-Mendota Priority Lake Priority Watershed Project**
Grant Begin Date:	**November 12, 1987**
Grant Expiration Date:	**December 31, 2009**

Final report contents: The document listed in parentheses next to each report topic provides a source of information or data for that topic. If you require DNR financial data reports for this final grant report, contact the Priority Watershed Grant Manager, Jeff Soellner, at jeffrey.soellner@wisconsin.gov or (608) 267-7152.

1. **Introduction:** Introduce the program and the project.

The purpose of the project was to assess the nonpoint pollutants affecting water quality within Lake Mendota. Implementation of best management practices and educational activities to control polluted runoff were needed to meet water resource objectives to protect and enhance Lake Mendota and other lakes, streams, groundwater and wetlands in the watershed.

2. **Watershed Description:** Describe particular attributes of watershed and what factors accounted for it being chosen as a Priority Watershed. Describe the quality of the water prior to project implementation. Include/attach a map of the watershed/lake. (watershed plan)

232 square mile drainage basin located in the Lower Rock River Basin. Sediment and phosphorus were the primary pollutants of concern with delivery rates of 9,613 t/y and 72,275 lbs/y respectively based on inventory and modeling. Water quality conditions did vary amongst the eleven different subwatersheds. Primary concerns that were constant included sedimentation, nutrient loading, and some channelization. Generalized conditions were decreased water clarity and nuisance algae blooms and macrophyte growth. Secondary impacts were low dissolved oxygen and thermal loading.

3. **Accomplishments:** Describe or list the following:
   - Number of landowners/operators eligible for cost-sharing and easements (annual reports) : **567**
   - Number of eligible landowners contacted during the project (annual reports): **455**
   - Number of eligible landowners participating during the project (annual reports): **237**
   - BMPs that were installed (DNR or grantee CSA data)

79 no. Barnyard Runoff Systems (Eaves, Sediment Basins & Roofs)
10 no. Diversions
58.1 ac Grassed Waterways
3,105 ft Streambank Protection
2 no. Terrace Systems
8 no. Agricultural Sediment Basins/Grade Stabilization Structures
12.8 miles Grassed Buffers along Surface Water
18.8 ac Wetland Restoration

- Number of critical sites addressed compared to total number detected (annual reports)

Barnyards:
10 Critical Site Animal Lots were addressed of the 10 Critical Site Animal Lots detected in Dane County (one critical site lot added during watershed implementation).
Cropland:
80 Critical Site Crop Fields (54 landowners) were addressed of the 80 Critical Site Crop Fields identified in watershed plan.

- Major information and education activities during the project (annual reports)

1998:

Activity:	Objective:	Attendance:
Presentation of watershed plan	**Inform Village Board of Deforest on program requirements**	**10**
Construction site erosion control ordinance workshop	**Inform builders, developers and engineers on ordinance**	**65**
Presentation at Sauk County LCD	**Use LMN as a case study for urban conservation**	**30**
Presentation to Waunakee Village Board	**Information on priority watershed requirements**	**10**
Attend Waunakee Village Board Meeting	**Provide technical background on construction site erosion control ordinance**	**10**
County Watershed Tour	**Tour Dane County Watersheds with Lakes & Watershed Commission**	**12**
Wisconsin Association of Vocational Ag Instructors	**Organized a urban and rural conservation program for ag teachers**	**35**
Presentation to Middleton High School	**Presentation to environmental conservation classes on LMN**	**65**
Presentation to Middleton High School	**Urban field trip showing effects of construction site erosion**	**65**
Presentation to Environmental Science class at MATC	**Inform students on LMN project goals**	**25**
Teacher Training Workshop	**Train area teachers on water quality testing procedures**	**77**
Presentation to Middleton High School	**Soils and habitat assessment field study with students**	**48**
Project WET	**Workshop for Deforest High School Teachers**	**24**
Presentation to Oregon High School	**Inform and educate students on stream ecology**	**56**
Presentation to Friends of Pheasant Branch	**Presentation on low input lawn care**	**34**
Presentation to Sherman Ave. Neighborhood Assoc.	**Presentation on Better Lawns and Gutters**	**11**
Stormwater Stenciling	**Teach 4-H youth leaders about stenciling program**	**22**
1999:		
Nutrient Management Planning Workshop	**Increase farmers knowledge of nutrient management planning**	**8**
2000:		
Nutrient Management Planning Workshop	**Increase farmers knowledge of nutrient management planning**	**13**
Presentation at Danco Prairie FS field day	**Inform farmers and consultants on nutrient management**	**10**
Presentation to Deforest High School Ag Class	**Educate ag students on conservation planning**	**15**
Work with Middleton High School Envirothon Team	**Inform students on landuse and its effects on environment**	**12**
Presentation to local municipalities	**Work with communities on implementation of erosion control and stormwater standards**	**100**
2001:		
Presentation to Metro Grow Employees	**Inform employees about nutrient management**	**20**
North American Lake Management Society Bus Tour	**Tour of conservation practices in LNM Watershed**	**20**
2002:		
Citizen Based Monitoring began in the LMN Watershed	**Staff worked with various citizen groups to train and assist in monitoring of water quality within the watershed.**	
Workshop on development of nutrient management plans	**Informed ag producers on the development and implementation of nutrient management plans**	**13**
Developed two newsletters	**Newsletter focused on watershed program**	**650**
2004:		
Municipal Roundtable	**Staff met with representatives of municipalities to discuss progress in updating erosion control ordinances.**	

2006:		
Workshop on development of nutrient management plans	**Informed ag producers on the development and implementation of nutrient management plans**	**10**
2007:		
Workshop on development of nutrient management plans	**Informed ag producers on the development and implementation of nutrient management plans**	**10**
2009:		
Workshop on development of nutrient management plans	**Informed ag producers on the development and implementation of nutrient management plans**	**18**

- Water and soil conservation ordinances adopted during the project (annual reports)

1995: Dane County Construction Site Erosion Control Ordinance
2001: Dane County Stormwater and Erosion Control Ordinance
2002: Dane County Manure Storage Ordinance
2005: Dane County Winter Manure Spreading Ordinance

4. **Urban Nonpoint Source Project Component:** If the watershed plan had an urban component, list and describe the accomplishments and goals met, as applicable, such as storm water management plans and utilities developed, storm water and erosion control ordinances developed, structural BMPs designed and installed, etc. If available, list the associated pollutant load reduction information for the urban practices installed.

The Dane County LCD worked very closely with the municipalities of Madison, De Forest, Waunakee, Middleton, and Sun Prairie throughout the course of the project. In the late 90's, the DNR implemented new protocols for municipal funding basically creating a competitive format under the Urban Nonpoint Source grant program. Those communities were therefore on their own to apply for and implement urban initiatives.

Unique to this project was the urban critical sites criteria which was a first for Wisconsin's Priority Watershed Program. While NR 120 didn't recognize this aspect, staff worked exclusively with all five major municipalities implement the 7.5 t/a/y soil loss standard from construction sites. Additionally, this approach also lead to Dane County amending its' own stormwater and erosion control ordinance (Chapter 14) to include such standards county-wide.

Dane County provided $198,803 in funding through the Urban Water Quality Grant Program to assist municipalities in the installation of best management practices resulting in a reduction of 36.7 lbs of phosphorus from reaching Lake Mendota annually.

Attached is additional information (pages 7-12 of this report) , which will provide a more detailed analysis of accomplishments, related to urban components.

5. **Water Resource Evaluation:** Describe the water resource goals met and the percent of applicable pollutant load reduction and other goals reached. (annual reports)
   - Barnyard phosphorus:
     Reduced barnyard phosphorus runoff by 8923 lbs annually (72 % of project goal)
   - Upland sediment
     Reduced upland sediment loss to surface water through conservation planning by 4,034 tons/annually (38% of project goal)
   - Streambank/shoreline erosion
     Reduced streambank erosion by 93 tons annually (26% of project goal)
   - Gully erosion
   - **Reduced gully erosion by 1,606 tons annually (no project goal)**
   - Nutrient management acres
     Nutrient management plans were developed on 45% of cropland within watershed.
     The below table lists nutrient management plans reviewed by county staff within the watershed. Typical, nutrient management plans are funded for a three year period. (no project goal)

- Conservation plan acres
  89.6% of cropland within the watershed is farmed at or below tolerable soil loss levels.
- Wetland restoration
  18.8 acres of cropland have been restored to wetlands.

6. **Financial Evaluation:** Compare the cost-share grant amount to the total amount of money spent on BMPs, including urban BMPs. List the amount of money spent per BMP. (DNR or grantee accounting data)

Rural Projects:

The original watershed grant amount was $2,878,340 of which $776,083.72 was spent on the installation of best management practices. Below is a table listing the amount spent per practice.

	Practice	Units installed	Total Cost-share
C3	Diversion	2050 lin. ft.	$6,686.79
C5	Grassed Waterways	10.9 acres	$20,437.32
L1	Barnyard Runoff Management	17 sites	$143,725.71
L2	Manure Storage (Manure Transfer)	1 no	$13,201.92
LR	Roof for Barnyard Management	7 sites	$400,059.53
M2	Grade Stabilization Structure	4 no.	$19,501.57
M4	Agricultural Sediment Basins	4 no.	$19,312.01
M5	Nutrient Management	1,851.7 acres	$11,687.53
MR	Streambank Protection	2455 lin. ft.	$18,340.34
R6	Critical Area Seeding	0.2 acres	$350.00
513	Total Confinement of Livestock	1 site	$122,781.00
			$776,083.72

In addition to cost-share funds from the priority watershed program, county staff worked with producers within the watershed to enter into 195 Federal Environmental Quality Incentive Program (EQIP) contracts for $1,516,874 in cost share and incentive payments. Of this amount, $1,128,817 has been used to install best management practices within the watershed.

Urban Projects: (Funding from Urban Non-Point Source Program)

Municipality Name	**Name of Grant**	**Grant Cycle**	**Objective**	**Completion Date**	**Cost**
Urban SW Construction Grant					
City of Madison	Wexford Retention Retrofit	2000	Retrofit dry to wet pond	2000	$249,325
City of Middleton	Pheasant Branch Creek Stabilization Conservation Project	2006-2007	Erosion control and streambank stabilization	2008	$58,450
City of Middleton	Hwy 12 Catch Basin	2005-2006	Proprietary device installation	2006	$65,000
City of Middleton	Pheasant Branch Wet Pond	1997-2001	Wet pond construction	2001	$151,200
City of Sun Prairie	Token Creek Water Control	2000	SW Control	2000	$37,392
University of Wisconsin	Lot 34	2005-2006	Retrofit parking lot	2007	$150,000
University of Wisconsin	Angler's Cove Parking Lot	2003-2004	Retrofit parking lot	2004	$40,000
Village of Deforest	Industrial Park Pond	2000-2003	Wet pond construction	2003	$24,500
				Total:	$917,547
Storm Water Planning Grants					
City of Middleton	Storm Water Plan	2005-2006	Develop storm water mgmt plan	2007	$85,000
Village of DeForest	Storm Water Plan	2005-2006	Develop storm water mgmt plan	2007	$70,000
Village of Waunakee	Storm Water Plan	2006-2007	Update storm water mgmt plan	2007	$43,610

Village of Waunakee	Storm Water Plan	2000	SW Plan/ Erosion Control Ord.	2000	$43,574	
Village of Maple Bluff	Storm Water Plan	2006-2007	Develop storm water mgmt plan	2007	$18,000	
Village of Shorewood Hills	Storm Water Plan	2006-2007	Develop storm water mgmt plan	2007	$63,982	
City of Sun Prairie	Storm Water Plan	2000-2001	SW Plan/ I&E/ Erosion Control Ord.	2001	$19,285	
University of Wisconsin	Storm Water Plan	2002-2005	Develop storm water mgmt plan	2005	$96,430	
				Total	$439,881	

Evaluate the effectiveness of local assistance grant expenditures. (DATCP or grantee accounting data)

The local assistance grant was effective in assisting Dane County to fund staff to work on the watershed project. Staff were able to conduct outreach programs promoting the watershed and to assist landowners in the design and installation of conservation practices. The urban staff funded by the local assistance grant focused on the municipalities within the watershed assisting in updating of ordinances and improving construction site erosion inspections. The rural staff partnered with the Natural Resources Conservation Service in administering the federal Environmental Quality Incentive Program providing landowners an alternative cost share source for the installation of conservation practices.

A frustration with the local assistance grant was that funds did not increase over the years to cover the increase in salary costs.

7. **Summary and Conclusions:** Summarize the report and evaluate the overall success of the project.

The Yahara-Mendota Priority Lake Project spanned a time of changes in both the priority watershed program and agriculture. During the early years of the project, cost share funds available for installation of best management practices were limited. This resulted in project staff using the federal Environmental Quality Incentive Program (EQIP) as a cost share source. This resulted in over $1.2 million dollars of federal funds being used to install conservation practices. In agriculture, the farms transformed to larger, family corporations resulting in the concentration of livestock. Thus, best management practices typically installed (i.e. barnyard runoff systems) no longer solved the barnyard runoff resource concern. This resulted in Roofs for Barnyard Management being promoted as the best management practice to solve the resource concern from animal waste runoff.

Agricultural Summary:

- **42% of landowners/producers within the watershed installed or implemented a best management practice.**
- **All animal waste critical sites identified in the watershed plan were addressed.**
- **All cropland critical sites identified in the watershed plan were addressed.**
- **79 animal lots within the watershed have installed conservation practices or implemented management changes, which reduced animal waste runoff.**
- **155.9 ac of cropland has been seeded to grasses to establish buffers along surface water and wetlands. These buffers trap sediment and filter nutrients before runoff enters surface water. (Assuming an average width of 100-ft, this represents about 12.8 miles of surface water with grassed buffers installed).**
- **As part of Dane County winter spreading ordinance, staff worked with 29 livestock operations to develop winter spreading plans to minimize runoff from applications of liquid manure on frozen, snow covered or ice covered ground.**
- **Greater than 45% of the cropland acres in the watershed developed and updated nutrient management plans.**
- **Completed Farm Practices Inventory Survey (FPI) with producers to establish baseline data and trends. The same producers are being surveyed in 2010 to identify changes that have occurred as a result of the watershed project.**

Urban Summary

- **Municipal adoption of the 7.5 tons/acre construction site erosion control standard.**
- **Development and application of two interim BMPs including polymers and urban catchment basins.**
- **Identification and mapping of all urban outfalls.**
- **Provided municipalities with hydric soils maps for consideration when developing.**
- **Provided technical assistance and guidance when applying for Urban Non-point Source grants.**
- **Sun Prairie, Waunakee, and DeForest developed stormwater management plans.**
- **Developed and administered intergovernmental agreements for erosion control and stormwater plan review and inspections in DeForest, Waunakee, Middleton, and Sun Prairie.**
- **Developed criteria for urban critical sites, which was a first for the Wisconsin Priority Watershed Program.**

- **Provided administrative and technical support on all phases of erosion control and stormwater management initiatives to municipal partners.**
- **Watershed plan was impetus for further development and adoption of Dane County Chapter 14 Code of Ordinances Subchapter II, in 2002.**
- **Conducted two USEPA funded research projects evaluating effectiveness of erosion control practices.**
- **Dane County provided $198,803 in cost share funds to municipalities for the installation of best management practices at channel outfalls reducing 36.7 lbs of phosphorus from reaching Lake Mendota annually.**

Completed by: **Name (first mi. Last)**	Steven J Ottelien and Peter L Jopke
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Date Completed: (mo day yr)	April 30, 2010
Signature:	

Attachments: Map of the project
Photos of the project

DNR Copy distribution (3):

(1) 2 copies to Priority Watershed Grant Manager – Jeff Soellner, WI DNR CF/2, PO Box 7921, Madison, WI 53707-7921
(2) NPS Region Coordinator

Lake Mendota Priority Watershed

Interim Review of Success in Meeting Urban Pollutant Reduction Goals

The urban project goals include both sediment and phosphorus objectives. They were broken down into two categories to include existing and transitional areas. A third component (future) was also included but it is assumed that these future developments will be addressed by the new Dane County Erosion Control and Stormwater Management Ordinance (Chapter 14). Phosphorus objectives will be met in the following categories if the overall sediment objectives are satisfied.

Urban Project Goals- (Existing)
Sediment-40%
Phosphorus-20%

Urban Project Goals- (Transitional)
Sediment-80%
Phosphorus-60%

Existing Urban Areas-Management Needs & Alternatives

Management	***Status***	***Recommendation***
Increase street-sweeping frequencies to one time per week in areas identified as downtown commercial strip.	At this time, project staff do not know whether this alternative is being implemented	Visit with municipalities to review street-sweeping frequencies and areas targeted.
Increase and maintain street sweeping in other established urban areas to once every three weeks.	At this time, project staff do not know whether this alternative is being implemented	Visit with municipalities to review street-sweeping frequencies and areas targeted.
Construct and maintain urban catchment basins where there is direct discharge of stormwater to surface waters.	To date, it is estimated that three basins have been constructed in such areas.	Staff met with municipalities on various occasions to identify and prioritize locations. Municipalities indicated financial support as a limiting factor. Will continue to encourage pursuing Urban Nonpoint Source and Stormwater DNR Grants.
Direct runoff to buffer strips, porous pavement, infiltration trenches, and shallow depressions where sediment can be deposited and runoff reduced.	This recommendation is targeted for redevelopment. It is not known to what extent this is occurring although contracted municipalities have been addressing these issues where they can according to ec/sw plans reviewed by this office.	Continue to encourage this through the plan review process.
Adopt effective storm water management plans for each future development site.	All municipalities have stormwater management plans including Sun Prairie, Waunakee, and Deforest which prepared plans during the planning phase of this project.	The new Dane County EC/SW Ordinance will force compliance.

Transitional Urban Areas- Management Needs & Alternatives

Management	***Status***	***Recommendation***
Apply and enforce the 7.5 tons/acre construction site erosion control standard to all municipalities in the watershed.	All municipalities adopted this standard prior to the County Requirements in August 2002. The LCD has also contracted for plan review/inspection of construction sites in DeForest, Middleton, Waunakee, and Sun Prairie. Madison has hired an additional staff person and does this internally.	Continue to work with municipality in the watershed in this capacity.
Avoid development in areas with hydric soils.	LCD staff have provide municipality with maps indicating where hydric soils are located within their municipality boundaries.	Continue to work with municipality staff on the importance of not developing in these areas. Suggest alternatives and continue to recognize the value of these areas during the plan review process.
Reduce direct discharge coming from developing areas by 80%.	Direct discharges have been addressed during plan review. All plans within the municipalities having contracts are meeting this requirement.	Continue to address through the plan review process. Although LCD staff do not do this per contract requirements, suggestions are made per the approval letter.
Maintain peak stormwater flows to pre-development conditions for the 1,2 and 10-year 24-hour storm.	Peak flows are addressed for the 2 and 10-year storms only. With the exception of Sun Prairie, all municipality administer this through their own consulting firms or staff.	Continue to address through the plan review process. Although LCD staff do not do this per contract requirements, suggestions are made per the approval letter.

Urban Streambank Erosion

Urban streambanks are evaluated on a site-by-site basis. Currently, the North Fork of Pheasant Branch Creek is be reconfigured by the City of Middleton. As part of the development in that sub-watershed, the stream will be re-routed with a meandering pattern while strategically rip rapping certain segment. The South Fork of Pheasant Branch had a portion of its banks stabilized in 1997-1998. The Village of DeForest has been conducting annual stream clean-ups on the Yahara River but has not done any stabilization work. Finally, the City of Sun Prairie has undertaken an aggressive approach to minimizing thermal runoff into Token Creek. Although this was not an original goal of the Plan, all development in the Token Creek Watershed will include management practices for thermal pollutant reduction.

Pollution Prevention Practices

Pollution prevention practices are intended to remove pollutants at the source and prevent the need for treatment after they enter the water resource. Types of pollution prevention practices identified in the plan include:

- Reduce or eliminate the use of galvanized roof materials, which are sources of zinc in urban runoff.
- Immediate removal of pet wastes from urban areas, which can contribute bacteria to area surface waters.
- Control the use of herbicide and pesticide applications.
- Proper disposal of automobile fluids to keep them out of the stormsewer system.
- Removal of accumulated sediment, leaf material, and other debris from catch basins, streets, and parking lots. This can contribute nutrients to surface waters while inhibiting overall municipal maintenance.
- Control development and redevelopment through zoning which may influence the overall stormwater management impacting water quality, flooding, and habitat degradation.
- Minimize the use of de-icing compounds. Sodium chloride levels have shown an increase in groundwater resources.
- Control construction site erosion.
- Reduce the amount of motorized traffic.
- Reduce the areal extent of parking lots.

The above programs are best administered through the local municipality. Each municipality should be encouraged to address these issues. All of the prevention practices listed were part of the Information and Education strategies developed for this watershed. However, due to budget deficiencies and changes at the staff level, the information and education strategies have not been given a high priority with the exception of construction site erosion control and post development stormwater. From a priority standpoint, the project goals will have a higher likelihood of being met with the emphasis being placed on proper erosion control and stormwater management.

Urban Critical Sites

This watershed plan was the first in Wisconsin to include urban critical sites. Urban critical sites are all transitional areas that exceed 7.5 tons/acre/year in soil loss during the construction phase. The other critical site component includes areas of direct discharge into Lake Mendota or other surface waters that meet the following criteria: outfalls with a ratio of sediment (tons) to land area (acres) that is greater or equal to 0.2 and where best management practices are identified through a feasibility study.

Since all municipalities in the watershed area have adopted the 7.5 tons/acre/year soil loss rate and are actively administering it, there are no critical sites falling into that category. However, the second critical site component is not actively being targeted. Part of the reason is that there is no legal authority under NR 120 governing critical sites in urban areas. Secondly, although areas were initially identified during the inventory phase, no additional effort has been made to work with communities where the ratio is greater than 0.2.

Appendix B

Excerpts from the *Black Earth Creek Priority Watershed Report*

APPENDIX B
Black Earth Creek Priority Watershed Report

The following tables represent conservation efforts in the Black Earth Creek (BEC) watershed in Dane County through 1998. The pollutant load levels reflected in the tables represent levels achieved as of December 31, 1998. The percentages of reduction are for implemented practices only. The tables consist of the following sections:

- Pollutant Source-The type and source of the nonpoint source pollutant identified as a water quality impairment.
- Inventoried Load-The amount of phosphorus, sediment, or soil loss calculated at the inception of the project. Provides the baseline from which to derive pollutant reduction goals.
- Goals-The amount by which the project aims to reduce that pollutant by. Usually expressed as a percentage in watershed plans.
- Reduction-As of December 31,1998, the amount of nonpoint source pollution reduced.
- % Reduction of goal-As of December 31, 1998, the percentage of nonpoint source pollution reduced relating to project goals.
- % Reduction of total load-As of December 31, 1998, the percentage of nonpoint source pollution reduced based on the total inventoried load.

Black Earth Creek Priority Watershed

Watershed Black Earth Creek	Project Start 1989	Project End 2001		
Pollutant Source	Barnyard (Phosphorus)	Upland Sediment	Gully	Streambank
Inventoried Load	3,752 lb.	426,726 tons	11,800 tons	39,010 tons
Goals (Reduce By)	1,876 lb. (50%)	213,363 tons (50%)	5,900 tons (50%)	19,505 tons (50%)
*Reduction	3,198 lb.	327,499 tons	10,555 tons	32,756
% Reduction of goal	170%	153%	179%	140%
% Reduction of total load	85%	77%	89%	70%

**Represents local, county, state, and federal funding sources.*

There were approximately 300 contacts made with 108 of them signing contracts. The following quantify the practice type and number installed:

Practice	**Unit**
Barnyard Runoff System	88
Rock Crossing	36
Lunker Structures	625
Fencing	34,380ft.
Rip Rap	37,440
Shaping and Seeding	31,875

The BEC watershed was completed in the year 2001. The project has been very successful as can be seen by the pollutant load reduction. Pollutant reduction goals have been exceeded by 61% on average. As part of the nonpoint source redesign in 1998, the BEC watershed ranked first in the state. In total, $1,518,935.00 in cost-share has been provided through this watershed project since 1989.

Water Quality Improvements

A major indicator of the benefits of the project can be seen in the Brown Trout fishery of Black Earth Creek. The Wisconsin Department of Natural Resources (WDNR) has been conducting annual spring densities of the stream. The data has shown that since 1989, the responses to the Black Earth Creek Priority Watershed Project were very positive both by the fish and by fishermen. Trout densities increased from 200-500% depending on the pre-existing habitat in the area and how limited it was. Fishermen responded to the habitat improvement work in such numbers that local biologists could not fish some improved stretches for a season, due to the number of anglers. It is not uncommon to now see vehicles from Illinois, Michigan, Minnesota, and Missouri parked along the stream and Trout Unlimited has selected Black Earth Creek as one of the top 100 streams in the country. This rating is based on many tangibles, but it is one of the best because it has a wild brown trout population that is easily accessible by a large population of people. Local residents have really come to appreciate the resource and are much more protective of it, in large part because of the watershed project. During the summer of 1999, the fishery was featured on ESPN Outdoors as a top trout-fishing destination in the Midwest.

Appendix C

Excerpts from *the Wetlands of Dane County, Wisconsin*

Full report can be viewed at http://danedocs.countyofdane.com/webdocs/PDF/capd/2012_postings/Publications/Wetlands_of_Dane_County_DCRPC_1974.pdf

THE WETLANDS OF DANE COUNTY, WISCONSIN

1974

Prepared by

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for the

Dane County Regional Planning Commission

in cooperation with the

Wisconsin Department of Natural Resources

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PHEASANT BRANCH MARSH

Yahara River Valley Region

Priority Group II

Wetland Description

Pheasant Branch Marsh, in the Town of Middleton, is under consideration by the City of Middleton for a purchase and preservation program. It is part of the Lake Mendota watershed, and as such, its preservation is important in protecting the quality of the lakes.

This report describes Pheasant Branch Marsh as of the beginning of 1973. The marsh, with a lowland area of 311 acres, has a surface watershed of 1,400 acres. This does not necessarily coincide with sources of spring water, which are more difficult to determine. There is a good possibility at this time that a student at the University of Wisconsin will be making a hydrologic study of the region. This will be necessary to understand the action of the marsh on ground and surface water and vice versa. Counting the springs and streams entering the marsh does not give a sufficient picture of this action. However, it can be said that there is a continuous flow of water through the lowland basin, and that over half of the water appears to pass down open channels, rather than through stands of emergent vegetation. This may limit the capacity of the marsh to clean the water.

Six plant communities can be recognized in the area: upland old field; upland forest; lowland forest; sedge meadow-shrub carr, including sedges, grasses, and shrubs; shallow marsh, including mostly bur reed; and submerged aquatic plants in open water. At least some of the upland old field has been used in the past as cropland or orchard. This area provides winter weed seeds and cover for birds, a winter source of apples for deer, and bird nest sites in summer. The proximity of upland old field, lowland shrub areas, and open water at the springs has made Pheasant Branch an attractive area for small birds in winter. We have noted much higher numbers of wintering small birds here than in most other marshes.

On the west edge of the area, on the hillside next to Pheasant Branch Road is a small region of recent dumping whose winter ecology deserves brief mention. It will serve as an example to show that limited disturbance can add to the food web, provided plants are allowed to re-invade. Due to the dumping and earlier plowing, several weed species are found to be abundant here. These are pioneer species; that is, they require bare soil to start their

growth, and in turn provide moisture and shade for other plant species to grow later. Especially notable for their seed crop are giant ragweed (Ambrosia trifida) and pigweed (Amaranthus sp., Chenopodium sp.). The seeds are being taken by large numbers of tree sparrows and mice (Microtus sp.). These in turn, especially the mice, provide food for various predators. Two owls, the great horned owl and the short-eared owl, have been seen in the area this winter. House cat tracks were seen in the weed area among the mouse tracks.

In winter, the only other heavy wildlife use is found in the open water channels. A large open channel is found in the center of the marsh, flowing southward from the largest spring. Here hundreds and sometimes thousands of ducks can be found. Recently a flock of 160 mallards and 4 black ducks was seen. Earl Loyster of the Department of Natural Resources has noted over 2,000 wintering ducks here on occasion.

The rest of the lowland, including the sedge-grass-shrub area, the black willow forest, and the large stands of bur reed, supports much more bird and animal life in the warmer seasons. During migration the open water is used by mallards, black ducks, shovelers, lesser scaup, wigeons, coots, blue-winged teal, green-winged teal, and wood ducks for rest and feeding.

The three lookout areas designated on the management map provide vantage points for observing without disturbing these ducks. The breeding season brings at least moderate numbers of the usual wetland nesting birds -- red-winged blackbirds, swamp sparrows, sora and Virginia rails, mallards, blue-winged teal, long-billed marsh wrens, short-billed marsh wrens, etc. -- along with a few representatives of species less commonly seen in Dane County. One immature male yellow-headed blackbird was seen, and a female harrier has been observed feeding in the area on several occasions.

The combination of lowland forest with shallow marsh and open water provides a suitable habitat for nesting wood ducks, as well as perches over water from which green herons and kingfishers can hunt. Dead and dying trees attract woodpeckers. The large stand of wild rice provides food for ducks, other birds, and muskrats. At least twenty-five muskrat houses were located in the marsh in 1972.

In spite of the heavy siltation which has occurred in the marsh, the diversity of submerged aquatic vegetation is good, not being limited to or dominated by two or three species. However, the almost complete dominance of bur reed in a large area north

of the pond suggests that the silt deposits have diminished the diversity of emergent vegetation in that part of the marsh. Excessive duckweed choking the open water during late summer serves as a warning that eutrophication is occurring.

In addition to having an above average diversity of the more common native wetland flora, Pheasant Branch Marsh has several small patches of the less commonly occurring small yellow ladyslipper (Cyripedium parviflorum). We know of few other stations for this species in Dane County.

Management Considerations

It has been of interest recently to use marshes as settling basins to protect water quality downstream. This is a useful technique because (1) marshes store organic material, thus reducing the flow of nutrients into downstream lakes; and (2) marsh vegetation slows and breaks up water flow, causing finer silt to be dropped. These are both functions which an open holding pond cannot perform.

However, there is a serious drawback to looking at the pollution-siltation problem in this way. The number of marshes available in southern Wisconsin is increasingly limited. Each can clean the water effectively only if the rate of inflow of nutrients and silt is not too great. Further, the process places a load on the marsh itself, leading to eutrophication and filling with sediment. If the load is too great, the marsh ceases to be effective in protecting downstream waters, and ceases to be a healthy ecosystem itself.

For these reasons, we should turn the problem around, and use the marshes as indicators of land use problems, just as canaries are used to detect gas problems in mines. If the nutrient and silt load on the marshes is too great, it is the land practices upstream which must be altered. We can use a marsh, such as Pheasant Branch, as a warning system to let us know when to improve land practices. Further, by protecting a marsh such as this one, we automatically receive three benefits: lake protection, a healthy marsh, and the knowledge that the upland is being properly used also.

The following guidelines include some concepts which are not generally familiar, and certainly not in general use at this point. These techniques include buffer zones near the marsh, protection of springs, identification and protection of water sources above springs, erosion controls upstream, control of nutrient sources, settling areas above the marsh to control silt, and graded density development.

Buffer zones are necessary to a balanced wetland ecosystem. This is generally known by biologists and by some planners, but is rarely regarded as important in practice. This is, of course, due to our outdated land use system. In practice, edges of wetlands are dredged and filled, often with high density residential or even commercial or industrial development nearest the lowland. The values of a buffer zone include: (1) an upland breeding area for water-using animals, such as ducks and turtles; (2) a foraging and resting area for water-breeding animals, such as frogs and blackbirds; (3) an undisturbed transition zone between water and land, this being a region of heavy wildlife use; (4) protection of water quality; (5) protection against water level fluctuation; and (6) a large enough area available for home ranges to make it possible for a large number of bird and animal species to use the wetland.

Buffer zones can also be used for locating upstream water control areas, such as grassy silt-settling basins and ponds to catch sudden heavy runoff. Since most people are not confident about entering the low portions of a wetland, the existence of an upland buffer makes possible various types of low-intensity recreation, such as picnicking, hiking, nature instruction, and wildlife observation.

Springs, once abundant, are becoming less so in the Dane County area. This is due to several factors: increased pumping of ground water for city use, increased development of the land surface, which must cause at least some water to flow overland rather than entering the ground, lack of understanding, or even negligence. Three spring areas have been identified in the Pheasant Branch Marsh area to date. These provide a relatively clean steady water flow. With the improved protection of Pheasant Branch Creek, the marsh has the potential of being fed mostly by clean water. This, of course, requires that the springs themselves be purchased and protected. Further, the ground water recharge areas for the springs should be located. These must be protected if spring flow is to continue.

The results of erosion and nutrient inputs are now attracting public concern. However, much discussion still centers on cleaning up the results of bad management without attacking the sources. Water control should be practiced as far upstream as possible. Ideally , as soon as the raindrop hits the ground, its course should be properly managed. Only then will downstream cleanup become worthwhile. Pheasant Branch now provides an opportunity to demonstrate proper water control. Its watershed is small enough to handle. It is not too late to identify and correct problems.

Graded density development is perhaps a new concept. It is almost the reverse of present practice (see Figs. 15 and 16). A natural area, such as a wetland, is identified. An appropriate buffer zone is planned, including water control areas if necessary. In the ring of land nearest the buffer zone, and elsewhere on steep hills, is a zone of low density development only. This might include parks, schools, or very low density residential zoning. Light industrial zoning is appropriate if buildings are sparse and no toxic effluents enter the wetland. It should be an area of great scenic value, being nearest the natural area, and would have higher property value. The low density mentioned is definitely lower than that of most present residential (R1) developments. Strict attention should be paid to preserving natural amenities, such as scenery, trees, and natural land contours. Pavement should be at an absolute minimum. Strict controls should be placed on the amount of soil laid bare by construction, especially where hills are steep.

The second zone, moving away from the natural area, could be of greater density and include the same types of use. Attention should still be paid to protecting the land during and after construction, as it should everywhere. However, tight restrictions would not be quite as crucial as in the first zone. Further zones, if desired, could include increased use density, all the way to R-4 residential or heavy industrial. A further and very important consideration would be the placing of major travel, power, and sewer routes away from the natural area. Where reasonable, such natural areas would be connected by a green corridor system, as advocated by the Dane County Regional Planning Commission.

Future Use

Pheasant Branch Marsh, due to its size, diversity, location, and upland buffer zone, is an ideal area to develop for low-intensity recreation and for teaching. Purchase and management suggestions in this report are made with these uses in mind. The types of use available here are quite close to present uses in the University of Wisconsin Arboretum. Public pressure on the Arboretum serves to alert us that there is a definite and growing need, both for low-intensity recreation and for school and public outdoor education. The Arboretum guide system is in the process of expanding its size and coverage, and will become available for areas such as Pheasant Branch.

Some suggested uses of Pheasant Branch Marsh, by region, are:

1) Hiking on and off trails, nature study. A limited amount of walking off trails will not injure any existing values, since large numbers of people do not choose to enter the wetter areas. Suggested trail areas are: the hill along the west side (areas 8 and 4) with a loop into the willow forest (area 9) and a bridge or two across the new ditch; the wooded hillside on the east (area 5) using the present motorcycle trail, connecting with the lookout designated on the east hill (area 10) and extending southward to the County Road M ; on the north side, looping up over the prairie hill (area 17), down to the major spring (area 16), and into the sedge meadow west of it (area 2); possibly also west of Pheasant Branch Road (areas 3 and 7). These trails can be planned to connect if desired, making it possible to walk all of the way around. Exact locations of trails should be planned by a naturalist, so as to take best advantage of various features while doing a minimum of damage. It will be found that the forested lowland will not be usable during some times due to mosquitoes. However, the Arboretum, which also has this problem, has never sprayed and has had no complaints by hikers. Boardwalks in the wetter portions of the marsh may be found desirable in the future.

2) Canoeing. A canoe can enter the marsh from the lower part of the creek. This is a perfectly compatible use, and does not require further development of the area other than proper water quality management, as outlined elsewhere in this report.

3) Snowshoeing. It is relatively easy to get around in an old field or sedge meadow on snowshoes. One can go anywhere without doing damage.

4) Horseback riding. It may be desirable to allow horses on certain trails. However, horses should not enter the lower areas where they will sink into soft soil.

5) Picnicking. The hillside on the west (area 8) is excellent for this use, combining opportunities for hiking, relaxing, nature study, and an excellent view. Facilities could be placed with minimum disturbance to the area. Maintenance of a natural grassland would eliminate any need for mowing, and would be more esthetic. Another possible picnic area would be on the hillside north of the marsh (area 17).

6) Public school field trips, public tours. This would be much the same sort of program as is now used in the Arboretum. The combination of steep hills, springs, marsh, and lowland forest would be excellent for introducing groups to natural diversity. Facilities used would be the trail system and picnic areas noted above. A shelter would be necessary at times. The existing house north of the marsh might be considered for this.

7) Availability of parking. Three areas are suggested as suitable for access to trails and picnic areas. None are deep within the natural area. For the west hill (area 8), a flat spot on top of the hill across the road could be used. For the southeast (areas 5 and 10), a flat place exists near the County road (M) just east of the creek. For the prairie hill area along the north (areas 16, 17, and perhaps 14) parking could be located where the present private road meets Pheasant Branch Road.

Non-compatible uses: Certain uses are not consistent with maintaining this natural area, or with public interest. Some of these are:

1) Snowmobiling, motorcycling, use of all-terrain vehicles. These are damaging to the plant communities, scare wildlife, and diminish the experience of those who come for other types of enjoyment.

2) Motorboating and fishing. The open water area is too small and shallow for these uses, which can easily be pursued in other areas nearby. Dredging for these purposes is not in the best interest of marsh preservation.

3) Skating. Due to the presence of open water in cold weather, the City of Middleton should not encourage skating here. A large proportion of the available ice surface is not reliable.

4) Shooting and trapping. As this area becomes more used by the general public, shooting will be increasingly hazardous. Due to probable use as a nature study and perhaps research area, trapping should be done only by the proper authorities to meet specific needs, as in the Arboretum.

Another type of future use of eventual public benefit is the restoration of natural communities. The dry hillside on the north, now containing some prairie remnants, is ideal for such restoration. The upland and lowland forested areas each once had characteristic wildflowers, and both areas have been disturbed. The restoration of such plants and removal of the exotic pest honeysuckle can bring much pleasure to future hikers. The maintenance of open grassland areas and semi-open areas will aid in wildlife attraction, public enjoyment, school projects, and teaching opportunities. If not maintained, some of these areas will go to shrubs and eventually to trees. The right balance in each area should be sought.

In order to carry out and aid in the above uses of the Pheasant Branch area, which could in time become the Pheasant Branch Natural Area, it is hoped that a full-time naturalist could be hired to live on the site. The present house on the north side is ideally located for this, as well as for a small nature center-shelter. The duties of such a naturalist should include:

Conducting public tours on suitable weekends;

Working with teachers and the guide system to expedite school tours;

Establishing and maintaining the trail system, as suitable;

Maintaining open areas, semi-open areas, and edge, and coordinating volunteers in brush removal;

Carrying out prairie restoration and aiding in school projects in study and restoration of prairie;

Carrying out upland and lowland forest floor plant restoration and aiding in school projects;

Coordinating overall maintenance and restoration, working in other plant communities needing attention;

Collecting seasonal data on vegetation, wildlife, water cycles, public uses, etc., and making them available to interested parties;

Acting as troubleshooter for water problems, land misuse, public nuisances and other problems, and informing appropriate parties when necessary.

Pheasant Branch Marsh offers an excellent opportunity, one which is rapidly becoming scarcer, yet more in demand. It is the hope of the writers that this opportunity be used to the fullest extent possible.

PHEASANT BRANCH MARSH
VEGETATION AND LAND USE

MAP KEY

Emergent vegetation, mostly bur reed (*Sparganium eurycarpum*) in dense stand, wild rice (*Zizania aquatica*) in open water area.

Mixed emergent vegetation, including sedges.

Sedge meadow, much of it with tussock sedge (*Carex stricta*) dominant. Note grazed portions (see below).

Wetland shrubs, mostly willows (*Salix bebbiana and S. petiolaris*) and red-osier dogwood (*Cornus stolonifera*).

Wetland disturbance plants, especially reed canary (*Phalaris arundinacea*) and giant ragweed (*Ambrosia trifida*).

Old field.

Upland and lowland wooded areas.

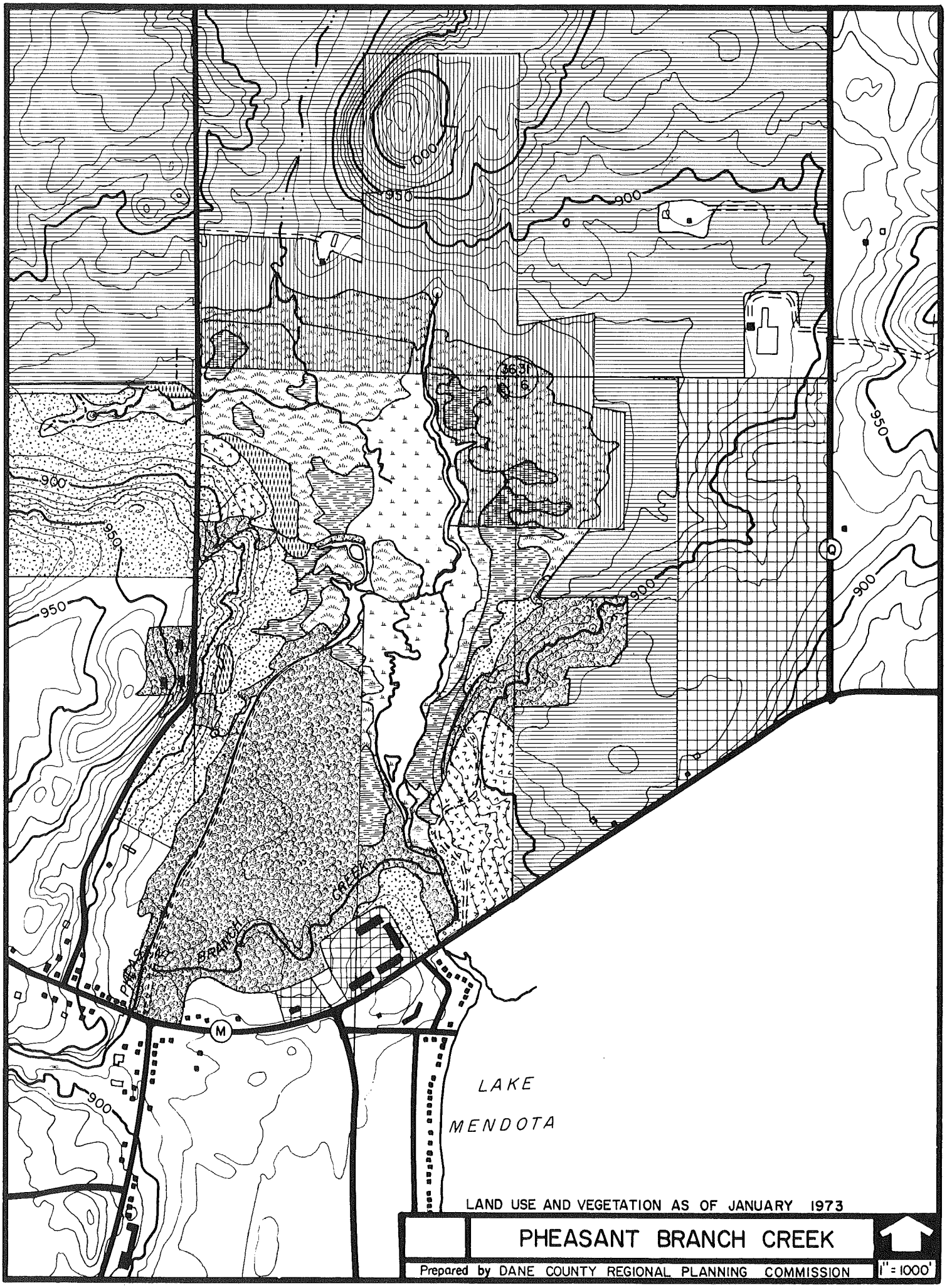
Grazed by cattle.

Cultivated.

Suburban development and construction areas.

Bulldozed (east side) and dump (west side) areas.

Spring.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PHEASANT BRANCH CREEK
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LAND USE AND VEGETATION AS OF JANUARY 1973
PHEASANT BRANCH CREEK
Prepared by DANE COUNTY REGIONAL PLANNING COMMISSION
1" = 1000'

PHEASANT BRANCH MARSH

MANAGEMENT SUGGESTIONS

MAP KEY

Known winter wildlife use area.

Present extent of wildlife and natural vegetation area.

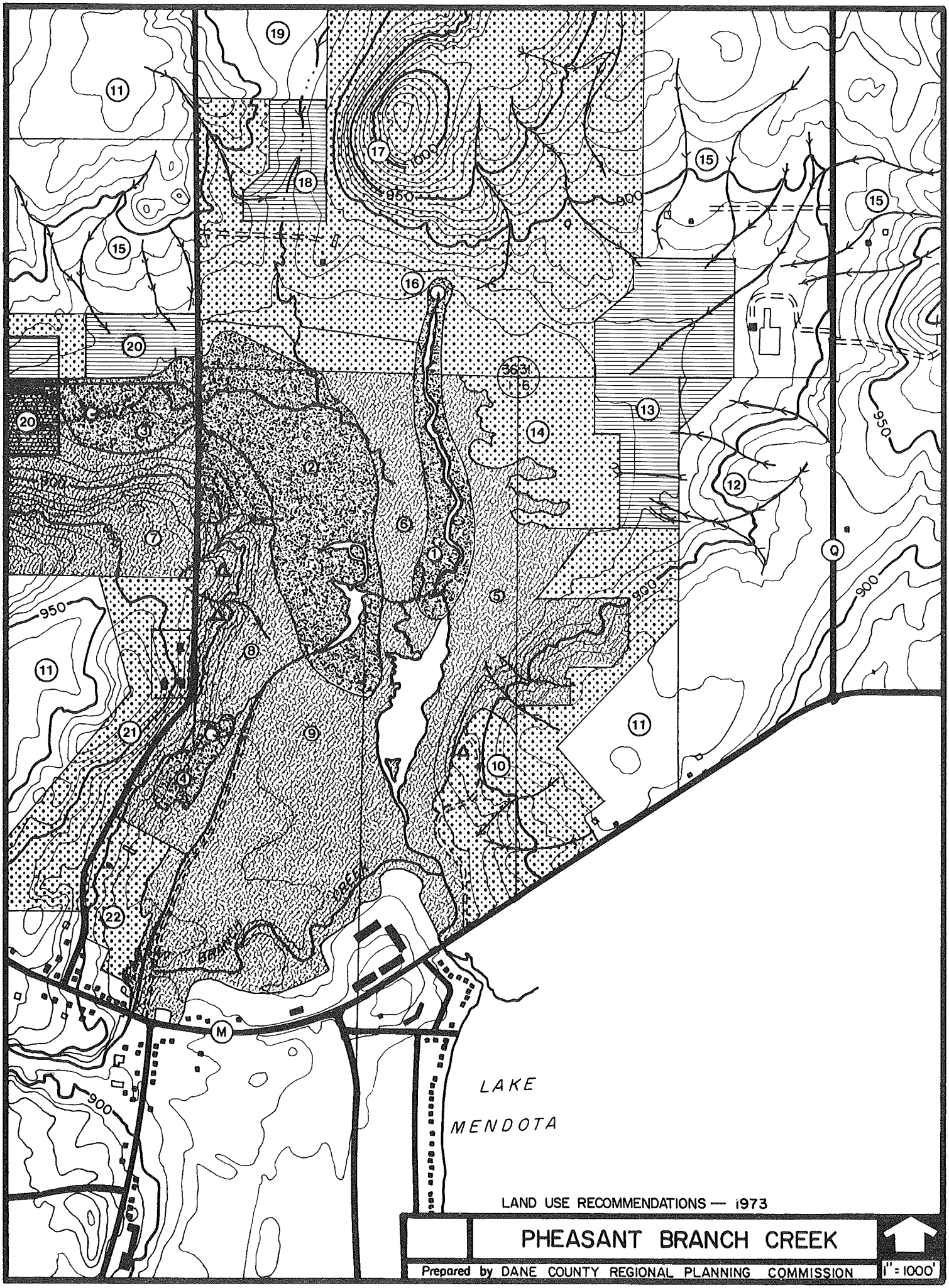
Buffer zone, additional to above.

Water collection and control area.

Limited development area.

Some patterns of surface flow toward marsh.

△ Wildlife and scenic observation point.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LAND USE RECOMMENDATIONS — 1973
PHEASANT BRANCH CREEK
Prepared by DANE COUNTY REGIONAL PLANNING COMMISSION
1" = 1000'

PHEASANT BRANCH MARSH
MANAGEMENT SUGGESTIONS

MAP EXPLANATION

Numbers in each category read roughly counterclockwise.

KNOWN WINTER WILDLIFE USE AREAS. These are areas of greatest winter wildlife density, and are considered high priority for purchase for protection and management.

1. Major spring-fed waterway. This remains open in winter, providing a wintering area for ducks numbering from several hundred to several thousand, and is, therefore, a high-priority purchase area.

2. Includes two ponds, one of which is partly open except in very cold weather. The combination of shrubs for cover, a weed patch for seed-eating small birds and mice, and open water makes this a major wildlife use area in winter. The presence of small birds and mice in turn attracts predators, such as hawks, owls, and foxes. This is a high-priority protection area.

3. Includes seepage-spring area, ditch, trees, shrubs, and other vegetative cover. Open water and cover together make this a wildlife use area. The presence of the spring and a major overland waterway entering the marsh also make it a high-priority purchase area.

4. Spring, shrubs, trees, and abandoned apple orchard. The orchard provides food for mammals, as evidenced by deer tracks. Its location close to the lowland woods make access to the orchard and spring easy for mammals. This is a high-priority purchase area for these reasons and because of the need to protect the spring as a water source.

OTHER WILDLIFE AND NATURAL VEGETATION AREAS. These are considered high priority for purchase, protection, and management, and are needed to protect the integrity of the whole marsh system. These areas contain natural vegetation as opposed to cropland, mowed, grazed, or other severely managed vegetation, and therefore support breeding wildlife and serve for the most part as reservoirs of native plant species. The open water is also included here. It receives heavy use as a feeding area by breeding wildlife and, especially, by migrating waterfowl.

5. Includes various types of marsh vegetation in lowland, oak-hickory forest on hill; high-priority purchase area.

6. Center of marsh, includes marsh vegetation in permanently standing water (except possibly during severe drought), areas of open water; high-priority purchase area.

7. High and low old field. This is former cropland, now useful for wildlife food and cover and as a buffer zone to protect the stream area. The northern half is a high-priority purchase area to provide undisturbed space for wildlife using the stream area, and to preserve water quality. The southern or upland half is also strongly recommended as part of the buffer zone. Possible future development should be very low density only, with strict erosion and runoff control.

8. Old field hillside. This long, narrow hill facing the marsh may be the most valuable portion of the upland area for wildlife use and observation. Its protection is essential also to maintaining water and vegetation quality in the lowland next to it (regions 2 and 9). The two triangles represent excellent wildlife and scenic observation locations. If managed to remain old field with scattered groups of shrubs and occasional trees, it will remain very useful, both for wildlife and for human recreation. This is a high-priority purchase area.

9. Lowland forest area, mostly black willow. Although disturbed, this is the only large lowland forest known to us in the Madison area. Its size, closeness to water, and remoteness from human activity make it valuable for wildlife. This is a high-priority purchase area.

BUFFER ZONES FOR FUTURE PLANNING, not now wildlife use areas. These are areas whose control or purchase is necessary to: (1) protect water quality in the marsh; (2) prevent intense human activity close to the wildlife areas; (3) protect scenic values; (4) make possible teaching and recreation areas; and (5) in one area, make possible rehabilitation of already existing marsh vegetation. The future use of these areas may vary from very low density development, such as placement of structures for homes or business, to open parklands. At all times, erosion and runoff control on hillsides should be a prime consideration.

10. Steep hillside close to and facing marsh. The portion of this in section 1, which is the steepest and closest to the marsh-wildlife area, has already been terraced for suburban development. It contains an excellent waterfowl observation point (triangle). This portion is a high-priority purchase area for public use and watershed protection. The portion in section 6 above the 900-foot contour is also recommended for purchase, but if developed, should be low density. There is a portion in section 6 which is below the 900-foot contour, now under cultivation, which should be purchased and added to the wildlife area.

14. Grazed sedge meadow. This is a high-priority purchase area for restoration. It is within the marsh basin, and extends across the northeastern and northern borders of the present wildlife use area (see vegetation map).

16. In addition to protecting sedge meadow south of this point, a buffer area is of high priority to protect this large spring. At present, use by cattle is causing serious erosion near the spring.

17. Steep hill, dry, with some prairie vegetation, possible recharge area for spring. The 16-17 area, lying in parts of sections 36 and 31, is shown as a buffer zone unit. This unit would make an excellent public use and teaching area. At a time when arboretums and public land recreation plans are popular, when city dwellers are casting about for outdoor recreation, and schools are emphasizing outdoor teaching, this area presents a rare opportunity. Upland, suitable for prairie restoration and teaching, hiking, and picnicking, is next to lowland and a spring, also suitable for hiking and teaching (see discussion of land use). Purchase of this area is strongly recommended for these purposes, as well as to enhance and protect the marsh. Meanwhile, negotiations to limit lowland grazing are strongly recommended.

21. Hillside buffer, separated from marsh by road. This area is recommended as an addition to the buffer zone by purchase, but if developed, should be very low density.

22. Partly residential, partly old-field. This is an area which need not be purchased, provided future use can be controlled. Its closeness to water and wildlife areas makes high-density development unsuitable.

WATER CONTROL AREAS. These are locations where deep or shallow basins may be necessary to collect future runoff if development increases it. It may turn out that no construction is necessary; however, purchase and maintenance of these as silt-collection areas is of high priority. They should be planted to dense grass whether shallow basins are constructed or not. In the event deep basins are later needed to collect rapid, heavy runoff and release it slowly, further construction plans can be pursued at these locations. However, control of runoff in development areas should make deep basins unnecessary.

13. Collection area for northeast and east. Note arrows indicating surface runoff patterns.

18. Collection area for north. A large flat basin exists north of region 19, now in use as cropland. The flow direction from this is not known, but it may drain naturally or artificially southward.

20. Two areas for collection from northwest and protection of stream. Note one area straddles the stream. It would be preferable to control the stream edges westward to its source, using native grasses or sedges near the stream, with erosion and runoff control on nearby slopes. A water collection area in the stream valley may be necessary, however.

LIMITED DEVELOPMENT AREAS. These are areas not explicitly needed as buffer zones, but which will have an influence on the marsh area. Low density development with control of erosion and runoff is the most intense suggested use. Open farmland would be preferable, with control of fertilizer runoff.

11. Hilltops (3 areas). The southeast, northwest, and southwest each have a hilltop area which could support low to moderate density development away from the marsh. Variable runoff problems exist; good planning is necessary.

12. Already developed. The northern half of this area is already causing runoff and scenic problems. The runoff affects a farmer's field (13), and will probably be piped into the sedge meadow (14), where it will continue to cause problems. Note the field in question is an area recommended as high priority for water collection. A slight backward slope will probably be necessary to avoid erosion within the collection area.

15. Slopes (3 areas). On the northeast and northwest are areas sloping directly toward the marsh where very low density to low density development is the most intensive use recommended. Water control should be strict.

19. Valley leading southward toward marsh. Low to moderate density development is the most intensive recommended, with strict water control to protect the stream feeding the marsh.

SIXMILE CREEK

Yahara River Valley Region
Priority Group II
Wetland Description

Sixmile Creek is one of the major stream systems supplying water to Lake Mendota. It drains low glaciated topography, including some wetland areas. Waunakee Marsh, discussed elsewhere in this report, is an especially important wetland in this system. Sixmile Creek itself is meandering, with wetland borders in many places. The landscape at the time of settlement was almost certainly open, with dry prairie on the uplands, wet prairie on the lowlands grading into sedge meadows along the creek edge. In some places there were probably shallow and deep marshes. Remnants of this native wetland vegetation are now scattered among larger regions of disturbance vegetation. Typical native streambank plants include glade mallow (*Napaea dioica*) and cup plant (*Silphium perfoliatum*). Much of the disturbance vegetation is reed canary grass (*Phalaris arundinacea*).

The upper portion of the creek, north of County Highway "M", still has areas of sedge meadow behind built-up stream banks. Much of this is grazed, but probably still functions as an important buffer zone protecting the stream and allowing a place for flood waters to spread out. South of Highway "M" the silt deposition is heavy. Bur reed (*Sparganium eurycarpum*), a silt indicator, is dominant here. In this region, there are disturbed remnants of sedge meadow, shallow marsh, and deep marsh. Near the mouth of the creek, along the edge of Lake Mendota, is sedge meadow with invading shrubs.

The condition of the creek itself reflects the load which has been placed on it by heavy agricultural and some urban land use in the area. The water is turbid with suspended silt, from the action of carp disturbing the bottom. Silt deposits are thick, up to two feet deep in places along the stream and several feet deep in the bay at its mouth. Stream banks are raw and unvegetated, cut by frequent floods. Debris of all kinds may be found in the stream, on the bottom, and on the banks, also attesting to the force of floods. Ditching upstream has increased the rate of runoff and erosion. The natural ability of the stream to hold and slowly release flood waters has been further decreased by land use along its banks. Heavy grazing has not only resulted in the loss of native vegetation, but in destabilization of the stream banks and fertilization of the water. Algal blooms and abundant attached algae indicate highly fertile water, from agriculture and from a cheese factory in Waunakee. The diversity of submerged aquatic plants is low. The areas sampled contained coontail (*Ceratophyllum demersum*) and water milfoil (*Myriophyllum* sp.) almost exclusively.

Although wildlife use of the creek system has undoubtedly declined, it is still important. Northern pike make an extensive run up the creek (Harold Meier, pers. comm.). Earl Loyster (pers. comm.) notes that they spawn in Waunakee Marsh. Waterfowl use is important during migration, especially at the confluence of Spring and Sixmile Creeks. Marsh birds are still present. The DNR lists fifteen species of fish for Sixmile Creek. Don Samuelsen has added 23 more by seining, making a total of 38. This list includes some important game species, e.g., northern pike, walleye, crappie, and largemouth bass.

Threats and Management

The Sixmile Creek area is in the path of suburban development. Unless careful planning is adhered to, this more intensive land use will result from a move that was intended to decrease the load on the Madison lakes and their associated watershed. The Waunakee area is now included in the Madison Metropolitan Sewerage System, which will decrease the nutrient load on Sixmile Creek and Lake Mendota. However, it could open this area up to increased development. The loss of this needed agricultural land would not result in the improvement of Sixmile Creek, because an increase in building and pavement coverage would increase overland runoff rates even further. Lawn fertilizers would be washed into the creek system, keeping it fertile. Population pressure would cause the loss of open space along the creek, with an attendant loss of wildlife use. Often under such circumstances, fill, pavement, buildings, and lawns extend right to the water's edge. Thus, Sixmile Creek, along with Spring Creek and the Upper Yahara River, urgently needs to be designated as a no-construction zone.

At the south end of Sixmile Creek, just north of its junction with Spring Creek, is a large region, perhaps as much as 80 acres, of shallow marsh and sedge meadow. Much of it is in a nearly undisturbed condition, so it still functions for flood control, for silt and nutrient control, as a wildlife area, and as open space. Most of it lies in a parcel of land which is at present offered for sale for development. There is no way intensive development can occur here without eliminating the above mentioned values and endangering the integrity of the creek system. Zoning is needed here, with a provision for graded density development. Filling of the marsh must be prevented.

Although Sixmile Creek is degraded, it is by no means beyond rehabilitation. Waterways and natural communities tend to repair themselves if the load is taken off of them. In this case, the enhancement of Sixmile Creek would bring a further benefit, a needed improvement in the water quality of Lake Mendota.

It is important to approach planning for an area under stress not by a delaying action, but by the establishment of positive goals. Our major recommendations are, therefore: (1) to control the human population density in the area, to protect both agricultural land and the watershed; and (2) to lessen the impact of agricultural activities on the watershed by instituting conservation practices. It is important to establish a buffer zone along the creek to slow runoff of water, soil, and fertilizer into it and to remove the impact of heavy stream bank grazing. The natural meanders must be protected, because they are crucial for slowing floods, especially since other land use practices at present tend to worsen flooding. Water should be held on the land as close as possible to where it fell as rain. Ditching should be stopped, and former wet areas restored. This means relinquishing some land to holding water after rainstorms rather than growing crops, but if the water is shunted quickly off the land, erosion of valuable soil increases and flood problems are merely compounded downstream. Water that runs off quickly is not available for seasonally restoring the water table. A further benefit of these protective programs should be the gradual re-establishment of natural diversity and improvement of wildlife use along the creek system.

PRELIMINARY LIST OF FISH SPECIES COLLECTED FROM SIXMILE CREEK

(Collections made by Don Samuelson and Barbara Bedford)

Amia calvai, Bowfin
Campostoma anomalum, Stoneroller
Catostomus commersoni (Lacepede), White sucker
Chrosomus erythrogaster (Rafinesque), Southern red-bellied dace
Cottus bairdii, Mottled sculpin
Cyprinus carpio L., Carp
Esox lucius L., Northern pike
Etheostoma exile (Girard), Iowa darter
Etheostoma flabellare, Fantail darter
Etheostoma nigrum (Raf.), Johnny darter
Eucalia inconstans (Kirtland), Brook stickleback
Fundulus diaphanus (Lesueur), Banded killifish
Ictalurus melas (Raf.), Black bullhead
Ictalurus natalis (Lesueur), Yellow bullhead
Ictalurus nebulosus (Lesueur), Brown bullhead
Labidesthes sicculus (Cope), Brook silverside
Lepisosteus osseus L., Long-nosed gar
Lepomis cyanellus (Raf.), Green sunfish
Lepomis gibbosus L., Pumpkinseed
Lepomis macrochirus (Raf.), Bluegill
Micropterus salmoides (Lacepede), Largemouth bass
Notemigonus crysoleucas (Mitchill), Golden shiner
Notropis atherinoides (Raf.), Emerald shiner
Notropis cornutus (Mitchill), Common shiner
Notropis hudsonius (Clinton), Spottail shiner
Noturus gyrinus (Mitchill), Tadpole madtom
Perca flavescens (Mitchill), Yellow perch
Percina caprodes (Raf.), Logperch
Percina maculata (Girard), Blackside darter
Pimephales notatus (Raf.), Bluntnose minnow
Pimephales promelas (Raf.), Fathead minnow
Pomoxis annularis (Raf.), White crappie
Pomoxis nigromaculatus (Lesueur), Black crappie
Rhynicthys atuatulus, Blacknose dace
Semotilus margarita, Pearl dace
Stizostedion vitreum vitreum (Mitchill), Walleye
Umbra limi (Kirtland), Central mudminnow

Spring Creek already shows the effects of the silt and nutrient loads from the farms in the watershed. Much of this may come from the tributaries at the west end of the creek, where there is little buffering wetland vegetation, and cultivated areas are close to the water courses. To protect the creek and Lake Mendota as well, it is important to establish buffer zones here. Grass strips and perhaps small holding ponds would be helpful. The present practice of hurrying the water off the farmlands creates floods and other problems downstream.

In the event that this region does become heavily developed, it would be extremely important to have Spring Creek preserved intact. Its functions would then be flood control, wildlife area, and open space.

WAUNAKEE MARSH

Yahara River Valley Region
Priority Group II
Wetland Description

Waunakee Marsh is the largest and most important remaining wetland in the Sixmile Creek watershed. Its 1,043 acres of shallow marsh and sedge meadow buffer the creek and Lake Mendota against the effects of a highly agricultural watershed which has undergone extensive wetland drainage.

A major source of water for the marsh appears to be ground water seepage from the many springs all around the edge and from upwellings within the marsh itself. However, a large amount of surface water runoff, high in silt and nutrients, enters the marsh from surrounding croplands and drained, cultivated wetlands to the north. Cattle, which graze almost the entire southern edge, add more nutrients to the water. Yet, observations indicate that the quality of water leaving Waunakee Marsh is clearly better than that entering the marsh overland. For a discussion of the effects of the marsh on water quality, see pages 27-29.

Waunakee Marsh also acts as an important flood control device. In a watershed so extensively ditched as that of Sixmile Creek, water runs off the land at a rate too fast for the stream valley to handle in times of heavy rainfall. Flooding and bank erosion result, as observations downstream will verify. Without the marsh to slow and spread out some of the water, conditions downstream would be even worse.

The vegetation of Waunakee Marsh presents an interesting picture. Dominant plants are those of the shallow cattail marsh and sedge meadow. Yet it is not uncommon, when walking through the marsh, to slip suddenly through the plant roots and peat into water more than chest deep. Technically then, the water depth is that of the deep marsh. The plants apparently are floating on great chunks of peat over the water. The origins of this situation are not known, but a number of explanations are possible. It is conceivable that in an extremely dry period oxidation and subsequent subsidence of the peat occurred to the extent that when re-flooded, the peat did not entirely re-wet and floated up to the surface. Alternatively, the floating peat may be a remnant bog mat from a colder time. However, long-time residents of the area say that at one time they could cross the marsh in "low boots" and claim that the water level has been slowly rising since the Wisconsin River was dammed at Prairie du Sac (1914). The prevalence of sedge meadow plants and air photos which show the meanderings of an old stream through the marsh certainly suggest that water levels were much lower in the past. Further research is needed to answer the question.

Its large size and the presence of springs enhance the wildlife value of Waunakee Marsh. The size of the marsh permits species diversity and enough territory for the larger avian predators. Six springs and numerous seeps provide a year-round supply of clean water and wintering areas for waterfowl.

Although the low ratio of open water to vegetative cover precludes large numbers of nesting marsh birds and waterfowl, mallards and blue-winged teal breed here in moderate numbers. The more numerous species are those of the sedge meadow, shrub areas, and wetland edge: American bitterns, woodcock, short-billed marsh wrens, bobolinks, willow flycatchers, sora rails, and Virginia rails. Harriers, birds not often seen in Dane County, also nest here. Great horned owls and red-tailed hawks feed in the marsh and nest in adjacent woods. Sandhill cranes were observed in the area in August of 1972 and October of 1973.

Game species and fur-bearing animals which use Waunakee Marsh include deer, pheasant, muskrat, mink, and fox. Northern pike use the marsh as a spawning ground.

The Department of Natural Resources owns and manages 296.8 acres of Waunakee Marsh for fish and game.

Threats and Management

Poor land-use practices in the watershed and the draining of large areas of wetland north of Waunakee Marsh have overtaxed its filtering functions and portend further deterioration. An immediate management goal should be the development and implementation of an erosion control program to maintain soil and nutrients on the upland. Ideally, such a program would involve maximum use of conservation tillage practices: no tillage, minimum tillage, or mulch tillage. However, the following standard conservation practices are also effective in minimizing soil loss, especially when used in combination: (a) contour plowing; (b) planting cover crops in winter; (c) planting forage crops on slopes; (d) terracing; (e) contour strip crops, (f) crop rotations; (g) grassed waterways; (h) buffer strips of native vegetation around waterways; (i) streambank fencing; and (j) gravelled cattle crossings on streams.

In lieu of good upland management, the construction of settling basins may be necessary in crucial areas. Appropriate locations for water-control areas are suggested on the map (areas 15-19). These should be given high priority for acquisition.

Flooding has been mentioned as a management technique to open up more areas for waterfowl nesting. It is our concern that were flooding attempted, all that would result would be a further floating up of the peat. It would be advisable to experiment with raising water levels to restore deep-water marshes in smaller or lower priority areas before working with a wetland as large and valuable as Waunakee Marsh.

Addendum

In 1974, the wetland complex north and upstream of Waunakee Marsh was drained in such a way as to partially bypass the marsh. This is expected to result in an increased nutrient load on Lake Mendota (Gjestson, pers. comm.).

WAUNAKEE MARSH

MAP KEY

Shallow marsh, most of which seems to be floating (see discussion). Cattail is dominant. Also present are sawgrass sedge (Carex lacustris), Carex aquatilis, soft-stem bulrush (Scirpus validus), tussock sedge, tufted loosestrife (Lysimachia thyrsiflora), marsh dock (Rumex orbiculatus), and others. Variations are due primarily to greater or lesser presence of cattail. Occasional sedge or sedge-forb areas have no cattail. There is a strip of sedge meadow around the edges which is too narrow to indicate.

Area of heavy siltation. This shallow marsh has plant species characteristic of silt flow, especially bur reed and jewelweed. There is some cattail and arrowhead, with many muskrat houses.

Mixed wetland vegetation, mostly tussock sedge with sparse to medium cattail density, and scattered forbs.

Sedge meadow, mostly tussock sedge with sawgrass sedge, bluejoint grass, and sedge meadow forbs such as marsh milkweed (Asclepias incarnata), marsh thistle (Cirsium muticum), and marsh lousewort (Pedicularis lanceolata).

Grazed lowland, some native sedges but mostly European grasses on wet muck.

Marsh edge disturbance species. Basically this is a sedge meadow with invading European grasses, briar bushes (Rubus spp.), and tall forbs such as nettle, greater ragweed (Ambrosia trifida), saw-toothed sunflower (Helianthus grosseserratus), blue vervain (Verbena hastata), bull thistle (Cirsium vulgare), and Canada thistle (Cirsium arvense).

Shrubs, mostly willows (Salix discolor, S. bebbii, S. petiolaris, S. interior, S. nigra) and red-osier dogwood (Cornus stolonifera). Some meadowsweet (Spiraea alba), gray dogwood, and bog birch (Betula sp. [sandbergii?]).

Very disturbed or once cultivated sedge meadow. Reed canary grass is dominant, with marsh nettle, giant ragweed, saw-toothed sunflower, and scattered remnant wetland plants.

Old field.

Grazed old field.

Open woods. Note grazed areas.

Wooded areas. The young upland woods contain mainly white, black, and bur oaks (Quercus alba, Q. velutina, Q. macrocarpa), black cherry (Prunus serotina), and shagbark hickory (Carya ovata).

Spring.

General pattern of water flow within the marsh.

Drainage ditch or channeled stream.

All other land is under cultivation.

WAUNAKEE MARSH

MAP EXPLANATION

1) Row of black willow (Salix nigra) and quaking aspen, (Populus tremuloides) along an old drainage ditch.

2) Grazed sedge meadow and spring area. This is an entry point for farm runoff from the west and itself a nutrient source (in the form of animal wastes) for the marsh. The small area to the east shows disturbance due to increased silt load.

3) Small open water area surrounded by shrubs with sandbar willow (Salix interior), tussock sedge (Carex stricta), bluejoint grass (Calamagrostis canadensis), reed canary grass (Phalaris arundinacea), bur reed (Sparganium eurycarpum), and box elder (Acer negundo).

4) Large spring area, wintering area for waterfowl. The spring contains an unidentified lavender bacterium or alga. The area has received silt from the upland. Twelve carp were observed in the area on July 8, 1973.

5) Sedge meadow, grazed occasionally in dry years, but in good condition with scattered fen plants. Tussock sedge is dominant. Other species include the sedges Carex sartwellii, C. prairea, C. aquatilis, C. sterilis, and C. tetanica, as well as bog goldenrod (Solidago uliginosa), sage willow (Salix candida), cottongrass (Eriophorum angustifolium), marsh lousewort (Pedicularis canadensis), turtlehead (Chelone glabra), and four-flowered loosestrife (Lysimachia quadriflora).

6) Sedge meadow and shrub island.

7) A small area of clone-forming Carex aquatilis and a floating mat of Carex lacustris with scattered Carex lasiocarpa, the wiregrass sedge. This second area bounces just like a bog mat.

8) Small wooded island. The soil is oxidized peat and is never more than two feet above water level. The trees are mostly quaking aspen, some young oaks (Quercus spp.), box elder, with open forest shrubs such as gray dogwood (Cornus racemosa), red raspberry (Rubus idaeus), and American hazelnut (Corylus americana). A small bluejoint grass meadow is on the north side. Some low prairie plants, such as prairie dock (Silphium terebinthinaceum), are around the edge of the island.

9) This area disturbed near the road edge. There are patches of giant reed grass (Phragmites communis), and also some nettles (Urtica dioica), reed canary grass, bur reed, and tall composites. The water is about four inches deep.

10) Sedge and bluejoint meadow. Very tall tussocks (to two feet) of Carex stricta are largely taken over by bluejoint grass.

11) Sedge meadow along creek, which was grazed until 15 years ago, according to the landowner. Bluejoint grass and composites, especially Joe-Pye-weed (Eupatorium maculatum), are dominant.

12) Cattail sedge meadow, water to four inches deep. The meadow has received silt from adjacent cornfields. There is a higher presence of bur reed, bur marigold (Bidens cernua), and jewelweed (Impatiens biflora) than in other similar areas.

13) This once-cultivated sedge meadow is not so dominated by reed canary grass as is the large area north of the road. Rather, it is coming into a mixture of European grasses, weeds, and native wetland plants.

Sources of Overland Runoff and Proposed Water-Control Areas

14) Confluence of two large drainage ditch networks draining former wetlands to the north and northwest and emptying into Waunakee Marsh. A delta of siltation on the map indicates the area of most severe disturbance, where the silt deposit is several feet deep. A water control area here is recommended.

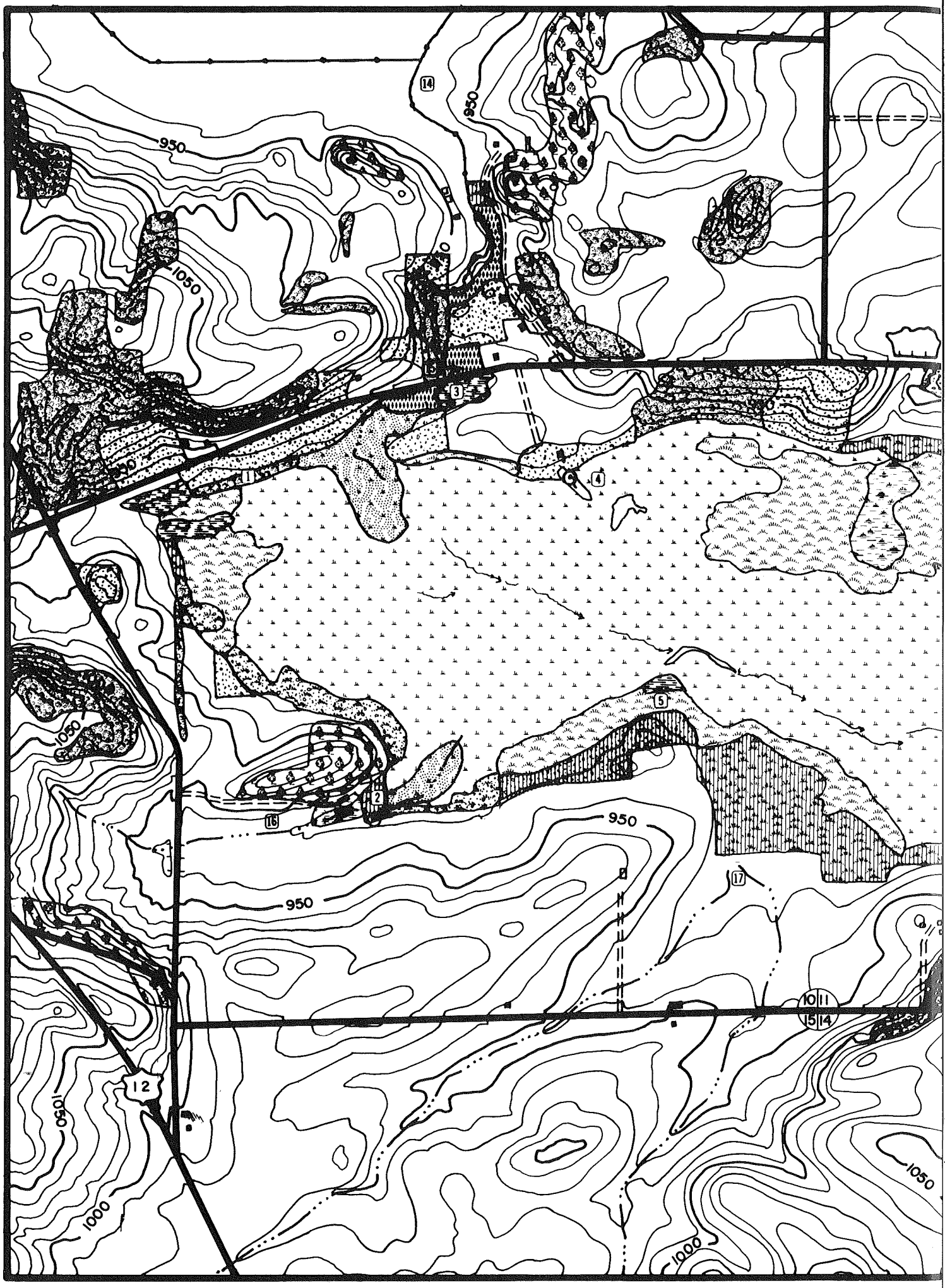
15) Old field, possible last resort for a ponding and silt-catching area.

16) Proposed water-control area. This drainageway, often too wet to cultivate, could serve to trap silt and nutrients from farmland to the west.

17) An intermittent stream feeding through cornfields into a grazed sedge meadow and then into the marsh. A water control area is recommended here.

18) Ditch carrying silty green-brown water into marsh. Cattle graze in the stream north of the road. An old field and disturbed sedge meadow area is on a slight ridge extending out into the marsh. This could serve as a water-control area.

19) Large area of ditched sedge meadow. Reed canary grass is dominant with scattered native wetland vegetation in wetter areas. The creek here still follows its natural meanders and its bank edges are still gradual. A suggested method of water control for this area might be to eliminate the ditches, thus forcing the water to spread out through the vegetation in order to filter out some of its nutrient and silt load.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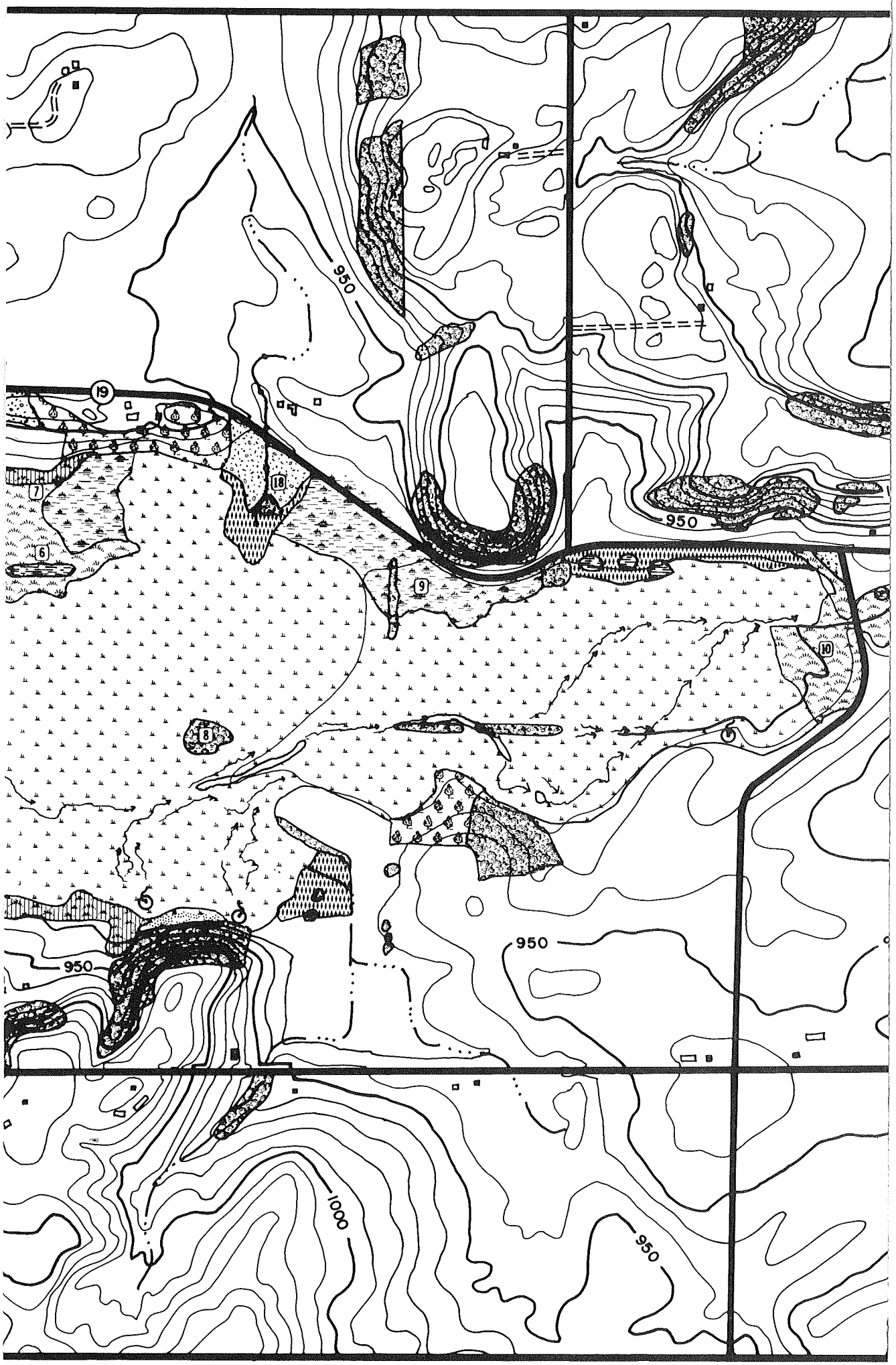
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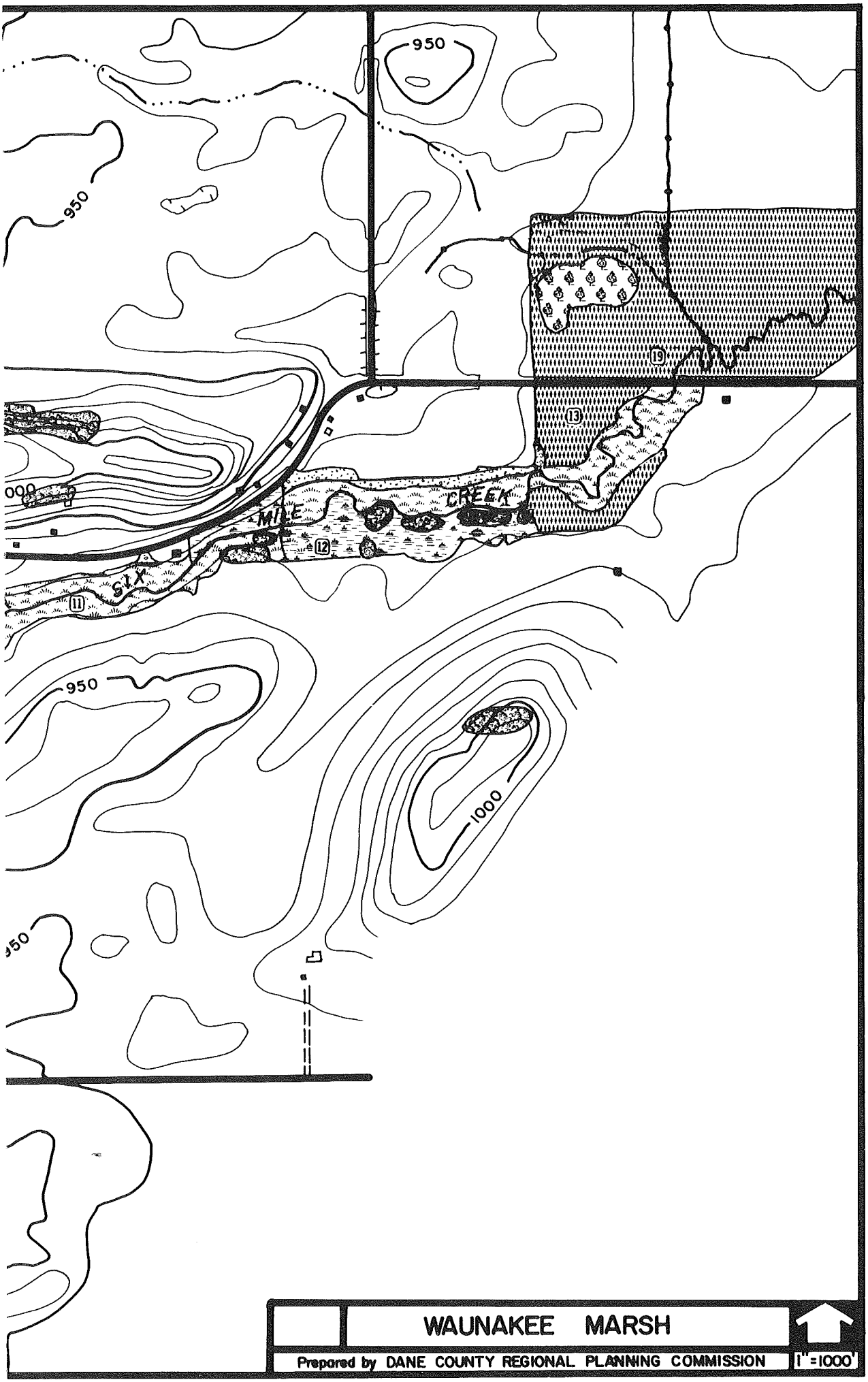
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SIX MILE CREEK
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WAUNAKEE MARSH
Prepared by DANE COUNTY REGIONAL PLANNING COMMISSION
1"=1000'

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